APPENDIX A

VOLUME 2

ENGINEERING TECHNICAL APPENDIX

NEW JERSEY COAST FROM
BARNEGAT INLET TO LITTLE EGG INLET

LONG BEACH ISLAND, NEW JERSEY

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX A

VOLUME 2

ENGINEERING TECHNICAL APPENDIX

NEW JERSEY COAST FROM BARNEGAT INLET TO LITTLE EGG INLET LONG BEACH ISLAND, NEW JERSEY

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX A

VOLUME 2 ENGINEERING TECHNICAL APPENDIX TABLE OF CONTENTS

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 1

GENERAL

This Engineering Technical Appendix was prepared in accordance with ER 1110-2-1150, Engineering and Design for Civil Works Projects. Information in this appendix supplements data in the Feasibility Study to satisfy criteria in ER 1110-2-1150.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 2

HYDRAULICS AND HYDROLOGY/ COASTAL PROCESSES

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 2
APPENDIX
HYDRAULIC & HYDROLOGY/COASTAL PROCESSES
BARNEGAT INLET TO LITTLE EGG INLET FEASIBILITY STUDY

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (cont'd)

EXISTING CONDITIONS

Basic Physical Characteristics. The basic physical characteristics of Long Beach Island are similar to those of many developed barrier islands found along the mid- and southern segments of the Atlantic Seaboard. The island's beach strand is comprised of quartz sand with median grain diameter of roughly 0.35 mm. The intratidal and swash zone, i.e., the foreshore, has a slope of about 1V to 11H and meets the beach berm at an elevation which varies from 7 to 8.5 feet above North American Vertical Datum (NAVD). The astronomical tide range at Long Beach Island is approximately 4.26 feet and mean sea level is about 0.7 feet below NAVD. The widths of the beach berm along the length of the island are highly variable over time, due to the presence of groins which compartment the beach along the entire developed ocean frontage. Accordingly, the berm' widths alternate from relatively broad to narrow at the ends of the groin compartments as dictated by alternating short-term changes in the directions of littoral transport.

The average beach berm widths along Long Beach Island are about 115 feet (as measured from the dune centerline) but may vary from as narrow as 50 feet to as broad as 200 feet or more. It is also of interest to note that a typical berm feature does not always exist. That is, on occasion, beach profile surveys reveal a continuous, upwardly sloping surface from the water line to the toe of the frontal dune situated at elevation 7 to 8.5 feet above NAVD. An exception to the island's relatively narrow beach berm is found along the northern-most 1 mile of shore located immediately south of the original Barnegat Inlet south jetty. In that area, the berm is relatively broad, having a width of about 200 feet but expanding to as much as 800 feet in the vicinity of the original jetty structure.

The island's oceanside development is fronted by a single dune line which has base widths of 150 to 500 feet, and peak elevations that generally vary from 16 to 21 feet above NAVD. An exception to these basic dune characteristics is found along the area extending about 1/2 mile south of the original Barnegat Inlet south jetty. Along that particular area, a broad series of dunes and hummocks reach elevations as high as 25 to 30 feet above NAVD. Also, there are a few very limited reaches of shore, particularly in the southern end of the developed area, where there is little or no frontal dune. Along the frontal dune, vegetative cover ranges from dense to very sparse and use of sand fences is a common practice, employed by the local authorities, to enhance dune development and to fix the position of the dune line against wind-induced migration. Pedestrian access to the beach strand, over the dune line, is generally provided at street ends. Landward of the frontal dune, the densely developed land area is flat and generally has elevations in the range of 4 to 6 feet above NAVD.

Winds, Waves, Tides, and Storm Surges. Given its north-northeast alignment, Long Beach Island has a direct exposure to normal oceanic conditions as well as storm tides and waves which are generated over a broad sector of Atlantic Ocean from north-northeast to south-southwest. These natural agents and the primary generating force of wind, to which the study area is exposed, are discussed in the following subsections of this report. The resulting effects of these natural agents on the study area's beach and dune system, in large measure, dictate the degree of damage-potential which exists in the study area, and the type and extent of additional shore protection necessary to effectively reduce the existing damage-potential to economically efficient levels of risk.

Winds. Data on prevailing winds over the ocean areas between New York Harbor Entrance and the Entrance to Delaware Bay, as published by the U.S. Navy Hydrographic Office, have been evaluated for the 10-year period 1932-1942, see USACE/Philadelphia, 1974 [Ref. 2]. These data show that, in the 5-degree quadrangle nearest the New Jersey coast, the winds over the offshore areas are distributed with respect to duration as follows: **onshore** (northeast, east and southeast winds), 27 percent; **upshore** (south winds), 11 percent; **offshore** (southwest, west and northwest winds), 44 percent; **downshore** (north winds), 15 percent; and **calms**, 3 percent. Analysis of onshore winds recorded during the period 1923-1952 at Atlantic City, New Jersey, only 12 miles from the south end of Long Beach Island, shows that the prevailing winds are from the south and of moderate velocity of from 14 to 28 miles per hour, USACE/Philadelphia, 1990 [Ref. 1]. Winds from the northeast have the greatest average velocity of about 20 miles per hour. The wind data for this period also show that winds in excess of 28 miles per hour occur from the northeast more than twice as frequently as from any other direction.

The maximum five-minute average wind velocity at Atlantic City was recorded during the hurricane of September 1944, with a value of 82 miles per hour from the north. Over the period 1960-1984, the fastest wind speed of 63 miles per hour was measured at the Atlantic City Marina during the passage of Hurricane Doria in August 1971. These statistics indicate that the most extreme winds occur with the relatively infrequent passage of hurricanes near the study area. However, of equal and perhaps more significance as regards effects on the shores of Long Beach Island, are the high winds associated with common, yearly occurrences of extratropical cyclones, i.e., northeasters.

An analysis was conducted to determine the frequency of storm winds in the general study area based on Atlantic City records for the period 1936-1958, USACE/Philadelphia, 1974 [Ref. 2]. The basic index used in that analysis was “storm-hours,” defined as a one-hour period in which wind velocities equaled or exceeded 32 miles per hour and which occurred during a 24-hour period when the average wind velocity was 25 miles per hour or higher. The analysis found that the number of storm-hours during each year varied from 101 to 293 with an average of approximately 175, and that the preponderance of these storm winds were blowing in the onshore directions from the north-east to south sector of the ocean. These results suggest that the study area could experience roughly 4 to 12 full days of storm activity during any year, an inference which is supported by the record of storm occurrences affecting Long Beach Island in the 12-year period 1962-1973, USACE/Coastal Engineering Research Center (CERC), 1980 [Ref. 3]. In that period, 77 storm events, some of which had durations greater than 24 hours, affected Long Beach Island. Therefore, in terms of the number of storm events from 1962 through 1973, the average annual storm exposure at Long Beach Island was 6 to 7 storms, with the average duration in excess of 24 hours.

An analysis of the recent Wave Information Studies Hindcast "Hindcast Wave Information for the U. S. Atlantic Coast: Update 1976 - 1993 with Hurricanes" (Wave Information Study (WIS) Report 33) prepared by Brooks et al., 1995 [Ref. 33] was performed to obtain insight into average wind conditions. WIS Station 70 centered off of Barnegat Inlet was selected for the Study area. **Tables 2-1 and 2-2** provide information on monthly distribution of wind magnitude and direction. The maximum wind speed over the time period analyzed was approximately 32 m/sec (72 mph) on 13 March 1993 from a direction of 95 degrees with respect to true north. The tables indicate the predominant wind direction is from 270 degrees or blowing offshore; however, there is no way to directly infer from these tables which direction bands contain the larger wind magnitudes.

Waves. The earliest recorded wave statistics for the region are based on limited visual observations made at Barnegat Light between July and October in 1939, USACE/Philadelphia, 1974 [Ref. 2]. The results of those observations gave an average nearshore significant wave height of 2.7 feet and a maximum wave height of 13 feet, with 12 percent of the observed waves having significant heights greater than 5 feet. Significant wave heights are defined as the average height of the highest one-third of the waves observed for a specified time period. Wave periods, during the 1939 observation, ranged from 6 to 11 seconds.

Results of the first detailed studies of wave characteristics in waters off the New Jersey coast were reported in 1958, and were based on computational (hindcasting) procedures utilizing synoptic weather information, USACE/BEB, 1958 [Ref. 4]. The results of those studies gave an average significant wave height of about 2 feet, and expected annual storm wave heights of 11 to 12 feet. Average wave periods were computed at approximately 8 seconds. The highest waves were found to approach the coast most frequently from the east-northeast. The 1958 report also provided information on swells based on the analysis of shipboard observations documented by the U.S. Navy Hydrographic Office. These data showed that swells of 6 to 12 feet in height approach the coastline from the east, while swells over 12 feet in height come predominantly from the easterly and southerly quadrants of the sea.

General wave statistics for the study area shoreline are presented in a report entitled "Hindcast Wave Information for the U. S. Atlantic Coast" (Wave Information Study (WIS) Report 30) prepared by Hubertz, et al., 1993. The revised WIS data is also available digitally through the Coastal Engineering Data Retrieval System developed by the U.S. Army Engineer Coastal Engineering Research Center. WIS Report 30 and information in CEDRS provides revised wave data for 108 locations along the U. S. Atlantic coast, and supersedes WIS Report 2 (Corson, et al. 1981), WIS Report 6 (Corson, et al. 1982) and WIS Report 9 (Jensen 1983). The wave information for each location is derived from wind fields developed in a previous hindcast covering the period 1956 through 1975, exclusive of hurricanes, and the present version of the WIS wave model, WISWAVE 2.0 (Hubertz 1992). Wave heights are universally higher for the revised hindcast than for the original hindcast since the values more closely correspond to maximum measured (buoy) values. A separate report (WIS Report 19) documents hindcast wave information for Atlantic Coast hurricanes during the 1976-1995 time period.

The most recent analysis of general wave statistics for the study area shoreline covers the time period of 1976 - 1993 and is presented in WIS Report 33. To better represent a realistic wave climate, tropical storms and hurricanes were included in the 1976-1993 hindcast. The update hindcast was performed using an updated version of WISWAVE 2.0, referred to as WISWAVE. Extratropical and tropical events were analyzed separately, but combined to form complete

Table 2-1. WIS Station 70 Occurrences of Wind Speed by Month for all Years (1976-1993)										
Wind Speed (m/sec)	**0.00-2.49**	**2.50-4.99**	**5.00-7.49**	**7.50-9.99**	**10.00-12.49**	**12.50-14.99**	**15.00-17.49**	**17.50-19.99**	**> 20.00**	**TOTAL**
JAN	122	905	851	1101	566	541	204	143	31	**4464**
FEB	78	877	792	1124	501	425	123	98	54	**4072**
MAR	123	1012	891	1211	547	396	149	104	31	**4464**
APR	223	1287	903	1093	435	299	63	17	.	**4320**
MAY	433	1714	1125	864	215	103	10	.	.	**4464**
JUN	494	1952	1084	657	98	31	4	.	.	**4320**
JUL	671	2341	951	435	59	7	.	.	.	**4464**
AUG	837	2276	887	385	53	17	3	5	1	**4464**
SEP	578	1904	934	693	148	55	3	1	4	**4320**
OCT	382	1435	982	1067	348	194	34	16	6	**4464**
NOV	170	1067	898	1132	537	384	74	46	12	**4320**
DEC	100	993	863	1188	586	464	138	87	45	**4464**
TOTAL	**4211**	**17763**	**11161**	**10950**	**4093**	**2916**	**805**	**517**	**184**	**52600**

Table 2-2. WIS Station 70 Occurrences of Wind Direction by Month for all Years (1976-1993)									
Direction Band	**337.50 - 22.49**	**22.50 - 67.49**	**67.50 - 112.49**	**112.50 - 157.49**	**157.50 - 202.49**	**202.50 - 247.49**	**247.50 - 292.49**	**292.50 - 337.49**	**TOTAL**
Center of Band	**(0.0)**	**(45.0)**	**(90.0)**	**(135.0)**	**(180.0)**	**(225.0)**	**(270.0)**	**(315.0)**	
JAN	541	340	285	213	383	526	820	1356	**4464**
FEB	602	397	283	255	323	544	556	1112	**4072**
MAR	716	392	346	331	556	597	543	983	**4464**
APR	532	351	306	504	561	590	591	885	**4320**
MAY	481	416	387	401	728	810	621	620	**4464**
JUN	427	288	211	289	724	1054	706	621	**4320**
JUL	435	254	252	354	581	1155	775	658	**4464**
AUG	501	445	386	310	607	1014	634	567	**4464**
SEP	587	597	463	375	468	737	560	533	**4320**
OCT	513	635	337	348	519	650	635	827	**4464**
NOV	497	363	356	296	459	652	731	966	**4320**
DEC	544	244	255	221	403	708	823	1266	**4464**
TOTAL	**6376**	**4722**	**3867**	**3897**	**6312**	**9037**	**7995**	**10394**	**52600**

time series and annual statistics. The hindcast has recently been updated to extend through 1995; however, the methods and resulting statistics have not been documented to date.

Hindcast results are available as time series every 3-hr for the 20-yr period or as tabular summaries. WIS Reports 30 and 33 contains tables presenting the distribution of spectral wave height, peak period and peak mean direction by month for the 20-yr period; the number of occurrences by 0.5-m height and 1-sec period categories for eight different direction bands and a final table for all directions and finally summary tables of mean and maximum wave heights by month for each of the 20 years hindcast. These tables also include the peak period and peak mean wave direction associated with the maximum wave height occurrence.

The WIS output results are a verified source of information for wind and wave climate along the U.S. Atlantic Coast and have been used to gain a basic understanding of the wind and wave climate at Long Beach Island. The wave statistics pertinent to the Long Beach Island study are those derived for Station 70. The location of Station 70 is Latitude 39.75 N, Longitude 74.00 W, in a water depth of approximately 59 ft (**Figure 2-1**). Monthly mean wave heights at Station 70 for the entire 1956-1975 hindcast range from 2.3 ft in July to 4.3 ft in January. Mean wave heights for the 1976-1995 hindcast are slightly larger, ranging from 2.3 ft in July to 5.2 ft in March. The maximum wave height (H_{mo}) at Station 70 for the 1956 - 1975 hindcast is reported as 23.0 ft, with an associated peak period of 15 seconds and a peak direction of 94 deg on 7 March 1962. Maximum wave conditions for the 1976-1993 hindcast are reported as 27.6 ft, with an associated peak period of 13 seconds and a peak direction of 115 degrees on 27 September 1985. Summary Statistics for WIS Station 70 are provided in **Table 2-3** for the years 1976-1995.

The actual wave spectrum experienced at any particular time along the project shoreline may show considerable local variation. This variability is largely due to the interaction of incident waves with: tidal currents at Barnegat and Little Egg Inlets, ebb shoal morphology at the two inlets, local shoreline alignment, nearshore bathymetry, and presence of shoreline stabilization structures. Therefore, the hindcast wave statistics should be viewed as a very general representation of the wave climate of the study area offshore. Inshore of the 60 ft depth, the effects enumerated above will modify the incident waves such that significant alongshore differences may exist with respect to breaking wave height and angle relative to the shoreline. Computer programs which transform offshore waves over varying bathymetry must be used to further investigate wave conditions closer to the shoreline.

Prototype wave data has been collected at Barnegat Inlet as part of the Monitoring of Completed Coastal Projects Program. Wave data collection at Barnegat Inlet was initiated May 1994. A directional wave gage (DWG) was deployed approximately 4000 ft off the south jetty tip, located in 43 ft of water seaward of the ebb shoal **(Figure 2-1)** for one year. Preliminary analysis of the first years worth of data (May 1994 - March 1995) resulted in an average wave height (Hs_{avg}) of 2.5 ft, an average peak period of 8.9 seconds, and an average mean direction of 128 degrees. Maximum wave conditions were measured on 23 September 1994. The maximum significant wave height of 12.6 ft had a corresponding peak period of 8.5 seconds and mean direction of 104 degrees. Another event (24 December 1994) had a slightly smaller wave height of 11.4 ft with a significantly longer peak period of 14.2 seconds. A nearshore wave gage,

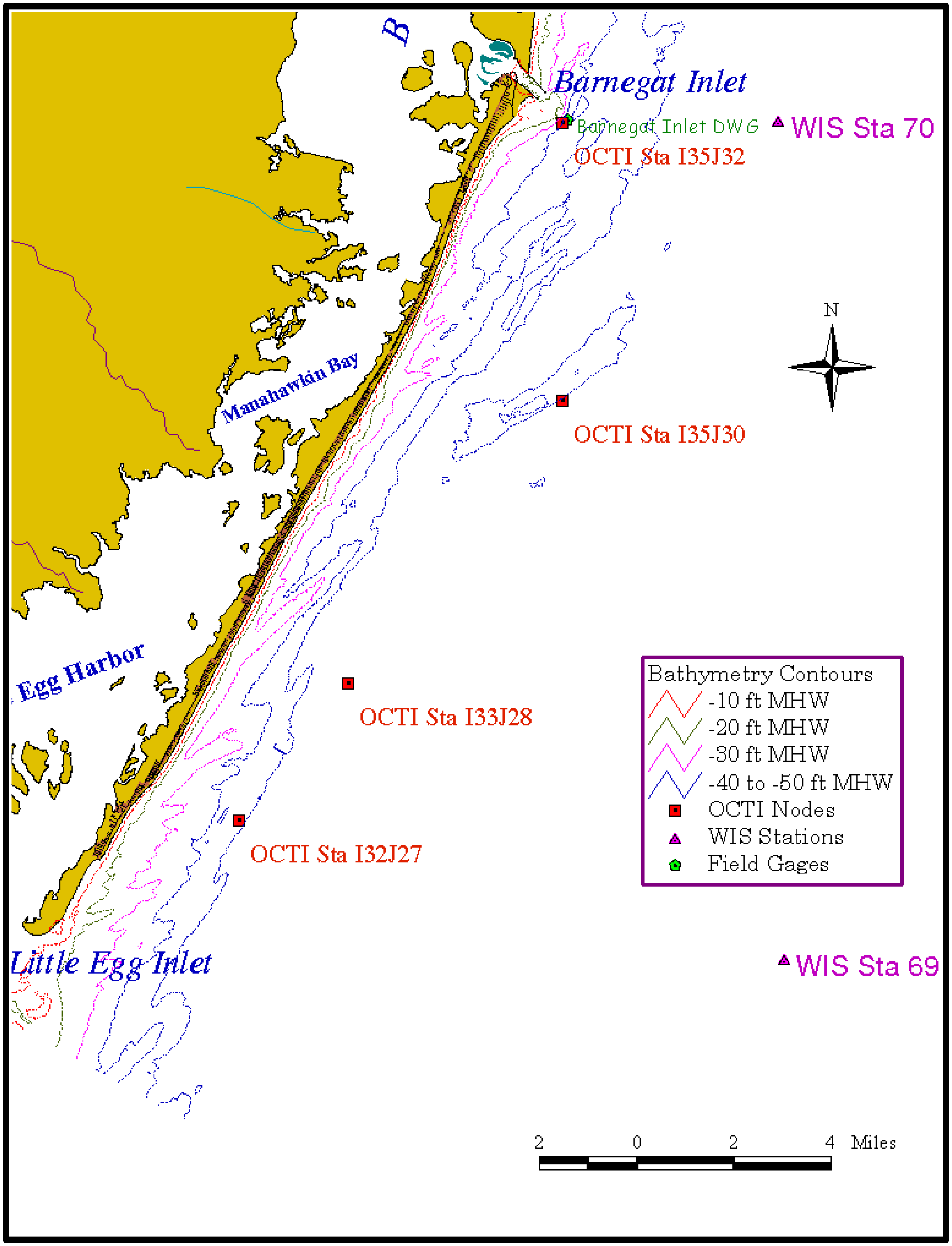


Figure 2-1. LBI Wave Hindcast Station and Field Wave Gage Locations.

MEAN WAVE HEIGHT (IN FEET) BY MONTH AND YEAR STATION A2070 (39.75N/74.00W/59 ft)													
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**MEAN**
1976	5.2	5.2	5.2	4.3	4.3	3.3	2.3	3.9	3.0	5.2	4.3	4.3	**4.3**
1977	4.9	4.3	4.9	4.3	2.6	3.0	2.3	2.3	3.0	4.9	6.2	5.6	**3.9**
1978	6.6	4.3	5.2	4.9	4.9	3.3	2.6	2.3	3.9	3.9	4.6	4.3	**4.3**
1979	6.6	6.2	6.2	4.9	4.3	2.6	2.3	2.6	4.9	3.3	4.6	5.6	**4.6**
1980	6.2	4.6	6.9	5.6	3.0	2.6	2.6	3.6	3.6	4.6	4.9	5.9	**4.6**
1981	4.6	7.9	5.2	5.2	5.2	2.6	3.3	2.6	4.9	4.3	5.2	4.3	**4.6**
1982	4.9	4.6	3.6	4.3	3.3	3.6	1.6	2.0	3.3	4.6	4.3	3.6	**3.6**
1983	4.9	5.6	5.9	4.6	3.9	2.6	2.3	2.0	3.3	5.2	4.6	6.2	**4.3**
1984	4.9	5.6	6.9	4.6	3.9	3.0	2.6	2.0	3.0	4.3	4.9	4.3	**4.3**
1985	4.6	5.2	4.6	4.3	3.6	2.6	2.3	2.3	3.6	3.0	5.9	3.9	**3.9**
1986	5.6	4.6	5.2	5.2	3.9	3.3	2.0	2.6	3.9	3.6	4.3	5.6	**4.3**
1987	5.2	4.6	5.6	6.2	3.6	2.6	2.0	2.6	3.0	3.9	4.6	3.6	**3.9**
1988	3.9	4.6	3.9	4.3	3.6	3.0	2.6	2.6	3.3	3.9	3.9	3.6	**3.6**
1989	3.9	4.3	5.6	3.9	4.3	2.6	2.3	3.6	6.9	3.9	4.9	4.3	**4.3**
1990	3.9	4.6	4.3	4.6	3.9	3.6	3.0	3.6	4.3	4.6	3.6	4.9	**3.9**
1991	4.3	3.6	4.9	3.9	2.6	2.6	2.6	3.0	3.9	4.3	4.3	4.3	**3.6**
1992	4.9	4.3	4.9	3.0	3.6	2.3	2.0	2.3	3.3	3.0	3.3	5.2	**3.6**
1993	4.9	5.2	5.2	5.9	3.3	2.6	2.3	2.6	3.3	3.9	4.9	4.9	**3.9**
1994	3.9	3.3	3.9	3.0	3.0	2.6	2.3	2.3	2.6	2.0	4.3	3.9	**3.0**
1995	4.3	3.0	3.0	2.6	2.6	3.0	2.0	3.9	3.9	3.6	4.3	3.6	**3.3**
MEAN	**4.9**	**4.9**	**5.2**	**4.6**	**3.6**	**3.0**	**2.3**	**2.6**	**3.6**	**3.9**	**4.6**	**4.6**	

LARGEST WAVE HEIGHT (IN FEET) BY MONTH AND YEAR STATION A2070 (39.75N/74.00W/59 ft)												
YEAR	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**
1976	12.1	13.8	13.1	10.5	10.5	7.2	4.9	18.7	7.9	12.1	9.5	9.5
1977	14.1	15.1	14.1	13.1	6.6	11.5	7.2	6.2	9.2	11.8	16.7	17.7
1978	19.0	14.4	14.8	17.1	13.8	9.8	8.9	6.9	8.9	10.5	12.8	11.5
1979	20.0	21.3	18.4	14.1	8.5	6.6	5.9	8.2	12.1	8.9	13.8	12.1
1980	21.3	16.1	19.7	13.8	9.2	6.2	5.2	12.1	8.2	22.6	11.8	17.1
1981	10.2	21.7	15.4	12.8	11.2	7.2	8.9	6.9	12.5	8.2	18.0	12.1
1982	14.1	15.7	9.8	12.5	6.9	8.9	4.3	6.6	9.5	19.7	12.1	9.8
1983	15.7	20.3	18.4	11.8	10.5	6.6	5.6	6.9	9.5	16.1	11.8	19.4
1984	14.1	14.4	19.4	15.7	9.2	8.2	6.9	5.9	7.5	21.0	10.2	9.2
1985	10.2	19.0	12.8	16.1	9.8	7.5	7.5	5.9	27.6	9.8	20.0	11.5
1986	12.1	14.8	16.1	15.7	11.8	9.5	4.6	12.5	9.5	9.5	11.2	24.6
1987	17.1	15.1	17.7	14.8	9.2	6.2	3.9	5.2	7.9	7.9	12.8	12.8
1988	9.2	14.4	8.5	10.8	8.9	8.2	8.2	6.9	8.9	10.2	10.8	8.9
1989	10.8	18.7	15.1	10.8	12.8	5.6	6.9	11.5	25.3	13.1	11.2	9.8
1990	9.5	11.5	13.1	9.8	11.2	8.9	6.9	10.8	9.2	13.8	7.5	11.8
1991	13.1	6.9	10.2	11.5	7.2	8.5	6.9	22.3	22.3	11.8	11.2	9.2
1992	19.0	8.5	11.2	7.9	7.5	6.6	4.9	5.9	11.5	8.9	9.5	18.4
1993	14.1	15.1	16.7	11.8	6.6	5.6	5.6	8.5	14.4	14.8	19.0	13.8
1994	12.1	9.5	17.4	6.6	11.2	8.9	5.9	5.6	10.2	7.9	13.8	15.4
1995	12.5	7.5	9.5	8.9	7.2	7.2	3.9	12.8	10.2	12.8	18.7	10.5

MEAN SPECTRAL WAVE HEIGHT (FEET)	3.9
MEAN PEAK WAVE PERIOD (SECONDS)	7.7
MOST FREQUENT 22.5 DEGREE (CENTER) DIRECTION BAND (DEGREES)	90.0
STANDARD DEVIATION OF WAVE Hmo (FEET)	2.6
STANDARD DEVIATION OF WAVE TP (SECONDS)	3.0
LARGEST WAVE Hmo (FEET)	27.6
WAVE TP ASSOCIATED WITH LARGEST WAVE Hmo (SECONDS)	13.0
PEAK DIRECTION ASSOCIATED WITH LARGEST WAVE HS (DEGREES)	115.0
DATE LARGEST Hmo OCCURRED	9/27/85 18:00

Table 2-3. WIS Station 70 Summary Wave Statistics (1976-1995).

located in approximately 17 ft of water 200 ft off of the south jetty, recorded non-directional wave data every 3 hours from May 1994 through June 1995. Analysis of the first 6 months of data (May 1994 - January 1995) resulted in an average significant wave height of 2.4 ft and an average peak period of 8.9 seconds. The September 1994 event showed slight attenuation of the and peak period of 9 seconds. The December 1994 event showed similar attenuation of the wave height by the ebb shoal, resulting in a 7.41 ft wave height. However, the impact of the shoal is seen by the shift in peak period (frequency) from 14.2 seconds offshore to 9.8 seconds nearshore.

Detailed studies have recently been conducted by the USACE Philadelphia District to develop combined wave/water-level frequency relationships for various open coast and estuarine areas within the district boundaries. The analysis relevant to the Long Beach Island area involved hindcasting by means of a two-dimensional wave model and statistical analyses related to 30 storms of record, for which time histories of wave characteristics were developed. The selected storm record included 15 hurricanes and 15 northeasters which generated major surges and/or waves along the study area. Several output nodes were analyzed for the Study reach with detailed analyses performed for OCTI Station I35J30 centrally located in the study reach and south of WIS Station 70 **(Figure 2-1)**. Details of the analysis will be presented later in this report in the subsection dealing with assessment of storm effects and damage parameters. Suffice it to mention at this point, that hindcasted significant wave heights for the 15 hurricanes of record varied from about 8 feet to 19 feet, with wave periods ranging from 7 to 14 seconds. In the case of the 15 major northeasters which were evaluated, significant wave heights varied from about 9 feet to 22 feet, with wave periods ranging from 10 to 17 seconds. It will be noted that in the study area, the storm waves having the greatest heights as well as the longest periods are associated with northeasters. The same relationship also obtains for the magnitudes of storm surges. The fact that northeasters represent the most intense storm conditions experienced in the study area reflects a recorded history which is absent of an event in which a hurricane has made a direct landfall at or proximate to Long Beach Island. **Figure 2-2** contains histograms which graphically summarize the distribution of wave conditions (Height, Period, and Direction) for OCTI Station I35J30. The Wave Roses shown in **Figure 2-3** further illustrate the directional distribution of wave height and period, showing the larger wave heights and periods originate from the northeast and southeast.

Tides. The tides affecting the study area are classified as semi-diurnal with two nearly equal high tides and two nearly equal low tides per day. The average tidal period is actually 12 hours and 25 minutes, such that two full tidal periods require 24 hours and 50 minutes. Thus, tide height extremes (highs and lows) appear to occur almost one hour (average is 50 minutes) later each day. The mean tide range for the Atlantic Ocean shoreline is reported as 4.29 feet at Seaside Heights in the Tide Tables published annually by the National Oceanic and Atmospheric Administration (NOAA). The spring tide range is reported as 5.15 feet. Barnegat Inlet and the back bay areas adjacent to the study area show a large attenuation of the tide range relative to the ocean shoreline, resulting in a mean tide range of approximately 0.5 ft throughout Barnegat Bay.

No official datum relationships have been established for National Ocean Service (NOS) tide gage stations in the project area (open ocean); therefore, interpolation between the nearest NOS stations with datum relationships was required. Two primary NOS stations are nearly

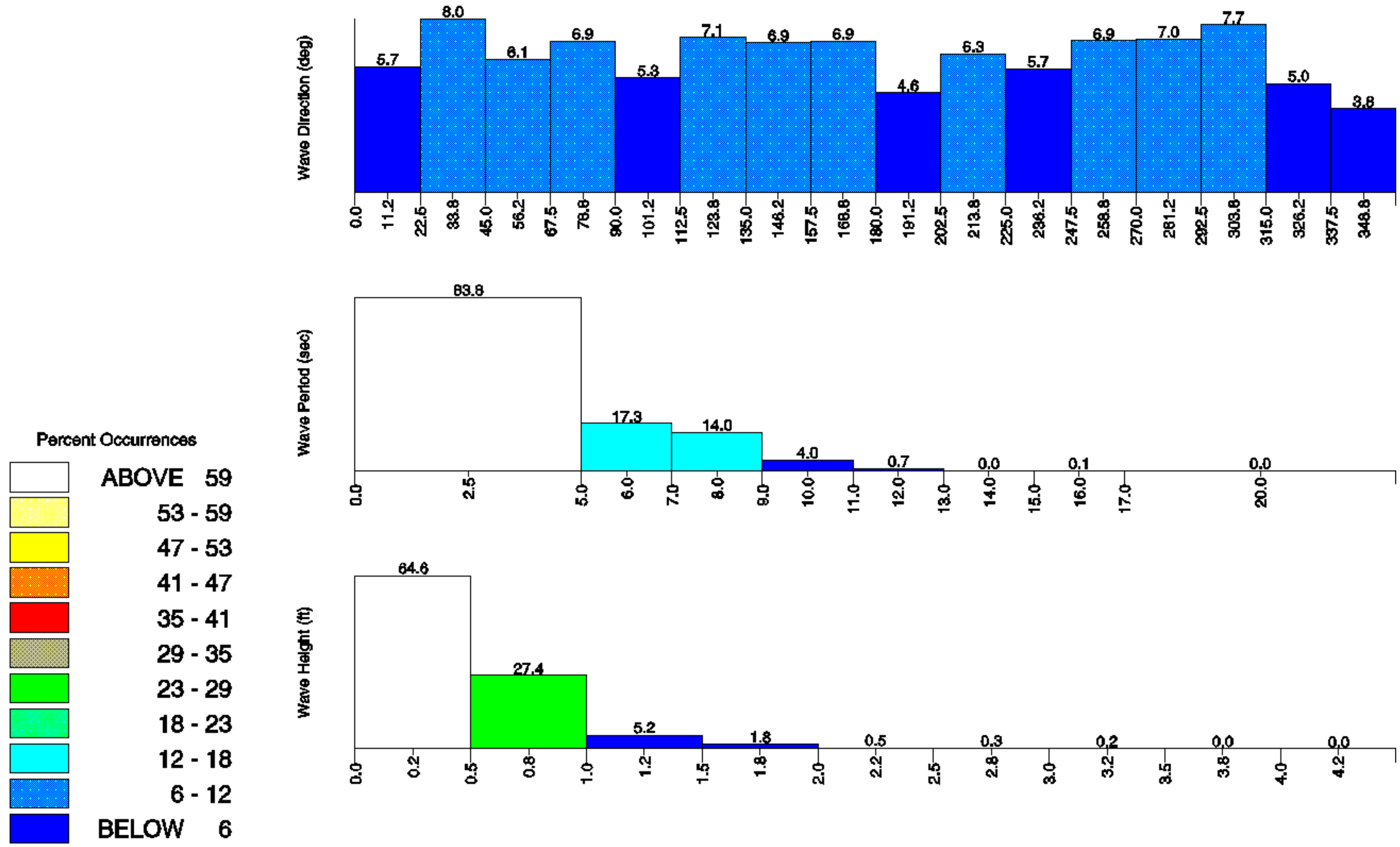


Figure 2-2 OCTI Station I35J30 Wave Histograms

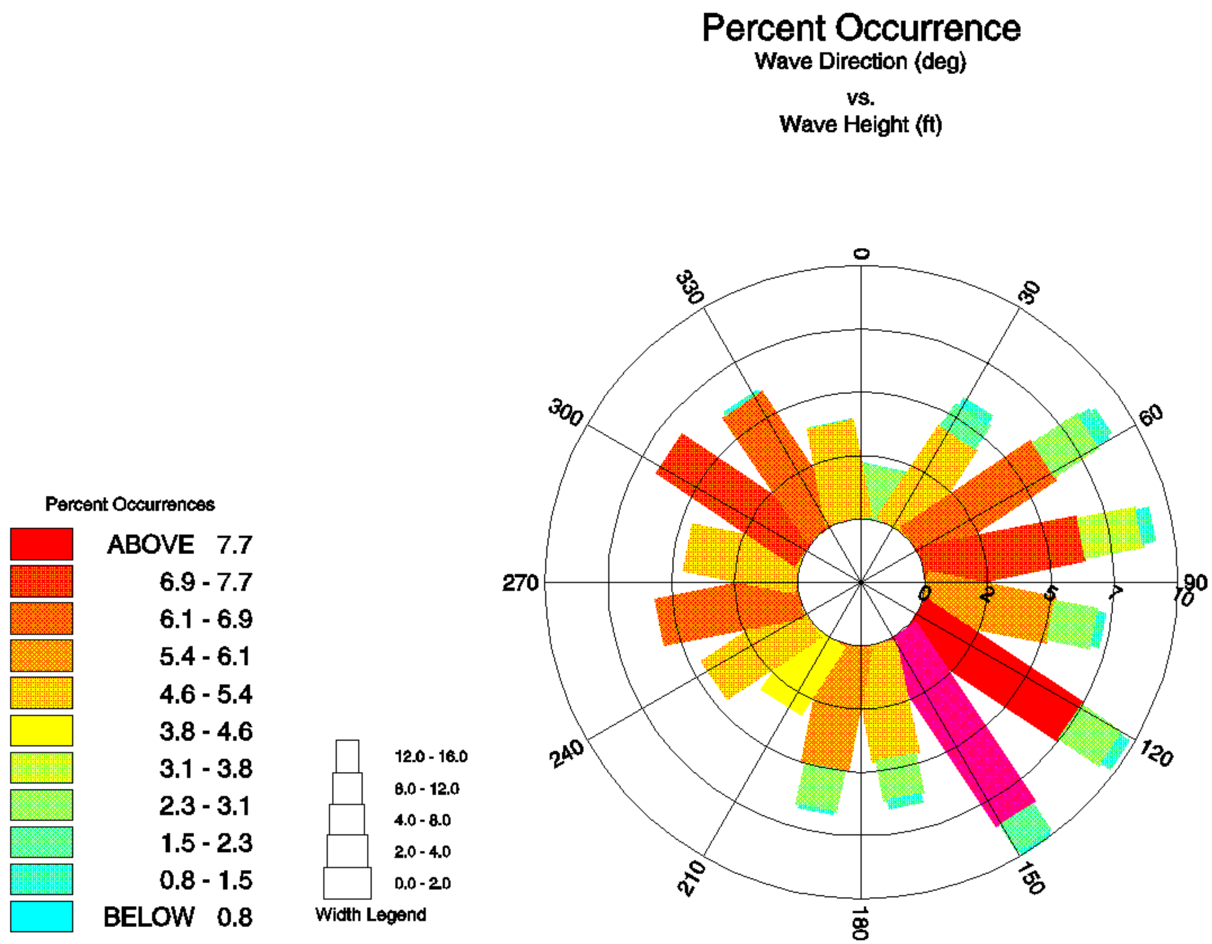


Figure 2-3 OCTI Station I35J30 Wave Roses

equidistant to the study area, with one gage located south of the area at Atlantic City, NJ and the other to the north at Sandy Hook, NJ. An additional secondary station is located in Long Branch, NJ. Interpolation between Atlantic City and Long Branch data, with consideration of Sandy Hook data, resulted in NAVD being approximately 2.9 ft above mean lower low water (MLLW) and approximately 1.5 ft below mean high water (MHW) for Barnegat Inlet (**Table 2-4**). Recent analyses have been conducted to establish datum relationships in the vicinity of Barnegat Inlet. Several tide gages were installed on the open Ocean and in Barnegat Bay for a 2-month period in the Fall of 1996. Resulting datum relationships for the Ocean gage are also presented in **Table 2-4**.

Storm Surges. The study area experiences events each year in which meteorological effects generate water levels exceeding the levels of predicted astronomical tides. As noted previously in regard to wave characteristics, the USACE Philadelphia District recently completed studies to establish wave and water-level frequency relationships for the open coast and estuarine areas within the district. Time histories of storm tides have been hindcasted for the areas of interest by means of a two-dimensional storm surge model along with associated wave hindcasting. Time histories of storm-induced water levels were developed for the same 30 storms and at the same computational stations used in the companion wave analysis. As noted previously, several computation stations exist along Long Beach Island. The details of the surge hindcast results will be presented in a later subsection of this report, along with comparable wave information. The general results for the study area were the development of water level histories for 30 extreme events for which the combined surge and astronomical tides had peak elevations ranging from as low as 3.4 feet above NAVD to as high as 8.4 feet above NAVD. The highest computed elevation value of +8.4 feet NAVD is related to a hurricane that passed the study area on August 18, 1899; however, a storm tide with almost an equivalent peak water level value, i.e., +8.0 feet NAVD, was computed for the unusually severe northeaster that devastated the mid-Atlantic coastline between the 5th and 8th days of March 1962. Indeed, the history of extreme events that have affected Long Beach Island demonstrates that in terms of both wave action and surge levels, northeasters have, in the main, been the most intense type of storm affecting the study area. For example, in the case of the 15 hurricanes of record referenced above, the average of the highest significant wave heights amounted to 13.7 feet and the average of the peak water surface elevations was +4.8 feet NAVD. By comparison, the computed values for the 15 severe northeasters that were examined give the average of the highest significant wave heights as 16.9 feet, and the average of peak water surface elevations as +6.3 feet NAVD.

An evaluation of extreme water levels in Barnegat Bay was also performed to determine potential flooding along the back bay shorelines. Several tide gages located throughout Barnegat Bay, including one located at Loveladies, have been used to assess the potential impact of Barnegat Inlet's south jetty realignment on tidal conditions throughout Barnegat Bay. Mean tidal ranges have increased slightly throughout the Bay. Additional efforts were performed as part of the Seaside Park Reconnaissance Study (1995) to establish stage frequency curves within the Bay for flood damage analysis. The resulting still water levels ranged from 1.2 ft NAVD to 6.7 ft NAVD for the 2- and 500-year recurrence intervals, respectively for the Study area.

2.9.3 **Sea Level Rise.** Relative mean sea level, on statistical average, is rising at the majority of tide gage locations situated on continental coasts around the world (National Research

TABLE 2-4. Tidal Data and Datum Relationships for Barnegat Inlet to Little Egg Inlet Feasibility Study					
	Atlantic City	**Barnegat Inlet (field study)**	**Barnegat Inlet (interpolated ocean)**	**Long Branch**	**Sandy Hook**
Tidal epoch (years data)	1960 - 1978 (1911-present)	1996 (27 Sep - 6 Nov)	N/A	1960-1978 (78-79,81-84)	1960-1978 (1910-present)
Latitude Longitude	39 deg 21 min N 74 deg 25 min W	39 deg 45 min N 74 deg 05 min W	39 deg 45 min N 74 deg 05 min W	40 deg 18 min N 73 deg 59 min W	40 deg 28 min N 74 deg 01 min W
Distance from AC	0 miles	34 miles	34 miles	70 miles	80 miles
MHHW	4.68	4.74	4.90	4.92	5.20
MHW	4.25	4.43	4.51	4.56	4.86
NAVD 88	2.97	2.94	2.94	2.86	2.90
MTL	2.20	2.37	2.34	2.38	2.53
NGVD	1.64	1.68	1.70	1.77	1.77
MLW	0.16	0.17	0.18	0.18	0.20
MLLW	0.00	0.00	0.00	0.00	0.00
Tidal Range (MHW-MLW)	4.09	4.26	4.33	4.38	4.66
Tide Tables **Mean Range**	4.09	N/A	*4.33*	4.38	4.66
Spring Range	4.95	N/A	*5.23*	5.26	5.60

* Elevation Units in ft
** NAVD 88 is 1.26 ft above NGVD based on CORPSCON Datum Conversion Program using Barnegat Inlet Coordinates

Council (NRC), 1987; Barth and Titus, 1984). Although local levels are falling in some areas, sea level is predominantly increasing with rates ranging from 0.04 to 0.20 in/yr (NRC, 1987). Major implications of a rise in sea level are increased shoreline erosion and coastal flooding. Other issues include the change in extent and distribution of wetlands and salinity intrusion into upper portions of estuaries and into groundwater systems. Although there is substantial local variability and statistical uncertainty, average relative sea level over the past century appears to have risen about 1 ft relative to the East Coast of the United States.

The risk of accelerated mean sea level rise as a contributing factor to long-term erosion and increased potential for coastal inundation is sufficiently documented to warrant consideration in the planning and design of coastal projects. Because of the enormous variability and uncertainty of the climatic factors that affect sea level rise, however, predicting future trends with any certainty is difficult. Many varying scenarios exist for future sea level rise. Engineer Regulation 1105-2-100 states that the potential for relative sea level change should be considered in every coastal and estuarine (as far inland as the new head of tide) feasibility study that the Corps undertakes and that the National Research Council study, Responding to Changes in Sea Level: Engineering Implications, 1987, be used until more definitive data become available. Corps of Engineer's policy calls for consideration of designs which are most appropriate for a range of possible future rates of rise. Strategies, such as beach fills which can be augmented in the future as more definitive information becomes available, should receive preference over those that would be optimal for a particular rate of rise, but unsuccessful for other possible outcomes. Potential sea level rise should be considered in every coastal study, with the degree of consideration dependent also on the quality of the historical record for the study site. Based on historical tide gage records at Atlantic City and Ventnor, NJ, sea level has been rising at an approximate average of 0.013 ft/yr (Hicks and Hickman, 1988). Over the proposed fifty year project life, it is assumed that sea level will rise by approximately 0.66 ft. This potential rise in sea level was incorporated into the ocean stage frequency analysis for the Atlantic City gage and in other project design aspects such as nourishment quantities.

Alongshore Sediment Transport. Alongshore or littoral transport can both supply and remove sand from coastal compartments. In order to determine the balance of sediment losses and gains in a system, net, rather than gross, transport rates are required. Net longshore transport refers to the difference between volume of material moving in one direction along the coast and that moving in the opposite direction.

A number of studies, beginning in the 1950's, have been conducted by the USACE which examined the magnitude and direction of alongshore sediment transport at Long Beach Island and the adjoining shores. A summary of the various results of these past Corps sediment transport estimates is presented in **Table 2-5**.

The values in **Table 2-5** indicate that gross alongshore sediment transport may vary from as low as 1/2 million to almost 2 million cubic yards per year and that, generally, there is a net southward transport which may vary from 50 to about 400 thousand cubic yards per year. Though there is a trend in the estimates for the net alongshore transport to be in the southward direction, the estimated differences between north and south transport quantities are not extremely large with respect to the gross sediment transport values. Hence, it can be expected that reversals in alongshore sediment transport contribute significantly to both the short- and long-term behavioral patterns of the Long Beach Island shoreline. This is manifestly evident in the reversing patterns of north-side and south-side accretion at and in the vicinity of the individual groins along the length of the island. Depending on the duration of the antecedent incident wave directions and intensities, a specific pattern may exist for an extended period time or change in a matter of a day or so.

Table 2-5

PRIOR USACE ESTIMATES OF ALONGSHORE SEDIMENT TRANSPORT
(LONG BEACH ISLAND, NJ, AND VICINITY)

Location or Reach	Method	Data Source	Database	Gross Transport (cy/yr) North	Gross Transport (cy/yr) South	Net Transport (cy/yr)
Barnegat Inlet	Wave hindcast & Energy flux-method	CERC TM-18				50,000 S
	Wave hindcast & Energy flux-method	WES (1979)	1972-1975	720,000	860,000	140,000 S
			1972	1,000,000	890,000	110,000 N
			1973	540,000	700,000	160,000 S
			1974	780,000	930,000	150,000 S
			1975	560,000	930,000	370,000 S
		CERC (1967)	1838-1953	500,000	550,000	50,000 S
		CENAP (1954)	1939-1941			250,000 S
	Wave hindcast & Energy flux-method	CERC MP 89-11	1956-1975			415,000 S
Long Beach Island	Historic	Caldwell (1966)	1838-1953	500,000	550,000	50,000 S
	Profile Analysis	CERC MR 80-9	1962-1973			150,000 S
		CENAP House Doc # 94-631 Grp III	1974	250,000	300,000	50,000 S

The majority of the historic alongshore transport analyses performed in the vicinity of the project area have focussed on the adjacent inlets, with only two studies reported for the central portions of Long Beach Island. The wide variation in results as shown in **Table 2-5** coupled with the lack of data for the main reaches of Long Beach Island warranted further investigation. A longshore transport analysis was conducted for the study area using the energy flux method- with longshore energy flux and transport rate expressions taken from the Shore Protection Manual (SPM Equations 4-39 and 4-49). Recent wave hindcast data from OCTI Station I35J30 (1987-1996) were used along with average shoreline angles for several communities on Long Beach Island to briefly examine alongshore transport trends. The methodology used is very sensitive to shoreline angle and results should only be examined for general transport trends. Results of this analysis shown in **Table 2-6** determined a potential net transport to the north for all communities with an average net transport rate to the south of approximately 95,000 cu yd/yr for the entire reach. Potential net transport rates decreased from the southern part of the study south of Loveladies. The large gradient in transport between Beach Haven Borough and Holgate implies that more sediment is being removed from the Holgate area than is being supplied, resulting in a relatively highly erosive shoreline as evidenced in shoreline positions observed over the same time period. The results displayed in **Table 2-6** consist of "potential" sediment transport rates based on the computed wave energy and its angle with respect to the shoreline, assuming an unlimited supply of sediment. A calibration constant was selected to provide the most reasonable sediment transport values. Actual sediment transport rates for the site may be slightly less when considering the impact of adjacent inlets and coastal structures. Alongshore sediment transport rates were utilized in computing nourishment requirements for with-project conditions as discussed later.

A numerical model study was conducted by the U.S. Army Engineer Waterways Experiment Station's Coastal and Hydraulics Laboratory to assist NAP in evaluating the impact of potential borrow sites on the Long Beach Island shorelines. Details of the study are presented in Appendix A of Section 2. A numerical wave model was used to transform offshore waves to the nearshore zone. The incorporation of nearshore bathymetry, including potential borrow sites, provides more accurate nearshore wave conditions which control the alongshore sediment transport. The study evaluated gradients in the alongshore sediment transport values to estimate shoreline change rates and nourishment requirements for proposed with-project conditions.

Bathymetry. An analysis of available offshore and nearshore bathymetric data was conducted to identify important geomorphic features which may impact nearshore wave transformation and resulting sediment transport patterns. A search of the NOS bathymetric database for the study area resulted in limited data available, with the most recent survey being performed in 1954. Near complete coverage of the project area (including Barnegat Bay) exist for the 1930's time period. The only other time period NOS surveyed the area was in 1954. The 1954 NOS survey shown in **Figure 2-4** was conducted in the vicinity of Little Egg and Beach Haven Inlets to document the change in conditions from the 1930's survey due to the opening and closing of Beach Haven Inlet.

Recent beach profile data were overlaid on the NOS bathymetry in an effort to confirm the overall bathymetric features represented by the NOS data set were accurate. Discrepancies along the finger shoals located adjacent to both Harvey Cedars and Brant Beach warranted further investigation. It should be noted such features significantly impact nearshore wave transformation and resulting storm-induced damage and alongshore sediment transport rates. Detailed surveys were conducted in the Fall of 1996 to resolve the nearshore features. The resulting bathymetry (**Figure 2-5**) indicated the features were similar to those observed in the 1930's NOS survey. The overall features had been translated slightly landward with moderate reductions in elevation.

TABLE 2-6. Potential Alongshore Sediment Transport Rates along Long Beach Island, NJ

		Shoreline Angle	Sediment Transport Rates (cu yd/yr)			
Community	Bundy	(deg N)	NORTH DIRECTED	SOUTH DIRECTED	NET	GROSS
Barnegat Light	1	39.91	-105,000	175,000	70,000	280,000
Loveladies 1	2	26.41	-95,000	200,000	105,000	295,000
Loveladies 2	3	21.40	-95,000	210,000	115,000	305,000
Harvey Cedars 1	4	21.23	-95,000	210,000	115,000	305,000
Harvey Cedars 2	5	26.26	-95,000	200,000	105,000	295,000
North Beach	6	29.48	-95,000	190,000	95,000	285,000
Surf City	7	31.24	-95,000	185,000	90,000	280,000
Ship Bottom	8	31.33	-95,000	185,000	90,000	280,000
Brant Beach	9	29.43	-95,000	190,000	95,000	285,000
BH Crest to BH Park	10	27.79	-95,000	190,000	95,000	285,000
Haven Beach to BH Ga	11	28.64	-95,000	190,000	95,000	285,000
Spray Bch to BH boro 1	12	26.96	-95,000	190,000	95,000	285,000
BH Boro	13	33.97	-105,000	185,000	80,000	290,000
BH Boro 2	14	42.20	-113,000	175,000	62,000	288,000
BH Boro, Holgate	15	29.28	-95,000	190,000	95,000	285,000
AVERAGE CONDITIONS		**29.70**	**-97,533**	**191,000**	**93,467**	**288,533**

Sed Tran Values Computed using OCTI gage I35J30 with shoreline angles determined from Dec 1997 shoreline.

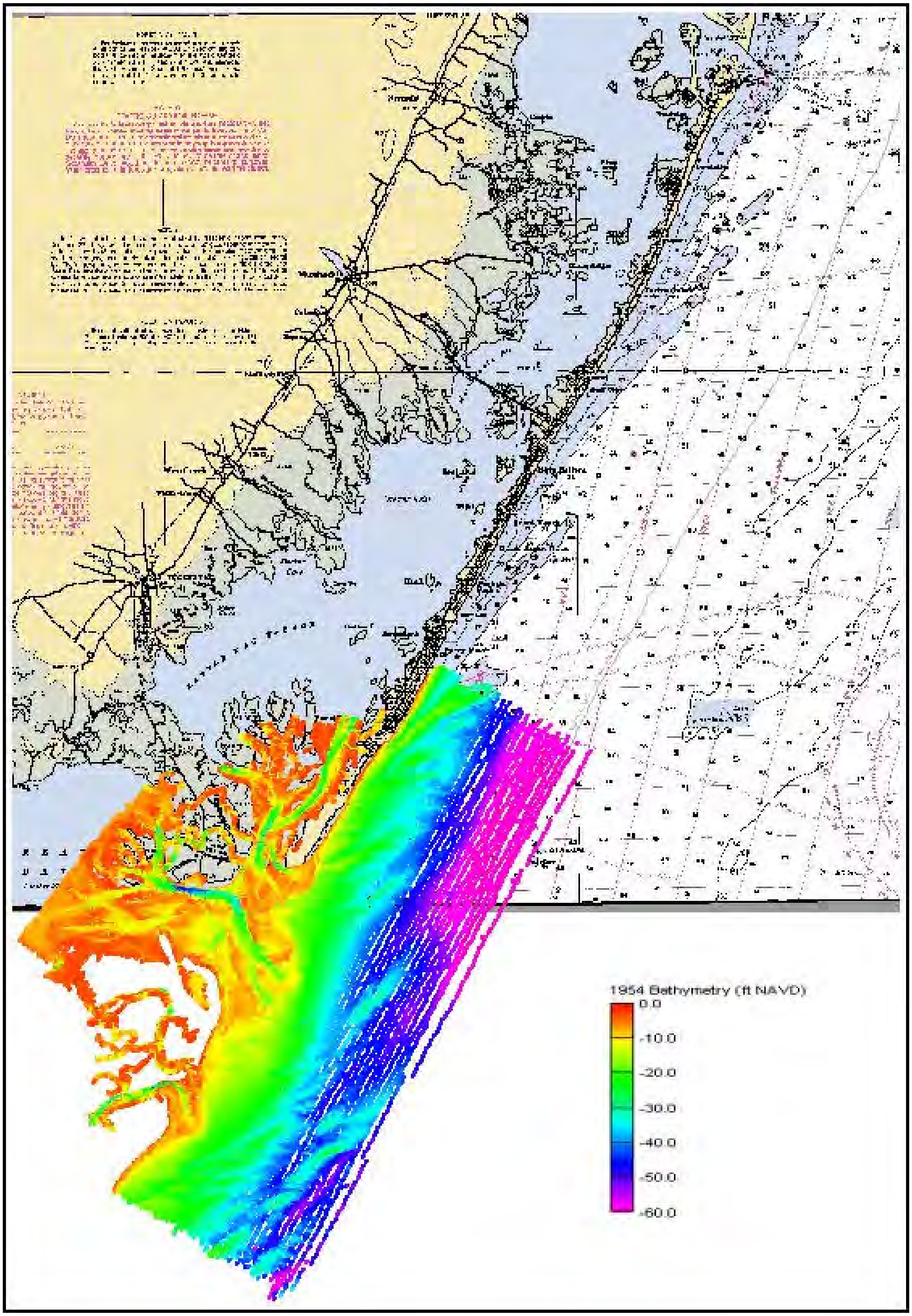


Figure 2-4 1954 NOS Bathymetric Survey in the Vicinity of Little Egg and Beach Haven Inlets, NJ.

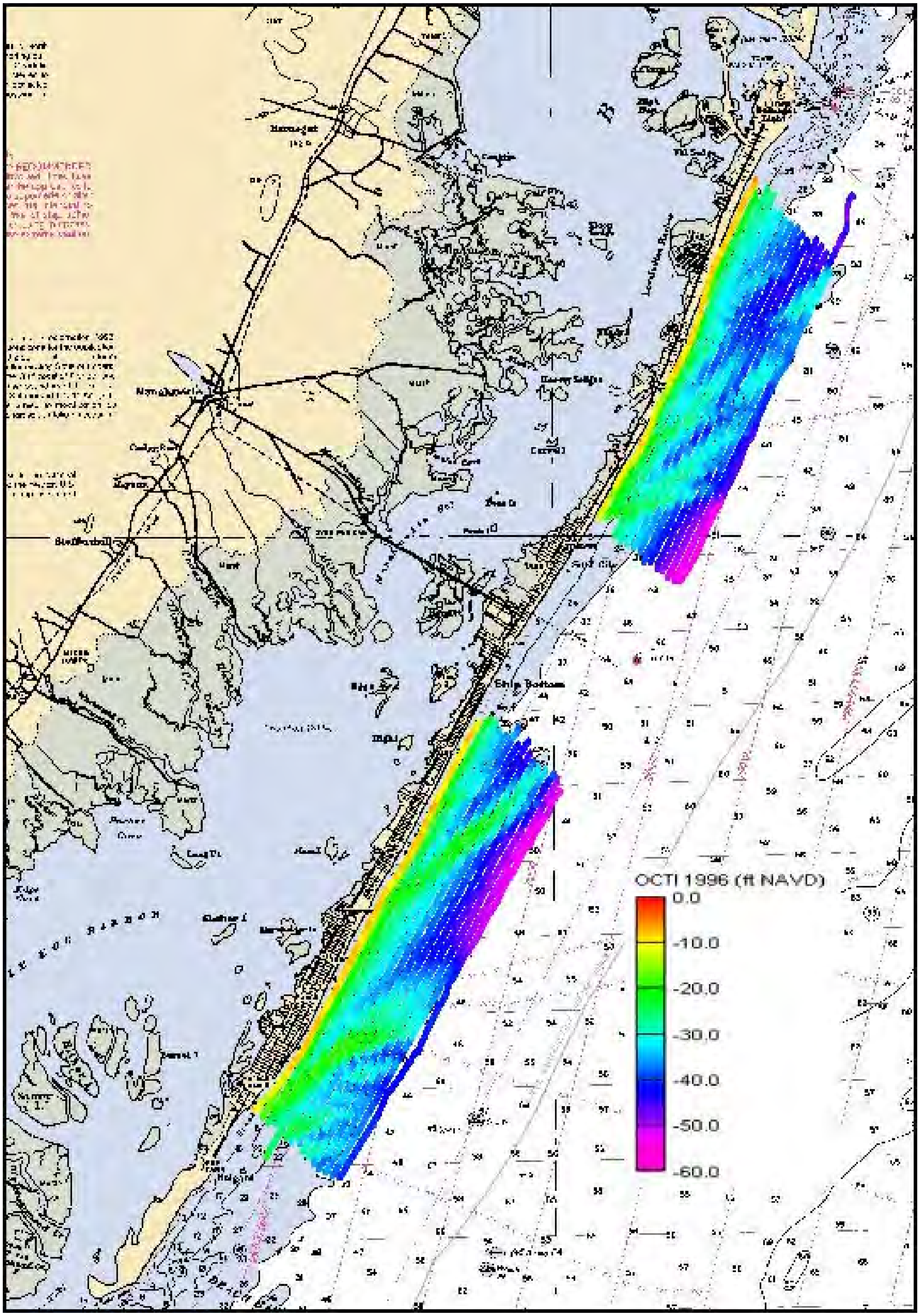


Figure 2-5 Nearshore Survey of Long Beach Island Finger Shoals (1996).

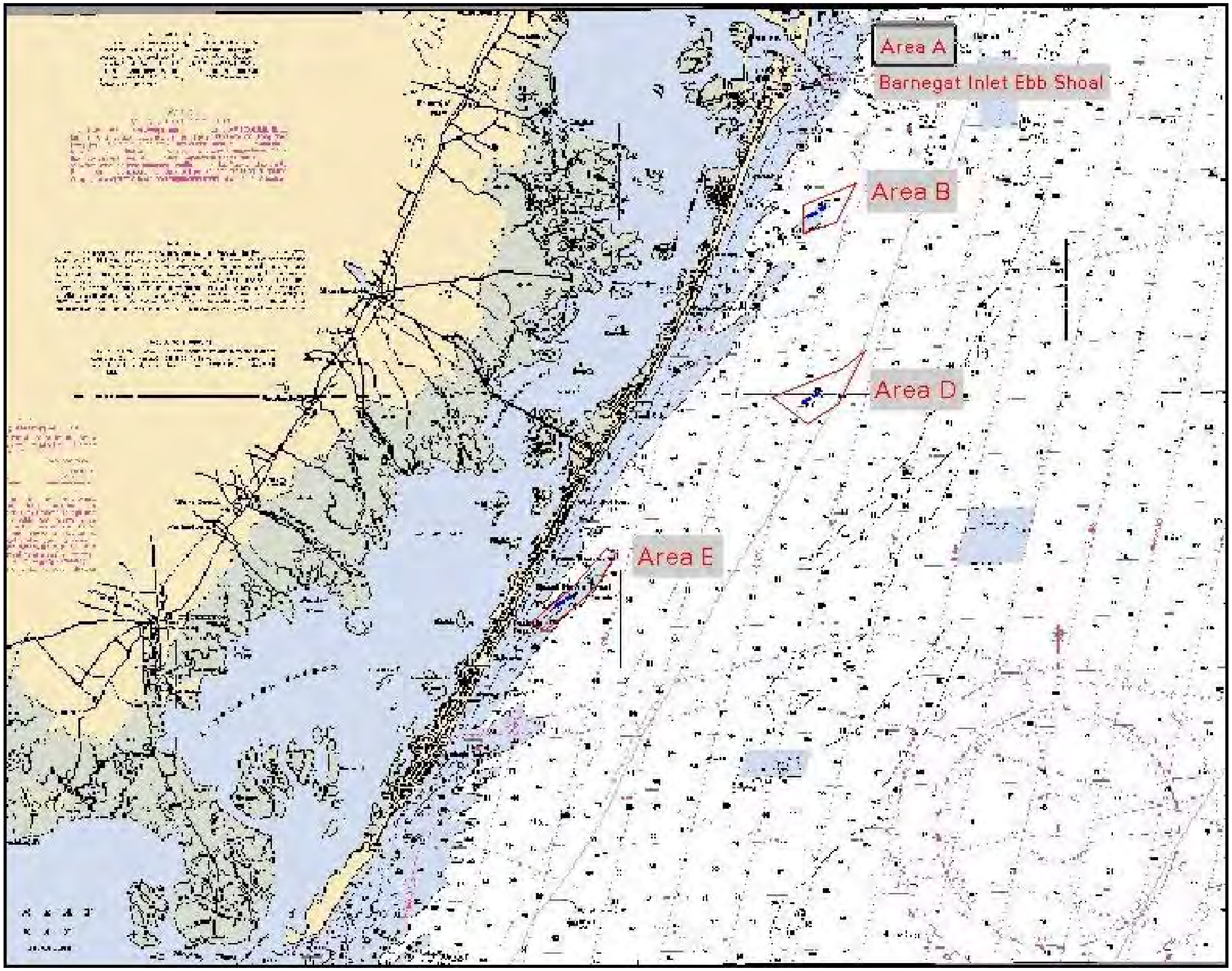


Figure 2-6 Survey Locations of Proposed Borrow Areas.

Additional surveys were conducted to characterize the potential borrow sites located in the Study area (**Figure 2-6**). The resulting survey data combined with vibracore measurements allowed for quantification of quality sediment that can be used in nourishment operations.

Routine surveys have been conducted in the vicinity of Barnegat Inlet since completion of the south jetty as part of the Barnegat Inlet MCCP Study. Surveys of the ebb shoal, flood shoal, and channel conditions aided in evaluating impacts of the construction on sediment bypassing, channel shoaling, and overall ebb and flood shoal feature changes. The survey data were incorporated into numerical bathymetric grids used for simulating wave and current conditions in the vicinity of Barnegat Inlet. **Figure 2-7** display the ebb shoal, flood shoal, and channel conditions for October 1997.

A numerical grid was developed for modeling nearshore wave transformations throughout the Study area. A compilation of survey data from various sources described above was converted to a common vertical datum and gridded on a scale fine enough to resolve all significant features which may impact wave transformations into the nearshore. The STWAVE grid (**Figure 2-8**) was extended beyond the bordering inlets to account for potential refraction around the ebb shoal complexes.

Beach Profile Characteristics. An analysis of recent and historic beach profile data was performed to identify the temporal and spatial variability in beach profile characteristics throughout the study area. The main profile characteristics of interest included: Dune Crest Elevation, Berm Elevation, Berm Width, MHW Location, Volume of Material above MHW, and Foreshore Slope. Results of the analysis were used to development representative profile conditions described further in *Section 4.1.6 Development of Input Data for Beach Profile Modeling*. Additional analyses were performed using the temporal changes in MHW position and volumetric change rates for each profile to assess long-term shoreline change rates and estimated nourishment requirements as described further in *Section 2.10.4 Examination of Beach Profile Data*. Several sources of beach profile data were assembled and analyzed. A wide array of survey techniques was utilized in the collection of the various sources of data. Onshore portions of the surveys were typically surveyed using the standard land surveying techniques. Nearshore and offshore portions of the surveys utilized fathometers and sea sleds. All data sources were adjusted to a common datum, NAVD 1988, and analyzed. **Table 2-7** summarizes the various profile data available throughout the communities along the Study area. **Figure 2-9** displays the locations of the LRP and MCCP profiles along LBI. The stationing scheme presented begins at Barnegat Inlet and extends to Little Egg Inlet. Further discussion is presented in *Section 2.10.3 Historic Shoreline Change Analysis*. Specifically, the beach profile data sources are:

1. Line Reference Points. Onshore and offshore profile surveys referred to as *Line Reference Point* (LRP) *Surveys* after the nomenclature used on the survey control sheets to designate the profile reference points, conducted by the USACE, Philadelphia

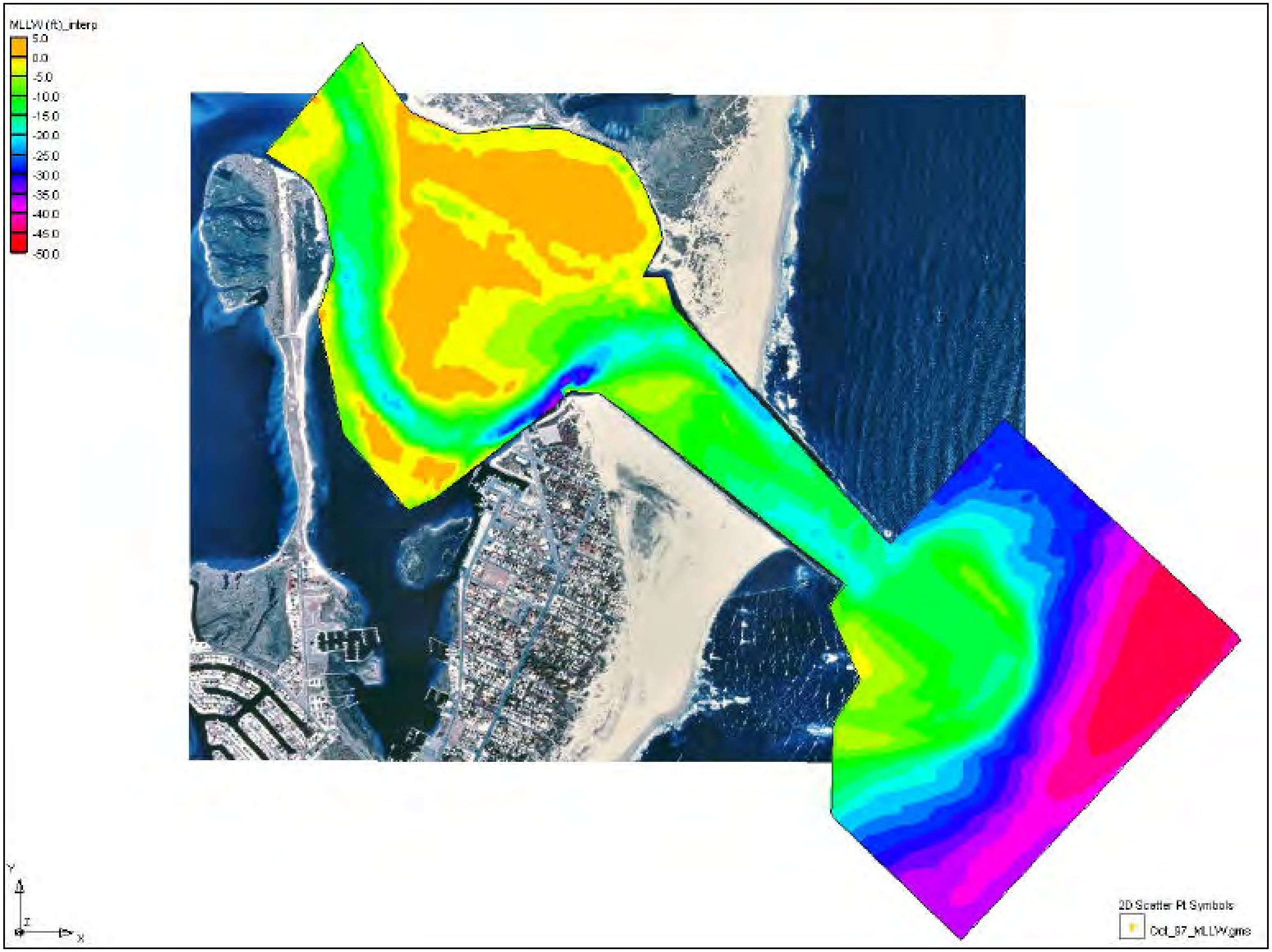


Figure 2-7 Barnegat Inlet Ebb Shoal, Flood Shoal, and Channel Conditions (October 1997).

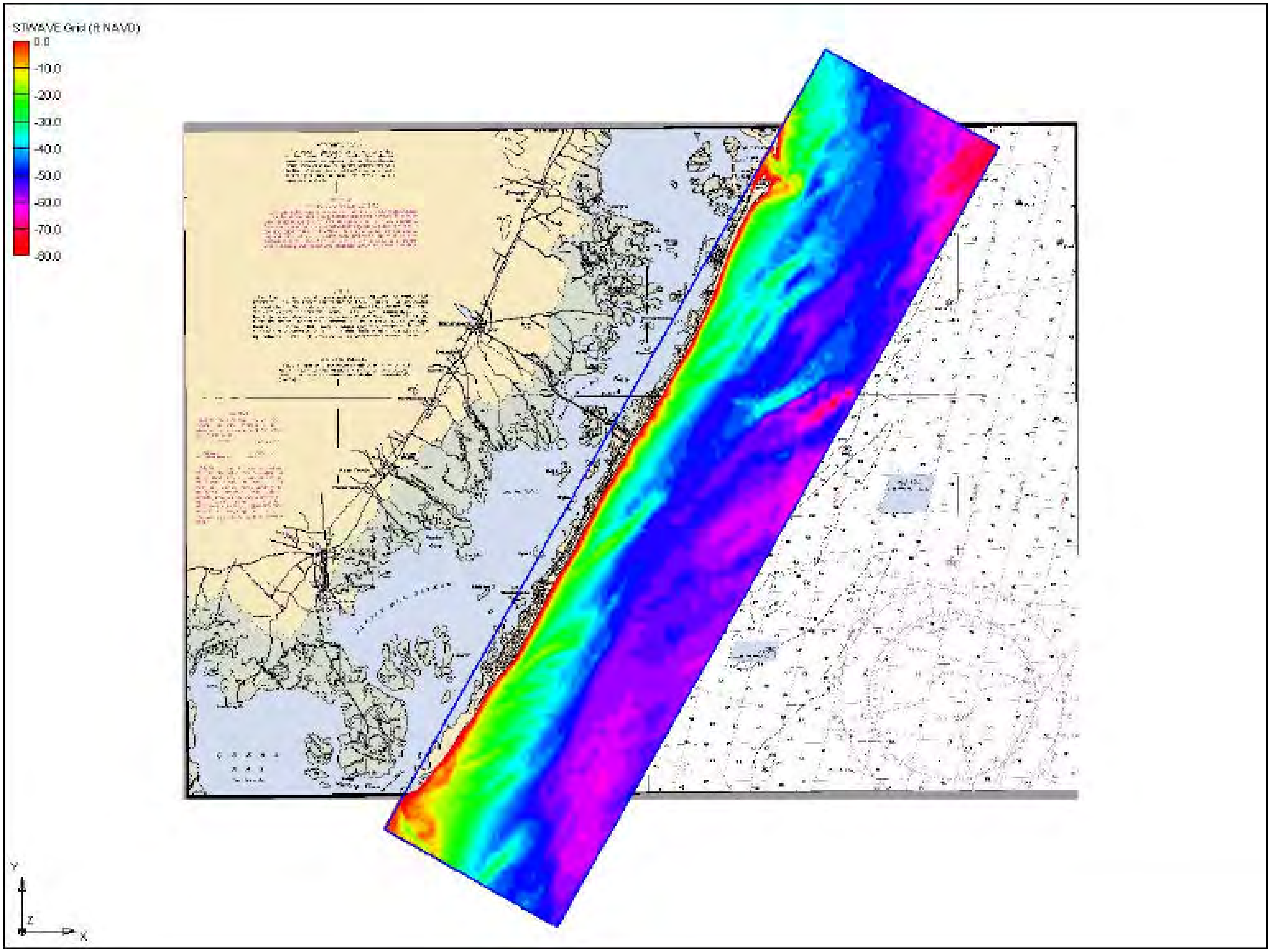


Figure 2-8 STWAVE Bathymetric Grid for LBI Wave modeling.

TABLE 2-7. BEACH PROFILE LOCATIONS ALONG LONG BEACH ISLAND, NJ. REFERENCE LINE STATIONING IN RELATION TO COMMUNITIES AND PROFILES BARNEGAT INLET TO LITTLE EGG INLET FEASIBILITY STUDY			
Name of Communities	Stationing (Ft X 1000)	Profiles	Station (ft)
Barnegat Light Borough	0 to 9.6	CERC-3 / LRP 54 /	2,725
		NJDEP-245 CERC-4 /	7,625
		LRP-55 / NJDEP-145	
Long Beach Township			
(LBT) * Loveladies	9.6 to 20.6	CERC-5 / LRP-56	13,025
Community		CERC-6 / LRP-57 /	16,725
		NJDEP-144 CERC-7	19,885
Harvey Cedars Borough	20.6 to 31.2	NJDEP-143	23,685
		CERC-8 / LRP-59	25,285
		CERC-9	27,285
		CERC-10 /	29,885
		LRP-60	30,105
		NJDEP-142	
Long Beach Township			
	31.2 to 37.7	CERC-11 / LRP-61	33,505
(LBT) * North Beach			
Surf City Borough	37.7 to 45.5	CERC-12 / LRP-62 / NJDEP-241	38,505
Ship Bottom Borough	45.5 to 52.2	NJDEP-141	45,705
		CERC-13 / LRP-64	46,765
		CERC-14 / LRP-65 /	51,865
		NJDEP-140	
Long Beach Township (LBT) *			
	52.2 to 61.9	LRP-66	55,365
Brant Beach Community * Beach		LRP-67	58,165
Haven Crest Community	61.9 to 63.5	CERC-15 /	61,965
		NJDEP-139 LRP-68	62,165
* Brighton Beach Community *	63.5 to 65.1		
Peahala Park Community * Beach	65.1 to 66.7		
Haven Park Community * Haven	66.7 to 69.0	LRP-69	66,465
Beach Community * Beach Haven	69.0 to 70.7		
Terrace Community	70.7 to 73.8	CERC-16 /	70,565
		NJDEP-138 LRP-70	70,795
* Beach Haven Garden Community	73.8 to 75.5	LRP-71	74,595
* Spray Beach Community * North	75.5 to 77.2		
Beach Haven Community	77.2 to 79.2		
Beach Haven Borough	79.2 to 89.1	CERC-17 / LRP-72 /	79,355
		NJDEP-137 NJDEP-136	84,155
		CERC-18 / LRP-73	85,455
Long Beach Township (LBT) *			
South Beach Haven Community *	89.1 to 91.3	NJDEP-135	92,355
Holgate Community * Beach Haven	91.3 to 93.1	CERC-19 /	89,755
Inlet Community	93.1 to 96.0	LRP-74 CERC-20	92,855
		LRP-75	94,705
* Holgate Wildlife Refuge		NJDEP-234	95,600

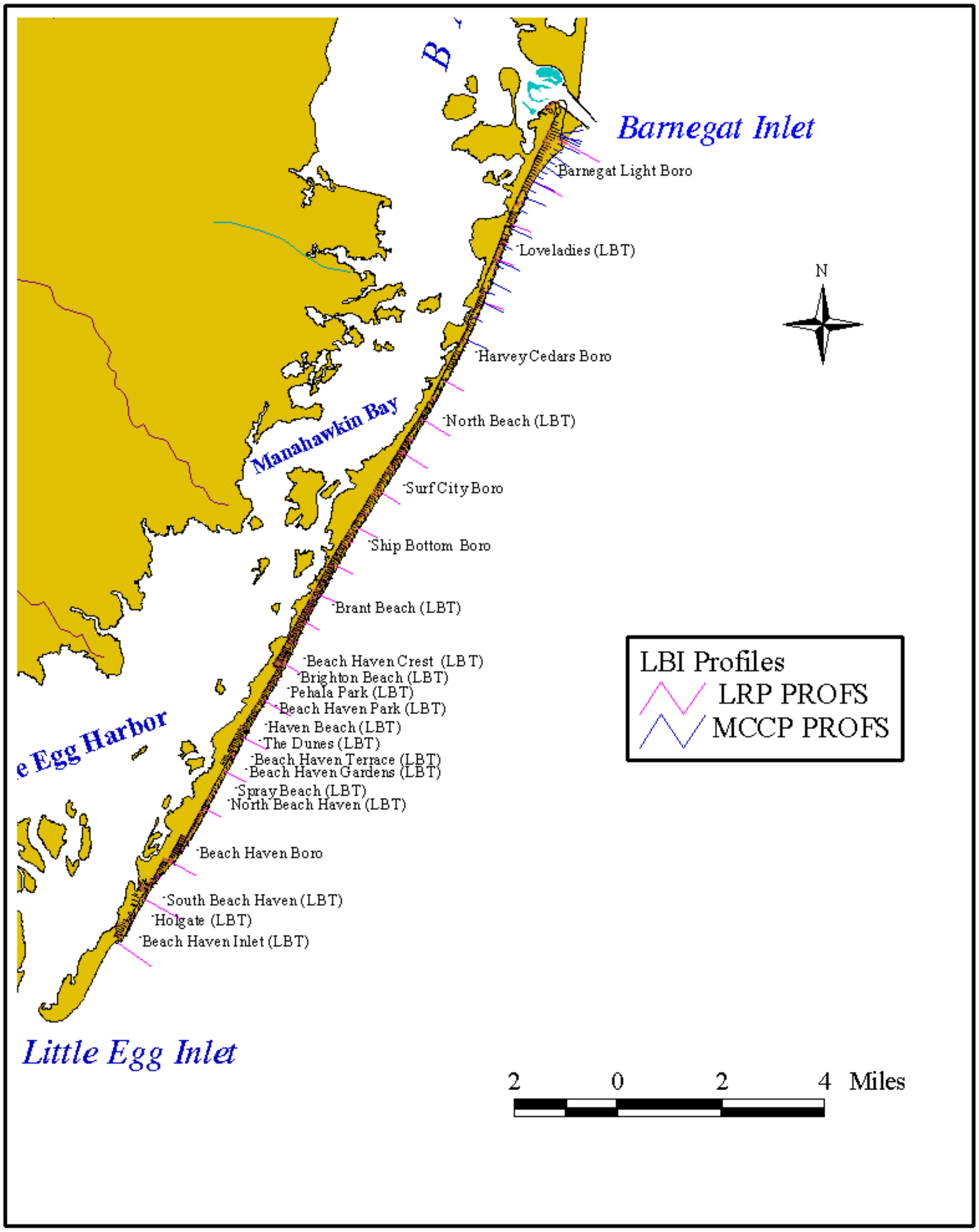


Figure 2-9 LRP and MCCP Profile Locations along LBI, NJ.

District, were initiated in 1955 and subsequently repeated in 1963, 1965, and 1984. Twenty-two (22) profiles were originally collected for the 1955 survey. The number of profiles decreased for the 1984 survey. The numbering sequence for the LRP profiles increases from north to south, and the vertical datums were MLW for the 1965 surveys and NGVD for the 1984 surveys. Several of the LRP profiles were recently re-surveyed by Offshore and Coastal Technologies Inc. - East Coast (OCTI-E) as described below.

2. CERCProfiles. A total of thirty-two (32) profiles were established and repeatedly surveyed, on LBI, as part of a broader field research program, Beach Evaluation Program (BEP), conducted by the USACE Coastal Engineering Research Center (CERC) in the period 1962 to 1973. The BEP was initiated after the Great East Coast Storm of March 1962 to observe variations on typical beaches in response to waves and tides of specific intensity and duration. **Figure 2-10** displays the CERC profile locations. Analysis of the CERC profile data focused on assessing the variability in the shape of the beach profile. Although the measured profile characteristics were not useful in developing representative profile conditions for the Feasibility Study, the understanding of the potential variability in profile characteristics through time would greatly benefit future risk and uncertainty analyses.

3. NJDEP Surveys. Onshore and nearshore profile surveys conducted by the Coastal Research Center, Stockton State College under contract to NJDEP were collected annually, beginning in 1986. Fourteen (14) profiles have been collected within the study area as part of a general NJDEP program of monitoring the state's beaches. These profiles, referred herein as NJDEP profiles, are numbered in the state's designation system: NJDEP Profile Nos. 245, 145, 144, 143, 142, 241, 141, 140, 139, 138, 137, 136, 135, and 234. New Jersey profile surveys available for this investigation are the annual surveys from 1986 to 1994 and semi-annual surveys from 1995 to present. The numbering sequence for the New Jersey profiles increases from south to north, and the vertical datum is NGVD. The beach profiles are collected using typical land based surveying techniques with the offshore limits of the surveys extending to wading depth.

Table 2-8 presents the locations of NJDEP beach profiles located in the study area along with average beach profile characteristics. The profiles were analyzed to assess the variability in profile characteristics at each profile and along the entire study area. The overall individual profile characteristics have been relatively stable over the monitoring period. Dune elevations have deviated approximately 1 ft with a mean elevation of + 18.6 ft NAVD. Berm dimensions as well show small changes, with the berm widths deviating 25 to 50 ft with a mean of 190 ft width, as measured from the centerline of the dune. The dune and berm system at Barnegat Inlet significantly bias average conditions.

4. Barnegat Inlet MCCP Surveys. A total of forty-two (42) profiles have been annually surveyed as part of the Barnegat Inlet Monitoring of Completed Coastal Projects (MCCP) Study since 1993. Beach profiles were established Eighteen (18) profiles were established north of Barnegat Inlet into Long Beach Island State Park and twenty-four (24) profiles were established south of Barnegat Inlet to Harvey Cedars (**Figure 2-11**).

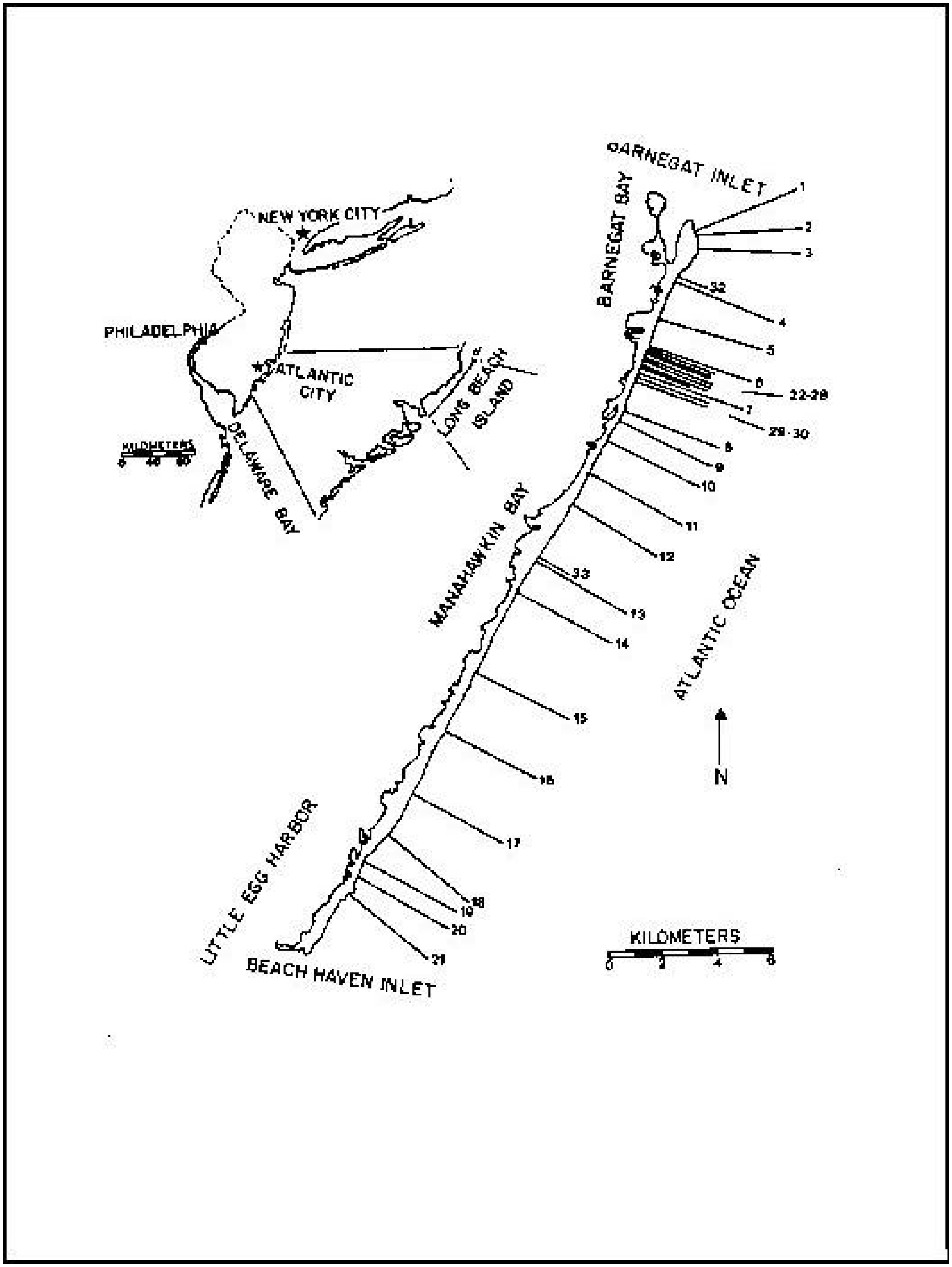


Figure 2-10 CERC MP-80-9 Profile Locations (1962-1973).

TABLE 2-8. NJDEP Average Beach Profile Characteristics (1986 - 1997).						
			Average Profile Characteristics			
Profile Type	Community	Alonghsore Coords wrt GENESIS grid	Dune El (ft NAVD)	Berm Width (ft, from cl)	Berm El (ft NAVD)	Vol above MHW (yd^3/ft)
NJDPE 245	Barnegat Light Borough	2,725	23.71	984	7.87	451.6
NJDPE 145	Barnegat Light Borough	7,625	19.60	180	7.35	135.9
NJDPE 144	Loveladies (LBT)	16,725	17.78	92	8.80	69.9
NJDPE 143	Harvey Cedars Borough	23,685	17.43	97	7.16	77.4
NJDPE 142	Harvey Cedars Borough	30,105	16.48	119	7.95	97.0
NJDPE 241	Surf City Borough	38,505	22.94	150	10.37	151.7
NJDPE 141	Ship Bottom Borough	45,705	19.92	136	9.18	97.7
NJDPE 140	Ship Bottom Borough	51,865	21.36	124	8.75	120.1
NJDPE 139	Beach Haven Crest (LBT)	61,965	17.90	104	8.33	65.9
NJDPE 138	Beach Haven Terrace (LBT)	70,565	19.33	113	7.66	98.1
NJDPE 137	Beach Haven Borough	79,355	16.52	133	7.70	92.8
NJDPE 136	Beach Haven Borough	84,155	15.28	122	7.33	62.5
NJDPE 135	South Beach Haven (LBT)	92,355	17.43	107	7.65	101.0
NJDPE 234	Holgate (LBT)	95,600	14.71	143	6.52	70.5
		AVERAGE CONDITIONS	**18.60**	**186**	**8.04**	**120.9**

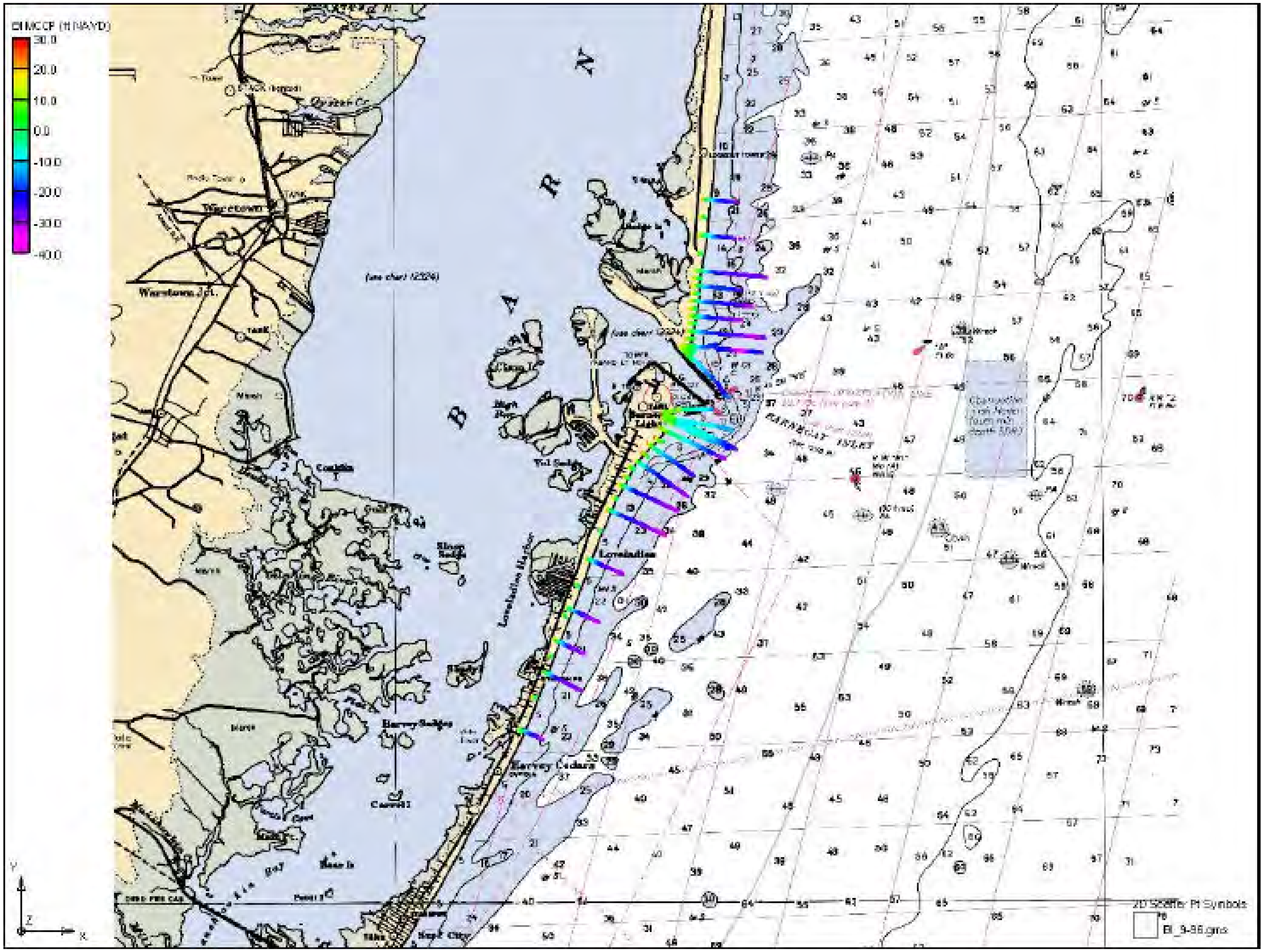


Figure 2-11 Barnegat Inlet MCCP Profile Locations.

Analysis of the survey data was performed to assess the impacts of the recent south jetty construction on adjacent shoreline stability. The analysis primarily focused on estimating volumetric change rates and variations in the MHW shoreline position as discussed in detail in the following section on historical shoreline analyses.

5. OCTI-E Surveys. Recent onshore and offshore profile data were collected by OCTI-E for the Philadelphia District July 1996 to document existing conditions. Forty-two (42) profiles were collected within the communities to be studied in detail. OCTI-E utilized a sea sled beach profiling system which provides a highly accurate depiction of the entire profile from the upper beach to beyond the theoretical closure depth. The locations of the profiles were selected to correspond to locations previously surveyed, allowing comparative analyses. Twenty-two (22) of the profiles re-occupied former LRP survey locations, with the remaining twenty (20) profiles located approximately midway between adjacent LRP profile locations. The twenty "sub-profiles" only extended seaward to wading depth and are denoted with the "-1" extension hereafter.

Table 2-9 presents the locations of OCTI-E beach profiles located in the study area along with beach profile characteristics. The profiles were analyzed and used to assess existing conditions. The existing conditions compared well to the NJDEP average profile characteristics. Select profiles were assembled and used as input for numerical modeling of storm-induced damages as discussed in *Development of Input Data for Storm Erosion Modeling*.

SUMMARY OF HISTORICAL SHORLINE CONDITIONS

Historical Shoreline Analysis. Analysis of historic shoreline positions constitutes a logical basis for estimating future shoreline locations, assuming there would be no new and large-scale systematic interventions to control future shoreline positions. It is assumed that the “without-project” condition prevails over the time period in which the future position of the shoreline is to be estimated. Therefore, the investigation reported here focused on those portions of the available data which reflect the current shore regime as dictated by the nearshore hydrodynamics, the existing shore protection structures along most of the island’s length, and the navigation improvements at the north end of the study area, i.e., the Barnegat Inlet dual jetty system.

Though emphasis is placed on defining the existing shore regime, the entire recorded history of ocean-shoreline positions at Long Beach Island, beginning in 1836, was examined to the extent of formulating a basic portrayal of the sequential changes in shoreline movement rates as conditions evolved from an essentially pristine state, to the existing condition, which includes significant artificial influences on the shore processes along the study area. Tracing the evolutionary changes in shoreline positions was of interest as it would provide the basis to: (a) develop the past and pre-intervention patterns of shore movements in the interest of defining cause and effect relationships induced by subsequent progressive anthropogenic influences on shore processes; (b) determine if and where conditions prior to human influence apparently followed the same patterns evident

TABLE 2-.9. OCTI-E July 1996 LBI Beach Profile Characteristics.					
		PROFILE CHARACTERISTICS			
Profile #	Community	Dune El (ft NAVD)	Avg Berm El (ft NAVD)	Berm Width (ft from cl Dune)	Vol above Berm (cu yd /ft)
LRP 54	LBT, Loveladies				111.50
LRP 55	LBT, Loveladies	20.10	7.30	205.00	51.73
LRP 55-1	LBT, Loveladies	21.60	7.90	124.00	62.58
LRP 56	LBT, Loveladies	20.50	8.40	67.00	52.59
LRP 56-1	LBT, Loveladies	18.50	7.90	115.00	40.37
LRP 57	LBT, Loveladies	20.70	8.10	98.00	33.12
LRP 57-1	LBT, Loveladies	18.90	8.30	110.00	25.19
LRP 58	Harvey Cedars Boro	15.60			24.41
LRP 58-1	Harvey Cedars Boro	17.20	7.90	136.00	27.10
LRP 59	Harvey Cedars Boro	16.50	7.90	91.00	16.89
LRP 59-1	Harvey Cedars Boro	14.60	7.80	78.00	19.15
LRP 60	LBT, North Beach	16.30	6.70	144.00	23.41
LRP 60-1	LBT, North Beach	13.00	7.60	114.00	8.77
LRP 61	LBT, North Beach	18.60	7.50	134.00	34.28
LRP 61-1	LBT, North Beach	17.00	7.30	126.00	26.51
LRP 62	Surf City Boro	22.40	9.00	127.00	61.70
LRP 62-1	Surf City Boro	21.00	8.40	106.00	35.52
LRP 63	Surf City Boro	21.90	8.00	90.00	39.81
LRP 63-1	Ship Bottom Boro	21.40	8.10	122.00	38.17
LRP 64	Ship Bottom Boro	21.60	8.10	136.00	51.40
LRP 64-1	Ship Bottom Boro	21.00	7.90	151.00	33.64
LRP 65	LBT, Brant Beach	22.20			51.90
LRP 65-1	LBT, Brant Beach	17.20	8.40	68.00	11.37
LRP 66	LBT, Brant Beach	15.40	7.50	83.00	21.31
LRP 66-1	LBT, Brant Beach	17.80	7.70	56.00	11.03
LRP 67	LBT, Brant Beach	18.70	9.30	68.00	22.10
LRP 67-1	LBT, Beach Haven Crest	18.90	7.60	99.00	26.97
LRP 68	LBT, Brighton Beach	18.90	7.60	114.00	26.94
LRP 68-1	LBT, Peahala Park	19.90	7.80	168.00	35.99
LRP 69	LBT, Beach Haven Park	21.10	7.60	120.00	30.63
LRP 69-1	LBT, Haven Beach	17.10	7.20	108.00	13.91
LRP 70	LBT, Beach Haven Terrace	15.90	6.30	143.00	32.88
LRP 70-1	LBT, Beach Haven Gardens	18.20	7.10	150.00	14.53
LRP 71	LBT, Spray Beach	22.70	7.90	118.00	47.78
LRP 71-1	LBT, North Beach Haven	18.20	7.40	103.00	24.70
LRP 72	Beach Haven Boro	20.80	7.90	120.00	45.84
LRP 72-1	Beach Haven Boro	18.40	7.10	104.00	37.21
LRP 73A	Beach Haven Boro	17.20	7.10	177.00	45.93
LRP 73-1	Beach Haven Boro	11.90	7.20	58.00	9.10
LRP 74	Beach Haven Boro	20.10	6.70	137.00	47.91
LRP 74-1	LBT, Holgate	19.60	8.60	99.00	40.99
LRP 75	Wildlife Refuge				
AVERAGE CONDITIONS		**18.72**	**7.74**	**114.92**	**34.56**

in the present shore regime, and how such patterns may influence future shore positions; and (c) evaluate if the present shore regime is more or less in a state of dynamic equilibrium or in a state of change with a particular trend, i.e., accretion or erosion. This investigation provided the opportunity to provide a very detailed analysis of historic shoreline movements which can readily be expanded as new shoreline position maps are added to the UASCE and NJDEP State's GIS database.

Prior Studies, Reports, and Projects for Manasquan to Barnegat Inlet. Reports pertinent to Long Beach Island were compiled and reviewed for this historic shoreline change evaluation. This information was used to develop a quantitative understanding of historic behavior of the study area shorelines. Shoreline change rates can vary significantly depending on the methodology used and time period analyzed. The reports reviewed include:

1. House Document No. 208, "Shore of New Jersey - Barnegat Inlet to Cape May Canal, Beach Erosion Control Study, " 1959;

2. House Document No. 94-631, "New Jersey Coastal Inlets and Beaches - Barnegat Inlet to Longport ," 1976;

3. USACE, Philadelphia District., <u>New Jersey Shore Protection Study - Report of Limited Reconnaissance Study</u>, Philadelphia, Pennsylvania, September 1990;

4. USACE, CERC MP-80-9, <u>Beach Changes at Long Beach Island, New Jersey, 1962-1973</u>, 1980;

5. Farrell, S. C., Speer, B., Hafner, S., Lepp, T., and Ebersold, S.E. 1998. "New Jersey Beach Profile Network, Analysis of the Shoreline Changes in New Jersey Coastal Reaches One through Fifteen, Raritan Bay to Delaware Bay," prepared for New Jersey Department of Environmental Protection, Coastal Research Center, Stockton State College, Pomona, NJ.

6. Farrell, S. C. et al. A number of profile lines are monitored annually by Stockton State College for the State of NJ as part of the NJ Beach Profile Network. A series of reports by Farrell, et al. (1991, 1993, 1994, 1995, 1997) analyzes this data for annual volumetric and morphologic changes.

7. Farrell, S.C., Inglin, D., Venanzi, P., and Leatherman, S. 1989. "A Summary Document for the Use and Interpretation of the Historical Shoreline Change Maps for the State of New Jersey," prepared for New Jersey Department of Environmental Protection, Coastal Research Center, Stockton State College, Pomona, NJ.

8. "Barnegat Inlet to Little Egg Inlet Reconnaissance Study," U.S. Army Engineer District, Philadelphia, March 1995.

Historic Shoreline Change Analysis. Digital shoreline change maps prepared for the State of New Jersey Historical Shoreline Map Series (Farrell et al. 1989) were reviewed to evaluate general shoreline trends. These maps include MHW shorelines from 1836-42, 1855, 1866-68, 1871-75, 1879-85, 1899, 1932-36, 1943, 1951-53, 1971, 1977, and 1986. Added to the analysis were interpreted MHW shoreline positions from recently digitize aerials for the years 1991, 1993, and 1997. Additionally a 1996 MHW shoreline obtained from digital photogrammetry was incorporated into the analysis. As part of the coastal structure inventory effort, the groins along LBI were remotely surveyed and mapped in July 1996 using the Scanning Hydrographic Operational Airborne Lidar Survey (SHOALS). The SHOALS survey also provided mapping of the MHW contour. Comparison of the SHOALS contour to the MHW contour derived from the photogrammetry yielded minor differences. The photogrammetry contour was utilized as the 1996 shoreline in the analysis.

All shoreline position data were initially converted to the NJ State Plane NAD 83 horizontal coordinate system, if necessary. As part of this feasibility study, a detailed quantitative analysis was done to compute shoreline change rates from these maps. Several of the shorelines were missing, incomplete, or invalid for this area, therefore shoreline change rates were computed for the following periods: 1899, 1934, 1952, 1971, 1977, 1986, 1991, 1993, 1996, and 1997.

The shoreline change analysis involved rotating and translating each digital shoreline to a user-defined coordinate system. The coordinate system will hereafter be referred to as the GENESIS coordinate system. The origin of the coordinate system is located adjacent to Barnegat Inlet (603,000 N, 338,900 E) with a rotation angle of 119.5 deg with respect to north (**Figure 2-12**). The alongshore coordinates ranged from 0 at Barnegat Inlet to 95,870 ft at the terminal groin located north of the Holgate Wildlife Refuge. Plotting the shorelines in the GENESIS coordinate system using a distorted scale (**Figure 2-13**) displays the deviation in shoreline orientation as well the overall historic shoreline changes throughout the Island.

The digital shorelines were segmented into discrete compartments alongshore that were spaced 1,000 ft. apart except in areas where groin compartments were used (**Figure 2-14**). In the vicinity of Barnegat Inlet, compartment boundaries were selected to correspond to limits represented by MCCP profile conditions for comparative purposes. **Figures 2-15 to 2-29** display the compartment boundaries and recent shoreline positions for each BUNDY.

A mean shoreline position was computed within each compartment by integrating the shoreline with respect to the coordinate system over the length of the compartment and dividing by the length of the compartment. A least squares fit of the mean shoreline positions versus date data was performed for each compartment to determine a shoreline change rate. **Figure 2-30** displays the digitized shorelines in GENESIS coordinates (compartment 58 located in Brant Beach), the computed mean shorelines for each time period, and the resulting shoreline change rates computed for select time periods. **Figure 2-31** displays the computed mean shoreline positions for all compartments throughout

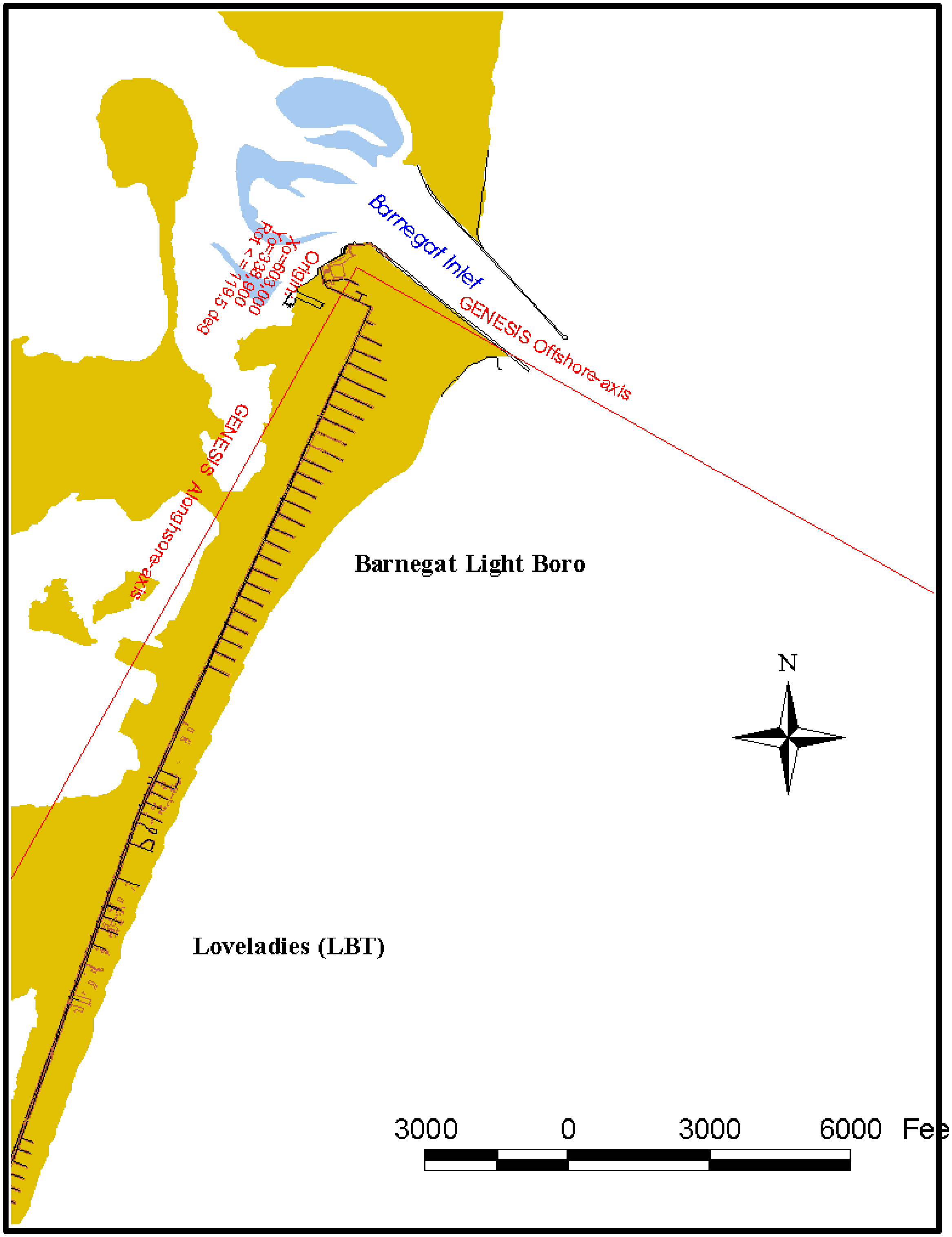


Figure 2-12 GENESIS Coordinate System for Shoreline Change Analyses.

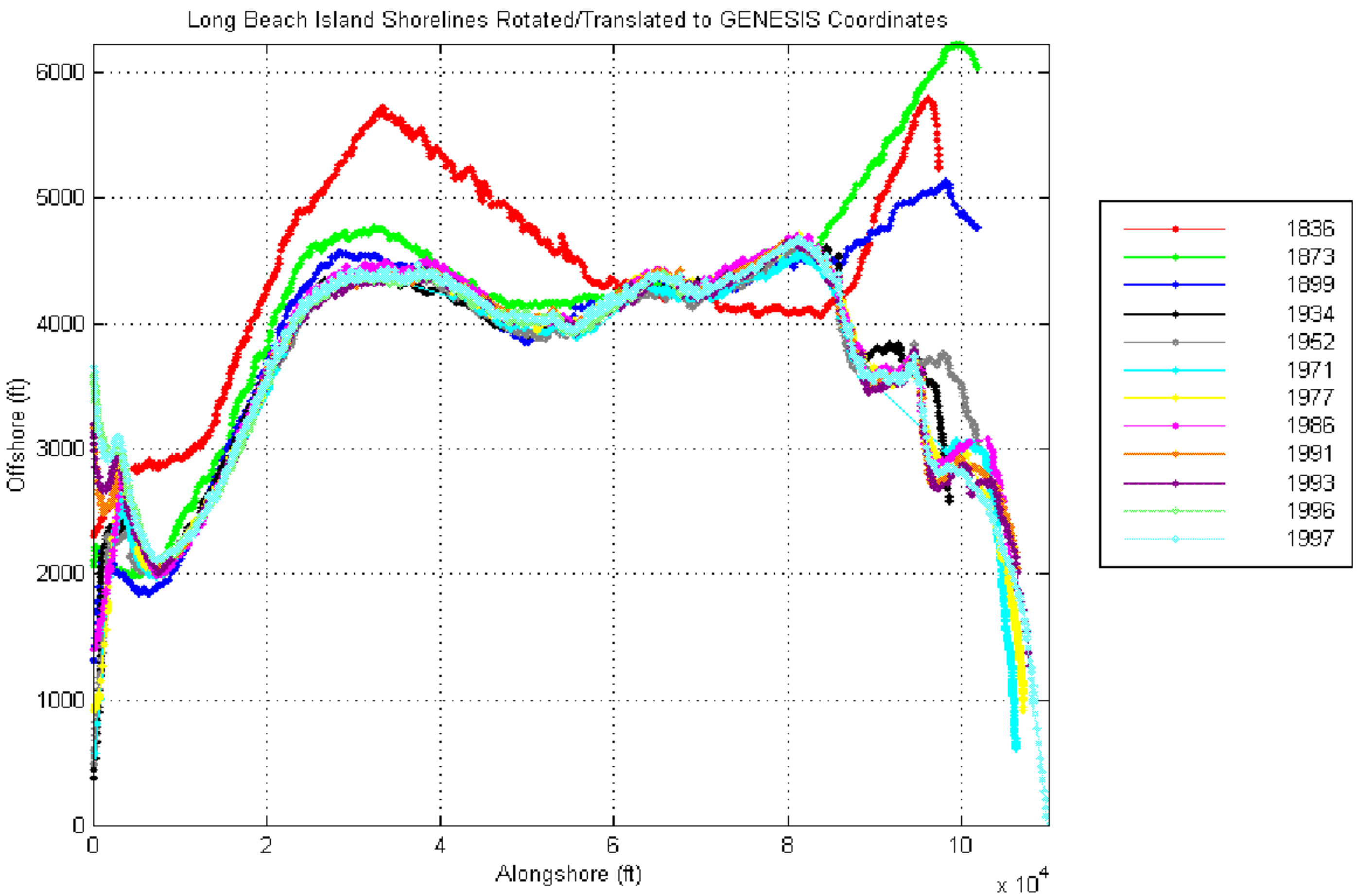


Figure 2-13 Historic Shoreline Positions in GENESIS Coordinate System.

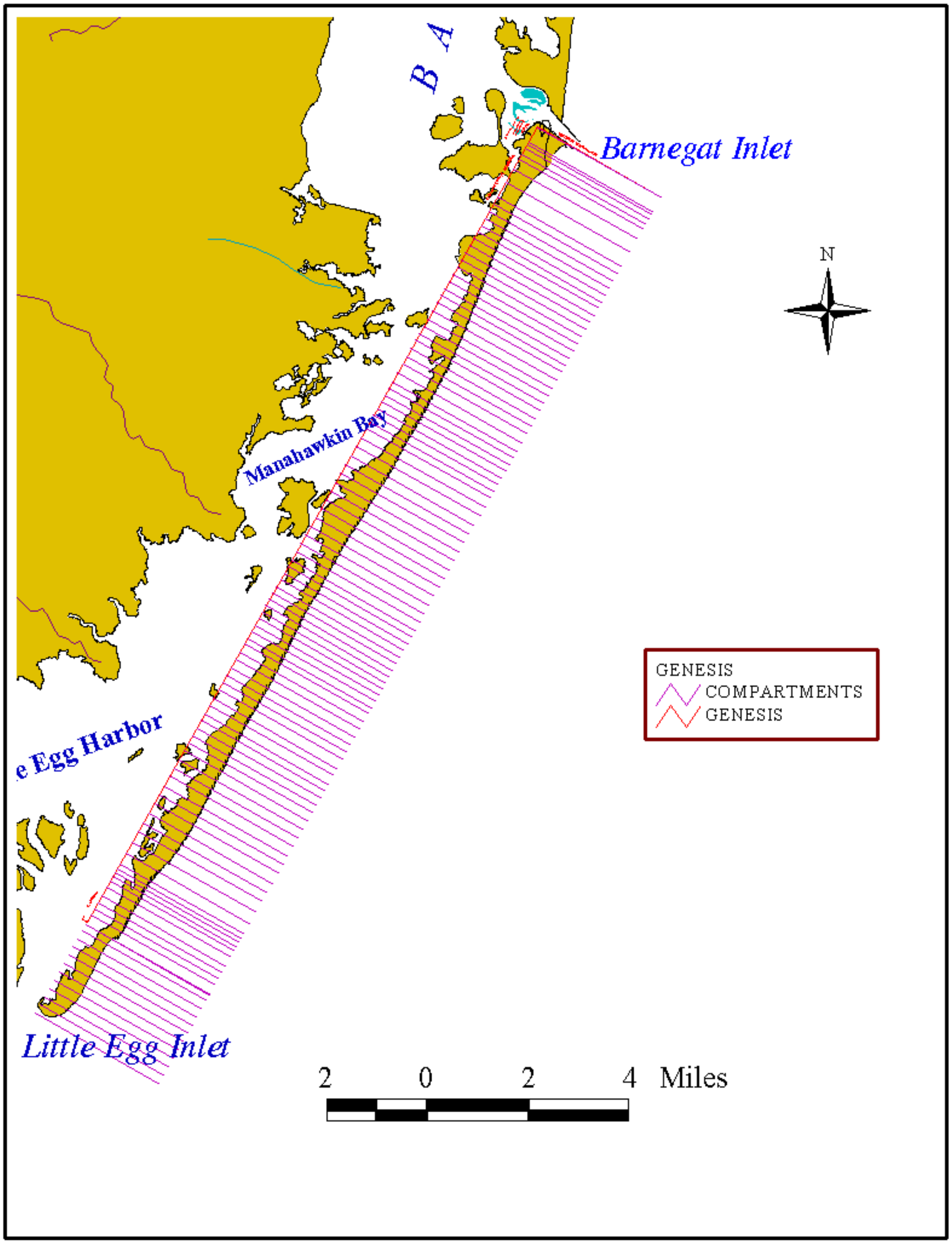


Figure 2-14 Shoreline Change Analysis Compartment Boundaries.

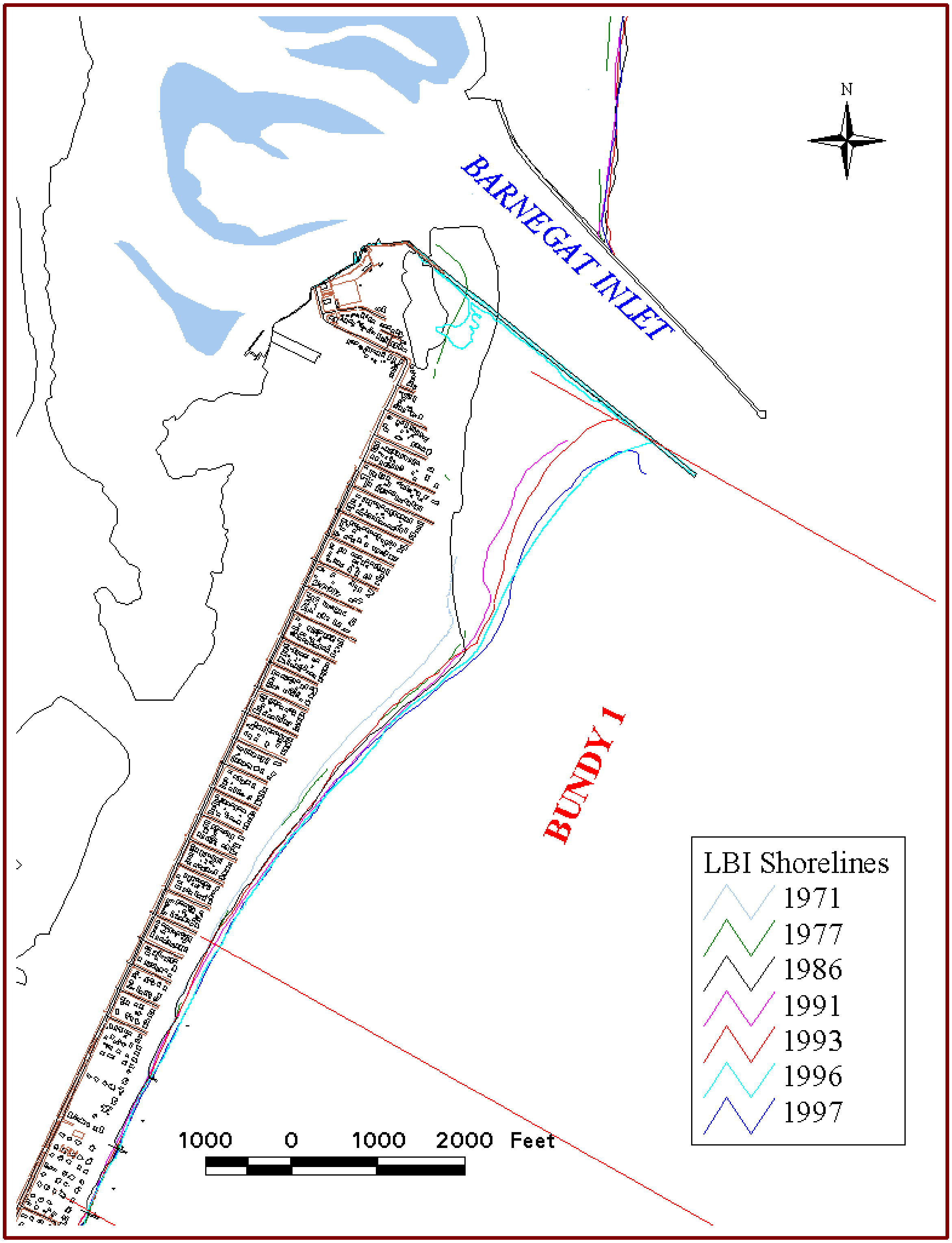


Figure 2-15 Recent Shoreline Conditions for BUNDY 1.

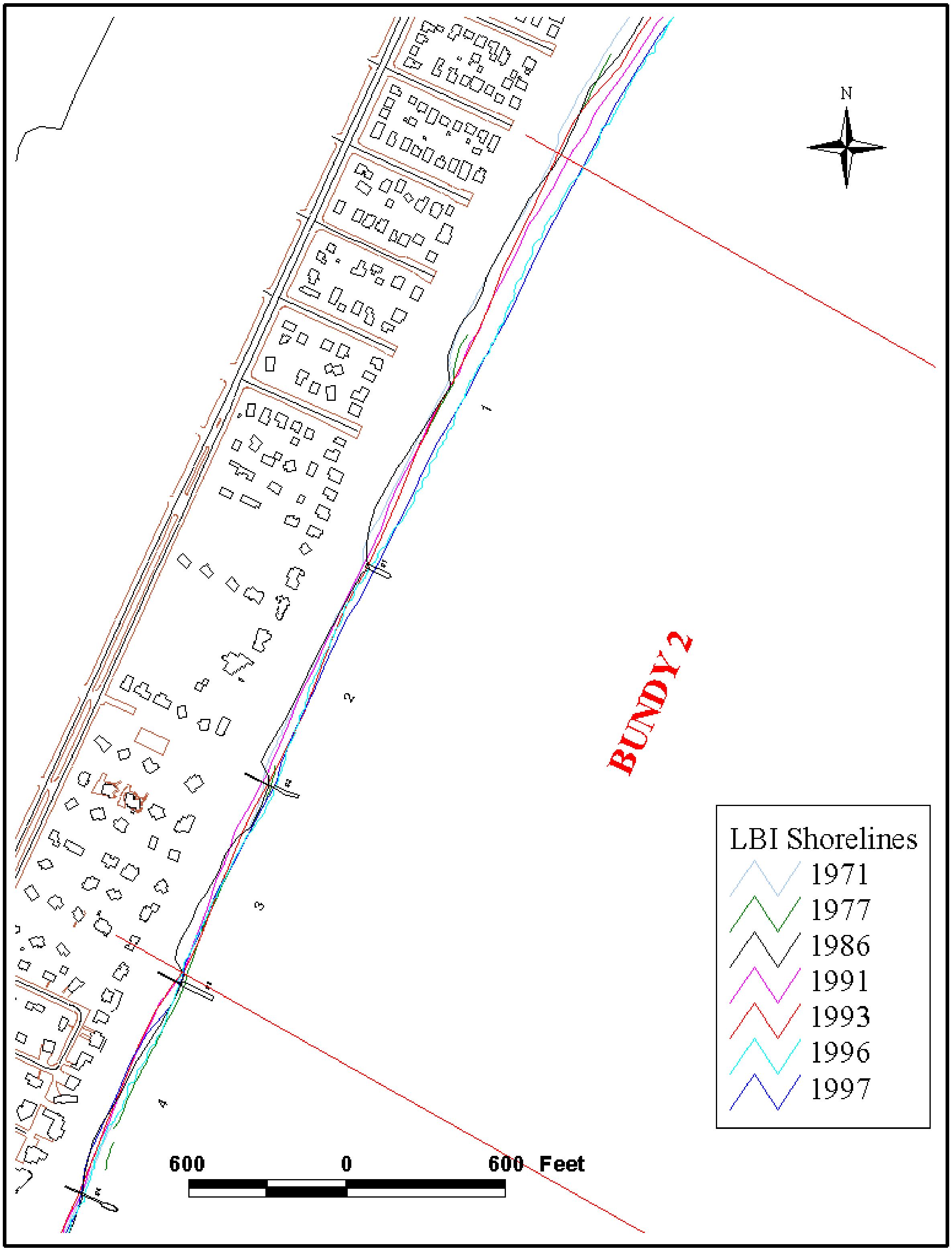


Figure 2-16 Recent Shoreline Conditions for BUNDY 2.

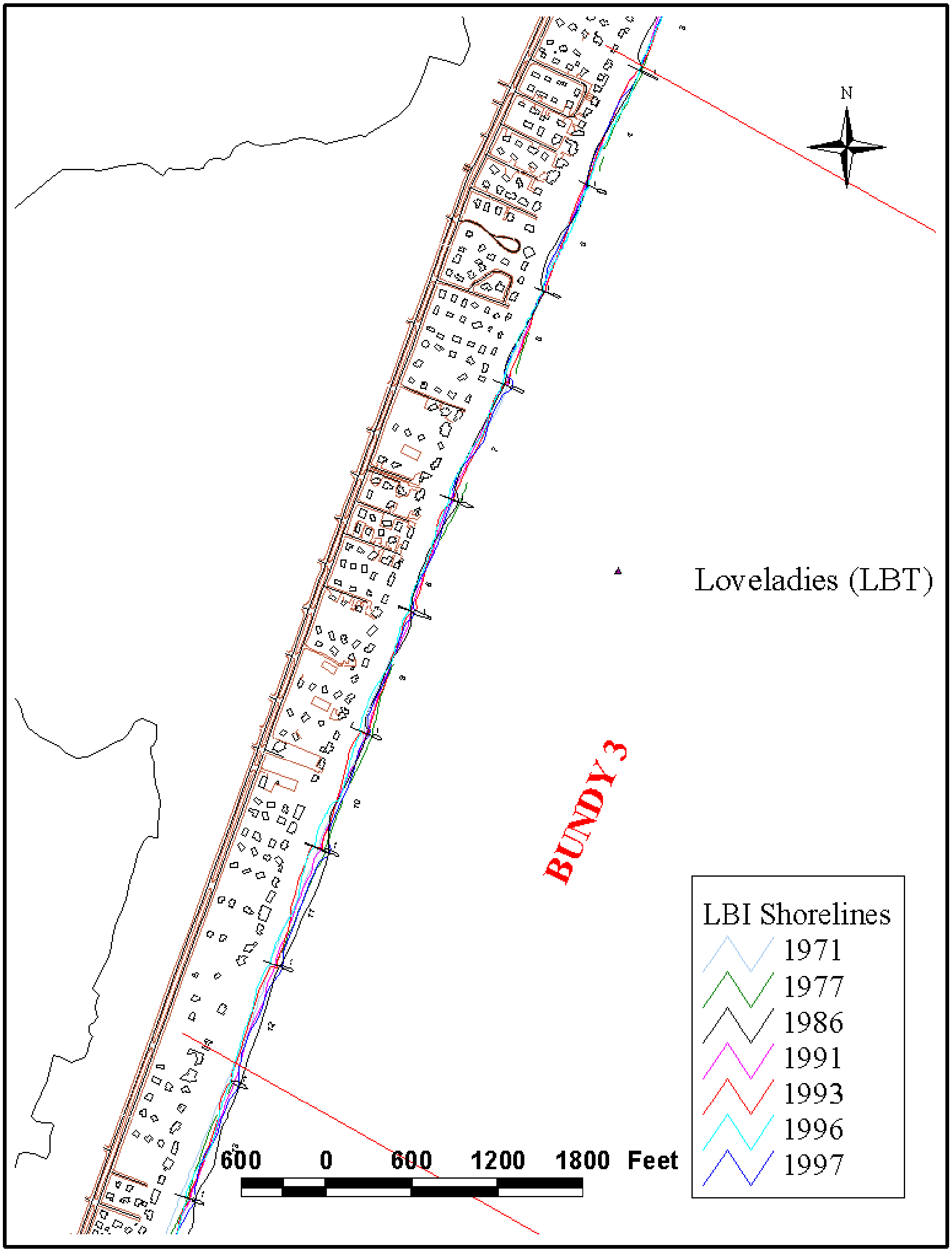


Figure 2-17 Recent Shoreline Conditions for BUNDY 3.

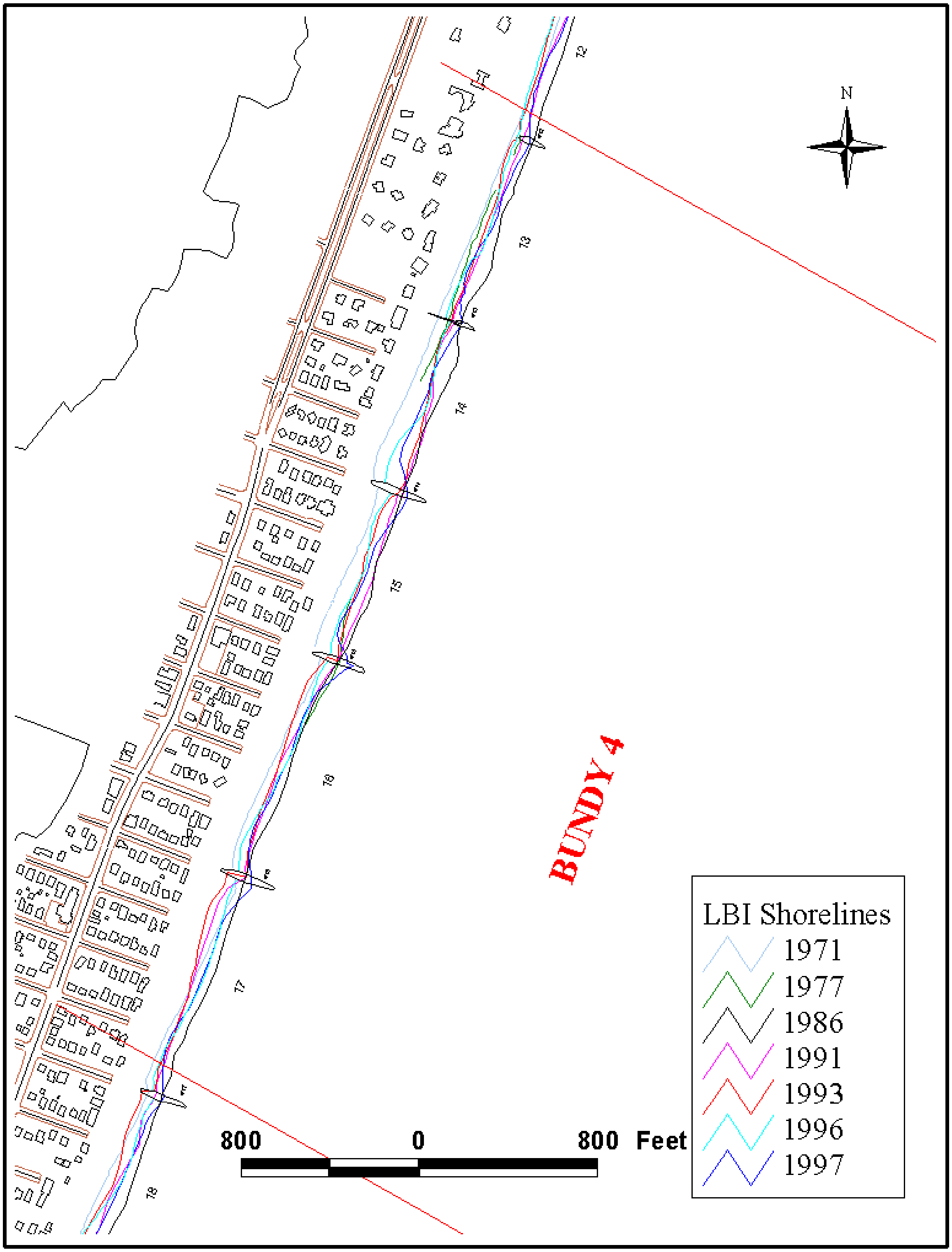


Figure 2-18 Recent Shoreline Conditions for BUNDY 4.

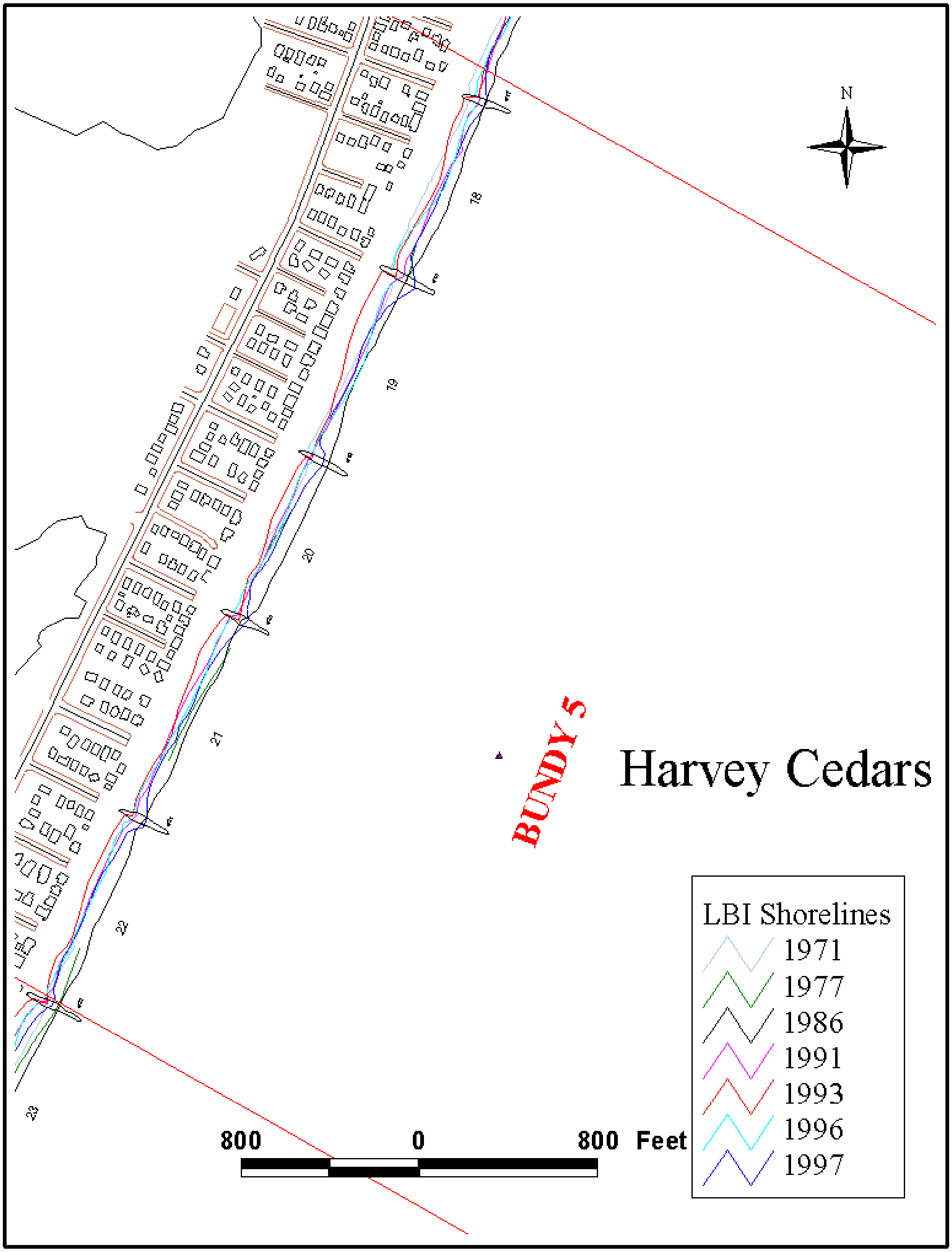


Figure 2-19 Recent Shoreline Conditions for BUNDY 5.

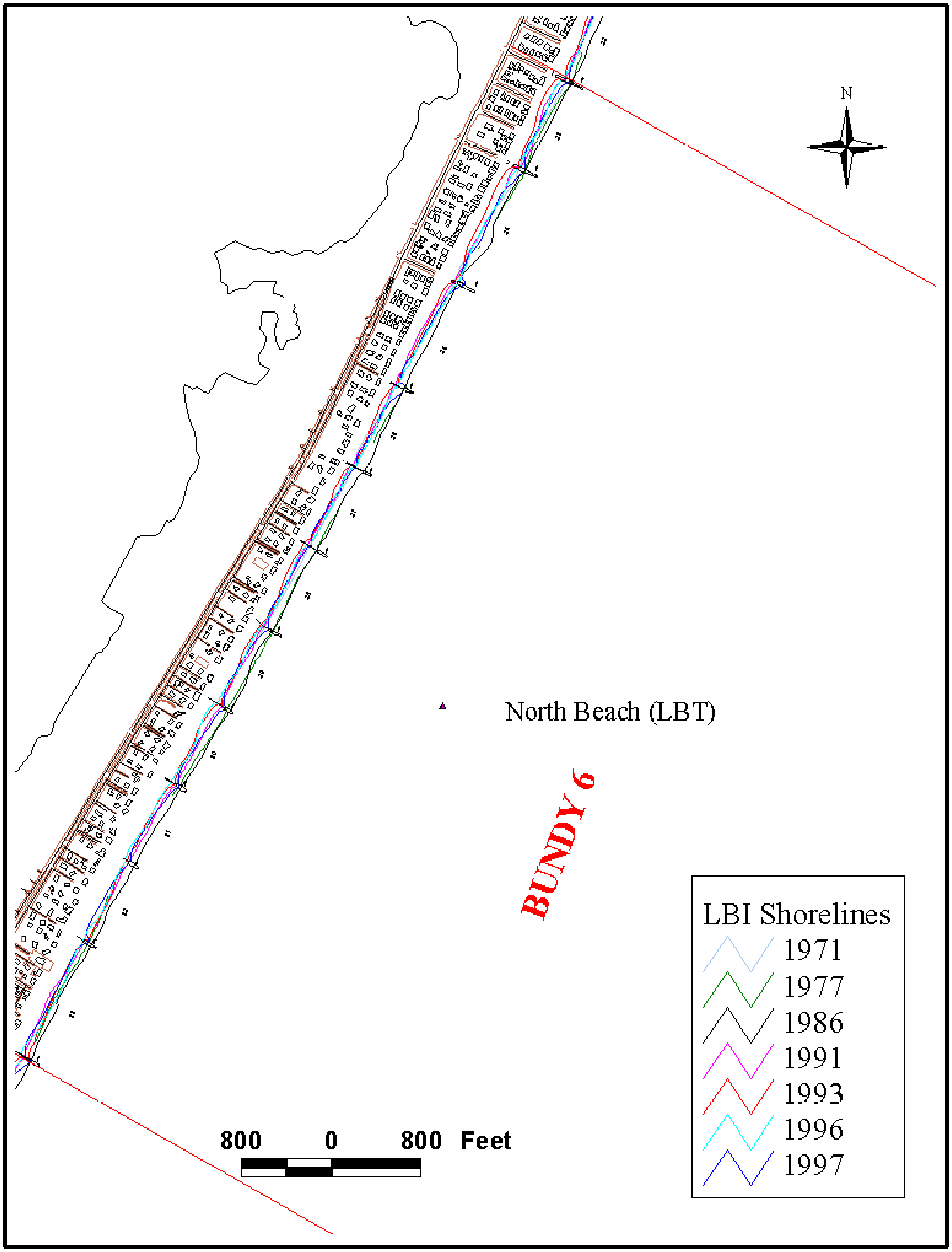


Figure 2-20 Recent Shoreline Conditions for BUNDY 6.

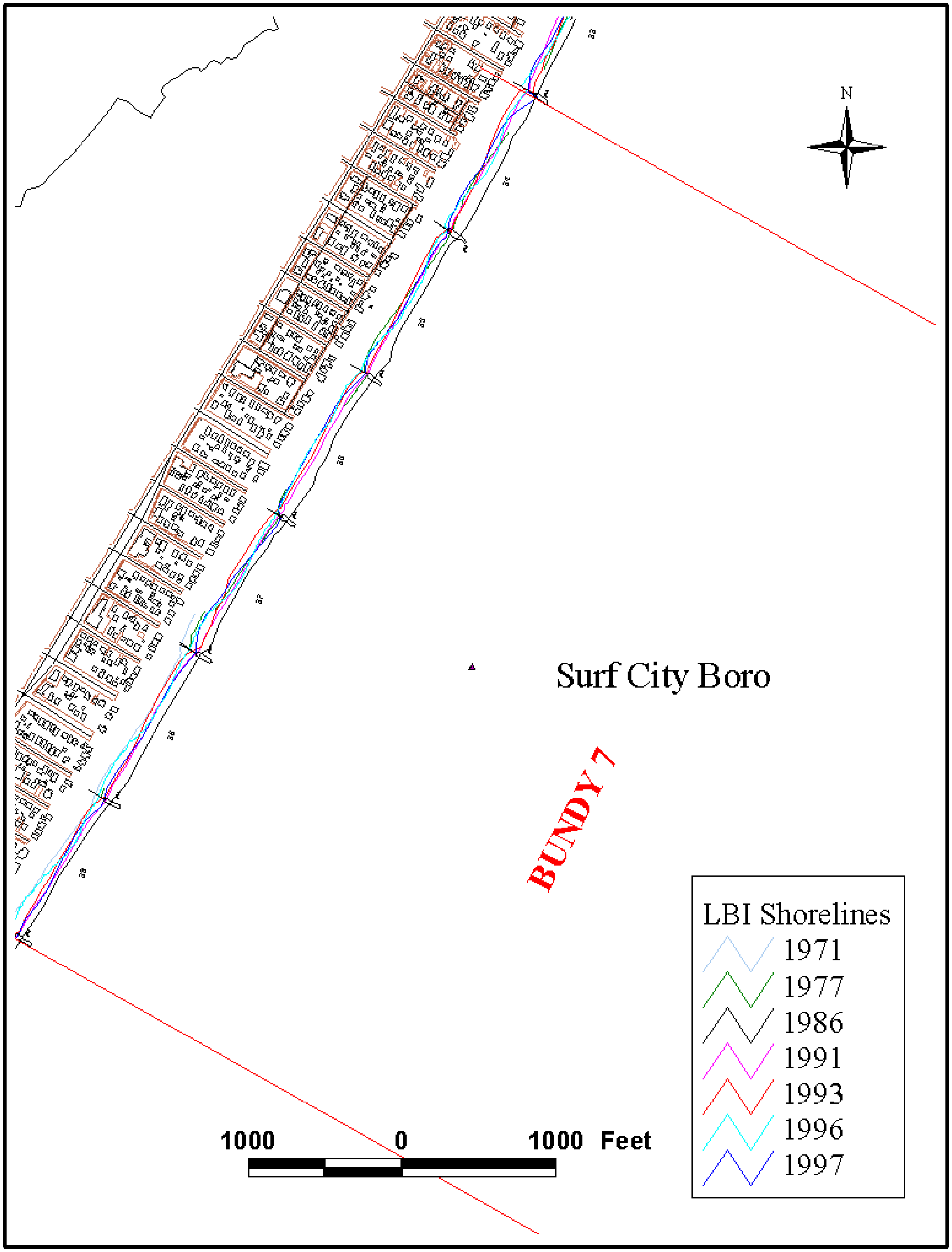


Figure 2-21 Recent Shoreline Conditions for BUNDY 7.

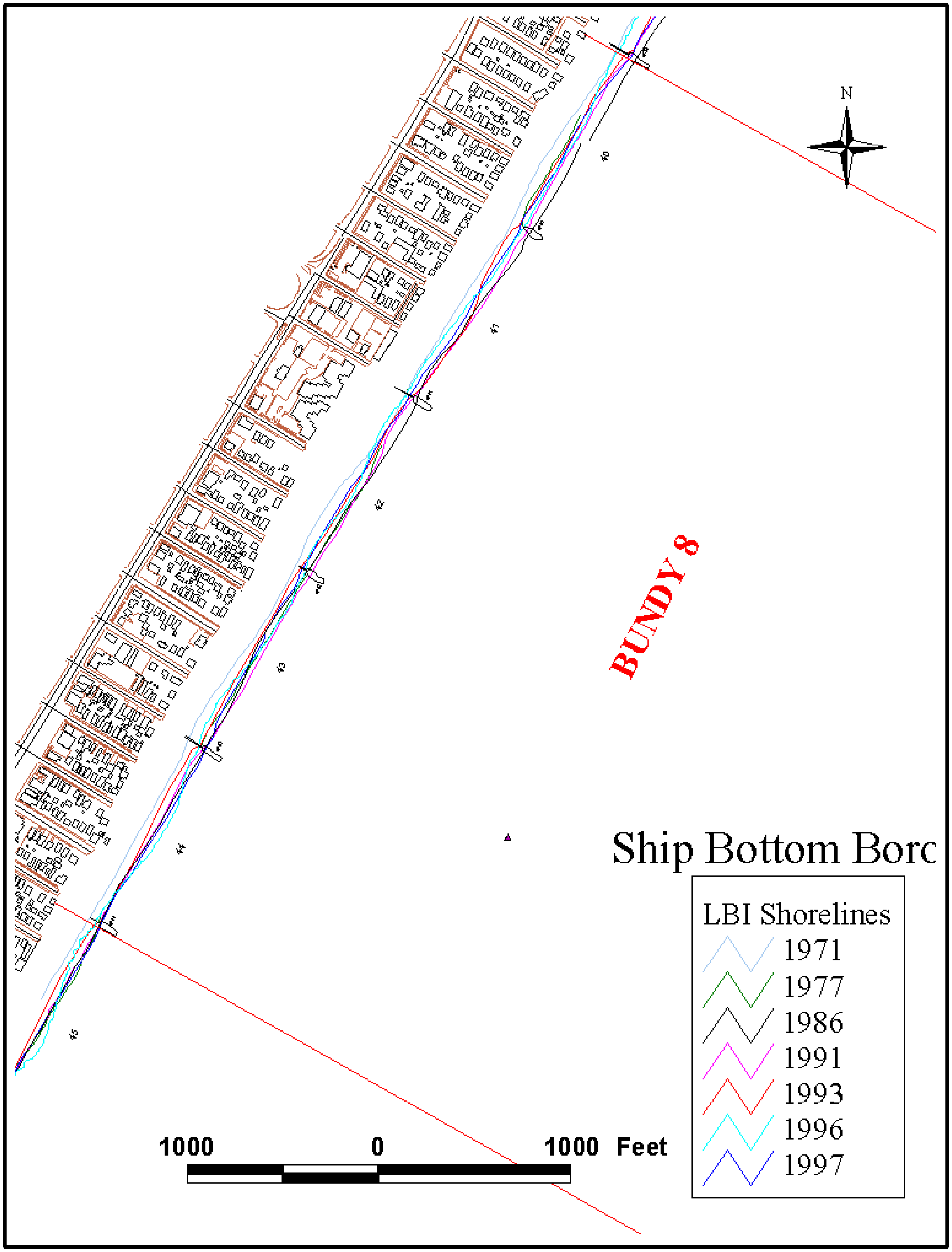


Figure 2-22 Recent Shoreline Conditions for BUNDY 8.

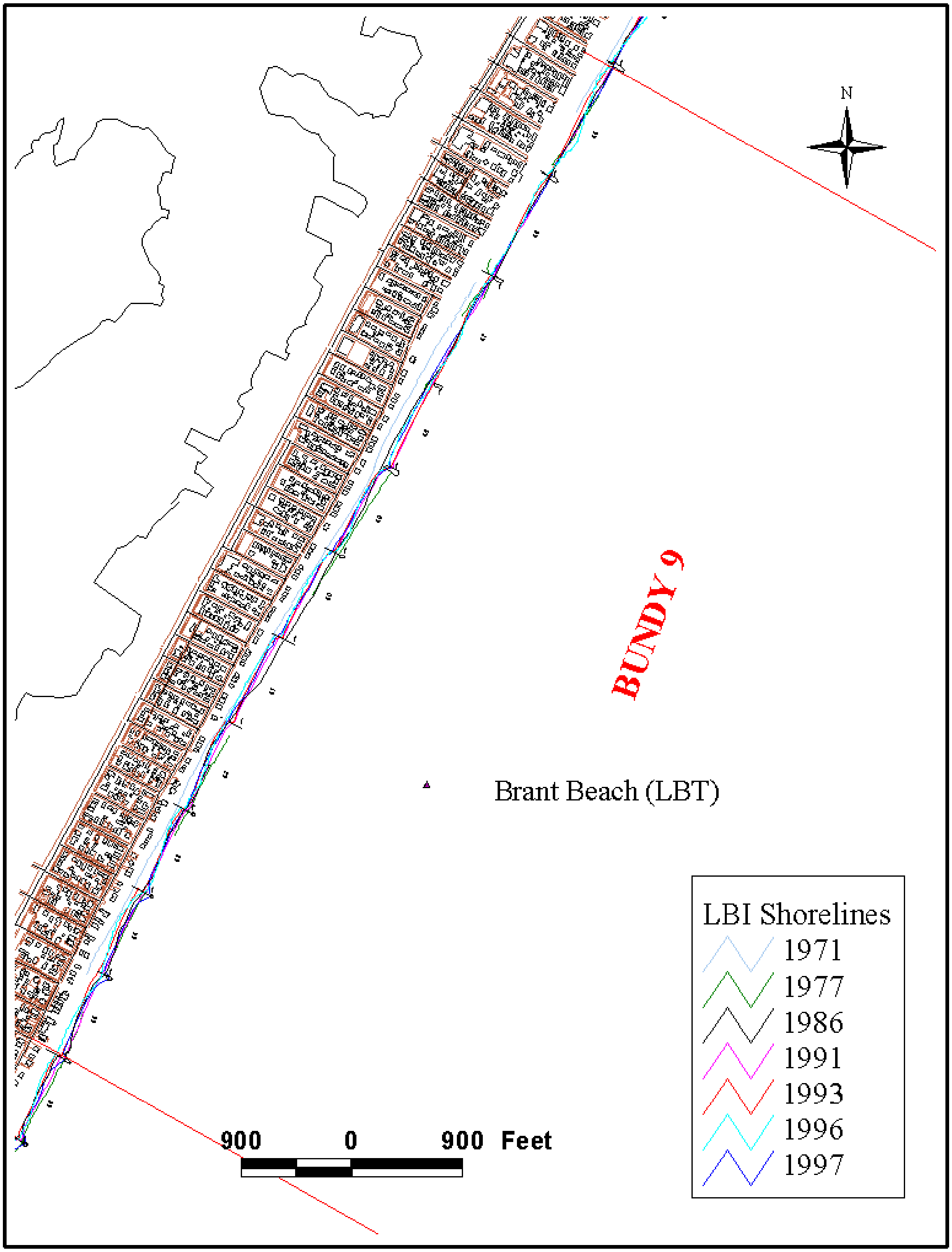


Figure 2-23 Recent Shoreline Conditions for BUNDY 9.

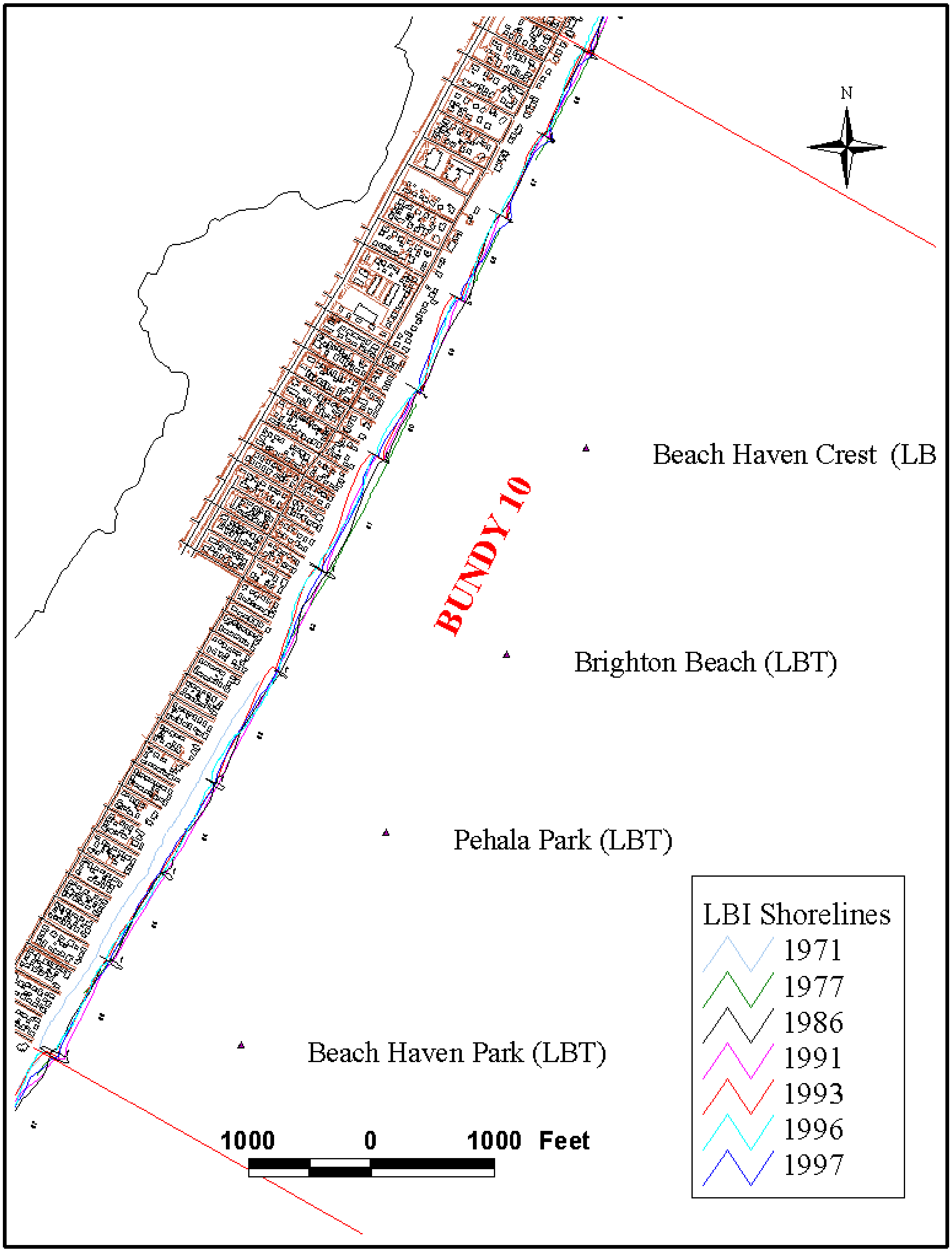


Figure 2-24 Recent Shoreline Conditions for BUNDY 10.

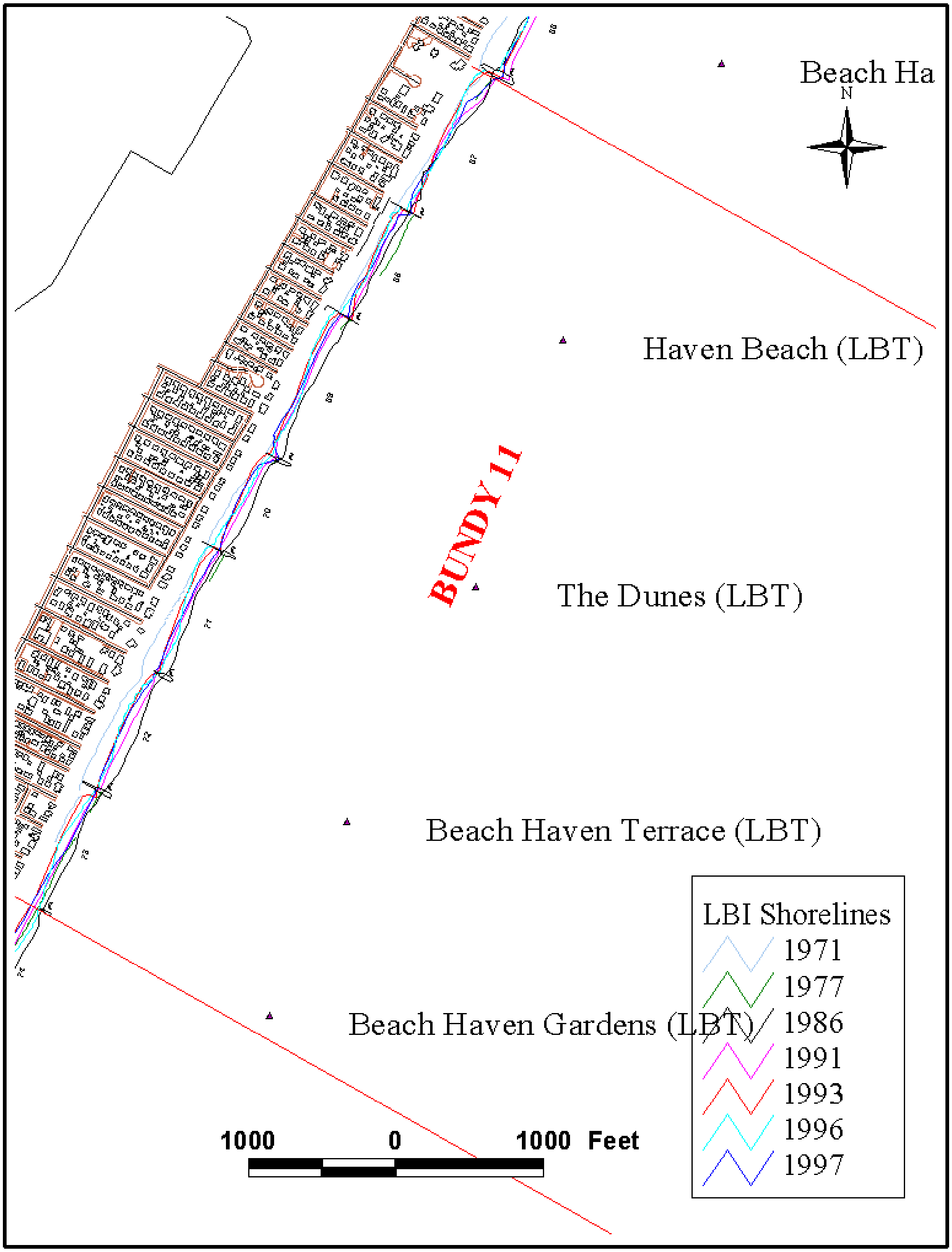


Figure 2-25 Recent Shoreline Conditions for BUNDY 11.

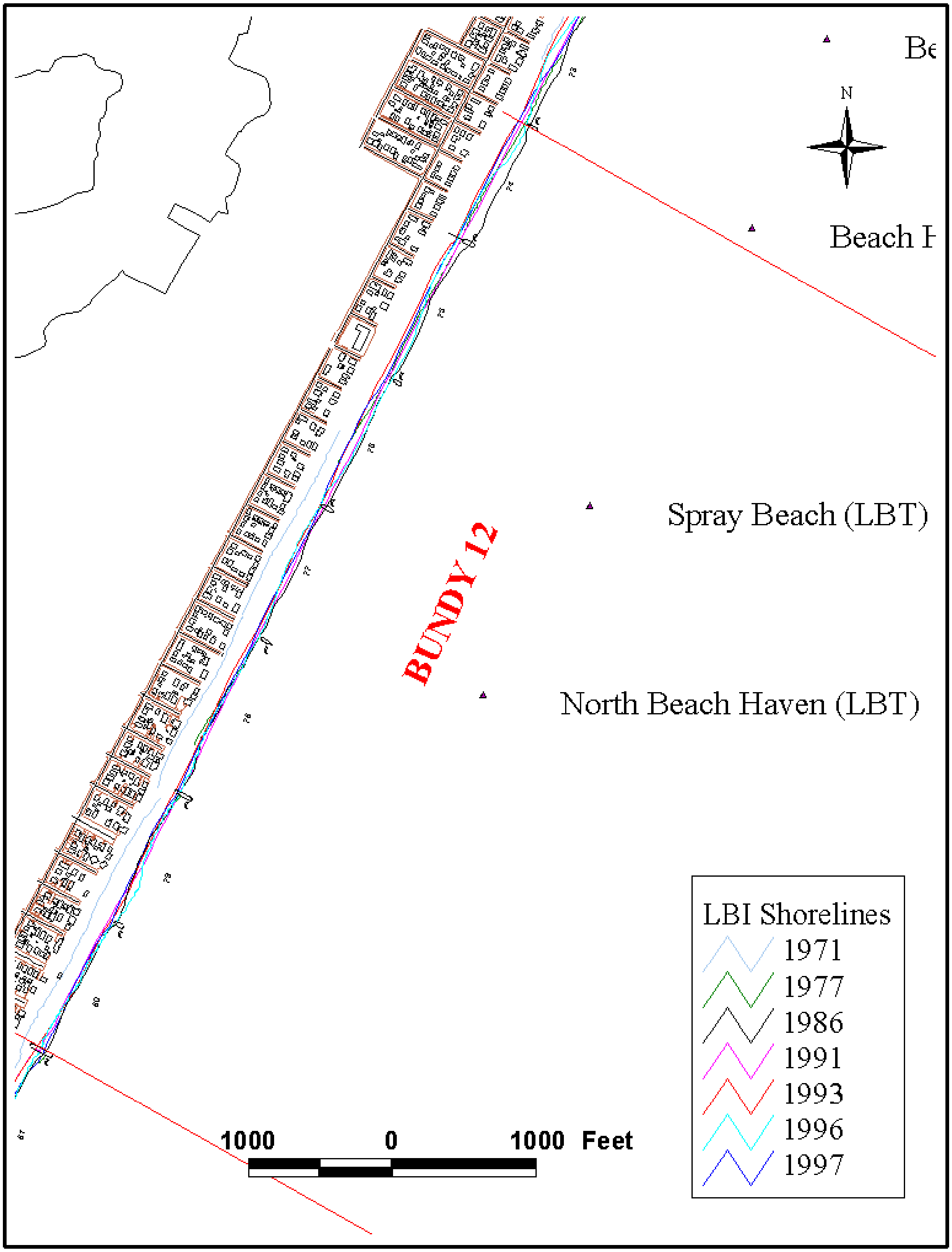


Figure 2-26 Recent Shoreline Conditions for BUNDY 12.

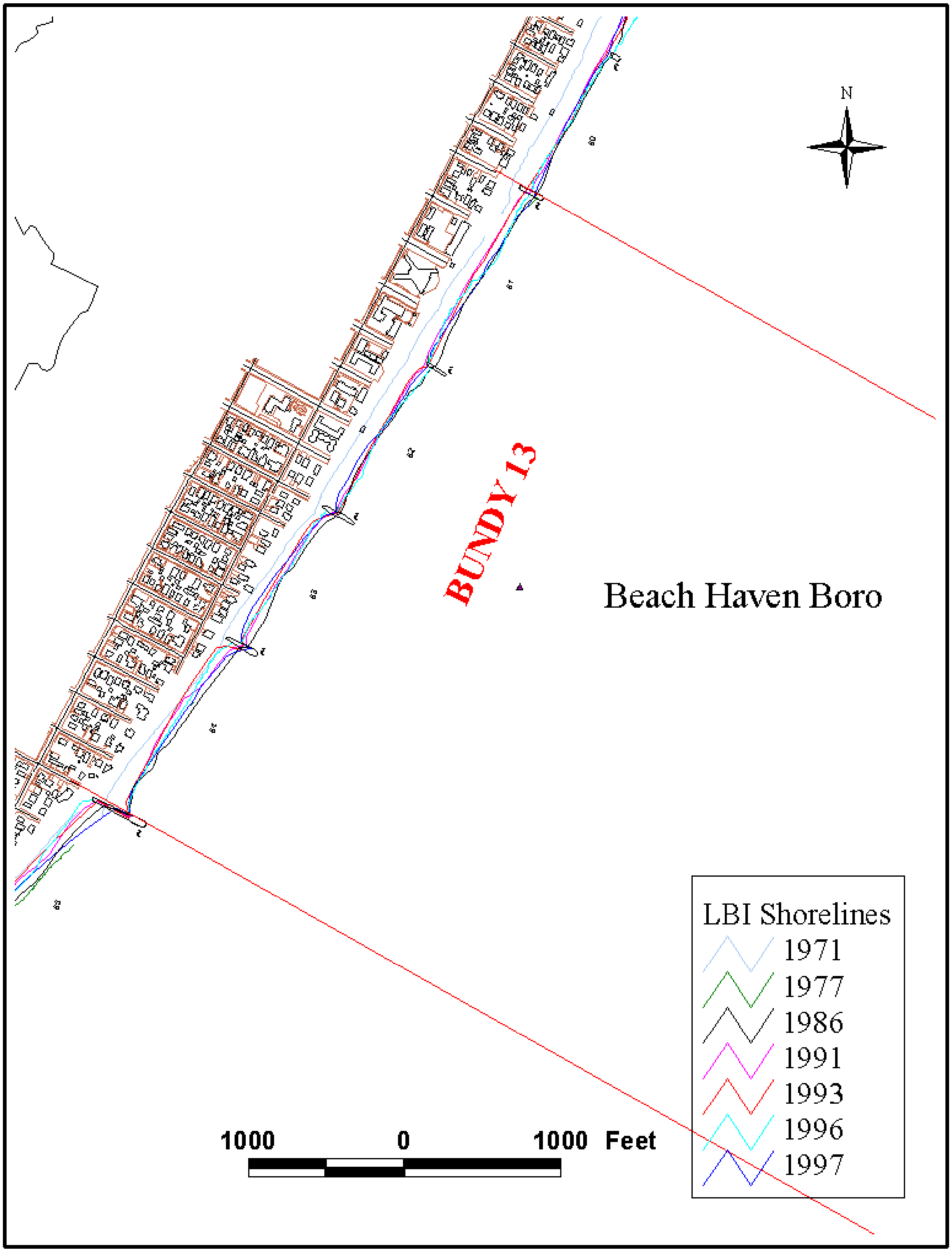


Figure 2-27 Recent Shoreline Conditions for BUNDY 13.

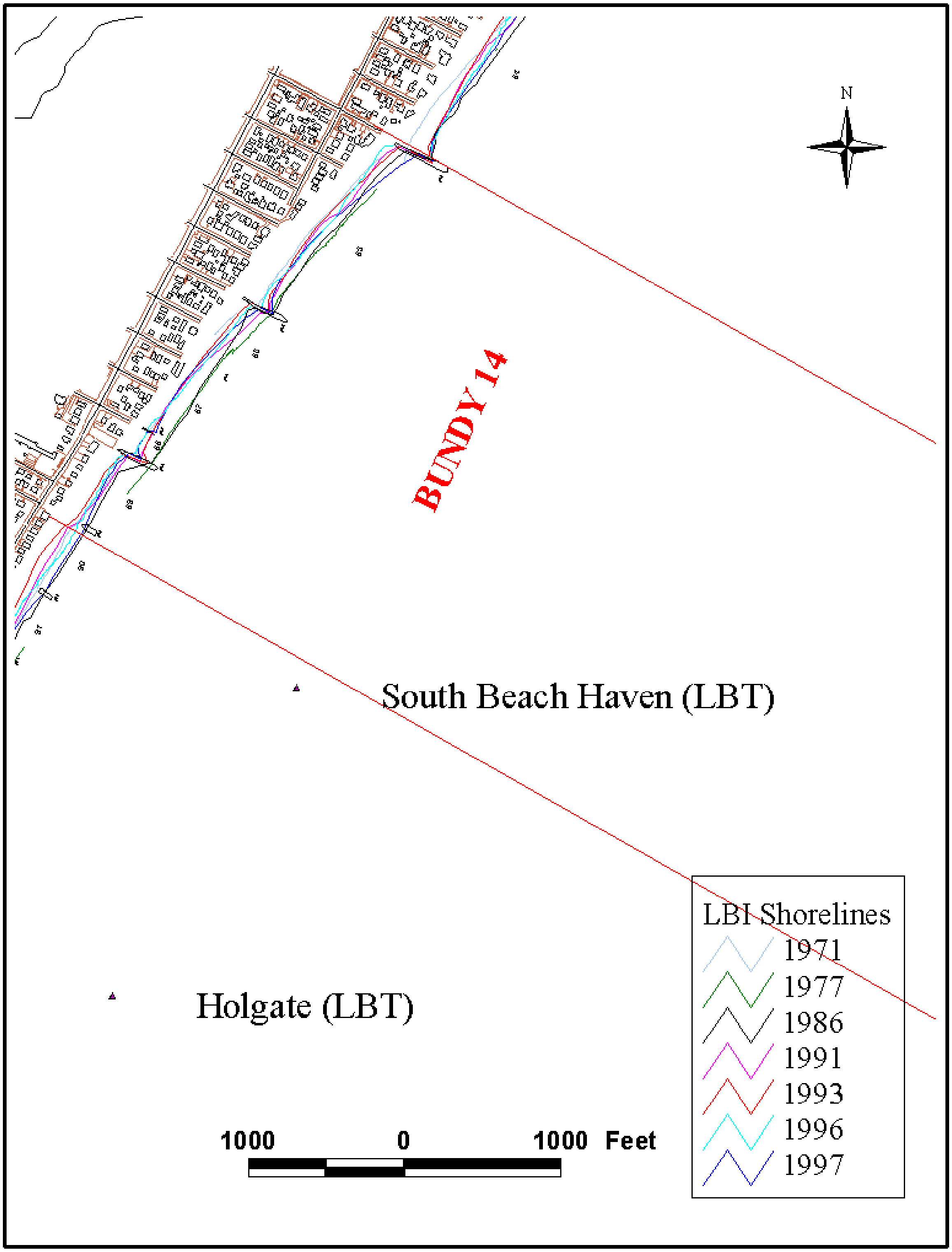


Figure 2-28 Recent Shoreline Conditions for BUNDY 14.

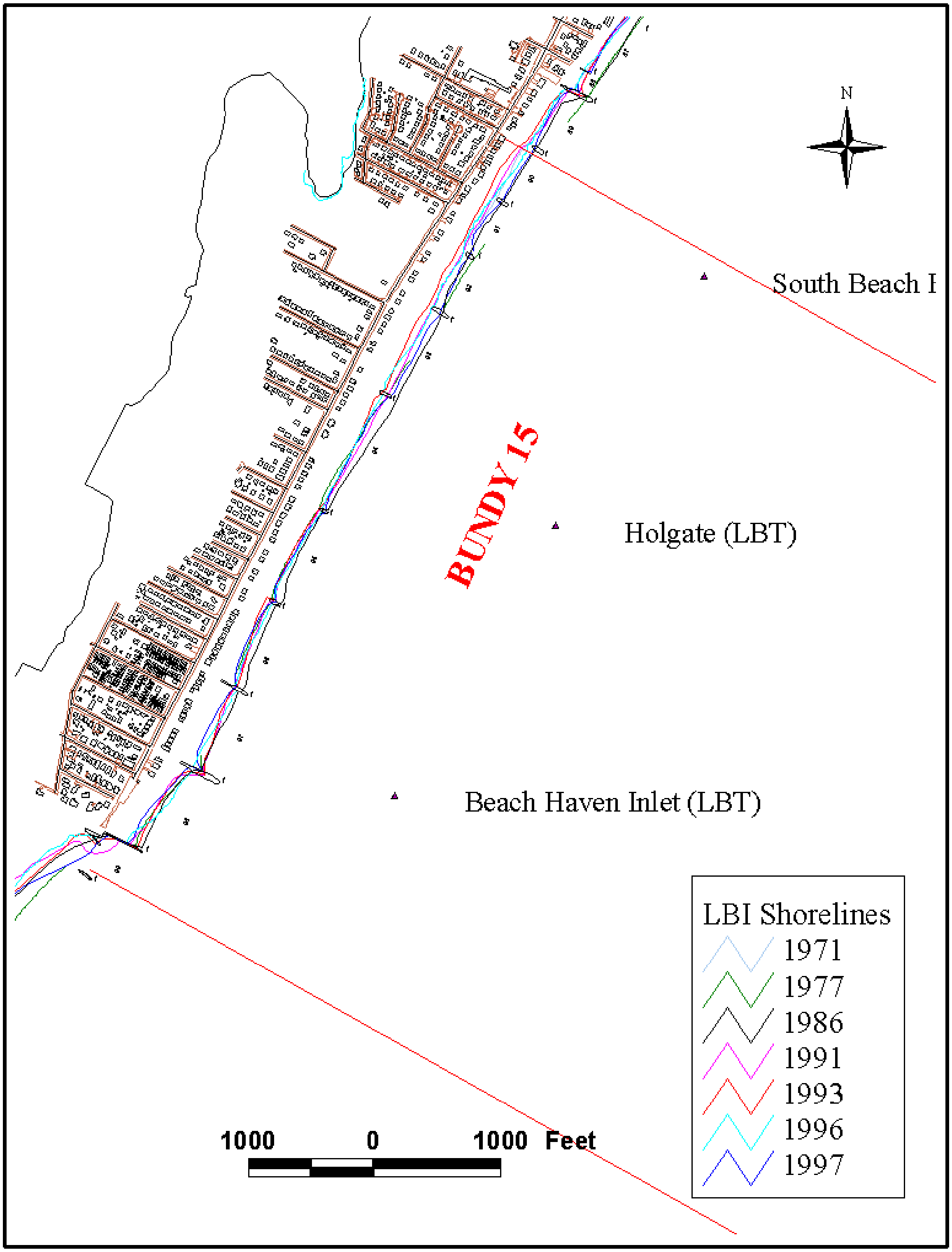
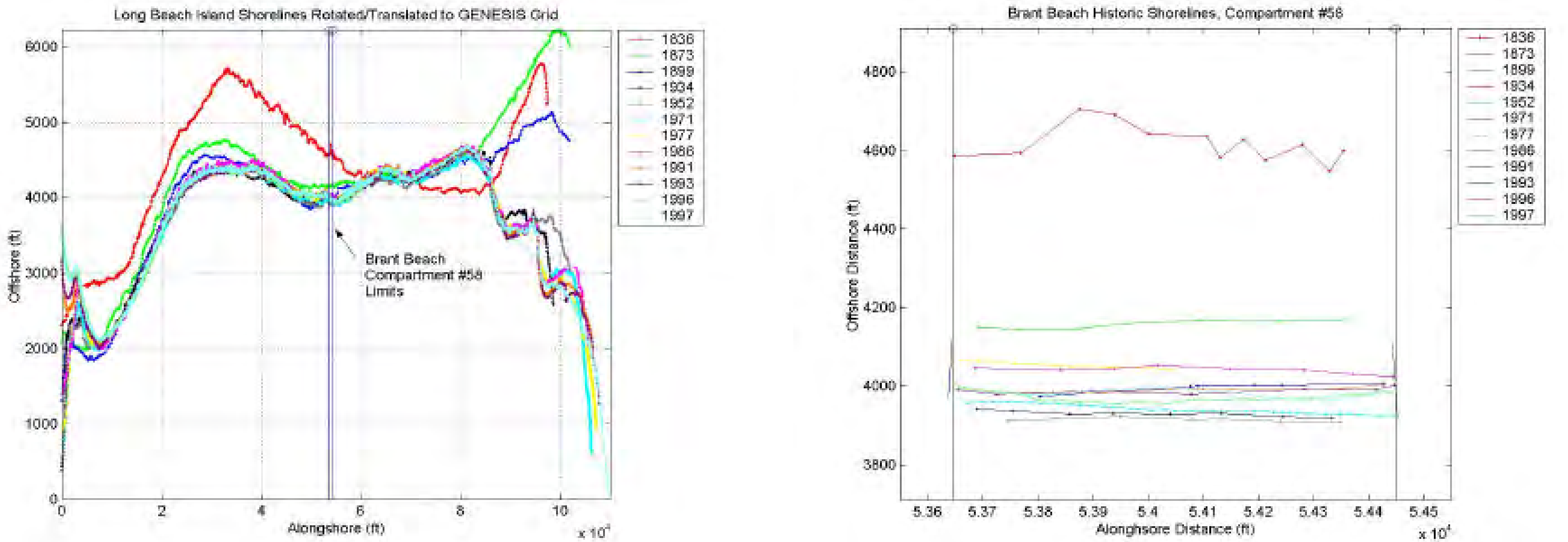
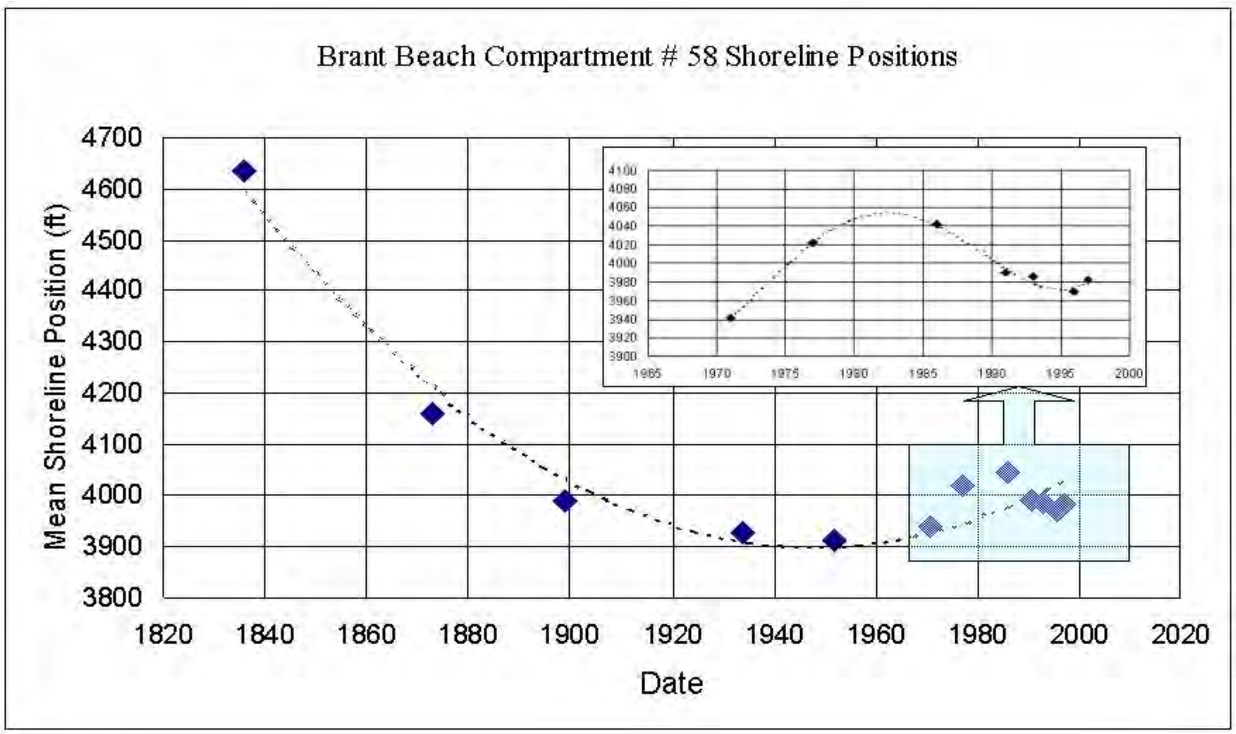


Figure 2-29 Recent Shoreline Conditions for BUNDY 15.





Shoreline Change Rates via Linear Regression

Epoch	Shoreline Change Rate (ft/yr)
1971-1997	0.26
1986-1997	-6.32
1991-1997	-2.51
1996-1997	12.60

Figure 2-30 Shoreline Change Analysis Results for Compartment 58 located in Brant Beach.

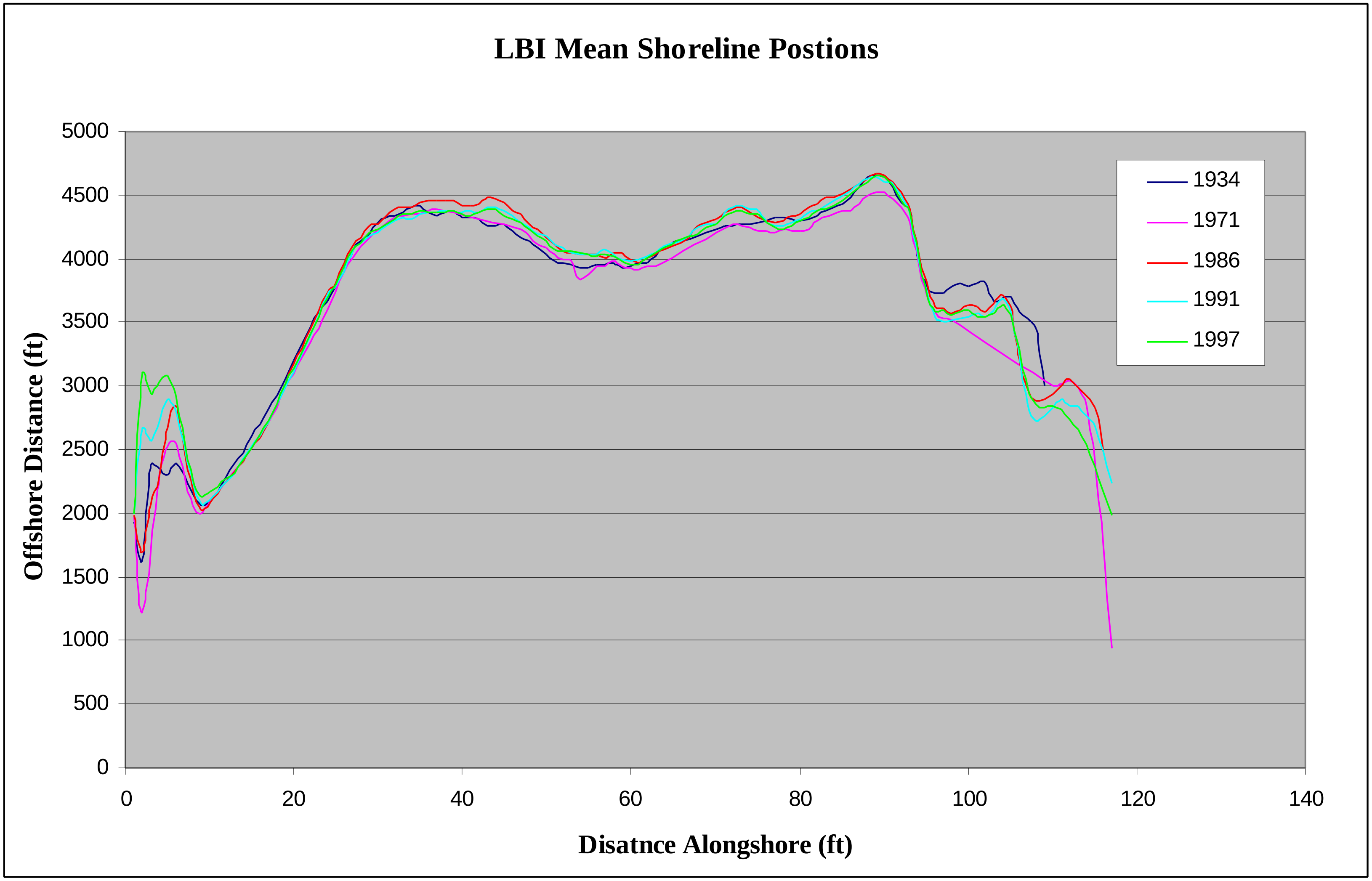


Figure 2-31 Computed Mean Shoreline Positions by Compartment.

LBI. Shoreline change rates were computed for sequential historic time periods and then relative to 1997 as displayed in **Figures 2-32 and 2-33**, respectively. Tabular results of computed mean shoreline positions, shoreline change rates by epoch, and shoreline change rates through 1997 are displayed in **Tables 2-10, 2-11, and 2-12**, respectively.

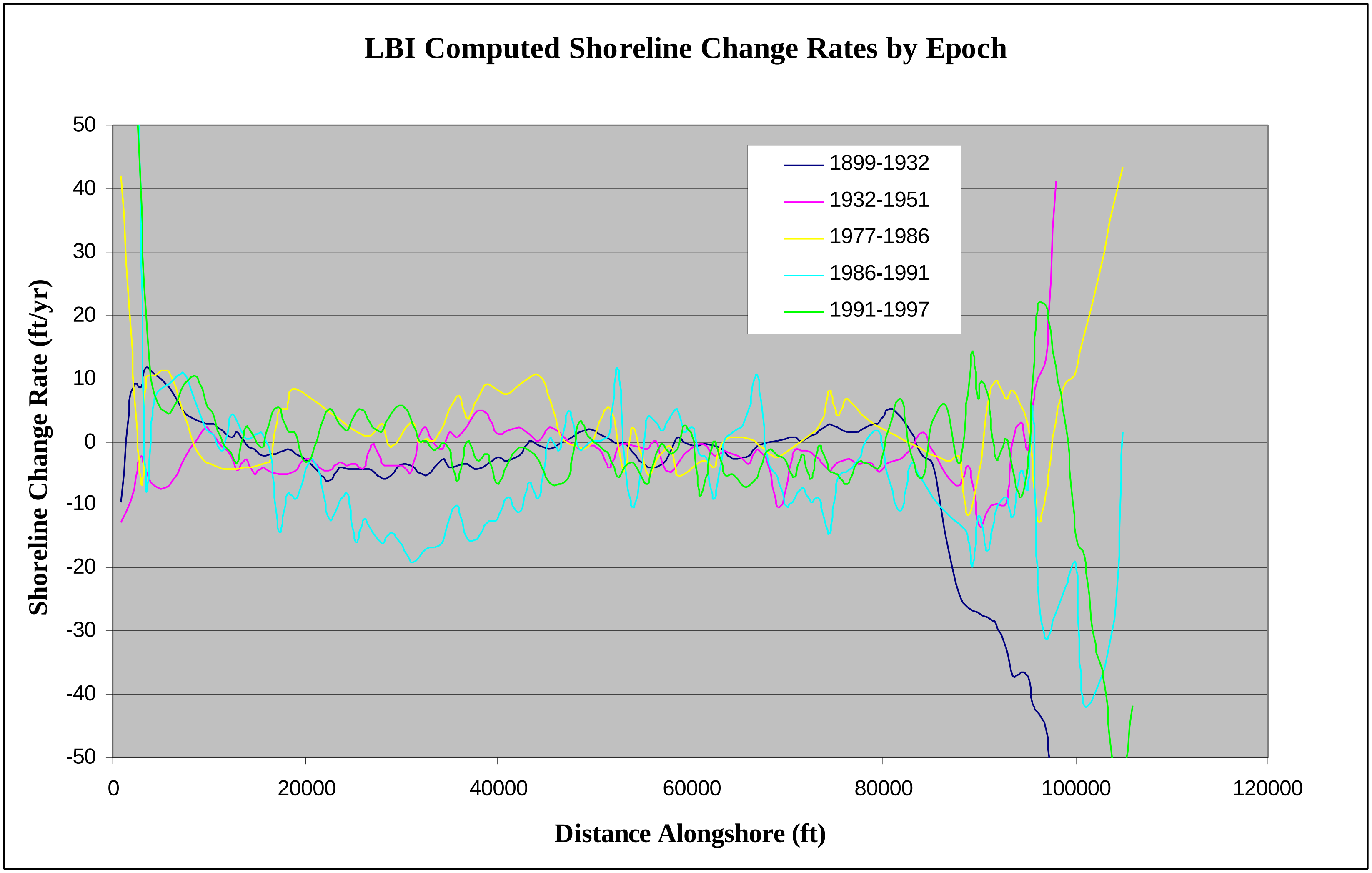


Figure 2-32 Computed Shoreline Change Rates by Epoch.

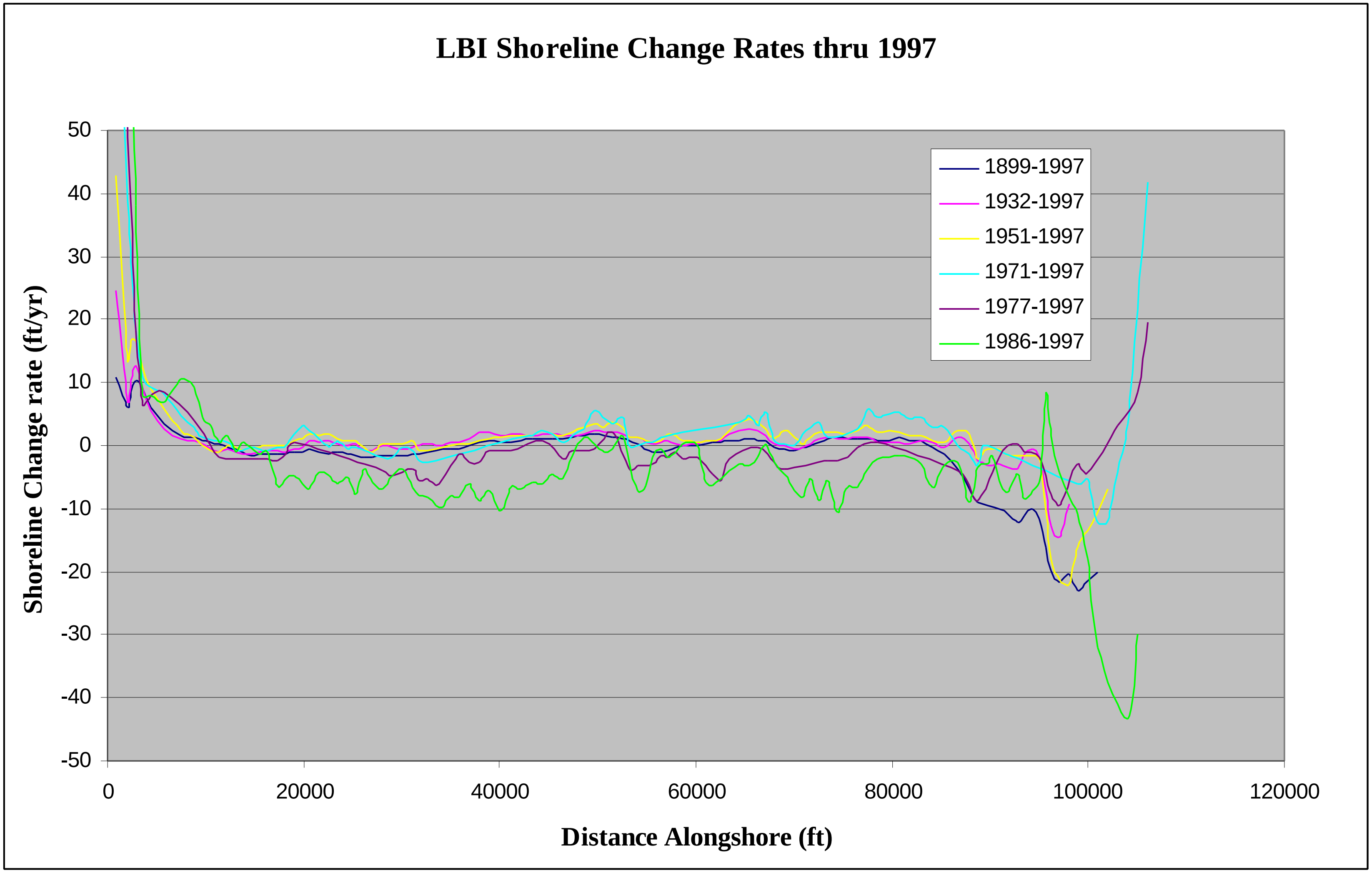


Figure 2-33 Computed Shoreline Change Rates Relative to 1997.

TABLE 2-10 Long Beach Island Computed Mean Shoreline Positions by Compartment.
Beachfills Not Removed

		Shoreline	GENESIS Coords		Mean	BOUNDING GROINS		MEAN SHORELINE POSITION (ft) wrt GENESIS COORDINATE SYSTEM											
BUNDY	COMMUNITY	Compartment	START	STOP	Distance	North	South	1836	1873	1899	1934	1952	1971	1977	1986	1991	1993	1996	1997
1	Barnegat Light	1	17.2	1821	919	None	None	2432.4	2172	1958.3	1621.4	1392.2	1214.6	1300.7	1690.9	2654.6	2749.9	3144.4	3100.6
		2	1821	2135	1978	None	None	2576.7	2100.7	2111.1	2383.6	2216.6	#N/A	#N/A	2067.5	2560	2757.5	2963	2936
		3	2135	2601	2368	None	None	2653.1	2046.1	2031.3	2349.9	2248.4	2293.3	#N/A	2276.2	2717.3	2876	2966.7	3030.3
		4	2601	3210	2906	None	None	2783.2	2026.2	2008.2	2306.2	2267.6	2529.5	2728.9	2674.1	2902.6	2945.4	3002.3	3084.6
		5	3210	3810	3510	None	None	#N/A	2017.4	1982.5	2395.8	2311.5	2551.9	2743.8	2837.8	2801.3	2749.6	2883.2	2924.5
		6	3810	5010	4410	None	None	#N/A	1995.5	1918.3	2296.7	2169.8	2305.9	2408.2	2503.5	2537.4	2437.1	2583.4	2583.3
		7	5010	6595	5803	None	None	2859.7	2015.9	1856	2157.6	2031.6	2059.3	2099.7	2202.2	2248.1	2199.4	2271.7	2274
2	Loveladies N	8	6595	8352	7474	None	None	2872.2	2099.2	1901.7	2065.1	2016.6	1997	#N/A	2022.7	2075.9	2046.1	2127.1	2130.9
		9	8352	9270.6	8811	None	None	2907.2	2226.3	1974.6	2090.8	2099.2	2087.2	2094.2	2078.6	2106.2	2116.5	2170.8	2166.8
		10	9270.6	10160.1	9715	1	2	2928.6	2377.5	2075.1	2168.9	2207.2	2166.2	#N/A	2160.9	2171.4	2193.6	2196.7	2208.6
		11	10160.1	10980.1	10570	2	3	2936.6	2494.5	2185.4	2285.9	2302.7	#N/A	2277.6	2243	2247.9	2265.2	2273.8	2271.6
3	Loveladies S	12	10980.1	11856.9	11419	3	4	2993.7	2548.6	#N/A	2390.3	2372.6	#N/A	2368.1	2327.7	2319.9	2318.4	2347.4	2319
		13	11856.9	12663.6	12260	4	5	3034.9	2710.6	2451.9	2473	2434	2419.6	#N/A	2410.9	2431.8	2428.5	2437.7	2421.9
		14	12663.6	13364	13014	5	6	3092.9	2752.8	2562	2610.4	2528.3	2519.4	2556.1	2515.5	2530.1	2535	2505.9	2510.2
		15	13364	14248.3	13806	6	7	3192.9	2839	2708.1	2691.8	2640.2	2625.6	#N/A	2599.1	2600.9	2612.8	2592	2614.7
		16	14248.3	15066.5	14657	7	8	3376	2957	2857.9	2819.2	2728.1	2716.3	#N/A	2711.9	2716	2711.7	2698.4	2719.3
		17	15066.5	15964.3	15515	8	9	3532.8	3047	3004	2928.9	2854	2836.3	2886.9	2853.3	2859.6	2858.5	2825.7	2854.6
		18	15964.3	16830.4	16397	9	10	3712.7	3316.2	#N/A	3058.6	2971.5	2983.1	3022.8	2998	2986.8	2965.1	2957.3	3009.9
		19	16830.4	17706.3	17268	10	11	3844	3438.1	3258.6	3195.3	3104.2	3091.4	3134.5	3180.4	3108.7	3082.8	3075.9	3141.1
		20	17706.3	18564.6	18135	11	12	3999.1	3543.9	3378.2	3338.3	3244.6	3228.5	3247.6	3295.4	3253.7	3219.2	3209.2	3264.3
4	Harvey Cedars N	21	18564.6	19425.6	18995	12	13	4114.4	3727.5	3527.5	3460.3	3379.3	3343.2	3370.6	3447.9	3401.5	3381.9	3382.7	3408.3
		22	19425.6	20221.9	19824	13	14	4248.5	3780.8	3667.8	3584	3531.5	3446.2	#N/A	3592.4	3560.2	3548.7	3518.2	3543
		23	20221.9	20999	20610	14	15	4361.7	3984.1	3784.5	3658.8	3609.4	3600.1	#N/A	3725.3	3711.6	3670.2	3655.1	3694.5
		24	20999	22048.2	21524	15	16	4538.6	4131.7	3948.8	3778.4	3703.5	3738.9	#N/A	3812.1	3787.9	3763.9	3777.6	3796.9
		25	22048.2	23091.7	22570	16	17	4725.7	4281	4127.2	3908.2	3824.9	3904.7	#N/A	3969.6	3908.2	3891.9	3926.4	3939
5	Harvey Cedars S	26	23091.7	23958.7	23525	17	18	4863.4	4454.3	4203.6	4056.9	3998.4	4006.7	#N/A	4106.1	4058.3	4018.6	4042.8	4074.2
		27	23958.7	24851.8	24405	18	19	4895.6	4536.9	4288	4138.6	4069.8	4106.7	#N/A	4162.9	4120.9	4071.4	4124	4131.9
		28	24851.8	25644.4	25248	19	20	4956.8	4613.2	#N/A	4194.3	4130.1	4165.3	#N/A	4256.1	4176.5	4155.3	4175.9	4203.6
		29	25644.4	26635.9	26140	20	21	5039.9	4601	4446.2	4289.7	4217.7	#N/A	4260	4268.2	4206	4185.1	4212.2	4235.4
		30	26635.9	27558.3	27097	21	22	5125.8	4647.4	4484.7	4322.5	4313.6	#N/A	#N/A	4337.1	4265.3	4238.5	4264.9	4278
6	North Beach	31	27558.3	28423	27991	22	23	5211.1	4686.4	4542.2	4332.6	4270.5	4327.4	4361.1	4386.7	4305.5	4264.5	4307	4315.8
		32	28423	29581	29002	23	24	5317	4702.3	4557.2	4367	4297	4337.8	4407.3	4398.3	4326.3	4260.2	4335.1	4353
		33	29581	30622.2	30102	24	25	5439.6	4711.3	4528.9	4403	4332	4345.5	#N/A	4401.2	4318	4322.3	4356.5	4352.3
		34	30622.2	31431.9	31027	25	26	5539.5	4728.8	4546.7	4415.5	4329	4348.5	4422.9	4450.1	4353.6	4340.6	4372.9	4375.6
		35	31431.9	32235.9	31834	26	27	5594.9	4735.2	#N/A	4367.4	4382.4	4384	4454.3	4452.6	4361.1	4343.5	4371.9	4362.3
		36	32235.9	33039.2	32638	27	28	5666.4	4757.6	4535.3	4342	4383.6	4391.8	4448.5	4452.9	4367.8	4342.8	4363.6	4368
		37	33039.2	33835.7	33437	28	29	5675.8	4737.3	#N/A	4370.9	4364.9	#N/A	4461.6	4461.9	4377.8	4346.5	4353.5	4369.7
		38	33835.7	34642	34239	29	30	5647.3	4684.8	4468.8	4373.1	4351.9	#N/A	4438.8	4460	4380.2	4337.3	4334.2	4379.5
		39	34642	35436.5	35039	30	31	5613	4685.1	4458.9	4319.8	4348	#N/A	#N/A	4424.1	4362.6	4334.7	4323.9	4356.2
		40	35436.5	36238.9	35838	31	32	5554.1	4647	4456.3	4324.9	4338	#N/A	4356.3	4423.4	4372.3	4363.2	4349.8	4335.2
		41	36238.9	37384.3	36812	32	33	5505.1	4601	4437.3	4308.5	4355.4	#N/A	4403.3	4436.1	4358.7	4376.2	4376.6	4360.1
7	Surf City	42	37384.3	38428.9	37907	33	34	5498	4563.8	4414.1	4263.7	4351	#N/A	4421.9	4484.1	4406.3	4380.5	4396.6	4388.2
		43	38428.9	39502.1	38966	34	35	5370.3	4500.4	4384.7	4264.3	4341.2	#N/A	4382.6	4465.7	4401.9	4379	4390.7	4389.3
		44	39502.1	40565.8	40034	35	36	5344.9	4428.3	4353.1	4267.2	4289.6	#N/A	#N/A	4438.2	4376	4348.6	4334.6	4335.4
		45	40565.8	41623.9	41095	36	37	5241.9	4391.1	4326.4	4217	4248	#N/A	4311.6	4381.8	4337.4	4303.8	4315.4	4315.6
		46	41623.9	42745	42184	37	38	5173.3	4361.1	4255.7	4172.7	4213.4	4232.3	#N/A	4345.9	4290	4267.3	4259.9	4283.8
		47	42745	43798.3	43272	38	39	5217.7	4320.3	4144.6	4145.3	4164.6	4176.4	#N/A	4278.2	4245.3	4219.1	4200.5	4236.6
8	Ship Bottom	48	43798.3	44851.2	44325	39	40	5083.4	4246.4	4105	4081.9	4085.3	4112	4142.2	4237.9	4193.1	4162.7	4173.6	4175.4
		49	44851.2	45895.2	45373	40	41	5040.3	4213.7	4076.9	4031.8	4074.5	4087.6	#N/A	4171.9	4174.3	4142.7	4124.8	4136.1
		50	45895.2	46960	46428	41	42	4950	4205.2	4002.5	3987.2	4013.5	4035	4104.7	4118	4111.1	4076.6	4068.2	4070.8
		51	46960	48017	47489	42	43	4935.1	4159.4	3952	3969.6	3966.8	3993.1	4066	4063.4	4088.6	4033.1	4050.1	4055.7
		52	48017	49076.3	48547	43	44	4861.3	4155.5	3907.9	3955.4	3935	3984.2	#N/A	4051.2	4044.9	4025.3	4061.1	4063.8
9	Brant Beach	53	49076.3	50127.5	49602	44	45	4783	4136.5	3864.8	3931.3	3921	3837.5	4046	4040.8	4040	4015.6	4040.9	4044.7
		54	50127.5	51063.2	50595	45	46	4747	4156.7	3887.2	3932.4	3910.5	#N/A	#N/A	4040	4040.4	4022.1	4021.3	4037.1
		55	51063.2	52048.4	51556	46	47	4658.8	4145.3	3942.7	3959.6	3885.5	3938.6	3985.3	4034.5	4040.6	4032.7	4036	4026.8
		56	52048.4	52828.4	52438	47	48	4622.3	4161.2	3965.8	3953.8	3936.9	3936.7	#N/A	4010.9	4069.8	4066.1	4033.1	4036
		57	52828.4	53645.9	53237	48	49	4569	4149.5	3962.7	3961.9	3955.8	3975.5	4087.9	4042.1	4032	4017.3	4028.7	4019.5
		58	53645.9	54449	54047	49	50	4632.7	4160	3990.1	3927.3	3913.1	3941.3	4021.9	4042.5	3989.9	3985.9	3969.4	3982
		59	54449	55255.2	54852	50	51	4695.7	4154.6	#N/A	3940.7	3925.5	3926.5	#N/A	3998.7	3976.1	3956.7	3930.1	3954.4
		60	55255.2	56046.2	55651	51	52	4503.2	4190.8	4110.4	3967.6	3946.9	3909.2	4016.9	3969	3988.7	3951.3	3965	3960.1
		61	56046.2	56805.8	56426	52	53	4430.2	4204.5	#N/A	3973.8	3977.4	3938.4	4032.2	4004.2	4019.6	3992.5	3997.8	4007.1
		62	56805.8	57545.8	57176	53	54	4344.5	4208.6	4148.3	4019.6	3955.4	3947.5	4056	4040.8	4050	4002.1	3998.2	4047.8
		63	57545.8	58304.3	57925	54	55	4322.5	4202	4132.6	4084.4	3997.4	#N/A	4087.8	4078.2	4099.2	4056.7	4050.8	4086.6

BUNDY	COMMUNITY	Shoreline Compartment	GENESIS Coords START	GENESIS Coords STOP	Mean Distance	BOUNDING GROINS North	BOUNDING GROINS South	MEAN SHORELINE POSITION (ft) wrt GENESIS COORDINATE SYSTEM 1836	1873	1899	1934	1952	1971	1977	1986	1991	1993	1996	1997
10	BH Crest to BH Park	64	58304.3	59055	58680	55	56	4300.1	4190.3	4106.1	4125.5	4059.4	#N/A	4149.3	4099.3	4124.6	4092.1	4090.5	4117.4
		65	59055	59802.1	59429	56	57	4332.4	4193.6	4145.4	4137.5	4099.6	#N/A	#N/A	4131.2	4138.7	4126.4	4115.9	4154.2
		66	59802.1	60556.5	60179	57	58	4308.7	4231.2	4182.2	4158.6	4140.4	#N/A	4209.2	4171.4	4182.2	4154.9	4155.9	4186.4
		67	60556.5	61373.3	60965	58	59	4297.6	4240.5	4204.8	4180.8	4171.5	#N/A	#N/A	4255.1	4245	4196.8	4211.2	4194.4
		68	61373.3	61993.1	61683	59	60	4269.3	4255	4221.7	4206.1	4192.7	#N/A	4316.1	4289	4276.4	4253.5	4213.2	4242.9
		69	61993.1	63027.1	62510	60	61	4308.8	4257.6	4259.5	4238.2	4197.9	#N/A	4355.8	4318.6	4272.9	4224.8	#N/A	4273.8
		70	63027.1	63907.7	63467	61	62	4327.7	4284.1	4308.3	4252.9	4225.6	#N/A	4362	4363.2	4363.8	4291	#N/A	4332.5
		71	63907.7	64949.8	64429	62	63	4293.2	4300	4358.2	4260.1	4225.1	4277.3	#N/A	4392.2	4398.9	4353.3	#N/A	4367.8
		72	64949.8	65798.5	65374	63	64	4230.6	4321.4	4359.6	4270.3	4219.5	4262.9	#N/A	4405.7	4418.6	4381.7	4382.6	4376.9
		73	65798.5	66631.8	66215	64	65	4257.9	4291	4347.4	4267.7	4205.6	4243.4	4360	4364.8	4391.8	4341.8	4358	4349.9
		74	66631.8	67520.1	67076	65	66	4284.1	4295.1	4307.4	4280.5	4260.6	4214.6	#N/A	4330.5	4382.6	4338.7	4333.7	4348.9
11	Haven Bch to BH Gardens	75	67520.1	68619.9	68070	66	67	4254.9	4301.2	4302.1	4296.7	4233.5	4224.5	4317.5	4302.1	4288	4253.5	#N/A	4279.3
		76	68619.9	69446	69033	67	68	4225.7	4300.7	4314.8	4322.8	4135.4	4207.6	4314.1	4291.2	4262.9	4238.4	#N/A	4249.6
		77	69446	70513.1	69980	68	69	4236.2	4327.9	4315.2	4325.5	4188	4228.8	#N/A	4304.5	4253	4222.1	#N/A	4234.7
		78	70513.1	71247.8	70880	69	70	4258.8	4335.3	4285.3	4309	4283.3	4214.9	#N/A	4337.8	4292.3	4252.6	#N/A	4258.1
		79	71247.8	72167.5	71708	70	71	4172.1	4352.3	4292.7	4296.2	4269	4215.8	#N/A	4346	4309	4273.5	#N/A	4296.9
		80	72167.5	73047.7	72608	71	72	4126.2	4396	#N/A	4305.8	4272.7	4236.6	#N/A	4410.3	4361.3	4315.6	#N/A	4326.4
		81	73047.7	73949.6	73499	72	73	4118	4391.9	4273.8	4334.9	4283.6	4305.5	4405.1	4427.8	4381.7	4346.1	#N/A	4377.5
12	Spray Bch to BH Boro N	82	73949.6	74872.3	74411	73	74	4109.3	4399.7	4284.3	4384.5	4299.7	#N/A	4413.2	4487.3	4413.4	4373.3	#N/A	4385
		83	74872.3	75947.1	75410	74	75	4128.3	4413.2	4323.4	4405	4343.8	#N/A	4443.2	4481.8	4452.3	4402.2	#N/A	4421.8
		84	75947.1	76951.7	76449	75	76	4076.8	4440.6	4376.2	4428	4376.4	4380.5	4452.9	4516	4492.5	4452.5	#N/A	4452.6
		85	76951.7	77951.8	77452	76	77	4097.9	4547.4	4434.9	4481.8	4419.2	4377	#N/A	4551.7	4537.1	4509.8	#N/A	4516.8
		86	77951.8	79166.5	78559	77	78	4121.7	4560.3	4484.4	4567.8	4508.8	4428.7	4554	4583.5	4587.6	4550.4	#N/A	4566.8
		87	79166.5	80182.3	79674	78	79	4089.5	4579.7	4530.8	4637.8	4549.1	4493.1	#N/A	4626.3	4633.2	4617.5	#N/A	4609.4
		88	80182.3	81201.1	80692	79	80	4087.2	4593.1	4473.8	4656.6	4595.1	4522.6	#N/A	4669.6	4638.2	4659.4	#N/A	4651.1
13	Beach Haven Boro	89	81201.1	82468.3	81835	80	81	4099.9	4644.1	4507.1	4643.8	4593.4	4525.7	#N/A	4660.6	4605	4612.6	#N/A	4645.2
		90	82468.3	83586.8	83028	81	82	4092.1	4587.3	4513.7	4561.9	4541.8	4472.8	#N/A	4606.3	4588.1	4585.7	#N/A	4576.5
		91	83586.8	84617.3	84102	82	83	4082.7	4682.3	4518.6	4444.1	4469.4	4400.2	#N/A	4526.4	4495.3	4473.1	#N/A	4461
		92	84617.3	85932.8	85275	83	84	4166.1	4806.4	4503.6	4381.7	4353.8	4279.8	#N/A	4393.7	4349.2	4327.7	#N/A	4368.3
14	Beach Haven Boro S	93	85932.8	87273.9	86603	84	85	4217.5	4929.1	4527.7	4000.6	3907.8	3977.3	4094.2	4065.6	4008.7	3997.7	#N/A	4043.2
		94	87273.9	88507.6	87891	85	8688	4362.9	5068.5	4629.4	3783	3655.8	3718.9	3842.2	3822.1	3756.4	3727	#N/A	3734.9
		95	88507.6	89048.2	88778	8688	89	4540.4	5145	4652.8	3730.5	3662.7	3578.8	3730.3	3622.4	3547.3	3549.6	#N/A	3591
15	BH Boro to Holgate	96	89048.2	89546.4	89297	89	90	4620.6	5213.3	#N/A	3732	3611	3536.5	#N/A	3610.4	3510.5	3466	#N/A	3596.6
		97	89546.4	90042.9	89795	90	91	4772.7	5263.7	#N/A	3777.8	3551.9	3522	#N/A	3577.2	3517.6	3474.5	#N/A	3557.8
		98	90042.9	90550.3	90297	91	92	4912.5	5294.3	#N/A	3805.7	3562.6	#N/A	3622	3591.8	3530.6	3487.1	#N/A	3588.8
		99	90550.3	91330.7	90941	92	93	5013.6	5344.6	4756.3	3784.3	3587	#N/A	3582.5	3637.8	3551.2	3495.7	#N/A	3595.7
		100	91330.7	92359.7	91845	93	94	5137.3	5469.4	4817.8	3808.1	3629.9	#N/A	3532.7	3622.2	3567.3	3532	#N/A	3550.6
		101	92359.7	93192.4	92776	94	95	5249.7	5537.1	4947	3803.5	3626.5	#N/A	3530.1	3591.2	3546.9	3532.2	#N/A	3549.3
		102	93192.4	93936.3	93564	95	96	5386	5640.2	4962.1	3661.9	3661.3	#N/A	3581.9	3656.3	3596	3584.1	#N/A	3569.4
		103	93936.3	94651	94294	96	97	5534.4	5727.3	4965.3	3688.5	3741.6	#N/A	#N/A	3715.8	3692.1	3685.4	#N/A	3638.8
		104	94651	95434	95043	97	98	5666.7	5827.4	5001.9	3701.4	3675.9	#N/A	3601.7	3627.5	3589.9	3596.6	#N/A	3564.8
		105	95434	95824	95629	98	99	5742.3	5900.4	5035.4	3585.2	3686.8	#N/A	#N/A	3209	3236.1	#N/A	#N/A	3292.6
Not Studied	Holgate Wildlife Refuge	106	95824	96500	96162	None	None	5771.4	5935.1	5034.2	3533.4	3710.1	#N/A	3090.7	2974.1	2859.7	2924.3	#N/A	2990.3
		107	96500	97500	97000	None	None	5635.3	6014.9	5053.5	3456.1	3691	#N/A	2955.6	2881.9	2724.3	2705.8	#N/A	2853.3
		108	97500	98500	98000	None	None	#N/A	6125.3	5110.4	2999.6	3741	#N/A	2869.5	2899.6	2764.1	2702.6	#N/A	2834.6
		109	98500	99500	99000	None	None	#N/A	6203.4	5000	#N/A	3591	3006.4	2854.2	2940.5	2825.7	2781.5	#N/A	2838.7
		110	99500	100500	100000	None	None	#N/A	6209.6	4888	#N/A	3489.2	3009.5	2897	3000.3	2903.1	#N/A	#N/A	2812.5
		111	100500	101500	101000	None	None	#N/A	6155.6	4818.8	#N/A	3243.8	3036.6	#N/A	3055	2844.3	2765.7	#N/A	2735.8
		112	101500	102500	102000	None	None	#N/A	#N/A	#N/A	#N/A	2976.1	2990.5	#N/A	#N/A	2839.5	2720.7	#N/A	2652.2
		113	102500	103500	103000	None	None	#N/A	#N/A	#N/A	#N/A	#N/A	2840.7	2567.9	#N/A	2769.4	2730.2	#N/A	2539.1
		114	103500	104500	104000	None	None	#N/A	#N/A	#N/A	#N/A	#N/A	2406.6	#N/A	2825.5	2684.3	2652.9	#N/A	2362.9
		115	104500	105500.5	105000	None	None	#N/A	#N/A	#N/A	#N/A	#N/A	1748.6	2082	2483.3	2491.2	2406.6	#N/A	2165.8
		116	105500.5	106500	106000	None	None	#N/A	#N/A	#N/A	#N/A	#N/A	934.8	1729.8	#N/A	2238.2	2186.9	#N/A	1986.6

TABLE 2-11 Long Beach Island Computed Shoreline Change Rates by Epoch

Beachfills Removed

		Shoreline	GENESIS Coords		Mean	BOUNDING GROINS			SHORELINE CHANGE RATES (ft/yr) by Epoch										
BUNDY	COMMUNITY	Compartment	START	STOP	Distance	North	South	Length	1836-1871	1871-1899	1899-1932	1932-1951	1951-1971	1971-1977	1977-1986	1986-1991	1991-1993	1993-1996	1996-1997
1	Barnegat Light	1	17.2	1821	919	None	None	1804	-7.66	-8.22	-9.63	-12.73	-9.35	14.06	42.18	131.88	293.56	131.5	-43.8
		2	1821	2135	1978	None	None	314	-14	0.4	7.79	-9.28	#N/A	#N/A	#N/A	54.83	307.04	68.5	-27
		3	2135	2601	2368	None	None	466	-17.85	-0.57	9.1	-5.64	2.36	#N/A	#N/A	73.25	171.63	30.23	63.6
		4	2601	3210	2906	None	None	609	-22.26	-0.69	8.51	-2.14	13.78	32.56	-5.92	34.33	73.19	18.97	82.3
		5	3210	3810	3510	None	None	600	#N/A	-1.34	11.81	-4.68	12.65	31.33	10.16	-7.26	-38.3	44.53	41.3
		6	3810	5010	4410	None	None	1200	#N/A	-2.97	10.81	-7.05	7.16	16.7	10.3	6.75	-74.3	48.77	-0.1
		7	5010	6595	5803	None	None	1585	-24.82	-6.15	8.62	-7	1.46	6.6	11.08	9.13	-36.07	24.1	2.3
2	Loveladies N	8	6595	8352	7474	None	None	1757	-22.74	-7.6	4.67	-2.69	-1.03	#N/A	#N/A	10.59	-22.07	27	3.8
		9	8352	9270.6	8811	None	None	919	-20.03	-9.68	3.32	0.47	-0.63	1.14	-1.69	5.49	7.63	18.1	-4
		10	9270.6	10160.1	9715	1	2	890	-16.21	-11.63	2.68	2.13	-2.16	#N/A	#N/A	2.09	16.44	1.03	11.9
		11	10160.1	10980.1	10570	2	3	820	-13	-11.89	2.87	0.93	#N/A	#N/A	-3.74	0.98	12.81	2.87	-2.2
3	Loveladies S	12	10980.1	11856.9	11419	3	4	877	-13.09	#N/A	#N/A	-0.98	#N/A	#N/A	-4.37	-1.55	-1.11	9.67	-28.4
		13	11856.9	12663.6	12260	4	5	807	-9.54	-9.95	0.6	-2.17	-0.76	#N/A	#N/A	4.16	-2.44	3.07	-15.8
		14	12663.6	13364	13014	5	6	700	-10	-7.34	1.38	-4.56	-0.47	5.99	-4.39	2.91	3.63	-9.7	4.3
		15	13364	14248.3	13806	6	7	884	-10.41	-5.03	-0.47	-2.87	-0.77	#N/A	#N/A	0.36	8.81	-6.93	22.7
		16	14248.3	15066.5	14657	7	8	818	-12.32	-3.81	-1.11	-5.06	-0.62	#N/A	#N/A	0.82	-3.19	-4.43	20.9
		17	15066.5	15964.3	15515	8	9	898	-14.29	-1.65	-2.15	-4.16	-0.93	8.26	-3.63	1.25	-0.81	-10.93	28.9
		18	15964.3	16830.4	16397	9	10	866	-11.66	#N/A	#N/A	-4.84	0.61	6.48	-2.68	-2.23	-16.07	-2.6	52.6
		19	16830.4	17706.3	17268	10	11	876	-11.94	-6.9	-1.81	-5.06	-0.67	7.04	4.96	-14.27	-19.19	-2.3	65.2
		20	17706.3	18564.6	18135	11	12	858	-13.39	-6.37	-1.14	-5.21	-0.85	3.12	5.17	-8.3	-25.56	-3.33	55.1
4	Harvey Cedars N	21	18564.6	19425.6	18995	12	13	861	-11.38	-7.69	-1.92	-4.5	-1.9	4.47	8.36	-9.23	-14.52	0.27	25.6
		22	19425.6	20221.9	19824	13	14	796	-13.76	-4.35	-2.39	-2.92	-4.49	#N/A	#N/A	-6.41	-8.52	-10.17	24.8
		23	20221.9	20999	20610	14	15	777	-11.11	-7.68	-3.59	-2.74	-0.49	#N/A	#N/A	-2.73	-30.67	-18.7	80.4
		24	20999	22048.2	21524	15	16	1049	-11.97	-7.03	-4.87	-4.16	1.86	#N/A	#N/A	-4.82	-17.78	-9.1	60.3
		25	22048.2	23091.7	22570	16	17	1044	-13.08	-5.92	-6.26	-4.63	4.2	#N/A	#N/A	-12.22	-12.07	-2.17	53.6
5	Harvey Cedars S	26	23091.7	23958.7	23525	17	18	867	-12.03	-9.64	-4.19	-3.25	0.44	#N/A	#N/A	-9.51	-29.41	-5.6	72.4
		27	23958.7	24851.8	24405	18	19	893	-10.55	-9.57	-4.27	-3.82	1.94	#N/A	#N/A	-8.36	-36.67	3.87	48.9
		28	24851.8	25644.4	25248	19	20	793	-10.11	#N/A	#N/A	-3.57	1.85	#N/A	#N/A	-15.84	-15.7	-6.8	68.7
		29	25644.4	26635.9	26140	20	21	992	-12.91	-5.95	-4.47	-4	#N/A	#N/A	0.89	-12.38	-15.48	9.03	23.2
		30	26635.9	27558.3	27097	21	22	922	-14.07	-6.26	-4.63	-0.49	#N/A	#N/A	#N/A	-14.29	-19.85	8.8	13.1
6	North Beach	31	27558.3	28423	27991	22	23	865	-15.43	-5.55	-5.99	-3.45	2.99	5.5	2.77	-16.16	-30.37	14.17	8.8
		32	28423	29581	29002	23	24	1158	-18.08	-5.58	-5.43	-3.89	2.15	11.35	-0.97	-14.33	-48.96	24.97	17.9
		33	29581	30622.2	30102	24	25	1041	-21.42	-7.02	-3.6	-3.94	0.71	#N/A	#N/A	-16.56	3.19	11.4	-4.2
		34	30622.2	31431.9	31027	25	26	810	-23.84	-7	-3.75	-4.81	1.03	12.15	2.94	-19.2	-9.63	10.77	2.7
		35	31431.9	32235.9	31834	26	27	804	-25.29	#N/A	#N/A	0.83	0.08	11.48	-0.18	-18.21	-13.04	9.47	-9.6
		36	32235.9	33039.2	32638	27	28	803	-26.73	-8.55	-5.52	2.31	0.43	9.26	0.48	-16.94	-18.52	6.93	4.4
		37	33039.2	33835.7	33437	28	29	797	-27.6	#N/A	#N/A	-0.33	#N/A	#N/A	0.03	-16.74	-23.19	2.33	16.2
		38	33835.7	34642	34239	29	30	806	-28.31	-8.31	-2.73	-1.18	#N/A	#N/A	2.29	-15.88	-31.78	-1.03	45.3
		39	34642	35436.5	35039	30	31	795	-27.29	-8.7	-3.97	1.57	#N/A	#N/A	#N/A	-12.24	-20.67	-3.6	32.3
		40	35436.5	36238.9	35838	31	32	802	-26.68	-7.33	-3.75	0.73	#N/A	#N/A	7.25	-10.17	-6.74	-4.47	-14.6
		41	36238.9	37384.3	36812	32	33	1145	-26.59	-6.3	-3.68	2.61	#N/A	#N/A	3.55	-15.4	12.96	0.13	-16.5
7	Surf City	42	37384.3	38428.9	37907	33	34	1045	-27.48	-5.76	-4.3	4.85	#N/A	#N/A	6.72	-15.48	-19.11	5.37	-8.4
		43	38428.9	39502.1	38966	34	35	1073	-25.59	-4.45	-3.44	4.27	#N/A	#N/A	8.98	-12.7	-16.96	3.9	-1.4
		44	39502.1	40565.8	40034	35	36	1064	-26.96	-2.89	-2.45	1.24	#N/A	#N/A	#N/A	-12.38	-20.3	-4.67	0.8
		45	40565.8	41623.9	41095	36	37	1058	-25.02	-2.49	-3.13	1.72	#N/A	#N/A	7.59	-8.84	-24.89	3.87	0.2
		46	41623.9	42745	42184	37	38	1121	-23.89	-4.05	-2.37	2.26	0.99	#N/A	#N/A	-11.12	-16.81	-2.47	23.9
		47	42745	43798.3	43272	38	39	1053	-26.39	-6.76	0.02	1.07	0.62	#N/A	#N/A	-6.55	-19.41	-6.2	36.1
8	Ship Bottom	48	43798.3	44851.2	44325	39	40	1053	-24.62	-5.44	-0.66	0.19	1.41	4.93	10.35	-8.92	-22.52	3.63	1.8
		49	44851.2	45895.2	45373	40	41	1044	-24.31	-5.26	-1.29	2.37	0.69	#N/A	#N/A	0.48	-23.41	-5.97	11.3
		50	45895.2	46960	46428	41	42	1065	-21.91	-7.8	-0.44	1.46	1.13	11.38	1.44	-1.37	-25.56	-2.8	2.6
		51	46960	48017	47489	42	43	1057	-22.81	-7.98	0.5	-0.16	1.38	11.9	-0.28	5.01	-41.11	5.67	5.6
		52	48017	49076.3	48547	43	44	1059	-20.76	-9.52	1.36	-1.13	2.59	#N/A	#N/A	-1.25	-14.52	11.93	2.7
9	Brant Beach	53	49076.3	50127.5	49602	44	45	1051	-19.01	-10.45	1.9	-0.57	-4.39	34.04	-0.56	-0.16	-18.07	8.43	3.8
		54	50127.5	51063.2	50595	45	46	936	-17.36	-10.37	1.29	-1.22	#N/A	#N/A	#N/A	0.08	-13.56	-0.27	15.8
		55	51063.2	52048.4	51556	46	47	985	-15.1	-7.79	0.48	-4.12	2.79	7.62	5.32	1.21	-5.85	1.1	-9.2
		56	52048.4	52828.4	52438	47	48	780	-13.56	-7.52	-0.34	-0.94	-0.01	#N/A	#N/A	11.72	-2.74	-11	2.9
		57	52828.4	53645.9	53237	48	49	818	-12.34	-7.18	-0.02	-0.34	1.04	18.35	-4.95	-2.01	-10.89	3.8	-20.7
		58	53645.9	54449	54047	49	50	803	-13.9	-6.53	-1.79	-0.79	1.48	13.16	2.23	-10.47	-2.96	-5.5	1.1
		59	54449	55255.2	54852	50	51	806	-15.91	#N/A	#N/A	-0.84	0.05	#N/A	#N/A	-4.5	-14.37	-8.87	12.8
		60	55255.2	56046.2	55651	51	52	791	-9.19	-3.09	-4.08	-1.15	-1.98	17.58	-5.18	3.92	-27.7	4.57	-16.4
		61	56046.2	56805.8	56426	52	53	760	-6.64	#N/A	#N/A	0.2	-2.05	15.31	-3.03	3.06	-20.07	1.77	9.3
		62	56805.8	57545.8	57176	53	54	740	-4	-2.32	-3.68	-3.57	-0.42	17.71	-1.64	1.83	-35.48	-1.3	49.6
		63	57545.8	58304.3	57925	54	55	759	-3.54	-2.67	-1.38	-4.83	#N/A	#N/A	-1.04	4.18	-31.48	-1.97	35.8
10	BH Crest to BH Park	64	58304.3	59055	58680	55	56	751	-3.23	-3.24	0.55	-3.67	#N/A	#N/A	-5.41	5.03	-24.07	-0.53	26.9
		65	59055	59802.1	59429	56	57	747	-4.08	-1.85	-0.23	-2.11	#N/A	#N/A	#N/A	1.49	-9.11	-3.5	38.3
		66	59802.1	60556.5	60179	57	58	754	-2.28	-1.88	-0.67	-1.01	#N/A	#N/A	-4.09	2.15	-20.22	0.33	30.5
		67	60556.5	61373.3	60965	58	59	817	-1.68	-1.37	-0.69	-0.52	#N/A	#N/A	#N/A	-2.01	-35.7	4.8	-16.8
		68	61373.3	61993.1	61683	59	60	620	-0.42	-1.28	-0.45	-0.74	#N/A	#N/A	-2.93	-2.51	-16.96	-13.43	29.7
		69	61993.1	63027.1	62510	60	61	1034	-1.51	0.07	-0.61	-2.24	#N/A	#N/A	-4.02	-9.09	-35.63	#N/A	#N/A
		70	63027.1	63907.7	63467	61	62	881	-1.28	0.93	-1.58	-1.52	#N/A	#N/A	0.13	0.12	-53.93	#N/A	#N/A
		71	63907.7	64949.8	64429	62	63	1042	0.2	2.24	-2.8	-1.94	2.75	#N/A	#N/A	1.33	-33.78	#N/A	#N/A
		72	64949.8	65798.5	65374	63	64	849	2.67	1.47	-2.55	-2.82	2.28	#N/A	#N/A	2.57	-27.33	0.3	-5.7
		73	65798.5	66631.8	66215	64	65	833	0.97	2.17	-2.28	-3.45	1.99	19.04	0.52	5.37	-37.04	5.4	-8.1
		74	66631.8	67520.1	67076	65	66	888	0.32	0.47	-0.77	-1.11	-2.42	#N/A	#N/A	10.37	-32.52	-1.67	15.2

		Shoreline	GENESIS Coords		Mean	BOUNDING GROINS			SHORELINE CHANGE RATES (ft/yr) by Epoch										
BUNDY	COMMUNITY	Compartment	START	STOP	Distance	North	South	Length	1836-1871	1871-1899	1899-1932	1932-1951	1951-1971	1971-1977	1977-1986	1986-1991	1991-1993	1993-1996	1996-1997
11	Haven Bch to BH Gardens	75	67520.1	68619.9	68070	66	67	1100	1.36	0.03	-0.15	-3.51	-0.47	15.18	-1.66	-2.81	-25.56	#N/A	#N/A
		76	68619.9	69446	69033	67	68	826	2.21	0.54	0.23	-10.41	3.8	17.39	-2.48	-5.63	-18.15	#N/A	#N/A
		77	69446	70513.1	69980	68	69	1067	2.7	-0.49	0.29	-7.64	2.15	#N/A	#N/A	-10.25	-22.89	#N/A	#N/A
		78	70513.1	71247.8	70880	69	70	735	2.25	-1.92	0.68	-1.43	-3.6	#N/A	#N/A	-9.05	-29.41	#N/A	#N/A
		79	71247.8	72167.5	71708	70	71	920	5.3	-2.29	0.1	-1.51	-2.8	#N/A	#N/A	-7.36	-26.3	#N/A	#N/A
		80	72167.5	73047.7	72608	71	72	880	7.94	#N/A	#N/A	-1.84	-1.9	#N/A	#N/A	-9.75	-33.85	#N/A	#N/A
		81	73047.7	73949.6	73499	72	73	902	8.06	-4.54	1.75	-2.85	1.15	16.26	2.45	-9.17	-26.37	#N/A	#N/A
12	Spray Bch to BH Boro N	82	73949.6	74872.3	74411	73	74	923	8.54	-4.44	2.86	-4.71	#N/A	#N/A	8.01	-14.71	-29.7	#N/A	#N/A
		83	74872.3	75947.1	75410	74	75	1075	8.38	-3.45	2.33	-3.4	#N/A	#N/A	4.17	-5.87	-37.11	#N/A	#N/A
		84	75947.1	76951.7	76449	75	76	1005	10.7	-2.48	1.48	-2.87	0.22	11.82	6.82	-4.68	-29.63	#N/A	#N/A
		85	76951.7	77951.8	77452	76	77	1000	13.22	-4.33	1.34	-3.48	-2.22	#N/A	#N/A	-2.91	-20.22	#N/A	#N/A
		86	77951.8	79166.5	78559	77	78	1215	12.9	-2.92	2.38	-3.28	-4.22	20.46	3.19	0.82	-27.56	#N/A	#N/A
		87	79166.5	80182.3	79674	78	79	1016	14.42	-1.88	3.06	-4.93	-2.95	#N/A	#N/A	1.37	-11.63	#N/A	#N/A
		88	80182.3	81201.1	80692	79	80	1019	14.88	-4.59	5.22	-3.42	-3.82	#N/A	#N/A	-6.25	15.7	#N/A	#N/A
13	Beach Haven Boro	89	81201.1	82468.3	81835	80	81	1267	16.01	-5.27	3.91	-2.8	-3.56	#N/A	#N/A	-11.06	5.63	#N/A	#N/A
		90	82468.3	83586.8	83028	81	82	1119	14.56	-2.83	1.38	-1.12	-3.63	#N/A	#N/A	-3.62	-1.78	#N/A	#N/A
		91	83586.8	84617.3	84102	82	83	1031	17.64	-6.3	-2.13	1.41	-3.64	#N/A	#N/A	-6.19	-16.44	#N/A	#N/A
		92	84617.3	85932.8	85275	83	84	1316	18.83	-11.65	-3.48	-1.55	-3.89	#N/A	#N/A	-8.86	-15.93	#N/A	#N/A
14	Beach Haven Boro S	93	85932.8	87273.9	86603	84	85	1341	20.93	-15.44	-15.06	-5.16	3.66	19.09	-3.09	-11.32	-8.15	#N/A	#N/A
		94	87273.9	88507.6	87891	85	8688	1234	20.75	-16.89	-24.18	-7.07	3.32	20.13	-2.17	-13.07	-21.78	#N/A	#N/A
		95	88507.6	89048.2	88778	8688	89	541	17.78	-18.93	-26.35	-3.77	-4.42	24.73	-11.66	-14.95	1.7	#N/A	#N/A
15	BH Boro to Holgate	96	89048.2	89546.4	89297	89	90	498	17.43	#N/A	#N/A	-6.72	-3.92	#N/A	#N/A	-19.88	-32.96	#N/A	#N/A
		97	89546.4	90042.9	89795	90	91	497	14.44	#N/A	#N/A	-12.55	-1.57	#N/A	#N/A	-11.86	-31.93	#N/A	#N/A
		98	90042.9	90550.3	90297	91	92	507	11.23	#N/A	#N/A	-13.51	#N/A	#N/A	-3.26	-12.18	-32.22	#N/A	#N/A
		99	90550.3	91330.7	90941	92	93	780	9.74	-22.63	-27.77	-10.96	#N/A	#N/A	5.98	-17.23	-41.11	#N/A	#N/A
		100	91330.7	92359.7	91845	93	94	1029	9.77	-25.06	-28.85	-9.9	#N/A	#N/A	9.68	-10.93	-26.15	#N/A	#N/A
		101	92359.7	93192.4	92776	94	95	833	8.45	-22.7	-32.67	-9.83	#N/A	#N/A	6.61	-8.82	-10.89	#N/A	#N/A
		102	93192.4	93936.3	93564	95	96	744	7.48	-26.08	-37.15	-0.03	#N/A	#N/A	8.04	-12	-8.81	#N/A	#N/A
		103	93936.3	94651	94294	96	97	715	5.67	-29.31	-36.48	2.95	#N/A	#N/A	#N/A	-4.72	-4.96	#N/A	#N/A
		104	94651	95434	95043	97	98	783	4.73	-31.75	-37.16	-1.42	#N/A	#N/A	2.79	-7.48	4.96	#N/A	#N/A
		105	95434	95824	95629	98	99	390	4.65	-33.27	-41.43	5.64	#N/A	#N/A	#N/A	5.39	#N/A	#N/A	#N/A
Not Studied	Holgate Wildlife Refuge	106	95824	96500	96162	None	None	676	4.81	-34.65	-42.88	9.82	#N/A	#N/A	-12.61	-22.77	47.85	#N/A	#N/A
		107	96500	97500	97000	None	None	1000	11.16	-36.98	-45.64	13.05	#N/A	#N/A	-7.97	-31.36	-13.7	#N/A	#N/A
		108	97500	98500	98000	None	None	1000	#N/A	-39.03	-60.31	41.19	#N/A	#N/A	3.25	-26.97	-45.56	#N/A	#N/A
		109	98500	99500	99000	None	None	1000	#N/A	-46.28	#N/A	#N/A	-30.77	-24.85	9.33	-22.85	-32.74	#N/A	#N/A
		110	99500	100500	100000	None	None	1000	#N/A	-50.83	#N/A	#N/A	-25.25	-18.37	11.17	-19.34	#N/A	#N/A	#N/A
		111	100500	101500	101000	None	None	1000	#N/A	-51.42	#N/A	#N/A	-10.91	#N/A	#N/A	-41.93	-58.22	#N/A	#N/A
		112	101500	102500	102000	None	None	1000	#N/A	#N/A	#N/A	#N/A	0.76	#N/A	#N/A	#N/A	-88	#N/A	#N/A
		113	102500	103500	103000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	-44.54	#N/A	#N/A	-29.04	#N/A	#N/A
		114	103500	104500	104000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	-28.1	-23.26	#N/A	#N/A
		115	104500	105500.5	105000	None	None	1001	#N/A	#N/A	#N/A	#N/A	#N/A	54.43	43.38	1.57	-62.67	#N/A	#N/A
		116	105500.5	106500	106000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	129.8	#N/A	#N/A	-38	#N/A	#N/A

TABLE 2-12 Long Beach Island Computed Shoreline Change Rates thru 1997

Beachfills Removed

BUNDY	COMMUNITY	Shoreline Compartment	GENESIS Coords START	STOP	Mean Distance	BOUNDING GROINS North	South	Length	SHORELINE CHANGE RATES (ft/yr) thru 1997 1836-1997	1871-1997	1899-1997	1932-1997	1951-1997	1971-1997	1977-1997	1986-1997	1991-1997	1993-1997	1996-1997
1	Barnegat Light	1	17.2	1821	919	None	None	1804	1.55	5.05	10.76	24.53	42.83	79.34	99.73	145.04	139.5	97.79	-43.8
		2	1821	2135	1978	None	None	314	2.38	5.01	6	7.18	13.61	#N/A	#N/A	91.81	102.6	50.13	-27
		3	2135	2601	2368	None	None	466	3.24	6.77	8.35	10.22	16.59	29.19	#N/A	73.35	62.8	36.65	63.6
		4	2601	3210	2906	None	None	609	4.1	8.48	10.42	12.58	16.79	18.41	18.38	38.08	38.4	31.15	82.3
		5	3210	3810	3510	None	None	600	#N/A	7.73	9.11	9.26	12.47	10.73	6.61	7.92	27.69	43.91	41.3
		6	3810	5010	4410	None	None	1200	#N/A	5.07	6.11	5.6	8.98	9.35	7.82	7.89	17.7	39.37	-0.1
		7	5010	6595	5803	None	None	1585	-1.21	2.45	3.51	2.77	5.88	8.33	8.46	6.84	9.2	19.91	2.3
2	Loveladies N	8	6595	8352	7474	None	None	1757	-2.62	0.56	1.58	0.94	2.34	4.87	#N/A	10.63	14.1	22.54	3.8
		9	8352	9270.6	8811	None	None	919	-2.78	0.1	1.39	0.85	1.31	2.83	3.97	9.32	12.99	13.85	-4
		10	9270.6	10160.1	9715	1	2	890	-2.93	-0.54	0.89	0.17	-0.07	1.45	#N/A	4.49	5.58	3.12	11.9
		11	10160.1	10980.1	10570	2	3	820	-2.84	-0.92	0.43	-0.55	-0.86	#N/A	-0.04	3.16	4.14	1.89	-2.2
3	Loveladies S	12	10980.1	11856.9	11419	3	4	877	-3.36	-1.7	#N/A	-1.08	-1.18	#N/A	-1.88	0.5	2.31	2.35	-28.4
		13	11856.9	12663.6	12260	4	5	807	-2.93	-1.56	-0.37	-0.55	-0.04	0.49	#N/A	1.59	-0.62	-0.56	-15.8
		14	12663.6	13364	13014	5	6	700	-2.7	-1.41	-0.66	-1.12	-0.33	-0.77	-2.03	-0.99	-5.14	-7.01	4.3
		15	13364	14248.3	13806	6	7	884	-2.86	-1.64	-1.17	-1.28	-0.85	-0.76	#N/A	0.63	0.25	-1.23	22.7
		16	14248.3	15066.5	14657	7	8	818	-3.25	-1.87	-1.54	-1.36	-0.37	-0.23	#N/A	-0.25	-0.71	0.44	20.9
		17	15066.5	15964.3	15515	8	9	898	-3.19	-1.6	-1.45	-0.93	-0.15	-0.4	-2.1	-1.31	-3.46	-3.27	28.9
		18	15964.3	16830.4	16397	9	10	866	-3.97	-2.44	#N/A	-0.8	0.04	-0.81	-2.16	-1.04	2.31	8.02	52.6
		19	16830.4	17706.3	17268	10	11	876	-3.66	-2.2	-1.37	-0.86	0.13	-0.28	-2.38	-6.23	3.63	10.68	65.2
		20	17706.3	18564.6	18135	11	12	858	-3.68	-2.07	-1.36	-1.07	0	-0.05	-1.31	-5.36	0.29	7.9	55.1
4	Harvey Cedars N	21	18564.6	19425.6	18995	12	13	861	-3.63	-2.17	-1.17	-0.45	0.83	1.77	0.43	-4.79	0.82	5.14	25.6
		22	19425.6	20221.9	19824	13	14	796	-3.34	-1.65	-1.02	-0.14	0.99	3.3	#N/A	-6.02	-5.04	-3.44	24.8
		23	20221.9	20999	20610	14	15	777	-3.39	-1.85	-0.61	0.79	1.8	2.25	#N/A	-6.96	-7.46	0.36	80.4
		24	20999	22048.2	21524	15	16	1049	-3.89	-2.32	-1.17	0.52	1.62	0.99	#N/A	-4.13	-1.29	4.25	60.3
		25	22048.2	23091.7	22570	16	17	1044	-4.13	-2.47	-1.4	0.69	1.74	-0.16	#N/A	-4.88	3.53	8.56	53.6
5	Harvey Cedars S	26	23091.7	23958.7	23525	17	18	867	-4.18	-2.54	-1.12	0.27	1.14	0.87	#N/A	-6.17	0.4	9.4	72.4
		27	23958.7	24851.8	24405	18	19	893	-4.14	-2.72	-1.36	-0.06	0.71	-0.46	#N/A	-5.08	2.03	12.53	48.9
		28	24851.8	25644.4	25248	19	20	793	-4.41	-2.95	#N/A	0.17	0.91	-0.35	#N/A	-7.68	1.81	7.72	68.7
		29	25644.4	26635.9	26140	20	21	992	-4.2	-2.71	-1.95	-0.86	-0.28	#N/A	-2.8	-3.7	6.13	11.76	23.2
		30	26635.9	27558.3	27097	21	22	922	-4.27	-2.61	-1.84	-0.91	-1.14	#N/A	#N/A	-5.94	3.72	9.63	13.1
6	North Beach	31	27558.3	28423	27991	22	23	865	-4.45	-2.59	-1.7	-0.03	0.32	-1.93	-3.92	-6.89	4.61	13.13	8.8
		32	28423	29581	29002	23	24	1158	-4.73	-2.56	-1.71	-0.22	0.23	-1.93	-4.71	-4.75	9.36	23.61	17.9
		33	29581	30622.2	30102	24	25	1041	-5.1	-2.48	-1.54	-0.55	0.23	-0.38	#N/A	-3.78	7.63	8.4	-4.2
		34	30622.2	31431.9	31027	25	26	810	-5.29	-2.34	-1.34	-0.16	0.71	-0.71	-3.83	-6.7	5.62	9.22	2.7
		35	31431.9	32235.9	31834	26	27	804	-5.95	-2.42	#N/A	-0.06	-0.7	-2.43	-5.67	-7.92	2.39	5.8	-9.6
		36	32235.9	33039.2	32638	27	28	803	-5.7	-2.31	-1.05	0.22	-0.74	-2.53	-5.4	-8.11	1.55	6.45	4.4
		37	33039.2	33835.7	33437	28	29	797	-6.23	-2.39	#N/A	0.05	-0.45	#N/A	-6.24	-9.48	-0.81	5	16.2
		38	33835.7	34642	34239	29	30	806	-5.36	-1.77	-0.64	0.05	-0.16	#N/A	-5.36	-9.66	-0.76	7.88	45.3
		39	34642	35436.5	35039	30	31	795	-5.4	-1.89	-0.62	0.42	-0.08	#N/A	#N/A	-7.95	-2.05	3.3	32.3
		40	35436.5	36238.9	35838	31	32	802	-5.04	-1.63	-0.51	0.59	0.37	#N/A	-1.44	-8.08	-6.31	-6.42	-14.6
		41	36238.9	37384.3	36812	32	33	1145	-4.57	-1.15	-0.12	0.93	0.18	#N/A	-2.61	-6.2	0.39	-3.07	-16.5
7	Surf City	42	37384.3	38428.9	37907	33	34	1045	-4.18	-0.54	0.6	2	0.85	#N/A	-2.74	-8.82	-1.37	2.72	-8.4
		43	38428.9	39502.1	38966	34	35	1073	-3.6	-0.21	0.74	1.99	1.18	#N/A	-0.73	-7.25	-0.96	2.88	-1.4
		44	39502.1	40565.8	40034	35	36	1064	-3.61	-0.13	0.53	1.54	1.33	#N/A	#N/A	-10.24	-7.01	-3.62	0.8
		45	40565.8	41623.9	41095	36	37	1058	-3.36	-0.12	0.56	1.81	1.59	#N/A	-0.72	-6.55	-2.33	3.16	0.2
		46	41623.9	42745	42184	37	38	1121	-3.28	-0.1	0.76	1.82	1.63	1.22	#N/A	-7.01	-1.69	2.6	23.9
		47	42745	43798.3	43272	38	39	1053	-3.58	0	1.1	1.52	1.62	1.5	#N/A	-5.73	-3.01	1.93	36.1
8	Ship Bottom	48	43798.3	44851.2	44325	39	40	1053	-3.24	0.11	1.14	1.94	2.37	2.25	0.67	-6.21	-1.79	3.28	1.8
		49	44851.2	45895.2	45373	40	41	1044	-3.22	0.08	1.08	1.89	1.77	1.79	#N/A	-4.51	-7.05	-2.65	11.3
		50	45895.2	46960	46428	41	42	1065	-3.19	-0.12	1.15	1.67	1.52	0.64	-2.07	-5.2	-6.56	-1.76	2.6
		51	46960	48017	47489	42	43	1057	-3.19	0.01	1.3	1.71	2.06	1.51	-0.78	-1.61	-3.6	5.65	5.6
		52	48017	49076.3	48547	43	44	1059	-2.94	0.11	1.62	1.98	2.78	2.76	#N/A	1.29	5.43	10.16	2.7
9	Brant Beach	53	49076.3	50127.5	49602	44	45	1051	-2.69	0.21	1.9	2.32	3.53	5.47	-0.41	0.2	2.55	7.54	3.8
		54	50127.5	51063.2	50595	45	46	936	-2.6	0.06	1.67	2.02	2.81	#N/A	#N/A	-1.1	-0.69	2.82	15.8
		55	51063.2	52048.4	51556	46	47	985	-2.42	-0.15	1.2	2.01	3.58	3.5	2.23	-0.52	-1.69	-0.88	-9.2
		56	52048.4	52828.4	52438	47	48	780	-2.28	-0.21	1.1	1.95	2.97	4.44	#N/A	1.65	-7.46	-8.33	2.9
		57	52828.4	53645.9	53237	48	49	818	-2.09	-0.24	0.87	1.23	1.33	0.01	-3.66	-2.6	-2.47	-0.91	-20.7
		58	53645.9	54449	54047	49	50	803	-2.68	-0.72	0.37	1.22	1.43	0.07	-3.23	-7.02	-4.09	-4.23	1.1
		59	54449	55255.2	54852	50	51	806	-3.57	-1.29	#N/A	0.42	0.7	0.42	#N/A	-6.32	-6.98	-4.7	12.8
		60	55255.2	56046.2	55651	51	52	791	-2.71	-1.61	-1.06	0.14	0.47	0.42	-2.99	-1.83	-4.7	0.53	-16.4
		61	56046.2	56805.8	56426	52	53	760	-2.31	-1.28	#N/A	0.63	0.85	1.32	-1.46	-0.42	-1.52	3.22	9.3
		62	56805.8	57545.8	57176	53	54	740	-1.8	-1.29	-0.75	0.68	1.74	1.56	-1.82	-1.81	-1.08	8.49	49.6
		63	57545.8	58304.3	57925	54	55	759	-1.29	-0.8	-0.33	0.39	1.54	#N/A	-0.95	-1.18	-2.62	5.3	35.8
10	BH Crest to BH Park	64	58304.3	59055	58680	55	56	751	-0.88	-0.39	0.03	0.06	0.77	#N/A	-2.09	0.23	-1.43	4.74	26.9
		65	59055	59802.1	59429	56	57	747	-0.88	-0.33	-0.04	0.2	0.82	#N/A	#N/A	0.56	1.13	4.54	38.3
		66	59802.1	60556.5	60179	57	58	754	-0.62	-0.27	0.04	0.33	0.45	#N/A	-1.89	-0.03	0.41	6.13	30.5
		67	60556.5	61373.3	60965	58	59	817	-0.3	0	0.31	0.71	0.88	#N/A	#N/A	-5.73	-6.18	0.65	-16.8
		68	61373.3	61993.1	61683	59	60	620	0.06	0.25	0.56	0.88	0.77	#N/A	-4.52	-6.23	-8.21	-5.14	29.7
		69	61993.1	63027.1	62510	60	61	1034	0	0.28	0.43	0.89	1.13	#N/A	-5.57	-5.26	2.93	12.25	#N/A
		70	63027.1	63907.7	63467	61	62	881	0.24	0.53	0.74	1.77	2.27	#N/A	-2.22	-3.98	-2.15	10.37	#N/A
		71	63907.7	64949.8	64429	62	63	1042	0.43	0.54	0.75	2.51	3.74	3.78	#N/A	-2.9	-3.66	3.63	#N/A
		72	64949.8	65798.5	65374	63	64	849	0.74	0.62	0.97	2.74	4.26	4.67	#N/A	-3.13	-5.99	-0.85	-5.7
		73	65798.5	66631.8	66215	64	65	833	0.53	0.54	0.72	2.29	3.66	3.15	-0.38	-1.77	-4.85	2.8	-8.1
		74	66631.8	67520.1	67076	65	66	888	0.34	0.43	0.67	1.57	2.73	5.27	#N/A	0.37	-5.46	1.58	15.2

		Shoreline	GENESIS Coords		Mean	BOUNDING GROINS			SHORELINE CHANGE RATES (ft/yr) thru 1997										
BUNDY	COMMUNITY	Compartment	START	STOP	Distance	North	South	Length	**1836-1997**	**1871-1997**	**1899-1997**	**1932-1997**	**1951-1997**	**1971-1997**	**1977-1997**	**1986-1997**	**1991-1997**	**1993-1997**	**1996-1997**
11	Haven Bch to BH Gardens	75	67520.1	68619.9	68070	66	67	1100	-0.02	-0.2	-0.15	0.17	1.11	0.74	-2.56	-2.76	0.22	6.45	#N/A
		76	68619.9	69446	69033	67	68	826	-0.11	-0.44	-0.44	0.12	2.51	0.15	-3.83	-4.41	-1.28	2.8	#N/A
		77	69446	70513.1	69980	68	69	1067	-0.3	-0.73	-0.71	-0.51	1.24	0.03	#N/A	-7.26	-1.92	3.15	#N/A
		78	70513.1	71247.8	70880	69	70	735	-0.12	-0.39	-0.19	-0.33	0.24	1.79	#N/A	-8.24	-4.62	1.38	#N/A
		79	71247.8	72167.5	71708	70	71	920	0.3	-0.27	0.11	0.39	1.22	3.02	#N/A	-5.35	-0.41	5.85	#N/A
		80	72167.5	73047.7	72608	71	72	880	0.73	-0.25	#N/A	1.1	2.17	3.64	#N/A	-8.75	-4.42	2.7	#N/A
		81	73047.7	73949.6	73499	72	73	902	1.08	0.39	1.17	1.28	2.22	1.34	-2.47	-5.54	1.19	7.85	#N/A
12	Spray Bch to BH Boro N	82	73949.6	74872.3	74411	73	74	923	1.33	0.56	1.26	1.01	2.18	#N/A	-2.47	-10.54	-3.43	2.93	#N/A
		83	74872.3	75947.1	75410	74	75	1075	1.37	0.59	1.16	0.99	1.88	#N/A	-1.76	-6.5	-3.28	4.9	#N/A
		84	75947.1	76951.7	76449	75	76	1005	1.62	0.53	1.05	1.3	2.49	2.67	-0.27	-6.58	-5.75	0.03	#N/A
		85	76951.7	77951.8	77452	76	77	1000	1.53	0.15	0.96	1.41	3.2	5.79	#N/A	-3.73	-2.53	1.75	#N/A
		86	77951.8	79166.5	78559	77	78	1215	1.68	0.25	0.71	0.61	2.19	4.41	0.43	-2.09	-2.06	4.1	#N/A
		87	79166.5	80182.3	79674	78	79	1016	2.07	0.39	0.67	0.41	2.35	5.09	#N/A	-1.72	-3.9	-2.02	#N/A
		88	80182.3	81201.1	80692	79	80	1019	2.39	0.82	1.41	0.5	2.12	5.25	#N/A	-1.59	1.39	-2.07	#N/A
13	Beach Haven Boro	89	81201.1	82468.3	81835	80	81	1267	2.01	0.25	0.9	0.19	1.47	4.12	#N/A	-1.77	7.66	8.15	#N/A
		90	82468.3	83586.8	83028	81	82	1119	1.84	0.19	0.67	0.73	1.71	4.43	#N/A	-2.88	-2.2	-2.3	#N/A
		91	83586.8	84617.3	84102	82	83	1031	0.89	-1.14	-0.14	0.66	0.8	2.79	#N/A	-6.53	-5.64	-3.02	#N/A
		92	84617.3	85932.8	85275	83	84	1316	-0.72	-2.91	-1.28	-0.18	0.59	2.9	#N/A	-3.06	5.07	10.15	#N/A
14	Beach Haven Boro S	93	85932.8	87273.9	86603	84	85	1341	-3.77	-6.27	-3.59	1.22	2.45	0.09	-4.03	-2.73	7.57	11.37	#N/A
		94	87273.9	88507.6	87891	85	8688	1234	-6.93	-9.74	-6.75	0.38	1.78	-1.21	-6.39	-8.93	-2.65	1.98	#N/A
		95	88507.6	89048.2	88778	8688	89	541	-9.14	-11.9	-9.06	-2.39	-2.22	-3.14	-8.72	-3.48	8.67	10.35	#N/A
15	BH Boro to Holgate	96	89048.2	89546.4	89297	89	90	498	-9.48	-12.39	#N/A	-2.7	-1.37	-0.01	#N/A	-2.92	19.87	32.65	#N/A
		97	89546.4	90042.9	89795	90	91	497	-10.41	-12.95	#N/A	-3.12	-0.45	-0.01	#N/A	-3.02	10.55	20.82	#N/A
		98	90042.9	90550.3	90297	91	92	507	-10.84	-12.94	#N/A	-3.24	-0.66	#N/A	-4.12	-1.58	14.2	25.42	#N/A
		99	90550.3	91330.7	90941	92	93	780	-11.68	-13.47	-10.17	-2.84	-0.66	#N/A	-1.97	-5.52	12.13	25	#N/A
		100	91330.7	92359.7	91845	93	94	1029	-12.61	-14.45	-10.91	-3.52	-1.56	#N/A	0.01	-7.53	-1.35	4.65	#N/A
		101	92359.7	93192.4	92776	94	95	833	-13.49	-15.35	-12.05	-3.64	-1.69	#N/A	0.21	-4.42	1.32	4.28	#N/A
		102	93192.4	93936.3	93564	95	96	744	-13.85	-15.28	-11.09	-1.31	-1.62	#N/A	-1.06	-8.56	-4.68	-3.67	#N/A
		103	93936.3	94651	94294	96	97	715	-13.85	-14.84	-10.15	-0.59	-1.71	#N/A	#N/A	-7.24	-10.35	-11.65	#N/A
		104	94651	95434	95043	97	98	783	-15.44	-16.45	-11.62	-1.97	-2.1	#N/A	-1.78	-5.86	-5.44	-7.95	#N/A
		105	95434	95824	95629	98	99	390	-18.66	-20.53	-16.13	-7.03	-10.31	#N/A	#N/A	8.08	10.56	#N/A	#N/A
Not Studied	Holgate Wildlife Refuge	106	95824	96500	96162	None	None	676	-21.04	-23.36	-19.79	-12.66	-18.03	#N/A	-7.57	1.48	22.61	16.5	#N/A
		107	96500	97500	97000	None	None	1000	-21.89	-25.21	-21.57	-14.48	-21.17	#N/A	-9.53	-4.35	27.02	36.87	#N/A
		108	97500	98500	98000	None	None	1000	#N/A	-25.42	-20.41	-9.14	-21.86	#N/A	-5.54	-8.13	17.7	33	#N/A
		109	98500	99500	99000	None	None	1000	#N/A	-26.94	-22.95	#N/A	-16.14	-6.17	-3.04	-10.95	5.14	14.3	#N/A
		110	99500	100500	100000	None	None	1000	#N/A	-26.48	-21.41	#N/A	-13.36	-5.3	-4.23	-18.09	-16.93	#N/A	#N/A
		111	100500	101500	101000	None	None	1000	#N/A	-25.58	-20.23	#N/A	-10.57	-12.1	#N/A	-31.92	-17.36	-7.47	#N/A
		112	101500	102500	102000	None	None	1000	#N/A	#N/A	#N/A	#N/A	-6.84	-11.94	#N/A	#N/A	-30.93	-17.12	#N/A
		113	102500	103500	103000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	-4.25	3.18	#N/A	-44.13	-47.77	#N/A
		114	103500	104500	104000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	3.39	#N/A	-43.33	-62.91	-72.5	#N/A
		115	104500	105500.5	105000	None	None	1001	#N/A	#N/A	#N/A	#N/A	#N/A	21.33	8.53	-29.83	-60.68	-60.2	#N/A
		116	105500.5	106500	106000	None	None	1000	#N/A	#N/A	#N/A	#N/A	#N/A	41.71	19.58	#N/A	-47.72	-50.07	#N/A

Examination of Beach Profile Data. Beach profile surveys along Long Beach Island have been conducted by various agencies since 1836. The data most relevant to this study are listed below in **Table 2-13**:

TABLE 2-13. Summary of Beach Profile Data Collection Efforts along LBI, NJ.		
AGENCY	DATA SET	DATES SURVEYED
USACE, Philadelphia District	Line Reference Point Surveys (LRP)	1965, 1984, 1996
USACE, Coastal Engineering Research Center (CERC).	CERC Surveys	1962-1973
NJDEP, Coastal Research Center at Stockton State College	New Jersey Beach Profile Network (NJBPN)	1986 to Present
USACE, Coastal and Hydraulics Laboratory (CHL)	Barnegat Inlet MCCP Surveys	1993 to Present

Each of these data provides information relevant to the evaluation of previous shoreline behavior and assessment of the continued evolution of the island's shoreline positions. The CERC survey data set is, by far, the most detailed in terms of the number of profiles, the associated number of repeat surveys, and the continuity of record which covers a continuous period of about 13 years, following the storm of March 1962. Therefore, the CERC data provide an extended view of shore behavior, and due to the relatively frequent repetition of the surveys, give valuable insights regarding short-term beach responses. The primary limitation of the CERC data set is that it does not provide information seaward of the intratidal zone. On the other hand, the LRP data set provides information on the offshore as well as onshore portions of the active beach profiles, but is extremely limited in regard to the number of comparable sequential surveys. The NJDEP and MCCP profile surveys constitute the latest set of recorded data and accordingly, are the most representative of the databases in regard to the present characteristics and behavior of Long Beach Island's beach and dune system. The MCCP profiles; however, are limited to the vicinity of Barnegat Inlet.

Analysis of the NJDEP profile data indicate volumetric changes in the profile only through the nearshore zone. The profiles do not extend beyond the surf zone where significant movement of littoral material occurs. Thus, storage of material removed from the nearshore during a significant event may not be accounted for. The lack of established survey controls for the NJDEP surveys prevented direct comparison of recent shoreline positions against historic shoreline positions determined through shoreline change mapping. However, the data identify relative changes in the shoreline position and account for losses and gains to the berm/dune system.

Qualitative changes over time for each profile are summarized by Farrell et. al (1998) as described above. Additional analyses were performed on the temporal changes in MHW positions for each profile to provide more quantitative shoreline change information. The MHW position, distance along profile corresponding to an elevation of approximately +1.5 ft NAVD, was determined for each profile. Analysis of the positions over time for each profile provides insight into the variability in shoreline positions and estimation of trends in shoreline movement. The MHW positions were plotted for each profile versus the date surveyed and a least squares fit was performed to estimate a shoreline change rate over the corresponding time period. **Figure 2-34** displays the shoreline positions at profile NJDEP 143 in Harvey Cedars. The figure shows the gross changes in the shoreline position on the order of 70 ft with an accretional trend of 0.7 feet per year**. Table 2-14** displays the results of the shoreline change rate analysis on the NJDEP profiles

Profile data collected as part of the MCCP program were used to compute shoreline change rates and volumetric change rates in the vicinity of Barnegat Inlet. Changes in the MHW contour position were analyzed for each profile to compute a shoreline change rate as shown in **Figure 2-35**. The shoreline change rates for the time period analyzed compare favorably to shoreline change rates computed using the shoreline positions shown previously. Additionally, volumetric changes across the entire profile over time were computed. Volumetric changes for representative reaches (compartments) were then computed using average-area-end method. A volumetric change rate was also computed using shoreline change rates (from shoreline positions) using the active profile (average berm elevation to depth-of-closure) assumption. Comparison of the two methods resulted in small refinements in the assumed depth-of-closure to provide equal volumetric change rates. Therefore, shoreline position data can be used with confidence to estimate historic volumetric changes and to predict future with-project nourishment requirements.

Summary of Historical Shoreline Conditions. Analysis of the overall study area indicates a relatively stable shoreline, with brief periods of erosion which are followed by a quick recovery. The bulk of the analysis was performed using the Leathermann Shoreline Change Maps (and recent additions) to document long-term conditions from 1839-1997. More recent conditions were analyzed using the NJDEP profile data from 1986 to present with detailed analyses conducted in the Barnegat Inlet vicinity using the MCCP profile data.

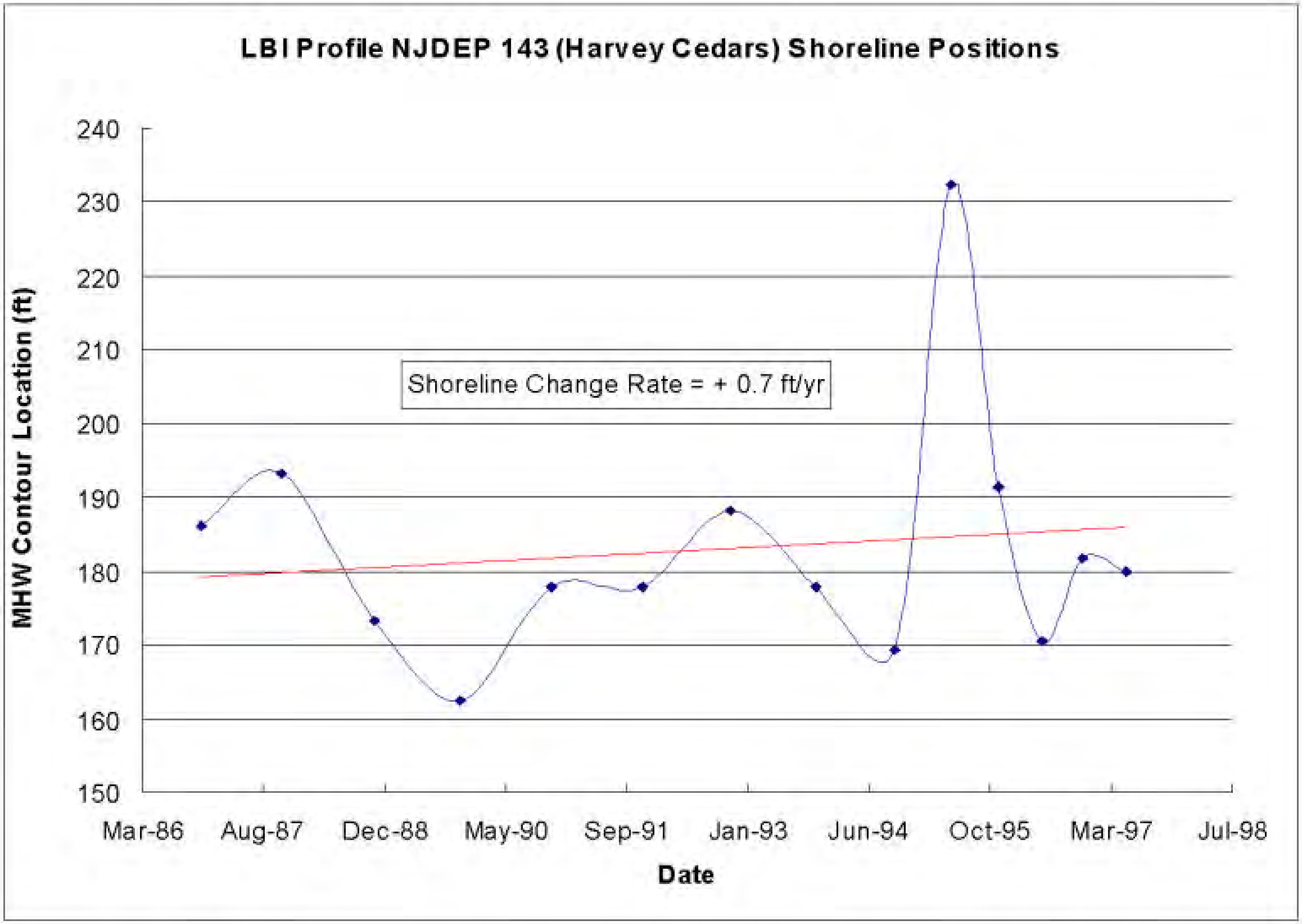


Figure 2-34 Profile NJDEP 143 (Harvey Cedars) MHW Shoreline Positions and Computed Shoreline Change Rate.

TABLE 2-14. SHORELINE CHANGE ANALYSIS RESULTS FOR NJDEP PROFILES LOCATED on Long Beach Island, NJ.															
NJDEP Profile	SURVEY DATE and SHORELINE POSITION														Sl Chg Rate (ft/yr)
									Nov-94	*Apr-95*	*Oct-95*	*Jun-96*	*Nov-96*	*May-97*	
OC245									1350.13	1398.49	1386.13	1315.02	1326.89	1339.91	***-20.5***
	Nov-86	*Oct-87*	*Nov-88*	*Nov-89*	*33189.5*	*Nov-91*	*Nov-92*	*Oct-93*	*Oct-94*	*Apr-95*	*Oct-95*	*Jun-96*	*May-97*	*Nov-97*	
OC145	351.59	389.61	395.70	373.30	384.07	387.78	415.13	397.42	416.96	412.99	443.47	435.01	472.31	456.41	***8.3***
	Nov-86	*Oct-87*	*Nov-88*	*Nov-89*	*33189.5*	*Nov-91*	*Nov-92*	*Oct-93*	*Sep-94*	*May-95*	*Dec-95*	*May-96*	*Nov-96*	*May-97*	
OC144	209.30	204.33	205.45	200.34	211.76	208.29	209.28	200.63	218.81	205.88	200.17	179.83	202.62	211.29	***-0.5***
	Nov-86	*Oct-87*	*Nov-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Sep-94*	*May-95*	*Dec-95*	*May-96*	*Nov-96*	*May-97*	
OC143	186.06	193.28	173.21	162.34	177.77	177.79	188.23	177.96	169.45	232.47	191.41	170.52	181.83	179.91	***0.7***
	Nov-86	*Oct-87*	*Nov-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Sep-94*	*May-95*	*Nov-95*	*May-96*	*Nov-96*	*May-97*	
OC142	400.20	422.76	405.75	440.63	427.41	441.82	419.49	428.27	430.12	450.95	448.24	450.73	457.47	443.11	***3.9***
									Oct-94	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC241									357.25	370.16	364.15	323.56	339.54	322.03	***-17.5***
	Nov-86	*Oct-87*	*Nov-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC141	267.56	274.08	256.62	None	249.03	261.12	215.44	255.73	241.64	249.68	268.64	234.78	266.77	225.63	***-2.1***
	Nov-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC140	353.96	342.47	301.08	320.74	311.49	314.24	338.38	319.27	235.04	322.45	344.63	309.25	323.72	302.28	***-2.6***
	Nov-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC139	198.37	176.27	224.97	193.02	199.77	159.50	190.82	182.89	210.26	171.49	192.33	180.93	191.71	205.24	***-0.5***
	Nov-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC138	297.67	260.72	255.91	281.86	280.45	261.27	259.55	281.15	270.26	271.40	279.15	255.21	252.24	239.08	***-2.1***
	Dec-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC137	297.06	283.68	307.64	276.48	277.19	289.47	279.55	285.40	262.72	265.52	291.50	245.51	289.54	259.59	***-2.7***
	Dec-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC136	256.37	247.07	233.78	203.94	226.24	203.47	176.78	219.40	208.36	191.95	185.30	186.77	213.21	211.73	***-4.6***
	Oct-86	*Oct-87*	*Dec-88*	*Nov-89*	*Nov-90*	*Nov-91*	*Nov-92*	*Nov-93*	*Oct-94*	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC135	311.35	307.25	373.99	355.81	357.58	312.97	351.39	353.01	346.63	357.35	367.19	340.08	352.05	384.33	***3.5***
									Nov-94	*Apr-95*	*Oct-95*	*May-96*	*Nov-96*	*May-97*	
OC234									348.45	305.89	379.91	255.76	425.70	327.77	***6.7***

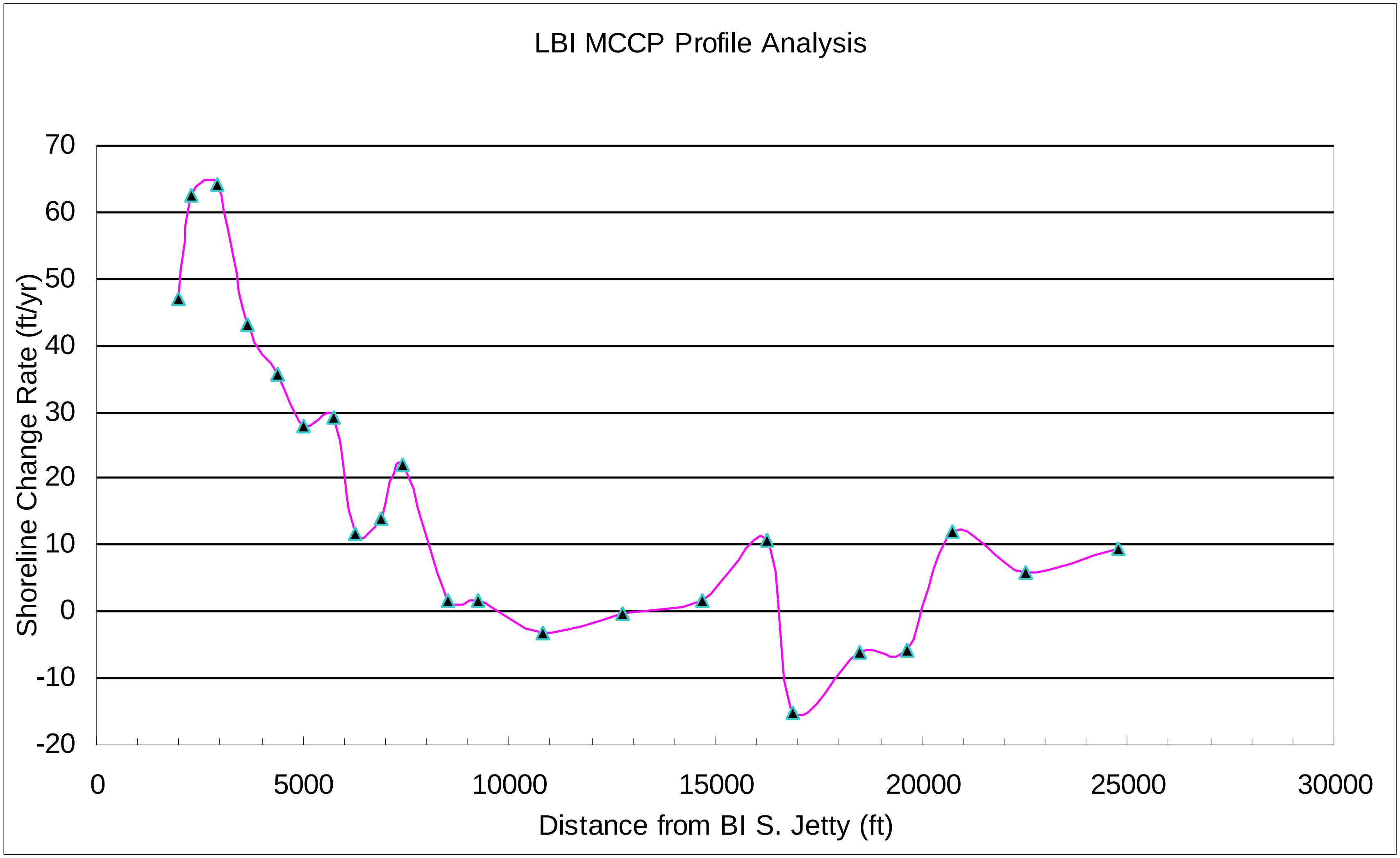


Figure 2-35. Shoreline Change Rate Analysis Results from Barnegat Inlet MCCP Profile Data (1993-1997)

WITHOUT PROJECT ANALYSIS

HYDRAULIC ANALYSIS

Storm erosion, Inundation and Wave Attack Analyses. Storm erosion, inundation and wave attack analyses were conducted for the communities north of Holgate Wildlife Refuge to determine the potential for erosion caused by waves and elevated water levels which accompany storms. Storm-induced erosion and coastal flooding is first evaluated for the without project condition, which is a projection of existing conditions in the base year. Similar analyses will then be conducted using selected alternatives for the with project conditions.

Factors Influencing Storm Effects. A brief summary of the mechanisms that result in erosion and inundation from coastal storms is provided in this section. Although wind, storm track, and precipitation are the primary meteorological factors affecting the damage potential of coastal storms, the major causes of damage and loss of life are storm surge, storm duration, and wave action.

Under storm conditions, there is typically a net increase in the ocean water level which is superimposed on the normal astronomic tide height fluctuations. The increase in water level caused by the storm is referred to as "storm surge." The effect of storm surge on the coast depends on the interaction between the normal astronomic tide and storm-produced water level rise. For example, if the time of normal high tide coincides with the maximum surge, the overall effect will be greater. If the surge occurs at low or falling tide, the impact will likely be lessened. The term "stage" as applied in this analysis pertains to the total water elevation, including both tide and storm surge components, relative to a reference datum (NAVD88, used herein). The term "surge" is defined as the difference between the observed stage and the stage that is predicted to occur due to normal tidal forces, and is thus a good indicator of the magnitude of storm intensity. Slowly moving "northeasters" may continue to build a surge that lasts through several high tides. Such a condition occurred during the devastating March 1962 storm that lasted for five high tides.

In addition to storm surge, a rise in water level in the near shore can occur due to wave setup. Although short period surface waves are responsible for minimal mass transport in the direction of wave propagation in open water, they cause significant transport near shore upon breaking. Water propelled landward due to breaking waves occurs rather rapidly, but water returned seaward under the influence of gravity is slower. This difference in transport rates in the onshore and offshore directions results in a pileup of water near shore referred to as wave setup. Wave setup was computed and included in this storm analysis.

There is typically also an increase in absolute wave height and wave steepness (the ratio of wave height to wave length). When these factors combine under storm conditions, the higher, steeper waves and elevated ocean stage cause a seaward transport of material from the beach face. Net movement of material is from the foreshore seaward toward the surf zone. This offshore transport creates a wider, flatter nearshore zone over which the incident waves break and dissipate energy.

Lastly, coastal structures can be exposed to the direct impact of waves and high velocity runup in addition to stillwater flooding. This phenomenon will be considered the wave attack for the purpose of this analysis. Reducing wave attack with a proposed project such as a beach fill would reduce the severity of coastal storm damage and also improve the utility of bulkheads and seawalls during the storm.

Wave zones are the regions in which at least a 3 ft wave or a velocity flow that overtops the profile crest by 3 ft can be expected to exist. These zones are the areas in which greater structural damages are expected to occur. The remaining zones are susceptible to flooding by overtopping and waves less than the minimum of 3 ft. Total water level information for the study area was compiled, and the values used as input to the economic model that ultimately computes damages associated with all three storm related damage mechanisms.

Modeling Storm-induced Erosion. Storm erosion analyses require either a long period of record over which important storm parameters as well as resultant storm erosion are quantified, or a model which is capable of realistically simulating erosion effects of a particular set of storm parameters acting on a given beach configuration. There are very few locations for which the necessary period of prototype information is available to perform an empirical analysis of storm-induced erosion. This is primarily due to the difficulty of directly measuring many important beach geometry and storm parameters, before, during, and immediately after a storm. Thus, a systematic evaluation of erosion under a range of possible starting conditions requires that a numerical model approach be adopted for the study area.

The USACE has developed, released and adopted the numerical storm-erosion model SBEACH (<u>S</u>torm induced <u>BEA</u>ch <u>CH</u>ange) for use in field offices (Rosati, et al., 1993). SBEACH is available via a user interface for the personal computer or through the Coastal Modeling System (CMS) (Cialone et al., 1992). Comprehensive descriptions of development, testing, and application of the model are contained in Reports 1 and 2 of the SBEACH series (Larson and Kraus 1989; Larson, Kraus, and Byrnes 1990)

Overview of SBEACH Methodology. SBEACH Version 3.2 (Windows version) was used in this analysis. SBEACH is a geomorphic-based two-dimensional model that simulates beach profile change, including the formation and movement of major morphologic features such as longshore bars, troughs, and berms, under varying storm waves and water levels (Rosati, et al. 1993). SBEACH has significant capabilities that make it useful for quantitative and qualitative investigation of short-term, beach profile response to storms. However, since SBEACH is based on cross-shore processes, there are shortcomings when used in areas having significant longshore transport.

Input parameters include varying water levels as produced by storm surge and tide, varying wave heights and periods, and grain size in the fine-to-medium sand range. The initial beach profile can be input as either an idealized dune and berm configuration or as a surveyed total profile configuration. SBEACH allows for variable cross-shore grid spacing, simulated water-level setup due to wind, advanced procedures for calculating the wave breaking index and breaker decay, and provides an estimation of dune overwash. Shoreward boundary conditions that may be specified include a vertical structure (that can fail due to either excessive scour or instability caused by wave action/water elevation) or a beach with a dune. Output results from SBEACH include calculated profiles, cross-shore parameters, and log and a report file.

SBEACH Calibration. Calibration refers to the procedure of reproducing with SBEACH the change in profile shape produced by an actual storm. Due to the empirical foundation of the SBEACH model and the natural variability that occurs along a beach under storm attack, proper use of the model requires calibration and verification using data from beach profiles surveyed before and after exposure to the effects of a particular storm. The calibration procedure involves iterative adjustments of controlling simulation parameters until agreement is obtained between measured and simulated profiles. In this investigation, model calibration and verification were based on original SBEACH calibration/verification efforts conducted by CERC at Point Pleasant Beach, see USACE/CERC, 1990. The Point Pleasant Beach profile used in calibration has similar characteristics in terms of nearshore, berm, and dune features to profiles found throughout Long Beach Island. The conditions selected for calibration were associated with a northeaster that occurred over the period 27 to 29 March 1984 during which the peak water level reached +6.2 feet NGVD, and maximum wave heights of 21.6 feet were recorded in a water depth of 50 feet off of Manasquan Inlet. The selected pre-storm profile surveys were taken on 26 and 27 March. Post-storm profiles were taken on 2 April. Examination of the post-storm profile shows considerable deposition on top of the dune. The eroded portion of the profile was contaminated with some recovery that occurred between post-storm and the survey. The calibration adjustment runs for this area were brought to a conclusion on reaching conditions that generally followed the pattern of the post-storm profile survey.

All in all, the calibration and verification of the SBEACH model produced acceptable but not outstanding results. Admittedly, the process lacked complete data with respect to overall onshore/offshore surveys of pre- and post-storm profiles, and measured water levels at Long Beach Island. Additionally, it should be appreciated that actual profile responses along the shores of the study area are probably significantly influenced by alongshore processes and the related effects of the adjacent jetties and groin field. Since the alongshore component of sediment transport and groin/sediment-transport interaction cannot be simulated by the SBEACH model, it is highly probable that, even with ideal data sets, extremely close correspondence between simulated and measured results is not achievable in the case of Long Beach Island.

Development of Input Data for Storm Erosion Modeling. Transects were selected representing the "average" shoreline, structure, backshore configuration, and upland development conditions for various reaches in the study area. For each reach, storm erosion and inundation were computed and reported relative to a designated baseline. Input data was developed for each cell as follows.

Profile Data. The principal physical characterization of each cell is provide by the cross-sectional configuration of its beach and dune system. In this investigation, the July 1996 most recent survey profiles were selected to represent the onshore and nearshore areas under the “without” (“W/O”) project base year condition. Each profile extended from the dunes to a sufficient distance seaward beyond the depth of closure. The original survey information was sufficient to perform beach/dune response modeling; however, economic damage assessment requires evaluation of damage potential landward of the first row of development. Therefore, the profiles were artificially extended in a landward direction until the profile reached the Bay. These extensions were based on general characteristics of the island's topography as determined by field investigations, USGS topographic sheets, 1996 digital ortho-photogrammetric data, and recent structure inventory surveys. Cross sections of representative beach profile lines can be seen in **Figures 2-36 to 2-39.** The profile line names correspond to the cells that they represent. The cell limits were previously described in Table 3-5 in Volume 1 and are graphically depicted in **Figure 2-40**.

Potential "future" damages were also evaluated for cells where long term erosion may result in profile conditions significantly different from those simulated in the "base year." Sufficient long term erosion warranted modification of profiles for cells 3 to 15 (Loveladies to Holgate), with the ends of the Island being historically stable. Long term erosion was incorporated by translating the profile landward a distance equal to the long term erosion rate adopted for each cell times the number of years projected into the future. It was assumed the locals would maintain existing dune conditions, as has been demonstrated historically. Therefore, no modifications were made to the profile above the berm. **Figure 2-41** shows both the base year and future (year 15) conditions for BUNDY 9 located in Brant Beach with a long term erosion rate of -2 ft/yr.

Model Parameters. Various model parameters required to run SBEACH are input into the reach and storm configuration files. The reach configuration parameters include grid data, profile characteristics, beach data (including grain size), sediment transport parameters, and seawall or bulkhead data. The storm configuration file includes information on wave angle, height and period, water elevation, wind speed and angle and other storm information.

Water Elevation. The water level is the most important or first-order forcing parameter controlling storm-induced beach profile change, normally exerting greater control over profile change during storms than either waves or wind. Water level consists of contributions from the tide, storm surge, wave- and wind-induced setup, and wave runup; the latter three are computed within SBEACH. Input data in this case is tide and storm surge data. The combined time series of tide and surge is referred to as the hydrograph of total water level. The shape of the hydrograph is characterized by its duration (time when erosive wave conditions and higher than normal water elevation occur) and by its peak elevation.

Water level input data files for representative 5-, 10-, 20-, 50-, 100-, 200-, and 500-yr events were developed for the study area as part of the wave hindcast conducted by OCTI. The Gumbel distribution (Fisher-Tippett Type I) was used.

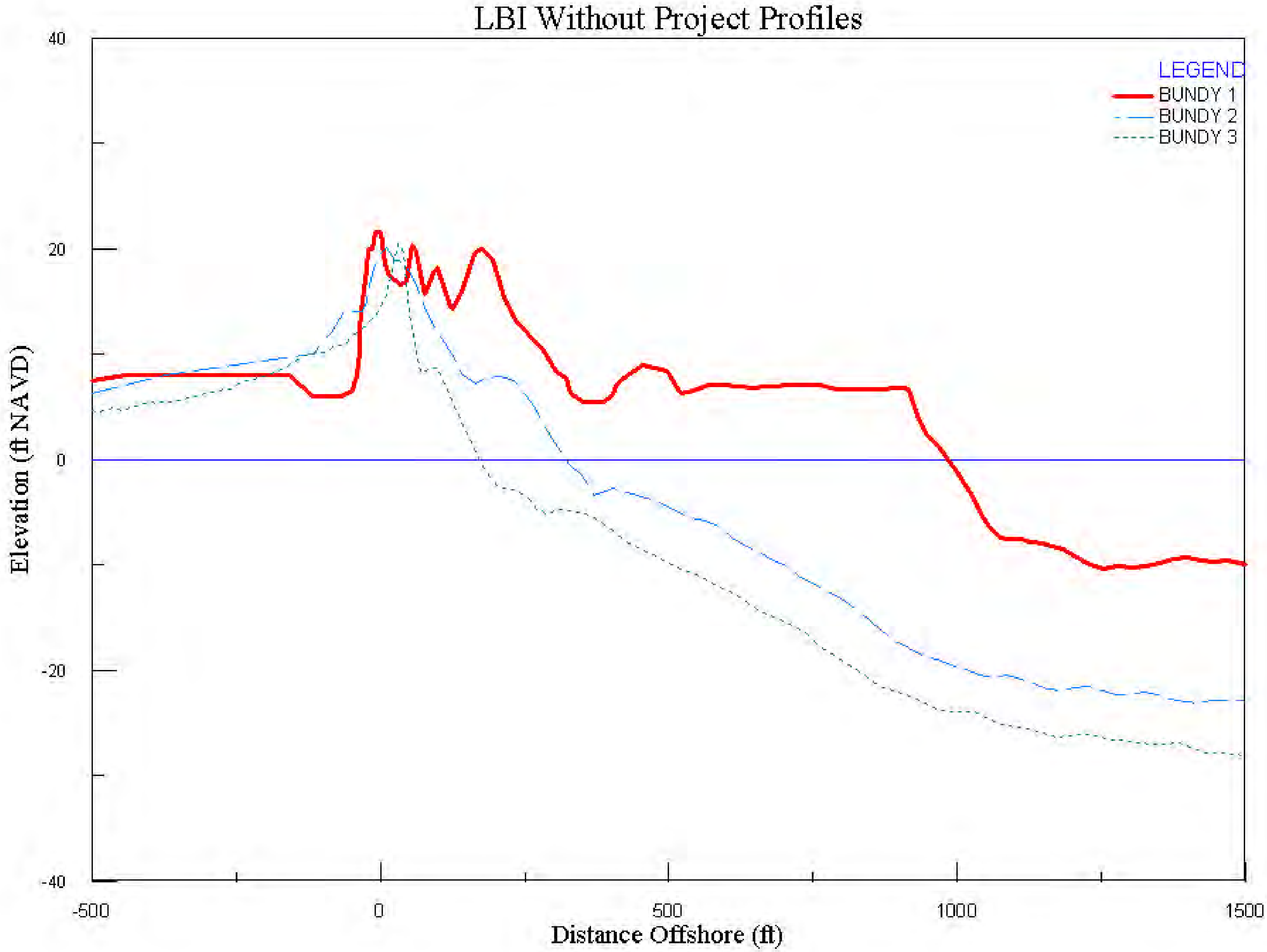


Figure 2-36 Representative Beach Profiles for BUNDYs 1-3 (Base Year).

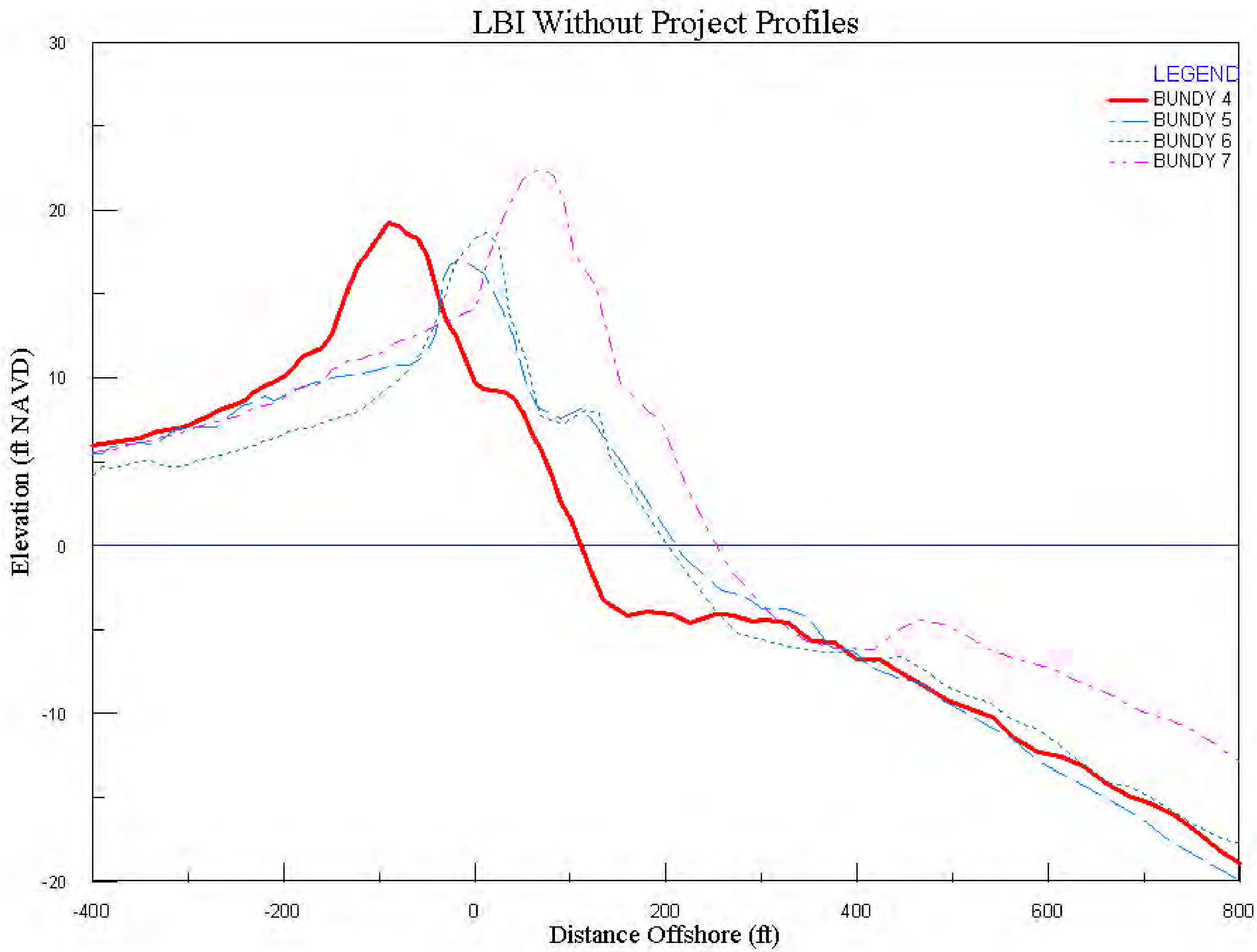


Figure 2-37 Representative Beach Profiles for BUNDYs 4-7 (Base Year).

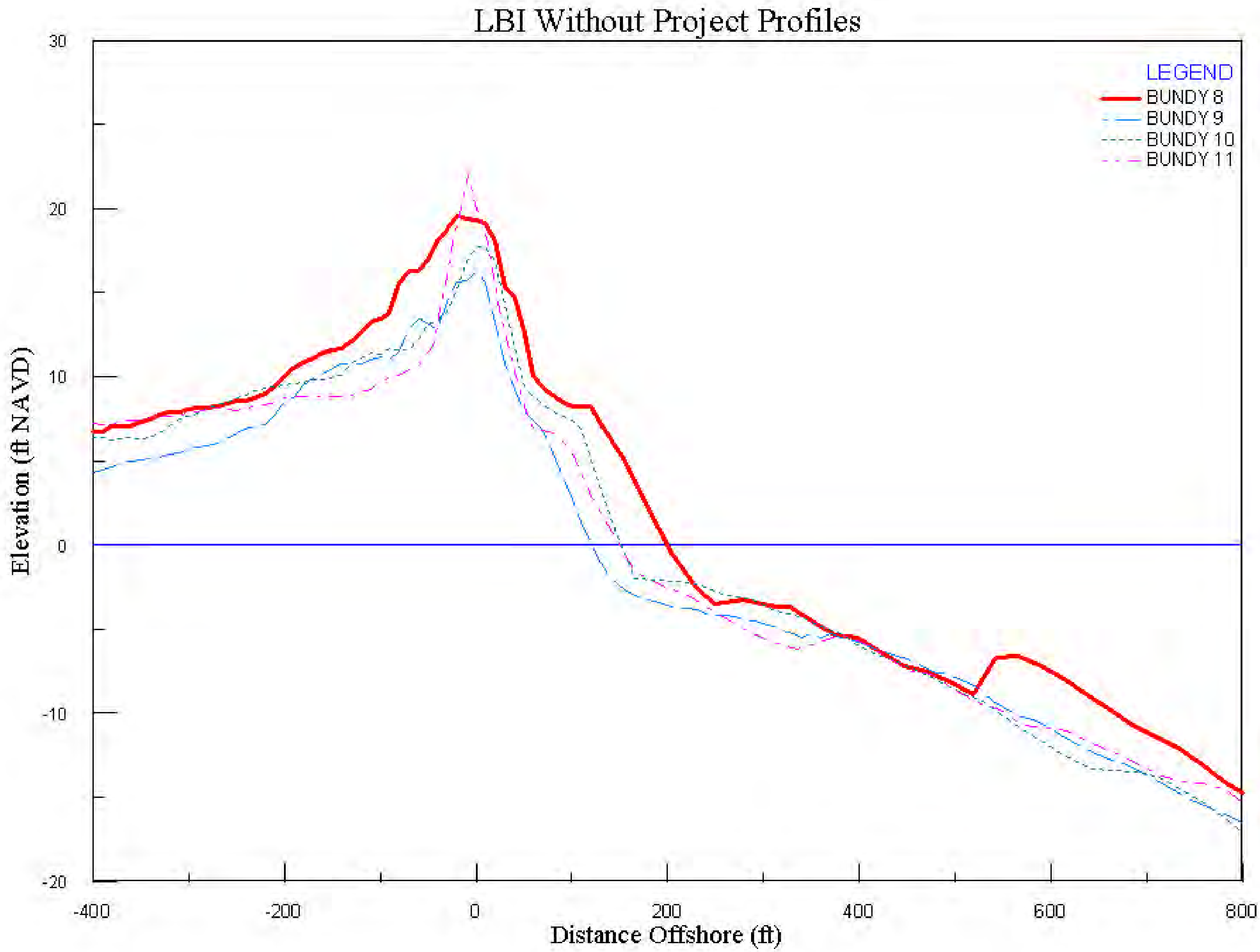


Figure 2-38 Representative Beach Profiles for BUNDYs 8-11 (Base Year).

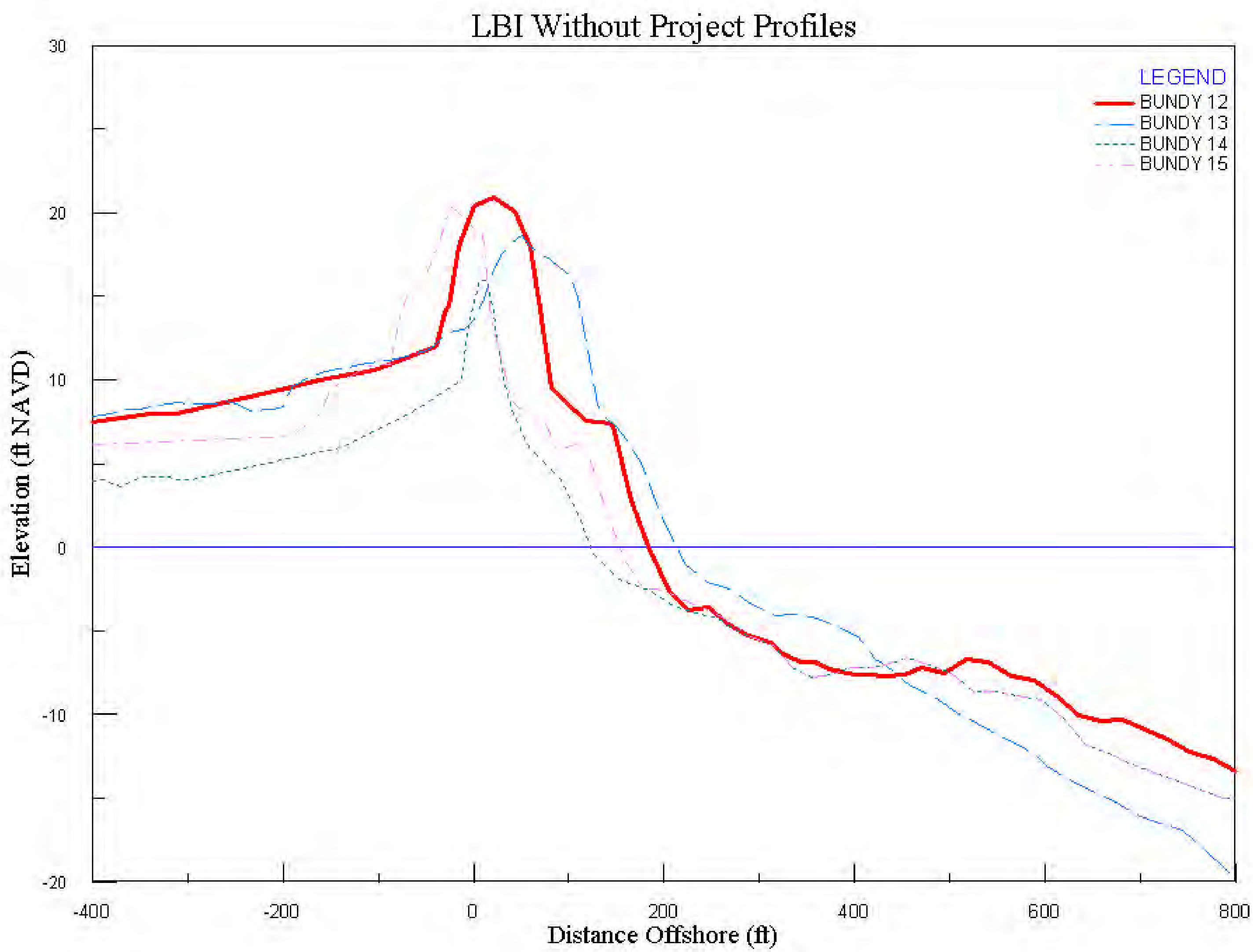


Figure 2-39 Representative Beach Profiles for BUNDYs 12-15 (Base Year).

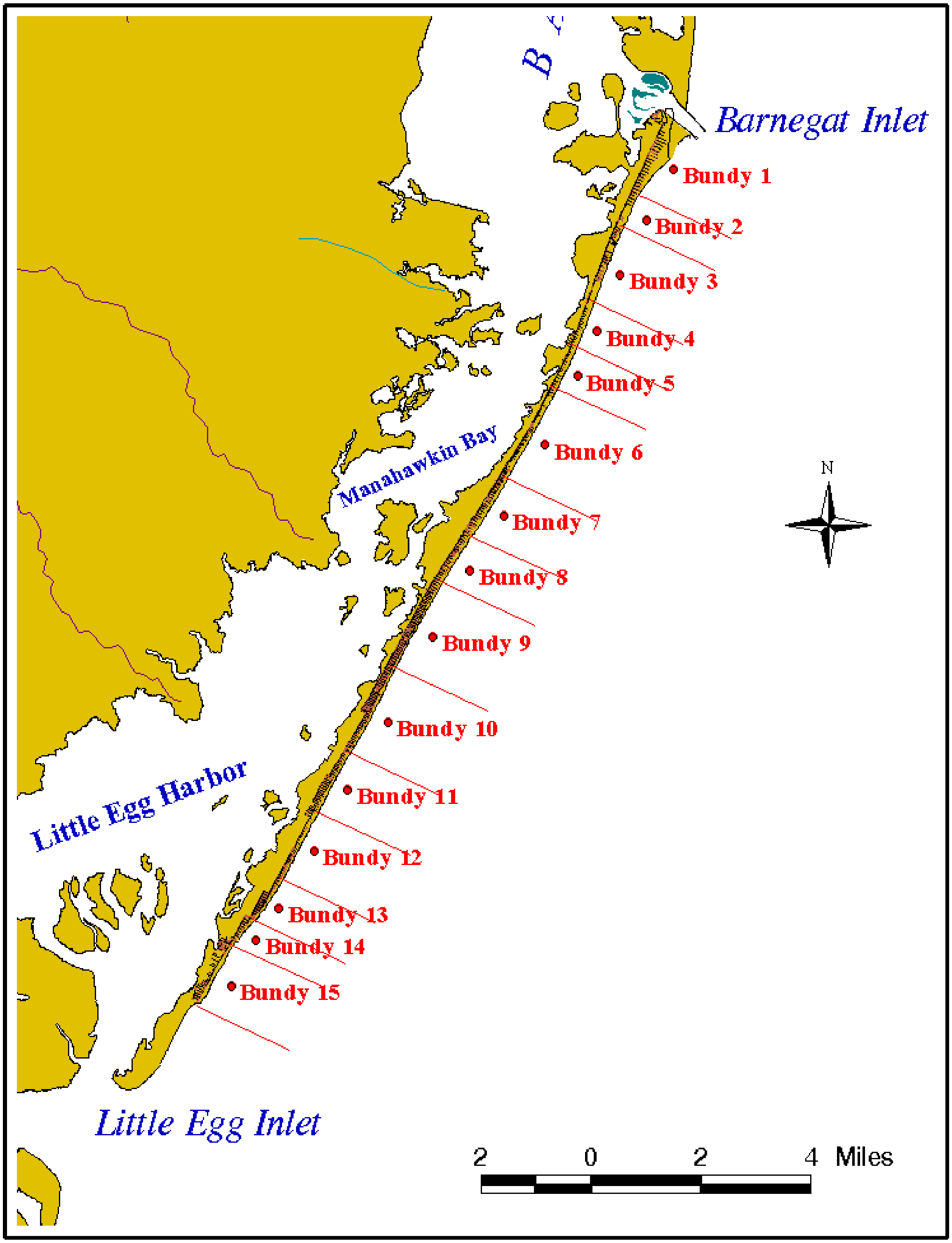


Figure 2-40 BUNDY Limits.

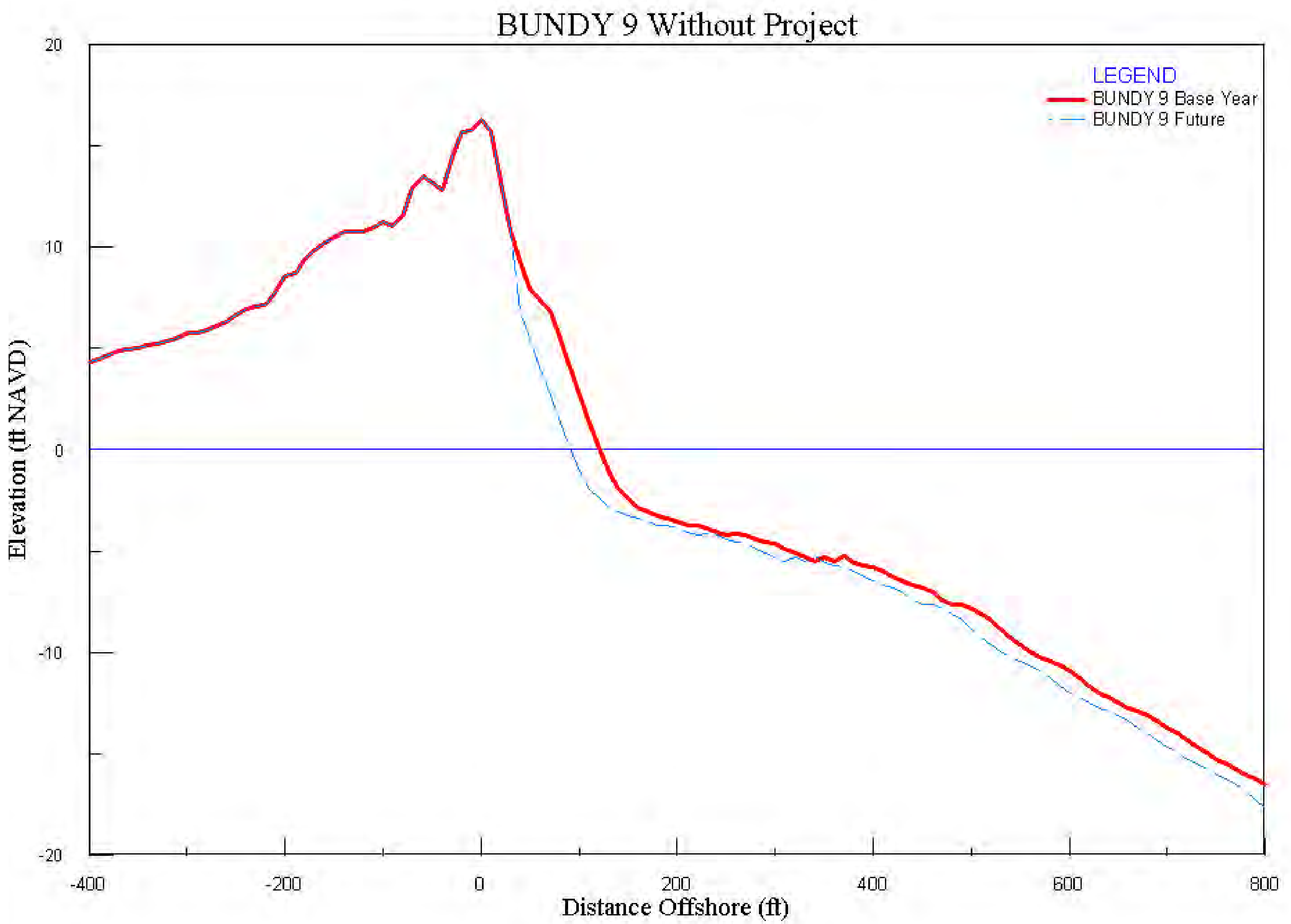


Figure 2-41 BUNDY 9 Without Project Profile Conditions for "Base Year" and "Future" Conditions.

Wave Height, Period, and Angle. Elevated water levels accompanying storms allow waves to attack portions of the profile that are out of equilibrium with wave action because the area of the beach is not normally inundated. Wave height and period are combined in an empirical equation within SBEACH to determine if the beach will erode or accrete for a time step. In beach erosion modeling, a storm is defined neither by the water level nor by the wave height or period alone, but by the combination of these parameters that produces offshore transport.

The SBEACH Version 3.2 allows for the input of random wave data, that is, waves with variable height, period, and direction or angle. Storm wave data for the seven representative events used in this analysis were generated in the OCTI wave hindcast described previously in the Physical Processes Section. Storm wave heights, as well as water levels, were developed by rescaling hindcasted actual storm time series. **Figures 2-42 to 2-49** display the storm conditions for the 2- to 500-yr events developed for SBEACH.

Storm Parameters. A variety of data sources were used to characterize the storms used in this analysis. The twenty highest ocean stages recorded at the Atlantic City tide gage between 1912 and 1997 were listed in a previous section on water levels. For each stage, additional information on the storm type causing the water surface elevation and if possible the actual storm surge hydrograph were obtained. Of the 20 highest events, 12 are northeasters and 8 are hurricanes. The duration of hurricanes along the New Jersey shore is generally less than 24 hours, while the average duration of northeasters is on the order of 40 hours, and in some cases (e.g., 5-7 March 1962) considerably longer. Though actual storm surge hydrographs are not available for all storm events, it was assumed that all hurricanes exhibit similar characteristics to one another. Northeasters demonstrate similar features; however, durations may vary significantly from storm to storm.

Storm Erosion Simulations. The SBEACH model was applied to predict storm-induced erosion for all cells within the study area. All representative storm events were run against the pre-storm profiles for both the base year and "future" conditions shown in **Figures 2-36 to 2-39.** Model output for each simulation includes a post-storm profile plot and plots showing volume change and maximum wave and water level conditions. Simulation results from each particular combination of profile geometry and storm characteristics yield predicted profile retreat at three selected elevation contours. In this analysis, profile retreat for a given storm event was measured landward from the proposed project baseline to the location of the top of the erosion scarp on the beach face. Typical plots of input pre-storm profiles and the resultant post-storm (50-yr event) profiles based on SBEACH predicted retreat are provided in **Figure 2-50** for BUNDY 9 located in Brant Beach.

Analysis of Erosion Model Results. Two approaches can be taken to estimate storm-induced beach erosion: the "design-storm" and the "storm-ensemble" approach. For the storm-ensemble approach, erosion rates are calculated from a large number of historical storms and then ranked statistically to yield an erosion-frequency curve. In the design-storm approach, the modeled storm is either a hypothetical or historical event that produces a specific storm surge hydrograph and wave condition of the desired frequency. The design-storm approach was used in the storm erosion and inundation analyses for this study area. Volumetric erosion into the

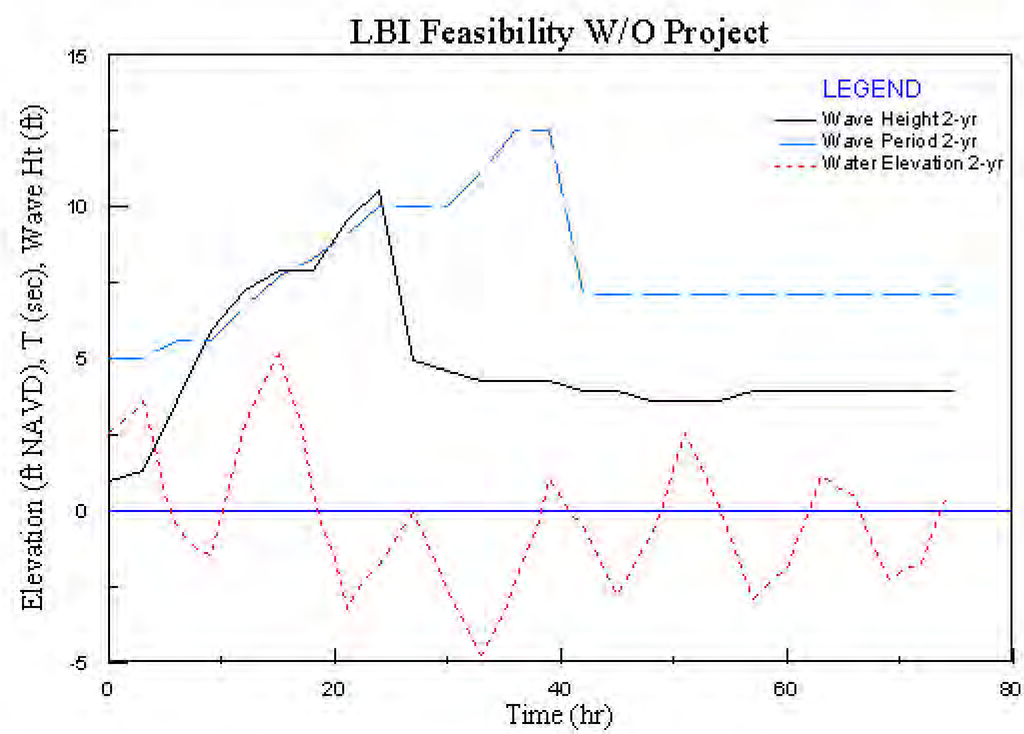


Figure 2-42 "2-yr" Storm Conditions used in Storm Damage Analysis.

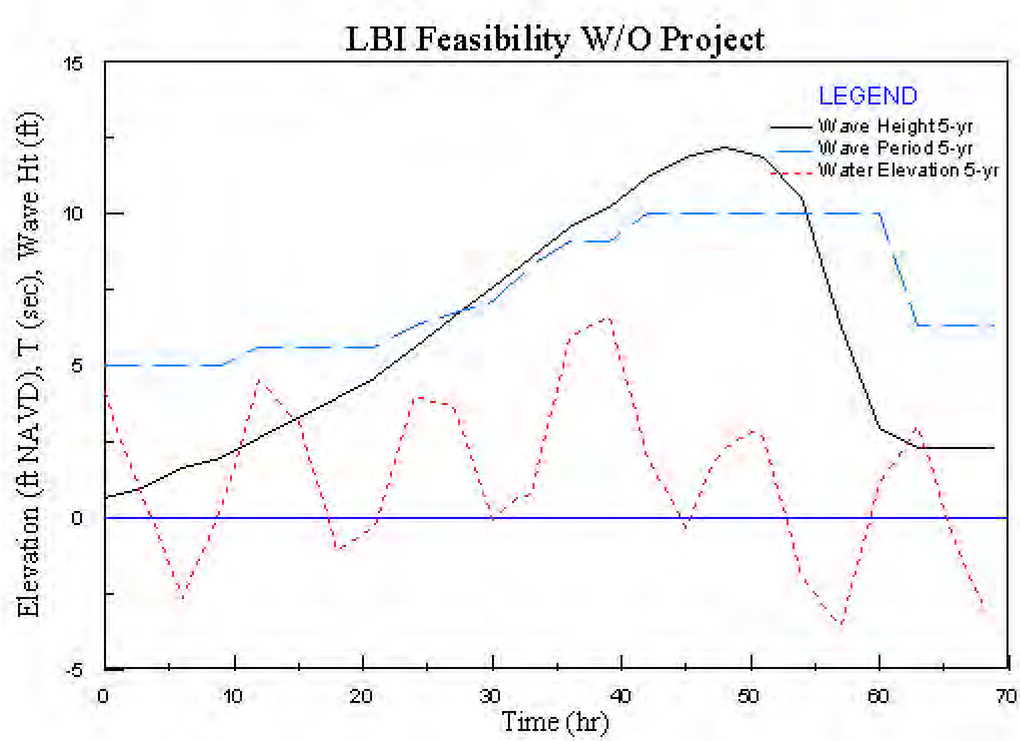


Figure 2-43 "5-yr" Storm Conditions used in Storm Damage Analysis.

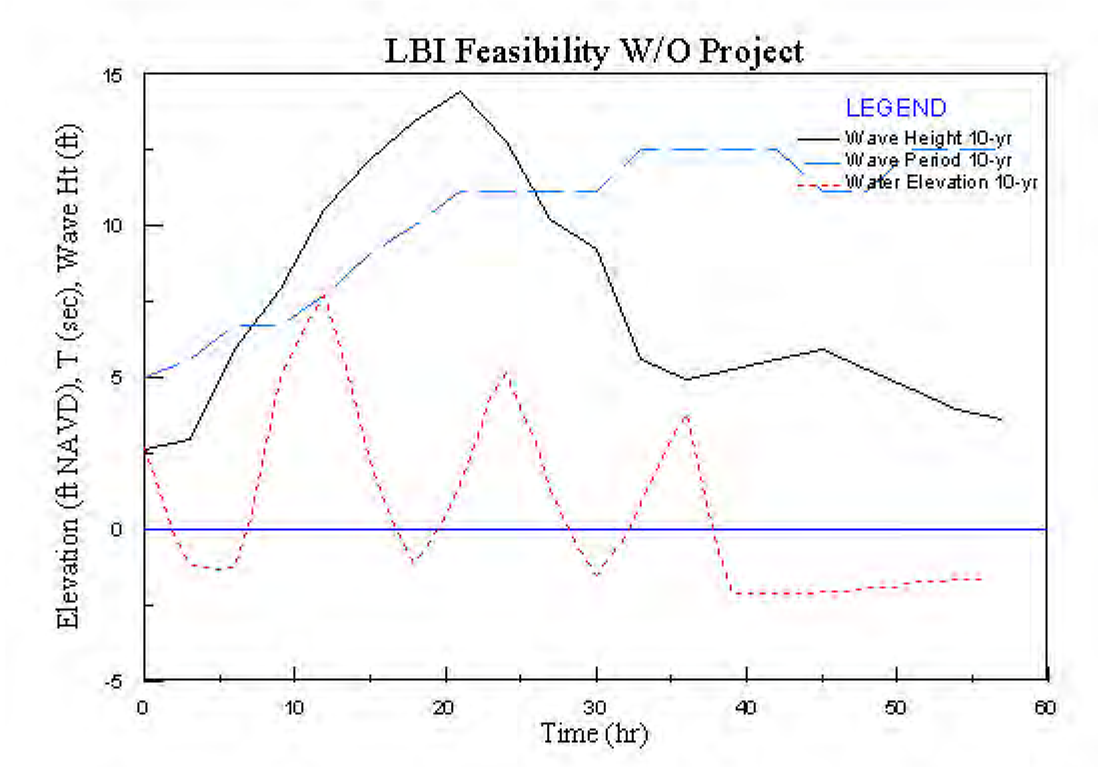


Figure 2-44 "10-yr" Storm Conditions used in Storm Damage Analysis.

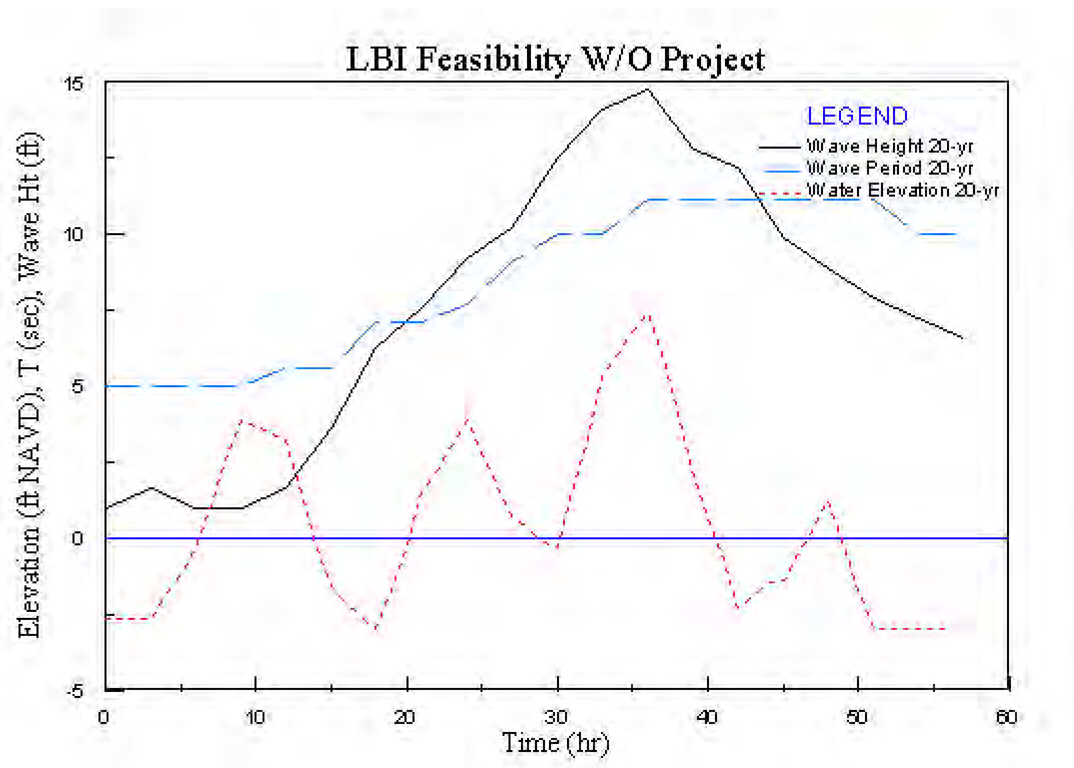


Figure 2-45 "20-yr" Storm Conditions used in Storm Damage Analysis.

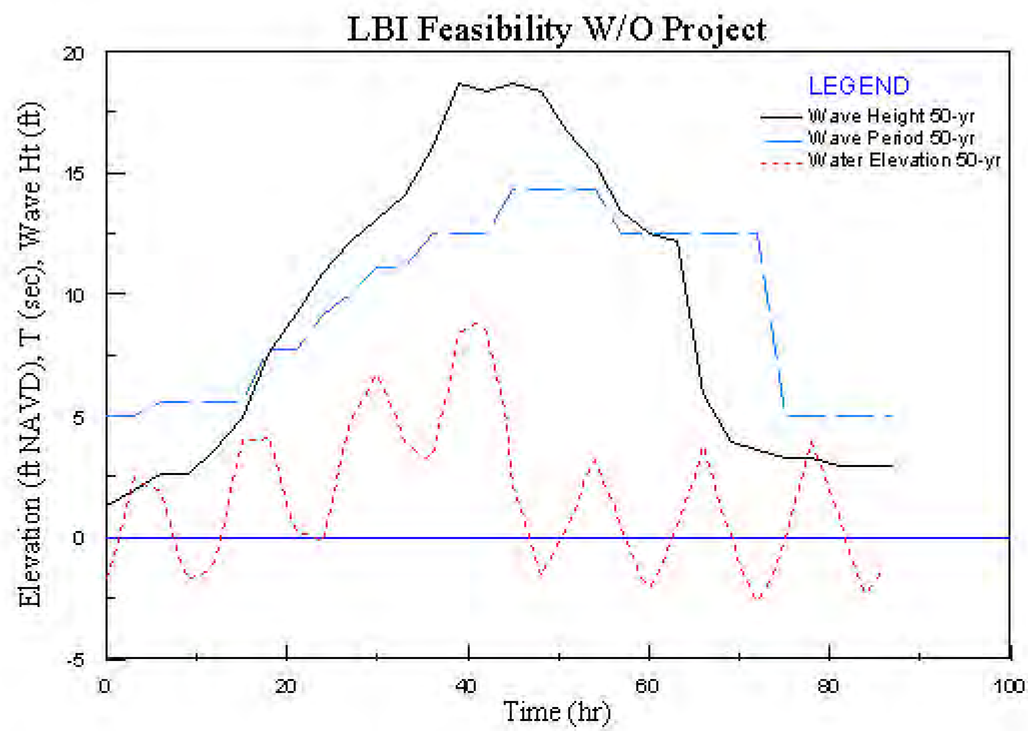


Figure 2-46 "50-yr" Storm Conditions used in Storm Damage Analysis.

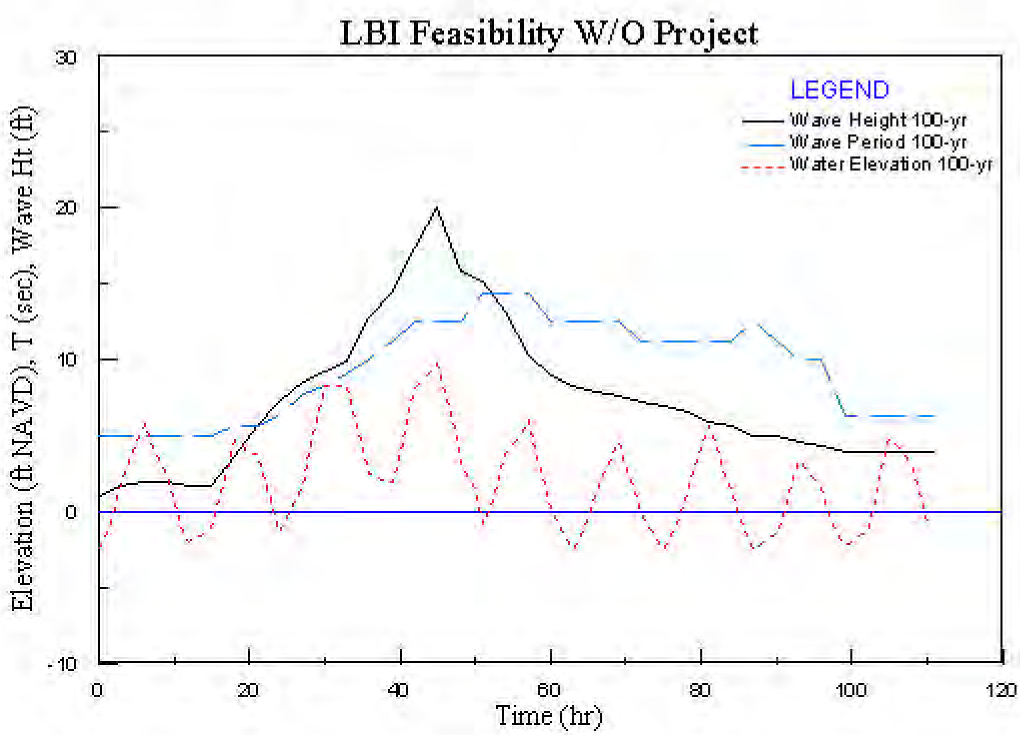


Figure 2-47 "100-yr" Storm Conditions used in Storm Damage Analysis.

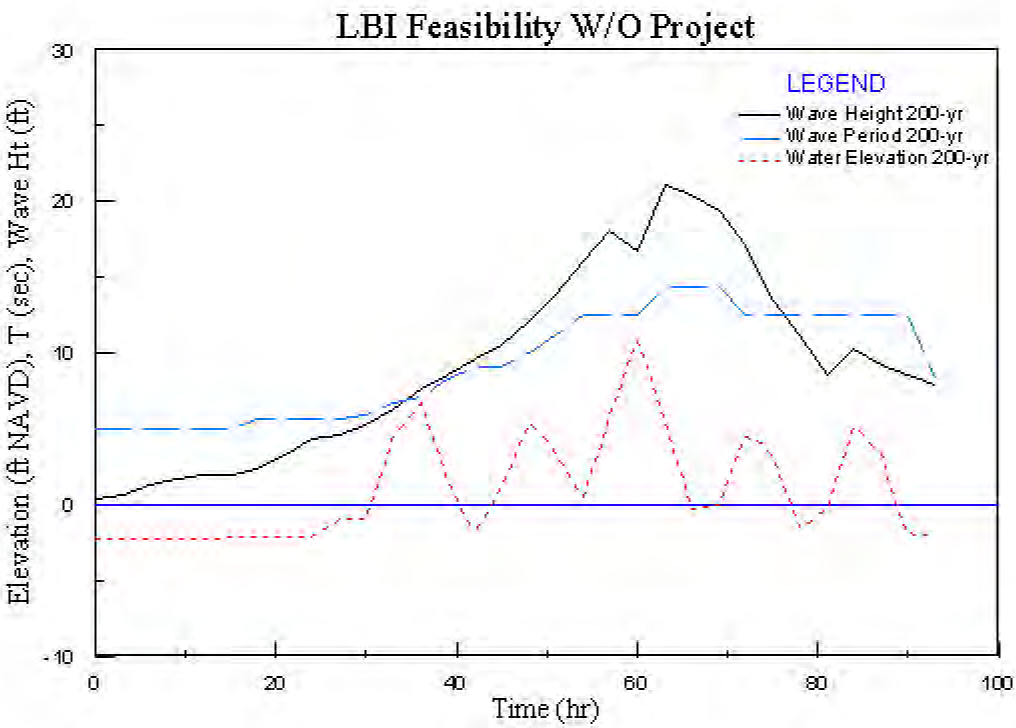


Figure 2-48 "200-yr" Storm Conditions used in Storm Damage Analysis.

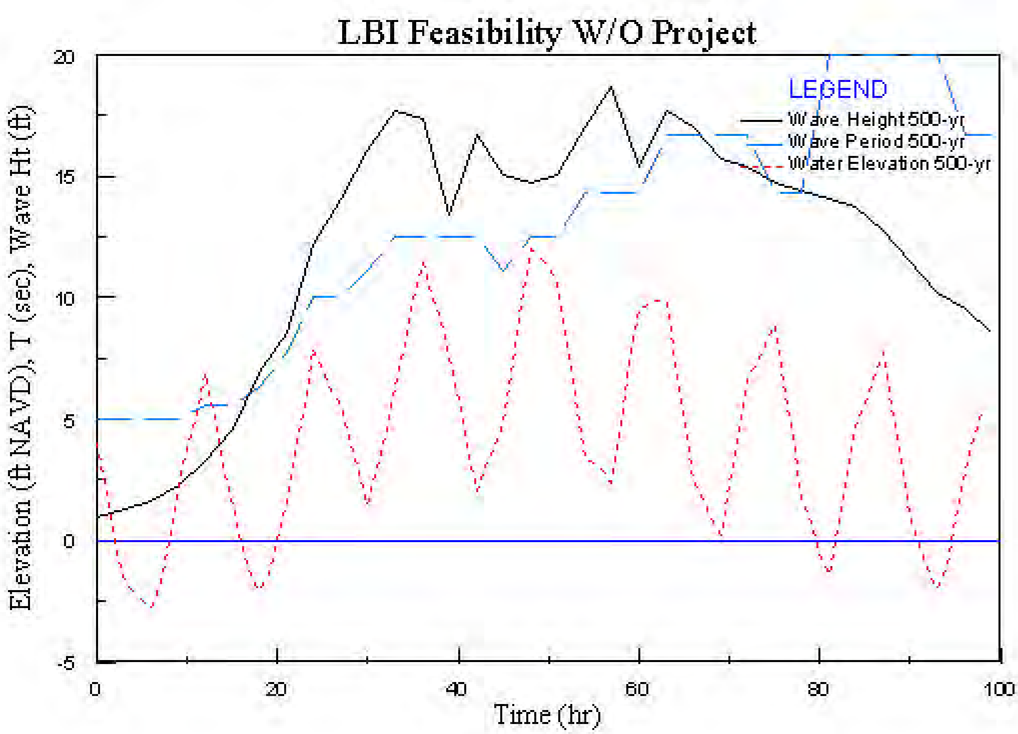


Figure 2-49 "500-yr" Storm Conditions used in Storm Damage Analysis.

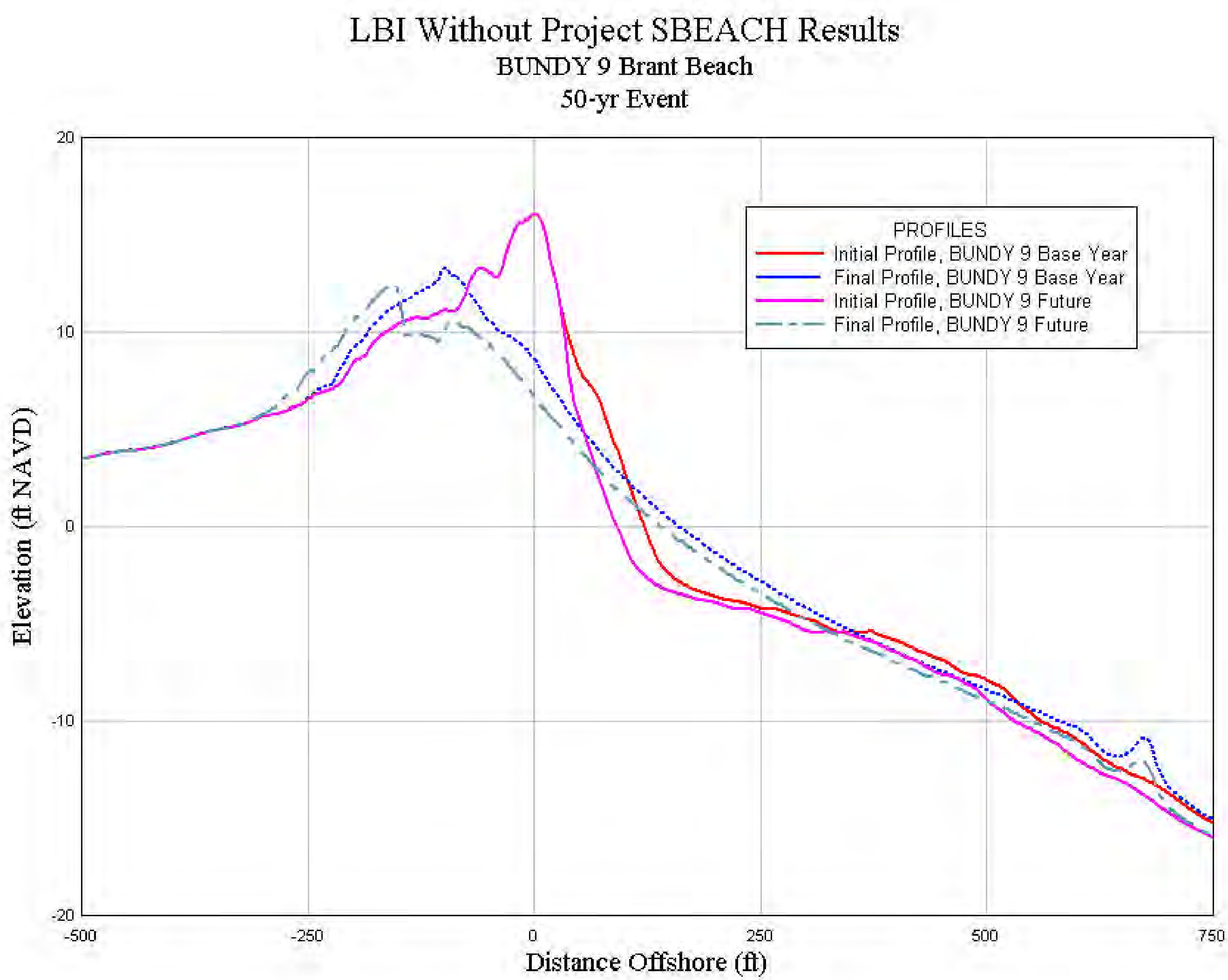


Figure 2-50 Pre- and Post-Storm Conditions for BUNDY 9 (Brant Beach).

community per unit length of shoreline can subsequently be computed from the pre- and post-storm profiles.

Results of the without project storm erosion analysis are presented in **Tables 2-15** and **2-16** for base and future conditions, respectively. Predicted shoreline erosion positions are reported relative to the designated economic baseline. The baseline commonly placed through the centerline of existing dunes. In order to satisfy constraints in the economic analyses, the baseline was offset 500 ft seaward to ensure all structures were landward of the "economic" baseline. The length of the groins along the Island governed the 500 ft offset. For most cells, assuming the majority of structures lie landward of the dune lines, zero erosion (not greater than 500 ft) into the community is reported until the 50-yr event for base year conditions. Slightly increased erosion is reported for the "future" conditions, with erosion typically beginning at the 20-yr event. These erosion values are used as input to the economic model that ultimately computes storm damages associated with storm-related erosion.

Storm Inundation and Wave Attack Evaluation. The project area is subject to inundation from several sources including ocean waves overtopping the beach and/or protective structures as well as flooding from the back bay. The inundation can be analyzed as two separate categories: 1) Static flooding due to superelevation of the water surfaces surrounding the project area and 2) wave attack, the direct impact of waves and high energy runup on coastal structures.

The model SBEACH calculates nearshore wave characteristics, wave runup, wave setup and elevation of the beach profile for each hindcasted event. The wave runup and wave setup values are used, along with the eroded beach elevations, to determine inland water surface profiles, inland wave characteristics, and volumes of eroded material which in turn are used to assess economic damages. SBEACH output parameters are used to define the maximum water depth, runup, and minimum dune crest elevation.

Inundation/Wave Attack Methodology. The inland wave attack and inundation methodology used in this project is based upon FEMA guidelines for coastal flooding analysis. The procedure divides possible storm conditions into four cases as follows:

- Case 1 (shown in **Figure 2-51**): Entire storm-generated profile is inundated. For this case, the maximum water elevation including wave setup is maintained to the crest of the eroded dune. Landward of this point, the wave setup decays at 1 ft vertical drop per 1000 ft of horizontal distance until the bay flood level is met. A wave height of 0.78 times the water depth at the crest of the dune is maintained landward of the dune.

- Case 2 (shown in **Figure 2-52**): The top of the dune is above the maximum water level, with wave runup greater than (3 ft above the dune crest elevation. In this case, the runup depth at the crest is limited to 3 ft, the water depth decays to 2 ft over first 50 ft landward of the crest, and stays at 2 ft until intersecting the bay water level. The wave height is limited to 0.78 times the water depth.

TABLE 2-15 Storm Erosion Analysis Predicted Shoreline Positions (Base Year Conditions)								
	Storm Return Period							
LOCATION	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr	200-yr	500-yr
BUNDY 1	0.0	0.0	0.0	0.0	0.0	180.0	242.5	322.5
BUNDY 2	292.5	317.5	322.5	340.0	407.0	442.5	463.0	517.5
BUNDY 3	477.5	482.5	477.5	492.5	517.5	545.0	562.5	637.5
BUNDY 4	487.5	562.5	577.5	577.5	582.5	607.5	612.5	657.5
BUNDY 5	407.5	422.5	422.5	482.5	522.5	537.0	547.0	582.5
BUNDY 6	492.5	497.5	492.5	497.5	512.5	532.5	552.5	582.5
BUNDY 7	432.5	437.5	437.5	437.5	452.5	452.5	487.0	502.5
BUNDY 8	407.5	497.5	492.5	507.5	512.5	527.5	532.5	587.5
BUNDY 9	507.5	517.5	507.5	532.5	567.5	597.5	627.5	682.5
BUNDY 10	437.5	502.5	497.5	502.5	527.5	557.5	601.0	627.5
BUNDY 11	517.5	522.5	517.5	547.5	622.5	707.5	758.0	797.5
BUNDY 12	482.5	487.5	482.5	487.5	497.5	522.5	532.5	577.5
BUNDY 13	427.5	442.5	442.5	452.5	462.5	487.5	522.5	572.5
BUNDY 14	492.5	507.5	507.5	577.5	577.5	587.0	604.0	632.5
BUNDY 15	522.5	522.5	527.5	527.5	532.5	567.5	572.5	617.5
Erosion Distance (ft) measured from Baseline								

TABLE 2-16 Storm Erosion Analysis Predicted Shoreline Positions (Future Conditions)								
	Storm Return Period							
LOCATION	2-yr	5-yr	10-yr	20-yr	50-yr	100-yr	200-yr	500-yr
BUNDY 1	0.0	0.0	0.0	0.0	0.0	180.0	242.5	322.5
BUNDY 2	292.5	317.5	322.5	340.0	407.0	442.5	463.0	517.5
BUNDY 3	482.5	482.5	487.5	507.5	547.5	580.5	607.5	697.5
BUNDY 4	572.5	582.5	582.5	587.5	592.5	627.5	637.5	682.5
BUNDY 5	497.5	512.5	512.5	532.5	542.5	570.0	592.5	682.5
BUNDY 6	507.5	512.5	512.5	527.5	552.5	572.5	642.5	704.0
BUNDY 7	452.5	452.5	452.5	457.5	477.5	484.8	500.0	542.5
BUNDY 8	432.5	507.5	507.5	512.5	517.5	537.5	542.5	607.5
BUNDY 9	522.5	527.5	527.5	552.5	584.0	624.0	642.5	687.5
BUNDY 10	497.5	507.5	507.5	507.5	532.5	562.5	604.0	712.5
BUNDY 11	517.5	527.5	522.5	557.5	647.5	757.5	792.0	840.0
BUNDY 12	487.5	487.5	492.5	492.5	507.5	522.5	537.5	577.5
BUNDY 13	457.5	467.5	467.5	472.5	487.5	537.5	582.5	617.5
BUNDY 14	502.5	532.5	552.5	627.5	687.5	702.0	730.0	770.0
BUNDY 15	527.5	532.5	537.5	537.5	557.5	592.0	622.5	652.5
Erosion Distance (ft) measured from Baseline								

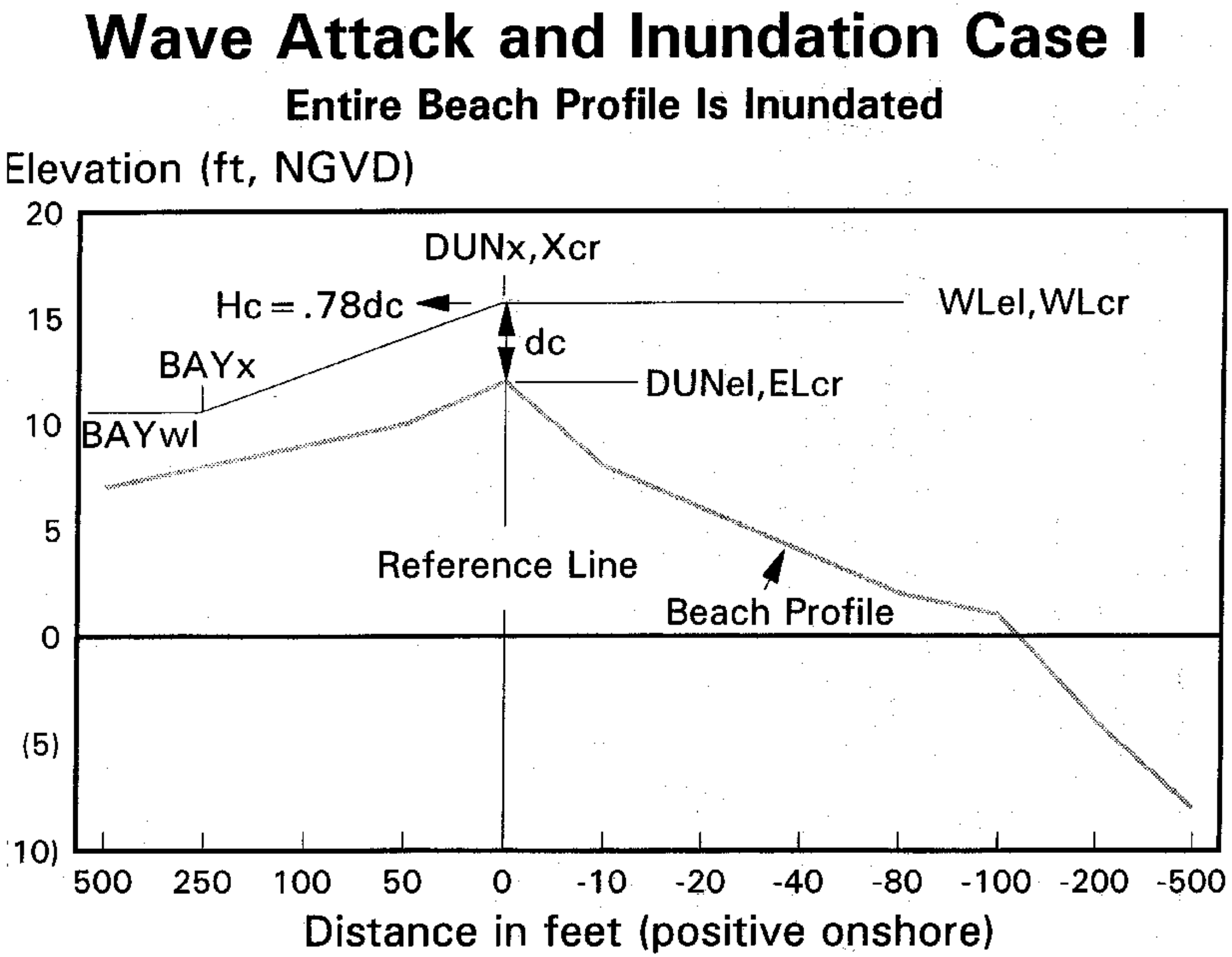


Figure 2-51 Illustration of FEMA Inland Wave Attack and Inundation CASE I.

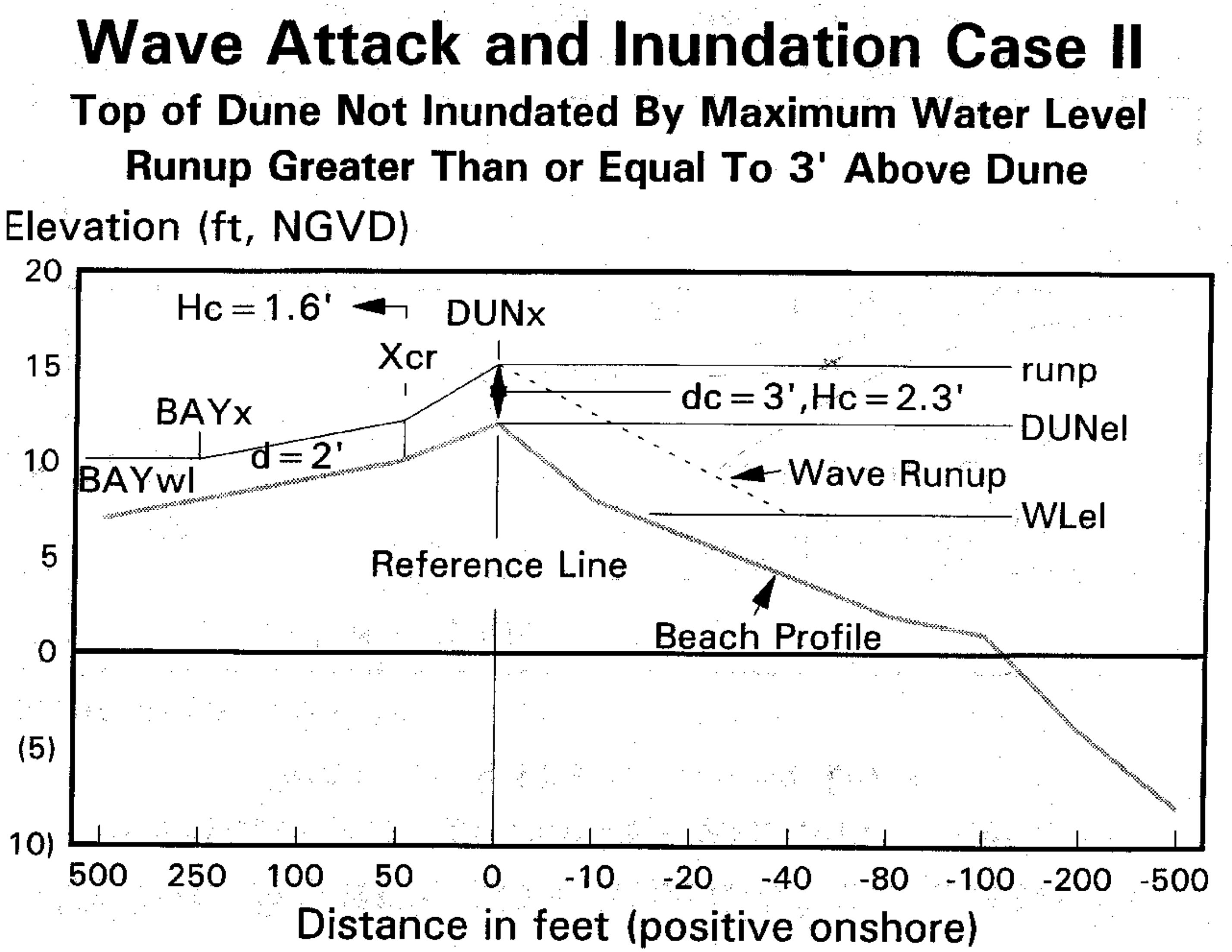


Figure 2-52 Illustration of FEMA Inland Wave Attack and Inundation CASE II.

- Case 3 (shown in **Figure 2-53**): The top of the dune is above the maximum water level, with wave runup exceeding but still less than 3 ft above the dune crest elevation. In this case, the depth at the dune crest is the calculated runup depth, which decays to 1 ft over the first 50 ft landward of the crest, and stays at 1 ft until it intersects the bay water level. The wave height is limited to 0.78 times the water depth.

- Case 4 (shown in **Figure 2-54**): The wave runup does not overtop the dune. In this case, the wave height seaward of the dune is limited to 0.78 times the water depth.

Back Bay Flooding. The project area is subject to flooding from back bay and adjacent waterways as well as direct ocean inundation. This elevated stage flooding is referred to as back bay stillwater flooding and is accounted for by subtracting the residual damages due to back bay flooding from the damages caused by ocean front inundation.

In order to quantify back bay water levels, the numerical model DYNLET (Amein and Cialone, 1994) was used. DYNLET is based on full one-dimensional shallow water equations employing an implicit finite-difference technique. The model simulates one-dimensional fluid flow through a tidal inlet and its tributaries. Flow conditions can be predicted in channels with varied cross section geometry and friction factors. Water surface elevation and average velocity can be computed at selected locations and times both across and along channels.

The model conducted for this study included Little Egg, Barnegat, and Mansquan Inlets. **Figure 2-55** depicts the channels that were modeled. A total of 114 cross-sections or nodes were input to describe the system. Depth soundings for each cross section were interpolated from the National Oceanic Atmospheric Administration (NOAA) Nautical Chart for Little Egg Harbor to Cape May. Recent bathymetric data from Barnegat and Manasquan Inlets were incorporated into the model. The model was calibrated to measured currents through Barnegat Inlet and water levels throughout Barnegat Bay. Predicted stages for 5 through 500-year storms were then used to drive the model. The tidal range is rapidly attenuated through the Barnegat Inlet system, with water levels throughout most of Barnegat Bay being fairly uniform. Therefore, it is assumed that Bay water levels for all communities can be represented by predicted water levels for Loveladies, as described earlier in ***Coastal Processes***.

Other Parameters. The output from the SBEACH modeling at each of the profile lines and 8 storm events was used to compute inland wave attack and inundation for each case. Inland island ground elevations for each shoreline cell were taken from quad sheets and recent surveys. Bay elevations were used as specified above. For all but the most extreme events, failure of the protective structures (dunes) is required for significant wave attack to occur. However, extreme waves on certain profiles can plunge over the fixed barriers and attack the adjacent structures causing significant damage. The recurrence interval in which the protective structure will fail was determined previously in conjunction with the erosion analysis.

Without Project Inundation and Wave Attack Results. Detailed results of the inundation and wave attack analyses for base and future conditions are summarized in the

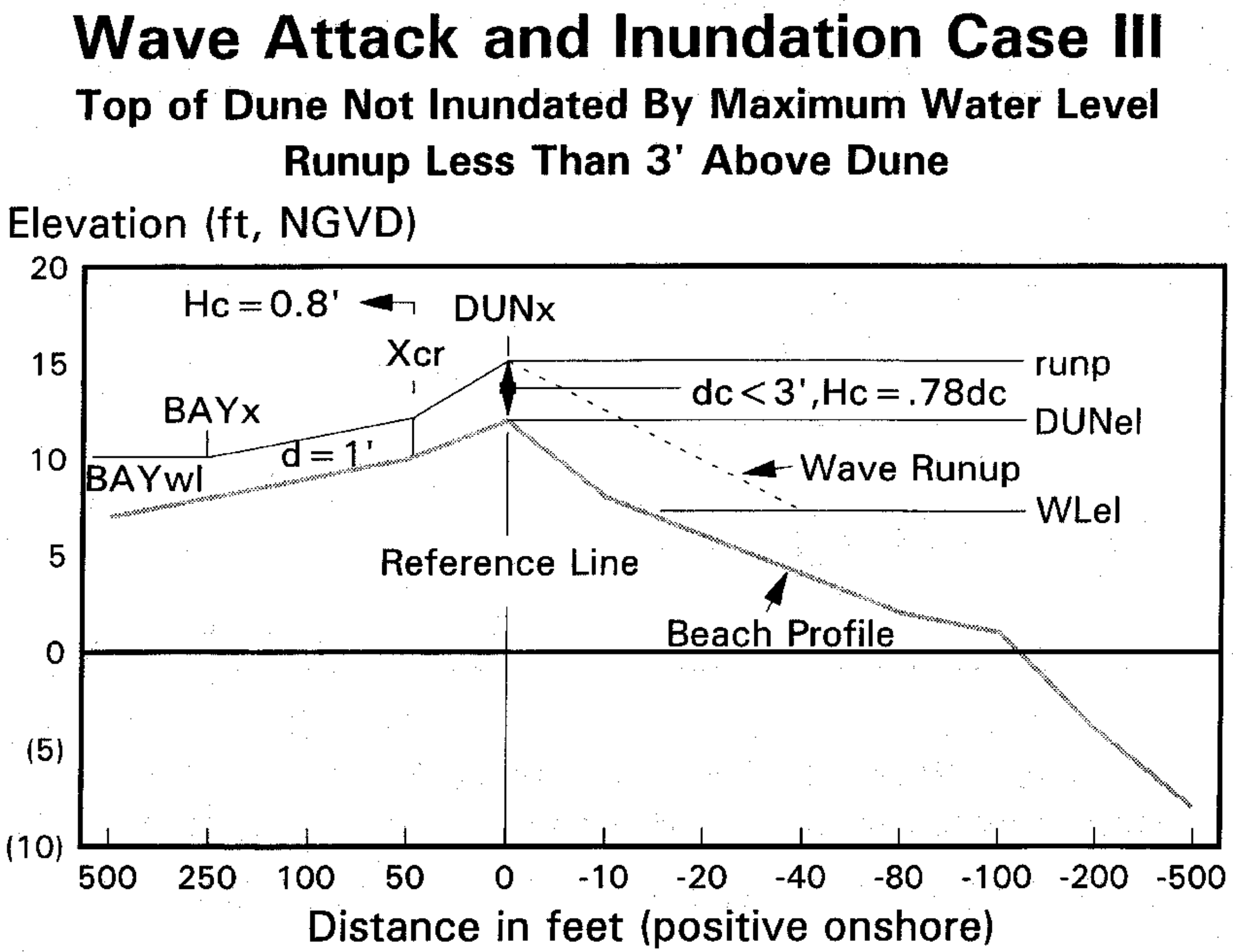


Figure 2-53 Illustration of FEMA Inland Wave Attack and Inundation CASE III.

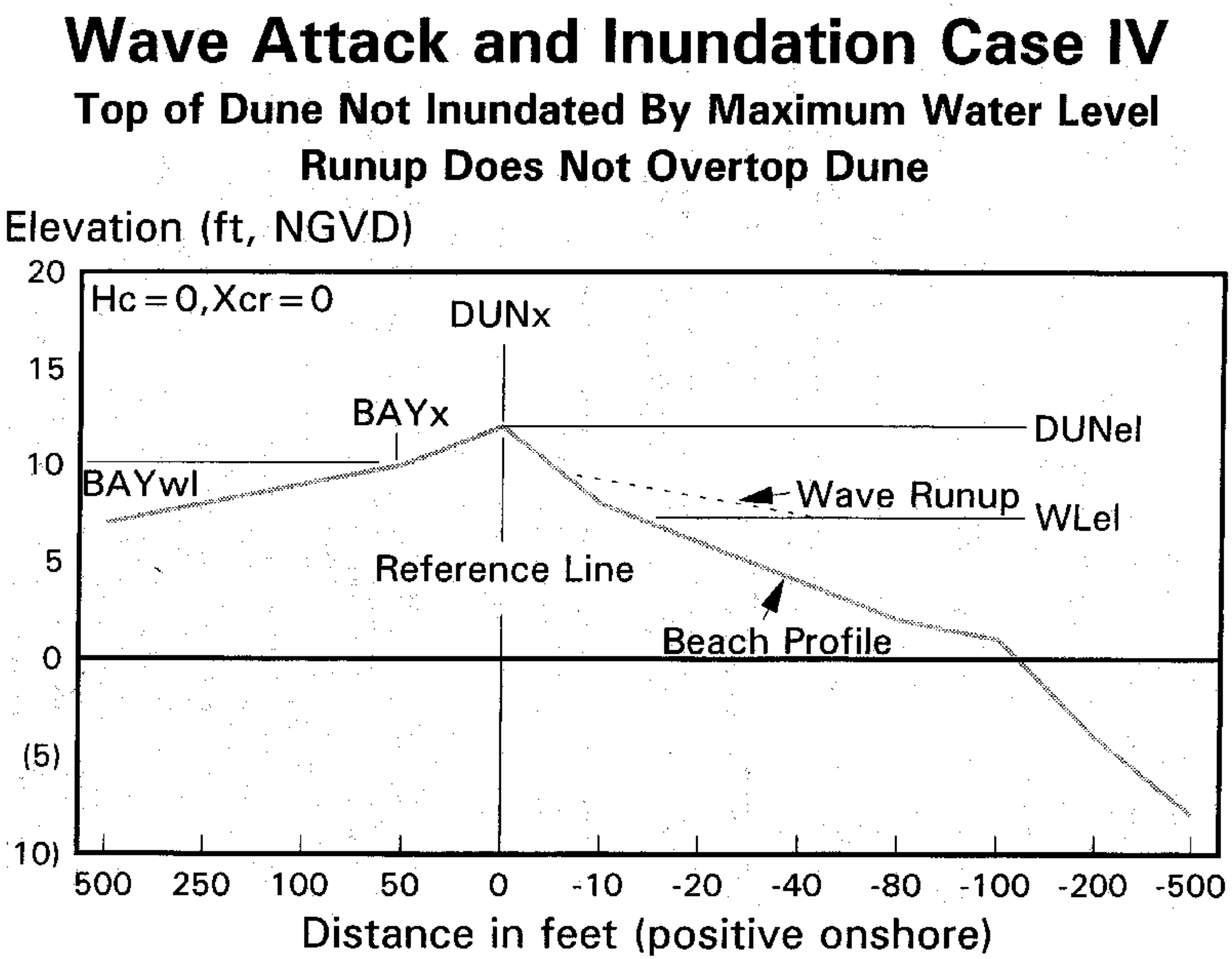


Figure 2-54 Illustration of FEMA Inland Wave Attack and Inundation CASE IV.

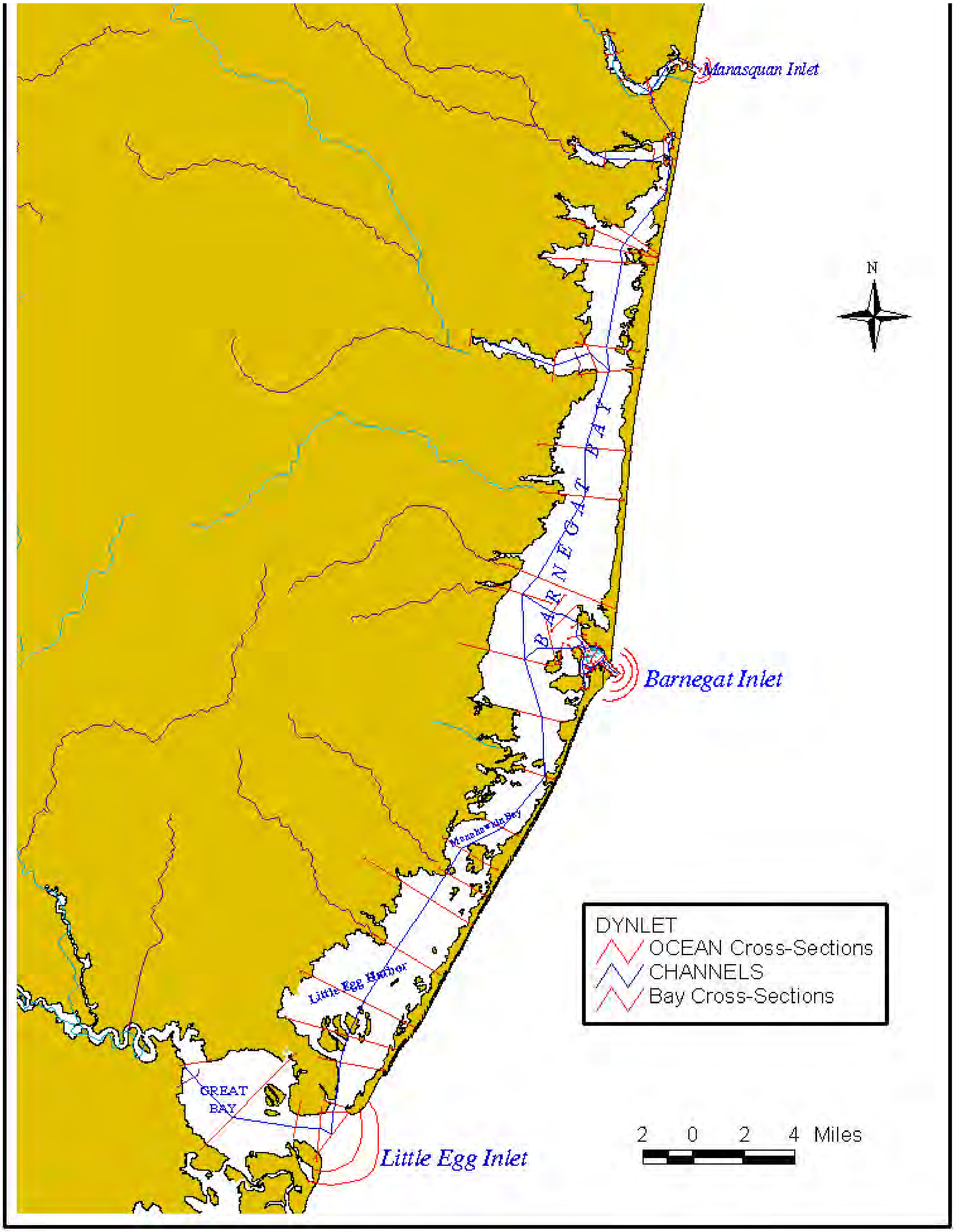


Figure 2-55 DYNLET Layout (Cross-Sections and Channels) used in Back-Bay Water Level Analysis.

Economics Appendix. Inundation curves and wave attack limits are provided in modified COSTDAM model format for each of the BUNDYs and respective storm conditions. Inundation curves and wave attack limits are provided in modified COSTDAM model format for each of the BUNDYs and respective storm conditions.

WITH PROJECT COASTAL PROCESSES ANALYSES

GENERAL. Benefits and costs for Long Beach Island were developed for the alternative plans recommneded for further analysis in the cycle 1 and 2 screenings as discussed in the plan formulation sections. This was done in order to optimize an NED plan in the study area. This was accomplished using the same numerical modeling techniques utilized in the without-project analysis coupled with engineering and technical assessments to interpret model results as applied to the various alternatives. Reduced damages based on the predicted reduction in storm impacts due to the with-project alternatives were compared to the without-project results to generate project benefits. Costs for each alternative were estimated based on standard construction practices and District experience in the construction of beach nourishment projects.

DESIGN ALTERNATIVE - BEACHFILL. In Cycle 3, the beach nourishment alternative required optimization of the design parameters. In developing these parameters the Shore Protection Manual, Coastal Engineering Tech Notes (CETN), the existing conditions in the study area and accepted coastal engineering practices were reviewed. Listed below are the boundary condition utilized to construct a logical methodology to efficiently identify the optimum plan. The necessary design parameters for beachfill include beach slope; berm elevation and width; and dune width, height and slope. The beach slope, berm elevation, dune top width, and dune slope are effected by the prevailing natural processes and were based on the study area existing beach conditions. Berm width and dune elevation were varied to achieve project optimization.

Beach Slope. Beach slopes are the result of on-site wave climate and the characteristics of the beach material. Both are similar throughout the study area. Existing beach slopes are rather steep in this region compared to other Atlantic ocean shorelines in the mid-Atlantic region. An average nearshore beach slope throughout the study area of 1 V:10 H was adopted for all alternatives.

Berm Elevation. Tides, waves, and beach slope determine the natural berm elevation. If the nourished berm is too high, scarping may occur, if too low, ponding of water and temporary flooding may occur when a ridge forms at the seaward edge. Design berm heights for each alternative have an elevation set at the natural berm crest elevation as determined by historical profiles. The existing berm elevations in the study area vary between + 6.3 ft NAVD and + 9.3 ft NAVD. The average berm elevation is 7.75 ft NAVD. It was determined that a constructable template which closely matches the prevailing natural berm height in the study area is + 8.0 ft. NAVD. This elevation was used for all designs.

Berm Width. An interval between successive berm widths was chosen for modeling purposes. This interval is set wide enough to discern significant differences in costs and benefits between alternatives but not so great that the NED plan can not be accurately determined. Additionally, due to the capability of the storm modeling methodology and effectiveness of the existing condition parameters, a 25-ft. interval achieved the desired accuracy. The largest design berm width is based on an analysis of existing beach profile and determining where berm distance quantities increased faster than additional benefits captured. Based on the Cycle 3 analysis, the largest berm width considered was 175 ft. The smallest berm width was determined in a similar manner, by analyzing benefits captured with minimum dimensions.

<u>Dune Position</u>. Following available Corps guidance, dunes were placed as landward as possible on the beach profile. Existing dunes throughout the Island typically lie just seaward of the first row of houses. The design layouts tie new dunes into existing wherever possible, allowing for smooth transitions of both dunes and berm.

<u>Dune Slope</u>. The existing dunes within the project area have seaward slopes averaging 1:5. This value was chosen for all design alternatives.

<u>Dune Top Width</u>. The existing dune top widths within the project area vary between 5 and 50 feet. Dune top widths of 25 ft. and 30 ft. were evaluated as alternatives. Since most dunes are already 25 ft. wide, only the 30-ft. alternative was uses.

<u>Dune Elevation</u>. The lowest design dune height evaluated was sufficiently above the height of the berm and existing protective structures in order to provide for additional storm damage protection, principally reducing inundation damages. Dune heights along the oceanfront of LBI average 18 ft. Therefore the minimal dune height evaluated was 20 ft. Additionally a 22 ft and 24 ft dune height were considered with the latter dropped as initial calculations for the additional sand quantities did not capture additional storm damage reduction benefits. The height of +20 ft. and +22 ft. NAVD are the most appropriate to capture significant benefits within this study area.

Summary of Alternatives. From cycle 1 and cycle 2 analyses, various beachfill options were recommended for analysis in cycle 3. Based on the design parameters discussed above, 6 combinations of berm widths and dune heights were generated. Several other berm and dune alternatives were easily identified as non-constructable given the footprint requirements of the varying dune options as well as the toe protection required for dune stability, real estate impacts and the limited sand quantities available.

As the modeling proceeded, it became evident that the "no dune" alternatives provided virtually no inundation benefits. This was important along the entire project area. Inundation was sensitive to dune height and erosion was sensitive to berm width. To a small degree, berm width affected the total storm stage due to the berm's ability to break the waves further offshore. Both dune and berm affected wave attack.

Six (6) beachfill alternatives were considered as an initial screening to narrow down the possible plans of improvement to achieve project optimization. Dune heights varying from 20 to 22 ft NAVD in combination with berm widths ranging from 125 to 175 feet were analyzed for several BUNDYs 3,6,7,9,11, and 14 (**Figures 2-56 to 2-61**). Based on the initial screening the more feasible alternatives were analyzed for all BUNDYs in order to achieve the optimal project beachfill dimensions. The plans were

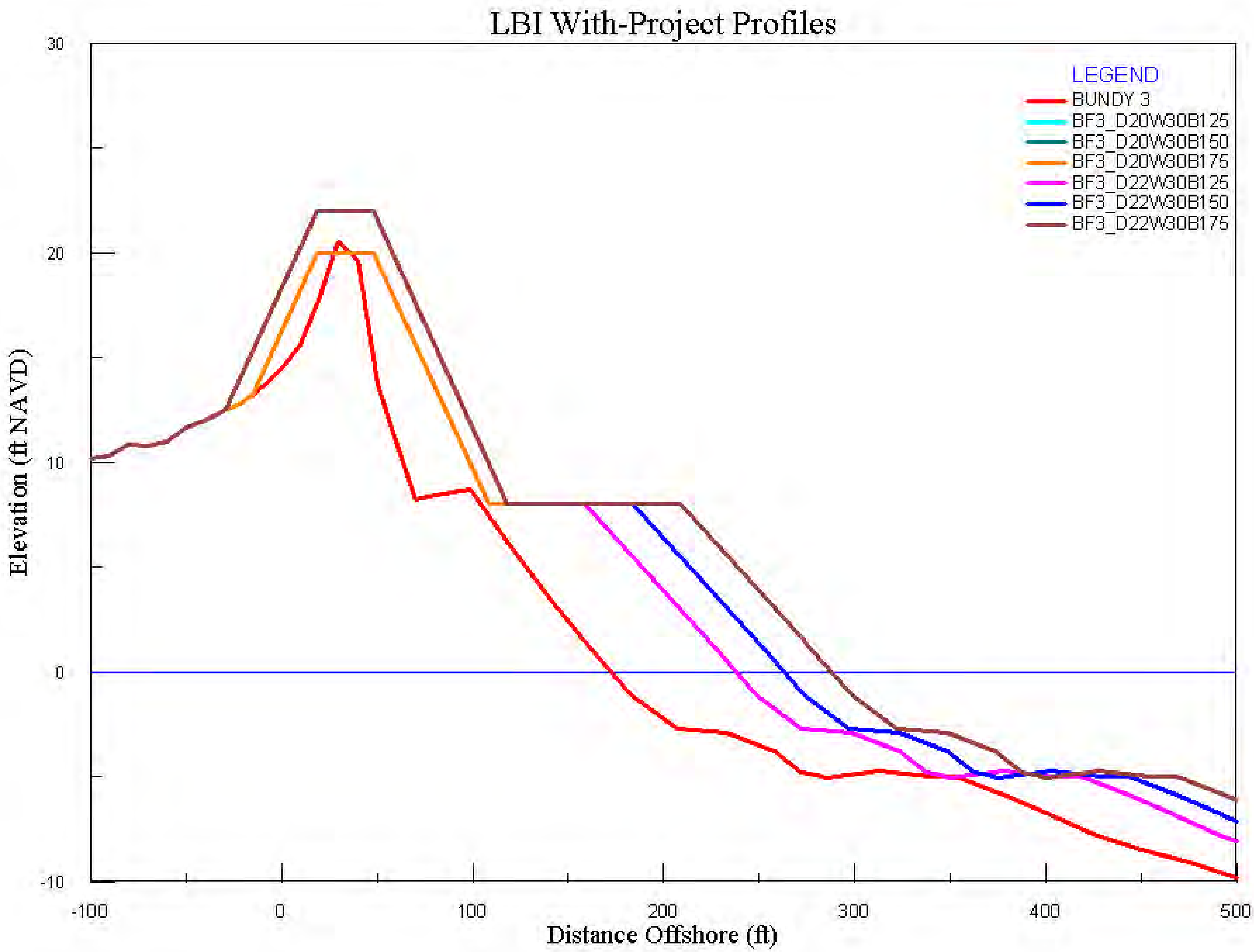


Figure 2-56 BUNDY 3 With-Project Alternatives

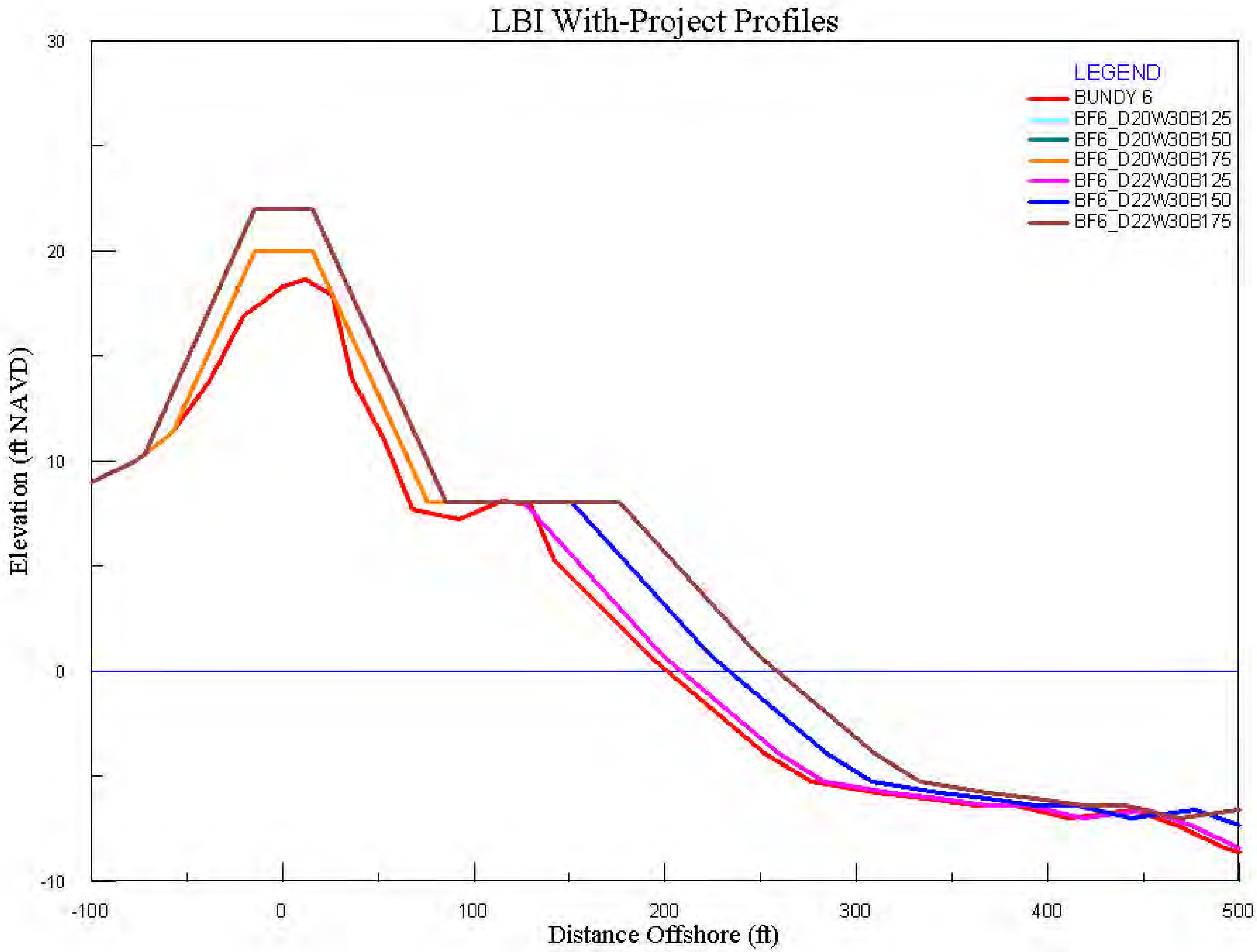


Figure 2-57 BUNDY 6 With-Project Alternatives

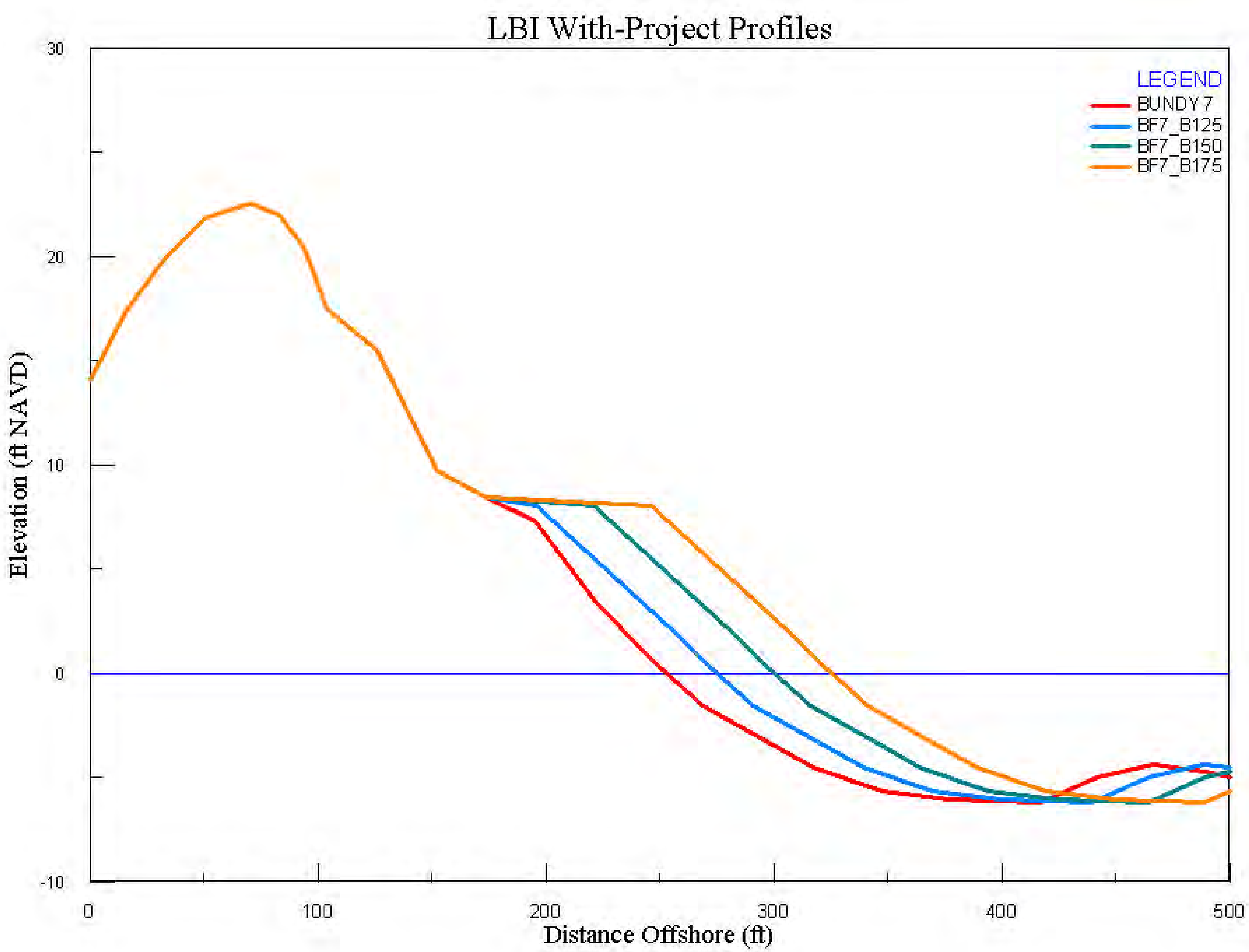


Figure 2-58 BUNDY 7 With-Project Alternatives

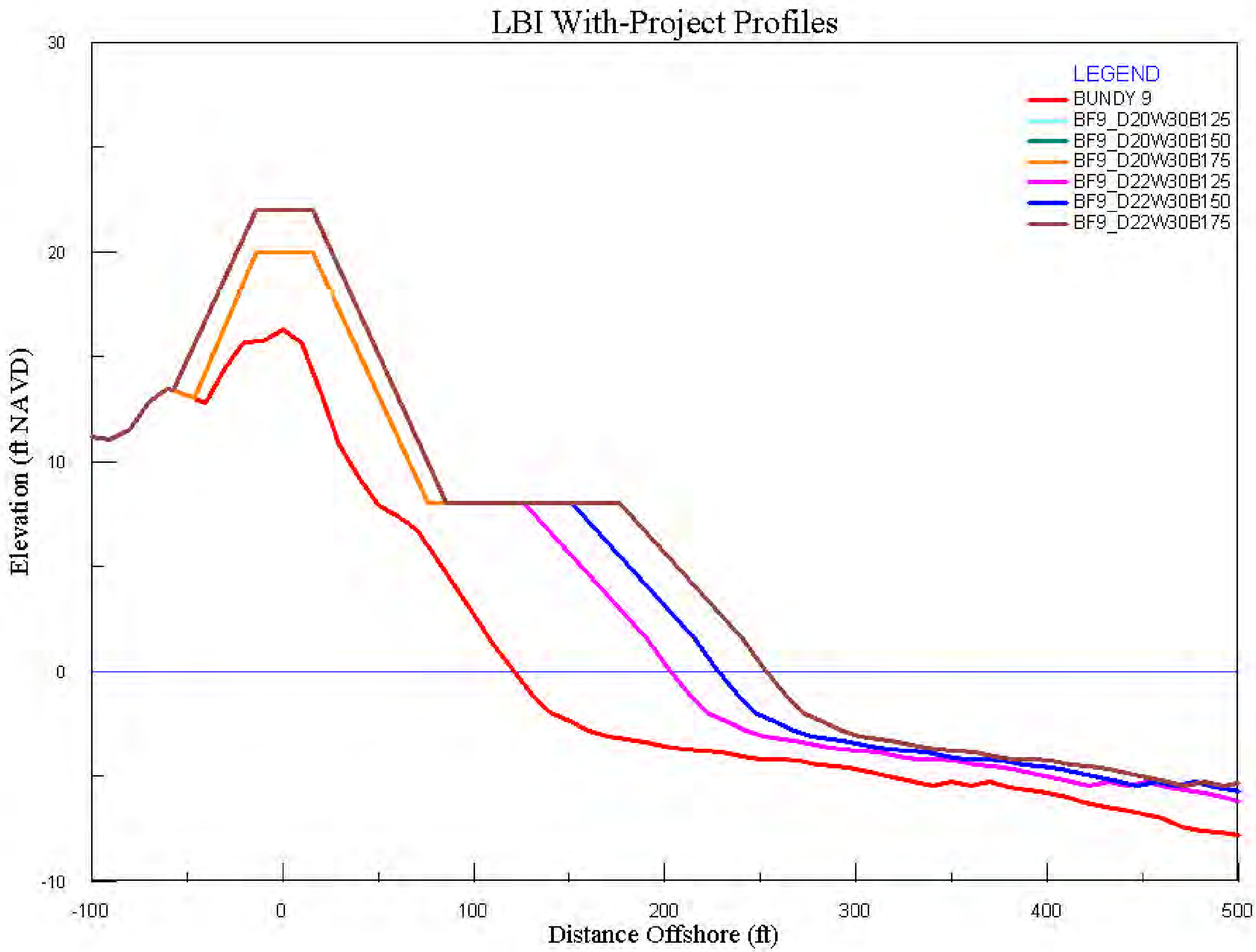


Figure 2-59 BUNDY 9 With-Project Alternatives

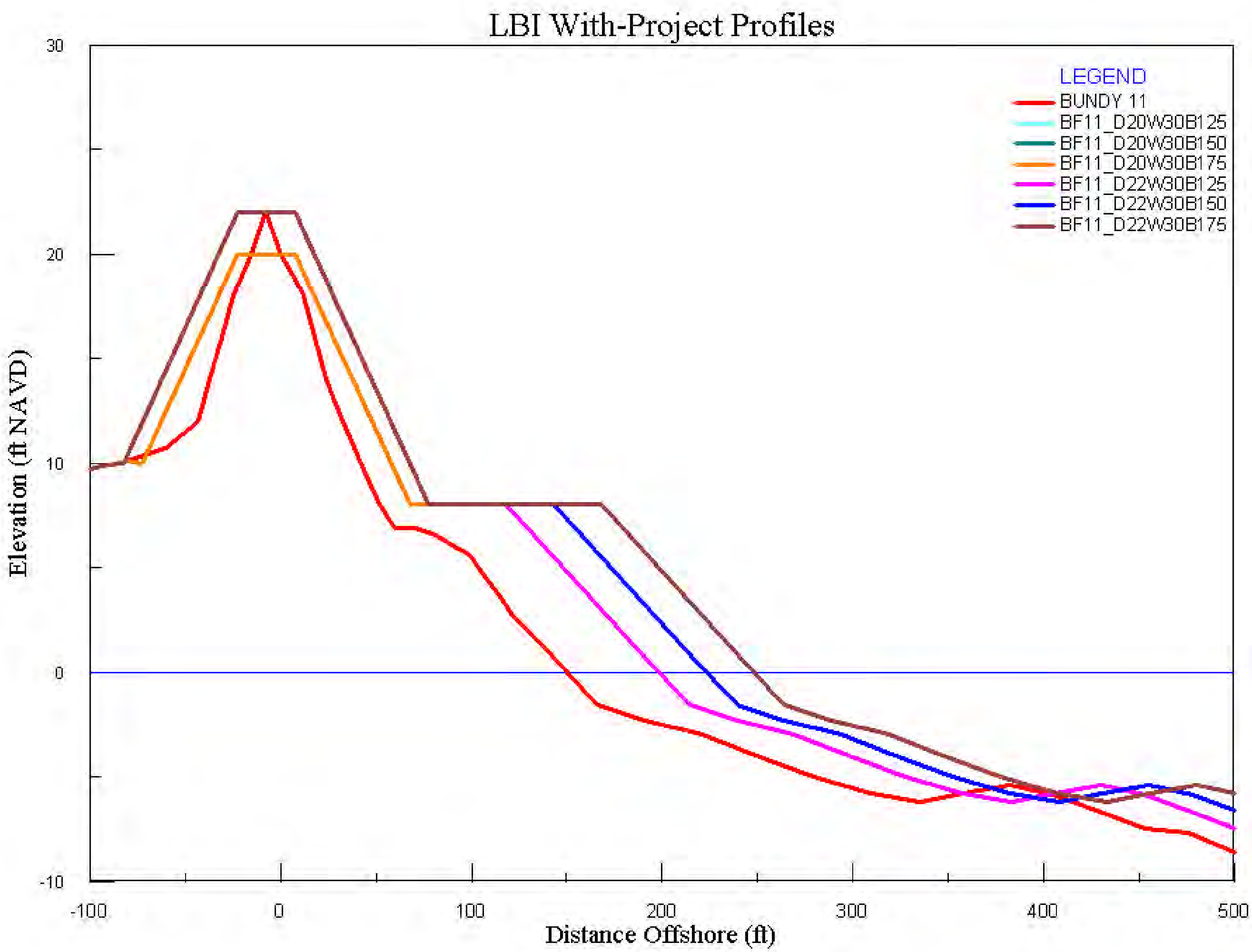


Figure 2-60 BUNDY 11 With-Project Alternatives

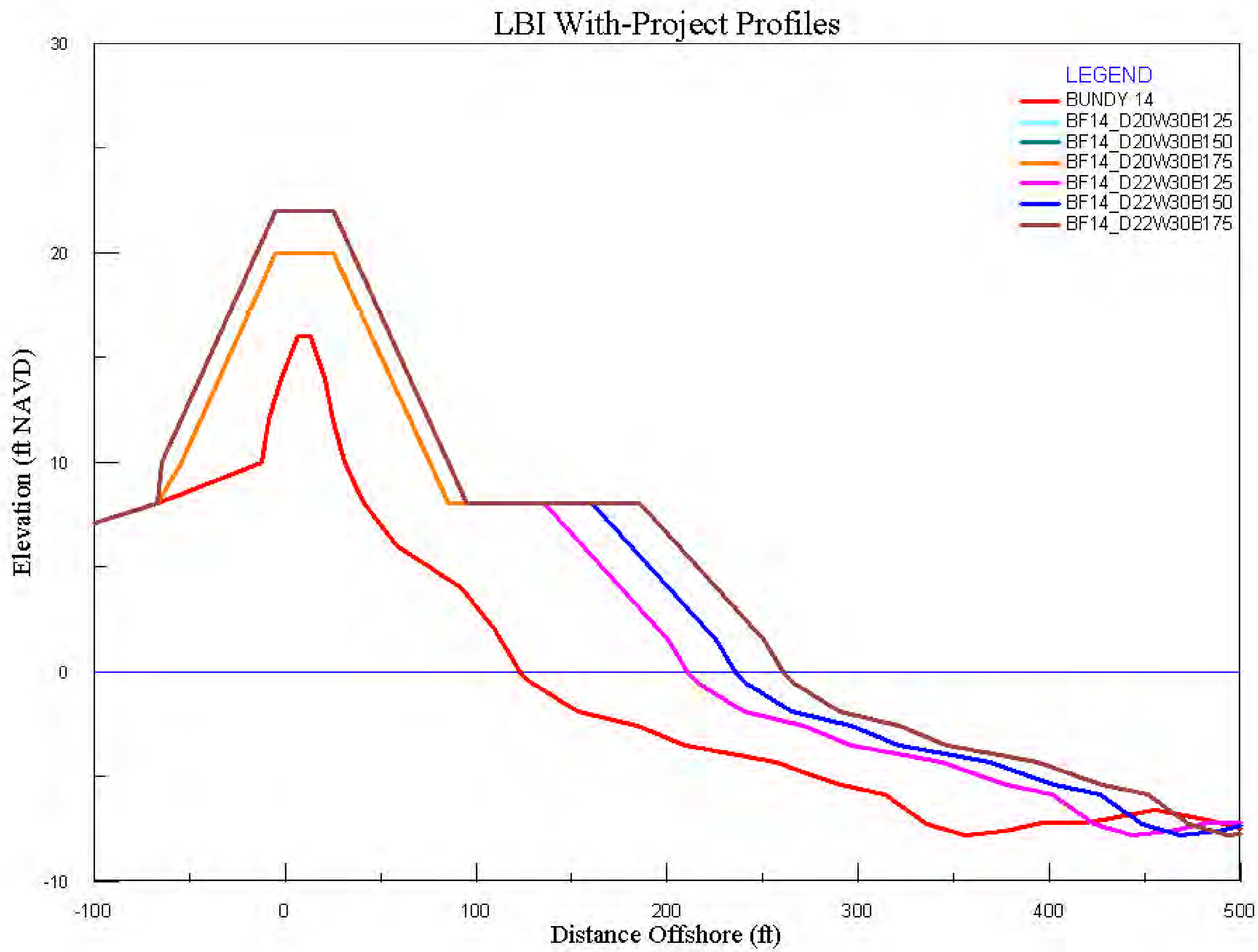


Figure 2-61 BUNDY 14 With-Project Alternatives

analyzed for erosion, wave attack and inundation damage reductions compared to the without project conditions.

Storm Impacts. The with-project conditions are the conditions that are expected based on the predicted impacts of storm events on the various project alternatives. The periodic nourishment associated with the project is designed to insure the integrity of the project design. In the case of beachfill this ensures the project design cross section will be maintained and the elimination of shoreline recession due to long-term erosion. However, coastal processes will continue to impact the shoreline along the project area. Storm-induced erosion, wave attack and inundation were evaluated for the with-project conditions using the same methodologies utilized in the without-project analyses. The following sections describe the coastal processes used to estimate the with-project damages.

Storm Induced Erosion. The numerical model SBEACH was applied to predict storm-induced erosion for the with-project conditions for the study area. All SBEACH input variables were identical to the without-project runs except the input profiles were modified to include the alternative beachfill designs. As in the without-project condition, storm events from 2 to 500 year return periods were analyzed on the with-project alternatives. Erosion distances are measured from the Hydraulic/Economic reference baseline to the landward-most occurrence of vertical erosion. The storm-induced recession distances (2- through 500-year) for six project alternatives for each BUNDY analyzed in the initial screening are presented in **Table 2-17**. Model results were reviewed and analyzed for reasonableness as applied to the varying with-project alternatives.

Storm Inundation. The post storm recession profiles generated by SBEACH were used to analyze inundation and wave attack using the same methodology described in the without-project analyses. The wave height frequency and stage-frequency data utilized to assess the alternative designs was identical to that used for the without-project conditions. **Figure 2-62** presents the total water elevation profiles for the 20 and 22 ft dunes on 125 ft berm alternatives in BUNDY 9 (Brant Beach) for the 200-yr event. Similar inundation profiles were computed for each alternative at each BUNDY and each storm event to determine the total water level across the beach profile and into the community. The inundation results are presented in the "contrl" file format which is compatible for use with the economic COSTDAM analysis to compute storm-induced damages. A unique contrl file was produced for each alternative for each BUNDY within the study area. Detailed results are presented in the Economics Appendix.

Table 2-17. LBI With-Project Erosion Values for BUNDY's evaluated in Initial Screening.
Distance from Economics Reference Line (ft)

Bundy 3

Return Period	Dune 20, Berm 125	Dune 20, Berm 150	Dune 20, Berm 175	Dune 22, Berm 125	Dune 22, Berm 150	Dune 22, Berm 175
2	368	348	322	368	348	322
5	468	372	358	468	392	352
10	472	372	352	472	398	352
20	472	472	462	472	468	462
50	472	472	462	472	470	468
100	492	472	462	482	478	472
200	512	488	478	488	482	478
500	552	538	528	538	528	522

Bundy 6

Return Period	BF6_D20B125.POS5	BF6_D20B150.POS5	BF6_D20B175.POS5	BF6_D22B125.POS5	BF6_D22B150.POS5	BF6_D22B175.POS5
2	408	388	358	402	388	358
5	498	402	388	498	428	388
10	502	408	392	502	443	392
20	508	502	492	508	502	492
50	508	508	508	508	502	502
100	532	512	508	512	512	508
200	548	522	508	522	512	508
500	568	562	552	562	557	552

Bundy 7

Return Period	Berm 125	Berm 150	Berm 175
2	338	312	288
5	432	428	318
10	432	428	318
20	438	432	428
50	438	432	428
100	442	438	438
200	452	452	442
500	492	488	478

Bundy 9

Return Period	Dune 20, Berm 125	Dune 20, Berm 150	Dune 20, Berm 175	Dune 22, Berm 125	Dune 22, Berm 150	Dune 22, Berm 175
2	402	378	352	398	378	352
5	438	402	392	433	398	382
10	448	402	388	443	398	382
20	508	498	492	508	498	492
50	508	498	492	508	498	492
100	512	508	502	512	508	502
200	518	512	508	518	512	508
500	578	568	558	568	558	552

Bundy 11

Return Period	Dune 20, Berm 125	Dune 20, Berm 150	Dune 20, Berm 175	Dune 22, Berm 125	Dune 22, Berm 150	Dune 22, Berm 175
2	408	388	362	408	388	362
5	502	408	388	508	402	388
10	502	408	388	512	508	388
20	512	508	502	512	508	508
50	512	508	502	518	512	508
100	522	512	508	522	518	512
200	552	522	512	528	522	518
500	568	562	562	572	568	562

Bundy 14

Return Period	Dune 20, Berm 125	Dune 20, Berm 150	Dune 20, Berm 175	Dune 22, Berm 125	Dune 22, Berm 150	Dune 22, Berm 175
2	392	372	348	392	372	348
5	438	392	372	433	378	372
10	488	392	382	482	388	378
20	492	488	482	488	488	482
50	492	488	482	492	488	482
100	502	488	488	498	492	488
200	522	498	492	518	492	488
500	552	548	542	552	548	542

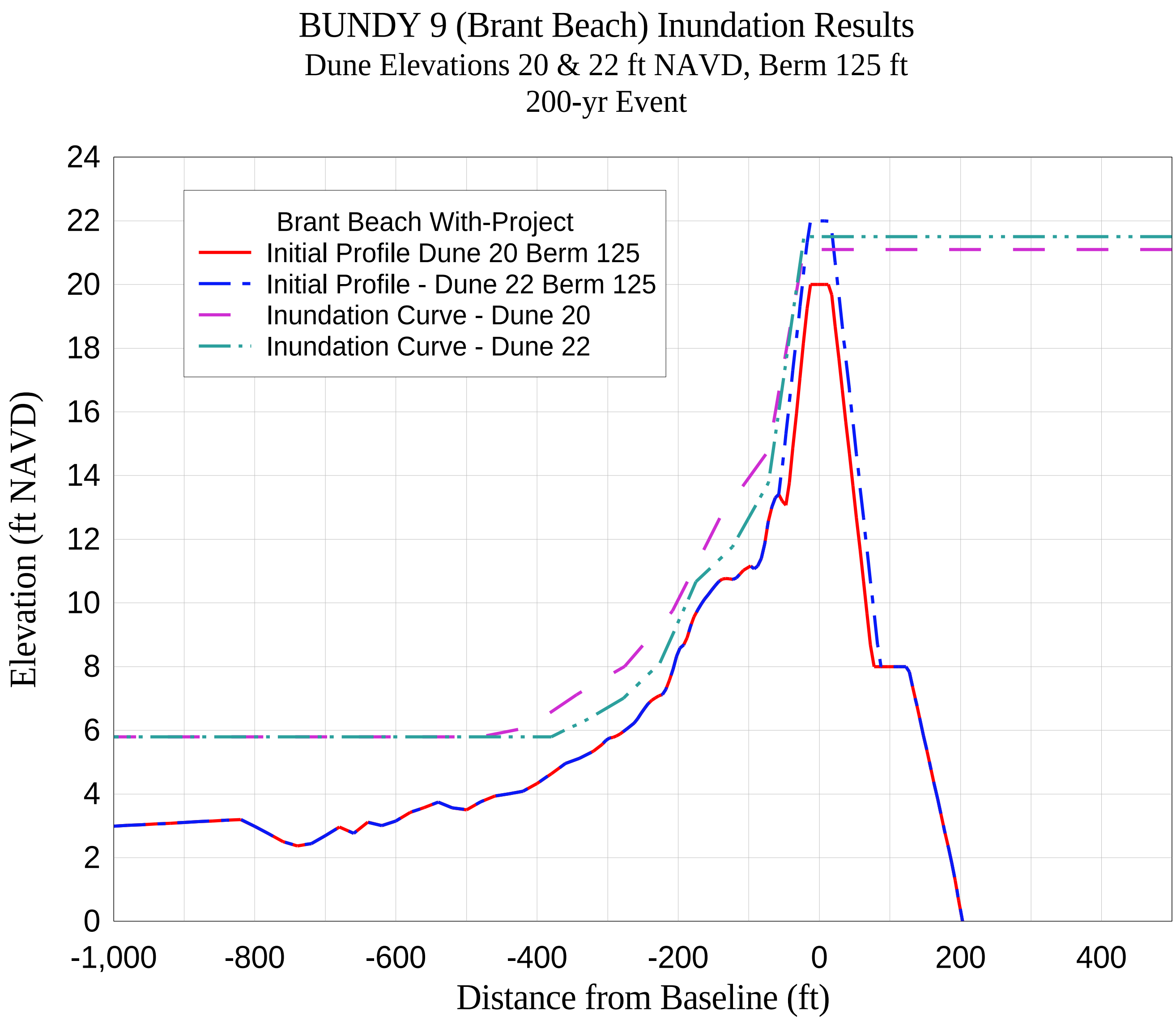


Figure 2-62 Inundation Curves for BUNDY 9 (Brant Beach) With-Project Atlernatives with Dune Elevations of 20 and 22 ft NAVD and Berm Width of 125 ft against a 200-yr Event.

Nourishment Requirements. In order to maintain the integrity of the design beachfill alternatives, beachfill nourishment must be included in the project design. If periodic nourishment were not performed throughout the life of the project, longshore and cross shore sediment transport mechanisms, separate from storm induced erosion, would act to erode the design beach. This erosion would reduce the protection from storm damage afforded by the project design. The nourishment quantities are considered sacrificial material which acts to ensure the integrity of the project design. Various coastal processes were analyzed to develop an estimate of the required annual nourishment fill volumes.

The nourishment parameters were developed by considering background erosion losses using shoreline recession rates developed in the historic shoreline change analysis, losses due to the predicted rate of sea level rise, losses due to storm induced dune erosion, and "spreading out" losses due to diffusion of the beachfill through longshore transport gradients. The results of these analyses were compared and the volumetric requirements were combined to obtain the total nourishment needs for each of the project alternatives. A number of numerical tools were utilized to aid in the analysis including the Planform Evolution Model in the Beach Fill Module 1.0 and GENESIS. Both tools allow the influence of retention structures (groins) to be included in the analysis.

Nourishment requirements were initially computed for the six BUNDYs evaluated in the initial screening. A range of berm widths (125, 150, and 175 ft) and nourishment intervals (3-, 5-, 7-, and 10-years) were evaluated. Therefore, twelve nourishment quantities were computed for each BUNDY analyzed as input into the cost/benefit analysis. This large number of alternative nourishment schemes provided a means of determining the economically optimum nourishment interval. The nourishment costs for each alternative, both initial and periodic nourishment throughout the project life, were annualized and compared to the corresponding average annual damages prevented by the alternative.

Historically, projects along the Atlantic Coast have initially used a 3-yr nourishment interval. Intuitively, for Long Beach Island with relatively small background erosion rates, a longer nourishment interval appeared feasible. Although background losses can be assumed to be nearly the same regardless of the fill width placed, "spreading out" losses increase as a function of beachfill width. The larger quantities of advanced nourishment required in order to maintain the integrity of the design profile throughout a 7- or 10-yr nourishment interval result in the fills diffusing fairly quick when compared to the 3-yr advanced nourishment. In terms of total volumes placed throughout a project life, there is little difference between placing smaller quantities more frequently versus large quantities at longer intervals. Therefore, it becomes an economic evaluation which is heavily dependent upon dredging operation costs, especially the frequency of mobilization/demobilization costs associated with each nourishment interval.

The initial screening resulted in a nourishment interval of three years to be used with a berm width of 125 ft. Detailed analyses were performed for all BUNDYs to determine overall nourishment requirements for the selected plan. **Table 2-18** summarizes the initial and periodic nourishment volumetric requirements for the Study area. The final nourishment quantities were increased by an overfill factor of a range of 1.05 to 1.60 depending on the grain size. Initial design volumes were determined by adding the advanced nourishment volumes and the design volumes obtained from the survey cross sections. Volumes were separated into "above berm" and "below berm" to account for the irregularities in shoreline positions found amongst the groin compartments. Volumes "above berm" were computed using the difference between the design template and existing conditions and multiplying the unit volume by the appropriate reach length. Volumes "below berm" were computed by comparing the existing shoreline position throughout the entire reach (BUNDY) to the proposed design MHW line. Total volumes "below berm" were computed by multiplying the difference in shoreline positions by an active profile depth, the average berm elevation to the depth of closure.

TABLE 2-18 LBI Initial and Periodic Nourishment Volume Requirements

BUNDY	Reach Length (ft)	Initial Vol Requirements BMAP Analysis (yd^3) Above Berm +20	Initial Vol Requirements BMAP Analysis (yd^3) Above Berm +22	Initial Vol Below Berm (yd^3) * BFM Analysis	Periodic Nourishment Requirements (yd^3) 3-yr	5-yr	7-yr	10-yr
1	6910	0	0	0	0	0	0	0
2	4298	0	0	0	0	0	0	0
3	7664	103,901	181,637	332,111	68,435	100,378	144,804	223,827
4	4491	0	27,215	52,062	19,906	33,688	47,469	71,969
5	4551	48,241	54,885	136,281	45,938	75,031	104,125	153,125
6	9815	70,432	175,394	638,446	181,452	302,421	443,551	658,607
7	6425	0	707	321,052	78,094	121,479	173,542	251,635
8	5285	7,764	48,041	185,792	25,010	37,516	50,021	66,099
9	9252	160,346	255,633	598,038	31,476	44,066	69,247	132,198
10	9199	122,338	214,705	491,020	30,063	48,563	63,825	84,175
11	6438	57,131	128,502	376,007	128,285	181,368	252,146	376,007
12	7260	0	37,099	394,722	32,625	47,125	59,813	81,563
13	4761	0	40,754	145,468	19,396	27,477	35,559	48,490
14	3156	89,492	125,735	174,733	147,875	203,125	261,625	346,125
15	6646	15,126	75,698	97,183	74,189	128,421	182,653	275,931
Total	96151	**674,770**	**1,366,004**	**3,942,915**	**882,744**	**1,350,658**	**1,888,380**	**2,769,751**
				50-yr Totals (Including Advanced)	**14,712,429**	**13,506,580**	**13,218,660**	**13,848,755**

	Estimated Total Volume Requirements (yd^3) 3-yr	5-yr	7-yr	10-yr
Dune +20	19,330,115	18,124,265	17,836,345	18,466,440
Dune +22	20,021,349	18,815,499	18,527,579	19,157,674

* Note: Add one cycle advanced nourishment to initial volumes to obtain total initial volume requirements.

** Note: Volumes do not include overfill and renourishment factors.

Major Rehabilitation. Major rehabilitation quantities were developed in accordance with ER 1110-2-1407 to identify additional erosional losses from the project due to higher intensity (low frequency) storm events. The nourishment rates developed for the project alternatives include losses due to storms that have occurred within the analysis period, storms of approximately 50 year return period and more frequent are encompassed in those rates. Major rehabilitation losses are computed as the losses that would occur from the 50% risk event over the project life. The annual percent frequency event with a 50% risk during the 50-year economic project life is 1.37%. The period of record of stages recorded at the study area is approximately 73 years. SBEACH was employed to compute volumetric erosion from the selected beach alternative design profile utilizing the 50- and 100-yr return period storm parameters utilized in the without- and with-project analyses. Volumetric erosion quantities for the 73-yr event were obtained by interpolating between the 50- and 100-yr events. Water levels and waves were hindcasted at the study area for the storm, and all model parameters were identical to the without and with-project analyses. Volumetric storm induced erosion was computed within each BUNDY for the design beach profile. Based on local profile analyses and experience developed at the Philadelphia, and other Corps coastal Districts, it is estimated that approximately 60% of the material displaced during large storms will return to the foreshore within weeks and only the remaining 40% will require mechanical replacement. As a conservative estimate of the necessary major rehabilitation quantity, a volume equal to 60% of the estimated storm eroded volume will require mechanical placement onto the subaerial beach to regain the design cross-section and insure the predicted level of storm damage reduction.

It is estimated that a volume of approximately 500,000 cubic yards along Long Beach Island would be required to perform major rehabilitation in response to the 50% risk event. **Table 2-19** displays the volumetric requirements for each BUNDY.

TABLE 2-19. Major Rehabilitation Volume Requirements.			
		Unit Volumetric Losses	Total Volume Losses
Bundy	Reach Length (ft)	(yd^3/ft)	(yd^3)
1	6910	0.00	**0**
2	4298	0.00	**0**
3	7664	6.00	**45,984**
4	4491	5.60	**25,150**
5	4551	6.50	**29,582**
6	9815	7.00	**68,705**
7	6425	7.40	**47,545**
8	5285	5.00	**26,425**
9	9252	4.60	**42,559**
10	9199	4.20	**38,636**
11	6438	5.90	**37,984**
12	7260	7.20	**52,272**
13	4761	7.30	**34,755**
14	3156	5.10	**16,096**
15	6646	6.00	**39,876**
		TOTAL	**505,568**
All Volumes should be adjusted with Overfill and Renourishment Factors			

Beachfill Monitoring Plan. The project monitoring plan will document beach fill performance and determine conditions within the borrow areas. Periodic assessments will assist in determining renourishment quantities. The program was developed in accordance with EM-1110-2-1004, ER-1110-2-1407, CETN-II-26 and the draft CETN dated 3/13/95 entitled "Recommended Base-level Physical Monitoring of Beach Fills." The following items are to be included in the project monitoring plan: Pre- and post-construction monitoring will consist of beach profile surveys, hydrographic surveys of borrow area, sediment sampling of the beach and borrow areas, aerial photography, and tidal data collection. The field data collection will be followed up by lab and data analyses. The proposed monitoring program will begin at the initiation of pre-construction efforts and continue throughout the project life.

Beach Profiles
PURPOSE: To quantify loss rates from project cells in order to define required renourishment quantities and determine the accuracy of predicted loss rates, and document cross-shore and longshore transport patterns of the beach fill.

FREQUENCY: Monthly onshore rod surveys for 2 years following construction; then quarterly onshore surveys for the next 3 years. Semi-annual onshore/offshore sled surveys (combine with monthly/quarterly onshore surveys in first 5 years).

NUMBER AND LOCATION: Total of 42 profile lines from Barnegat Inlet to Little Egg Inlet.

Inlet Hydrographic Surveys
PURPOSE: To document changes in Barnegat Inlet channels and ebb shoal complex.

FREQUENCY: Comprehensive hydrographic survey of Barnegat Inlet channels and ebb shoal complex every 2 years.

Borrow Site Hydrographic Surveys
PURPOSE: To document changes in borrow site conditions and evaluate infilling rates.

FREQUENCY: Comprehensive hydrographic survey of all borrow sites every 2 years.

Aerial Photography
PURPOSE: Document changes along Long Beach Island shoreline as supplement to beach profile data.

FREQUENCY: Quarterly flights

LOCATION: Long Beach Island, Barnegat Inlet complex, and Island Beach State Park.

Tidal Data
Tide gage installed at tip of Barnegat Inlet northern jetty if not already in place.

Sediment Sampling

PURPOSE: Identify sediment resorting and fill behavior; identify cross-shore and longshore grain size distribution changes; evaluate fill factor method.

FREQUENCY: Collect samples post-fill and then semi-annually (Winter and Summer, coordinated with beach profiles) every 3 years.

NUMBER AND LOCATION: Along 14 established lines only; sample at dune, berm, high tide, mid tide, low tide lines, then 6 ft intervals to 30 ft (total of 10 samples per profile line).

APPENDIX A

Wave Climate and Littoral Sediment Transport Potential, Long Beach Island, New Jersey

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Draft Technical Report CHL-99-xx
April 1999

Wave Climate and Littoral Sediment Transport Potential, Long Beach Island, New Jersey

by Mary A. Cialone and Edward F. Thompson

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Prepared for U.S. Army Engineer District, Philadelphia

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Contents

SF 298

List of Figures

List of Tables

Preface

This study was authorized by the U.S. Army Engineer District, Philadelphia (NAP), and was conducted by personnel of the Coastal Processes Branch (CPB), Coastal Sediments and Engineering Division (CSED) and Coastal Hydrodynamics Branch CHB), Navigation and Harbors Division (NHD), Coastal and Hydraulics Laboratory (CHL), of the U.S. Army Engineer Waterways Experiment Station (WES). The study was conducted during the period October 1998 through April 1999. Mr. John McCormick, NAP, oversaw progress of the study.

Ms. Mary A. Cialone, CPB, was the WES point of contact for the study. This report was prepared by Ms. Cialone and Dr. Thompson, CHB. Mr. Mark B. Gravens, CPB, provided valuable consultation. Direct supervision was provided by Mr. Bruce A. Eersole, Chief, CPB. General supervision was provided by Mr. Thomas Richardson, Chief, CSED, Mr. Charles C. Calhoun, Jr., former Assistant Director, CHL, and Dr. James R. Houston, Director, CHL.

At the time of publication of this report, COL Robin R. Cababa, EN, was Commander of WES.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

1 Introduction

Background

Long Beach Island is located on the southern portion of the barrier islands of New Jersey, just south of where the general shoreline orientation changes from north-northeast to a northeast direction (Figure 1). The 32-km-long barrier island separates the Atlantic Ocean from three shallow bays extending along the western side of the island. The northernmost bay is Barnegat Bay, the centrally-located bay is Manahawkin Bay, and the southernmost bay is Little Egg Harbor. Long Beach Island is bounded on the north by Barnegat Inlet and on the south by Little Egg Inlet. Tides are semidiurnal with a neap range of 0.9 m and a spring range of 1.5 m. A generally accepted estimate of net sediment transport along Long Beach Island is approximately 75,000-150,000 m^3/yr towards the south, however estimates range from 40,000 to 4,000,000 m^3/yr (NAP, 1999)

The oceanfront along Long Beach Island is developed entirely for residential use. The bay side of the island has residential development, commercial marinas, and numerous boat ramps. A 9.7-km-long causeway provides the only vehicular access to Long Beach Island. Beach erosion along Long Beach Island oceanfront communities of Harvey Cedars, Loveladies, and Brant Beach has required recent placement of material. Some material has been trucked in from inland sources, some borrow material has come from maintenance dredging of Barnegat Inlet, and some material has come from offshore borrow areas. The offshore bathymetry includes finger-like shoal features which extend out from the shoreline in a north-easterly direction (Figure 2).

The present study was conducted to assist NAP in evaluating the impacts of borrowing sediment from four borrow sites on nearshore wave climate, longshore transport potential, beach nourishment requirements, and shoreline change rates. Approximately 6.7×10^6 m^3 of sediment proposed for the present study is to be excavated from the potential borrow sites and placed along a 27-km stretch of Long Beach Island from Loveladies to Holgate for initial construction. Approximately 1.5×10^6 m^3 of material is needed for periodic nourishment every 7 years over the 50-yr project life.

Needs and Objectives

As part of a beach nourishment feasibility study for Long Beach Island, New Jersey, a study of the impacts of borrowing material from nearshore and offshore regions on the regional coastal processes was required. Four potential borrow sites for the Long Beach Island nourishment project were identified (Figure 1): Area A-the ebb shoal at Barnegat Inlet, Area B-nearshore shoal off of Loveladies, Area D-offshore borrow area, and Area E-nearshore shoal off of Brant Beach/Beach Haven Crest. Note that these borrow sites are in three different coastal environments. Specific analyses to determine the impacts of borrowing material from these sites are: 1) to examine the relative changes in wave climate due to bathymetric changes created at the borrow sites; 2) to determine the changes in potential longshore transport rates; 3) to examine the impacts on nourishment requirements for proposed beachfill areas; and 4) to look at the relative impacts on shoreline change rates. Therefore, the objective of this study was to perform these analyses and determine the relative impacts of the four borrow sites on these processes.

Study Approach

The study described in this report was performed by the U.S. Army Engineer Waterways Experiment Station (WES), Coastal and Hydraulics Laboratory (CHL).   The approach consisted of the following components:

a. Evaluate offshore wave climate

b. Use a numerical model to transform offshore wave climate to nearshore areas, for existing and proposed bathymetric configurations

c. Estimate littoral transport potential along the coast, both for the existing and proposed bathymetric configurations

d. Estimate nourishment requirements for segments of Long Beach Island defined by NAP for existing and proposed bathymetric configurations, and

e. Estimate shoreline change rates for existing and proposed bathymetric configurations for segments of Long Beach Island defined by NAP.

Offshore wind wave and swell climate was investigated with the Wave Information Study (WIS) numerical hindcast information covering the 20-yr time period 1976-1995 and with the Offshore and Coastal Technologies, Inc.-East Coast (OCTI) numerical hindcast covering the 10-year time period 1987-1996. Buoy measurements and a directional wave gage near Barnegat Inlet were used to help validate the hindcasts. The offshore wave climate evaluation is presented in Chapter 2.

A numerical wave model was used to transform offshore wave to the nearshore zone. The numerical model used for the studies, STWAVE, is a standard WES tool for shallow water wave transformation. Development of the two numerical model grids (one for the entire study region and a more refined grid for the Barnegat Inlet area), model output stations, longshore sediment transport calculation procedures, and other aspects of the modeling approach are described in Chapter 3. In addition to existing bathymetry, the proposed borrow area bathymetry configuration was used in numerical simulations.

Study results are presented in Chapter 4. Littoral transport results needed for assessing impacts on beach nourishment rates and shoreline change rates along Long Beach Islands are presented. Beach nourishment rates and shoreline change rates are also presented.

Conclusions and recommendations are given in Chapter 5. This chapter is followed by references and appendices with detailed information supporting the main report.

This study only involved use of wave transformation model results to estimate potential sediment transport rates, renourishment requirements, and expected shoreline change rates. A thorough analysis of historical shoreline changes and inferred volumetric changes should also be done to gain additional information about sand transport processes in the region.

2 Offshore Wave Climate

Evaluation of the incident wave climate is a critical first step in nearshore wave climate and littoral transport studies. Ideally, a long-term, high-quality hindcast is available with at least a few years of concurrent deep water directional wave measurements in the same area to validate the hindcast. This study used a relatively recent 20-yr hindcast and a recent 10-yr hindcast, as discussed in the following sections. Nearby directional measurements (at Barnegat Inlet) were available for only a 1-year period. Previous studies of this general area have used a variety of sources for wave information, including nondirectional gages mounted on the "Steel Pier" at Atlantic City, shipboard wave observations, and Coast Guard station observations (GDM, 1984)

WIS Hindcasts

The WES Wave Information Studies (WIS) has developed wave information along U.S. coasts by computer simulation of past wind and wave conditions. This type of simulation is termed hindcasting. The present hindcast information base consists of two 20-yr blocks. WIS produced the first block, covering years 1956-75, in the early 1980's (Corson et al. 1982). The second block, covering years 1976-95, was produced in the mid 1990's (Brooks and Brandon 1995). The more recent hindcast is considered to be more reliable since it was produced using an improved wave hindcast model and results were evaluated against an extensive array of wave measurements which were not available during the initial study. Also, the 1976-95 hindcasts include tropical storms whereas the previous hindcasts do not.

The 1976-95 WIS parameters are available at 3-hr intervals over the 20-yr period. At each 3-hr interval, a number of wave parameters are given. Parameters typically used to represent waves are significant wave height, H_s, peak spectral period, T_p, and peak direction, $?_p$. WIS parameters of importance to this study include overall H_s, T_p, and $?_p$, and, when more than one wave component is present (such as a locally-generated sea and a swell coming from a distant storm), H_s, T_p, and $?_p$ values for primary and secondary wave components.

Hindcast information for the period 1976-1995 from two nearby WIS stations AU2069 (WIS 69) and AU2070 (WIS 70), was used to examine offshore wave climate. Station AU2070 is located 8 km off of Barnegat Inlet at 39.75N, 74.0W and AU2069 is located approximately 20 km south of Barnegat Inlet at 39.5N, 74.0W(Figure 3). Results from the two stations were similar and Hindcast Station AU2070 was selected for use in the analysis (Figure 4) due to its closer proximity to the project study grid boundary. A percent occurrence table of significant wave height, peak period, and peak direction was constructed for Station AU2070 (Appendix A). At Station AU2070, waves typically approach the study area from between 67.5 and 180.0 deg azimuth. Wave heights are most likely in the 0.5 to 1.0-m range with a mean of 0.9 m. The maximum hindcast wave height was 8.4 m. The highest percentage of wave periods is 5.0 to 9.0 sec, with a mean wave period of 6.4 sec.

For littoral transport studies, the primary and secondary wave components were taken separately. Breaking wave height and direction are critical to longshore sediment transport. Hence, it was useful to retain information about both components of the offshore wave climate. A wave height threshold of 0.3 m was used to eliminate waves that would not likely cause transport. The primary component distribution for Station AU2070 (Figure 5) is very similar to Figure 4. The secondary component distribution shows an increased frequency of offshore-traveling wave conditions (Figure 6). As will be shown in the model simulations, waves from 67.5 to 180 deg were used in model simulations, therefore a large percentage of the secondary component waves were eliminated because they would not impact the coast. Even though wave heights are relatively low, the secondary components were included for littoral transport studies.

NDBC Buoy 44025 and DWG Measurements

The offshore directional wave measurement station nearest the study area is National Data Buoy Center (NDBC) buoy 44025, located at 40.25 N, 73.17 W. Water depth at the buoy is 40 m. Directional wave data were available for six years, from November 1991 to November 1997. Data were collected hourly for 1024 sec at a rate of 1 Hz. Although NDBC buoy 44025 is distant from the study area, it provides a valuable indication of the WIS wave climate quality. Wave statistics for buoy 44025 (Figure 7) and for the nearest WIS station (AU2070) (Figure 4) indicate very similar wave direction, wave period, and wave height climates. The distribution for the WIS station AU2070 is quite consistent with buoy 44025. Overall, the study area offshore wave climate as represented by WIS station AU2070 appears acceptable.

In May 1994, a directional wave gauge (DWG) was deployed 1300 m off the Barnegat Inlet south jetty tip in approximately 12 m of water for a one-year period. The average significant wave height, Hs_{avg} , for that time period was 0.7-0.8 m, the average peak period, T_{avg} , was 8.9 sec, and the maximum significant wave height, Hs_{max} , was 3.8 m. The wave statistics for this shorter time period show less directional spread, a longer average wave period, and a somewhat smaller distribution of wave heights than the WIS AU2070 hindcast and NDBC buoy 44025 data (Figure 8).

OCTI Hindcast

OCTI performed a hindcast for NAP which was also analyzed for possible use as a source for wave statistics to use in the potential littoral transport computations. OCTI Station I=35, J=30 located at 39.5833N, 74.1666W was selected due to its proximity to the grid offshore boundary. Water depth at the hindcast station was 19 m. A percent occurrence table of significant wave height, peak period, and direction were constructed for the hindcast station (Appendix B). At the hindcast station, waves approach the study area from a broader range of directions with the highest percentages being the nearly shore-normal angles between 157.5 and 202.5 deg azimuth (Figure 9). Wave heights are statistically most likely in the 0.5 to 1.0-m range with a mean of 0.9 m. The maximum hindcast wave height was 5.9 m. The highest percentage of wave periods is 0.0 to 5.0 sec, with a mean wave period of 5.4 sec. These data do not correspond to the buoy data as well as the WIS data, but both the WIS and the OCTI datasets were retained for use in computing littoral sediment transport as requested by NAP.

3 Modeling Approach

Wave Model and Grids

Wave Model

The WES spectral wind-wave growth and propagation model STWAVE (STeady-state spectral WAVE) (Smith et al., 1999) was chosen for wave transformation modeling in this study (Appendix C). The spectral representation was expected to be advantageous for transforming waves over the complex bathymetry of the borrow areas and the finger-like shoals which exist offshore of Long Beach Island. As described in Appendix C, model input requirements include a bathymetric grid, water level, and a two-dimensional wave spectrum at the offshore boundary. Details of these data requirements, as they apply to this study, are given in the following sections.

Grids

An STWAVE grid was developed to include coastal bathymetry extending from Station AU2070 west to the Long Beach Island shoreline and from north of Barnegat Inlet to Beach Haven (Figure 3). The grid encompassed all four potential borrow areas outlined in Chapter 1. Wave transformation between offshore and the Long Beach Island shoreline was modeled with this 100-m resolution grid referred to as Grid 1. A finer grid, with 50 m resolution, was developed for the Borrow Area A Barnegat Inlet area (Figure 3) and is referred to as Grid 2. This grid was needed for investigation of sediment transport potential along beaches to the south of Barnegat Inlet, outside the immediate influence of Borrow Area A. Specifications for the two grids are given in Table 1.

Bathymetry data were taken from several sources provided by NAP. As provided, the data were all referenced to mean high water (MHW). (Adjustment of the model to another datum can be easily accomplished within the STWAVE model framework.) Data sources included 1936 and 1954 National Ocean Survey (NOS) surveys, 1996 OCTI surveys of two nearshore regions, 1996 profile data collected along Long Beach Island for the feasability study, and 1996 profile data north and south of Barnegat Inlet and a 1997 ebb shoal survey collected as part of the Monitoring Completed Navigation Projects program for Barnegat Inlet. These data were combined into one dataset and converted to metric units using Spectra Precision Software TerraModel. For the many places with data overlap, the most recent data superceded any older data. Data outside the STWAVE grid boundaries were eliminated to reduce the size of the dataset. Contour maps for the existing condition bathymetric configuration for the two grids are given in Figures 10-11.

STWAVE is available in the PC-based Surface Modeling System (SMS) (SMS 1995). Hence, SMS was used for grid building and output visualization in this study. The digital bathymetry provided by NAP was input into SMS to build the uniform rectangular grids required by STWAVE. Grids in SMS were built in the New Jersey State Plane coordinate system (metric). Grid specifications are given in Table 1. In addition, borrow areas were numerically “dredged” using SMS grid modification capabilities. Contour maps for the borrow area bathymetric configuration for the two grids are given in Figures 12-13.

Table 1
Specifications for STWAVE Grids from SMS

Parameter	Grid 1[1]	Grid 2
Cell size	100 m	50 m
Origin, x (state plane)	195282.57 m	190639.71 m
Origin, y (state plane)	103801.49 m	105515.86 m
x-axis length	9750 m	6000 m
y-axis length	30500 m	10000 m
Counterclockwise rotation of x-axis from east	150.5^{O}	160^{O}
No. of I=s (columns)	97	120
No. of J=s (rows)	305	200

[1] Used for existing conditions and borrow area bathymetry

Incident Wave Conditions

STWAVE input requirements include wave conditions defined at the offshore grid boundary. The first step in generating input wave conditions was to examine the percent occurrence tables computed from the WIS parameters at station AU2070 and OCTI station i35j30 (as described in Chapter 2 and given in Appendices A and B). From these data, intervals selected for the wave parameters were 0.5 m for wave height, 2 sec for peak period, and 22.5 deg for direction. Wave height ranges .3-.75, .75-1.25, 1.26-1.75, etc.; period ranges 3-5 sec, 5-7 sec, 7-9 sec, etc, and direction ranges 56.25-78.75,78.75-101.25, etc. were simulated with the parameters described in Table 2. An STWAVE simulation was run for each combination shown in Table 2, for a total of 756 wave conditions simulated.

For each STWAVE input height/period/direction combination, the ACES 2.0 software was used to generate a directional wave spectrum in a water depth appropriate to the corresponding Grid 1 seaward boundary (20 m). Spectral frequencies ranged from 0.04 Hz to 0.33 Hz at 0.01 Hz intervals. Spectral direction components covered ∀85 deg from normal incidence to the grid, in 5-deg increments. A single water level was used in all simulations, representing Mean Sea Level (0.61 m below the MHW datum).

For Grid 2 simulations, wave spectra from Grid 1 were saved at five points corresponding to the Grid 2 offshore boundary. The spectra were averaged for each case to give a representative incident spectrum for the Grid 2 boundary. Boundary points which were not consistent with the more representative boundary points were omitted from averaging.

Table 2
Wave Conditions Simulated with STWAVE

Wave Height (m)	Wave Period (sec)	Wave Direction (deg N)
0.5	4	67.5
1.0	6	90.0
1.5	8	112.5
2.0	10	135.0
2.5	12	157.5
3.0	14	180.0
3.5	16	
4.0	18	
4.5	20	
5.0		
5.5		
6.0		
6.5		
7.0		

STWAVE Output

The main output from STWAVE simulations consists of arrays of significant wave height, peak period, and peak direction over the entire grid for each incident wave condition. These relatively large files are useful for visualizing wave transformation over the entire grid. The height/period/direction information at selected stations in the grid is another, much more condensed output which was useful for the littoral transport computations required in this study. Station output at grid cells along a nearshore reference line was generated for each STWAVE simulation, as discussed in the following sections. Station output can be generated during the STWAVE runs or it can be extracted from the main output arrays as a post-processing step.

Wave Transformation Examples

Figures 14 and 15 illustrate the Grid 1 wave transformation patterns for the existing condition bathymetric configuration and borrow area bathymetric configuration, respectively. These patterns are for one incident wave case (waves approaching from the most northerly angle band 67.5 deg). In this case, a 3-m wave height and longer than average (10-sec) peak period were selected to illustrate wave transformation over the four borrow areas. Note the changes in wave height in the vicinity of the borrow areas induced by the changes in bathymetric configuration from Figure 14 to Figure 15.

Similarly, Figures 16 and 17 show computed Grid 1 wave transformation patterns for the existing condition bathymetric configuration and borrow area bathymetric configuration, respectively, for the case with the same offshore wave height and peak period but approaching from a southerly direction (180 deg). In these cases, wave heights are more noticeably reduced as waves propagate from the offshore boundary into the nearshore area. The wave height reduction in shallow water is mainly due to the effects of refraction and nonlinear wave-wave interaction introduced in the STWAVE model. The wave-wave interaction induces significant loss of wave energy in the high frequency range through energy transferring from spectral peak to high frequency components.

Figures 18 through 21 show wave transformation patterns for Grid 2 for the same incident wave conditions described above. Changes in the vicinity of Borrow Area A are observed.

Littoral Transport

The approach to estimating littoral transport was to use STWAVE to transform each incident wave condition to near-breaking; transform the near-breaking wave to a point at which breaking begins, using the assumption of locally straight, parallel bottom contours; and compute potential longshore transport rate from that breaking wave height and angle. With consideration of the WIS and OCTI percent occurrence tables, the potential transport rate due to each incident wave condition was then converted to an annual potential transport volume of sediment. Finally, potential transport contributions from all incident wave conditions were added to give estimates of annual northward, southward, net, and gross longshore transport. Details of the approach are given in the following paragraphs.

Calculation of Breaking Wave Conditions

Stations for saving STWAVE wave parameters to be used in littoral transport estimation were selected with two primary objectives. First, the stations should be shoreward of all significant effects of irregular bathymetry, so that STWAVE will have included these effects in wave transformation. Second, stations should be seaward of the nearshore surf zone, so that STWAVE has not yet invoked breaking limits on wave height and the breaking wave height and angle needed for calculating longshore transport rates can be accurately estimated.

A nearshore station was selected for every alongshore grid cell of the proejct study grids. Nearshore stations for Grid 1 and Grid 2 are illustrated in Figures 22 and 23. Stations in Grid 1 were placed around the 6-m contour, where bottom contours were reasonably parallel to the shoreline. Near Barnegat Inlet, the ebb shoal extends offshore, causing wave breaking there rather than on the nearshore beach slope. These breaking waves are not directly driving littoral transport at the beach. Hence, nearshore stations in shoal areas were placed regardless of water depth to follow a smooth line of stations reasonably parallel to the beach or along expected paths of longshore transport around small inlets. These stations are expected to be representative of the breaking wave conditions actually driving nearshore littoral transport across shoal areas and along the adjacent beaches.

A shoreline angle was specified for each nearshore station to establish the orientation of the straight, parallel bottom contours to be used in calculating wave breaking conditions. Shoreline angles were computed from a recent digitized shoreline provided by NAP.

A computer program adapted from the GENESIS shoreline modeling system program NSTRAN (Gravens, Kraus, and Hansen 1991) was used to iteratively calculate breaking wave heights and angles. Inputs to the program included nearshore station output from STWAVE and shoreline angles. The breaking criterion is $H_s = 0.78\ d$, where d = water depth.

Calculation of Longshore Transport Rates

The program calculates potential longshore transport rates as

$$Q = K\ H_{bs}^{\frac{5}{2}}\ \sin(2\, a_b) \tag{1}$$

where Q = potential longshore transport rate
K = constant
H_{bs} = significant wave height at breaking
a_b = breaking wave angle relative to bottom contours

When H_{bs} is in meters and Q in m^3/day, the generally accepted value of K is $K = 5100$ (Equation 6-7b of USACE 1992). Program calculations were done in metric units with Q expressed in m^3/sec. The corresponding constant is $K = 0.0590$.

When Equation 1 is applied to the study area, longshore transport rates computed by WIS are unreasonably large. As in previous model studies, a calibration of the constant K was needed. Previous estimates of net and gross longshore transport rate along Long Beach Island provided a reasonable basis for calibration (GDM 1984, NAP 1999). The value of K in Equation 1 was reduced from 0.059 to 0.023 after calibration. The same calibration value of K was found in a concurrent STWAVE study of Cape Fear River Entrance and Smith Isle to Ocean Isle Beach, North Carolina (Thompson et al., 1999). Transport computed with the OCTI dataset did not require a reduction in the K coefficient and 0.059 was used.

A Q was calculated with Equation 1 for each wave condition. Using percent occurrences from WIS, Q was converted to an annual longshore transport volume in m^3/yr. Following standard convention, longshore transport toward the right of an observer on the beach facing the ocean is positive (southward transport in this study), and transport toward the left is negative (northward transport in this study).

Contributions from all wave conditions were added together to give total annual northward and southward potential longshore transport volumes, which can be expressed as annual transport *rates*. Net potential longshore transport rates are determined as the difference between magnitude of the northward and southward rates. Gross potential longshore transport rates are the combined magnitudes of northward and southward transport rates.

This study used both primary and secondary WIS wave components, as represented in wave climate percent occurrence tables. This approach is expected to give a better estimate of net transport rates than if only overall WIS parameters were used. However, it tends to increase northward, southward, and gross transport rates because wave components contribute individually rather than as combined events. The impact on longshore transport rates is expected to be small, but it is advisable to consider net transport rate as the most accurate littoral transport parameter in this study.

4 Littoral Transport Potential

Net Potential Transport

The net potential transport computed for this study is strictly controlled by the calibration coefficient K as described in the previous section. The selection of this coefficient is therefore critical. It was the intent of this study to compute "reasonable" transport values along Long Beach Island, with the ultimate goal being the comparison of these values for with- and without-project conditions. A reasonable transport value for Long Beach Island is on the order of 75,000 to 150,000 m^3/yr.

Calibrated net potential longshore transport rates for Long Beach Island using the WIS and OCTI wave climatology are given in Figures 24a and 24b, respectively. Alongshore cell numbers shown on the x-axis refers to the Grid 1 cell number, with Cell 1 located at the northern grid limit and Cell 300 located near the southern grid limit. Townships are given at their general location for reference. It is important to remember that these are *potential* transport rates and do not consider the availability of sediment or the influence of coastal structures on sand transport rates. It is interesting to note the nodal zone in the vicinity of Barnegat Inlet, where the general shoreline orientation of New Jersey changes. The potential net transport shows a notable change from net northerly transport to net southerly transport in this region. The predominant shoreline orientation changes dramatically at Barnegat Inlet. The position of Long Island, NY affects the wave climate which in turn affects transport rates. The sheltering effect created by Long Island, NY limits waves from the north impinging on northern New Jersey. South of Barnegat Inlet, the sheltering effect is not as apparent and net transport along Long Beach Island, NJ is generally to the south. There is a local reversal (transport to the north) near Barnegat Inlet (cell 134-135), probably due to the effects of the inlet and its shoal system on the downdrift beaches.

Using OCTI and WIS hindcast wave climatology for this study, net potential transport north of Barnegat Inlet is approximately 400,000-500,000 m^3/yr to the north. Net potential transport across Barnegat Inlet is approximately 500,000-600,000 m^3/yr to the south. Using the 1976-1995 WIS hindcast for Station 70 and the GENESIS support program SEDTRAN (Gravens et al., 1991), the net potential transport rate near Barnegat Inlet is estimated to be 530,000 m^3/yr to the south, assuming a local shoreline orientation of 29 deg east of north. In 1954, the Corps of Engineers estimated that the net littoral transport in the Barnegat Inlet area was 190,000 m^3/yr to the south (USACE, 1954). Other USACE estimates of net longshore transport at Barnegat Inlet range from 80,000 m^3/yr to the north to 280,000 m^3/yr to the south (USACE, 1995). The average of grid cells 135 through 305 was used to estimate the net potential transport along Long Beach Island for this study. Using OCTI hindcast wave climatology, the net potential transport for Long Beach Island was approximately 76,000 m^3/yr to the south and using the WIS hindcast wave climatology, the net potential transport was approximately 114,000 m^3/yr to the south. NAP estimates of net longshore transport for Long Beach Island using an earlier OCTI hindcast and SEDTRAN are approximately 70,000 to 140,000 m^3/yr. Prior USACE NAP estimates of net longshore transport for Long Beach Island based on 1838-1953 data and 1974 data indicate a much lower value (approximately 40,000 m^3/yr) (USACE, 1995).

It is evident that there is great variability in longshore transport estimates due to the quality of the input data as well as the level of sophistication used in the analysis. A reasonable transport value for Long Beach Island is on the order of 75,000 to 150,000 m^3/ yr.

By comparing the with- and without-project conditions it is observed that there are changes in the net transport potential induced by the project. The greatest changes are in the vicinity of Borrow Area A (affecting cells 50-70) and Borrow Area E (affecting cells 230-280).

Grid 1 Erosion and Accretion

The northerly (defined as negative) and southerly (defined as positive) longshore potential transport rates computed for Long Beach Island were used to estimate areas of erosion and accretion. Shoreline reaches defined by NAP for Grid 1 were used in these computations with slight adjustments to the suggested Reach 3-5 boundaries (Table 3). Longshore transport values for cells in each reach were summed and an average northerly and southerly longshore transport value was determined for each reach (Table 4). Three methods of computing erosion or accretion $X_{(i)}$ for a given Reach i were defined as follows: In Method 1 (Figure 25a), the average north and south transport values for a given reach were applied at the cell faces (the boundaries of the reach):

$$X_{(i)} = LT_{S(i-1)} - LT_{S(i)} + LT_{N(i)} - LT_{N(i+1)} \qquad (2a)$$

where $LT_{S(i)}$ is the southerly longshore transport value for a given Reach i and $LT_{N(i)}$ is the northerly longshore transport value for a given Reach i. $LT_{S(i)}$ is applied at the right face of Reach i and $LT_{N(i)}$ is applied at the left face of Reach i. In Method 2 (Figure 25b), transport values for adjacent reaches were averaged to determine transport values at the cell faces:

$$X_{(i)} = LT_{S(i-1/2)} - LT_{S(i+1/2)} + LT_{N(i+1/2)} - LT_{N(i-1/2)} \qquad (2b)$$

Distances to the cell face from (i-1), (i), and (i+1) were incorporated into the calculations to weight the transport rates used in the averaging. In Method 3 (Figure 25c), the transport rates at the cell faces were determined by averaging 25 cells around the reach boundaries. Equation 2b applies to this method also. The number of cells used in the averaging corresponds to the average length of the reaches.

These procedures were repeated for each reach. A boundary reach, Reach 0, across Barnegat Inlet (cells 58-61) was used to provide an adjacent cell for Reach 1. It was assumed that the southerly transport rate at the inlet would lose 175,000-225,000 m^3 of sediment to the inlet and/or ebb shoal based on recent inlet dredging records. Northerly-directed transport into Reach 12 from the southern boundary of the grid was estimated by averaging the northerly transport rates from the 5 cells closest to the grid boundary. This estimate is reasonable because the northerly-directed transport is fairly constant in this region (Table 4). This analysis assumes no losses or gains due to cross-shore transport processes.

Table 3. Long Beach Island Shoreline Reaches for Grid 1

Reach	Grid cells	Township
1	62-81	Barnegat Light

2	82-94	Loveladies North
3	95-119	Loveladies South
4	120-130	Harvey Cedars North
5	131-144	Harvey Cedars South
6	145-174	North Beach
7	175-194	Surf City
8	195-210	Ship Bottom
9	211-238	Brant Beach
10	239-266	Beach Haven Crest to Beach Haven Park
11	267-286	Haven Beach to Beach Haven Gardens
12	287-305	Spray Beach to Beach Haven Boro North

Table 4. Southerly and northerly longshore transport potential for Long Beach Island

Reach	Southerly and (Northerly) Longshore Transport WIS Without-Project (m^3/yr)	Southerly and (Northerly) Longshore Transport WIS With-Project (m^3/yr)	Southerly and (Northerly) Longshore Transport OCTI Without-Project (m^3/yr)	Southerly and (Northerly) Longshore Transport OCTI With-Project (m^3/yr)
0	403300	289400	363000	392000
1	453500 (-136300)	282600 (-136900)	589000 (-241800)	386900 (-231500)
2	204300 (-254300)	199400 (-251400)	265600 (-368100)	264400 (-357700)
3	179900 (-257500)	179800 (-256900)	267400 (-359300)	273400 (-355900)
4	197900 (-288500)	203800 (-277400)	293100 (-395900)	310100 (-384300)
5	292300 (-254500)	305600 (-247200)	379700 (-361300)	398200 (-357000)
6	323400 (-213400)	327500 (-216700)	422400 (-325900)	434500 (-331600)
7	226800 (-192900)	233800 (-195500)	293500 (-301700)	307400 (-310400)
8	262000 (-177700)	273800 (-191600)	316300 (-286600)	334600 (-308000)
9	272600 (-184500)	254100 (-213000)	336700 (-288500)	332200 (-318900)
10	349300 (-176400)	300400 (-170500)	419000 (-282600)	381200 (-270300)
11	293300 (-184400)	348000 (-165100)	360400 (-298300)	416800 (-278800)
12	339300 (-166100)	341700 (-166100)	402800 (-283700)	407700 (-283700)
13	(-157500)	(-157500)	(-277600)	(-277600)

Southerly transport is given first followed by northerly transport given in parentheses

The three methods of computing erosion and accretion described above, and an average value, are given in Tables 5a and 5b for each bathymetric configuration (with- and without-project) and each wave dataset (WIS and OCTI), providing a range of results. Discussion and comparisons will focus on the average conditions as well as the range of responses. Since the overall trends for the three methods are similar, Figures 26 and 27 show only Method 1 erosion and accretion quantities for WIS and OCTI, respectively.

Table 5a. Erosion and accretion potential for Long Beach Island (WIS)

Reach	Erosion/Accretion without project (m^3/yr)	Erosion/Accretion with project (m^3/yr)

	1	2	3	Avg	1	2	3	Avg
1	67800	248200	354200	223400	121300	153900	192300	155800
2	252300	154100	44600	150400	88600	86500	40800	72000
3	55500	27200	38700	40500	40200	14100	36200	30200
4	-52000	-52500	-51100	-51900	-54200	-59200	-63100	-58800
5	-135600	-94900	-132400	-121000	-132400	-90600	-134400	-119100
6	-51500	-3600	700	-18100	-43000	7800	24900	-3400
7	81300	2400	60300	48000	89800	4600	52200	48900
8	-28300	-23800	-22100	-24700	-18600	-4600	-5300	-9500
9	-18800	-44800	-131500	-65000	-22800	-18300	-72000	-37700
10	-68700	-5000	76400	900	-51700	-75300	-36300	-54400
11	37700	-6300	-19900	3900	-46600	-18300	-29900	-31600
12	-54600	-84900	-101700	-80400	-2200	-47900	-52600	-34200

Table 5b. Erosion and accretion potential for Long Beach Island (OCTI)

Reach	Erosion/Accretion without project (m^3/yr)				Erosion/Accretion with project (m^3/yr)			
	1	2	3	Avg	1	2	3	Avg
1	400	185400	297400	161100	181300	239900	285700	235600
2	264600	153800	37900	152100	120800	94300	42400	85800
3	34700	600	7500	14300	19300	-12900	2300	2900
4	-60200	-50000	-43200	-51100	-64000	-53300	-50700	-56000
5	-122100	-92700	-131900	-115600	-113500	-84200	-130600	-109400
6	-66800	9600	8100	-16400	-57600	21500	31800	-1400
7	113700	20800	86400	73600	124700	25900	83100	77900
8	-20900	-23600	-26800	-23800	-16300	-8300	-10100	-11500
9	-26300	-55900	-129500	-70600	-46200	-40300	-101300	-62600
10	-66600	-800	58200	-3000	-40400	-64600	-19700	-41600
11	44000	1800	8000	17900	-30700	-4100	-11600	-15500
12	-48500	-98000	-121100	-89200	3000	-59700	-67200	-41300

The three computation methods and WIS and OCTI data show the same trends of erosion and accretion. Reaches 1 and 2 are highly accretional and Reach 3 is accretional. For the with-project condition, these areas show less accretion (except Reach 1, Method 1-WIS; Reach 1, Methods 1 and 2-OCTI; and Reach 2, Method 3,-OCTI). Since the reaches would remain accretional, this is not considered an adverse impact of the project. Reaches 4 through 6, and 8 through 12 have erosion potential for with- and/or without-project construction. Considering the length of each reach, Reaches 4 and 5 (both corresponding to Harvey Cedars) appear to have the greatest potential for erosion. The project mitigates erosion in Reaches 5 and 6, but slightly increases the erosion potential in Reach 4. Reaches 8 through 10 and 12 show some erosion potential. The with-project condition decreases erosion in Reaches 8, 9 (except Method 1), and 12, but increases erosion potential in Reaches 10 (except Method 1) and 11. It should be noted that the degree of adverse impacts in Reach 4, and Reaches 10 and 11 are different. The with-project condition causes more erosion potential in these reaches, however, considering the amount of increased erosion (volume) and the length of each reach, the impact to Reaches 10 and 11 is 2-3 times greater than the impact to Reach 4. Reach 4 is a highly erosive area and will change slightly with the project in place. Reaches 10 and 11 show large increases in the erosion volumes directly due to the project (Borrow Area E).

Another observation is that the range of results varies from reach to reach. Reaches 1 and 2 have the greatest variability in response, depending on which calculation method is used. The most consistent response is observed in Reaches 3, 4, 5, and 8. Neglecting

Reaches 1 and 2, volumes can be considered to be within ∀30,000 m^3 of the average erosion/accretion volumes. From these statements one can identify Reaches 1, 2, and 7 as accretional and Reaches 4, 5, 8, 9, and 12 as erosional. Reach 3 shows fairly consistent responses from method to method, but the OCTI dataset indicates less accretion than the WIS dataset. Considering the standard deviation of ∀30,000 m^3, this reach could be erosional or accretional. Due to the variability of results in Reaches 6, 10, and 11 and the average standard deviation of ∀30,000 m^3, it is more difficult to classify these regions as erosional or accretional. However, it can be reiterated that a comparison of with- and without-project conditions in these reaches shows a slight gain of material in Reach 6, and a large decrease in volumes (strong negative impact) in Reaches 10 and 11 due to the project (Borrow Area E).

Note that these erosion and accretion values are based on potential transport rates. Actual erosion and accretion may be limited by the presence of coastal structures and/or other engineering activities. It is recommended that historical accretion and erosion analysis (based on an analyses of historical shoreline position data) be done for comparison with these project results, i.e., compare potential erosion/accretion with observed erosion/accretion.

Grid 1 Renourishment Requirements

Areas with potential for erosion for with- and/or without-project conditions were considered areas needing periodic renourishment. Reaches 5, 9, and 12 require 65,000 to 121,000 m^3/yr, however, Reaches 9 and 12 cover longer stretches of shoreline and are therefore less of an erosional problem than Reach 5, as will be shown in the following section (Figures 28 and 29-Method 1 only). Reaches 4, 10, and 11 would require additional placement of material with the project in place. Reaches 5, 6, 8, 9, and 12 would require less material with the project in place. Computation with the OCTI and WIS data show the same trends, however, the OCTI computations predict greater renourishment requirements in Reaches 9, 10, and 12 and smaller renourishment requirements in Reaches 4, 5, 6, and 8 as compared to the WIS computations. It should be reiterated that coastal structures or engineering activities could influence the renourish- ment requirements. It is recommended that analysis of historical shoreline changes be made to assess renourishment requirements.

Grid 1 Shoreline Retreat Rate

The potential for shoreline erosion was computed from the erosion rates as follows. Equation 6-19 from (USACE, 1992) estimates the rate of shoreline change:

$$\frac{\Delta x}{\Delta t} - \frac{1}{(D_b + D_c)}\left[\frac{\Delta Q_l}{\Delta y} \pm q\right] = 0 \qquad (3)$$

where ♠x is the cross-shore displacement of the profile, ♠t is the time period, D_b is the berm crest elevation, D_c is the depth of closure, ♠Q_l is the longshore transport rate, ♠y is the reach length, and q is a line source or sink of sediment along the reach. Basically this means that if we neglect source or sink terms, the entire quantity of material required for renourishment is assumed to cause the beach profile to shift landward uniformly. The quantity of material divided by the length of shoreline and height of the active profile (D_{b+} D_c) leaves the distance of shoreline retreat in a given time period, in this case, one year. As requested by NAP, the active profile height assumed for Long Beach Island was

11.2 m. Each nourishment quantity was divided by the reach length and active profile height to determine the shoreline retreat rate (Tables 6a and 6b; Figures 30 and 31-(Method 1 only)).

Tables 6a and 6b show that the greatest potential for shoreline retreat is in Harvey Cedars (Reaches 4 and 5) where the predictions show a shoreline retreat rate of 4-8 m/yr. This area has historically had beach erosion problems and has had recent nourishment projects to maintain the beaches. The predictions show a shoreline retreat rate of 1-4 m/yr in Ship Bottom (Reach 8), Brant Beach (Reach 9), and Spray Beach (Reach 12). The with-project conditions tend to balance out the erosion in Harvey Cedars so that the southern portion erodes slightly less, and the northern portion erodes slightly more. The with-project conditions decrease the shoreline retreat rate in Reaches 6, 8, 9, and 12. The with-project conditions increase the shoreline retreat rate in Reaches 10 and 11. The largest potential negative impact of the project is in Reach 11, with the shoreline retreat rate increasing by 1 to 1.5 m/yr (0.4 m/yr to 1.4 m/yr (WIS), and accreting 0.8 m/yr to eroding 0.7 m/yr (OCTI)). Note that the presence of functioning coastal structures may prevent these rates from being realized.

Table 6a. Shoreline retreat rate for Long Beach Island (WIS)

Reach	Shoreline Retreat without project (m/yr)				Shoreline Retreat with project (m/yr)			
	1	2	3	Avg	1	2	3	Avg
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	4.2	4.3	4.1	4.2	4.4	4.8	5.1	4.8
5	8.6	6.1	8.4	7.7	8.4	5.8	8.6	7.6
6	1.5	0.1	-	0.5	1.3	-	-	0.4
7	-	-	-	-	-	-	-	-
8	1.6	1.3	1.2	1.4	1.0	0.3	0.3	0.5
9	0.6	1.4	4.2	2.1	0.7	0.6	2.3	1.2
10	2.2	0.2	-	0.8	1.6	2.4	1.2	1.7
11	-	0.3	0.9	0.4	2.1	0.8	1.3	1.4
12	2.6	4.0	4.8	3.8	0.1	2.3	2.5	1.6

Table 6b. Shoreline retreat rate for Long Beach Island (OCTI)

Reach	Shoreline Retreat without project (m/yr)				Shoreline Retreat with project (m/yr)			
	1	2	3	Avg	1	2	3	Avg
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	0.5	-	0.2
4	4.9	4.1	3.5	4.2	5.2	4.3	4.1	4.5
5	7.8	5.9	8.4	7.4	7.2	5.4	8.3	7.0
6	2.0	-	-	0.7	1.7	-	-	0.6
7	-	-	-	-	-	-	-	-
8	1.2	1.3	1.5	1.3	0.9	0.5	0.6	0.6
9	0.8	1.8	4.1	2.2	1.5	1.3	3.2	2.0
10	2.1	-	-	0.7	1.3	2.1	0.6	1.3
11	-	-	-	-	1.4	0.2	0.5	0.7
12	2.3	4.6	5.7	4.2	-	2.8	3.2	2.0

Grid 2 Erosion and Accretion

The net longshore transport potential computed for the Grid 2 Borrow Area A region using the WIS and OCTI datasets are given in Figures 32 and 33, respectively. Shoreline reaches defined by NAP for Grid 2 were modified for used in these computations (Table 7). The original NAP reaches were combined to depict the general trend of transport. Longshore transport values for cells in each reach were summed and an average northerly and southerly longshore transport value was determined for each reach (Table 8). Southerly and northerly longshore transport potential was used to estimate areas of erosion and accretion using the three methods outlined for Grid 1.

Table 7. Grid 2 Shoreline Reaches

Reach	Grid cells	Township
1	110-136	Barnegat Light
2	137-144	Barnegat Light
3	145-168	Barnegat Light/Loveladies
4	169-190	Loveladies

Table 8. Southerly and northerly longshore transport potential for Grid 2

Reach	Southerly and (Northerly) Longshore Transport WIS without project (m^3/yr)	Southerly and (Northerly) Longshore Transport WIS with project (m^3/yr)	Southerly and (Northerly) Longshore Transport OCTI Without project (m^3/yr)	Southerly and (Northerly) Longshore Transport OCTI with project (m^3/yr)
0	413400	314500	491700	403100
1	227000 (-107600)	241000 (-102800)	280900 (-197800)	296500 (-191400)
2	225300 (-202900)	226800 (-202800)	256600 (-308700)	258600 (-308700)
3	219800 (-201100)	220500 (-201100)	266500 (-307300)	267800 (-307300)
4	193300 (-225500)	193600 (-225500)	243600 (-319300)	244200 (-319300)
5	(-174100)	(-174100)	(-273600)	(-273600)

Southerly transport Is given first followed by northerly transport given in parentheses

A boundary reach across Barnegat Inlet (cells 82-109) was used to provide an adjacent cell for Reach 1. It was assumed that the southerly transport rate at the inlet would lose 175,000-225,000 m^3 of sediment to the inlet and/or ebb shoal based on recent inlet dredging records Northerly transport into Reach 4 from the south was provided by averaging cells 191-200. This analysis assumes no losses or gains from cross-shore transport.

The WIS and OCTI data show the same trends of erosion and accretion (Figures 34 and 35-Method 1 only, Table 9a and 9b). Reach 4, corresponding to an 1100–m portion of Loveladies, has erosion potential for with- and without-project conditions. The with-project conditions show less accretion in Reach 1, more accretion in Reach 2, and minimal change to Reaches 3 and 4.

Table 9a. Erosion and accretion potential for Grid 2 (WIS)

Reach	Erosion/Accretion without project (m^3/yr)				Erosion/Accretion with project (m^3/yr)			
	1	2	3	Avg	1	2	3	Avg
1	281600	207300	243200	244000	173500	159100	198500	177000
2	0	23100	80000	34400	12500	27200	80900	40200
3	29800	29300	43500	34300	30600	30200	44300	35100
4	-24900	-44900	-12100	-27300	-24400	-44700	-11900	-27000

Table 9b. Erosion and accretion potential for Grid 2 (OCTI)

Reach	Erosion/Accretion without project (m^3/yr)				Erosion/Accretion with project (m^3/yr)			
	1	2	3	Avg	1	2	3	Avg
1	321700	267700	365700	318400	223900	230200	323700	259200
2	22900	28100	74700	41900	36500	32800	75800	48400
3	2100	9700	26900	12900	2900	10700	27600	13700
4	-22800	-59000	-32800	-38200	-22100	-58500	-32300	-37700

Grid 2 Renourishment Requirements

Areas with potential for erosion were considered areas needing periodic renourishment. Reach 4 requires approximately 25,000-40,000 m^3/yr. (Figures 36 and 37 correspond to Method 1.) Impacts on Reach 4 for with-project conditions are minimal. Computation with the OCTI and WIS data show the same trends.

Grid 2 Shoreline Retreat Rate

The potential for shoreline erosion for Grid 2 was computed from the renourishment quantities as explained previously (Tables 10a and 10b, Figures 38 and 39-Method 1 only).

Tables 10a and 10b show that the only potential for shoreline retreat for Grid 2 is in Loveladies (Reach 4). The predictions show a shoreline retreat rate of approximately 2-3 m/yr. The impact of with-project conditions on the shoreline retreat rate is minimal.

Table 10a. Shoreline retreat rate for Grid 2 (WIS)

Reach	Shoreline Retreat without project (m/yr)				Shoreline Retreat with project (m/yr)			
	1	2	3	Avg	1	2	3	Avg
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	2.0	3.6	1.0	2.2	2.0	3.6	1.0	2.2

Table 10a. Shoreline retreat rate for Grid 2 (OCTI)

Reach	Shoreline Retreat without project (m/yr)				Shoreline Retreat with project (m/yr)			
	1	2	3	Avg	1	2	3	Avg
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	1.9	4.8	2.7	3.1	1.8	4.8	2.6	3.1

5 Conclusions

A numerical model study has provided information to assist NAP in evaluating the impact of potential borrow sites on the Long Beach Island shoreline. Wave transformation and nearshore bathymetry were modeled with the spectral wave model STWAVE. The offshore wave climate was evaluated, and a 20-yr WIS hindcast (1976-95) and a 10-yr OCTI hindcast (1987-96) were used as the incident wave climate for model simulations. Wave climate was estimated for without-project and with-project bathymetric conditions.

Analysis of the WIS and OCTI climatology shows that the hindcast statistics differ somewhat. The WIS data show a better correspondence to the NDBC buoy data, both in directional distribution and frequency distribution. The OCTI statistics show a broader distribution of directions and a higher percentage of short period waves than the WIS and NDBC statistics. However, both the WIS and OCTI hindcasts were used in all analyses for comparison purposes.

An STWAVE grid (Grid 1) was developed to include coastal bathymetry extending from WIS Station AU2070 west to the Long Beach Island shoreline and from north of Barnegat Inlet to Beach Haven and encompassed all four potential borrow areas. Wave transformation between offshore and the Long Beach Island shoreline was modeled with this 100-m resolution grid. A finer grid (Grid 2), with 50 m resolution, was developed for the Borrow Area A Barnegat Inlet area. This grid was needed for investigation of sediment transport potential along beaches to the south of Barnegat Inlet, outside the immediate influence of Borrow Area A. For each grid and bathymteric configuration, STWAVE simulations for 756 incident wave conditions were made. For each simulation, the nearshore wave conditions were saved for use in littoral transport computations. Changes in wave height in the vicinity of the borrow areas induced by the changes in bathymetric configuration were observed.

Net *potential* longshore transport rates for Long Beach Island using the WIS and OCTI wave climatology were computed using an adapted version of the GENESIS shoreline modeling system program NSTRAN. A nodal zone in the vicinity of Barnegat Inlet, where the general shoreline orientation of New Jersey changes was observed. The potential net transport shows a notable change from net northerly transport to net southerly transport in this region. The position of Long Island, NY affects the wave climate which in turn affects transport rates. The sheltering effect created by Long Island, NY limits waves from the north from impinging on northern New Jersey. South of Barnegat Inlet, the sheltering effect is not as apparent and net transport along Long Beach Island, NJ is generally to the south. There is a local reversal (transport to the north) about 6-7 km south of Barnegat Inlet, probably due to the influence of Barnegat Inlet and its ebb shoal complex on the downdrift beaches.

An important point to note is that regardless of the value of the K coefficient in the transport computations, the general trends and reversals in transport mentioned above, are preserved. However, the magnitude of net potential transport computed for this study is strictly controlled by the calibration coefficient K. The selection of this coefficient is therefore critical. It was the intent of this study to compute “reasonable” transport values along Long Beach Island, with the ultimate goal being the comparison of these values for with- and without-project conditions. A reasonable transport value for Long Beach Island is on the order of 75,000 to 150,000 m^3/yr. The K coefficient was calibrated to bring the WIS transport results into this acceptable range.

The average of net potential transport for grid cells 135 through 305 was used to estimate the net potential transport along Long Beach Island. Using OCTI hindcast wave climatology, the net potential transport for Long Beach Island was approximately 76,000 m^3/yr and using the WIS hindcast wave climatology, the net potential transport was approximately 114,000 m^3/yr. By comparing the with- and without-project conditions it is observed that there are changes in the net tranport potential induced by the project. The greatest changes are in the vicinity of Borrow Area A (affecting cells 50-70) and Borrow Area E (affecting cells 230-280).

Computations of erosion and accretion along Long Beach Island (by three methods) show that the WIS and OCTI data produce the same trends of erosion and accretion. Reaches 1 and 2 are highly accretional and Reach 3 is accretional. For the with-project condition, these areas show less accretion. Since the reaches would remain accretional, this is not considered an adverse impact of the project. Reaches 4 through 6, and 8 through 12 have erosion potential for with- and/or without-project construction. Considering the length of each reach, Reaches 4 and 5 (both corresponding to Harvey Cedars) appear to have the greatest potential for erosion. The project mitigates erosion in Reaches 5 and 6, but increases the erosion potential in Reach 4. The with-project condition decreases erosion in Reaches 8, 9, and 12, but increases erosion potential in Reaches 10 and 11. It should be noted that the degree of adverse impacts in Reach 4, and Reaches 10 and 11 are different. The with-project condition causes more erosion potential in these reaches, however, considering the amount of increased erosion (volume) and the length of each reach, the impact to Reaches 10 and 11 is 2-3 times greater than the impact to Reach 4. Reach 4 is a highly erosive area and will change slightly with the project in place. Reaches 10 and 11 show large increases in the erosion volumes directly due to the project (Borrow Area E).

Using three methods and two wave datasets to compute erosion/accretion potential, results in a range of responses. The range of results varies from reach to reach. Reaches 1 and 2 have the greatest variability in response. The most consistent response is observed in Reaches 3, 4, 5, and 8. Neglecting Reaches 1 and 2, volumes can be considered to be within ∀30,000 m^3 of the average erosion/accretion volumes. From these statements one can identify Reaches 1, 2, and 7 as accretional and Reaches 4, 5, 8, 9, and 12 as erosional. Reach 3 shows fairly consistent responses from method to method, but the OCTI dataset indicates less accretion than the WIS dataset. Considering the standard deviation of ∀30,000 m^3, this reach could be erosional or accretional. Due to the variability of results in Reaches 6, 10, and 11 and the average standard deviation of ∀30,000 m^3, it is more difficult to classify these regions as erosional or accretional. However, it can be reiterated that a comparison of with- and without-project conditions in these reaches shows a slight gain of material in Reach 6, and a large decrease in vol-umes (strong negative impact) in Reaches 10 and 11 due to the project (Borrow Area E).

Note that these erosion and accretion values are based on potential transport rates. Actual erosion and accretion may be limited by the presence of functioning coastal structures and/or other engineering activities. It is recommended that historical accretion and erosion analysis (based on an analyses of historical shoreline position data) be done for comparison with these potential transport calculations. To the other extreme, if the project is constructed and the groins are not refurbished, then their functionality is further reduced. Potential transport rates may then be realized.

Areas with potential for erosion for with- and/or without-project conditions were considered areas needing periodic renourish- ment. Reaches 5, 9, and 12 each require 65,000-121,000 m^3/yr, however, Reaches 9 and 12 cover longer stretches of shoreline and are therefore less of an erosional problem than Reach 5. Reaches 4, 10, and 11 would require additional placement of material with the project in place. Reaches 5, 6, 8, 9, and 12 would require less material with the project in place. Computation with the OCTI and WIS data show the same trends, however, the OCTI computations predict greater renourishment requirements in Reaches 9, 10, and 12 and smaller renourishment requirements in Reaches 4, 5, 6, and 8 as compared to the WIS computations. It should be reiterated that coastal structures or engineering activities could influence the renourishment requirements.

The greatest potential for shoreline retreat is in Harvey Cedars (Reaches 4 and 5) where the predictions show a shoreline retreat rate of 4-8 m/yr. This area has historically had beach erosion problems and has had recent nourishment projects to maintain the beaches. The predictions show a shoreline retreat rate of 1-4 m/yr in Ship Bottom (Reach 8), Brant Beach (Reach 9), and Spray Beach (Reach 12). The with-project conditions tend to balance out the erosion in Harvey Cedars so that the southern portion erodes slightly less, and the northern portion erodes slightly more. The with-project conditions decrease the shoreline retreat rate in Reaches 6, 8, 9, and 12. The with-project conditions increase the shoreline retreat rate in Reaches 10 and 11.

The largest potential negative impact of the project is in Reach 11 (Haven Beach to Beach Haven Gardens), where the shoreline retreat rate increases 1-1.5 m/yr. This change is directly related to bathymetric changes in Borrow Area E (removal of the nearshore shoal). Note that the presence of functioning coastal structures may prevent these rates from being realized. Harvey Cedars and Loveladies appear to be particularly susceptible to erosion, with or without the project constructed.

For Grid 2, the WIS and OCTI data show the same trends of erosion and accretion. Reach 4, corresponding to Loveladies, has erosion potential for with- and without-project construction. Areas with potential for erosion were considered areas needing periodic renourishment. Reach 4 requires 25,000-40,000 m^3/yr. Impacts on Reach 4 for with-project conditions would be minimal. Computations with the OCTI and WIS data show the same trends. Results show that the only potential for shoreline retreat for Grid 2 is in Loveladies (Reach 4) at a rate of 2-3 m/yr.

Dredging the offshore borrow areas (B and D) has the least impact on the Long Beach Island shoreline. Removal of material from Borrow Area A reduces accretion rates at the northern end of Long Beach Island, which may or may not be considered troublesome. Removal of the nearshore shoal (Borrow Area E) has a strong negative impact on Reach 11 (Haven Beach to Beach Haven Gardens) and is not recommended.

References

Bouws, E., Gunther, H., Rosenthal, W., and Vincent, C.L. 1985. ASimilarity of the Wind Wave Spectrum in Finite Depth Water: 1. Spectral Form,@ *J. Geophys. Res.*, 90(C1), 975-986.

Brooks, R.M., and Brandon, W.A. 1995. A Hindcast Wave Information for the U.S. Atlantic Coast: Update 1976-1993 with Hurricanes, WIS Report 33, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Corson, W.D., Resio, D.T., Brooks, R.M., Ebersole, B.A., Jensen, R.E., Ragsdale, D.S., and Tracy, B.A. 1982. "Atlantic Coast Hindcast, Phase II Wave Information," WIS Report 6, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Davis, J.E. 1992. ASTWAVE Theory and Program Documentation,@ Chapter 8 in Coastal Modeling System User=s Manual, Instructional Report CERC-91-1, Supplement 1, Ed. M. A. Cialone, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

GDM. 1984. Phase II General Design Memorandum, Barnegat Inlet, Ocean County, New Jersey.

Gravens, M.B., Kraus, N.C., and Hanson, H. 1991. AGENESIS: Generalized Model for Simulating Shoreline Change, Report 2, Workbook and System User=s Manual,@ Technical Report CERC-89-19, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Leenknecht, D.A., and Tanner, W.W. 1997. AGrid Generation and Data Analysis for Wave Transformation Models,@ *Proceedings*, 4th Congress on Computing in Civil Engineering, Philadelphia, PA.

NAP. 1999 (draft report). Barnegat Inlet to Little Egg Inlet Draft Feasability Report.

Resio, D.T. 1987. AShallow-Water Waves. I: Theory,@ *J. Wtrway., Port, Coast., and Oc. Engrg.*, 113(3), 264-281.

Resio, D.T. 1988a. AShallow-Water Waves. II: Data Comparisons,@ *J. Wtrway., Port, Coast., and Oc. Engrg.*, 114(1), 50-65.

Resio, D.T. 1988b. AA Steady-State Wave Model for Coastal Applications,@ *Proc.*, 21st Coast. Engrg. Conf., ASCE, 929-940.

SMS. 1995. ASurface-Water Modeling System,@ Version 5.0, Brigham Young University, Provo, UT.

Smith, J.M., Resio, D.T., and Zundel, A.K. 1999. “STWAVE: Steady-State Spectral Wave Model, Rport 1, User’s Manual for STWAVE Version 2.0,” Instruction Report CHL-99-1, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Thompson, E.F., Hadley, L.L., Brandon, W.A., McGehee, D.D., and Hubertz, J.M. 1996. AWave Response of Kahului Harbor, Maui, Hawaii,@ Technical Report CERC-96-11, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Thompson, E.F., Lin, L., and Jones, D.L. 1999 (draft report). Wave Climate and Littoral Sediment Transport Potential, Cape Fear River Entrance and Smith Isle to Ocean Isle Beach, North Carolina.

USACE, New York. 1954. “Atlantic Coast of New Jersey, Sandy Hook to Barnegat Inlet,” Beach Erosion Control Report on Cooperative Study, New York, NY.

USACE. 1992. ACoastal Littoral Transport,@ Engineer Manual EM 1110-2-1502, US Army Corps of Engineers, Washington, DC.

USACE, Philadelphia. 1995. “New Jersey Shore Protection Study, Barnegat Inlet to Little Egg Inlet Reconnaissance Study,” Philadelphia, PA.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix A
WIS Offshore Wave Climate

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 0.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 3075
% OF TOTAL: 5.4

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1745	.	.	.	.	.	.	.	.	.	1745
0.75-1.24	1261	359	.	.	.	.	.	.	.	.	1620
1.25-1.74	11	1091	.	.	.	.	.	.	.	.	1102
1.75-2.24	.	520	5	.	.	.	.	.	.	.	525
2.25-2.74	.	160	11	.	.	.	.	.	.	.	171
2.75-3.24	.	11	63	.	.	.	.	.	.	.	74
3.25-3.74	.	.	13	.	.	.	.	.	.	.	13
3.75-4.24	.	.	5	.	.	.	.	.	.	.	5
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3017	2141	97	0	0	0	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 4.2 MEAN TP(SEC) = 4.4

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 22.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 1877
% OF TOTAL: 3.3

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1141	77	11	.	.	.	.	.	.	.	1229
0.75-1.24	515	438	.	.	.	.	.	.	.	.	953
1.25-1.74	1	544	.	.	.	.	.	.	.	.	545
1.75-2.24	.	268	8	.	.	.	.	.	.	.	276
2.25-2.74	.	59	59	.	.	.	.	.	.	.	118
2.75-3.24	.	3	58	1	.	.	.	.	.	.	62
3.25-3.74	.	.	11	.	.	.	.	.	.	.	11
3.75-4.24	.	.	6	3	.	.	.	.	.	.	9
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1657	1389	153	4	0	0	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 4.2 MEAN TP(SEC) = 4.6

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 45.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 2222
% OF TOTAL: 3.9

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1078	403	88	.	.	.	.	.	.	.	1569
0.75-1.24	225	605	106	.	.	.	.	.	.	.	936
1.25-1.74	1	515	32	.	.	.	.	.	.	.	548
1.75-2.24	.	229	95	3	.	.	.	.	.	.	327
2.25-2.74	.	32	184	.	.	.	.	.	.	.	216
2.75-3.24	.	.	143	.	.	.	.	.	.	.	143
3.25-3.74	.	.	29	8	.	.	.	.	.	.	37
3.75-4.24	.	.	6	6	.	.	.	.	.	.	12
4.25-4.74	.	.	.	3	.	.	.	.	.	.	3
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1304	1784	683	20	0	0	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 4.5 MEAN TP(SEC) = 5.2

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 67.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 2830
% OF TOTAL: 5.0

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	850	617	533	172	.	.	.	.	.	.	2172
0.75-1.24	159	641	313	51	.	.	.	.	.	.	1164
1.25-1.74	1	354	210	27	.	.	.	.	.	.	592
1.75-2.24	.	155	220	27	.	.	.	.	.	.	402
2.25-2.74	.	13	224	8	.	.	.	.	.	.	245
2.75-3.24	.	.	121	8	.	.	.	.	.	.	129
3.25-3.74	.	.	87	6	.	.	.	.	.	.	93
3.75-4.24	.	.	10	8	.	.	.	.	.	.	18
4.25-4.74	.	.	.	8	.	.	.	.	.	.	8
4.75-5.24	.	.	.	1	.	.	.	.	.	.	1
5.25-5.74	.	.	.	5	.	.	.	.	.	.	5
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1010	1780	1718	321	0	0	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 5.6 MEAN TP(SEC) = 6.1

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 90.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 13044
% OF TOTAL: 22.9

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	836	699	1632	3008	2890	1196	219	59	29	.	10568
0.75-1.24	189	915	1076	1452	1353	626	179	37	6	.	5833
1.25-1.74	1	420	605	811	677	263	82	17	.	.	2876
1.75-2.24	.	121	342	287	318	164	71	13	.	.	1316
2.25-2.74	.	25	210	160	138	118	39	10	.	.	700
2.75-3.24	.	1	109	191	70	54	22	6	.	.	453
3.25-3.74	.	.	41	99	53	20	10	13	.	.	236
3.75-4.24	.	.	3	70	44	15	1	6	.	.	139
4.25-4.74	.	.	1	35	35	8	.	3	.	.	82
4.75-5.24	.	.	.	17	13	17	5	.	.	.	52
5.25-5.74	.	.	.	.	11	15	.	.	.	.	26
5.75-6.24	.	.	.	.	3	1	.	.	.	.	4
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1026	2181	4019	6130	5605	2497	628	164	35	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 6.0 MEAN TP(SEC) = 9.7

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 112.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 12846
% OF TOTAL: 22.5

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	578	643	3641	4260	1943	355	75	18	13	.	11526
0.75-1.24	140	689	954	1692	1042	388	61	13	8	.	4987
1.25-1.74	1	376	429	799	542	361	58	13	5	.	2584
1.75-2.24	.	102	212	254	362	184	56	18	1	.	1189
2.25-2.74	.	17	148	130	213	80	51	10	.	.	649
2.75-3.24	.	1	77	133	85	53	30	1	.	.	380
3.25-3.74	.	.	25	77	59	25	22	1	.	.	209
3.75-4.24	.	.	8	39	73	15	8	.	.	.	143
4.25-4.74	.	.	1	20	51	23	3	3	.	.	101
4.75-5.24	.	.	.	11	27	18	1	.	.	.	57
5.25-5.74	.	.	.	1	17	30	8	6	.	.	62
5.75-6.24	.	.	.	.	11	15	.	1	.	.	27
6.25-6.74	.	.	.	.	3	1	.	.	.	.	4
6.8+	.	.	.	.	.	8	3	.	8	.	19
TOTAL	719	1828	5495	7416	4428	1556	376	84	35	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 8.4 MEAN TP(SEC) = 9.3

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 135.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 10229
% OF TOTAL: 17.9

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	746	947	4075	2715	650	124	17	15	11	.	9300
0.75-1.24	181	718	1228	1360	624	147	41	8	9	.	4316
1.25-1.74	.	284	335	480	342	94	27	13	5	.	1580
1.75-2.24	.	100	254	254	203	88	37	5	5	.	946
2.25-2.74	.	17	104	112	154	82	46	1	5	.	521
2.75-3.24	.	.	59	90	107	54	15	8	3	.	336
3.25-3.74	.	.	23	73	53	32	8	6	3	.	198
3.75-4.24	.	.	5	41	51	23	5	3	3	.	131
4.25-4.74	.	.	.	18	18	6	1	1	3	.	47
4.75-5.24	.	.	.	6	6	11	1	8	1	.	33
5.25-5.74	.	.	.	.	6	13	1	1	5	.	26
5.75-6.24	.	.	.	.	3	3	1	1	1	.	9
6.25-6.74	.	.	.	.	.	5	.	3	1	.	9
6.8+	.	.	.	.	.	1	.	1	.	.	2
TOTAL	927	2066	6083	5149	2217	683	200	74	55	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 7.5 MEAN TP(SEC) = 8.6

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 157.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 8150
% OF TOTAL: 14.3

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1257	1729	2881	1285	337	10	.	.	3	.	7502
0.75-1.24	260	1019	1095	1139	366	34	1	5	.	.	3919
1.25-1.74	.	415	362	412	186	30	5	.	.	.	1410
1.75-2.24	.	145	186	111	131	15	.	.	.	.	588
2.25-2.74	.	25	167	47	32	10	1	.	.	.	282
2.75-3.24	.	.	51	29	10	5	.	.	.	.	95
3.25-3.74	.	.	25	37	8	3	.	.	.	.	73
3.75-4.24	.	.	.	23	8	3	.	.	.	.	34
4.25-4.74	.	.	.	6	1	1	.	.	.	.	8
4.75-5.24	.	.	.	3	1	1	.	.	.	.	5
5.25-5.74	.	.	.	.	5	.	.	.	.	.	5
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1517	3333	4767	3092	1085	112	7	5	3	0	

MEAN Hmo(M) = 0.9 LARGEST Hmo(M) = 5.6 MEAN TP(SEC) = 7.4

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 180.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 8361
% OF TOTAL: 14.6

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2419	3531	2193	588	35	.	.	.	.	.	8766
0.75-1.24	530	1644	638	152	10	.	.	.	.	.	2974
1.25-1.74	1	985	263	56	8	.	.	.	.	.	1313
1.75-2.24	.	302	359	17	1	.	.	.	.	.	679
2.25-2.74	.	47	278	20	.	.	.	.	.	.	345
2.75-3.24	.	.	95	27	.	.	.	.	.	.	122
3.25-3.74	.	.	23	29	.	.	.	.	.	.	52
3.75-4.24	.	.	1	13	3	.	.	.	.	.	17
4.25-4.74	.	.	.	11	5	.	.	.	.	.	16
4.75-5.24	.	.	.	3	1	.	.	.	.	.	4
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	2950	6509	3850	916	63	0	0	0	0	0	

MEAN Hmo(M) = 0.8 LARGEST Hmo(M) = 4.9 MEAN TP(SEC) = 5.9

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 202.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 5023
% OF TOTAL: 8.8

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
	PEAK PERIOD (IN SECONDS)										
0.00-0.74	2164	1160	318	.	.	.	.	.	.	.	3642
0.75-1.24	1125	1303	222	6	.	.	.	.	.	.	2656
1.25-1.74	46	876	357	.	.	.	.	.	.	.	1279
1.75-2.24	.	167	607	5	.	.	.	.	.	.	779
2.25-2.74	.	18	131	10	.	.	.	.	.	.	159
2.75-3.24	.	.	32	17	.	.	.	.	.	.	49
3.25-3.74	.	.	1	15	.	.	.	.	.	.	16
3.75-4.24	.	.	.	5	.	.	.	.	.	.	5
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3335	3524	1668	58	0	0	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 4.1 MEAN TP(SEC) = 5.2

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 225.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 2942
% OF TOTAL: 5.2

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
	PEAK PERIOD (IN SECONDS)										
0.00-0.74	2311	248	5	.	.	.	.	.	.	.	2564
0.75-1.24	1656	260	51	.	.	.	.	.	.	.	1967
1.25-1.74	92	232	61	.	.	.	.	.	.	.	385
1.75-2.24	.	58	44	.	.	.	.	.	.	.	102
2.25-2.74	.	1	6	1	.	.	.	.	.	.	8
2.75-3.24	.	.	.	1	.	.	.	.	.	.	1
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4059	799	167	2	0	0	0	0	0	0	

MEAN Hmo(M) = 0.8 LARGEST Hmo(M) = 2.8 MEAN TP(SEC) = 4.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 247.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 2082
% OF TOTAL: 3.6

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
	PEAK PERIOD (IN SECONDS)										
0.00-0.74	2368	13	1	.	.	.	.	.	.	.	2382
0.75-1.24	954	35	.	.	.	.	.	.	.	.	989
1.25-1.74	66	68	.	.	.	.	.	.	.	.	134
1.75-2.24	.	42	6	.	.	.	.	.	.	.	48
2.25-2.74	.	.	3	.	.	.	.	.	.	.	3
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3388	158	10	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 2.4 MEAN TP(SEC) = 3.5

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 270.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 2927

% OF TOTAL: 5.1

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	3458	11	.	.	.	.	.	.	.	.	3469
0.75-1.24	1079	22	.	.	.	.	.	.	.	.	1101
1.25-1.74	244	121	.	.	.	.	.	.	.	.	365
1.75-2.24	.	53	5	.	.	.	.	.	.	.	58
2.25-2.74	.	6	3	.	.	.	.	.	.	.	9
2.75-3.24	.	1	.	.	.	.	.	.	.	.	1
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4781	214	8	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 3.0 MEAN TP(SEC) = 3.4

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 292.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 3582
% OF TOTAL: 6.3

PEAK PERIOD (IN SECONDS)

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2917	5	.	.	.	.	.	.	.	.	2922
0.75-1.24	2008	73	.	.	.	.	.	.	.	.	2081
1.25-1.74	225	539	.	.	.	.	.	.	.	.	764
1.75-2.24	.	318	.	.	.	.	.	.	.	.	318
2.25-2.74	.	22	.	.	.	.	.	.	.	.	22
2.75-3.24	.	18	.	.	.	.	.	.	.	.	18
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	5150	975	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.9 LARGEST Hmo(M) = 3.1 MEAN TP(SEC) = 3.8

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 315.0 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 4141
% OF TOTAL: 7.3

PEAK PERIOD (IN SECONDS)

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2330	1	.	.	.	.	.	.	.	.	2331
0.75-1.24	2631	171	.	.	.	.	.	.	.	.	2802
1.25-1.74	23	1096	.	.	.	.	.	.	.	.	1119
1.75-2.24	.	691	.	.	.	.	.	.	.	.	691
2.25-2.74	.	114	5	.	.	.	.	.	.	.	119
2.75-3.24	.	11	5	.	.	.	.	.	.	.	16
3.25-3.74	.	.	1	.	.	.	.	.	.	.	1
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4984	2084	11	0	0	0	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 3.6 MEAN TP(SEC) = 4.1

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 337.5 DEGREES AZIMUTH

STATION: A2070 (39.8N, 74.0W / 18.0M) NO. CASES: 3830
% OF TOTAL: 6.7

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
	PEAK PERIOD (IN SECONDS)										
0.00-0.74	2280	.	.	.	.	.	.	.	.	.	2280
0.75-1.24	2202	159	.	.	.	.	.	.	.	.	2361
1.25-1.74	42	1146	.	1	.	.	.	.	.	.	1189
1.75-2.24	.	475	.	.	.	.	.	.	.	.	475
2.25-2.74	.	205	3	.	.	.	.	.	.	.	208
2.75-3.24	.	8	17	.	.	.	.	.	.	.	25
3.25-3.74	.	.	10	.	.	.	.	.	.	.	10
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4524	1993	30	1	0	0	0	0	0	0	

MEAN Hmo(M) = 1.0   LARGEST Hmo(M) = 3.7   MEAN TP(SEC) = 4.2

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
FOR ALL DIRECTIONS

STATION: A2070 (39.8N, 74.0W / 18.0M)   NO. CASES: 57079
% OF TOTAL: 152.7

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
	PEAK PERIOD (IN SECONDS)										
0.00-0.74	28485	10092	15385	12031	5857	1687	311	94	57	.	73999
0.75-1.24	15123	9058	5686	5855	3396	1196	284	65	24	.	40687
1.25-1.74	764	9069	2659	2588	1757	749	172	44	10	.	17812
1.75-2.24	.	3754	2349	961	1018	453	165	37	6	.	8743
2.25-2.74	.	770	1545	492	539	290	138	22	5	.	3801
2.75-3.24	.	59	835	501	273	167	68	17	3	.	1923
3.25-3.74	.	.	296	347	174	82	41	22	3	.	965
3.75-4.24	.	.	47	212	181	58	15	10	3	.	526
4.25-4.74	.	.	3	106	112	41	5	8	3	.	278
4.75-5.24	.	.	.	44	51	49	8	8	1	.	161
5.25-5.74	.	.	.	6	41	59	10	8	5	.	129
5.75-6.24	.	.	.	.	18	20	1	3	1	.	43
6.25-6.74	.	.	.	.	3	6	.	3	1	.	13
6.8+	.	.	.	.	.	10	3	1	8	.	22
TOTAL	44372	32802	28805	23143	13420	4867	1221	342	130	0	

MEAN Hmo(M) = 0.9   LARGEST Hmo(M) = 8.4   MEAN TP(SEC) = 6.4

Appendix B
OCTI Offshore Wave Climate

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 0.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 538
% OF TOTAL: 1.9

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1375	.	.	.	.	.	.	.	.	.	1375
0.75-1.24	479	.	.	.	.	.	.	.	.	.	479
1.25-1.74	.	.	.	.	.	.	.	.	.	.	0
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1854	0	0	0	0	0	0	0	0	0	

(PEAK PERIOD (IN SECONDS))

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 1.2 MEAN TP(SEC) = 3.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 22.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1385
% OF TOTAL: 4.8

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2750	699	.	.	.	.	.	.	.	.	3449
0.75-1.24	358	837	.	.	.	.	.	.	.	.	1195
1.25-1.74	10	93	.	.	.	.	.	.	.	.	103
1.75-2.24	.	24	.	.	.	.	.	.	.	.	24
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3118	1653	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.6 LARGEST Hmo(M) = 2.0 MEAN TP(SEC) = 4.1

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 45.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1414
% OF TOTAL: 4.9

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	1130	282	13	.	.	.	.	.	.	.	1425
0.75-1.24	861	1357	.	.	.	.	.	.	.	.	2218
1.25-1.74	6	875	6	.	.	.	.	.	.	.	887
1.75-2.24	.	258	17	.	.	.	.	.	.	.	275
2.25-2.74	.	3	58	.	.	.	.	.	.	.	61
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1997	2775	94	0	0	0	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 2.5 MEAN TP(SEC) = 4.6

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 67.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 2832
% OF TOTAL: 9.8

PEAK PERIOD (IN SECONDS)

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	637	448	485	837	1420	213	.	.	.	.	4040
0.75-1.24	665	913	210	355	696	158	.	.	.	.	2997
1.25-1.74	3	1185	144	117	320	48	.	.	.	.	1817
1.75-2.24	.	220	127	65	144	72	.	.	.	.	628
2.25-2.74	.	6	48	58	44	24	.	.	.	.	180
2.75-3.24	.	.	3	6	10	17	.	.	.	.	36
3.25-3.74	.	.	.	.	6	6	.	.	.	.	12
3.75-4.24	.	.	.	.	.	6	.	.	.	.	6
4.25-4.74	.	.	.	.	.	10	.	.	.	.	10
4.75-5.24	.	.	.	.	.	13	.	.	.	.	13
5.25-5.74	.	.	.	.	.	3	.	.	.	.	3
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1305	2772	1017	1438	2640	570	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 5.3 MEAN TP(SEC) = 7.9

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 90.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 2859
% OF TOTAL: 9.9

PEAK PERIOD (IN SECONDS)

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	696	230	417	568	792	193	.	.	.	.	2896
0.75-1.24	678	1089	541	506	668	124	.	.	.	.	3606
1.25-1.74	.	1061	244	399	279	110	.	.	.	.	2093
1.75-2.24	.	175	158	155	224	62	.	.	.	.	774
2.25-2.74	.	.	68	62	151	.	.	.	.	.	281
2.75-3.24	.	.	3	89	27	6	.	.	.	.	125
3.25-3.74	.	.	.	20	6	10	.	.	.	.	36
3.75-4.24	.	.	.	.	10	.	.	.	.	.	10
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	10	.	.	.	.	10
5.75-6.24	.	.	.	.	.	6	.	.	.	.	6
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1374	2555	1431	1799	2157	521	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 5.9 MEAN TP(SEC) = 7.7

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 112.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1921
% OF TOTAL: 6.6

PEAK PERIOD (IN SECONDS)

HEIGHT IN METERS	0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	479	230	351	623	630	199	.	.	.	.	2512
0.75-1.24	596	885	251	282	286	103	.	.	.	.	2403
1.25-1.74	.	672	86	179	124	20	.	.	.	.	1081
1.75-2.24	.	79	72	86	93	.	.	.	.	.	330
2.25-2.74	.	.	79	41	58	.	.	.	.	.	178
2.75-3.24	.	.	6	13	24	.	.	.	.	.	43
3.25-3.74	.	.	.	6	17	.	.	.	.	.	23
3.75-4.24	.	.	.	.	10	.	.	.	.	.	10
4.25-4.74	.	.	.	.	10	.	.	.	.	.	10

4.75-5.24	.	.	.	.	6	.	.	.	.	.	6
5.25-5.74	.	.	.	.	10	.	.	.	.	.	10
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1075	1866	845	1230	1268	322	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 5.7 MEAN TP(SEC) = 7.5

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 135.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1831

% OF TOTAL: 6.3

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	606	361	244	272	592	182	.	.	.	.	2257
0.75-1.24	692	865	193	227	313	44	.	.	.	.	2334
1.25-1.74	.	803	79	103	96	.	.	.	.	.	1081
1.75-2.24	.	151	41	48	68	.	.	.	.	.	308
2.25-2.74	.	.	75	44	65	.	.	.	.	.	184
2.75-3.24	.	.	10	51	27	.	.	.	.	.	88
3.25-3.74	.	.	.	3	3	3	.	.	.	.	9
3.75-4.24	.	.	.	3	6	10	.	.	.	.	19
4.25-4.74	.	.	.	.	6	6	.	.	.	.	12
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1298	2180	642	751	1176	245	0	0	0	0	

MEAN Hmo(M) = 1.0 LARGEST Hmo(M) = 4.5 MEAN TP(SEC) = 7.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 157.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1955

% OF TOTAL: 6.7

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	658	461	206	613	382	10	.	.	.	.	2330
0.75-1.24	944	927	113	306	220	10	.	.	.	.	2520
1.25-1.74	.	1051	55	62	51	3	.	.	.	.	1222
1.75-2.24	.	151	86	37	31	3	.	.	.	.	308
2.25-2.74	.	10	75	44	37	3	.	.	.	.	169
2.75-3.24	.	.	10	75	10	.	.	.	.	.	95
3.25-3.74	.	.	.	27	27	3	.	.	.	.	57
3.75-4.24	.	.	.	.	13	3	.	.	.	.	16
4.25-4.74	.	.	.	.	3	.	.	.	.	.	3
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1602	2600	545	1164	774	35	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 4.6 MEAN TP(SEC) = 6.4

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 180.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 3920

% OF TOTAL: 13.5

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2071	1258	79	.	.	.	.	.	.	.	3408
0.75-1.24	2181	3481	279	55	.	.	.	.	.	.	5996
1.25-1.74	.	3129	124	75	3	.	.	.	.	.	3331
1.75-2.24	.	365	151	62	.	.	.	.	.	.	578
2.25-2.74	.	3	72	75	3	.	.	.	.	.	153

2.75-3.24	.	.	6	20	.	.	.	.	.	.	26
3.25-3.74	.	.	.	3	6	.	.	.	.	.	9
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4252	8236	711	290	12	0	0	0	0	0	

MEAN Hmo(M) = 1.1 LARGEST Hmo(M) = 3.6 MEAN TP(SEC) = 4.9

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 202.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 4278

% OF TOTAL: 14.7

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	2908	3763	93	.	.	.	.	.	.	.	6764
0.75-1.24	2216	2295	158	.	.	.	.	.	.	.	4669
1.25-1.74	.	2964	.	.	.	.	.	.	.	.	2964
1.75-2.24	.	320	10	.	.	.	.	.	.	.	330
2.25-2.74	.	.	13	.	.	.	.	.	.	.	13
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	5124	9342	274	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.9 LARGEST Hmo(M) = 2.4 MEAN TP(SEC) = 4.7

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 225.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1809

% OF TOTAL: 6.2

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	3587	34	.	.	.	.	.	.	.	.	3621
0.75-1.24	1513	665	.	.	.	.	.	.	.	.	2178
1.25-1.74	6	417	.	.	.	.	.	.	.	.	423
1.75-2.24	.	10	.	.	.	.	.	.	.	.	10
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	5106	1126	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.7 LARGEST Hmo(M) = 2.1 MEAN TP(SEC) = 3.7

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 247.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 303

% OF TOTAL: 1.0

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	965	3	.	.	.	.	.	.	.	.	968

0.75-1.24	75	.	.	.	.	.	.	.	.	.	75
1.25-1.74	.	.	.	.	.	.	.	.	.	.	0
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	1040	3	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.5 LARGEST Hmo(M) = 1.1 MEAN TP(SEC) = 2.9

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 270.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 247

% OF TOTAL: 0.9

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	851	.	.	.	.	.	.	.	.	.	851
0.75-1.24	.	.	.	.	.	.	.	.	.	.	0
1.25-1.74	.	.	.	.	.	.	.	.	.	.	0
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	851	0	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.3 LARGEST Hmo(M) = 0.7 MEAN TP(SEC) = 2.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 292.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1231

% OF TOTAL: 4.2

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	4146	.	.	.	3	.	.	.	.	.	4149
0.75-1.24	93	.	.	.	.	.	.	.	.	.	93
1.25-1.74	.	.	.	.	.	.	.	.	.	.	0
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4239	0	0	0	3	0	0	0	0	0	

MEAN Hmo(M) = 0.5 LARGEST Hmo(M) = 1.0 MEAN TP(SEC) = 2.9

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION

22.5 DEGREES ABOUT 315.0 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1391

% OF TOTAL: 4.8

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	4663	.	.	.	.	.	.	.	.	.	4663
0.75-1.24	130	.	.	.	.	.	.	.	.	.	130
1.25-1.74	.	.	.	.	.	.	.	.	.	.	0
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	4793	0	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.5 LARGEST Hmo(M) = 1.0 MEAN TP(SEC) = 3.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD BY DIRECTION
22.5 DEGREES ABOUT 337.5 DEGREES AZIMUTH

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 1100
% OF TOTAL: 3.8

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	3501	.	.	.	.	.	.	.	.	.	3501
0.75-1.24	279	.	.	.	.	.	.	.	.	.	279
1.25-1.74	10	.	.	.	.	.	.	.	.	.	10
1.75-2.24	.	.	.	.	.	.	.	.	.	.	0
2.25-2.74	.	.	.	.	.	.	.	.	.	.	0
2.75-3.24	.	.	.	.	.	.	.	.	.	.	0
3.25-3.74	.	.	.	.	.	.	.	.	.	.	0
3.75-4.24	.	.	.	.	.	.	.	.	.	.	0
4.25-4.74	.	.	.	.	.	.	.	.	.	.	0
4.75-5.24	.	.	.	.	.	.	.	.	.	.	0
5.25-5.74	.	.	.	.	.	.	.	.	.	.	0
5.75-6.24	.	.	.	.	.	.	.	.	.	.	0
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	3790	0	0	0	0	0	0	0	0	0	

MEAN Hmo(M) = 0.6 LARGEST Hmo(M) = 1.7 MEAN TP(SEC) = 3.0

PERCENT OCCURRENCE (X1000) OF HEIGHT AND PERIOD
FOR ALL DIRECTIONS

STATION: OCTI2 (0.0N, 0.0W / 0.0M) NO. CASES: 29014
% OF TOTAL: 100.0

HEIGHT IN METERS	PEAK PERIOD (IN SECONDS) 0.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-LONGER	TOTAL
0.00-0.74	31029	7775	1892	2915	3822	799	.	.	.	.	48232
0.75-1.24	11766	13317	1747	1733	2185	441	.	.	.	.	31189
1.25-1.74	37	12252	741	937	875	182	.	.	.	.	15024
1.75-2.24	.	1757	665	454	561	137	.	.	.	.	3574
2.25-2.74	.	24	492	327	361	27	.	.	.	.	1231
2.75-3.24	.	.	41	258	99	24	.	.	.	.	422
3.25-3.74	.	.	.	62	68	24	.	.	.	.	154
3.75-4.24	.	.	.	3	41	20	.	.	.	.	64
4.25-4.74	.	.	.	.	20	17	.	.	.	.	37
4.75-5.24	.	.	.	.	6	13	.	.	.	.	19
5.25-5.74	.	.	.	.	10	13	.	.	.	.	23
5.75-6.24	.	.	.	.	.	6	.	.	.	.	6
6.25-6.74	.	.	.	.	.	.	.	.	.	.	0
6.8+	.	.	.	.	.	.	.	.	.	.	0
TOTAL	42832	35125	5578	6689	8048	1703	0	0	0	0	

MEAN Hmo(M) = 0.9 LARGEST Hmo(M) = 5.9 MEAN TP(SEC) = 5.4

Appendix C
Wave Model Description

The WES spectral wind-wave growth and propagation model STWAVE (St͟eady-state spectral W͟A͟V͟E͟) (Resio 1987, 1988a, 1988b, Davis 1992), modified for wave-current interaction, was chosen for wave transformation modeling in the vicinity of Long Beach Island. STWAVE, which numerically solves the steady-state spectral energy-balance equation, was modified to solve the steady-state conservation of wave

$$\frac{\partial}{\partial x}\left(C_{ga_x}\frac{E(f,q\,)}{w_r}\right)+\frac{\partial}{\partial y}\left(C_{ga_y}\frac{E(f,q\,)}{w_r}\right)=\Sigma\frac{S}{w_r}$$

action:
where

E = spectral energy density
f = frequency of spectral component
? = propagation direction of spectral component
C_{ga} = absolute group velocity of spectral component
x,y = spatial coordinates
S = energy source/sink terms
$?_r$ = relative angular frequency (frequency relative to the current)

The source terms include wind input, nonlinear wave-wave interactions, dissipation within the wave field, and depth- and steepness-limited breaking. The terms on the left-hand side of Equation 1 represent wave propagation (refraction and shoaling) and the source terms on the right-hand side of the equation represent energy growth or decay in the spectrum. The assumptions made in STWAVE are:

a. Mild bottom slopes.
b. Negligible wave reflection.
c. Spatially homogeneous offshore waves.
d. Steady waves and winds.
e. Linear refraction and shoaling.
f. Linear wave-current interaction.
g. Nonlinear wave-wave interaction.

STWAVE includes two breaking mechanisms: depth limited and steepness limited. The depth criterion limits the wave height-to-water depth ratio to 0.64. The steepness limit is expressed as

$$H_{mo_{\max}} = 0.1\, L \tanh kd$$

where L is wavelength, k is wave number, and d is water depth (corrected for tide/surge).

STWAVE is a half-plane model, meaning that waves propagate only in directions headed from the seaward boundary into the grid interior. Typically waves propagate and/or winds blow toward a coast near the grid boundary opposite the seaward boundary. Waves reflected from the coast or waves generated by winds blowing offshore are neglected. Incident waves with dominant direction of more than about 60 deg from perpendicular to the seaward boundary are not accurately modeled because a significant fraction of the directionally spread energy is directed seaward and truncated by the model. For applications such as Long Beach Island, where a wide range of wave directions is important, more than one STWAVE grid must be developed.

STWAVE is a finite-difference model which calculates wave spectra on a rectangular grid with square grid cells using a backward ray-tracing scheme. The inputs needed to execute STWAVE are:

a. Bathymetry and shoreline position.
b. Size and resolution of the grid.
c. 2D wave spectrum on the offshore grid boundary (optional).
d. Wind speed and direction (optional).
e. Current field (optional).
f. Water level.

The model outputs zero-moment wave height (H_{mo}), peak spectral period (T_p), and mean wave direction ($?_m$) at all grid points, and the 2D spectrum at selected grid points.

Directional wave spectra for model input are typically obtained from validated theoretical spectral forms or field measurements. If incident wave parameters significant height, peak period, and peak direction are specified, ACES 2.0 software (Leenknecht and Tanner 1997) can be helpful for creating the 2D spectrum needed for STWAVE. The ACES 2.0 software generates a directional spectrum for given wave parameters and water depth, based on the TMA frequency spectrum (Bouws et al. 1985) with $\cos^n q_m$ form of directional spreading. Two parameters are specified regarding spectral shape: a spectral peak enhancement factor, ?, and the directional spreading parameter, n. Spectral shape parameters in this study were determined based on peak spectral period to give an approach equivalent to that described by Thompson et al. (1996) (Table C1). The ACES software requires that n be an even number.

Table C1
Spectral Shape Parameters Used in ACES 2.0

***T_p* (sec)**	*?*	***n***
4-10	3.3	4
12	4	10
14	5	16
16	6	20
18	7	26
20	8	30

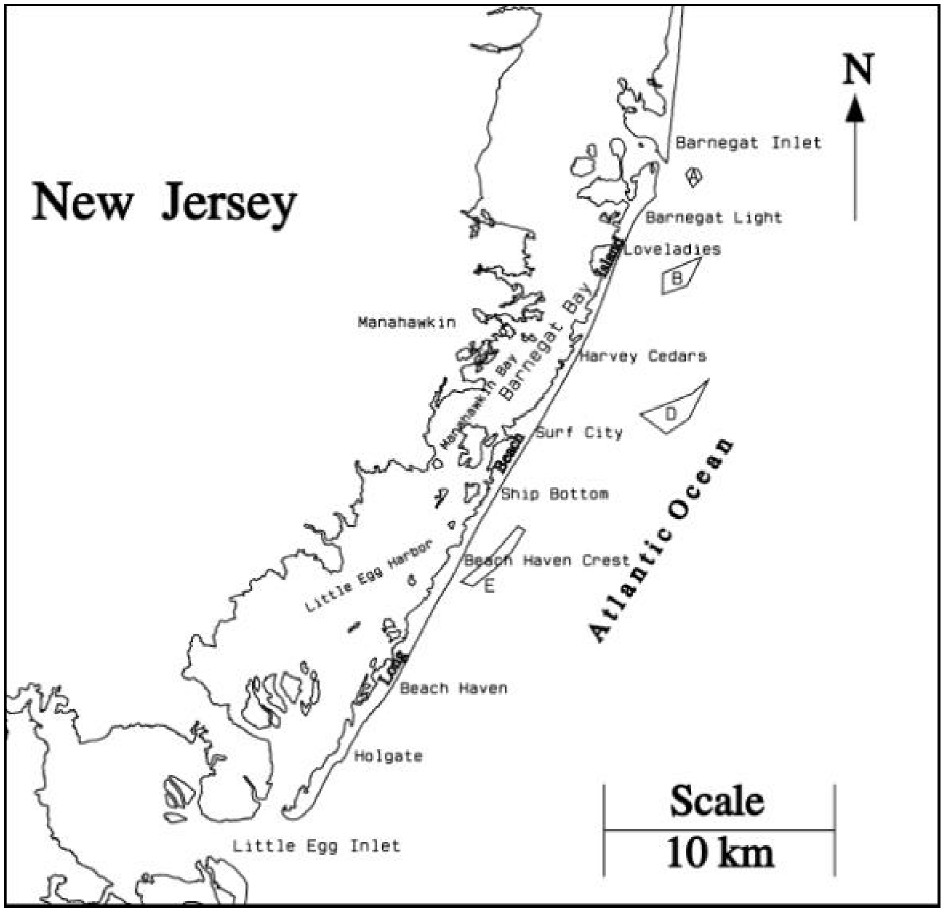


Figure 1. Study area location map

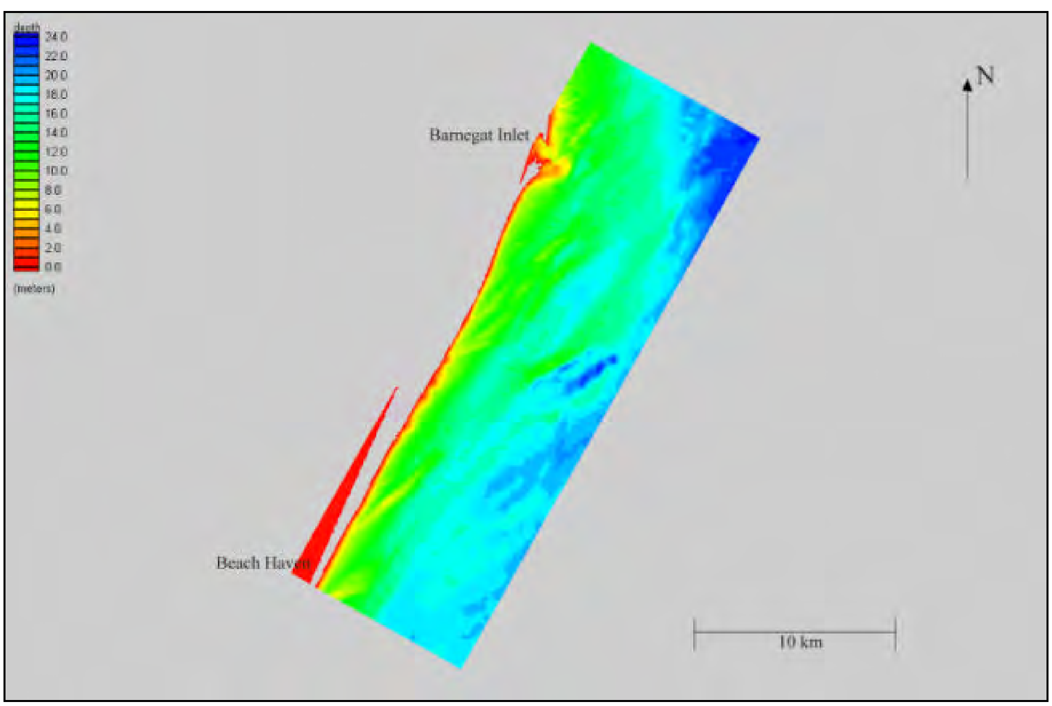


Figure 2. Regional bathymetry

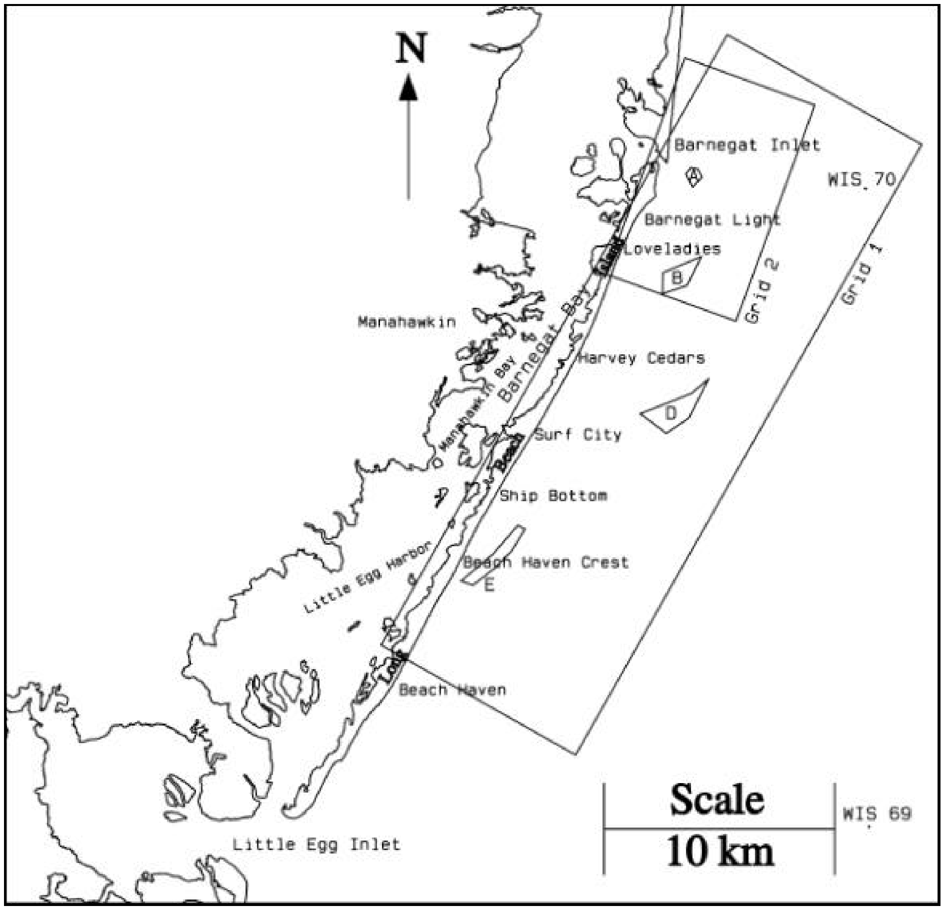


Figure 3. WIS stations and grid limits

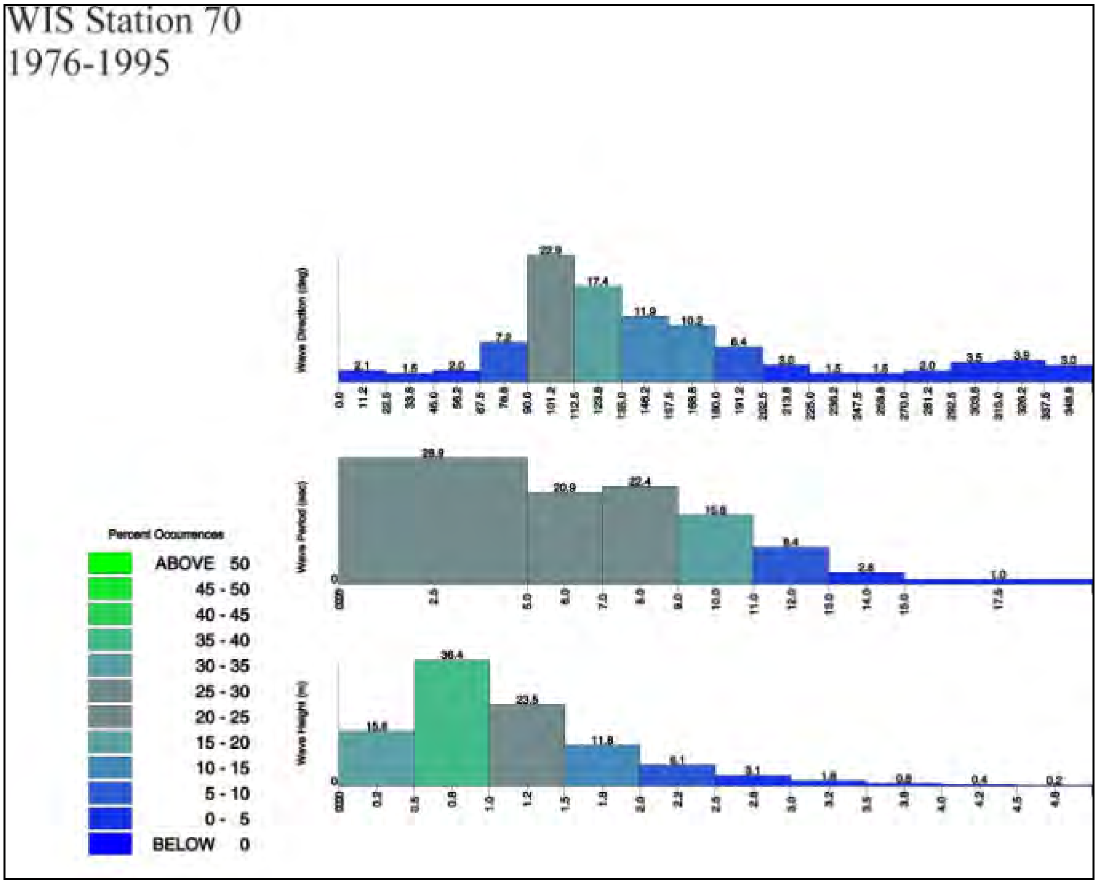


Figure 4. Wave statistics for WIS Station AU2070

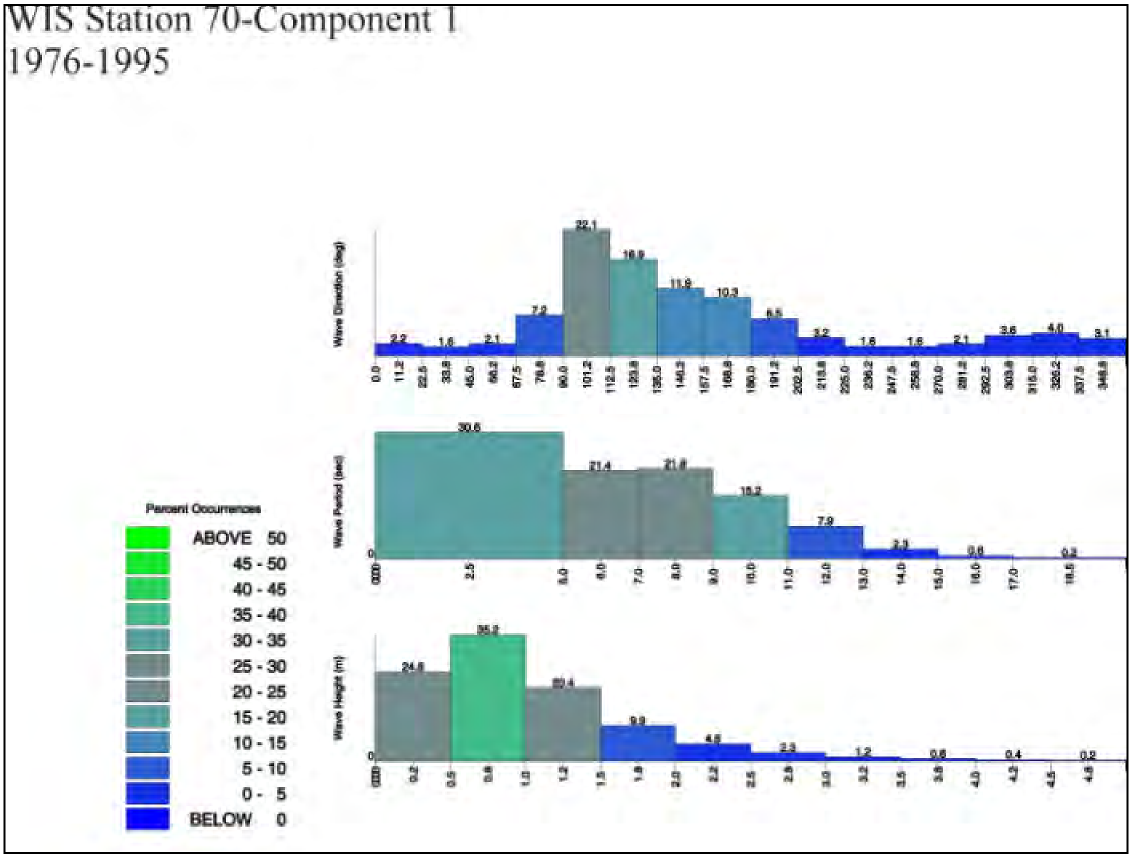


Figure 5. Wave statistics for WIS Station AU2070-component 1

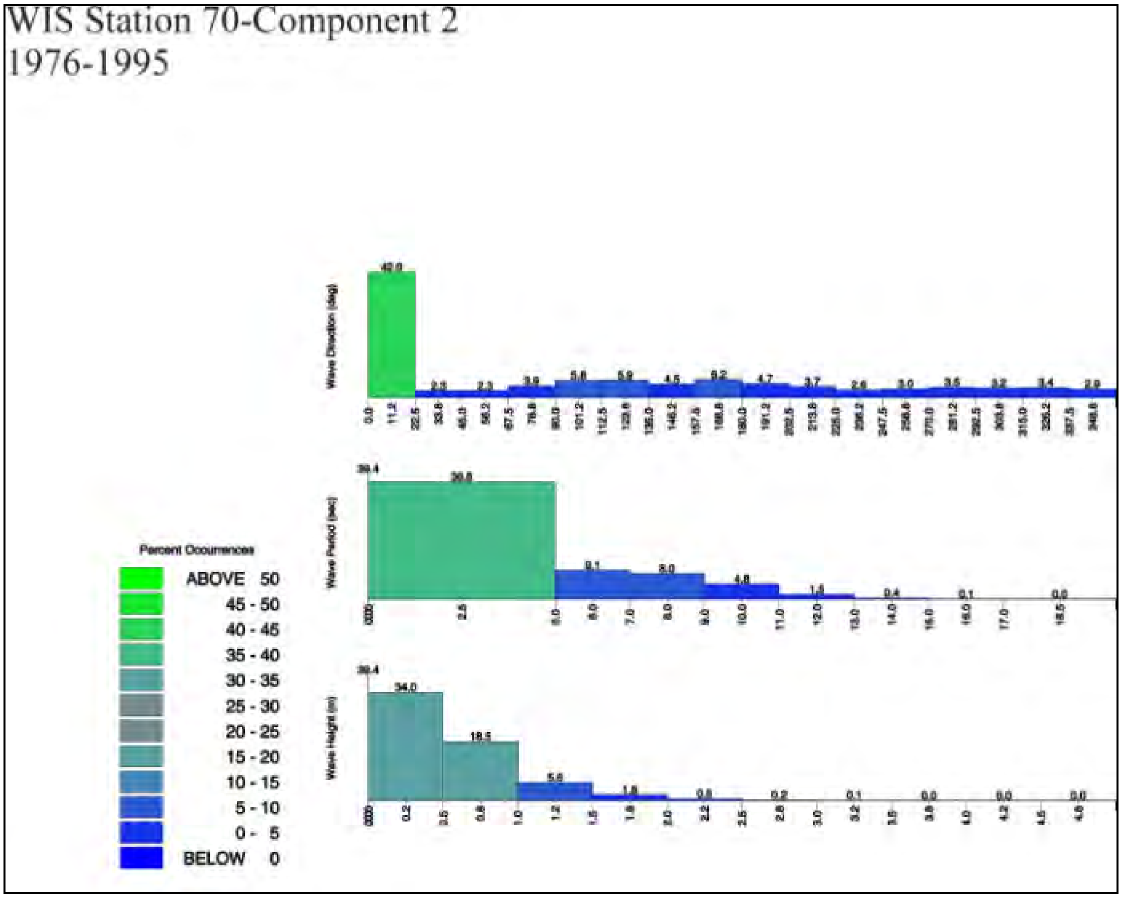


Figure 6. Wave statistics for WIS Station AU2070-component 2

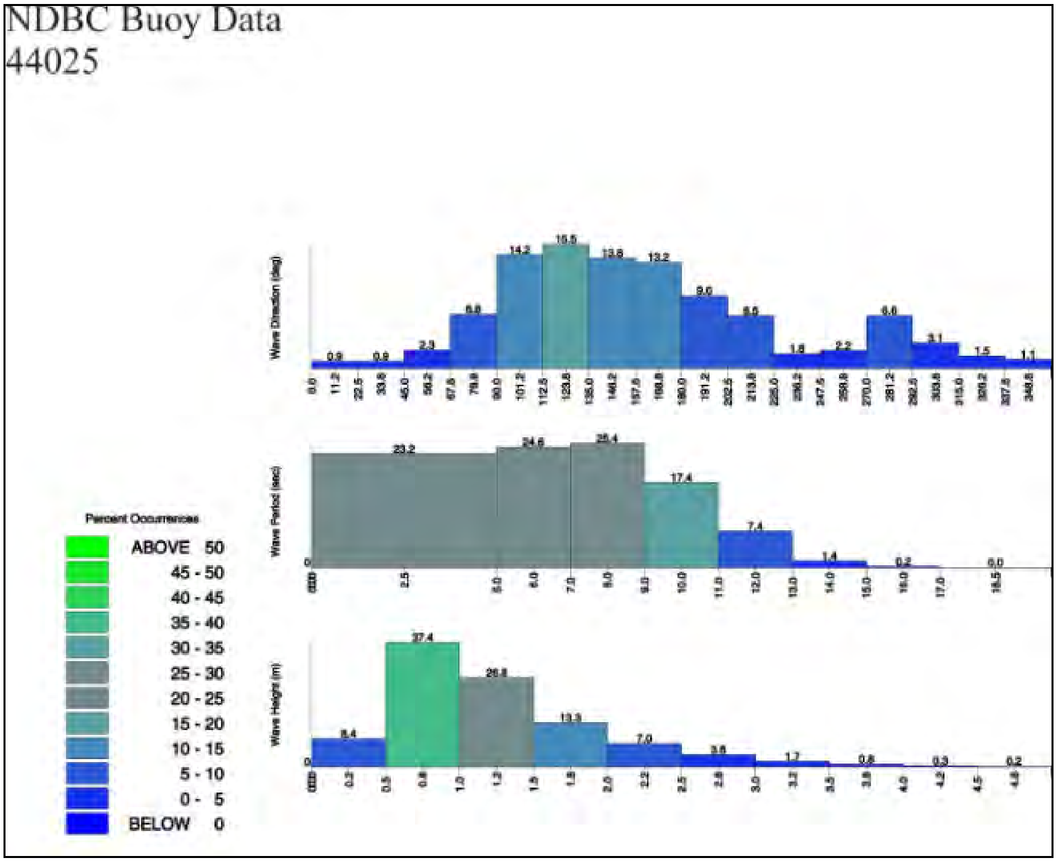


Figure 7. Wave statistics for NDBC Buoy 44025

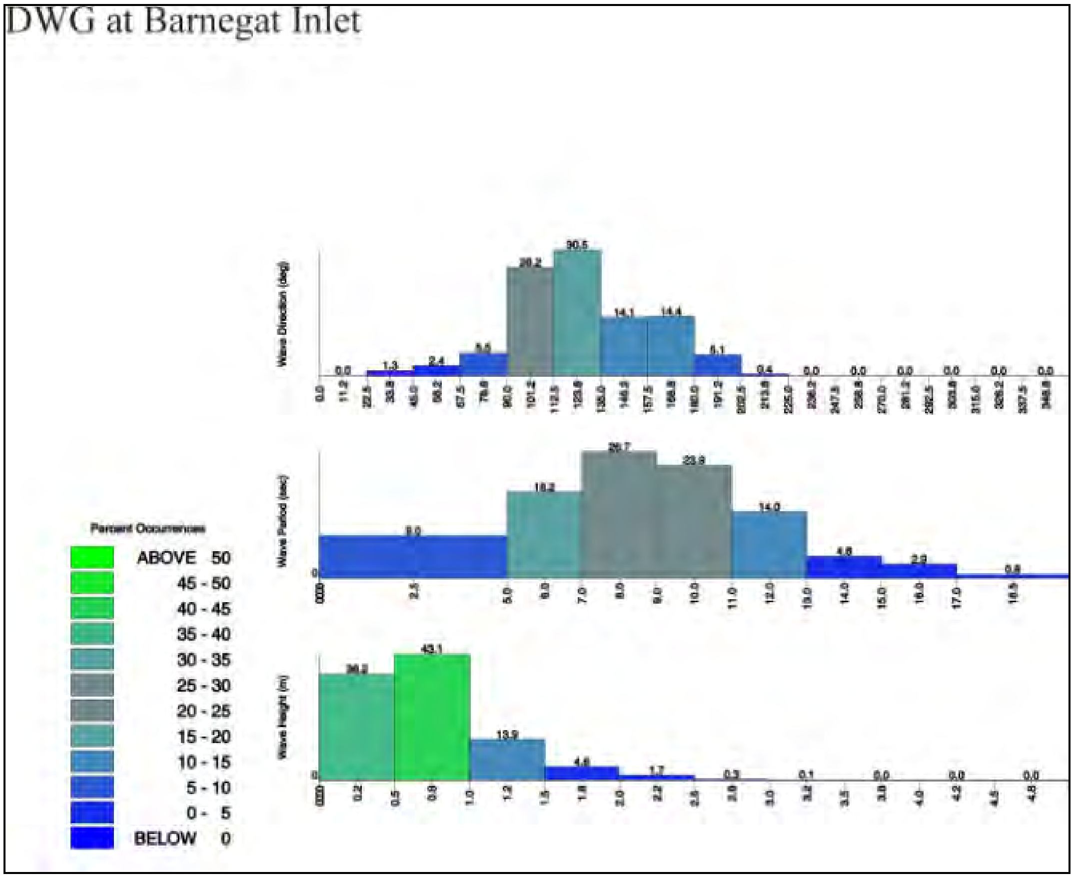


Figure 8. Wave statistics for DWG at Barnegat Inlet

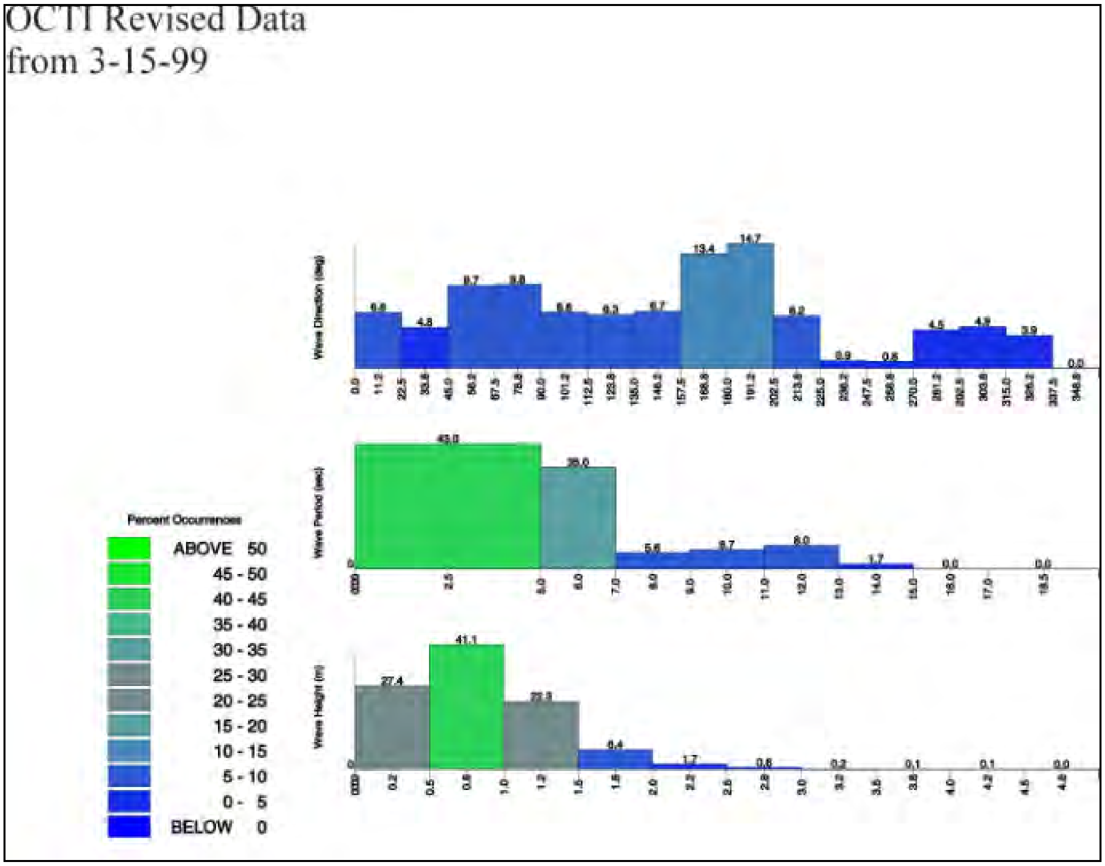


Figure 9. Wave statistics for OCTI Station (i=35 j=30)

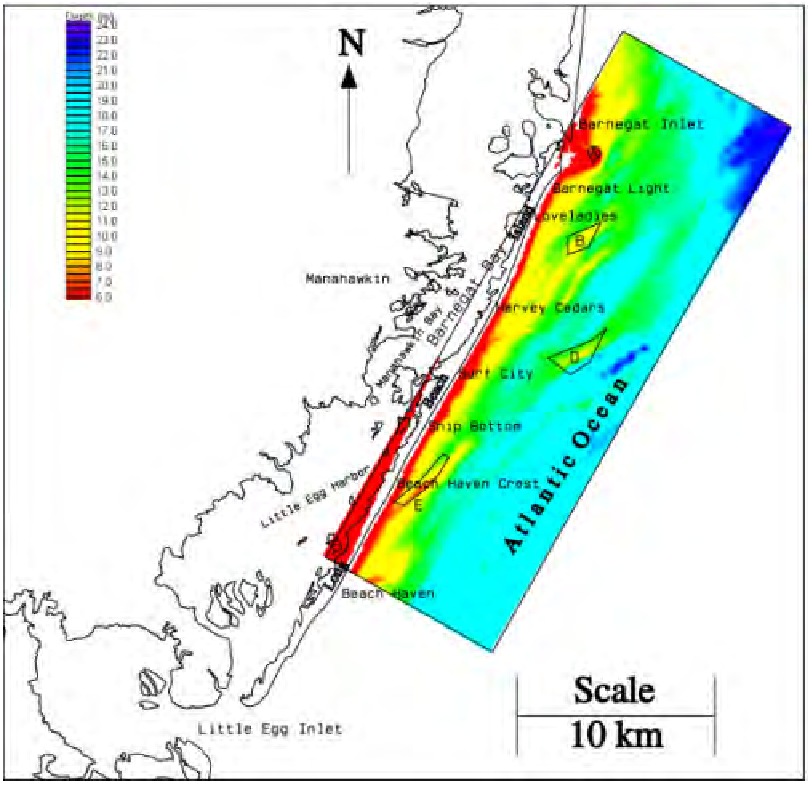


Figure 10. Grid 1 existing condition bathymetry

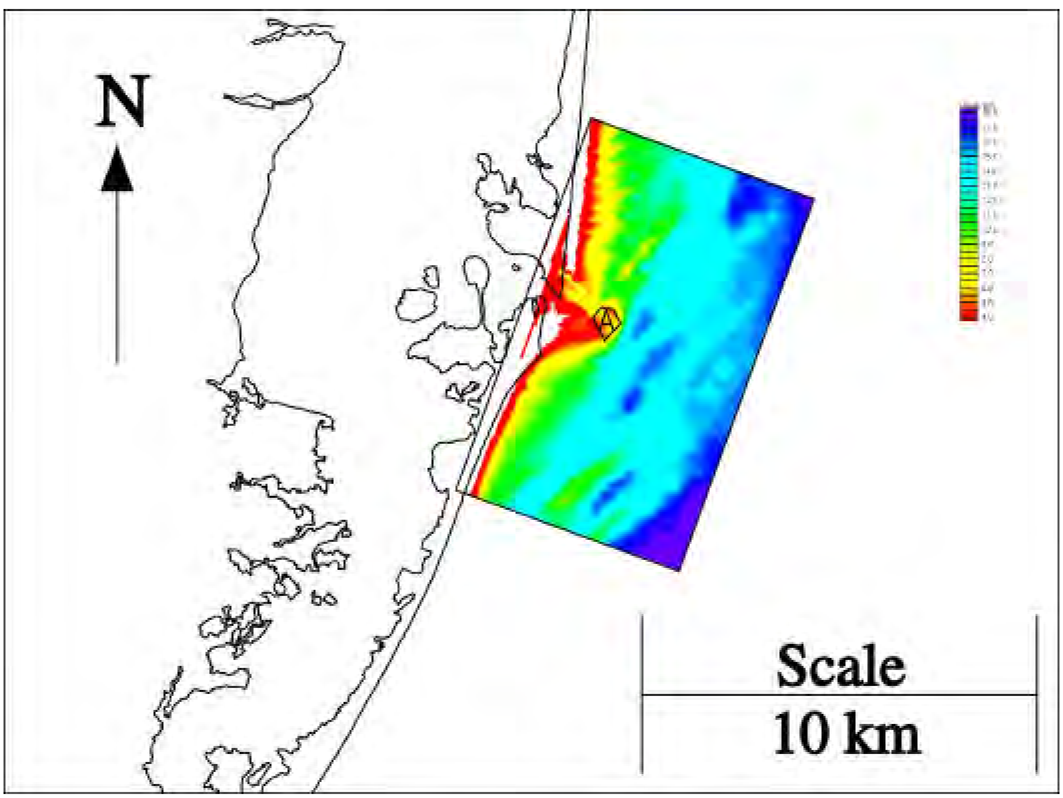


Figure 11. Grid 2 existing condition bathymetry

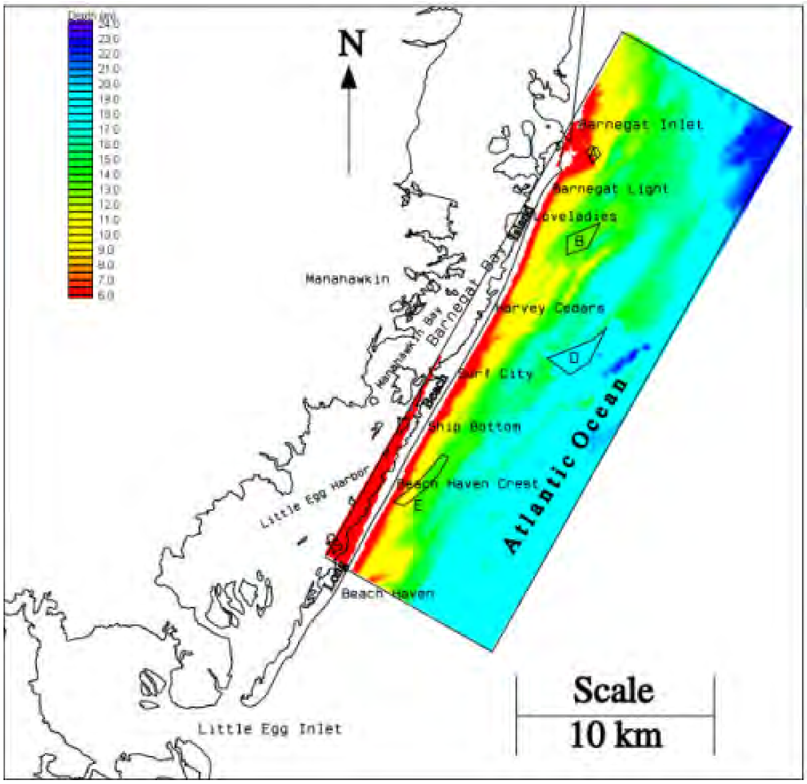


Figure 12. Grid 1 borrow area bathymetry

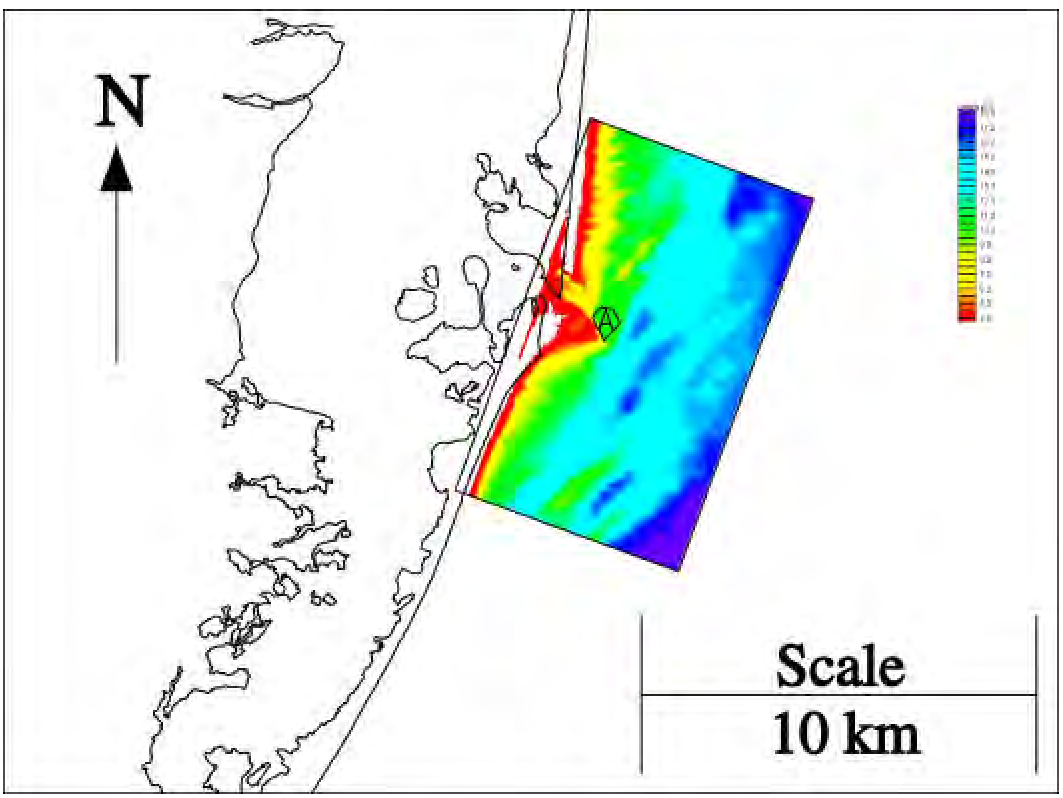


Figure 13. Grid 2 borrow area bathymetry

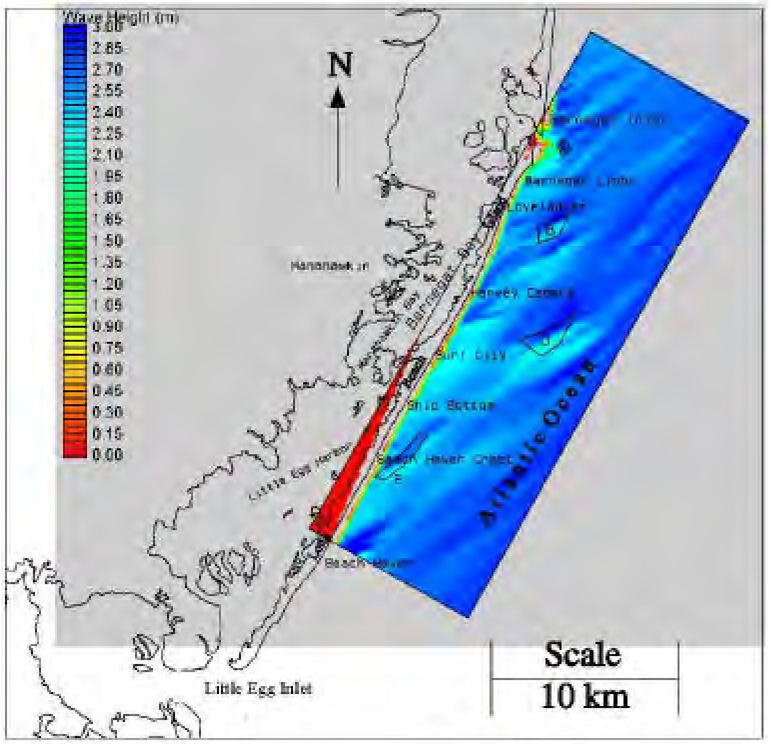


Figure 14. Grid 1 waves from 67 deg H= 3 m, T=10 sec –without-project condition

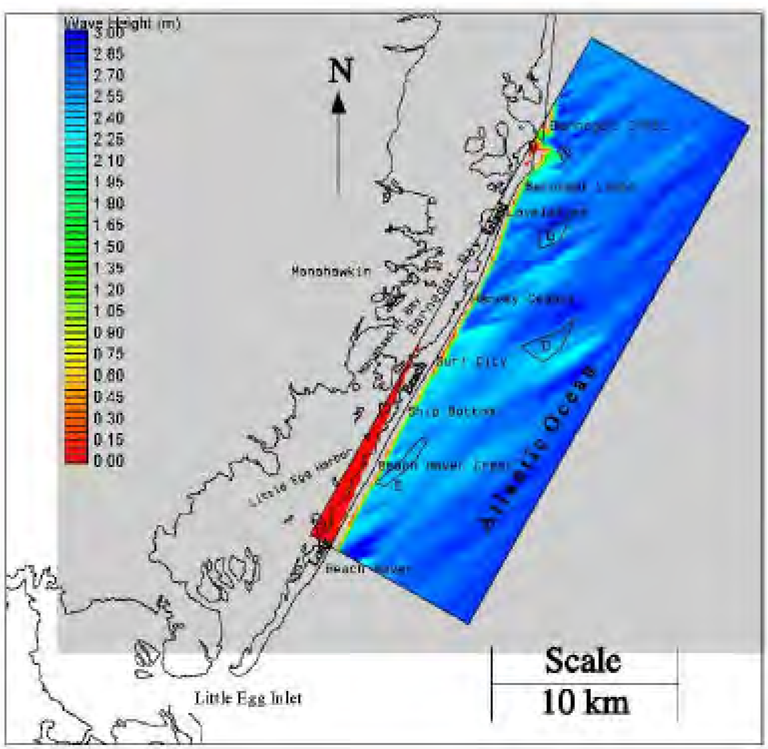


Figure 15. Grid 1 waves from 67 deg H= 3 m, T=10 sec –with-project condition

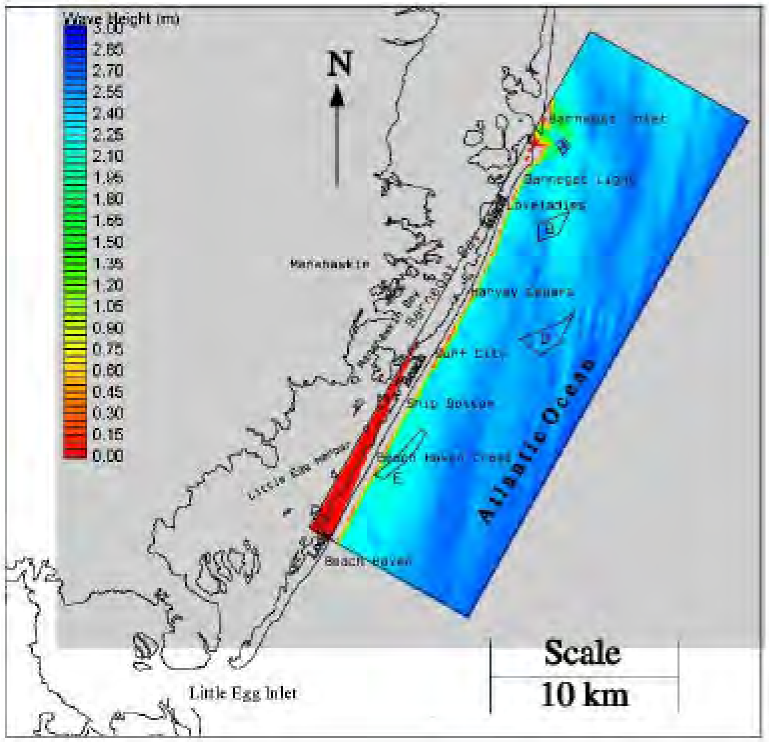


Figure 16. Grid 1 waves from 180 deg H= 3 m, T=10 sec –without-project condition

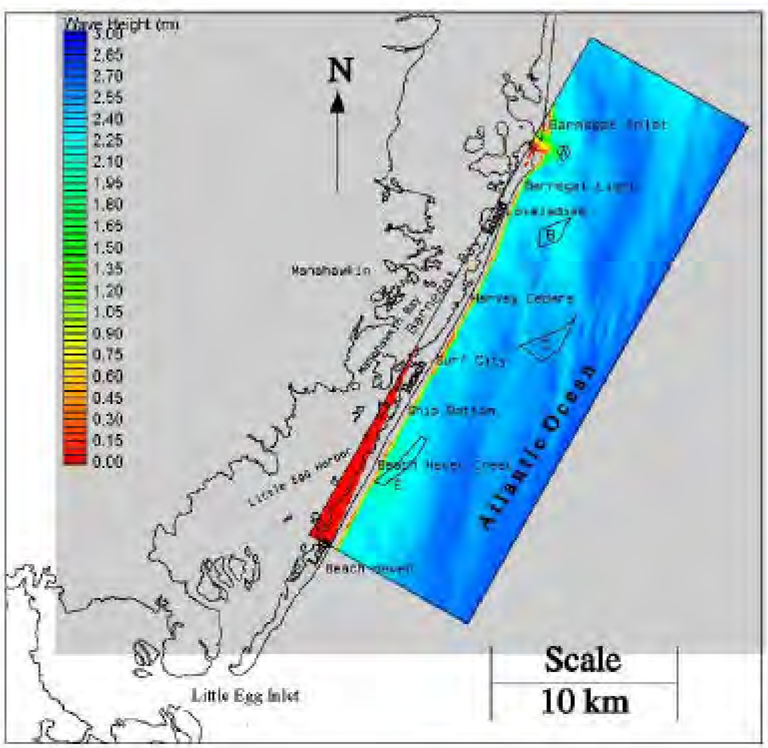


Figure 17. Grid 1 waves from 180 deg H= 3 m, T=10 sec –with-project condition

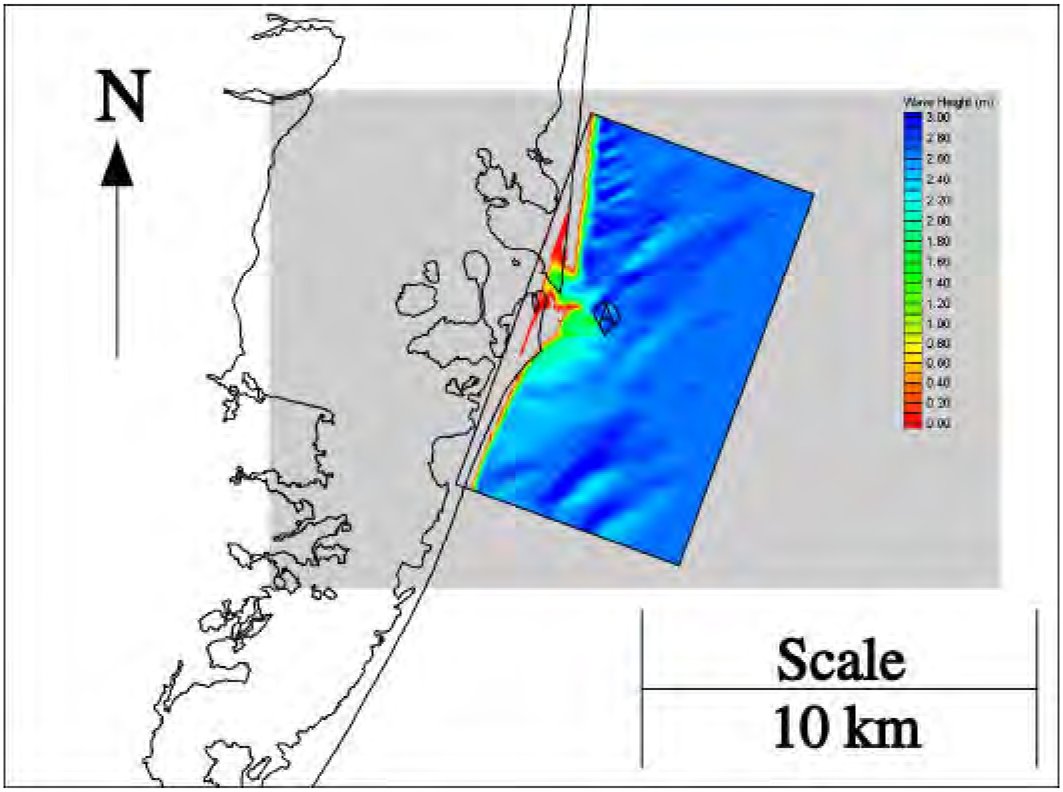


Figure 18. Grid 2 waves from 67 deg H= 3m, T=10 sec –without-project condition

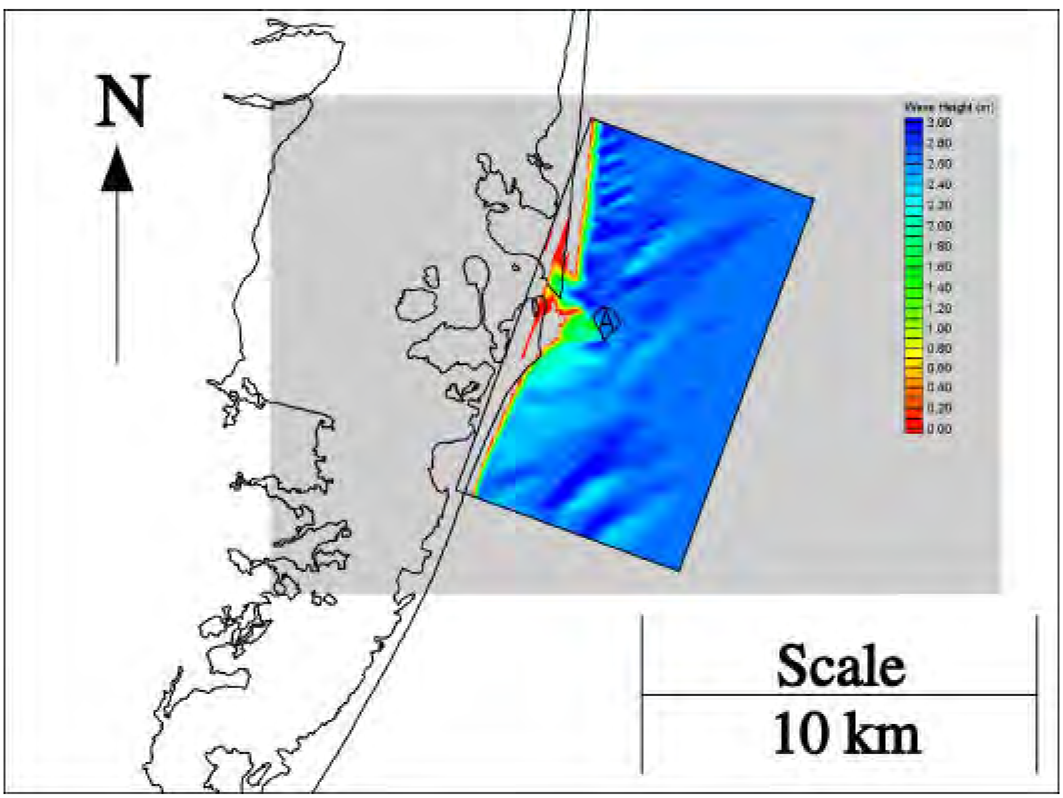


Figure 19. Grid 2 waves from 67 deg H= 3m, T=10 sec –with-project condition

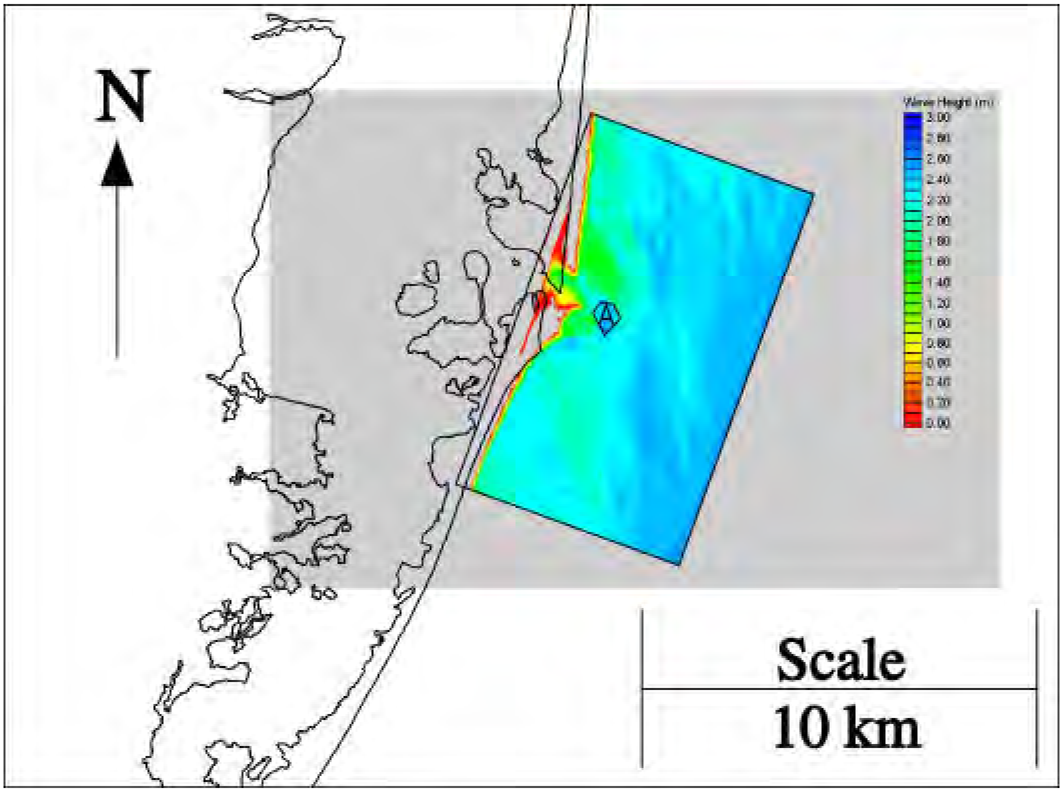


Figure 20. Grid 2 waves from 180 deg H= 3m, T=10 sec –without-project condition

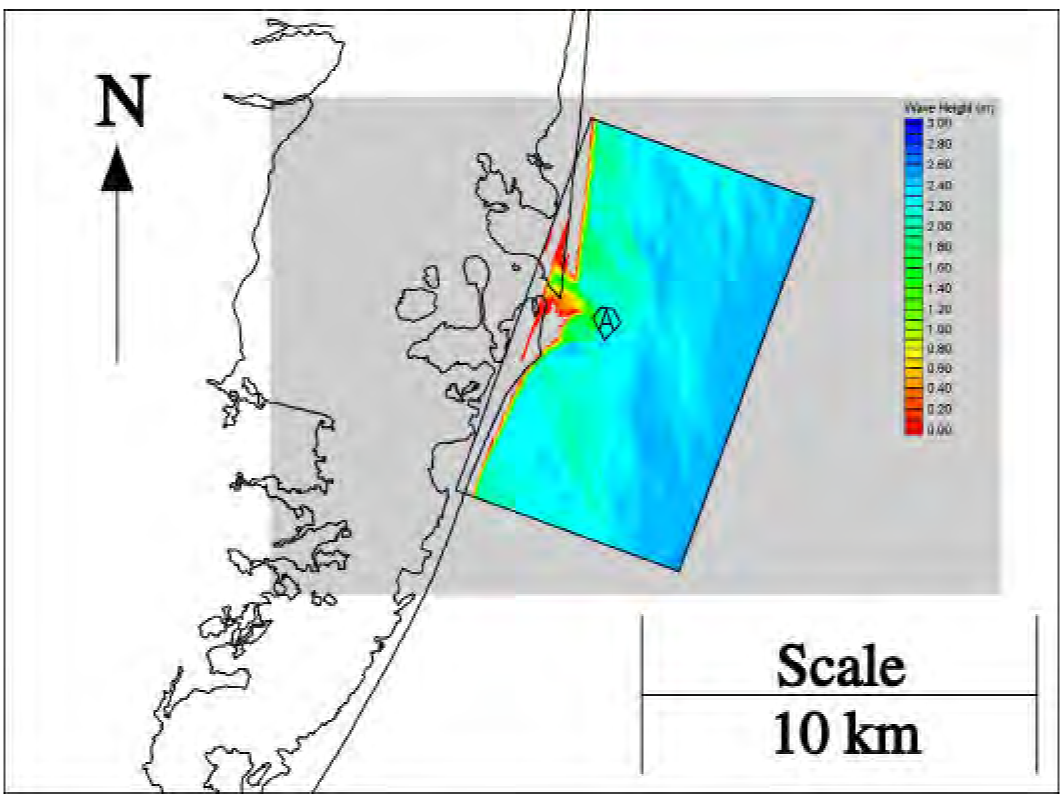


Figure 21. Grid 2 waves from 180 deg H= 3m, T=10 sec –with-project condition

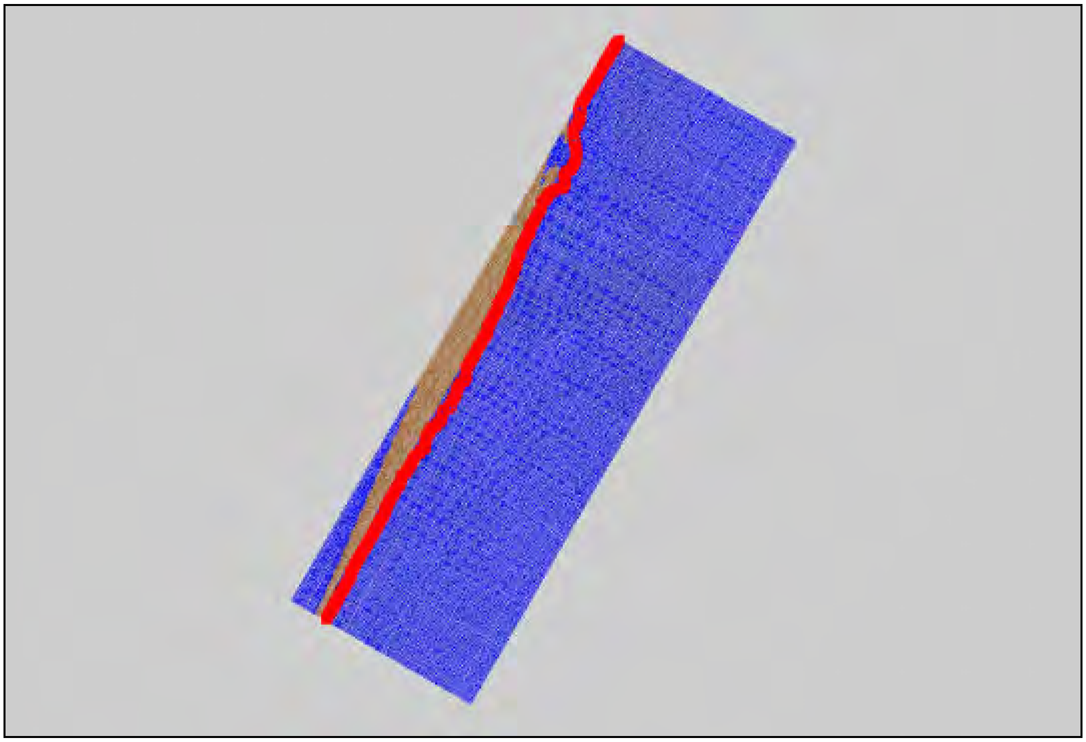


Figure 22. Location of Grid 1 nearshore reference line

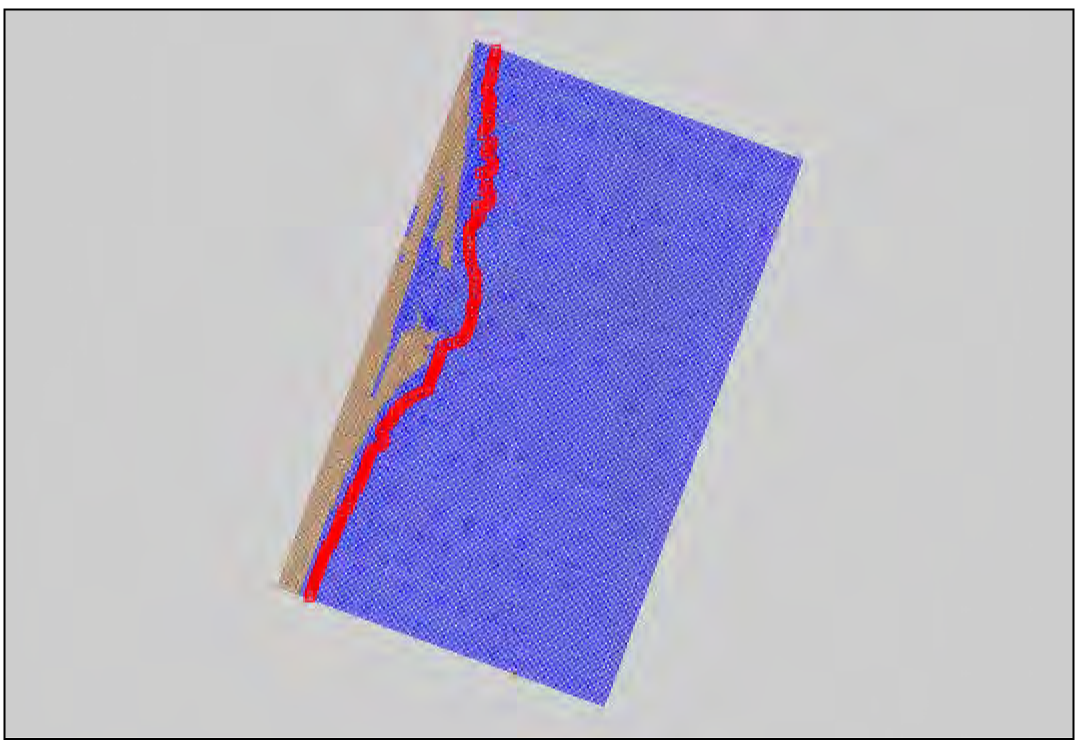


Figure 23. Location of Grid 2 nearshore reference line

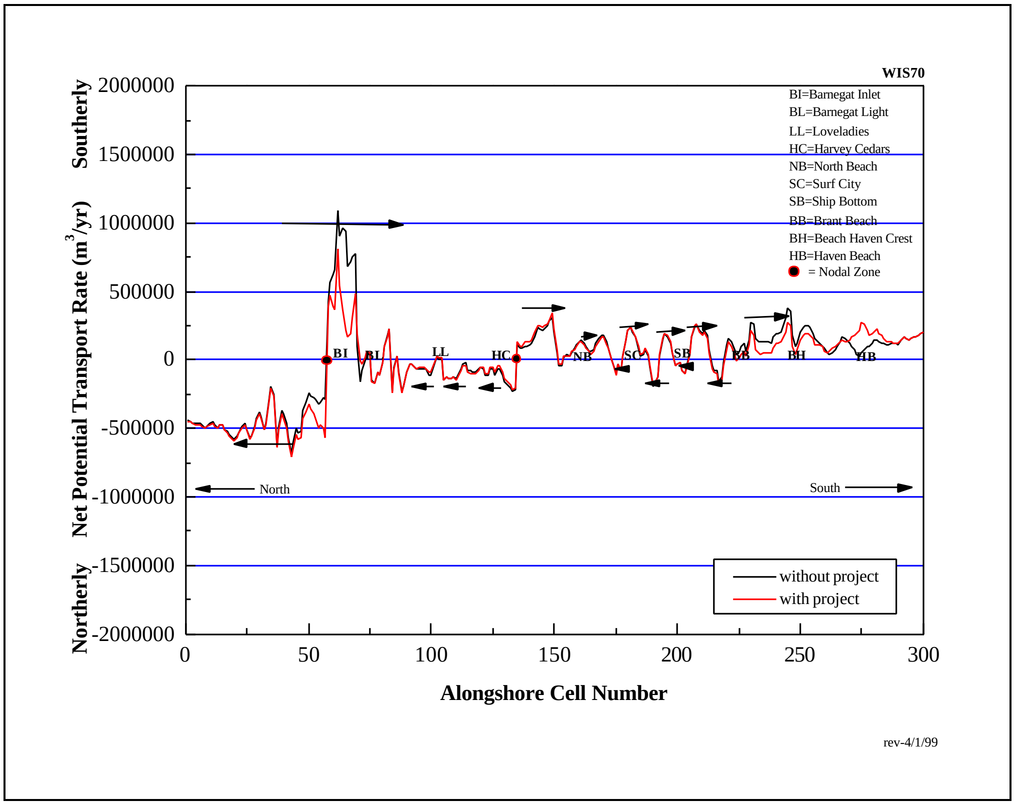


Figure 24a. Net potential transport for Long Beach Island using WIS wave climatology

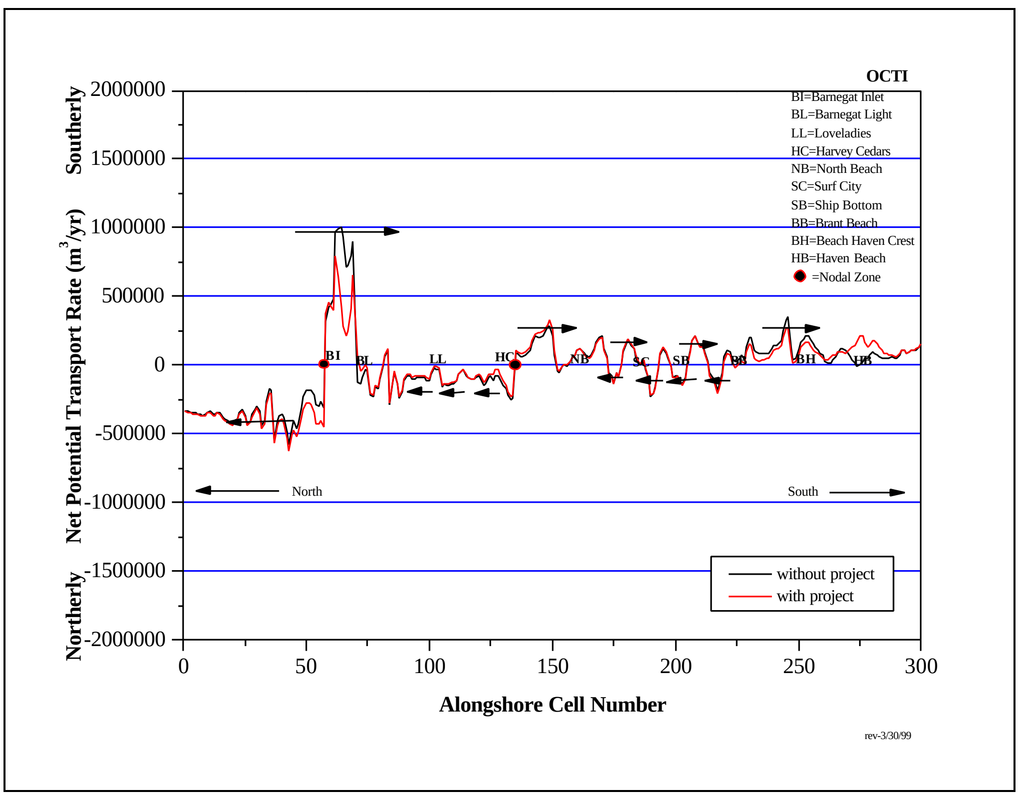


Figure 24b. Net potential transport for Long Beach Island using OCTI wave climatology

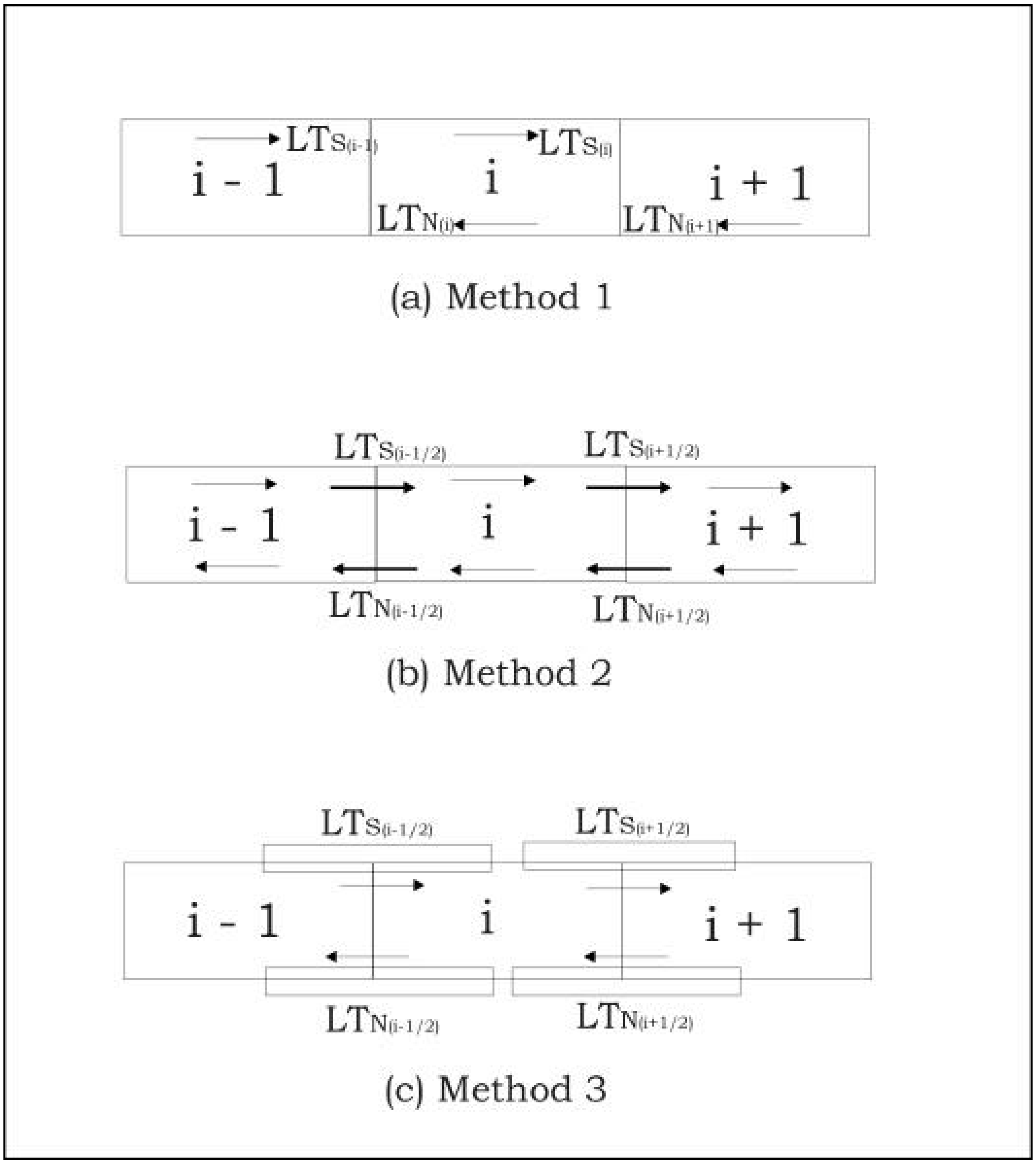


Figure 25. Methods of computing erosion/accretion volumes

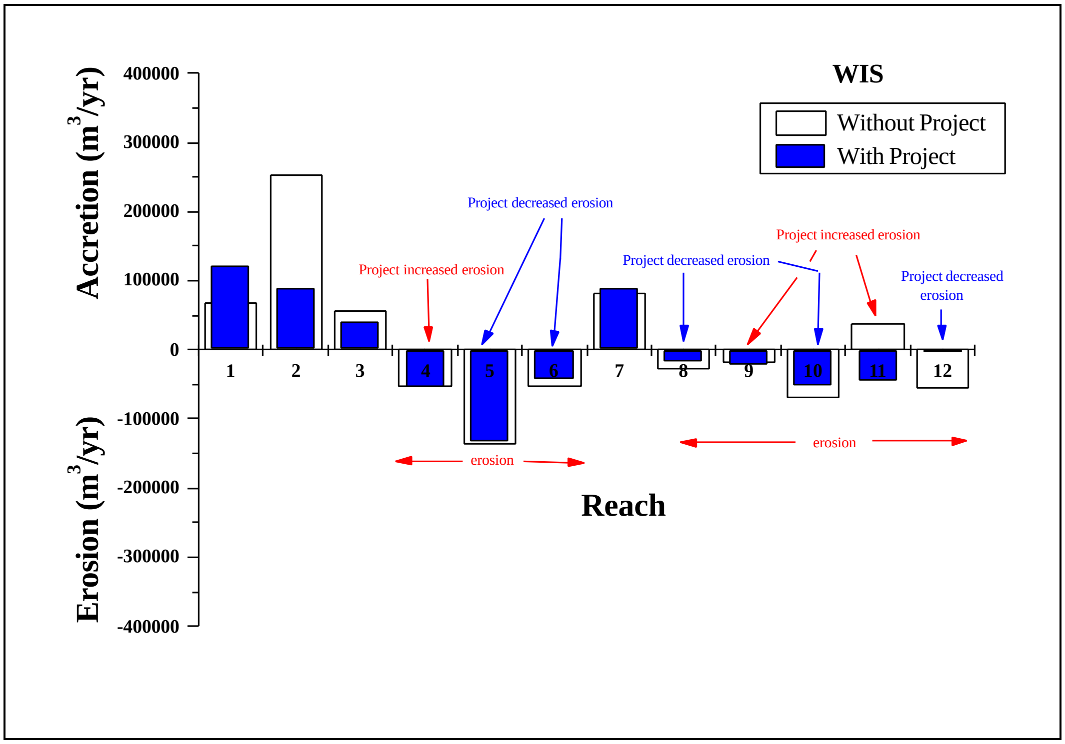


Figure 26. Erosion and accretion for Long Beach Island reaches with WIS climatology

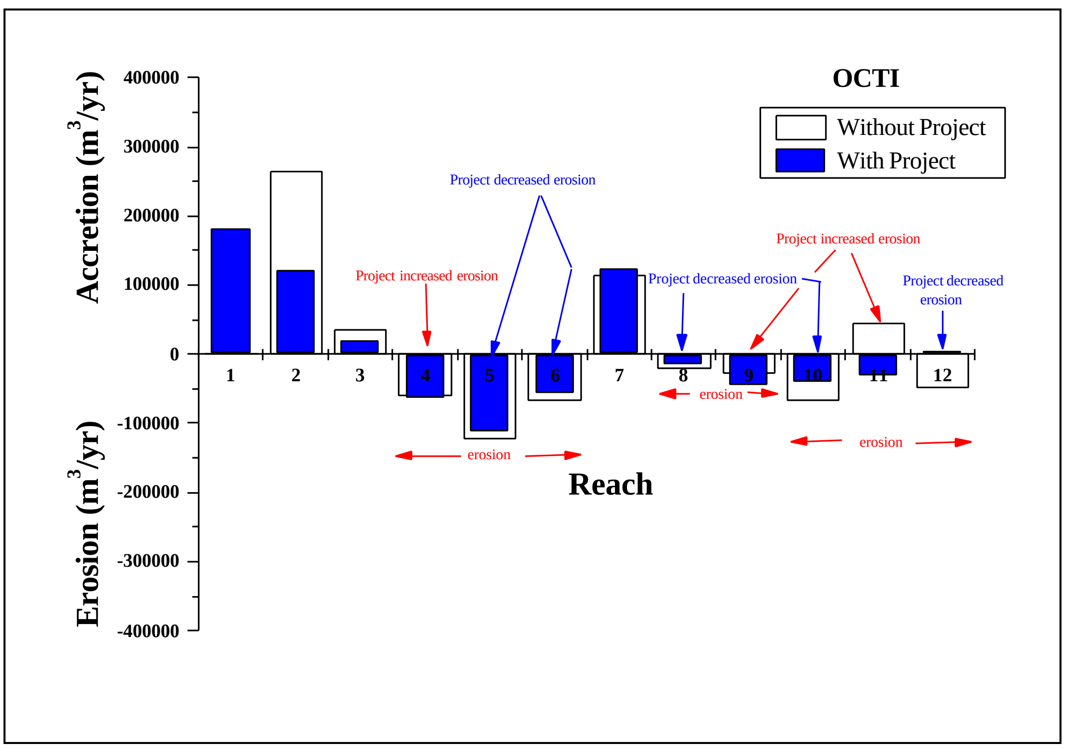


Figure 27. Erosion and accretion for Long Beach Island reaches with OCTI climatology

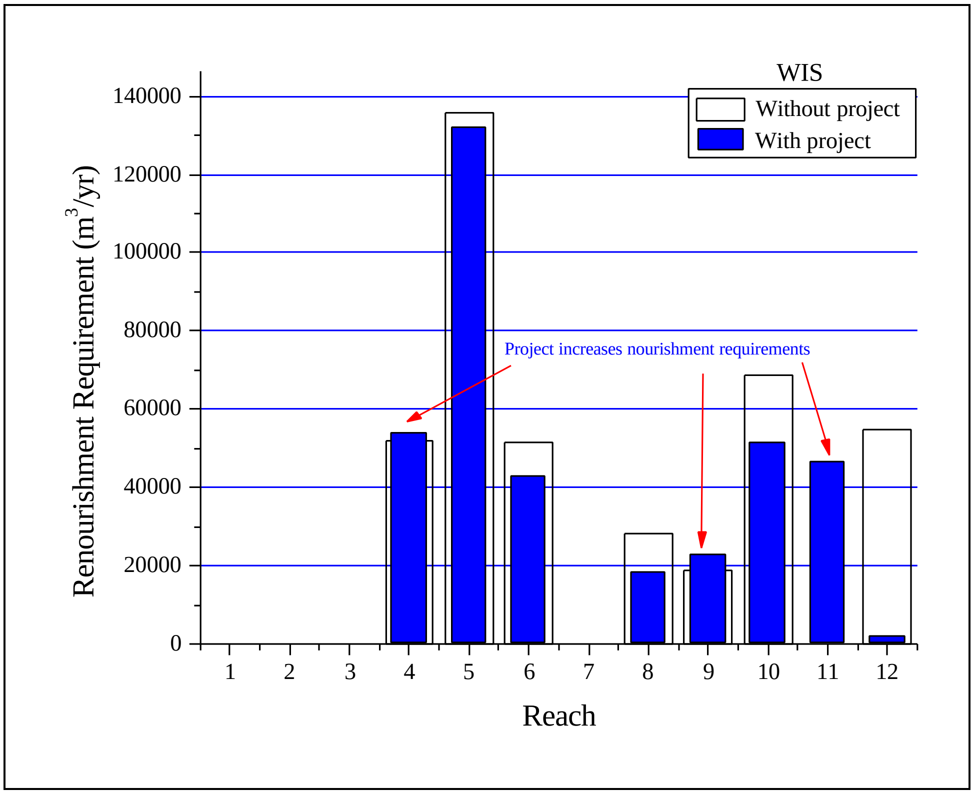


Figure 28. Renourishment requirements with WIS climatology

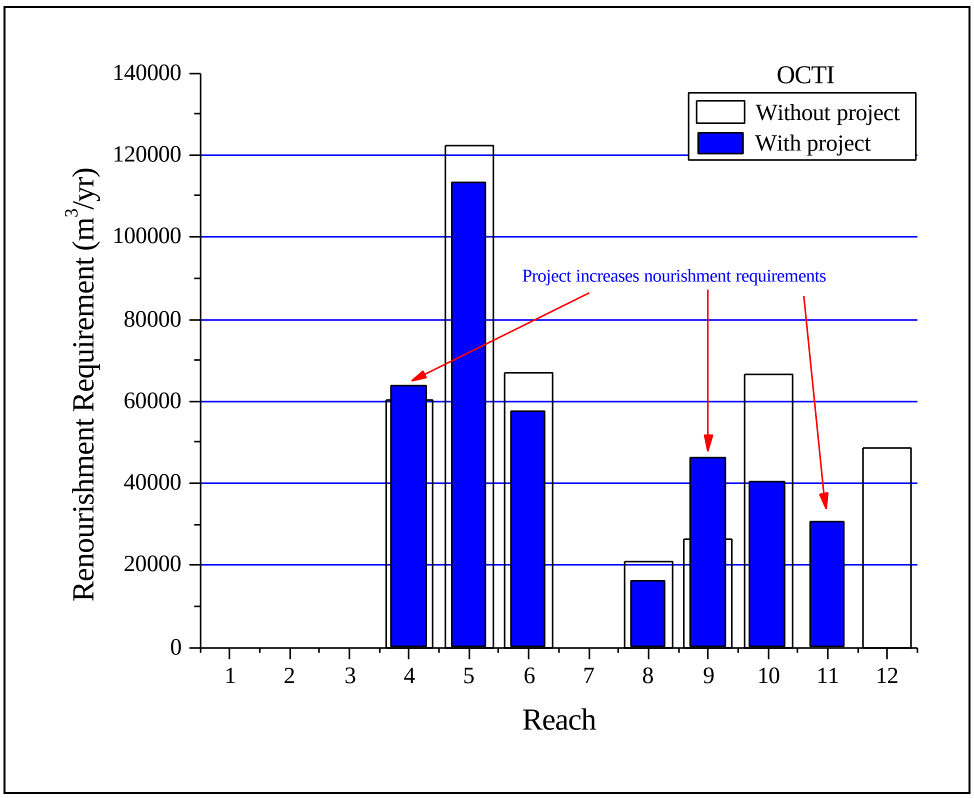


Figure 29. Renourishment requirements with OCTI climatology

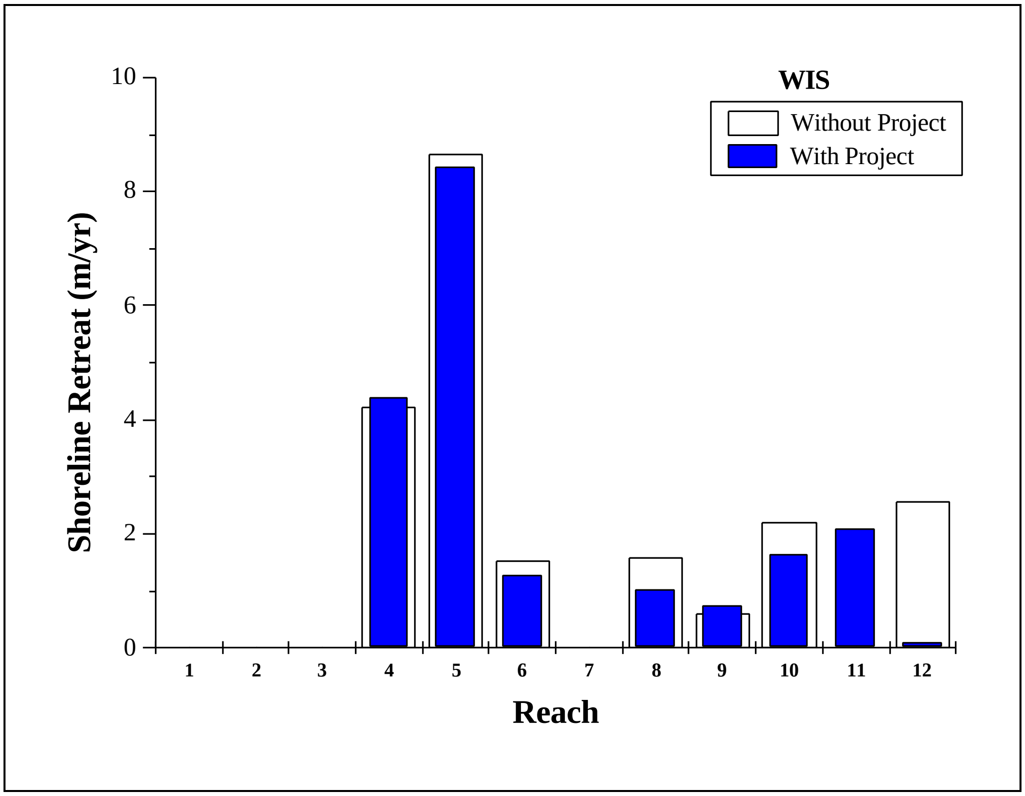


Figure 30. Shoreline retreat with WIS climatology

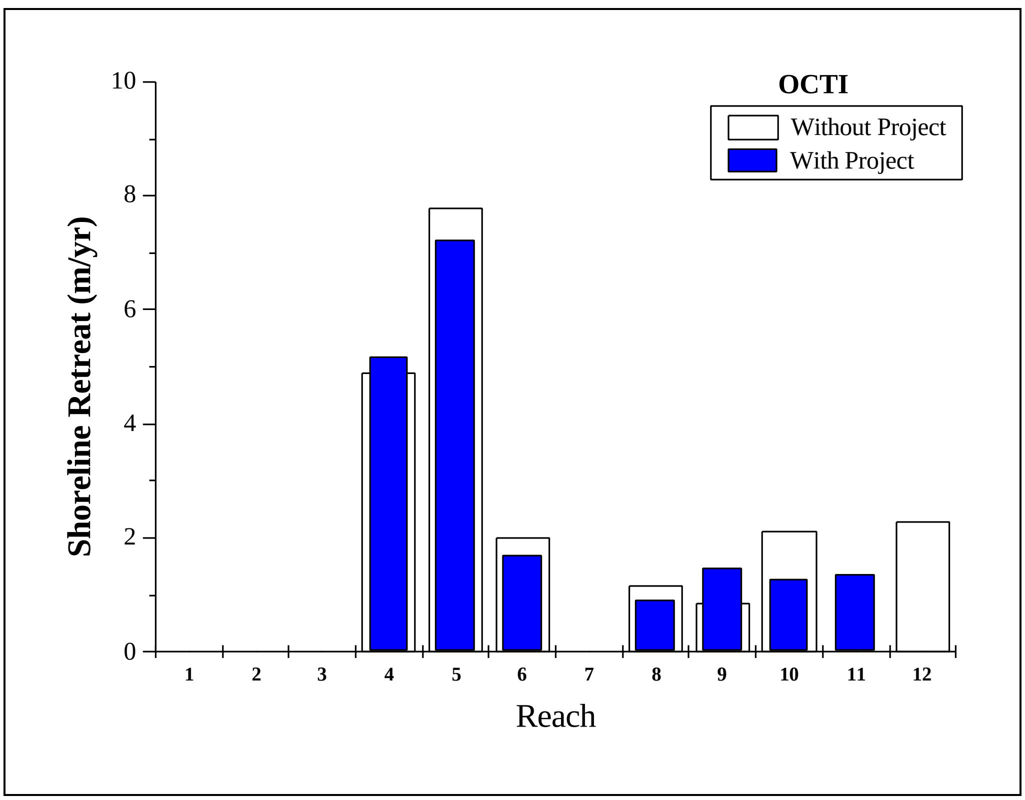


Figure 31. Shoreline retreat with OCTI climatology

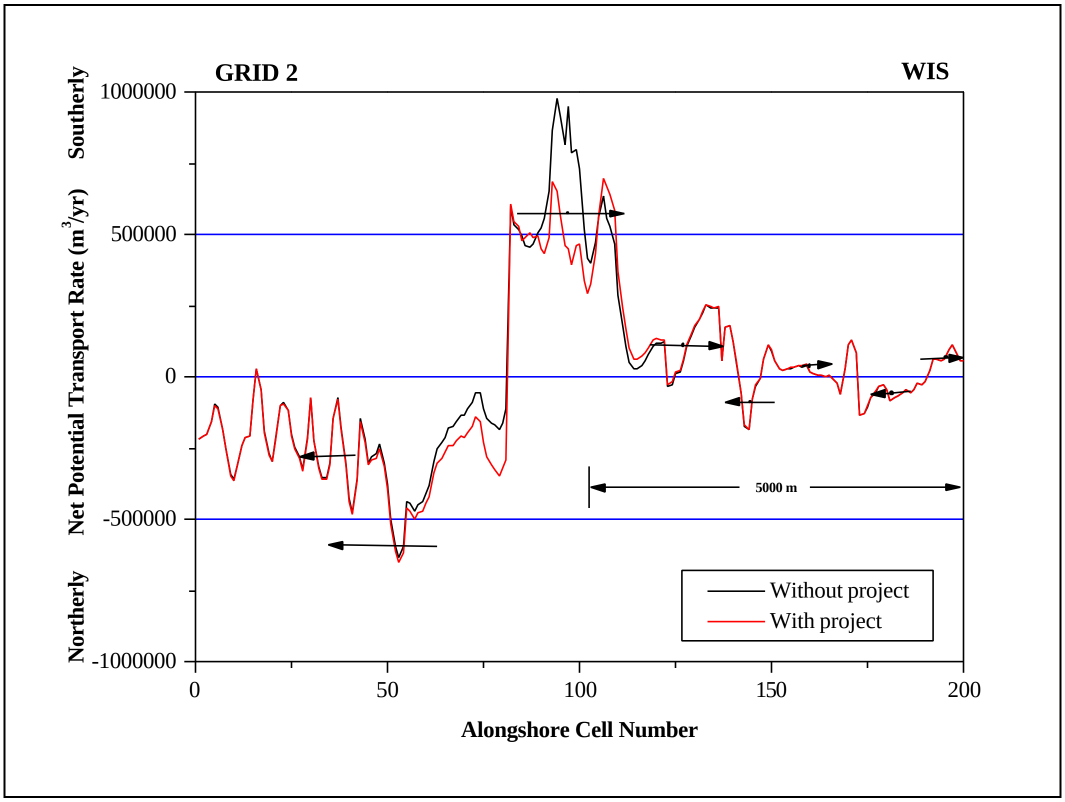


Figure 32. Net potential transport for Grid 2 using WIS wave climatology

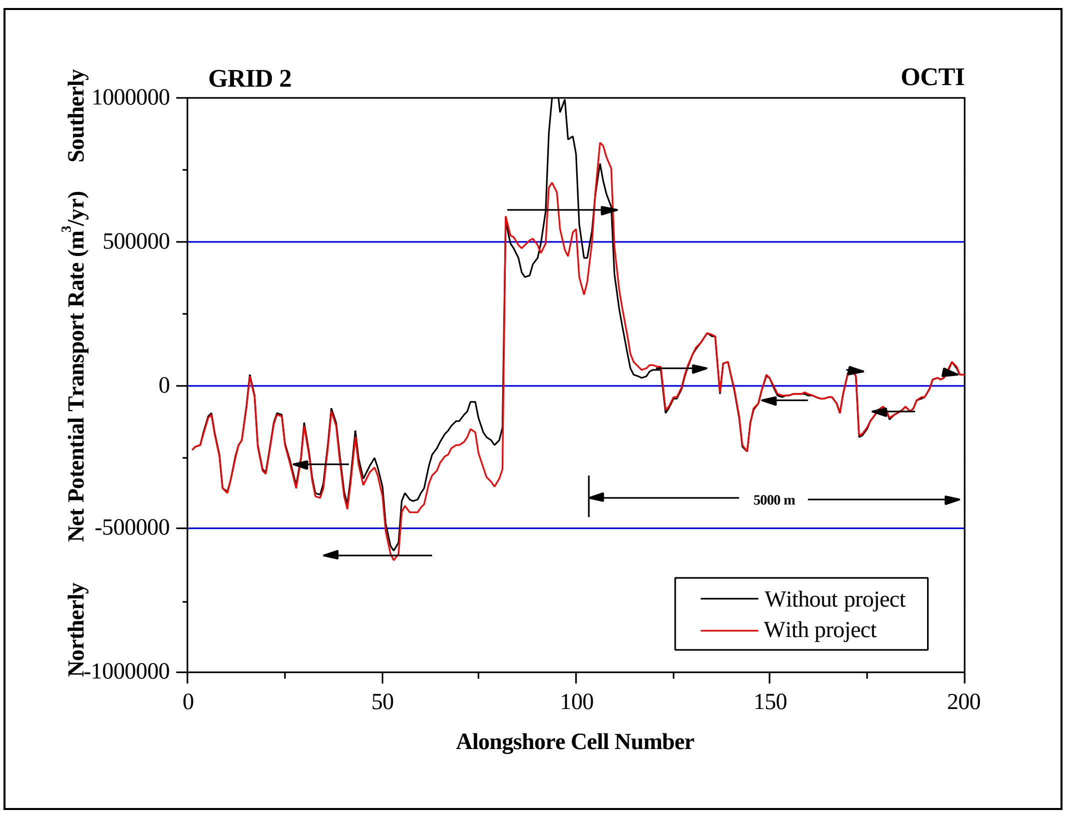


Figure 33. Net potential transport for Grid 2 using OCTI wave climatology

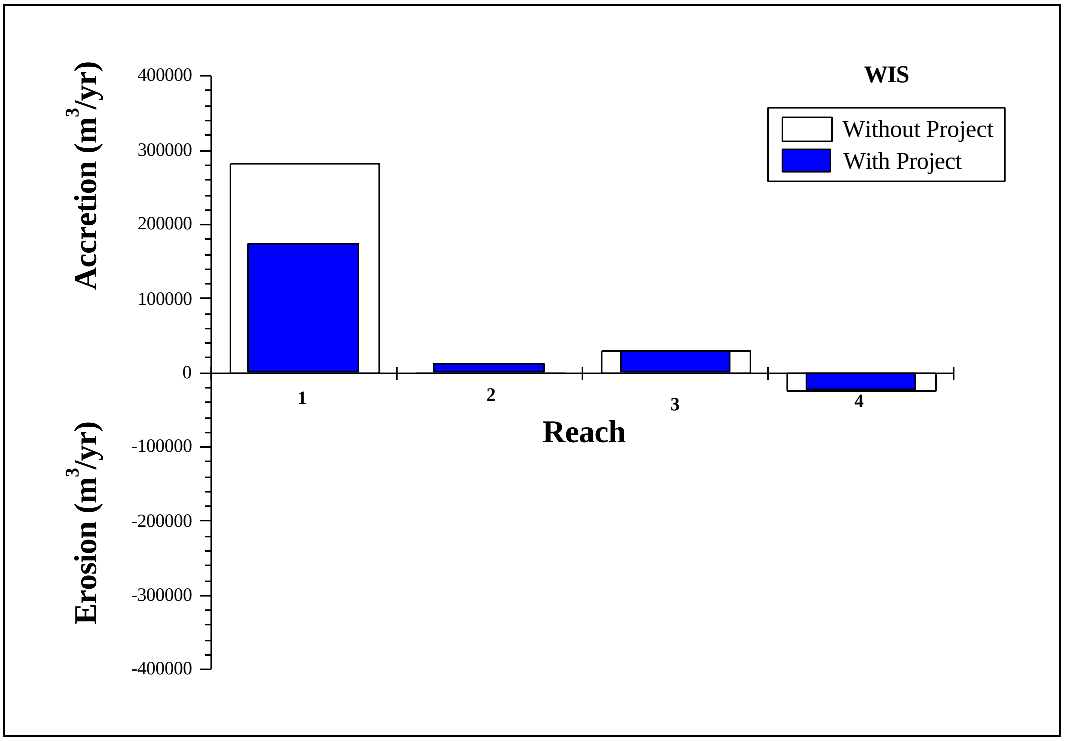


Figure 34. Erosion and accretion for Grid 2 using WIS wave climatology

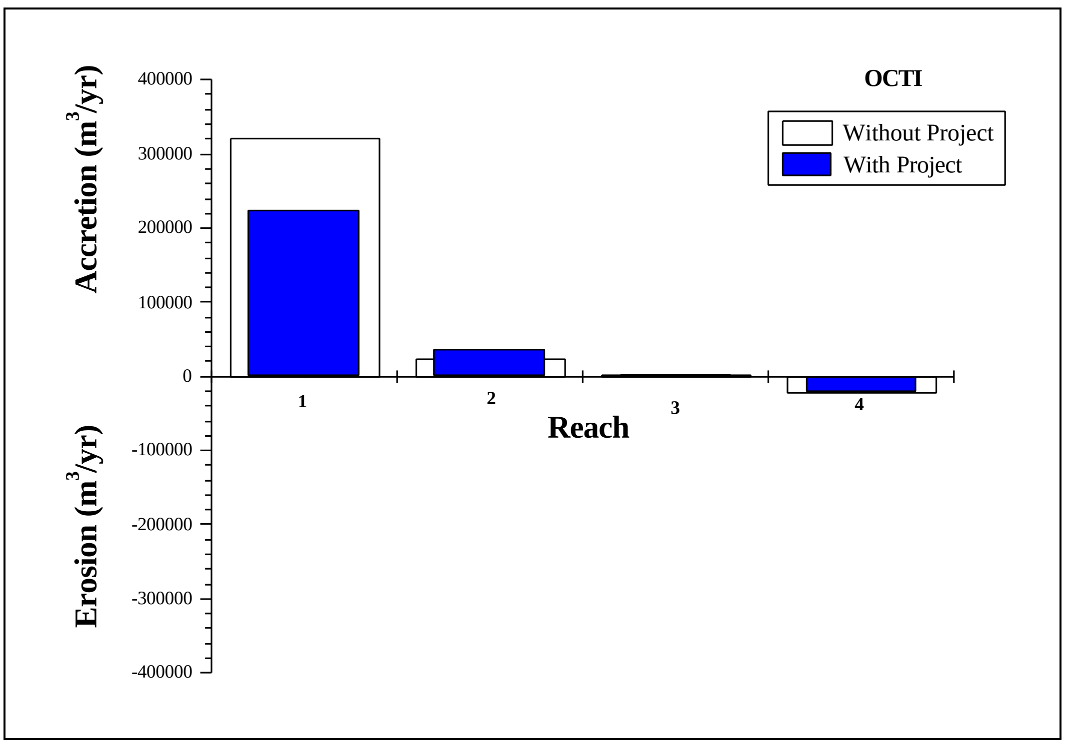


Figure 35. Erosion and accretion for Grid 2 using OCTI wave climatology

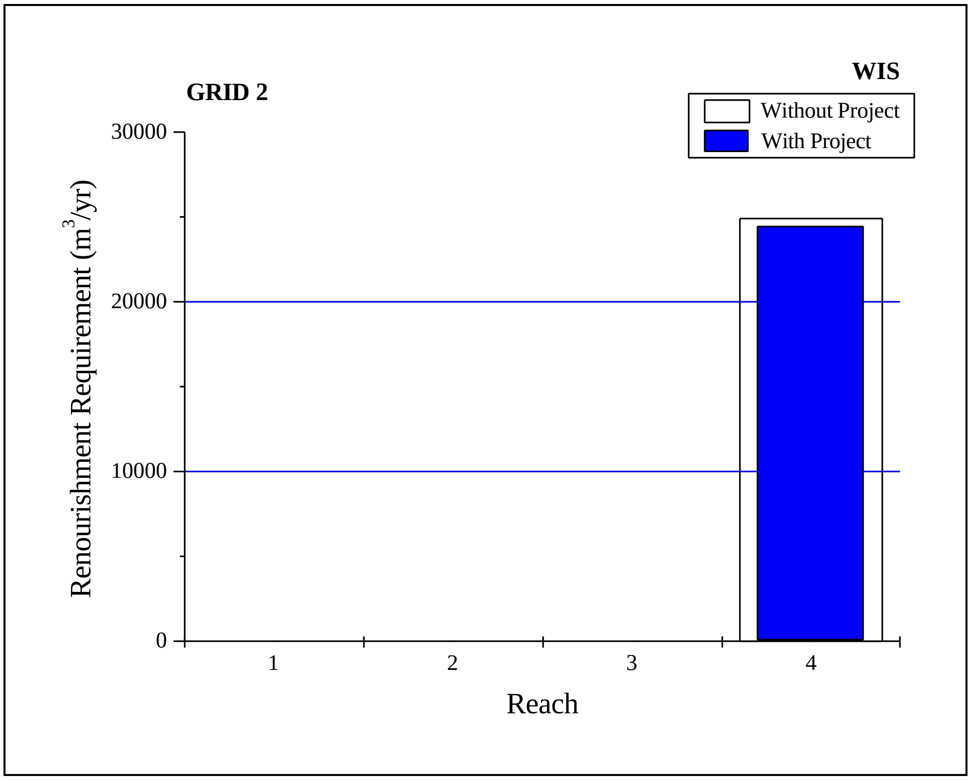


Figure 36. Renourishment requirements with WIS climatology

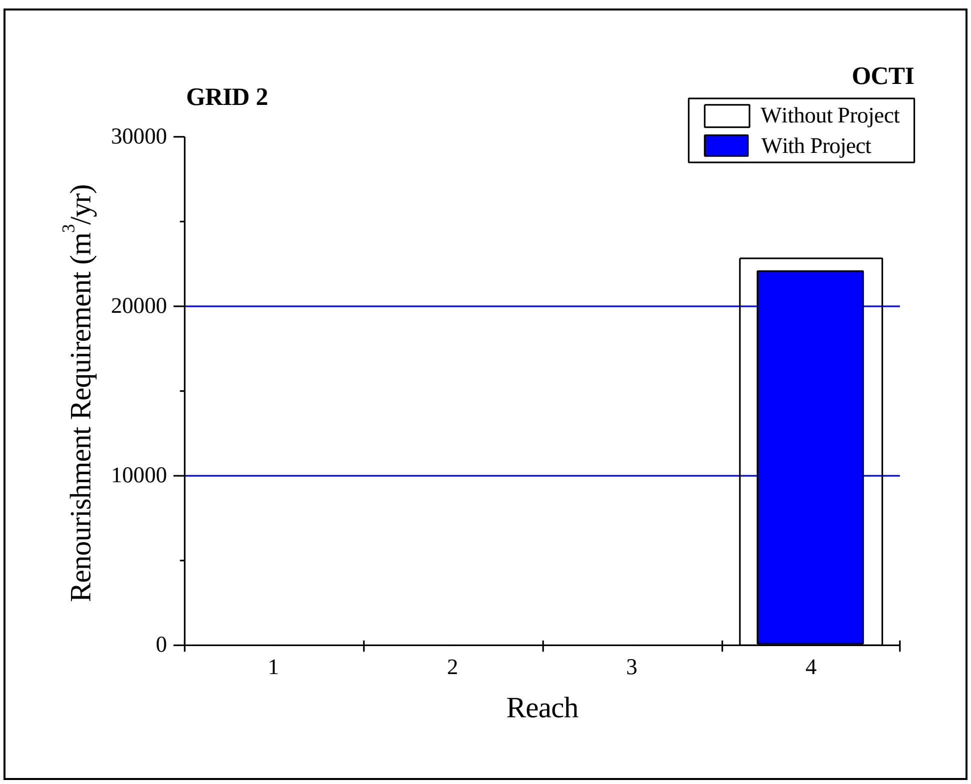


Figure 37. Renourishment requirements with OCTI climatology

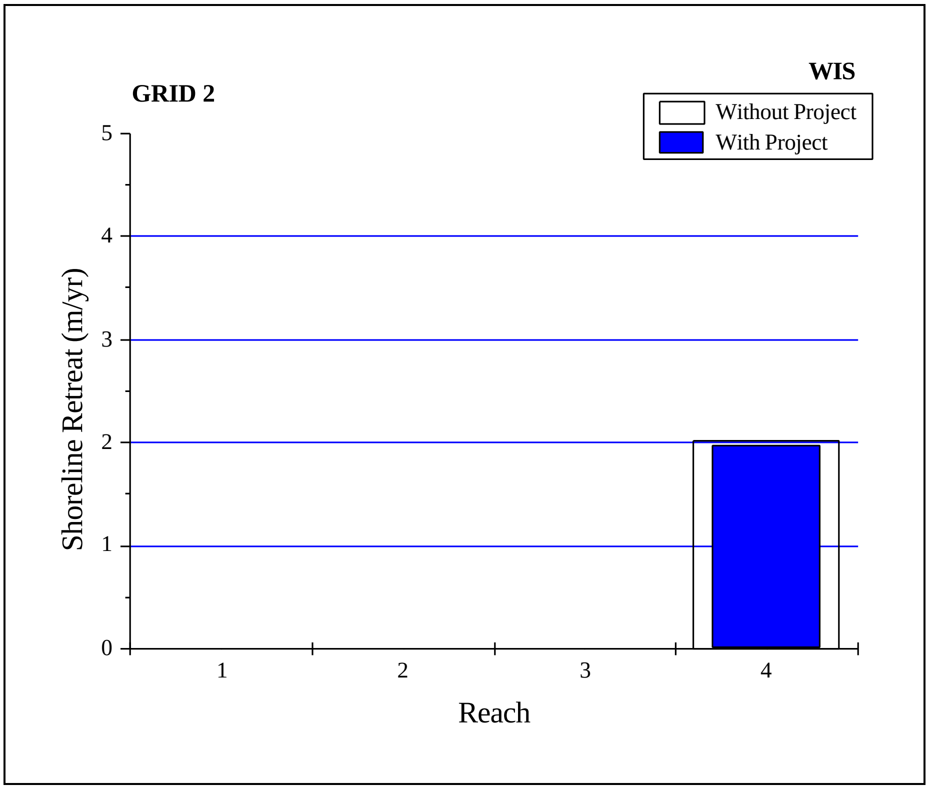


Figure 38. Shoreline retreat for Grid 2 using WIS wave climatology

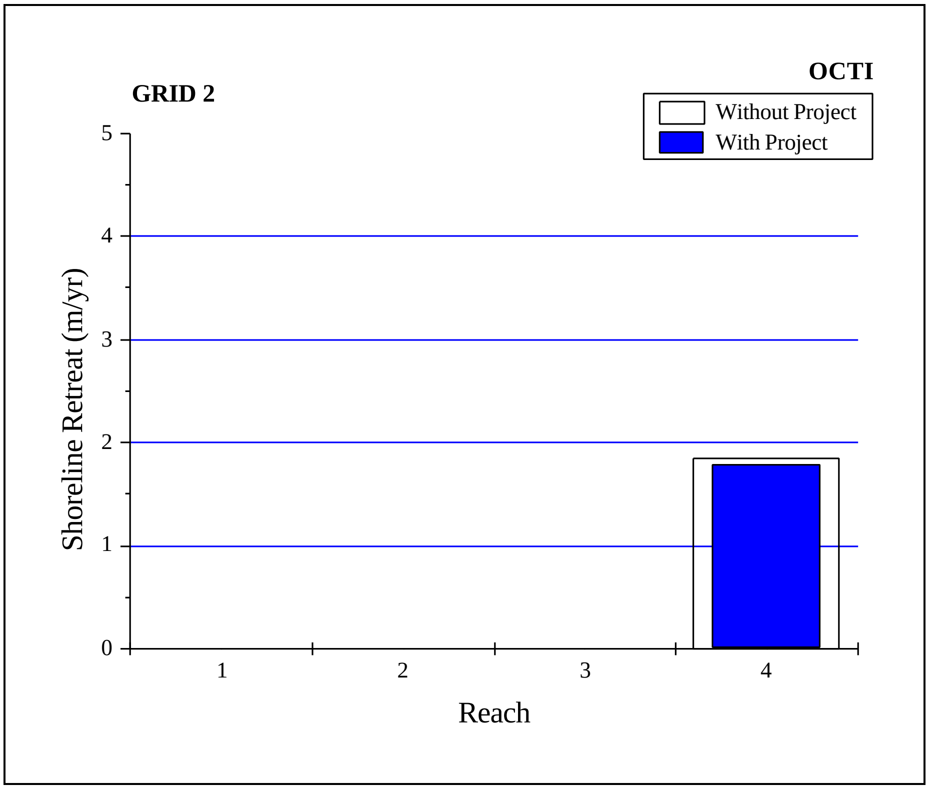


Figure 39. Shoreline retreat for Grid 2 using OCTI wave climatology

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 3

SURVEYING AND MAPPING REQUIREMENTS

Survey data used for the Feasibility Study was collected in 1996 at Long Beach Island, New Jersey. The spacing between survey lines was 500 feet. Each profile was extended landward using 1996 digital photogrammetric elevations.

Data collected for the study mapping effort include the following: aerial photography, first floor elevations of structures in a three-block area fronting the ocean, elevations and locations of all shore protection structures, street centerlines, and spot elevations throughout the study area. Computer programs used to read and store the mapping include AutoCAD and ARCInfo, which is a program used for Geographic Information Systems (GIS).

Mapping developed for this Feasibility Study is sufficient for the plans and specs phase, but new survey data will be required. Beach profile surveys every 100 feet from landward of the existing dune to beyond the depth of closure will be necessary to accurately determine quantities in developing the plans and specs.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 4

GEOTECHNICAL INVESTIGATION

This section contains one representative sample each of a Vibrocore Log, Vibrocore Penetration Log, Vibrocore Grain Size Analysis, and Beach Grain Size Analysis. Also included are the summary sheets for the grain size analyses for both the vibrocores and beach samples. The complete set of 48 Vibrocore Logs, 53 Vibrocore Penetration Logs, Grain Size Analysis of 139 Vibrocore Samples, and Grain Size Analysis of 172 Beach Samples are on file in the Philadelphia District office.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SAMPLE VIBROCORE LOG

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

GEO — Technical Services

ENGINEERS VIBRACORE LOG

Boring No.	NJV-250
Sheet	1 of 1
Date: Start	6/5/96
End	6/5/96
O.G. Elev.	−21.7'
G.W. Elev.	———

Project: N.J. COAST, DELAWARE BAY BEACH RESTORATION PROJECT
Project Site: BARNEGAT INLET
Proposed Location: NOT GIVEN, BASED ON FIELD CONDITIONS
Actual Location: Lat. 39°45'59.935" Long. 74°06'10.124"
Inspector: H.SCHWANGER Drillers Name/Company: N.PRICE/ALPINE
Equipment Used PNEUMATIC VIBRACORE 3 7/8"ID PLASTIC WITH OUTER STEEL
Checked By: *D.E.F.* Date: *6/96* Water: Depth: +21.7' Time: 1033

Depth From	Depth To	Description	Remarks
0.0'	8.0'	**POORLY GRADED SAND,** (sp), light grey, dense to very dense, 20% medium sand, 80% fine sand	*Vibration time 1033–1037* *Penetration 19.9'* *Recovery 16.1'*
8.0'	19.9'	**POORLY GRADED SAND,** (sp), light grey, very dense, 100% fine sand	
		End of Boring 19.9'	

DRAWN BY: TPG

DWG FILE: D:\3510\LOG3

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SAMPLE VIBROCORE PENETRATION LOG

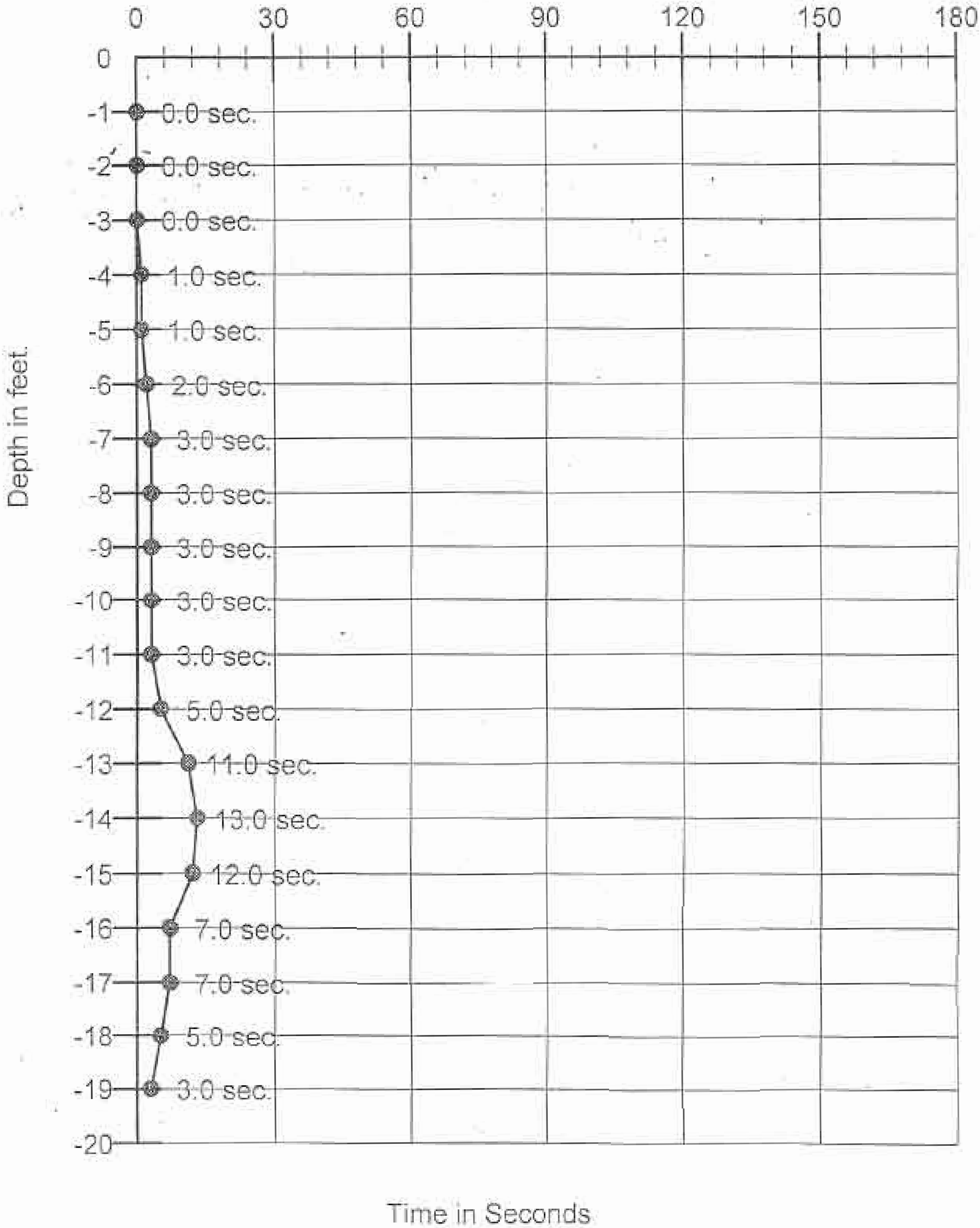
THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PENETRATION GRAPH

Core No: NJV 250 Run#: 1 Location: East: 603780.3 ft. North: 340200.2 ft.

Date: 6/6/96 Start Time: 10:33 A Stop Time: 10:35 A Jet to:

W.D. Raw: 21.7 ft. W.D.Corrected: 21.7 ft. Total Penetration: 19.9 ft. Total Recovery: 16.1 ft.



THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

VIBROCORE GRAIN SIZE ANALYSIS SUMMARY AND DETAILED DATA FOR ONE VIBROCORE SAMPLE

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

GEO-Technical Services, Inc.

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 250	1.5-2.0	1.50	0.354	1.10	0.466
NJV 250	3.5-4.0	1.74	0.299	0.60	0.660
NJV 250	6.5-7.0	1.68	0.312	0.92	0.528
NJV 250	8.5-9.0	2.90	0.134	0.64	0.642
NJV 251	1.5-2.0	1.20	0.435	0.66	0.633
NJV 251	3.5-4.0	1.92	0.264	0.57	0.674
NJV 251	6.5-7.0	1.92	0.265	0.42	0.747
NJV 251	8.5-9.0	1.54	0.345	0.91	0.532
NJV 252	1.5-2.0	1.88	0.273	0.72	0.607
NJV 252	3.5-4.0	1.13	0.456	0.52	0.697
NJV 252	6.5-7.0	2.64	0.160	0.81	0.570
NJV 252	8.5-9.0	2.74	0.149	0.69	0.620
NJV 253	1.5-2.0	1.63	0.323	0.82	0.566
NJV 253	3.5-4.0	1.41	0.373	0.86	0.551
NJV 253	6.5-7.0	1.93	0.262	0.67	0.628
NJV 253	8.5-9.0	2.09	0.234	0.41	0.753
NJV 254	1.5-2.0	1.92	0.264	0.52	0.697
NJV 254	3.5-4.0	2.13	0.229	0.45	0.732
NJV 254	6.5-7.0	1.77	0.294	0.79	0.578
NJV 254	8.5-9.0	1.69	0.310	0.56	0.678
NJV 256	1.5-2.0	2.07	0.239	0.66	0.633

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 257	1.5-2.0	2.27	0.208	0.55	0.683
NJV 257	3.5-4.0	1.96	0.257	0.83	0.562
NJV 257	6.5-7.0	2.51	0.175	0.58	0.669
NJV 257	8.5-9.0	2.46	0.182	0.66	0.633
NJV 259	1.5-2.0	2.26	0.208	0.71	0.611
NJV 259	3.5-4.0	1.93	0.263	0.93	0.525
NJV 259	6.5-7.0	2.31	0.201	0.48	0.717
NJV 259	8.5-9.0	2.75	0.149	0.68	0.624
NJV 260	1.5-2.0	1.71	0.305	0.57	0.674
NJV 260	3.5-4.0	1.73	0.301	0.44	0.737
NJV 260	6.5-7.0	1.76	0.294	0.61	0.655
NJV 260	8.5-9.0	2.34	0.198	0.63	0.646
NJV 262	1.5-2.0	0.88	0.544	0.96	0.514
NJV 262	3.5-4.0	0.87	0.545	1.00	0.500
NJV 263	1.5-2.0	2.14	0.227	0.67	0.628
NJV 263	3.5-4.0	1.67	0.315	0.95	0.517
NJV 263	6.5-7.0	1.96	0.258	0.41	0.753
NJV 263	8.5-9.0	-0.57	1.480	1.82	0.283
NJV 264	1.5-2.0	1.23	0.425	0.69	0.620
NJV 264	3.5-4.0	2.10	0.234	0.70	0.615

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 265	8.5-9.0	-0.19	1.140	0.94	0.521
NJV 266	1.5-2.0	1.93	0.262	0.55	0.683
NJV 267	6.5-7.0	2.59	0.167	0.59	0.664
NJV 268	1.5-2.0	2.25	0.211	0.44	0.737
NJV 268	3.0-3.5	2.37	0.194	0.49	0.712
NJV 268	7.0-7.5	2.35	0.196	0.47	0.722
NJV 268	8.0-8.5	2.27	0.207	0.63	0.646
NJV 269	1.5-2.0	2.38	0.192	0.50	0.707
NJV 270	1.5-2.0	1.80	0.287	0.52	0.697
NJV 270	3.5-4.0	1.76	0.295	0.55	0.683
NJV 270	6.5-7.0	1.58	0.335	0.60	0.660
NJV 270	8.5-9.0	1.68	0.312	0.82	0.566
NJV 271	1.5-2.0	2.00	0.250	0.40	0.758
NJV 271	3.5-4.0	2.16	0.225	0.48	0.717
NJV 271	6.5-7.0	2.03	0.245	0.73	0.603
NJV 272	1.5-2.0	2.19	0.219	0.39	0.763
NJV 272	3.5-4.0	2.20	0.218	0.42	0.747
NJV 272	6.5-7.0	2.34	0.198	0.41	0.753
NJV 272	8.5-9.0	2.12	0.230	0.40	0.758
NJV 273	1.5-2.0	1.36	0.389	0.96	0.514
NJV 275	1.5-2.0	1.18	0.442	0.94	0.521
NJV 275	3.5-4.0	1.43	0.372	0.68	0.624

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 275	6.5-7.0	1.34	0.394	0.68	0.624
NJV 275	8.5-9.0	1.56	0.340	0.65	0.637
NJV 276	1.5-2.0	1.74	0.300	0.66	0.633
NJV 276	3.5-4.0	1.64	0.321	0.56	0.678
NJV 276	6.5-7.0	1.60	0.330	0.65	0.637
NJV 276	8.5-9.0	1.73	0.301	0.58	0.669
NJV 277	1.5-2.0	1.76	0.295	0.54	0.688
NJV 277	3.5-4.0	1.72	0.303	0.66	0.632
NJV 277	6.5-7.0	1.72	0.304	0.57	0.674
NJV 277	8.5-9.0	1.87	0.273	0.55	0.683
NJV 278	1.5-2.0	1.05	0.482	0.98	0.507
NJV 278	3.5-4.0	1.26	0.418	0.78	0.582
NJV 278	6.5-7.0	1.72	0.303	0.56	0.678
NJV 278	8.5-9.0	1.67	0.315	0.63	0.646
NJV 279	1.5-2.0	0.92	0.528	1.16	0.447
NJV 279	3.5-4.0	1.81	0.285	0.59	0.664
NJV 279	6.5-7.0	1.60	0.330	0.75	0.594
NJV 279	8.5-9.0	1.63	0.324	0.75	0.594
NJV 280	2.0-2.5	1.46	0.364	0.76	0.590
NJV 280	3.5-4.0	1.46	0.363	0.78	0.582

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 280	6.5-7.0	1.54	0.344	0.67	0.628
NJV 280	7.5-8.0	1.53	0.345	0.70	0.615
NJV 281	1.5-2.0	1.50	0.352	0.64	0.642
NJV 281	3.5-4.0	1.36	0.390	0.73	0.603
NJV 281	6.5-7.0	1.36	0.389	0.75	0.594
NJV 281	9.0-9.5	1.18	0.440	0.88	0.543
NJV 282	1.5-2.0	1.52	0.349	0.74	0.599
NJV 282	3.5-4.0	1.59	0.333	0.71	0.611
NJV 282	6.5-7.0	1.53	0.346	0.80	0.574
NJV 282	8.5-9.0	1.61	0.328	0.71	0.611
NJV 283	3.5-4.0	0.29	0.819	0.87	0.547
NJV 283	6.5-7.0	1.45	0.367	0.69	0.620
NJV 283	9.0-9.5	1.19	0.437	0.80	0.574
NJV 284	1.5-2.0	3.53	0.087	0.42	0.747
NJV 284	3.5-4.0	0.94	0.521	0.85	0.555
NJV 285	1.5-2.0	3.53	0.087	0.43	0.742
NJV 285	3.5-4.0	1.47	0.361	0.46	0.727
NJV 285	6.5-7.0	1.43	0.372	0.61	0.655
NJV 285	8.5-9.0	1.05	0.484	0.77	0.586
NJV 286	1.5-2.0	1.97	0.256	0.45	0.732
NJV 286	3.5-4.0	1.82	0.283	0.58	0.669
NJV 286	6.5-7.0	2.26	0.208	0.46	0.727

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS
(METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
VIBRACORE SAMPLE TESTING

BORING NO.	SAMPLE DEPTH (FT)	MEAN DIAMETER		STANDARD DEVIATION	
		(PHI)	(MM)	(PHI)	(MM)
NJV 286	8.5-9.0	2.22	0.215	0.46	0.727
NJV 287	1.5-2.0	3.14	0.114	1.04	0.486
NJV 287	3.5-4.0	3.21	0.108	0.80	0.574
NJV 287	6.5-7.0	2.96	0.128	0.67	0.628
NJV 287	8.5-9.0	3.25	0.105	0.70	0.615
NJV 288	1.5-2.0	1.28	0.411	0.38	0.768
NJV 288	5.5-6.0	0.96	0.513	0.69	0.620
NJV 288	6.5-7.0	2.79	0.145	0.91	0.532
NJV 288	8.5-9.0	3.01	0.124	0.72	0.607
NJV 389	1.5-2.0	1.33	0.398	0.78	0.582
NJV 389	3.5-4.0	1.79	0.288	0.62	0.651
NJV 389	4.5-5.0	2.10	0.233	0.91	0.532
NJV 389	6.5-7.0	1.54	0.343	0.47	0.722
NJV 390	1.5-2.0	1.62	0.326	0.53	0.692
NJV 390	3.5-4.0	1.74	0.300	0.74	0.599
NJV 391	1.5-2.0	1.54	0.345	0.590	0.664
NJV 391	6.5-7.0	3.25	0.105	0.75	0.594

ACES	Mode: Single Case	Functional Area: Littoral Processes
Application: Calculation of Composite Grain Size Distributions		

Composite of Grain Size Distributions

Composite	Title	Date Analyzed
NJV 250-1	NJ COAST, DELAWARE BEACH RESTORATION PROJECT	08/06/96
Analyzer	Comment	Total Weight
MMA	DEPTH 1.5'-2.0'	100.00

Type of Samples	Samples in Composite	Top of Composite	Bottom of Composite
	1	0.00 feet	0.00 feet

ASTM MESH	MM Size	PHI Size	Weight (%)	ASTM MESH	MM Size	PHI Size	Weight (%)	ASTM MESH	MM Size	PHI Size	Weight (%)
4.00	4.76	-2.25	4.037	10.00	2.00	-1.00	3.256	20.00	0.84	0.25	3.700
40.00	0.42	1.25	22.888	60.00	0.25	2.00	43.595	80.00	0.177	2.50	19.779
100.0	0.149	2.75	1.843	200.0	0.074	3.75	0.902				

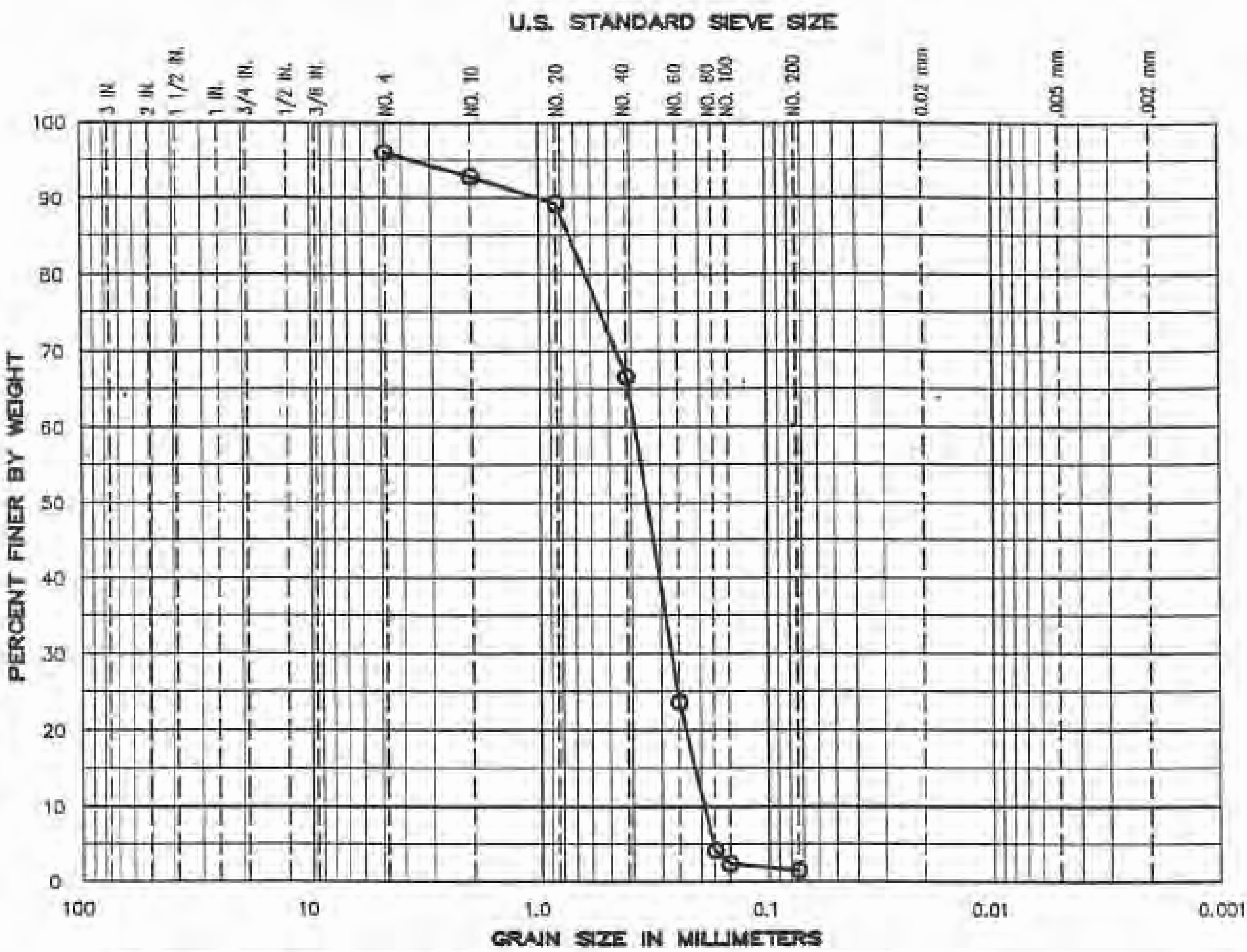
Options: F10: Return to Menu

ACES	Mode: Single Case	Functional Area: Littoral Processes
Application: Calculation of Composite Grain Size Distributions		

Grain Size Classification by Weight Percent

Method	Gravel	Sand Coarse	Sand Medium	Sand Fine	Silt	Clay	Options:
							F1: Next Screen
Wentworth	7.29	3.70	66.48	22.52	0.00	0.00	F10: Return
Unified	4.04	3.26	26.59	66.12	0.00	0.00	

Standard Statistics	Method of Moments	Folk Graphic Measures	Grain Size
Median Diameter		1.91 phi	0.266 mm
Mean Diameter	1.50 phi	1.83 phi	0.354 mm
Standard Deviation	1.10 phi	0.88 phi	
Skewness	-2.08	-0.43	
Kurtosis	7.59	1.81	



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

VIBRACORE SAMPLE TESTING

	Boring	Sample No.	El. or Depth	Classification & Remarks	Nat.WC	LL	PL	PI
o	NJV 250	1	1.5'–2.0'	(VISUAL) POORLY GRADED				
△				LT GREY FINE GRAINED SAND				
□								
+								
*								

GEO-TECHNICAL SERVICES, INC.

CLASSIFICATION TEST

GRADATION CURVES

CONTRACT NO: DACW61–95–D–0008
DELIVERY ORDER NO. 0005

Project: LONG BEACH ISLAND BEACH NOURISHMENT	
Location: NEW JERSEY	
Date: 8/96	
By: D.D.F.	Chk'd By: D.S.R.
	Sheet of

DWGNAME: C:\ACADR12\NJVGRN1

BEACH GRAIN SIZE ANALYSIS SUMMARY AND DETAILED DATA FOR ONE BEACH SAMPLE

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

GEO-Technical Services, Inc.

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ Survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
54	WATER	13	2.47	0.181	0.94	0.521
54	WATER	19	2.22	0.215	0.43	0.742
54	WATER	25	2.26	0.208	0.47	0.722
54	WATER	31	2.39	0.190	0.60	0.660
54	TOE OF DUNE		1.11	0.464	0.53	0.692
54	MID TIDE		1.48	0.360	0.55	0.683
54	BERM CREST		1.99	0.252	0.41	0.753
54	MHW		1.82	0.283	0.44	0.737
55	WATER	13	1.90	0.268	0.76	0.590
55	WATER	19	2.92	0.132	0.83	0.562
55	WATER	25	2.92	0.132	0.75	0.594
55	WATER	31	2.77	0.147	0.83	0.562
55	TOE OF DUNE		1.66	0.316	0.43	0.742
55	MID TIDE		0.99	0.503	0.74	0.599
55	BERM CREST		1.48	0.358	0.42	0.747
55	MHW		1.26	0.417	0.52	0.697
56	WATER	13	1.90	0.269	0.45	0.732
56	WATER	19	2.04	0.244	0.64	0.642
56	WATER	25	3.12	0.115	0.70	0.615
56	WATER	31	2.90	0.134	0.90	0.536
56	TOE OF DUNE		1.44	0.369	0.43	0.742

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
56	MID TIDE		0.96	0.515	0.80	0.574
56	BERM CREST		1.52	0.349	0.44	0.737
56	MHW		1.07	0.477	0.76	0.590
57	WATER	13	2.23	0.213	0.67	0.628
57	WATER	19	2.51	0.176	0.68	0.624
57	WATER	25	2.98	0.127	1.02	0.493
57	WATER	31	3.13	0.114	0.87	0.547
57	TOE OF DUNE		1.43	0.372	0.46	0.727
57	MID TIDE		0.67	0.629	0.94	0.521
57	BERM CREST		1.12	0.460	0.49	0.712
57	MHW		1.38	0.383	0.44	0.737
58	WATER	13	2.04	0.243	0.80	0.574
58	WATER	19	2.41	0.188	0.67	0.628
58	WATER	25	2.79	0.144	0.73	0.603
58	WATER	31	1.81	0.286	0.48	0.717
58	TOE OF DUNE		1.47	0.360	0.46	0.727
58	MID TIDE		0.59	0.665	0.90	0.536
58	BERM CREST		1.56	0.339	0.42	0.747
58	MHW		1.18	0.441	0.50	0.707
59	WATER	13	2.09	0.235	0.83	0.562
59	WATER	19	2.60	0.165	0.78	0.582

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
59	WATER	25	2.21	0.216	0.92	0.528
59	WATER	31	2.93	0.131	1.08	0.473
59	TOE OF DUNE		0.70	0.616	0.69	0.620
59	MID TIDE		0.69	0.621	0.89	0.539
59	BERM CREST		1.40	0.379	0.47	0.722
59	MHW		0.78	0.584	0.69	0.620
60	WATER	13	2.18	0.221	0.80	0.574
60	WATER	19	1.64	0.320	0.69	0.620
60	WATER	25	2.38	0.193	0.67	0.628
60	WATER	31	2.75	0.149	0.79	0.578
60	TOE OF DUNE		1.49	0.355	0.58	0.669
60	MID TIDE		0.59	0.667	0.95	0.517
60	BERM CREST		1.54	0.344	0.50	0.707
60	MHW		0.13	0.916	0.73	0.603
61	WATER	13	2.68	0.156	0.83	0.562
61	WATER	19	3.33	0.099	0.58	0.669
61	WATER	25	1.90	0.268	0.36	0.779
61	WATER	31	2.23	0.212	0.52	0.697
61	TOE OF DUNE		1.38	0.385	0.56	0.678
61	MID TIDE		1.09	0.469	0.490	0.712
61	BERM CREST		0.69	0.620	0.68	0.624

GEO-Technical Services, Inc.

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
61	MHW		1.47	0.362	0.48	0.717
62	WATER	13	2.62	0.163	0.77	0.586
62	WATER	19	3.06	0.120	1.12	0.460
62	WATER	25	3.03	0.123	0.85	0.555
62	WATER	31	3.38	0.096	0.53	0.692
62	TOE OF DUNE		1.52	0.349	0.43	0.742
62	MID TIDE		1.78	0.291	0.38	0.768
62	BERM CREST		1.36	0.391	0.42	0.747
62	MHW		1.31	0.404	0.40	0.758
63	WATER	13	3.04	0.121	0.79	0.578
63	WATER	19	3.32	0.100	0.61	0.655
63	WATER	25	3.48	0.090	0.39	0.763
63	WATER	31	3.56	0.085	0.29	0.818
63	TOE OF DUNE		1.54	0.345	0.50	0.707
63	MID TIDE		1.17	0.443	0.48	0.717
63	BERM CREST		1.44	0.369	0.40	0.758
63	MHW		1.49	0.357	0.45	0.732
64	WATER	13	2.11	0.232	0.77	0.586
64	WATER	19	2.78	0.147	1.00	0.500
64	WATER	25	3.41	0.094	0.48	0.717
64	WATER	31	3.48	0.090	0.54	0.688

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
64	TOE OF DUNE		1.51	0.352	0.42	0.747
64	MID TIDE		1.31	0.402	0.46	0.727
64	BERM CREST		1.34	0.394	0.48	0.717
64	MHW		1.17	0.443	0.47	0.722
65	WATER	13	1.93	0.263	0.82	0.566
65	WATER	19	2.98	0.127	0.74	0.599
65	WATER	25	3.35	0.098	0.53	0.692
65	WATER	31	3.53	0.087	0.34	0.790
65	TOE OF DUNE		1.41	0.375	0.57	0.674
65	MID TIDE		1.16	0.449	0.59	0.664
65	BERM CREST		1.55	0.341	0.42	0.747
65	MHW		1.52	0.348	0.48	0.717
66	WATER	13	2.11	0.232	0.79	0.578
66	WATER	19	3.02	0.123	0.78	0.582
66	WATER	25	3.50	0.088	0.40	0.758
66	WATER	31	3.55	0.086	0.34	0.790
66	TOE OF DUNE		1.42	0.374	0.42	0.747
66	MID TIDE		1.23	0.428	0.56	0.678
66	BERM CREST		1.32	0.401	0.50	0.707
66	MHW		1.43	0.371	0.48	0.717
67	WATER	13	2.50	0.177	0.84	0.559

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
67	WATER	19	2.85	0.139	0.82	0.566
67	WATER	25	3.43	0.093	0.43	0.742
67	WATER	31	3.11	0.116	0.82	0.566
67	TOE OF DUNE		1.53	0.345	0.45	0.732
67	MID TIDE		1.33	0.396	0.56	0.678
67	BERM CREST		1.33	0.398	0.40	0.758
67	MHW		1.31	0.404	0.49	0.712
68	WATER	13	2.76	0.148	0.95	0.517
68	WATER	19	3.06	0.120	1.00	0.500
68	WATER	25	3.43	0.093	0.53	0.692
68	WATER	31	3.58	0.084	0.24	0.847
68	TOE OF DUNE		1.62	0.326	0.44	0.737
68	MID TIDE		1.27	0.414	0.66	0.633
68	BERM CREST		1.59	0.332	0.41	0.753
68	MHW		1.60	0.330	0.44	0.737
69	WATER	13	2.51	0.176	0.93	0.525
69	WATER	19	3.01	0.124	0.76	0.590
69	WATER	25	2.11	0.232	0.60	0.660
69	WATER	31	2.96	0.128	0.87	0.547
69	TOE OF DUNE		0.84	0.560	0.54	0.688
69	MID TIDE		1.58	0.334	0.44	0.737

GEO-Technical Services, Inc.

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ Survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
69	BERM CREST		1.35	0.393	0.62	0.651
69	MHW		1.62	0.326	0.44	0.737
70	WATER	13	3.06	0.120	1.03	0.490
70	WATER	19	3.32	0.100	0.62	0.651
70	WATER	25	3.41	0.094	0.53	0.692
70	WATER	31	3.47	0.090	0.39	0.763
70	TOE OF DUNE		1.56	0.338	0.47	0.722
70	MID TIDE		1.10	0.466	0.81	0.570
70	BERM CREST		1.73	0.302	0.37	0.774
70	MHW		1.78	0.290	0.36	0.779
71	WATER	13	2.49	0.178	0.79	0.578
71	WATER	19	3.38	0.096	0.58	0.669
71	WATER	25	3.55	0.086	0.30	0.812
71	WATER	31	3.56	0.085	0.28	0.824
71	TOE OF DUNE		1.48	0.359	0.48	0.717
71	MID TIDE		1.41	0.377	0.57	0.674
71	BERM CREST		1.07	0.475	0.54	0.688
71	MHW		1.55	0.342	0.45	0.732
72	WATER	13	2.52	0.175	0.75	0.594
72	WATER	19	3.14	0.114	0.65	0.637
72	WATER	25	3.17	0.111	0.63	0.646

GEO-Technical Services, Inc.

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ Survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
72	WATER	31	3.59	0.083	0.21	0.864
72	TOE OF DUNE		1.79	0.289	0.35	0.785
72	MID TIDE		1.55	0.341	0.55	0.683
72	BERM CREST		1.57	0.337	0.47	0.722
72	MHW		1.56	0.340	0.56	0.678
73	WATER	13	2.79	0.144	0.83	0.562
73	WATER	19	2.17	0.223	0.72	0.607
73	WATER	25	1.95	0.260	0.29	0.818
73	WATER	31	3.11	0.116	0.76	0.590
73	TOE OF DUNE		1.62	0.324	0.41	0.752
73	MID TIDE		1.57	0.338	0.48	0.717
73	BERM CREST		1.44	0.369	0.45	0.732
73	MHW		1.76	0.295	0.47	0.722
74	WATER	13	2.53	0.173	1.15	0.450
74	WATER	19	3.47	0.090	0.46	0.727
74	WATER	25	3.39	0.095	0.64	0.642
74	WATER	31	2.37	0.193	0.58	0.669
74	TOE OF DUNE		1.73	0.302	0.39	0.763
74	MID TIDE		1.44	0.368	0.51	0.702
74	BERM CREST		1.65	0.319	0.42	0.747
74	MHW		1.40	0.379	0.44	0.737

SUMMARY SHEET
GRAIN SIZE DISTRIBUTION ANALYSIS (METHOD OF MOMENTS)
LONG BEACH ISLAND BEACH NOURISHMENT
NEW JERSEY
BEACH GRAB SAMPLE TESTING

~~BORING~~ survey line	LOCATION	NUMBER	MEAN DIAMETER		STANDARD DEVIATION	
			(PHI)	(MM)	(PHI)	(MM)
75	WATER	13	2.62	0.163	0.82	0.566
75	WATER	19	3.11	0.116	1.08	0.473
75	WATER	25	3.03	0.122	0.77	0.586
75	WATER	31	2.99	0.126	0.91	0.532

ACES	Mode: Single Case	Functional Area: Littoral Processes
Application: Calculation of Composite Grain Size Distributions		

Composite of Grain Size Distributions

Composite	Title	Date Analyzed
P54W13	LONG BEACH ISLAND-BEACH GRAB SAMPLE TESTING	08/13/96
Analyzer	Comment	Total Weight
MMA		100.00

Type of Samples	Samples in Composite	Top of Composite	Bottom of Composite
	1	0.00 feet	0.00 feet

ASTM MESH	MM Size	PHI Size	Weight (%)	ASTM MESH	MM Size	PHI Size	Weight (%)	ASTM MESH	MM Size	PHI Size	Weight (%)
10.00	2.00	-1.00	0.373	20.00	0.84	0.25	1.453	40.00	0.42	1.25	11.896
60.00	0.25	2.00	28.877	80.00	0.177	2.50	17.373	100.0	0.149	2.75	6.753
200.0	0.074	3.75	33.274								

Options: F10: Return to Menu

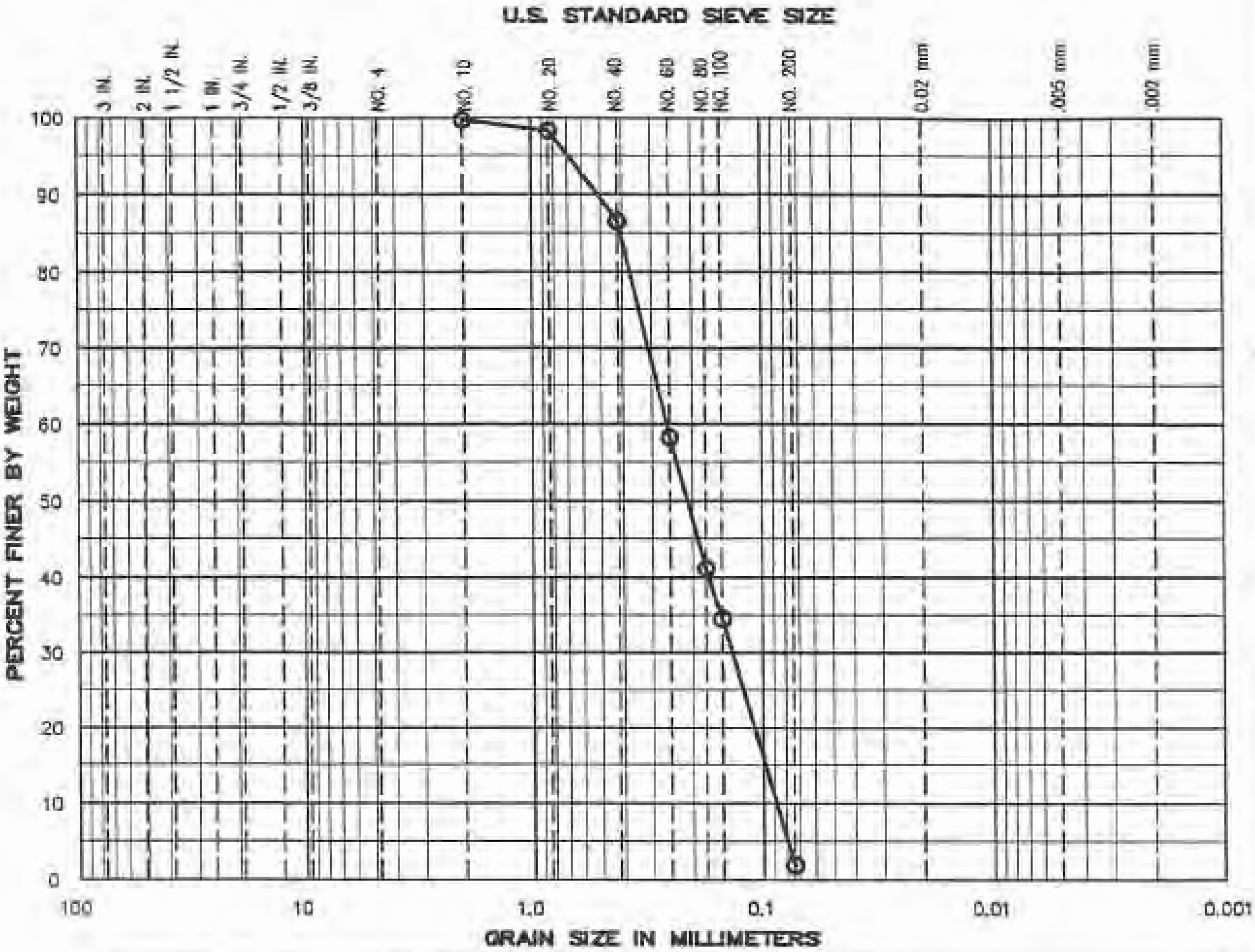
ACES	Mode: Single Case	Functional Area: Littoral Processes
Application: Calculation of Composite Grain Size Distributions		

Grain Size Classification by Weight Percent

Method	Gravel	Sand			Silt	Clay
		Coarse	Medium	Fine		
Wentworth	0.37	1.45	40.77	57.40	0.00	0.00
Unified	0.00	0.37	13.35	86.28	0.00	0.00

Options:
F1: Next Screen
F10: Return

Standard Statistics	Method of Moments	Folk Graphic Measures	Grain Size
Median Diameter		2.46 phi	0.182 mm
Mean Diameter	2.47 phi	2.67 phi	0.181 mm
Standard Deviation	0.94 phi	0.87 phi	
Skewness	-0.23	0.15	
Kurtosis	2.61	0.61	



GRAVEL		SAND			SILT OR CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	

BEACH GRAB SAMPLE TESTING

	Profile	Location	No.	Classification & Remarks	Nat.WC	LL	PL	PI
O	54	WATER	13	(VISUAL) SAND, LIGHT GREY,				
△				MEDIUM GRAINED				
□								
+								
*								

GEO-TECHNICAL SERVICES, INC.
CLASSIFICATION TEST GRADATION CURVES

Project: LONG BEACH ISLAND BEACH NOURISHMENT	
Location: NEW JERSEY	
Date: 8/96	
By: D.D.F.	Chk'd By: D.S.R.
Sheet of	

CONTRACT NO: DACW61-95-D-0008
DELIVERY ORDER NO. 0006

DWGNAME: K:3510\PROFILES

DUFFIELD ASSOCIATES

DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-392

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Barnegat Inlet, NJ
Northing Coord.	: N 335,203.9
Easting Coord.	: E 607,956.2

Uncorrected Depth	: 18.0 feet
Tide	: 3.8 feet
Corrected Depth	: 14.2 feet
Vibration time	: 6'10"
Core penetration	: 17.22 feet
Core recovery	: 20.0 feet
Percent recovery	: 116 %

Depth in Feet	Surf. Elev. -11.9	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0	-15	SP		Light gray/ white fine SAND, little medium sand, trace coarse sand, trace gravel, trace silt/clay	1	1/0.0 -5.0
5	-20	SP		Light gray fine SAND and medium sand, trace coarse sand, trace silt/clay, trace gravel	2	2/5.0-10.0
10	-25	SP		Light gray fine SAND and medium sand, trace silt/clay, trace coarse sand, trace gravel	3	3/10.0-15.0
15		SP		Light gray fine SAND, little medium sand, trace coarse sand, trace gravel, trace silt/clay	4	4/15.0-17.0
	-30	SP		Light gray fine SAND and medium sand, trace silt/clay, trace coarse sand, trace gravel, trace shell		5/17.0-20.0
20						

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES

DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-393

Date	:	July 19,1998
Weather	:	Clear and warm
Vibrocore contractor	:	Alpine Ocean Seismic Sur.
Location	:	Barnegat Inlet, NJ
Northing Coord.	:	N 336,428.5
Easting Coord.	:	E 607,576.8

Uncorrected Depth	:	21.5 feet
Tide	:	4.3 feet
Corrected Depth	:	17.2 feet
Vibration time	:	4'53"
Core penetration	:	18.18 feet
Core recovery	:	18.7 feet
Percent recovery	:	103 %

Depth in Feet	Surf. Elev. -14.9	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0	-15	SP		Light gray fine SAND and medium sand, trace coarse sand, trace silt/clay, trace gravel, trace shells	1	1/0.0 - 5.0
5	-20	SP		Gray medium SAND and fine sand, trace coarse sand, trace gravel	2	2/5.0-6.6
		SP		Gray fine SAND, trace medium sand, trace silt/clay, trace coarse sand, trace gravel	2	3/6.6-10.0
10	-25	SP		White/gray fine SAND, some medium sand, trace silt/clay, trace coarse sand, trace gravel	3	4/10.0-15.0
15	-30	SP		White/gray fine SAND, some medium sand, trace silt/clay, trace coarse sand	4	5/15.0-18.7
20						

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES
DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore – New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-394

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Barnegat Inlet, NJ
Northing Coord.	: N 336,878.7
Easting Coord.	: E 608,669.9

Uncorrected Depth	: 20.6 feet
Tide	: 4.8 feet
Corrected Depth	: 15.8 feet
Vibration time	: 5'15"
Core penetration	: 18.31 feet
Core recovery	: 18.7 feet
Percent recovery	: 102 %

Depth in Feet	Surf. Elev. -13.5	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0–5	-15	SP		Gray fine SAND, some medium sand, trace silt/clay, trace coarse sand, trace gravel, trace shells	1	1/0.0 – 5.0
5–10	-20	SP		Gray fine SAND, little medium sand, trace silt/clay, trace coarse sand, trace gravel	2	2/5.0-10.0
10–12	-25	SP		Light gray fine SAND, little medium sand, trace silt/clay, trace coarse sand, trace gravel	3	3/10.0-12.0
12–15		SM/SC		Gray/black fine SAND, trace silt/clay, trace medium sand, trace coarse sand, trace gravel	3	4/12.0-15.0
15–18.7	-30	SP/SM/SC		Gray/black fine SAND, trace silt/clay, trace medium sand, trace coarse sand, trace gravel	4	5/15.0-18.7
20						

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES

DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

Vibrocore NJV-395

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Barnegat Inlet, NJ
Northing Coord.	: N 335,920.2
Easting Coord.	: E 609,235.0

Uncorrected Depth:	17.5 feet
Tide	: 2.1 feet
Corrected Depth	: 15.4 feet
Vibration time	: 5'53"
Core penetration	: 17.1 feet
Core recovery	: 18.0 feet
Percent recovery	: 105 %

Depth in Feet	Surf. Elev. -13.1	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0	-15	SP		White/light gray fine SAND, trace medium sand, trace silt/clay, trace coarse sand	1	1/0.0 - 5.0
5	-20	SP		Gray fine SAND, trace medium sand, trace silt/clay, trace coarse sand, trace grave, trace shell	2	2/5.0-10.0
10	-25	SP		Light gray fine SAND, trace medium sand, trace silt/clay, trace coarse sand	3	3/10.0-15.0
15	-30	SP		Gray fine SAND, little medium sand, trace silt/clay	4	4/15.0-18.0
20						

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES
DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-471

Date	: July 18,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Harvey Cedars, NJ
Northing Coord.	: N 307,848.6
Easting Coord.	: E 609,122.1

Uncorrected Depth:	52.2 feet
Tide	: 5.2 feet
Corrected Depth	: 47.0 feet
Vibration time	: 5'02"
Core penetration	: 16.08 feet
Core recovery	: 17.0 feet
Percent recovery	: 106 %

Depth in Feet	Surf. Elev. -44.7	USCS	DESCRIPTION	Core Interval	Sample No./Interval
0	-45	SP	White/light gray fine SAND, little medium sand, trace coarse sand, trace silt/clay, trace shells, trace gravel	1	1/0.0 -5.0
5	-50	SP	White/light gray fine SAND, trace medium sand, trace silt/clay, trace coarse sand, trace gravel, trace shells	2	2/5.0-10.0
10	-55	SP	Gray fine SAND, trace medium sand, trace gravel, trace coarse sand, trace silt/clay	3	3/10.5-11.5
		CL	Gray SILT/CLAY, trace fine sand		
		SP	Gray fine SAND, trace shell fragments		4/12.0-15.0
		ML/CL	Gray SILT/CLAY, trace fine sand		
		GP	Gray/tan GRAVEL, some medium sand, little coarse sand, little fine sand, trace silt/clay, trace shells		
15	-60	SP	Tan medium SAND, some fine sand, little coarse sand, trace gravel, trace silt/clay	4	5/15.0-17.0
20					

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES
DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-472

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Harvey Cedars, NJ
Northing Coord.	: N 305,788.0
Easting Coord.	: E 604,107.6

Uncorrected Depth:	49.0 feet
Tide	: 1.4 feet
Corrected Depth	: 47.6 feet
Vibration time	: 6'14"
Core penetration	: 15.19 feet
Core recovery	: 18.4 feet
Percent recovery	: 121 %

Depth in Feet	Surf. Elev. -45.3	USCS	DESCRIPTION	Core Interval	Sample No./Interval
0		ML/CL	Gray SILT/CLAY, trace fine sand, trace medium sand, trace coarse sand	1	1/0.0 -3.2
		GP/SP	GRAVEL and medium sand, some coarse sand, trace fine sand, trace silt/clay		2/3.2-5.0
5	-50	SP	Tan/gray medium SAND, some gravel, little fine sand, trace coarse sand, trace silt/clay	2	3/5.0-10.0
10	-55	SP	Tan/gray medium SAND, little fine sand, trace coarse sand, trace gravel, trace silt/clay	3	4/10.0-15.0
15	-60	SP	Gray/brown medium to fine SAND, trace coarse sand	4	5/15.0-18.4
20	-65				

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES

DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-473

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Beach Haven Crest, NJ
Northing Coord.	: N 285,814.4
Easting Coord.	: E 585,286.0

Uncorrected Depth:	31.4 feet
Tide	: 0.6 feet
Corrected Depth	: 30.8 feet
Vibration time	: 2'44"
Core penetration	: 18.43 feet
Core recovery	: 20.0 feet
Percent recovery	: 109 %

Depth in Feet	Surf. Elev. -28.5	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0–5	-30	SP		Tan/gray fine SAND, trace medium sand, trace coarse sand, trace silt/clay	1	1/0.0 -5.0
5–8.4	-35	SP		Gray fine SAND, trace medium sand, trace coarse sand, trace silt/clay	2	2/5.0-8.4
8.4–10		ML/CL		Gray/brown SILT/CLAY		3/8.4-10.0
10–15	-40	ML/CL		Gray SILT/CLAY, little fine sand	3	4/10.0-15.0
15–17	-45	ML/CL		Gray SILT/CLAY		5/15.0-17.0
17–20		SW/SM/SC		Gray/brown medium SAND, some gravel, little coarse sand, trace fine sand, trace silt/clay	4	6/17.0-20.0

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES
DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL (302)239-6634 FAX (302)239-8485
E-MAIL DUFFIELD@DUFFNET.COM

U.S. Army Corps of Engineers
Vibrocore – New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Vibrocore NJV-474

Date	: July 19,1998
Weather	: Clear and warm
Vibrocore contractor	: Alpine Ocean Seismic Sur.
Location	: Beach Haven Crest, NJ
Northing Coord.	: N 281,875.6
Easting Coord.	: E 582,501.2

Uncorrected Depth	: 36.0 feet
Tide	: 0.4 feet
Corrected Depth	: 35.6 feet
Vibration time	: 2'35"
Core penetration	: 18.02 feet
Core recovery	: 17.0 feet
Percent recovery	: 94 %

Depth in Feet: 0–20; Surf. Elev. –33.3 (scale marks –35, –40, –45, –50)

USCS	DESCRIPTION	Core Interval	Sample No./Interval
SP	Gray fine SAND, little silt/clay, trace medium sand, trace coarse sand	1	1/0.0 – 5.0
SP	Gray fine SAND, some silt/clay, trace medium sand	2	2/5.0-6.6
ML/CL	Gray SILT/CLAY, trace fine sand	2	3/6.6-9.7
SP/GP	Gray coarse SAND and gravel, trace fine sand, trace medium sand	2	
GP/SP	Gray GRAVEL and coarse sand, trace medium sand, trace fine sand	3	4/11.0-15.0
ML/CL	Gray SILT/CLAY	3	
SP	Light gray medium SAND, some fine sand, trace coarse sand, trace gravel, trace silt/clay	3	
SP	Light gray medium SAND, some fine sand, trace coarse sand, trace gravel, trace silt/clay	4	5/15.0-17.2

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

DUFFIELD ASSOCIATES
DUFFIELD ASSOCIATES, INC.
CONSULTANTS IN THE GEOSCIENCES
5400 LIMESTONE ROAD
WILMINGTON, DELAWARE 19808-1232
TEL. (302)239-6634 FAX (302)239-8485
E-MAIL: DUFFIELD@DUFFNET.COM

Vibrocore NJV-475

U.S. Army Corps of Engineers
Vibrocore - New Jersey
Contract Number DACW-61-98-D-0008
Task Order 2
Barnegat Inlet Study Area

Date	:	July 19,1998
Weather	:	Clear and warm
Vibrocore contractor	:	Alpine Ocean Seismic Sur.
Location	:	Beach Haven Crest, NJ
Northing Coord.	:	N 279,871.2
Easting Coord.	:	E 579,684.7

Uncorrected Depth	:	32.7 feet
Tide	:	0.5 feet
Corrected Depth	:	32.2 feet
Vibration time	:	3'00"
Core penetration	:	19.07 feet
Core recovery	:	17.0 feet
Percent recovery	:	89 %

Depth in Feet	Surf. Elev. -29.9	USCS	GRAPHIC	DESCRIPTION	Core Interval	Sample No./Interval
0	-30	ML/CL		Gray SILT/CLAY, little sand	1	1/0.5 - 5.0
		SM/ML/SC/CL		Gray SILT/CLAY and fine sand, trace medium sand, trace coarse sand		
5	-35	SM/SC		Gray fine SAND, little silt/clay, trace medium sand	2	2/5.0-10.0
10	-40	SP		Gray fine SAND, little silt/clay, little medium sand, trace coarse sand	3	3/10.0-15.0
15	-45	SP		Gray coarse SAND, some silt/clay	4	
		ML/CL		Gray SILT/CLAY, trace medium sand, trace fine sand		4/16.2-17.0
		SP		Gray medium SAND, little fine sand, trace coarse sand, trace gravel, trace silt/clay		
20						

Notes:
1. Sample depths are based on core recovery lengths.
2. Water depth is in terms of MLLW.
3. Ground surface elevation is in terms of NVGD.

SECTION 5

ENVIRONMENTAL AND CULTURAL INVESTIGATIONS

The Environmental Inpact Statement (EIS) is integrated into the main report. Additional environmental and cultural data can be found in Appendices C-E (Volume 3) and in the main report itself.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 6

PROJECT DESIGN

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

BARNEGAT INLET TO LITTLE EGG HARBOR FEASIBILITY STUDY

EXISTING STRUCTURES.

PRIOR AND EXISTING SHORE PROTECTION MEASURES

Stabilization of the South Shoulder of Barnegat Inlet. The first efforts to control shore erosion on Long Beach Island had taken place prior to 1920. Those early efforts involved stabilization structures along the south shoulder of Barnegat Inlet to arrest the inlet's southward migration, and oceanfront erosion control measures involving the construction of a "jetty" (groin) at Surf City and two "hurdle" structures at Beach Haven. Beginning in 1926, concentrated efforts were taken by the State and Federal governments to stabilize the south shoulder of Barnegat Inlet by means of groins, revetments, and bulkheads. This work was accomplished in various stages up to 1956 and included repairs and restorations as well as new work. By 1956, the 3,000 linear feet of inlet shoreline between the lighthouse and the land anchor point of the original south jetty were stabilized by nine groins and approximately 1,250 lineal feet of bulkheads. These protective structures are now land-locked in the area which has filled with littoral material between the new and original south jetty structures. The 4,270 feet long new south jetty was constructed from 1987 to 1991 nearly parallel to the existing north jetty to correct for shoaling and channel instability created by the original converging configuration of the Barnegat Inlet jetties.

Placement of Oceanfront Fixed Structures in the Period 1920-1940. The ocean shoreline, south of the original Barnegat Inlet south jetty, has a history of shore protection concerns and actions which began essentially at the same time it became evident that action was needed to address the southward migration of Barnegat Inlet. Apart from the work prior to 1920, previously mentioned with respect to Surf City and Beach Haven, records indicate that the State and local communities constructed at least six groins on Long Beach Island in the latter half of the 1920's, see USACE, 1974. Four of these groins were built in Harvey Cedars, and two in Beach Haven. Though protective measures along the oceanfront may have been implemented in the 1930's, there is no documentation of additional shore protection works until 1940, at which time, two timber bulkheads, having a composite length of 950 feet, were constructed at Harvey Cedars. This was followed in 1946 by construction of a 250-foot long timber bulkhead at Brant Beach (LBT); construction of one groin in Holgate (LBT) in 1947; construction of one groin at the north end of Brant Beach in 1949 (LBT); and, also in 1949, construction of one groin at the south end of Beach Haven Park (LBT).

Placement of Oceanfront Fixed Structures in the 1950's**.** Shore protection measures at Long Beach Island, in the decade of the 1950's, began with the construction, in 1950, of two timber bulkheads, having a combined length of 560 feet, at Brant Beach (LBT). As an alternative to bulkhead construction, a gravel-fill dike having a length of 2,800 feet was constructed at Surf City in the period 1953-1954. At Beach Haven, two groins were constructed in 1953, and one groin in 1956 along with a 200-foot long timber bulkhead. At the southern end of the island in Holgate (LBT), four groins were built in 1957 and one groin in 1958.

Placement of Oceanfront Fixed Structures in the 1960's and Present Conditions. The decade of the 1960's was, by far, the study area's most prolific period in the construction of shore protection measures, principally with the placement of groins. At present, there are 101 groin structures which compartment the shoreline along the developed oceanfront of Long Beach Island. Of the 101 existing groins, 86 of these structures were constructed n the 1960's, and most of these, i.e., 69 groins, were built in the period 1963-1964.

The Long Beach Island groin structures are spaced at intervals that range from 750 to 1,000 feet, with the average spacing being 900 feet. The groin lengths range from 250 to 420 feet, with an average length of 285 feet. This results in an average spacing-to-length ratio of about 3 to 1, which is at the upper end of spacing-to-length relationships usually applied in groin field planning and design. The horizontal inshore segments of most of the groins have crown levels at elevations of about 8.2 feet above NGVD and are generally above the level of the natural beach berm and foreshore surface elevations; thereby, obviating any significant littoral transport directly through the respective groin compartments.

Most of the groins, 75 in number, are of composite stone and timber construction. Additionally, 26 groins are constructed of stone, 1 groin is of timber construction, 1 groin is comprised of stone and sand bags, and 1 groin was built with a combination of stone and surplus steel submarine defense netting. A visual inspection of the structural conditions of the island's existing oceanfront groins was conducted by the USACE, Philadelphia District in 1990. The findings of the 1990 inspection, given in qualitative terms, were that: 17 groins (16%) were in good condition; 63 groins (61%) were in fair condition; 22 groins (21%) were in poor condition; and 2 groins (2%), in Barnegat Light, were covered by beach material and not visible for inspection. It should be noted that groins are the only type of fixed shore protection measure which now exists along the oceanfront of Long Beach Island. The timber bulkheads and gravel-filled dike, mentioned previously, were all destroyed by the severe storm of March 1962. Remnants of bulkheads constructed before 1962 remain in some other sections of Long Beach Island. However, all are either damaged beyond functional use or are completely buried under the existing dune. It should be noted also that most of these remaining bulkheads are small scale and were originally designed to protect one home.

A detailed evaluation of Long Beach Island's coastal structures was made in 1971 as part of a larger Federal inventory of the entire East Coast. The Philadelphia District Corps of Engineers updated this inventory and reassessed the condition of the coastal structures on Long Beach Island in 1990 via site inspection as part of a larger Corps of Engineers limited Reconnaissance Study of the New Jersey coast from Manasquan Inlet to Cape May.

The Philadelphia District Corps of Engineers updated this inventory and reassessed the condition of the coastal structures on Long Beach Island in 1996 via site inspection as part of a larger Corps of Engineers feasibility study of the New Jersey coast from Barnegat Inlet to Little Egg Inlet. The findings of the 1996 inspection, given in qualitative terms, were that: 15 groins (15%) were in excellent condition; 53 groins (53%) were in good condition; 21 groins (21%) were in fair condition; 9 groins (9%) were in poor condition; and 2 groins (2%), in Barnegat Light, were covered by beach material and not visible for inspection. The results of the Long Beach Island portion of that survey can be found in Table 1.

		Adjacent	Dist to			SHOALS		Dist from end	MHW	Area						Shoreline Change			OFFSETS	
GROIN ID	Length (N)	LRP	Groin	LOCATION	ST_NAME	LENGTH	LENGTH	to c.l. Dune	Peak El	Above Profile	CONTYPIN	CONTYPOT	PROFILE	CONDITION	PERMEABILITY	N of Grn	S of Grn	Net Transport	Mean	Std
1	9253	54,55	-710.5	Loveladies	LAYLIA	116.55	40	277.2	2.50		stone	stone	LEVEL	good	High	28.78	2.31		-172.9	609.1
2	890	55-1	182.4	Loveladies	DOLPHIN	143.32	75	270.6			wood	stone	SLOPED	good	Medium	2.31	1.06		-74.6	19.0
3	820	55-1	1000.5	Loveladies	Seaview Drive North	175.23	150	250.8	1.00	9.62	wood	stone	SLOPED	good	Medium	1.06	-1.03		-63.7	31.5
4	877	56	-633.4	Loveladies	Arts Lane/Sandy Cove	222.75	170	281.4	5.00	20.38	wood	stone	LEVEL	fair	Low	-1.03	0.82		-80.9	23.4
5	807	56	156.5	Loveladies	Coast Ave	252.78	182	298.4	6.00	31.99	wood	stone	SLOPED	fair	Low	0.82	-1.23		-96.8	23.9
6	700	56	870.8	Loveladies	Tidal/Riviera	184.49	170	284.9	1.50	11.43	wood	stone	SLOPED	fair	Low	-1.23	-0.36		-105.6	35.8
7	884	56-1	-218.8	Loveladies	Pompano/Oceana Drs.	193.69	170	305.0	0.00	9.50	wood	stone	LEVEL	good	Low	-0.36	-0.23		-113.4	47.8
8	818	57	-410.3	Loveladies	Nautilus/September L	187.66	146	305.0	2.00	19.83	wood	stone	SLOPED	good	Low	-0.23	-1.16		-140.1	44.0
9	898	57	-94.4	Loveladies	Panorama South	185.70	170	302.0	2.50	10.21	wood	stone	SLOPED	good	Low	-1.16	-1.33		-148.6	50.1
10	866	57-1	-363.3	Loveladies	Windrift	194.32	148	298.0	2.00	N/A	wood	stone	SLOPED	good	Medium	-1.33	-2.17		-139.7	63.6
11	876	57-1	508.6	Loveladies	South of Longview Ln	224.66	180	291.1	0.75	11.07	wood	stone	SLOPED	poor	Medium	-2.17	-1.52		-150.7	54.3
12	858	57-1	1392.6	Loveladies	North of Seashell Ln	170.27	110	270.1	1.50	9.81	wood	stone	SLOPED	fair	Low	-1.52	0.03		-153.1	58.3
13	861	58	-1343.4	Loveladies	Seashell Ln	190.34	148	285.6	1.50	17.50	wood	stone	SLOPED	excellent	Low	0.03	0.58		-150.4	59.3
14	796	58	-541.9	Harvey Cedars	85th St	225.10	200	310.4	5.00	N/A	stone	stone	SLOPED	excellent	High	0.58	0.54		-166.9	54.6
15	777	58	254.7	Harvey Cedars	82nd St	211.29	200	324.3	4.00	N/A	stone	stone	SLOPED	excellent	High	0.54	0.46		-125.5	55.2
16	1049	58-1	-376.9	Harvey Cedars	78th St	251.48	200	327.9	3.00	22.10	stone	stone	SLOPED	excellent	High	0.46	-0.59		-136.9	48.3
17	1044	58-1	676.4	Harvey Cedars	74th. St	190.87	200	321.0	3.50	N/A	stone	stone	SLOPED	excellent	High	-0.59	-0.22		-134.6	39.2
18	867	59	995.3	Harvey Cedars	Sussex Ave	203.51	200	338.2	4.00	N/A	stone	stone	SLOPED	fair	High	-0.22	-0.85		-82.3	67.6
19	893	59	-96.7	Harvey Cedars	Essex Ave	201.16	200	340.2	2.00	10.23	stone	stone	SLOPED	fair	High	-0.85	-1.53		-100.6	37.8
20	793	59	691.9	Harvey Cedars	Mercer Ave	193.37	200	320.4	3.50	10.88	stone	stone	SLOPED	poor	High	-1.53	-3.12		-59.8	38.4
21	992	59-1	-142.1	Harvey Cedars	Burlington Ave	204.69	200	302.4	2.00	17.86	stone	stone	SLOPED	poor	High	-3.12	-5.87		-80.2	40.7
22	922	59-1	786.5	Harvey Cedars	Salem Ave	229.52	200	337.6	5.00	N/A	stone	stone	SLOPED	poor	High	-5.87	-3.58		-55.1	59.4
23	865	60	-1220.9	Harvey Cedars	Cumberland Ave	224.88	225	318.3	2.50	15.22	stone	stone	SLOPED	poor	High	-3.58	-3.46		-27.1	53.0
24	1158	60	-73.3	Harvey Cedars	Bergen Ave	255.41	200	331.9	5.00	13.64	stone	stone	SLOPED	fair	High	-3.46	-1.40		-21.1	55.1
25	1041	60-1	-931.2	North Beach		214.51	154	297.9	1.30	8.66	wood	stone	SLOPED	fair	Medium	-1.40	-2.97		-33.2	76.1
26	810	60-1	-117.6	North Beach		232.59	170	294.0	1.20	9.90	wood	stone	SLOPED	excellent	High	-2.97	-4.61		-19.5	69.3
27	804	60-1	697.6	North Beach		275.80	120	311.4	1.00	13.14	wood	stone	SLOPED	fair	Medium	-4.61	-4.60		6.1	61.1
28	803	61	-1107.2	North Beach		202.50	170	304.9	1.10	10.70	wood	stone	SLOPED	fair	Medium	-4.60	-7.32		-30.6	69.4
29	797	61	-308.1	North Beach		201.15	166	317.7	1.50	17.90	wood	stone	SLOPED	good	Medium	-7.32	-6.83		-35.3	31.9
30	806	61	488.8	North Beach		172.99	144	298.3	1.60	12.40	wood	stone	SLOPED	good	Medium	-6.83	-7.80		-28.6	21.6
31	795	61-1	-1067.6	North Beach		174.03	88	274.0	1.60	9.70	wood	stone	SLOPED	good	Medium	-7.80	-3.73		-45.8	31.6
32	802	61-1	-273.6	North Beach		248.42	135	339.0	2.00	23.20	wood	stone	SLOPED	fair	Medium	-3.73	-3.86		-46.9	39.9
33	1145	61-1	872.2	Surf City		212.78	146	302.3	1.50	N/A	wood	stone	SLOPED	fair	Medium	-3.86	-4.85		-75.3	35.1
34	1045	62	290.2	Surf City	19th St	250.55	153	296.7	2.20	16.64	wood	stone	SLOPED	fair	Medium	-4.85	-3.01		-32.8	36.6
35	1073	62-1	-623.6	Surf City	15th St	251.05	160	294.8	5.00	N/A	wood	stone	SLOPED	good	Medium	-3.01	-10.00		-8.1	27.8
36	1064	62-1	459.1	Surf City	11th St	223.81	160	304.8	2.00	18.90	wood	stone	SLOPED	fair	Medium	-10.00	-2.75		19.4	51.0
37	1058	63	-1069.1	Surf City	7th St. North	235.30	165	331.3	4.00	N/A	wood	stone	SLOPED	good	Medium	-2.75	-1.19		39.1	49.6
38	1121	63	46.2	Surf City	3rd St. North	235.14	158	314.9	2.00	14.10	wood	stone	SLOPED	good	Medium	-1.19	-0.61		34.6	40.9
39	1053	63	1107.3	Surf City	1st St South	227.34	150	303.6	2.00	9.60	wood	stone	SLOPED	excellent	Medium	-0.61	0.07		24.1	32.3
40	1053	63-1	-372.7	Ship Bottom	5th St	183.39	117	290.2	0.60	5.90	wood	stone	SLOPED	good	Medium	0.07	-0.03		29.9	42.7
41	1044	63-1	684.8	Ship Bottom	9th St	203.39	150	287.3	0.40	5.60	wood	stone	SLOPED	good	Medium	-0.03	-1.41		53.4	13.9
42	1065	64	31.7	Ship Bottom	13th St	216.24	130	314.2	1.60	10.84	wood	stone	SLOPED	excellent	Medium	-1.41	0.12		45.4	46.9
43	1057	64-1	-628.8	Ship Bottom	17th St	221.29	92	304.9	0.60	2.80	wood	stone	SLOPED	good	Medium	0.12	2.30		45.0	47.7
44	1059	64-1	426.9	Ship Bottom	21st St	176.29	50	277.4	0.60	N/A	wood	stone	SLOPED	good	Medium	2.30	2.38		-4.0	25.6
45	1051	65	-1306.5	Ship Bottom	25th St	174.36	70	276.2	1.40	4.70	wood	stone	SLOPED	good	Medium	2.38	-1.07		-15.7	18.6
46	936	65	-374.3	Ship Bottom	29th St	179.38	124	287.2	0.90	6.80	wood	stone	SLOPED	good	Medium	-1.07	2.28		3.5	26.5
47	985	65	619.2	Ship Bottom	34th St	158.96	74	273.0	2.00	6.98	wood	stone	SLOPED	good	Medium	2.28	3.64		13.8	72.7
48	780	65-1	-485.2	Long Beach Township	38th St	215.24	200	282.5	3.00	N/A	stone	stone	SLOPED	good	High	3.64	-1.44		19.0	39.1
49	818	65-1	325.0	Long Beach Township	42nd St	150.11	112	219.5	3.00	N/A	wood	combo	SLOPED	good	Medium	-1.44	-2.12		61.9	63.3
50	803	66	-374.4	Long Beach Township	46th St	192.87	160	257.5	2.00	13.70	wood	wood	SLOPED	needs attention	High	-2.12	-1.19		37.2	61.4
51	806	66	446.1	Long Beach Township	50th St	186.02	120	223.3	-0.50	6.10	wood	combo	SLOPED	poor	Medium	-1.19	-0.86		-18.7	33.8
52	791	66-1	-319.2	Long Beach Township	Sumner Ave/ 54th	174.89	120	223.1	1.50	9.00	wood	combo	SLOPED	fair	Low	-0.86	0.02		-9.9	57.0
53	760	66-1	429.8	Long Beach Township	Selfridge Ave/57th	179.63	108	260.9	4.00	N/A	wood	stone	SLOPED	fair	Low	0.02	-0.27		-4.5	77.5
54	740	67	-499.2	Long Beach Township	Stanton Ave/ 60th	226.52	120	281.5	2.00	9.90	wood	combo	SLOPED	poor	High	-0.27	-1.01		-20.1	69.4
55	759	67	253.2	Long Beach Township	Goldsborough Av/63rd	188.26	163	247.9	0.30	6.40	wood	stone	SLOPED	fair	Medium	-1.01	-1.25		-39.5	38.1
56	751	67-1	-1085.1	Long Beach Township	Goodrich Ave/ 66th	232.63	120	305.6	5.00	20.70	wood	stone	SLOPED	good	Medium	-1.25	0.53		-51.1	81.4
57	747	67-1	-345.6	Long Beach Township	Stockton Ave/ 69th	182.43	172	243.3	6.00	11.30	wood	stone	SLOPED	good	Medium	0.53	-1.22		-49.6	59.2
58	754	67-1	400.4	Long Beach Township	Coughlan	173.13	158	239.7	5.50	15.40	wood	wood	SLOPED	excellent	Low	-1.22	-5.56		-71.1	25.3
59	817	67-1	1233.7	Long Beach Township	CULVER	207.41	140	285.7	3.00	N/A	wood	wood	SLOPED	excellent	Low	-5.56	-5.04		-66.0	39.8
60	620	68	-636.2	Long Beach Township	WINIFRED	162.56	140	247.4	4.00	7.20	wood	wood	SLOPED	excellent	Low	-5.04	-5.17		-31.8	31.6
61	1034	68	396.3	Long Beach Township	New York	182.24	115	294.5	1.30	8.40	wood	stone	LEVEL	good	High	-5.17	-3.69		-76.8	25.3
62	881	68-1	-491.9	Long Beach Township	SAILBOAT	169.73	80	266.0	0.40	2.30	wood	stone	LEVEL	good	Medium	-3.69	1.63		-14.2	80.5
63	1042	68-1	543.1	Long Beach Township	MARINERS	156.93	128	269.6	0.30	3.30	wood	stone	SLOPED	good	Medium	1.63	2.45		7.3	57.6
64	849	68-1	1381.7	Long Beach Township	MURIEL	162.25	65	276.6	2.50	7.00	wood	stone	LEVEL	good	High	2.45	0.98		34.2	26.2
65	833	69	-218.9	Long Beach Township	TEXAS	194.84	130	294.4	2.00	10.70	wood	stone	SLOPED	good	Medium	0.98	3.84		65.2	67.9
66	888	69	660.8	Long Beach Township	Nebraska	230.33	200	319.1	5.00	30.00	stone	stone	SLOPED	good	Low	3.84	-1.56		57.2	62.6
67	1100	69-1	-332.7	Long Beach Township	S. Carolina	180.78	176	264.2	0.50	9.70	wood	wood	SLOPED	excellent	Low	-1.56	-2.51		42.9	71.3
68	826	69-1	504.5	Long Beach Township	Mississippi	214.30	172	292.3	0.60	9.10	wood	wood	SLOPED	poor	Low	-2.51	-2.19		-7.7	69.3
69	1067	70	-708.1	Long Beach Township	Hollybanks	242.18	146	313.8	2.00	8.00	wood	stone	SLOPED	excellent	Medium	-2.19	-1.28		-44.6	55.6
70	735	70	16.0	Long Beach Township	Ryerson	182.22	85	284.1	2.00	8.10	wood	stone	SLOPED	good	Medium	-1.28	0.19		-20.5	81.0
71	920	70	944.2	Long Beach Township	Indiana	164.05	85	277.3	0.70	4.30	wood	stone	SLOPED	good	Medium	0.19	-0.35		-36.0	74.3
72	880	70-1	-279.6	Long Beach Township	Delaware	182.12	100	272.1	2.50	13.70	wood	stone	LEVEL	good	Medium	-0.35	-1.60		-22.1	54.3
73	902	70-1	626.5	Long Beach Township	31st	222.50	85	294.9	0.90	8.60	wood	stone	LEVEL	good	Medium	-1.60	-4.41		-47.5	62.0
74	923	71	-278.5	Long Beach Township	27th	197.76	85	273.1	1.50	23.00	wood	stone	LEVEL	good	Medium	-4.41	-2.64		0.4	58.3
75	1075	71	808.7	Long Beach Township	23rd	159.89	100	271.1	-0.50	12.40	wood	stone	LEVEL	good	Medium	-2.64	0.67		-23.5	67.4
76	1005	71-1	-329.4	Long Beach Township	19th	109.26	50	254.1	4.00	N/A	stone	stone	LEVEL	good	Medium	0.67	2.65		-15.6	71.4
77	1000	71-1	675.2	Long Beach Township	15th	157.09	125	272.9	4.00	N/A	wood	stone	LEVEL	good	Medium	2.65	1.87		-20.7	55.6
78	1215	72	-226.1	Beach Haven	Tenth st	153.01	125	294.3	2.50	16.80	stone	stone	LEVEL	good	Medium	1.87	3.64		-29.6	58.6
79	1016	72	777.3	Beach Haven	Seventh st	120.61	125	263.1	2.00	N/A	stone	stone	SLOPED	good	Medium	3.64	3.02		-3.4	81.3
80	1019	72-1	1796.4	Beach Haven	Third st	140.87	65	288.2	2.50	N/A	stone	stone	SLOPED	good	Low	3.02	2.39		58.0	129.3

Table 1

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

		Adjacent	Dist to			SHOALS		Dist from end	MHW	Area						Shoreline Change			OFFSETS	
GROIN ID	Length (N)	LRP	Groin	LOCATION	ST_NAME	LENGTH	LENGTH	to c.l. Dune	Peak El	Above Profile	CONTYPIN	CONTYPOT	PROFILE	CONDITION	PERMEABILITY	N of Grn	S of Grn	Net Transport	Mean	Std
81	1267	72-1	-1718.0	Beach Haven	Amber	196.57	70	332.6	2.00	N/A	stone	stone	SLOPED	fair	Medium	2.39	2.74		56.5	87.8
82	1119	72-1	-604.8	Beach Haven	ocean	212.78	80	344.5	2.00	N/A	stone	stone	SLOPED	good	Medium	2.74	0.42		102.1	73.6
83	1031	72-1	411.6	Beach Haven	Chatsworth	219.32	90	292.9	4.00	27.00	stone	stone	SLOPED	good	Medium	0.42	0.97		141.0	83.4
84	1316	73A	42.5	Beach Haven	Holyoke	400.99	180	389.0	5.00	49.90	stone	combo	SLOPED	fair	Low	0.97	-2.50		294.2	154.3
85	1341	73-1	-647.6	Beach Haven	Jeffries	240.67	160	345.0	5.00	N/A	combo	combo	SLOPED	good	Low	-2.50	-4.54		240.5	61.4
86	#N/A	73-1	#N/A	Beach Haven	Leeward		0				stone	stone	SLOPED	excellent	Low	*-4.54*	*-4.97*			
87	1041	73-1	382.1	Beach Haven	Nelson		56				wood	wood	SLOPED	good	Low	*-4.54*	*-4.97*			
88	193	73-1	575.1	Long Beach Township	Nelson	230.05	110	335.3	5.00	N/A	stone	stone	SLOPED	good	Low	*-4.54*	*-4.97*		207.4	114.1
89	541	73-1	118.9	Beach Haven	Marshall	148.20	25	274.4	0.60	N/A	stone	stone	SLOPED	good	Medium	-4.97	-0.73		82.3	97.8
90	498	74	-950.4	Beach Haven	Susan	158.86	30	274.7	-0.90	N/A	stone	stone	SLOPED	good	Medium	-0.73	-1.43		35.6	
91	497	74	-462.4	Beach Haven	webster	137.20	25	241.6	-0.20	N/A	stone	stone	SLOPED	good	Medium	-1.43	-3.53		-53.6	66.7
92	507	74	45.3	Beach Haven	Rosemma	243.80	70	299.2	-0.20	N/A	stone	stone	SLOPED	good	Medium	-3.53	-3.97		-39.7	64.9
93	780	74	825.9	Beach Haven	Julia	178.33	35	213.0	1.20	N/A	stone	stone	SLOPED	fair	Medium	-3.97	-2.97		-52.3	61.4
94	1029	74-1	-536.8	Beach Haven	Holgate	162.13	70	229.8			stone	stone	SLOPED	good	Medium	-2.97	-1.06		-54.0	55.4
95	833	74-1	286.6	Long Beach Township	Caroline	99.23	60	255.1	1.50	N/A	combo	stone	SLOPED	excellent	Medium	-1.06	-2.95		-98.8	30.0
96	744	74-1	1028.0	Long Beach Township	Pershing	278.99	60	355.6	1.50	N/A	wood	stone	SLOPED	good	Low	-2.95	-6.30		-112.5	37.0
97	715	75	-1074.2	Long Beach Township	Washington	292.67	150	386.3	5.00	N/A	stone	stone	SLOPED	good	Low	-6.30	-5.38		212.7	359.5
98	780	75	-278.9	Long Beach Township	Cleveland	237.48	275	318.4	2.50	N/A	wood	combo	SLOPED	poor	Low	-5.38				
99	366	75	128.0	Long Beach Township	Cleveland-Refuge		60				stone	stone	SLOPED	fair	Low					

Table 1

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXISTING UTILITIES

Existing utilities which terminate, cross or are buried along the beach or study areas are identified in the following listing. Utilities which cross the beach area include approximately six abandoned sanitary sewer outfalls varying in size from 12 inch to 24 inch, one operating 48 inch sanitary sewer outfall and seven Trans-Atlantic copper or fiber optic communication cables. None of the other utilities - gas, electric, phone, cable television lines, and water - were found to cross the beach. These utilities are underground or via the utility poles. Most only extend as Far East as the landward toe of the dune.

Sewage treatment for Long Beach Island is consolidated under the Ocean County Utilities Authority. Sewage is pumped off the island to be treated on the mainland via 24 inch and 36 inch diameter pipes. These two pipes lay side by side on the bottom of Barnegat Bay in the vicinity of the Manahawkin Bay Bridge (Rt. 72 causeway). After treatment, the effluent is pumped from the treatment station on the mainland back to the island via a 48 inch diameter pipe which also lays on the bottom of Barnegat Bay in the vicinity of the Rt. 72 causeway. The effluent connects to a 48 inch outfall extending eastward one mile into the Atlantic Ocean off 5th Street in Ship Bottom. The pipes and outfalls are supported by two 10 ton concrete blocks paired on each side of each pipe or outfall in 50-75 feet intervals. Steel chains and anchors help secure the pipes and outfall, along with the concrete blocks, to the bay and ocean bottom.

There are several formerly used sanitary sewer outfalls located on Long Beach Island. Use of these outfalls ceased when the sanitary sewer system was consolidated and updated under the Ocean County Utilities Authority. The following is a list of known abandoned outfall pipes:

a. An abandoned 14 inch cast iron outfall beginning at Long Beach Boulevard and South 2nd Street in Surf City and extends approximately 1000 feet under 2nd Street and into the Atlantic Ocean. The outfall was a part of the old Surf City Borough Sewage Treatment Plant.

b. An abandoned 14 inch cast iron outfall beginning at Long Beach Boulevard and South 3 rd Street extends approximately 1000 feet under South 3rd Street and into the Atlantic Ocean. The outfall was a part of the old Ship Bottom Borough Sewage Treatment Plant.

c. An abandoned 24 inch cast iron outfall extends from Long Beach Boulevard and Rhode Island Avenue (82nd Street) to approximately 1000 feet under Rhode Island Avenue and into the Atlantic Ocean. The outfall was part of the old Long Beach Township Sewage Treatment Plant.

d. An abandoned 24 inch cast iron outfall extends from Long Beach Boulevard and Massachusetts Avenue (81st Street) to approximately 1000 feet under Massachusetts Avenue and into the Atlantic Ocean. The outfall was part of the old Long Beach Township Sewage Treatment Plant.

e. An abandoned 12 inch cast iron outfall beginning underneath Center Street and Bay Avenue extends approximately 1000 feet under Center Street and into the Atlantic Ocean.

The outfall was a part of an old Beach Haven Sewer plant at this location.

f. An abandoned 16 inch cast iron outfall beginning underneath Nelson and Bay Avenues extends approximately 1000 feet under Nelson Avenue and into the Atlantic Ocean. The outfall was a part of the old Beach Haven Sewer plant at this location. Approximate locations of the above outfall pipes can be found in Figure 1 (Sanitary Sewer Outfall Locations).

There are several Trans-Atlantic Telephone (T.A.T.) cables crossing the beach and off shore zone within the study area. The cables are owned by several interests and maintained by AT&T Inc. Coordination with AT&T has taken place to identify the locations of the cables. The approximate locations of the cables in relation to the proposed borrow areas can be seen in Figure 2 (Potential Borrow Areas).

Two 1 inch diameter transatlantic fiber optic cables (T.A.T. 9 and T.A.T. 11) cross the north end of Long Beach Island. T.A.T. 9 was installed in 1991 and T.A.T. 11 was installed in 1993. The cables leave Manahawkin, N.J. and continue through Barnegat Bay to the barrier island. Both cables are 100 feet apart and are buried 6 feet under the bay bottom. The cables continue eastward passing through the barrier island in the vicinity of Bergen Avenue in Harvey Cedars. Exiting the barrier island, the cables continue just under the ocean floor to approximately 3 miles into the Atlantic Ocean where they separate to continue on to different destinations.

There are three cable crossings in which the cables have been retired and no longer in use.

a. A 4 inch diameter copper coaxial transatlantic cable (Bermuda "A" Cable) installed in 1962 crosses to the island in the same general area as T.A.T. cables 9 and 11. South of the groin off Bergen Avenue in Harvey Cedars, the cable continues eastward to Bermuda. The cable was retired by AT&T in 1990 and is no longer active.

b. A 4 inch diameter transatlantic copper coaxial cable (T.A.T. 3) was installed in 1963, intersecting the island at Taylor Avenue in Beach Haven. Off Taylor Avenue the cable continues eastward to England. The cable was retired in 1986 and is no longer active.

c. A 4 inch diameter copper coaxial cable (T.A.T. 4) was installed in 1965 and crosses the island at the Leeward Avenue at the southern end of Beach Haven. Off Leeward Avenue the cable continues eastward to France. The cable was retired in 1987 and is no longer active.

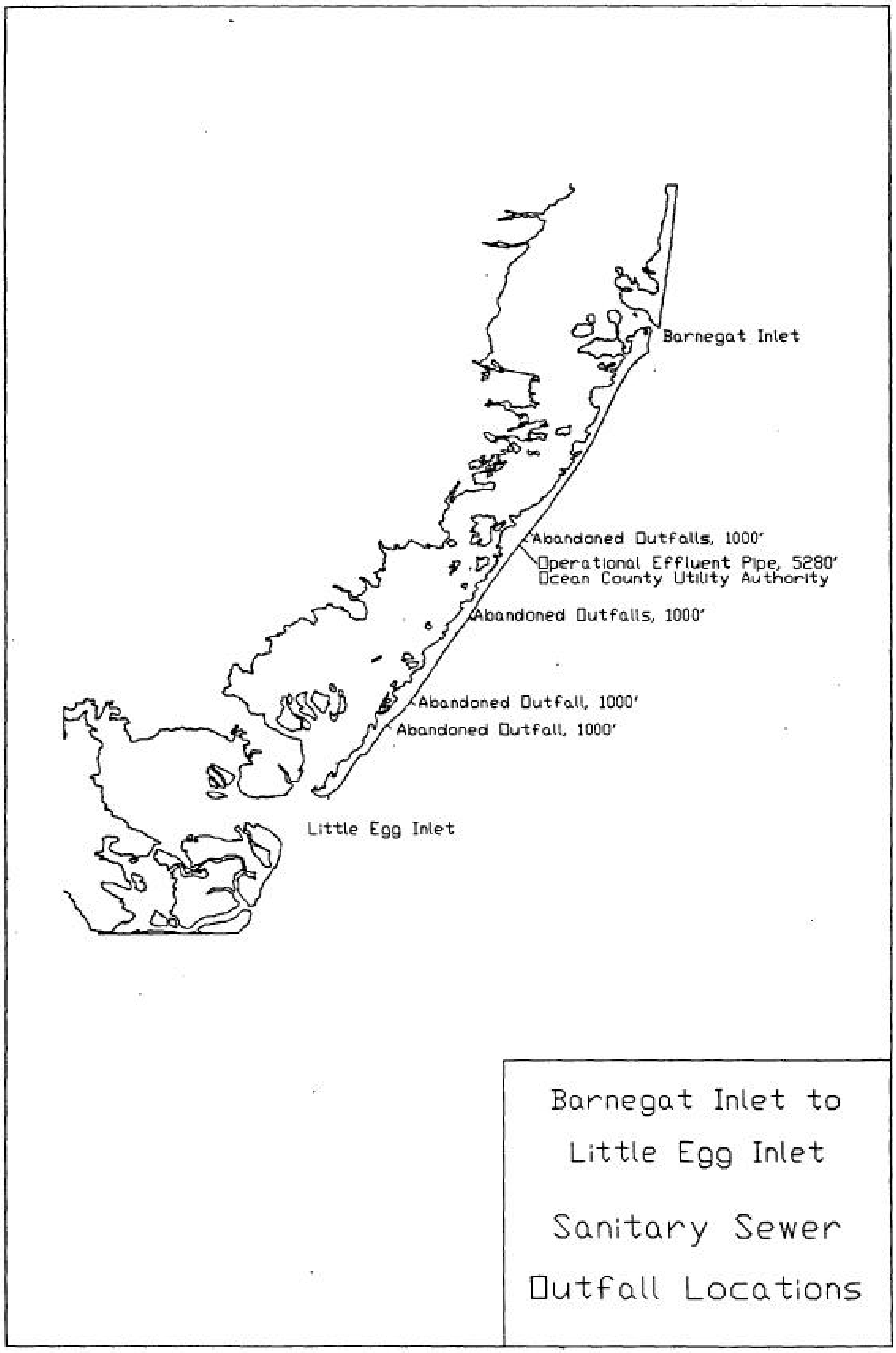


Figure 1 SANITARY SEWER OUTFALL LOCATIONS

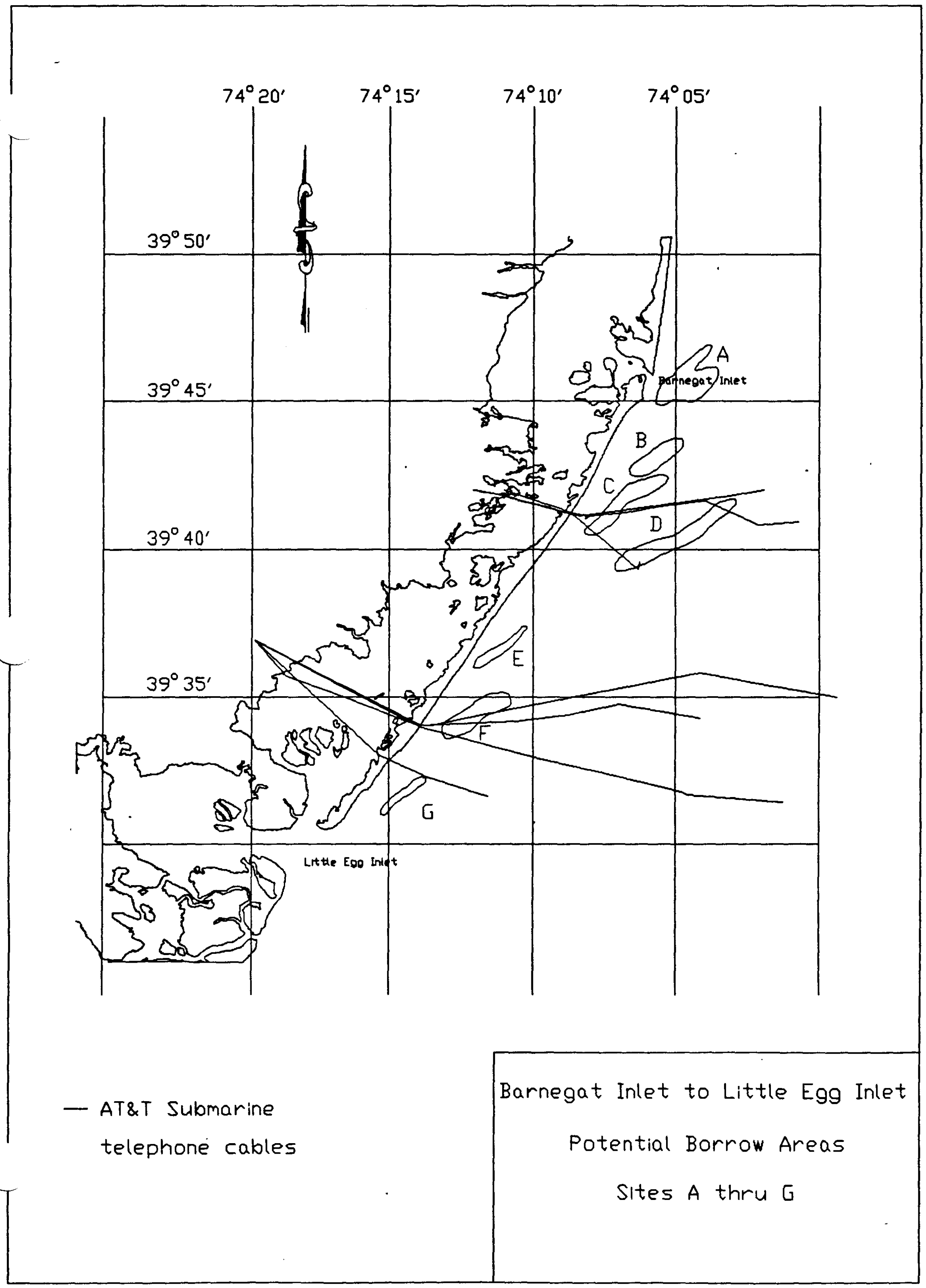


Figure 2 TRANS-ATLANTIC TELEPHONE CABLES

A 4 inch diameter copper coaxial transatlantic cable (T.A.T. 7) was installed in 1983 and crosses the island at Taylor Avenue in Beach Haven. The cable continues eastward off Taylor Avenue to Europe. The cable was slated for retirement in June 1994.

A 1 inch diameter transatlantic fiber optic cable (T.A.T. 8) was installed in 1988. This cable also intersects the barrier island in the same area as T.A.T. 7. Off Taylor Avenue in Beach Haven, the cable continues eastward to Europe.

Environmental Constraints. Appropriate measures must be taken to ensure that any resulting projects can meet all local, regional, state, and federal regulations. it must be evident that all necessary permits and approvals are likely to be issued by the regulatory agencies. Further environmental constraints relate other agencies plans to protect and maintain or control the types of flora and fauna found within the ecosystem which may be affected.

DESCRIPTION AND DISCUSSION OF ALTERNATIVES

Coastal protection alternatives can be classified into two groups: Non-structural and structural. Non-structural alternatives primarily consist of those measures which are addressed at controlling or regulating the use of land and buildings such that damages to property are reduced or eliminated. For example, these measures may establish ocean front setback limits or restrict building below a certain elevation. The retreat option is also a non-structural measure. This option is not considered feasible due to the level of development and/or economic base of this region. Since the study area is already fully developed, implementation of other non structural alternatives could only affect future construction.

Structural alternatives are composed of those measures which act to block or otherwise retard erosive coastal processes or which restore or nourish beaches to compensate for erosion. Typically, the hardened structural alternatives consist of seawalls, bulkheads, revetments, breakwaters, or groins. Beach and dune fill is considered a soft structural alternative. In general, seawalls, bulkheads and revetments are shore parallel structures used to retain fill and/or reduce direct wave attack on the back shore. Typical construction materials are timber and steel sheet piles, rock and/or concrete. Breakwaters are also shore parallel structures, typically constructed of rock or concrete, and placed offshore to reduce incoming wave energy. Groins, on the other hand, are typically shore perpendicular structures used to interrupt the long shore sediment transport to build a protective beach , retard erosion of an existing beach or prevent longshore transport of sand to some downdrift point. Groins can be constructed of a wide variety of material, the most widely used in LBI study area are timber and rock. Beach and dune fill is the placement of sand on the beach to provide a larger berm and/or dune and to offset erosion. Of the structural alternatives, seawalls, bulkheads, revetments, breakwaters and groins are typically expensive to construct. The beach/dune fill option, however, is usually less expensive and more environmentally favorable since it responds to the natural beach environment.

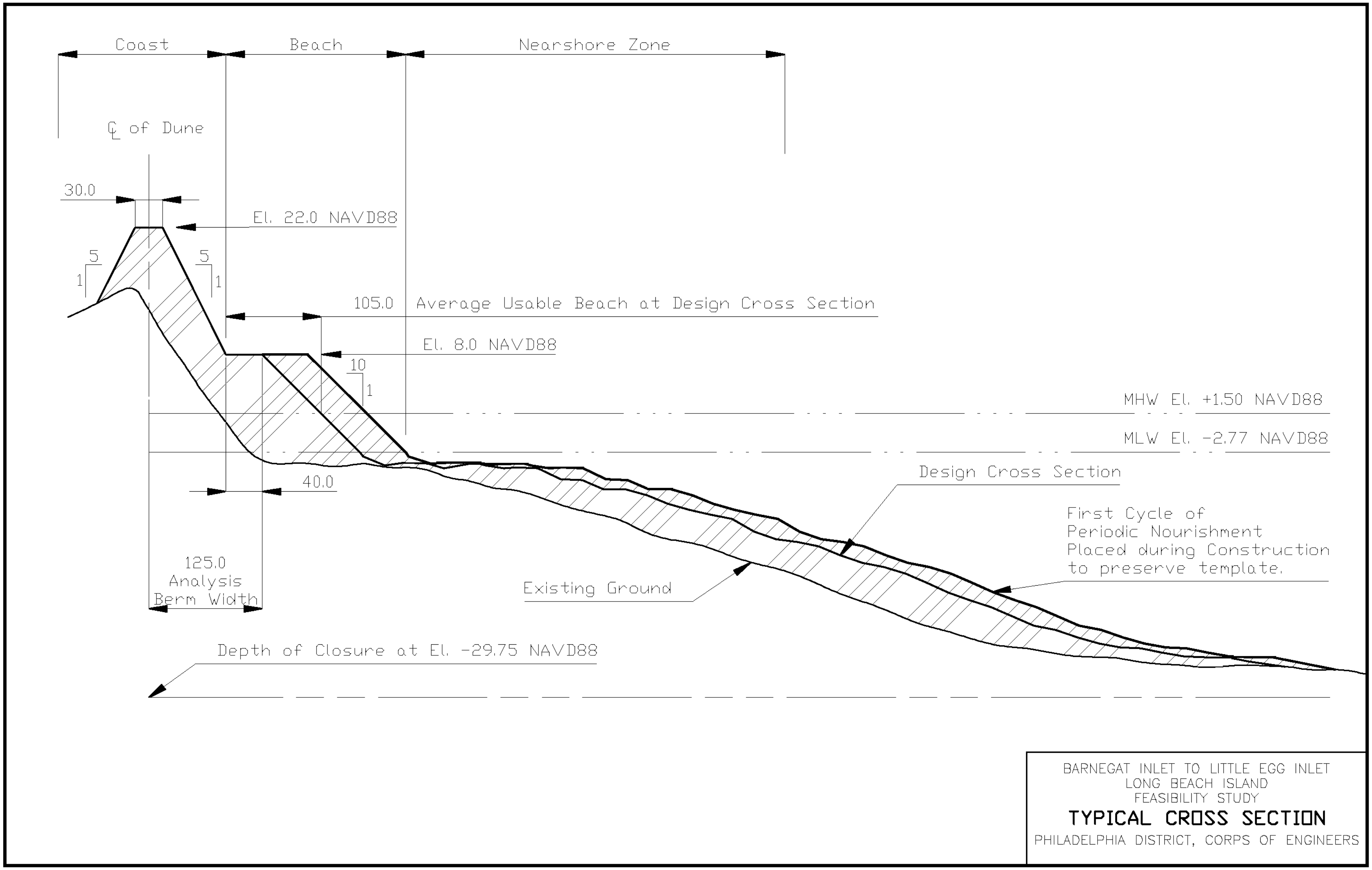
GENERAL DESCRIPTION OF SELECTED PLAN

The selected plan developed during this study is based in part on previously authorized Federal projects (see Prior Reports, Studies and Related Projects). Since that time however, much has changed in terms of state-of-the-art coastal engineering, public interest, and environmental awareness. The proposed plan is a beachfill and dune which accomplishes shore protection, while at the same time enhances recreation. This plan was chosen for its effectiveness in reducing overtopping, alleviating erosion and ease of construction in conjunction with the existing groin field. Also, the existing groin field can help stabilize the beachfill and reduce the nourishment cycle, thereby reducing the overall cost of the project.

The plan consists of placement of beachfill and dune construction, including dune grass and sand fencing. Beachfill would be placed on various stretches of Long Beach Island where the existing berm and dune are below the minimum measurements of the design cross section. The plan provides a design cross section of dune with a 1V:: 5H back slope with a crest width of 30 feet at elevation + 22 NAVD88. The dune will have a fore slope of 1V:: 5H down to elevation + 8 NAVD88 then a fore shore beachfill slope of 1V:: 10H. (See Figure 3 – TYPICAL CROSS SECTION). This will produce a beach width of approximately 120 ft between elevation +8 and 0 NAVD88. In addition, the first cycle of periodic nourishment would be placed at the time of initial construction. This project will result in a continuous dune line extending the length of the developed portion of the Long Beach Island. The constructed dune would be stabilized and maintained with dune grass and sand fencing.

This design has no traditional defined berm but is in keeping with the natural conditions found in this area of the New Jersey coastline. The design was based on existing beaches of Long Beach Island that were demonstrated as effective in the storm erosion model and observed in recent storms. The cross section will be overlaid on the existing conditions cross section and in general aligned on the back slope of the dune at elevation +10 NAVD88. Required quantity computations were based on this overlay alignment.

The beach fill will be tapered at the terminal groin in Holgate to eventually blend into the natural beach.



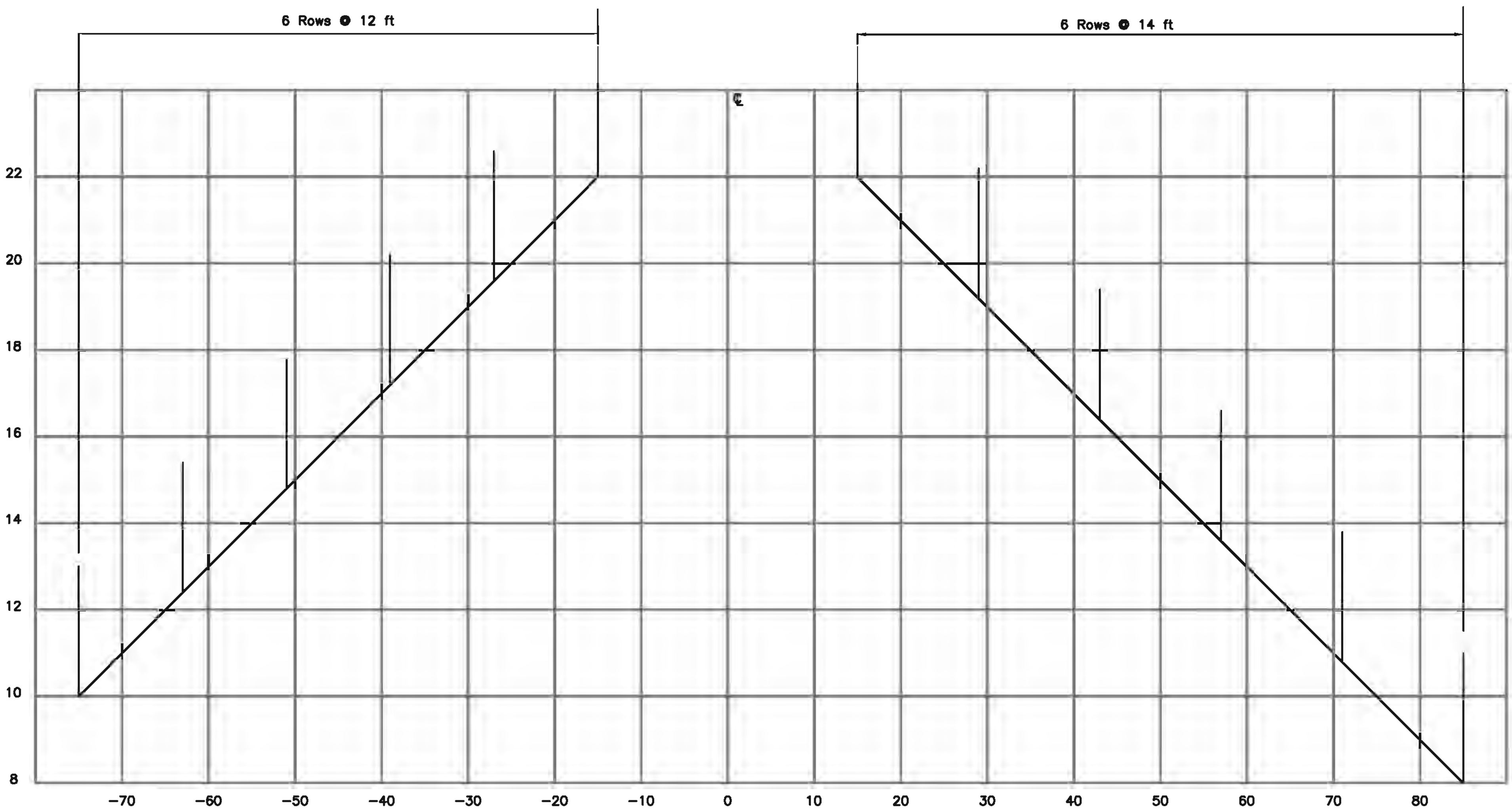
Coast
Beach
Nearshore Zone
℄ of Dune
30.0
El. 22.0 NAVD88
5
1
5
1
105.0 Average Usable Beach at Design Cross Section
El. 8.0 NAVD88
10
1
MHW El. +1.50 NAVD88
MLW El. -2.77 NAVD88
40.0
Design Cross Section
First Cycle of
Periodic Nourishment
Placed during Construction
to preserve template.
125.0
Analysis
Berm Width
Existing Ground
Depth of Closure at El. -29.75 NAVD88
BARNEGAT INLET TO LITTLE EGG INLET
LONG BEACH ISLAND
FEASIBILITY STUDY
TYPICAL CROSS SECTION
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS

Figure 3

Dune Fencing Typical Configuration

Alternate Methods Exist including "Z" and "S" configurations. These configurations use fewer dune parallel fencing and more perpendicular configurations.

Sand Fencing has been calculated to allow four rows of fencing on dune slopes.



BARNEGAT INLET TO LITTLE EGG INLET
FEASIBILITY STUDY

DUNE GRASS AND SAND FENCE QUANTITIES
DUNE ELEVATION = 22 FT

BUNDY	BEGINNING STATION	ENDING STATION	LENGTH (FT)	AREA (SF)	SURFACE AREA (CSF)	AREA (Acres)	PLANTS (PLANTS/CSF)	FENCE (FT)	
1	-2842.65	4893	7,736	1,336,568.42	13,365.68	30.68	385868	46416	*
2	4893	8388.4	3,495	603,840.05	6,038.40	13.86	174329	20970	
3	8388.4	16052.5	7,664	1,324,128.80	13,241.29	30.40	382276	45984	
4	16052.5	20643.2	4,591	793,198.76	7,931.99	18.21	228997	27546	
5	20643.2	25094.5	4,451	769,010.60	7,690.11	17.65	222014	26706	
6	25094.5	34903.3	9,809	1,694,725.91	16,947.26	38.90	489268	58854	
7	34903.3	41335.1	6,432	1,111,273.02	11,112.73	25.51	320825	38592	
8	41335.1	46620	5,285	913,102.91	9,131.03	20.96	263613	31710	
9	46620	55871.6	9,252	1,598,491.60	15,984.92	36.70	461485	55512	
10	55871.6	65070.2	9,199	1,589,334.65	15,893.35	36.48	458841	55194	
11	65070.2	71508.7	6,439	1,112,482.43	11,124.82	25.54	321174	38634	
12	71508.7	78769.1	7,260	1,254,328.69	12,543.29	28.79	362125	43560	
13	78769.1	83529.9	4,761	822,570.09	8,225.70	18.88	237476	28566	
14	83529.9	86685.6	3,156	545,270.16	5,452.70	12.52	157420	18936	
15	86685.6	93331.17	6,646	1,148,246.34	11,482.46	26.36	331499	39876	
			S =	14,676,163.96	146,761.64	336.90	4,237,013.00	509,670.00	

Dune El. =	22	ft
Toe El. =	8	ft
Top Width =	30	ft
Plant Count Factor =	28.87	Plants/CSF
Slope of Dune =	5	H to 1V
Exposed fence =	3	ft
Number of Rows =	6	

43561.46 Sq-ft per acre

* Barnegat Light will not require dune grass plantings.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

LBI Groin Profiles
Cut and Fill Report

Profile 1:	LBI04 Groin
Profile 2:	LBI04 Temp
XOn:	38.77 ft
XOff:	256.94 ft
Volume Change:	
Above Datum:	34.402 cu. yd/ft
Below Datum:	-11.668 cu.yd/ft
Total Volume:	22.735 cu.yd/ft
Shoreline Change:	38.66 ft
From:	144.19 ft
To:	182.86 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	190.98	-1.4	35.932	6.37	35.932	35.932
2	256.94	-2.34	-13.198	-5.4	22.735	49.13

Profile 1:	LBI05 Groin
Profile 2:	LBI05 Temp
XOn:	45.18 ft
XOff:	284.05 ft
Volume Change:	
Above Datum:	53.198 cu. yd/ft
Below Datum:	-10.865 cu.yd/ft
Total Volume:	42.333 cu.yd/ft
Shoreline Change:	-18.35 ft
From:	235.10 ft
To:	216.75 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	220.37	-0.63	54.233	8.36	54.233	54.233
2	284.05	-1.24	-11.901	-5.05	42.333	66.134

Profile 1:	LBI06 Groin
Profile 2:	LBI06 Temp
XOn:	104.61 ft
XOff:	279.30 ft
Volume Change:	
Above Datum:	16.622 cu. yd/ft
Below Datum:	-14.145 cu.yd/ft
Total Volume:	2.478 cu.yd/ft
Shoreline Change:	-39.91 ft
From:	248.99 ft
To:	209.09 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	202.29	1.17	18.871	5.22	18.871	18.871
2	279.3	-2.43	-16.393	-5.75	2.478	35.264

Profile 1:	LBI07 Groin
Profile 2:	LBI07 Temp
XOn:	145.31 ft
XOff:	293.34 ft
Volume Change:	
Above Datum:	7.038 cu. yd/ft
Below Datum:	-27.034 cu.yd/ft
Total Volume:	-19.996 cu.yd/ft
Shoreline Change:	-24.38 ft
From:	217.95 ft
To:	193.58 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	201.7	-1.4	7.855	3.76	7.855	7.855
2	293.34	-1.85	-27.851	-8.21	-19.996	35.706

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI08 Groin
Profile 2: LBI08 Temp
XOn: 142.00 ft
XOff: 324.62 ft
Volume Change:
Above Datum: 18.050 cu. yd/ft
Below Datum: -19.720 cu.yd/ft
Total Volume: -1.669 cu.yd/ft
Shoreline Change: -38.17 ft
From: 277.66 ft
To: 239.49 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	232.23	1.25	18.224	5.45	18.224	18.224
2	324.62	-2.6	-19.893	-5.81	-1.669	38.117

Profile 1: LBI09 Groin
Profile 2: LBI09 Temp
XOn: 188.10 ft
XOff: 367.29 ft
Volume Change:
Above Datum: 15.906 cu. yd/ft
Below Datum: -17.902 cu.yd/ft
Total Volume: -1.996 cu.yd/ft
Shoreline Change: -7.98 ft
From: 291.60 ft
To: 283.63 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	281.22	0.42	16.187	4.69	16.187	16.187
2	367.29	-2.13	-18.183	-5.7	-1.996	34.371

Profile 1: LBI10 Groin
Profile 2: LBI10 Temp
XOn: 134.40 ft
XOff: 321.94 ft
Volume Change:
Above Datum: 14.768 cu. yd/ft
Below Datum: -24.228 cu.yd/ft
Total Volume: -9.460 cu.yd/ft
Shoreline Change: -35.54 ft
From: 263.94 ft
To: 228.40 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	223.91	0.74	15.485	4.67	15.485	15.485
2	321.94	-2.1	-24.944	-6.87	-9.46	40.429

Profile 1: LBI11 Groin
Profile 2: LBI11 Temp
XOn: 57.00 ft
XOff: 275.81 ft
Volume Change:
Above Datum: 25.102 cu. yd/ft
Below Datum: -19.592 cu.yd/ft
Total Volume: 5.509 cu.yd/ft
Shoreline Change: 5.78 ft
From: 180.57 ft
To: 186.35 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	194.22	-1.36	25.944	5.1	25.944	25.944
2	195.48	-1.58	-0.001	-0.02	25.943	25.945
3	195.72	-1.63	0	0.01	25.943	25.945

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI12 Groin
Profile 2: LBI12 Temp
XOn: 82.60 ft
XOff: 253.00 ft
Volume Change:
Above Datum: 16.669 cu. yd/ft
Below Datum: -15.658 cu.yd/ft
Total Volume: 1.011 cu.yd/ft
Shoreline Change: -31.75 ft
From: 210.85 ft
To: 179.11 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	175.15	0.68	16.796	4.9	16.796	16.796
2	175.7	0.6	-0.001	-0.04	16.795	16.797
3	182.57	-0.6	0.118	0.46	16.913	16.914

Profile 1: LBI13 Groin
Profile 2: LBI13 Temp
XOn: 58.70 ft
XOff: 243.76 ft
Volume Change:
Above Datum: 15.247 cu. yd/ft
Below Datum: -19.887 cu.yd/ft
Total Volume: -4.639 cu.yd/ft
Shoreline Change: -34.22 ft
From: 194.10 ft
To: 159.88 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	157.84	0.35	15.997	4.36	15.997	15.997
2	243.76	-2.03	-20.636	-6.48	-4.639	36.634

Profile 1: LBI14 Groin
Profile 2: LBI14 Temp
XOn: 79.30 ft
XOff: 303.25 ft
Volume Change:
Above Datum: -6.608 cu. yd/ft
Below Datum: -91.813 cu.yd/ft
Total Volume: -98.422 cu.yd/ft
Shoreline Change: -99.47 ft
From: 229.03 ft
To: 129.57 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	96.69	5.68	0.749	1.16	0.749	0.749
2	303.25	-2.34	-99.171	-12.96	-98.422	99.92

Profile 1: LBI15 Groin
Profile 2: LBI15 Temp
XOn: 104.80 ft
XOff: 313.70 ft
Volume Change:
Above Datum: 3.397 cu. yd/ft
Below Datum: -49.893 cu.yd/ft
Total Volume: -46.496 cu.yd/ft
Shoreline Change: -93.58 ft
From: 279.90 ft
To: 186.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	179.71	1.14	6.775	2.44	6.775	6.775
2	313.7	-2.28	-53.271	-10.73	-46.496	60.046

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1:	LBI16 Groin
Profile 2:	LBI16 Temp
XOn:	130.25 ft
XOff:	322.70 ft
Volume Change:	
Above Datum:	-1.057 cu. yd/ft
Below Datum:	-52.553 cu.yd/ft
Total Volume:	-53.610 cu.yd/ft
Shoreline Change:	-101.98 ft
From:	294.63 ft
To:	192.65 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	169.94	3.92	3.096	2.11	3.096	3.096
2	322.7	-1.5	-56.707	-10.02	-53.61	59.803

Profile 1:	LBI17 Groin
Profile 2:	LBI17 Temp
XOn:	162.80 ft
XOff:	353.90 ft
Volume Change:	
Above Datum:	4.135 cu. yd/ft
Below Datum:	-44.671 cu.yd/ft
Total Volume:	-40.537 cu.yd/ft
Shoreline Change:	-78.65 ft
From:	308.00 ft
To:	229.35 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	213.8	2.69	6.071	3.21	6.071	6.071
2	353.9	-2.06	-46.608	-8.98	-40.537	52.679

Profile 1:	LBI18 Groin
Profile 2:	LBI18 Temp
XOn:	174.00 ft
XOff:	378.50 ft
Volume Change:	
Above Datum:	-0.212 cu. yd/ft
Below Datum:	-60.944 cu.yd/ft
Total Volume:	-61.156 cu.yd/ft
Shoreline Change:	-114.23 ft
From:	351.46 ft
To:	237.24 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	212.19	4.33	3.77	2.67	3.77	3.77
2	378.5	-2.64	-64.926	-10.54	-61.156	68.696

Profile 1:	LBI19 Groin
Profile 2:	LBI19 Temp
XOn:	141.75 ft
XOff:	337.53 ft
Volume Change:	
Above Datum:	15.461 cu. yd/ft
Below Datum:	-27.374 cu.yd/ft
Total Volume:	-11.913 cu.yd/ft
Shoreline Change:	-29.83 ft
From:	269.15 ft
To:	239.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	236.75	0.44	15.696	4.46	15.696	15.696
2	337.53	-1.75	-27.608	-7.4	-11.913	43.304

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI20 Groin
Profile 2: LBI20 Temp
XOn: 133.30 ft
XOff: 321.02 ft
Volume Change:
Above Datum: 9.120 cu. yd/ft
Below Datum: -27.508 cu.yd/ft
Total Volume: -18.388 cu.yd/ft
Shoreline Change: -81.80 ft
From: 306.73 ft
To: 224.93 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	215.44	1.64	10.308	3.39	10.308	10.308
2	321.02	-1.39	-28.697	-7.34	-18.388	39.005

Profile 1: LBI21 Groin
Profile 2: LBI21 Temp
XOn: 97.40 ft
XOff: 302.10 ft
Volume Change:
Above Datum: 27.555 cu. yd/ft
Below Datum: -11.168 cu.yd/ft
Total Volume: 16.387 cu.yd/ft
Shoreline Change: 5.99 ft
From: 225.54 ft
To: 231.53 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	236.98	-0.94	27.967	5.41	27.967	27.967
2	302.1	-2.38	-11.579	-4.8	16.387	39.546

Profile 1: LBI22 Groin
Profile 2: LBI22 Temp
XOn: 116.50 ft
XOff: 333.14 ft
Volume Change:
Above Datum: 25.767 cu. yd/ft
Below Datum: -17.863 cu.yd/ft
Total Volume: 7.904 cu.yd/ft
Shoreline Change: -40.77 ft
From: 293.84 ft
To: 253.08 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	245.71	1.27	25.874	5.41	25.874	25.874
2	333.14	-2.38	-17.97	-5.55	7.904	43.844

Profile 1: LBI23 Groin
Profile 2: LBI23 Temp
XOn: 107.60 ft
XOff: 317.90 ft
Volume Change:
Above Datum: 18.619 cu. yd/ft
Below Datum: -18.508 cu.yd/ft
Total Volume: 0.111 cu.yd/ft
Shoreline Change: -37.66 ft
From: 273.97 ft
To: 236.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	229.6	1.16	19.727	4.37	19.727	19.727
2	317.9	-2.35	-19.616	-6	0.111	39.343

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI25 Groin
Profile 2: LBI25 Temp
XOn: 73.15 ft
XOff: 274.44 ft
Volume Change:
Above Datum: 26.023 cu. yd/ft
Below Datum: -14.779 cu.yd/ft
Total Volume: 11.245 cu.yd/ft
Shoreline Change: -43.94 ft
From: 245.94 ft
To: 202.01 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	197.67	0.75	27.211	5.9	27.211	27.211
2	274.44	-2.17	-15.966	-5.62	11.245	43.178

Profile 1: LBI26 Groin
Profile 2: LBI26 Temp
XOn: 64.00 ft
XOff: 285.65 ft
Volume Change:
Above Datum: 48.812 cu. yd/ft
Below Datum: -8.197 cu.yd/ft
Total Volume: 40.615 cu.yd/ft
Shoreline Change: -10.63 ft
From: 238.61 ft
To: 227.98 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	228.35	-0.06	49.509	8.13	49.509	49.509
2	285.65	-1.96	-8.894	-4.19	40.615	58.403

Profile 1: LBI27 Groin
Profile 2: LBI27 Temp
XOn: 53.30 ft
XOff: 324.50 ft
Volume Change:
Above Datum: 75.483 cu. yd/ft
Below Datum: -11.017 cu.yd/ft
Total Volume: 64.466 cu.yd/ft
Shoreline Change: -15.87 ft
From: 257.43 ft
To: 241.57 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	243.11	-0.27	81.549	11.6	81.549	81.549
2	324.5	-2.17	-17.084	-5.67	64.466	98.633

Profile 1: LBI28 Groin
Profile 2: LBI28 Temp
XOn: 115.20 ft
XOff: 317.80 ft
Volume Change:
Above Datum: 29.717 cu. yd/ft
Below Datum: -12.428 cu.yd/ft
Total Volume: 17.289 cu.yd/ft
Shoreline Change: 28.33 ft
From: 211.47 ft
To: 239.80 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	250.26	-1.81	32.098	6.42	32.098	32.098
2	317.8	-2.24	-14.809	-5.92	17.289	46.907

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI29 Groin
Profile 2: LBI29 Temp
XOn: 126.50 ft
XOff: 327.80 ft
Volume Change:
Above Datum: 14.741 cu. yd/ft
Below Datum: -34.663 cu.yd/ft
Total Volume: -19.922 cu.yd/ft
Shoreline Change: -62.45 ft
From: 281.53 ft
To: 219.09 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	212.75	1.1	16.763	5.25	16.763	16.763
2	327.8	-2.62	-36.685	-8.61	-19.922	53.448

Profile 1: LBI30 Groin
Profile 2: LBI30 Temp
XOn: 135.00 ft
XOff: 308.10 ft
Volume Change:
Above Datum: 10.979 cu. yd/ft
Below Datum: -29.158 cu.yd/ft
Total Volume: -18.179 cu.yd/ft
Shoreline Change: -68.14 ft
From: 275.03 ft
To: 206.89 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	201.54	0.92	12.435	5.05	12.435	12.435
2	308.1	-2.77	-30.614	-7.76	-18.179	43.049

Profile 1: LBI31 Groin
Profile 2: LBI31 Temp
XOn: 87.12 ft
XOff: 238.36 ft
Volume Change:
Above Datum: 15.976 cu. yd/ft
Below Datum: -8.141 cu.yd/ft
Total Volume: 7.835 cu.yd/ft
Shoreline Change: -18.11 ft
From: 202.16 ft
To: 184.06 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	185.34	-0.22	16.093	4.42	16.093	16.093
2	238.36	-1.75	-8.258	-4.21	7.835	24.351

Profile 1: LBI32 Groin
Profile 2: LBI32 Temp
XOn: 84.15 ft
XOff: 332.22 ft
Volume Change:
Above Datum: 17.420 cu. yd/ft
Below Datum: -56.489 cu.yd/ft
Total Volume: -39.069 cu.yd/ft
Shoreline Change: -86.60 ft
From: 276.25 ft
To: 189.65 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	180.59	1.56	17.498	4.9	17.498	17.498
2	186.69	0.52	-0.021	-0.09	17.477	17.519
3	192.86	-0.56	0.097	0.42	17.574	17.617

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI33 Groin
Profile 2: LBI33 Temp
XOn: 150.30 ft
XOff: 355.55 ft
Volume Change:
Above Datum: 13.039 cu. yd/ft
Below Datum: -28.731 cu.yd/ft
Total Volume: -15.692 cu.yd/ft
Shoreline Change: -71.55 ft
From: 328.65 ft
To: 257.10 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	249.83	1.26	13.921	3.78	13.921	13.921
2	355.55	-1.7	-29.614	-7.56	-15.692	43.535

Profile 1: LBI34 Groin
Profile 2: LBI34 Temp
XOn: 143.30 ft
XOff: 379.18 ft
Volume Change:
Above Datum: 33.984 cu. yd/ft
Below Datum: -21.350 cu.yd/ft
Total Volume: 12.634 cu.yd/ft
Shoreline Change: -7.73 ft
From: 299.58 ft
To: 291.86 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	290.62	0.21	34.235	6.27	34.235	34.235
2	379.18	-2.16	-21.601	-6.59	12.634	55.836

Profile 1: LBI35 Groin
Profile 2: LBI35 Temp
XOn: 81.80 ft
XOff: 319.77 ft
Volume Change:
Above Datum: 32.362 cu. yd/ft
Below Datum: -20.621 cu.yd/ft
Total Volume: 11.741 cu.yd/ft
Shoreline Change: -48.57 ft
From: 284.19 ft
To: 235.62 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	232.18	0.59	32.862	5.9	32.862	32.862
2	319.77	-1.56	-21.121	-6.51	11.741	53.983

Profile 1: LBI36 Groin
Profile 2: LBI36 Temp
XOn: 71.90 ft
XOff: 280.98 ft
Volume Change:
Above Datum: 19.092 cu. yd/ft
Below Datum: -25.147 cu.yd/ft
Total Volume: -6.055 cu.yd/ft
Shoreline Change: -15.60 ft
From: 202.95 ft
To: 187.36 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	186.02	0.23	19.364	4.58	19.364	19.364
2	280.98	-1.92	-25.419	-7.23	-6.055	44.784

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI37 Groin
Profile 2: LBI37 Temp
XOn: 93.70 ft
XOff: 302.78 ft
Volume Change:
Above Datum: 8.099 cu. yd/ft
Below Datum: -43.342 cu.yd/ft
Total Volume: -35.243 cu.yd/ft
Shoreline Change: -42.20 ft
From: 224.75 ft
To: 182.56 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	181.99	0.1	8.682	2.66	8.682	8.682
2	302.78	-1.92	-43.925	-9.82	-35.243	52.607

Profile 1: LBI38 Groin
Profile 2: LBI38 Temp
XOn: 79.60 ft
XOff: 300.48 ft
Volume Change:
Above Datum: 22.098 cu. yd/ft
Below Datum: -32.816 cu.yd/ft
Total Volume: -10.718 cu.yd/ft
Shoreline Change: -61.56 ft
From: 257.28 ft
To: 195.73 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	192.55	0.55	22.711	5.43	22.711	22.711
2	300.48	-2.29	-33.429	-8.36	-10.718	56.14

Profile 1: LBI39 Groin
Profile 2: LBI39 Temp
XOn: 63.20 ft
XOff: 281.51 ft
Volume Change:
Above Datum: 24.188 cu. yd/ft
Below Datum: -28.125 cu.yd/ft
Total Volume: -3.937 cu.yd/ft
Shoreline Change: -42.59 ft
From: 225.97 ft
To: 183.38 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	182.04	0.23	25.05	5.69	25.05	25.05
2	281.51	-2.53	-28.987	-7.87	-3.937	54.037

Profile 1: LBI40 Groin
Profile 2: LBI40 Temp
XOn: 110.19 ft
XOff: 288.34 ft
Volume Change:
Above Datum: 12.561 cu. yd/ft
Below Datum: -20.716 cu.yd/ft
Total Volume: -8.155 cu.yd/ft
Shoreline Change: -9.38 ft
From: 209.02 ft
To: 199.64 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	198.93	0.12	12.627	3.84	12.627	12.627
2	288.34	-2.16	-20.782	-6.28	-8.155	33.408

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI41 Groin
Profile 2: LBI41 Temp
XOn: 100.80 ft
XOff: 294.52 ft
Volume Change:
Above Datum: 22.735 cu. yd/ft
Below Datum: -15.421 cu.yd/ft
Total Volume: 7.314 cu.yd/ft
Shoreline Change: 3.23 ft
From: 210.04 ft
To: 213.27 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	215.54	-0.39	23.213	5.46	23.213	23.213
2	294.52	-2.37	-15.899	-5.44	7.314	39.112

Profile 1: LBI42 Groin
Profile 2: LBI42 Temp
XOn: 134.36 ft
XOff: 332.36 ft
Volume Change:
Above Datum: 16.845 cu. yd/ft
Below Datum: -26.626 cu.yd/ft
Total Volume: -9.781 cu.yd/ft
Shoreline Change: -16.08 ft
From: 249.63 ft
To: 233.55 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	233.22	0.05	16.896	4.61	16.896	16.896
2	332.36	-2.25	-26.678	-7.27	-9.781	43.574

Profile 1: LBI43 Groin
Profile 2: LBI43 Temp
XOn: 84.28 ft
XOff: 292.79 ft
Volume Change:
Above Datum: 20.049 cu. yd/ft
Below Datum: -26.053 cu.yd/ft
Total Volume: -6.005 cu.yd/ft
Shoreline Change: -35.19 ft
From: 232.08 ft
To: 196.90 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	195.12	0.31	20.143	4.91	20.143	20.143
2	292.79	-2.17	-26.148	-7.23	-6.005	46.291

Profile 1: LBI44 Groin
Profile 2: LBI44 Temp
XOn: 97.90 ft
XOff: 262.62 ft
Volume Change:
Above Datum: 14.302 cu. yd/ft
Below Datum: -12.558 cu.yd/ft
Total Volume: 1.744 cu.yd/ft
Shoreline Change: -14.51 ft
From: 207.83 ft
To: 193.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	188.88	0.77	14.405	4.28	14.405	14.405
2	192.09	0.21	-0.026	-0.21	14.379	14.43
3	197.94	-0.8	0.037	0.17	14.416	14.467

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI46 Groin
Profile 2: LBI46 Temp
XOn: 130.25 ft
XOff: 302.87 ft
Volume Change:
Above Datum: 12.016 cu. yd/ft
Below Datum: -19.296 cu.yd/ft
Total Volume: -7.280 cu.yd/ft
Shoreline Change: -18.72 ft
From: 237.52 ft
To: 218.80 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	218.03	0.13	12.146	3.74	12.146	12.146
2	302.87	-1.72	-19.426	-6.18	-7.28	31.573

Profile 1: LBI47 Groin
Profile 2: LBI47 Temp
XOn: 122.40 ft
XOff: 275.94 ft
Volume Change:
Above Datum: 14.739 cu. yd/ft
Below Datum: -10.008 cu.yd/ft
Total Volume: 4.730 cu.yd/ft
Shoreline Change: -52.62 ft
From: 271.51 ft
To: 218.90 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	215.98	0.5	15.704	4.53	15.704	15.704
2	275.94	-1.51	-10.973	-4.94	4.73	26.677

Profile 1: LBI48 Groin
Profile 2: LBI48 Temp
XOn: 80.70 ft
XOff: 276.94 ft
Volume Change:
Above Datum: 22.790 cu. yd/ft
Below Datum: -9.886 cu.yd/ft
Total Volume: 12.903 cu.yd/ft
Shoreline Change: -54.67 ft
From: 275.78 ft
To: 221.11 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	205.58	2.68	27.454	5.94	27.454	27.454
2	276.94	1.08	-14.551	-5.51	12.903	42.005

Profile 1: LBI49 Groin
Profile 2: LBI49 Temp
XOn: 63.00 ft
XOff: 250.00 ft
Volume Change:
Above Datum: 53.285 cu. yd/ft
Below Datum: 0.592 cu.yd/ft
Total Volume: 53.877 cu.yd/ft
Shoreline Change: 29.44 ft
From: 195.78 ft
To: 225.22 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	229.85	-0.8	55.176	8.93	55.176	55.176
2	250	-0.8	-1.299	-1.74	53.877	56.475

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI50 Groin
Profile 2: LBI50 Temp
XOn: 54.80 ft
XOff: 237.03 ft
Volume Change:
Above Datum: 58.776 cu. yd/ft
Below Datum: 1.191 cu.yd/ft
Total Volume: 59.967 cu.yd/ft
Shoreline Change: -3.86 ft
From: 227.84 ft
To: 223.98 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	224.24	-0.05	60.195	9.59	60.195	60.195
2	237.03	-2.09	-0.228	-0.48	59.967	60.422

Profile 1: LBI51 Groin
Profile 2: LBI51 Temp
XOn: 39.15 ft
XOff: 240.00 ft
Volume Change:
Above Datum: 85.748 cu. yd/ft
Below Datum: 5.244 cu.yd/ft
Total Volume: 90.992 cu.yd/ft
Shoreline Change: 24.09 ft
From: 209.11 ft
To: 233.20 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	230.88	0.4	91.258	12.85	91.258	91.258
2	240	0.4	-0.266	-0.79	90.992	91.524

Profile 1: LBI52 Groin
Profile 2: LBI52 Temp
XOn: 46.50 ft
XOff: 250.00 ft
Volume Change:
Above Datum: 66.291 cu. yd/ft
Below Datum: 2.432 cu.yd/ft
Total Volume: 68.723 cu.yd/ft
Shoreline Change: 28.22 ft
From: 196.09 ft
To: 224.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	234.04	-1.68	69.538	10.01	69.538	69.538
2	250	-1.68	-0.815	-1.38	68.723	70.352

Profile 1: LBI53 Groin
Profile 2: LBI53 Temp
XOn: 75.90 ft
XOff: 225.95 ft
Volume Change:
Above Datum: 31.953 cu. yd/ft
Below Datum: 0.687 cu.yd/ft
Total Volume: 32.640 cu.yd/ft
Shoreline Change: 11.67 ft
From: 201.37 ft
To: 213.04 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	221.77	-1.51	32.703	6.05	32.703	32.703
2	225.95	-1.42	-0.063	-0.41	32.64	32.765

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI54 Groin
Profile 2: LBI54 Temp
XOn: 47.70 ft
XOff: 261.29 ft
Volume Change:
Above Datum: 57.054 cu. yd/ft
Below Datum: -0.203 cu.yd/ft
Total Volume: 56.851 cu.yd/ft
Shoreline Change: 70.74 ft
From: 146.57 ft
To: 217.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	226.26	-1.55	60.495	9.15	60.495	60.495
2	261.29	-1.88	-3.644	-2.81	56.851	64.139

Profile 1: LBI56 Groin
Profile 2: LBI56 Temp
XOn: 71.50 ft
XOff: 289.53 ft
Volume Change:
Above Datum: 37.712 cu. yd/ft
Below Datum: -13.464 cu.yd/ft
Total Volume: 24.248 cu.yd/ft
Shoreline Change: -26.99 ft
From: 249.14 ft
To: 222.16 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	216.09	1.05	38.34	7.16	38.34	38.34
2	289.53	-1.35	-14.091	-5.18	24.248	52.431

Profile 1: LBI57 Groin
Profile 2: LBI57 Temp
XOn: 55.20 ft
XOff: 217.41 ft
Volume Change:
Above Datum: 26.544 cu. yd/ft
Below Datum: -1.666 cu.yd/ft
Total Volume: 24.878 cu.yd/ft
Shoreline Change: -14.58 ft
From: 205.26 ft
To: 190.68 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	188.25	0.41	27.126	5.5	27.126	27.126
2	217.41	-1.53	-2.248	-2.08	24.878	29.374

Profile 1: LBI58 Groin
Profile 2: LBI58 Temp
XOn: 78.00 ft
XOff: 225.97 ft
Volume Change:
Above Datum: 31.129 cu. yd/ft
Below Datum: -0.016 cu.yd/ft
Total Volume: 31.113 cu.yd/ft
Shoreline Change: 14.78 ft
From: 208.91 ft
To: 223.69 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	218.59	0.88	31.302	6.01	31.302	31.302
2	225.97	0.76	-0.188	-0.69	31.113	31.49

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI59 Groin
Profile 2: LBI59 Temp
XOn: 113.60 ft
XOff: 311.25 ft
Volume Change:
Above Datum: 18.530 cu. yd/ft
Below Datum: -15.220 cu.yd/ft
Total Volume: 3.310 cu.yd/ft
Shoreline Change: -18.96 ft
From: 250.71 ft
To: 231.76 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	203.43	4.89	18.816	5.66	18.816	18.816
2	205.69	4.5	-0.021	-0.25	18.795	18.837
3	230.23	0.26	0.529	0.58	19.324	19.367

Profile 1: LBI60 Groin
Profile 2: LBI60 Temp
XOn: 111.61 ft
XOff: 255.81 ft
Volume Change:
Above Datum: 30.683 cu. yd/ft
Below Datum: 0.959 cu.yd/ft
Total Volume: 31.642 cu.yd/ft
Shoreline Change: -5.84 ft
From: 244.22 ft
To: 238.39 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	240.52	-0.37	31.947	6.69	31.947	31.947
2	255.81	-2.43	-0.305	-0.54	31.642	32.252

Profile 1: LBI61 Groin
Profile 2: LBI61 Temp
XOn: 123.50 ft
XOff: 292.87 ft
Volume Change:
Above Datum: 17.885 cu. yd/ft
Below Datum: -11.899 cu.yd/ft
Total Volume: 5.986 cu.yd/ft
Shoreline Change: -38.78 ft
From: 266.87 ft
To: 228.09 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	223.33	0.82	18.318	4.95	18.318	18.318
2	292.87	-2.14	-12.332	-4.79	5.986	30.65

Profile 1: LBI62 Groin
Profile 2: LBI62 Temp
XOn: 117.10 ft
XOff: 269.53 ft
Volume Change:
Above Datum: 17.016 cu. yd/ft
Below Datum: -4.928 cu.yd/ft
Total Volume: 12.088 cu.yd/ft
Shoreline Change: -9.73 ft
From: 227.52 ft
To: 217.79 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	219.47	-0.29	18.57	4.9	18.57	18.57
2	269.53	-1.19	-6.481	-3.5	12.088	25.051

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI63 Groin
Profile 2: LBI63 Temp
XOn: 112.00 ft
XOff: 253.13 ft
Volume Change:
Above Datum: 14.303 cu. yd/ft
Below Datum: -9.383 cu.yd/ft
Total Volume: 4.920 cu.yd/ft
Shoreline Change: -38.30 ft
From: 234.22 ft
To: 195.92 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	199.73	-0.66	14.525	4.47	14.525	14.525
2	253.13	-1.43	-9.605	-4.86	4.92	24.13

Profile 1: LBI64 Groin
Profile 2: LBI64 Temp
XOn: 124.00 ft
XOff: 273.63 ft
Volume Change:
Above Datum: 10.373 cu. yd/ft
Below Datum: -13.200 cu.yd/ft
Total Volume: -2.827 cu.yd/ft
Shoreline Change: -43.87 ft
From: 250.86 ft
To: 206.99 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	198.59	1.45	12.068	4.37	12.068	12.068
2	273.63	-1.97	-14.895	-5.36	-2.827	26.962

Profile 1: LBI65 Groin
Profile 2: LBI65 Temp
XOn: 103.90 ft
XOff: 284.48 ft
Volume Change:
Above Datum: 17.262 cu. yd/ft
Below Datum: -20.462 cu.yd/ft
Total Volume: -3.199 cu.yd/ft
Shoreline Change: -49.79 ft
From: 249.81 ft
To: 200.03 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	200.95	-0.16	18.201	5.06	18.201	18.201
2	284.48	-2.52	-21.4	-6.92	-3.199	39.601

Profile 1: LBI66 Groin
Profile 2: LBI66 Temp
XOn: 98.80 ft
XOff: 298.07 ft
Volume Change:
Above Datum: -0.062 cu. yd/ft
Below Datum: -27.458 cu.yd/ft
Total Volume: -27.521 cu.yd/ft
Shoreline Change: -71.47 ft
From: 275.62 ft
To: 204.16 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	180.46	4.08	5.917	1.96	5.917	5.917
2	298.07	-2	-33.437	-7.68	-27.521	39.354

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI67 Groin
Profile 2: LBI67 Temp
XOn: 74.00 ft
XOff: 244.06 ft
Volume Change:
Above Datum: 23.288 cu. yd/ft
Below Datum: -6.997 cu.yd/ft
Total Volume: 16.291 cu.yd/ft
Shoreline Change: -26.01 ft
From: 212.97 ft
To: 186.97 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	174.19	2.21	24.68	6.65	24.68	24.68
2	244.06	-1.19	-8.389	-3.24	16.291	33.07

Profile 1: LBI68 Groin
Profile 2: LBI68 Temp
XOn: 72.00 ft
XOff: 247.15 ft
Volume Change:
Above Datum: 44.638 cu. yd/ft
Below Datum: 1.883 cu.yd/ft
Total Volume: 46.522 cu.yd/ft
Shoreline Change: -26.54 ft
From: 246.72 ft
To: 220.18 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	230.52	-1.79	48.465	8.25	48.465	48.465
2	247.15	-0.15	-1.943	-3.15	46.522	50.408

Profile 1: LBI69 Groin
Profile 2: LBI69 Temp
XOn: 102.80 ft
XOff: 330.61 ft
Volume Change:
Above Datum: 37.015 cu. yd/ft
Below Datum: -21.277 cu.yd/ft
Total Volume: 15.738 cu.yd/ft
Shoreline Change: -33.32 ft
From: 276.61 ft
To: 243.29 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	239.35	0.68	38.57	7.63	38.57	38.57
2	330.61	-2.09	-22.832	-6.76	15.738	61.402

Profile 1: LBI70 Groin
Profile 2: LBI70 Temp
XOn: 153.00 ft
XOff: 324.33 ft
Volume Change:
Above Datum: 14.503 cu. yd/ft
Below Datum: -16.873 cu.yd/ft
Total Volume: -2.370 cu.yd/ft
Shoreline Change: -33.96 ft
From: 281.73 ft
To: 247.77 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	240.62	1.23	15.469	4.77	15.469	15.469
2	242.34	0.94	-0.005	-0.08	15.464	15.474
3	242.74	0.84	0.001	0.05	15.464	15.475

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI71 Groin
Profile 2: LBI71 Temp
XOn: 141.75 ft
XOff: 292.24 ft
Volume Change:
Above Datum: 8.195 cu. yd/ft
Below Datum: -13.927 cu.yd/ft
Total Volume: -5.732 cu.yd/ft
Shoreline Change: -56.66 ft
From: 281.35 ft
To: 224.69 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	211.49	2.28	8.984	3.48	8.984	8.984
2	219.77	0.85	-0.027	-0.09	8.957	9.012
3	220.46	0.72	0	0.01	8.957	9.012

Profile 1: LBI72 Groin
Profile 2: LBI72 Temp
XOn: 106.50 ft
XOff: 278.16 ft
Volume Change:
Above Datum: 12.312 cu. yd/ft
Below Datum: -12.679 cu.yd/ft
Total Volume: -0.367 cu.yd/ft
Shoreline Change: -53.59 ft
From: 266.88 ft
To: 213.30 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	203.46	1.7	14.524	4.04	14.524	14.524
2	278.16	-2.27	-14.891	-5.38	-0.367	29.416

Profile 1: LBI73 Groin
Profile 2: LBI73 Temp
XOn: 80.70 ft
XOff: 286.24 ft
Volume Change:
Above Datum: 27.276 cu. yd/ft
Below Datum: -18.105 cu.yd/ft
Total Volume: 9.171 cu.yd/ft
Shoreline Change: -10.77 ft
From: 215.47 ft
To: 204.70 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	206.51	-0.31	27.794	5.96	27.794	27.794
2	286.24	-2.81	-18.623	-6.31	9.171	46.417

Profile 1: LBI74 Groin
Profile 2: LBI74 Temp
XOn: 108.30 ft
XOff: 287.91 ft
Volume Change:
Above Datum: 23.430 cu. yd/ft
Below Datum: -9.973 cu.yd/ft
Total Volume: 13.457 cu.yd/ft
Shoreline Change: -40.48 ft
From: 269.91 ft
To: 229.43 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	221.36	1.39	24.034	5.74	24.034	24.034
2	287.91	-1.68	-10.577	-4.29	13.457	34.611

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI75 Groin
Profile 2: LBI75 Temp
XOn: 115.00 ft
XOff: 262.92 ft
Volume Change:
Above Datum: 12.551 cu. yd/ft
Below Datum: -10.120 cu.yd/ft
Total Volume: 2.432 cu.yd/ft
Shoreline Change: -55.39 ft
From: 256.71 ft
To: 201.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	205.68	-0.75	13.127	3.91	13.127	13.127
2	262.92	-1.82	-10.696	-5.05	2.432	23.823

Profile 1: LBI76 Groin
Profile 2: LBI76 Temp
XOn: 130.00 ft
XOff: 230.71 ft
Volume Change:
Above Datum: 3.180 cu. yd/ft
Below Datum: -7.012 cu.yd/ft
Total Volume: -3.832 cu.yd/ft
Shoreline Change: -27.82 ft
From: 209.36 ft
To: 181.55 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	177.13	0.76	3.58	2.05	3.58	3.58
2	230.71	-1.04	-7.412	-3.74	-3.832	10.992

Profile 1: LBI77 Groin
Profile 2: LBI77 Temp
XOn: 121.40 ft
XOff: 269.80 ft
Volume Change:
Above Datum: 17.927 cu. yd/ft
Below Datum: -7.307 cu.yd/ft
Total Volume: 10.620 cu.yd/ft
Shoreline Change: -35.92 ft
From: 250.13 ft
To: 214.22 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	220.13	-1.02	18.923	5.17	18.923	18.923
2	269.8	-1.79	-8.303	-4.51	10.62	27.226

Profile 1: LBI78 Groin
Profile 2: LBI78 Temp
XOn: 154.60 ft
XOff: 298.60 ft
Volume Change:
Above Datum: 4.325 cu. yd/ft
Below Datum: -23.727 cu.yd/ft
Total Volume: -19.402 cu.yd/ft
Shoreline Change: -78.01 ft
From: 287.85 ft
To: 209.84 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	199.15	1.85	5.009	3.04	5.009	5.009
2	298.6	-2.02	-24.41	-6.63	-19.402	29.419

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI79 Groin
Profile 2: LBI79 Temp
XOn: 204.50 ft
XOff: 319.94 ft
Volume Change:
Above Datum: 1.762 cu. yd/ft
Below Datum: -11.980 cu.yd/ft
Total Volume: -10.218 cu.yd/ft
Shoreline Change: -55.52 ft
From: 313.83 ft
To: 258.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	250.6	1.33	4.358	2.55	4.358	4.358
2	319.94	-1.47	-14.576	-5.68	-10.218	18.934

Profile 1: LBI80 Groin
Profile 2: LBI80 Temp
XOn: 232.32 ft
XOff: 357.56 ft
Volume Change:
Above Datum: -2.866 cu. yd/ft
Below Datum: -19.892 cu.yd/ft
Total Volume: -22.757 cu.yd/ft
Shoreline Change: -78.40 ft
From: 357.04 ft
To: 278.64 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	265.58	2.26	2.503	2.03	2.503	2.503
2	357.56	-2.22	-25.261	-7.41	-22.757	27.764

Profile 1: LBI81 Groin
Profile 2: LBI81 Temp
XOn: 211.80 ft
XOff: 397.06 ft
Volume Change:
Above Datum: 4.700 cu. yd/ft
Below Datum: -48.041 cu.yd/ft
Total Volume: -43.342 cu.yd/ft
Shoreline Change: -75.63 ft
From: 347.76 ft
To: 272.14 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	264.36	1.34	6.017	3.09	6.017	6.017
2	397.06	-1.85	-49.359	-10.04	-43.342	55.377

Profile 1: LBI82 Groin
Profile 2: LBI82 Temp
XOn: 162.00 ft
XOff: 365.76 ft
Volume Change:
Above Datum: -1.973 cu. yd/ft
Below Datum: -61.664 cu.yd/ft
Total Volume: -63.637 cu.yd/ft
Shoreline Change: -118.39 ft
From: 344.70 ft
To: 226.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	207.76	3.2	5.583	3.29	5.583	5.583
2	365.76	-1.33	-69.22	-11.83	-63.637	74.803

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI83 Groin
Profile 2: LBI83 Temp
XOn: 103.00 ft
XOff: 322.40 ft
Volume Change:
Above Datum: 38.144 cu. yd/ft
Below Datum: -12.426 cu.yd/ft
Total Volume: 25.718 cu.yd/ft
Shoreline Change: -36.38 ft
From: 292.09 ft
To: 255.72 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	245.21	1.81	39.028	7.41	39.028	39.028
2	322.4	-1.67	-13.31	-4.66	25.718	52.338

Profile 1: LBI84 Groin
Profile 2: LBI84 Temp
XOn: 58.20 ft
XOff: 455.66 ft
Volume Change:
Above Datum: 47.648 cu. yd/ft
Below Datum: -94.640 cu.yd/ft
Total Volume: -46.991 cu.yd/ft
Shoreline Change: -169.62 ft
From: 451.60 ft
To: 281.98 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	258.64	4.03	60.997	8.22	60.997	60.997
2	455.66	-1.07	-107.989	-14.8	-46.991	168.986

Profile 1: LBI85 Groin
Profile 2: LBI85 Temp
XOn: 91.00 ft
XOff: 314.81 ft
Volume Change:
Above Datum: -14.913 cu. yd/ft
Below Datum: -71.442 cu.yd/ft
Total Volume: -86.355 cu.yd/ft
Shoreline Change: -148.87 ft
From: 313.19 ft
To: 164.32 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	134.71	5.11	4.641	2.87	4.641	4.641
2	314.81	-1.92	-90.996	-13.64	-86.355	95.638

Profile 1: LBI88 Groin
Profile 2: LBI88 Temp
XOn: 96.30 ft
XOff: 289.76 ft
Volume Change:
Above Datum: 2.028 cu. yd/ft
Below Datum: -35.575 cu.yd/ft
Total Volume: -33.547 cu.yd/ft
Shoreline Change: -99.70 ft
From: 282.45 ft
To: 182.75 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	164.43	3.16	8.126	3.22	8.126	8.126
2	168.42	2.47	-0.028	-0.19	8.099	8.154
3	169.07	2.35	0	0.01	8.099	8.155

Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1: LBI89 Groin
Profile 2: LBI89 Temp
XOn: 53.20 ft
XOff: 191.81 ft
Volume Change:
Above Datum: 14.663 cu. yd/ft
Below Datum: -9.299 cu.yd/ft
Total Volume: 5.364 cu.yd/ft
Shoreline Change: -42.31 ft
From: 173.22 ft
To: 130.92 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	132.06	-0.2	16.152	5.53	16.152	16.152
2	191.81	-2.09	-10.788	-4.88	5.364	26.94

Profile 1: LBI90 Groin
Profile 2: LBI90 Temp
XOn: 39.00 ft
XOff: 176.43 ft
Volume Change:
Above Datum: 20.446 cu. yd/ft
Below Datum: 1.209 cu.yd/ft
Total Volume: 21.655 cu.yd/ft
Shoreline Change: 91.14 ft
From: 39.87 ft
To: 131.02 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	139.14	-1.4	25.613	6.91	25.613	25.613
2	176.43	-1.73	-3.958	-2.87	21.655	29.572

Profile 1: LBI91 Groin
Profile 2: LBI91 Temp
XOn: 69.20 ft
XOff: 199.50 ft
Volume Change:
Above Datum: 14.795 cu. yd/ft
Below Datum: -3.062 cu.yd/ft
Total Volume: 11.733 cu.yd/ft
Shoreline Change: -29.41 ft
From: 190.40 ft
To: 160.99 ft

Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	170.85	-1.7	15.733	4.18	15.733	15.733
2	199.5	-0.85	-4	-3.77	11.733	19.733

Profile 1: LBI92 Groin
Profile 2: LBI92 Temp
XOn: 56.25 ft
XOff: 280.02 ft
Volume Change:
Above Datum: 28.029 cu. yd/ft
Below Datum: -29.700 cu.yd/ft
Total Volume: -1.671 cu.yd/ft
Shoreline Change: -83.12 ft
From: 261.11 ft
To: 177.99 ft

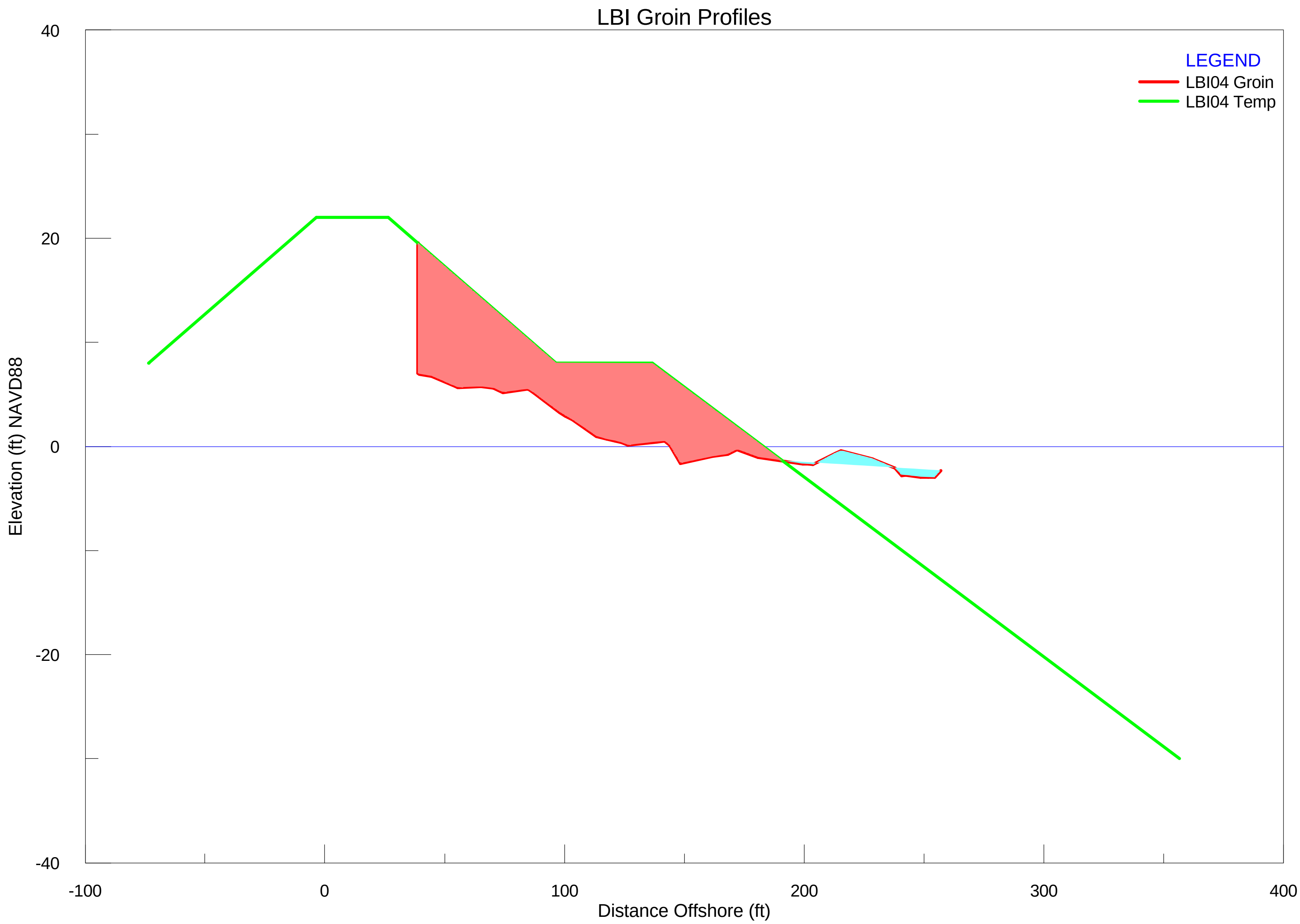
Cell Changes:

Cell #	Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
1	180.98	-0.52	28.207	6.11	28.207	28.207
2	280.02	-1.29	-29.878	-8.14	-1.671	58.085

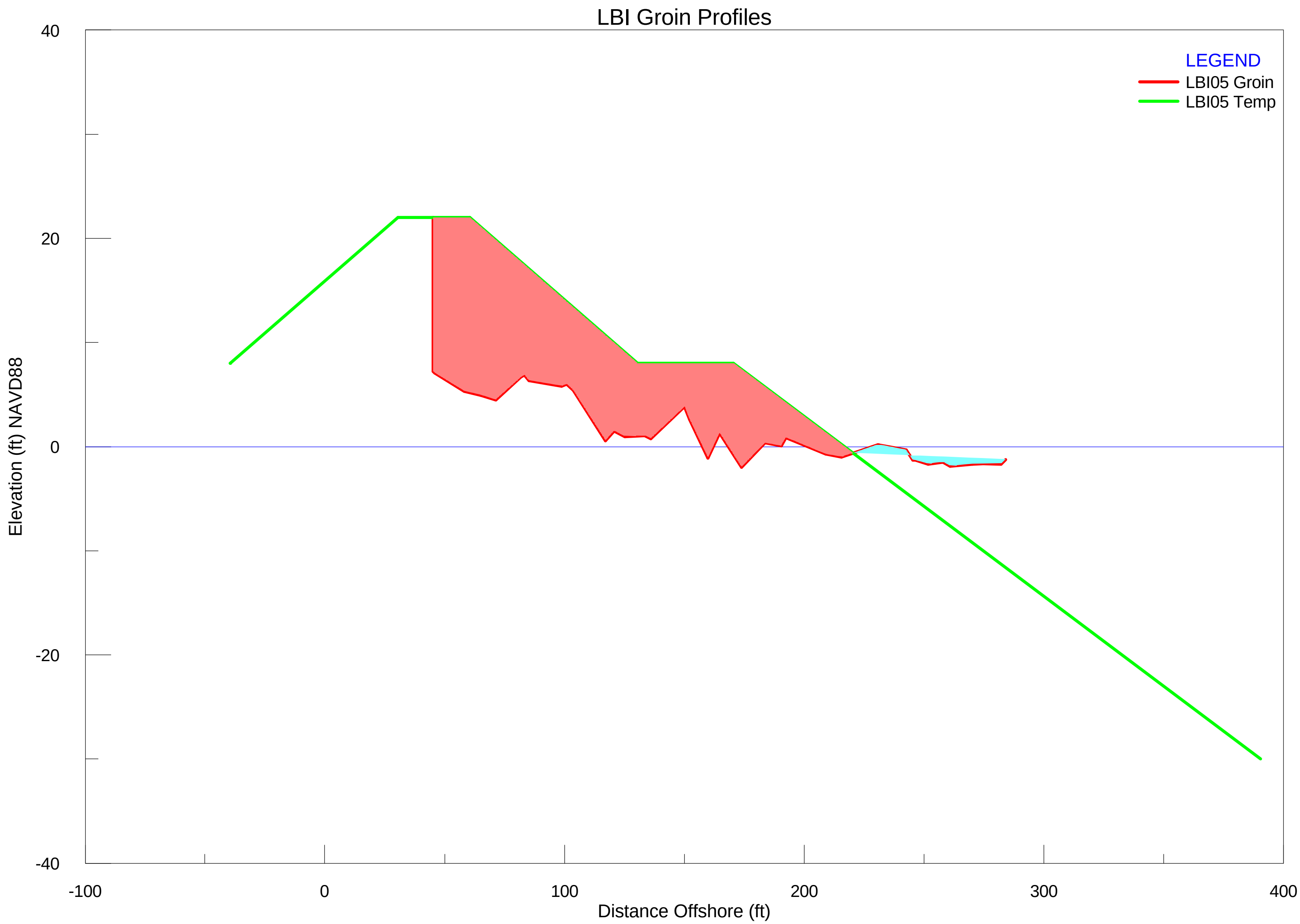
Barnegat Inlet to Little Egg Harbor
Feasibility Study
Groin Sections and Volumes

Profile 1:	LBI93 Groin								
Profile 2:	LBI93 Temp								
XOn:	33.50 ft								
XOff:	215.00 ft								
Volume Change:									
Above Datum:	52.004 cu. yd/ft								
Below Datum:	0.889 cu.yd/ft								
Total Volume:	52.893 cu.yd/ft	Cell Changes:							
Shoreline Change:	11.66 ft	Cell #		Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
From:	183.35 ft		1	207.17	-2.1	53.089	8.25	53.089	53.089
To:	195.02 ft		2	215	-2.1	-0.196	-0.68	52.893	53.285

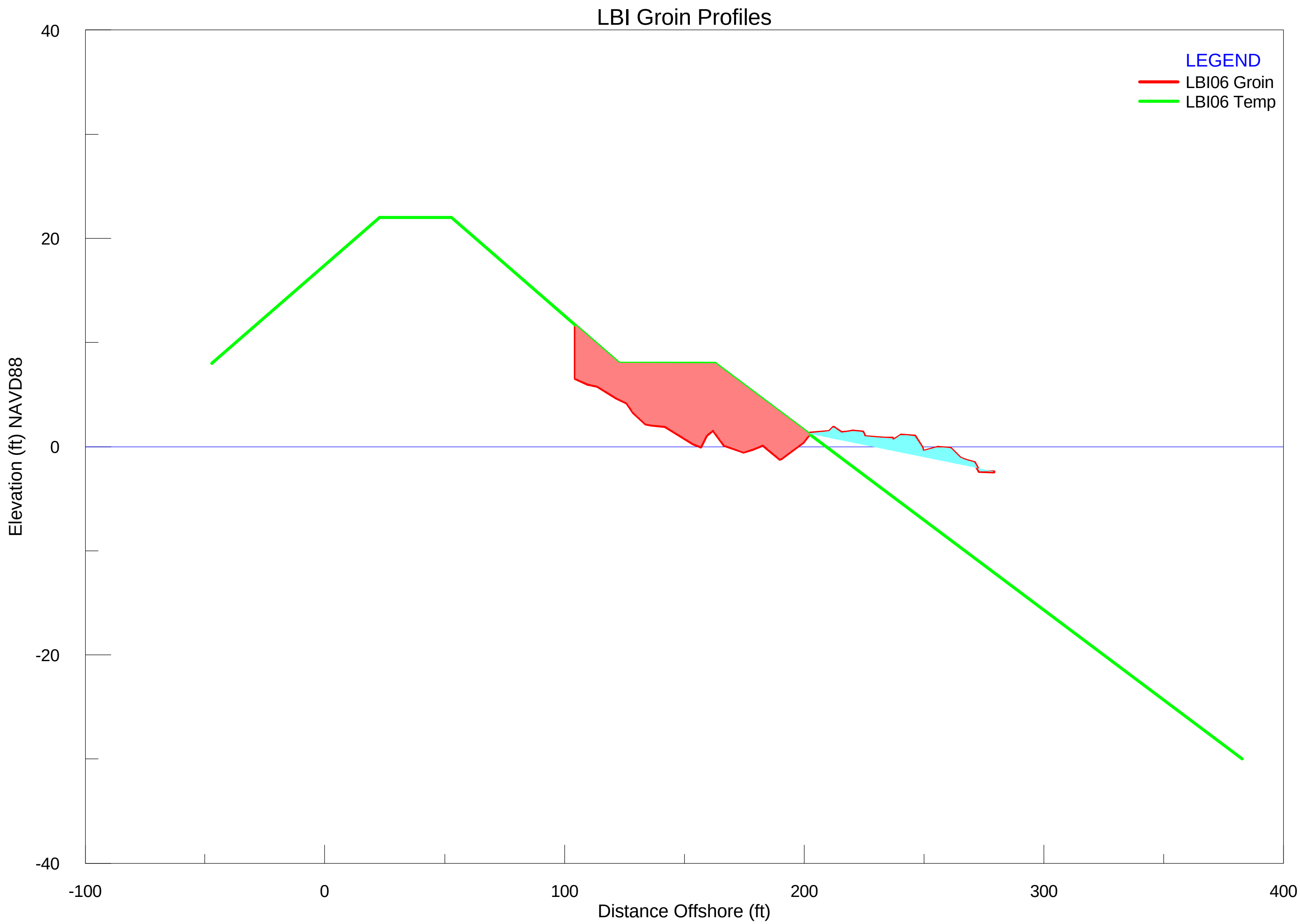
Profile 1:	LBI95 Groin								
Profile 2:	LBI95 Temp								
XOn:	97.50 ft								
XOff:	272.96 ft								
Volume Change:									
Above Datum:	4.416 cu. yd/ft								
Below Datum:	-41.857 cu.yd/ft								
Total Volume:	-37.440 cu.yd/ft	Cell Changes:							
Shoreline Change:	-113.58 ft	Cell #		Ending Distance(ft)	Ending Elevation(ft)	Cell Volume(cu. yd/ft)	Cell Thickness(ft)	Cumulative Volume(cu. yd/ft)	Gross Volume(cu. yd/ft)
From:	269.90 ft		1	158.99	-0.46	6.018	2.64	6.018	6.018
To:	156.32 ft		2	272.96	-0.54	-43.459	-10.3	-37.44	49.477

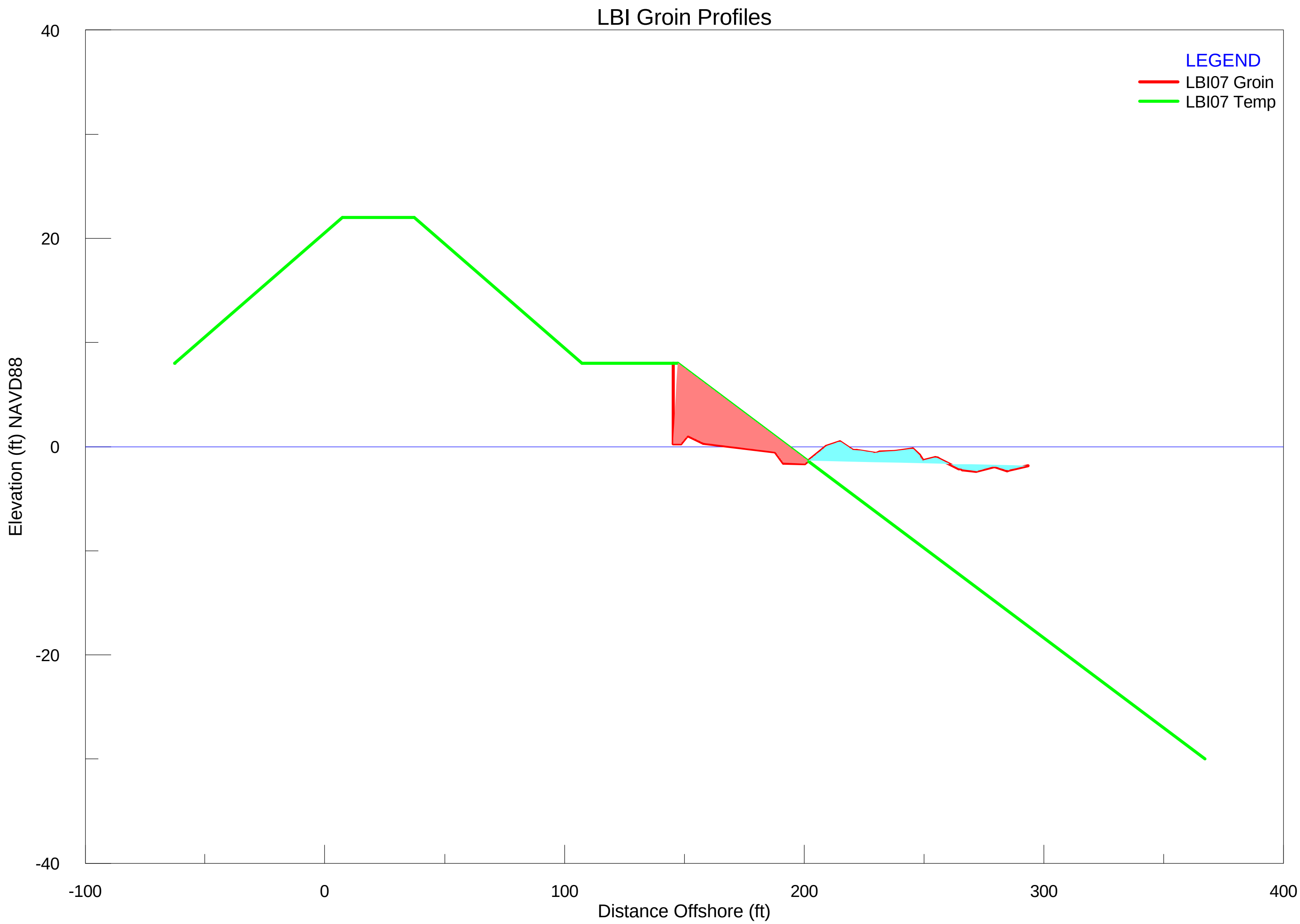


LBI Groin Profiles
LEGEND
LBI04 Groin
LBI04 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

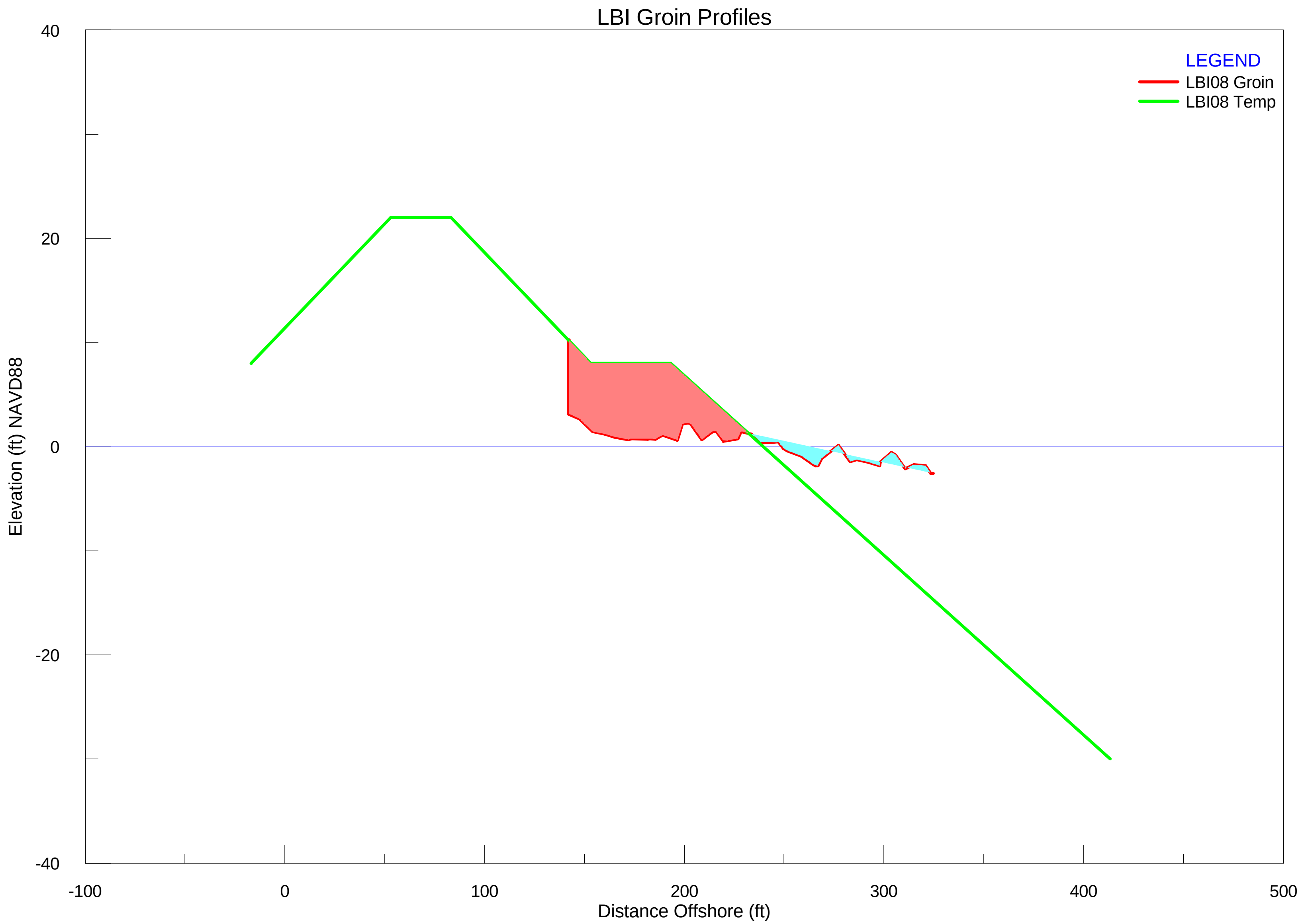


LBI Groin Profiles
LEGEND
LBI05 Groin
LBI05 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

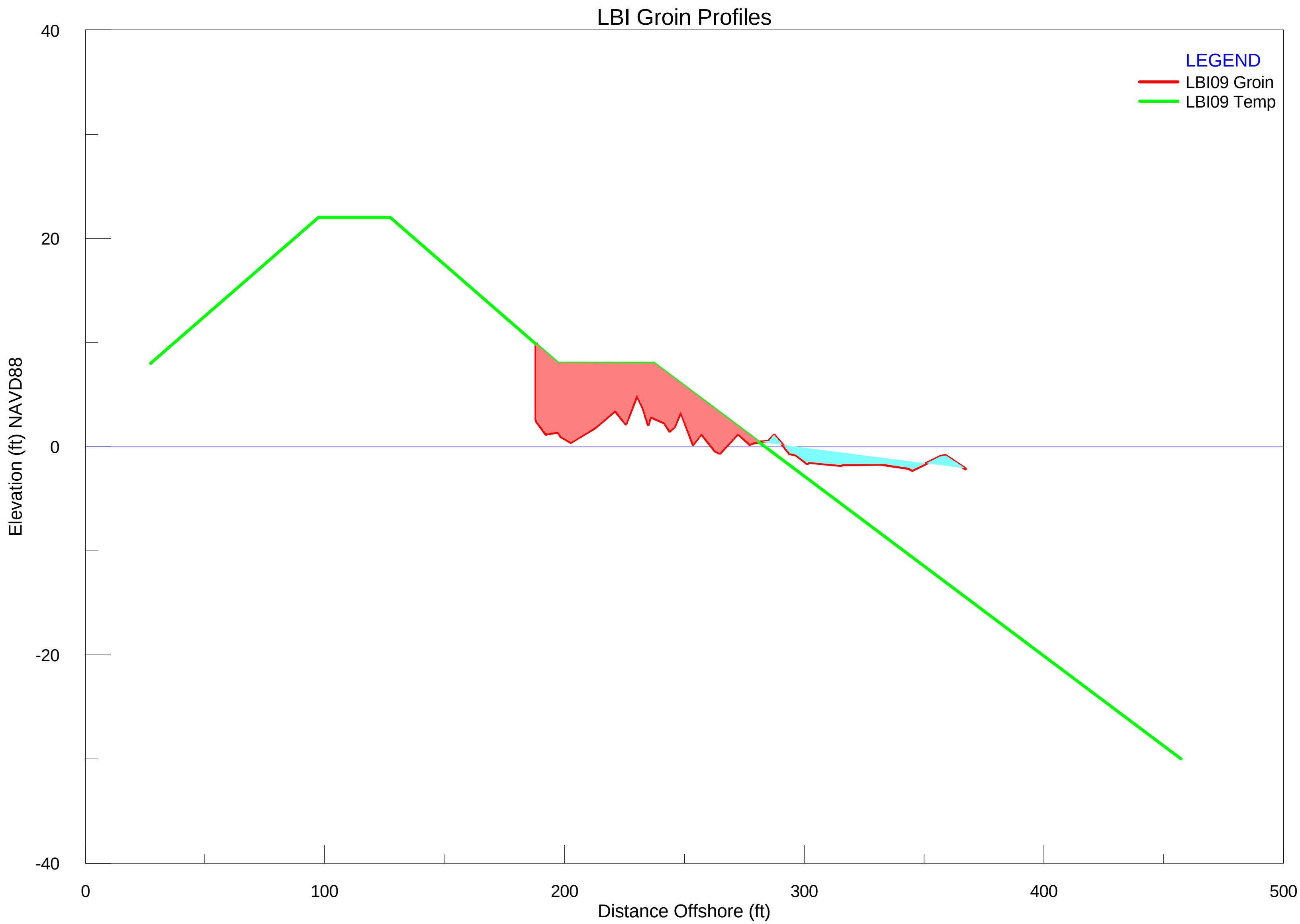

LBI Groin Profiles
LEGEND
LBI06 Groin
LBI06 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

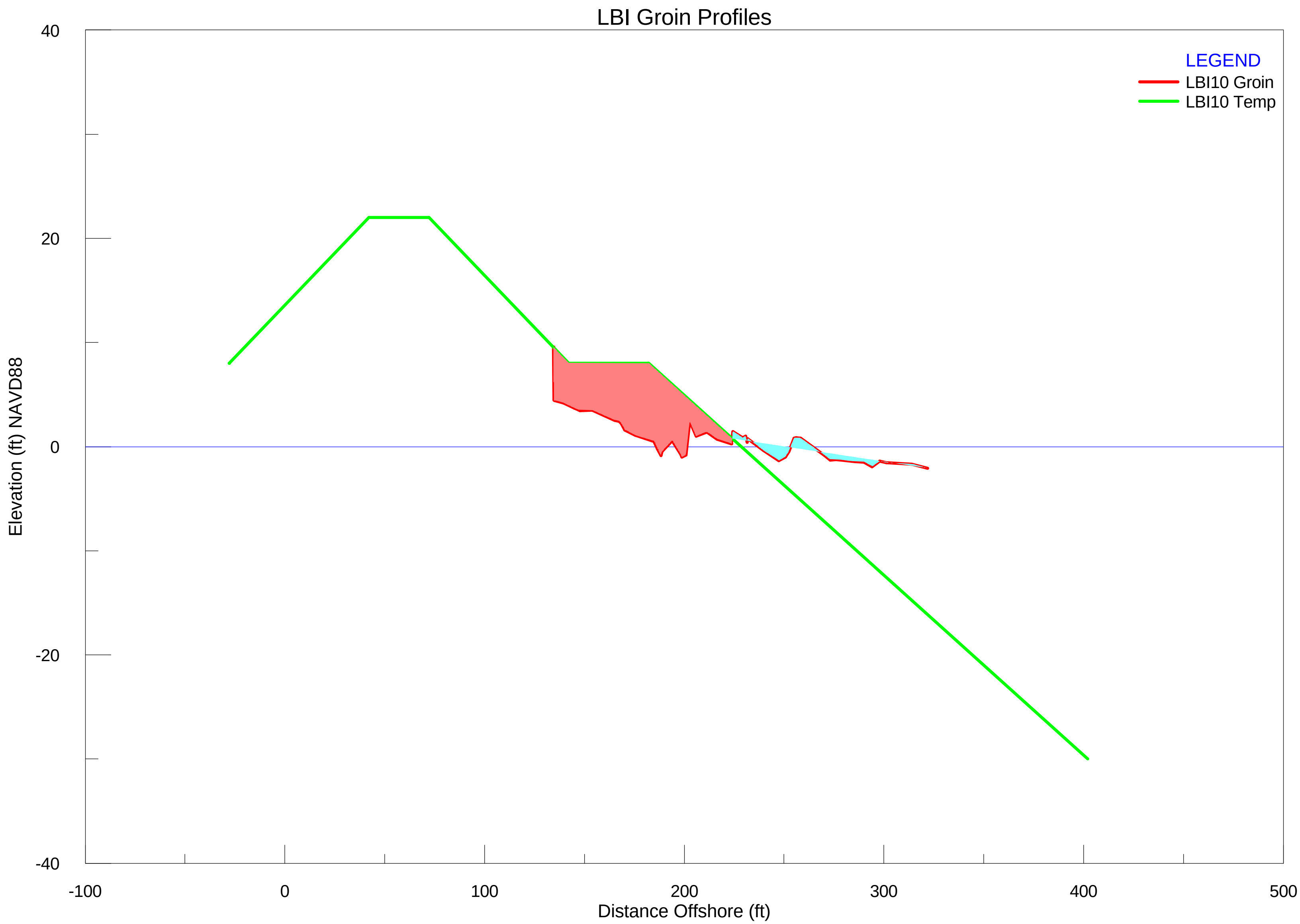


LBI Groin Profiles
LEGEND
LBI07 Groin
LBI07 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

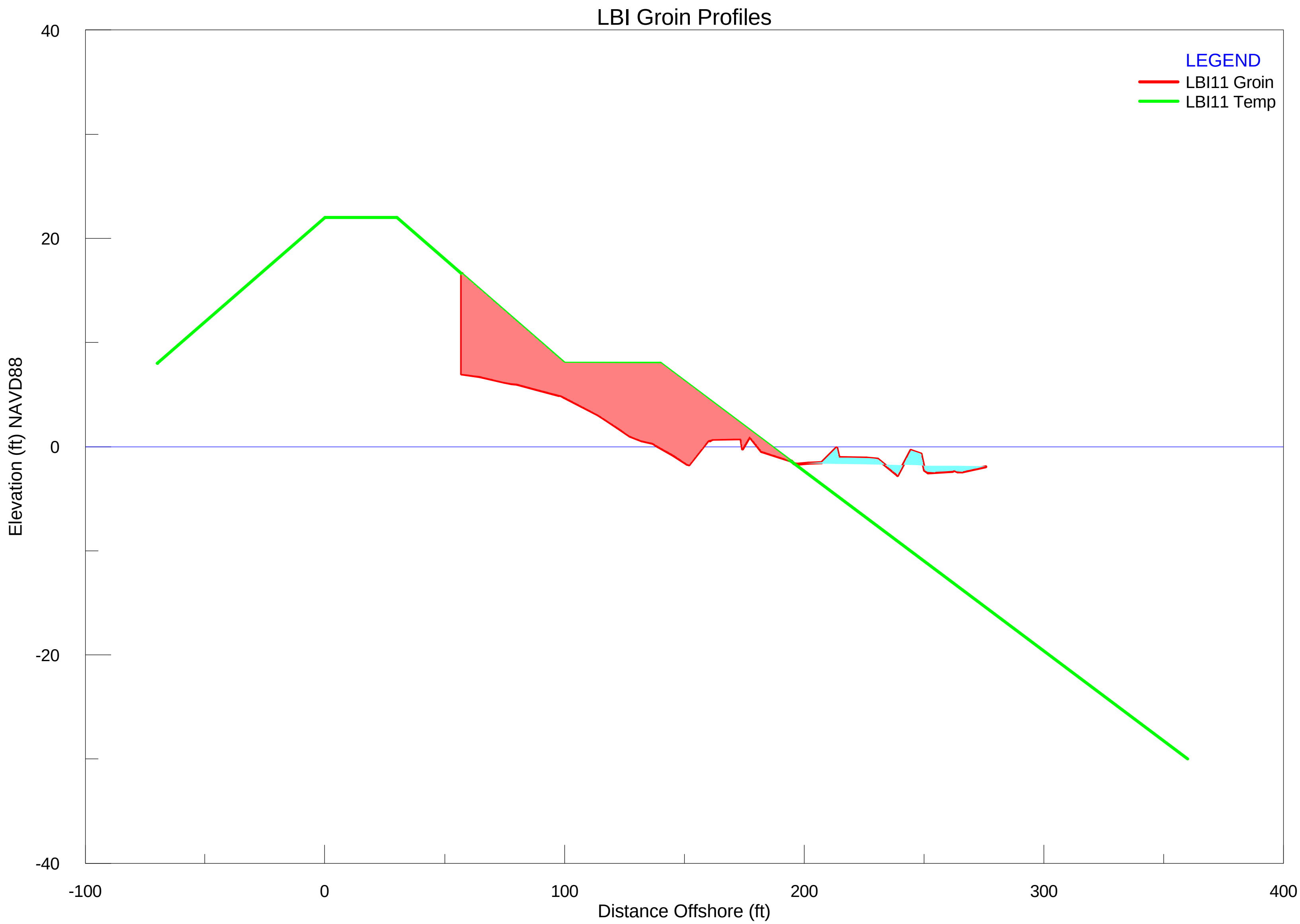


LBI Groin Profiles
LEGEND
LBI08 Groin
LBI08 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)

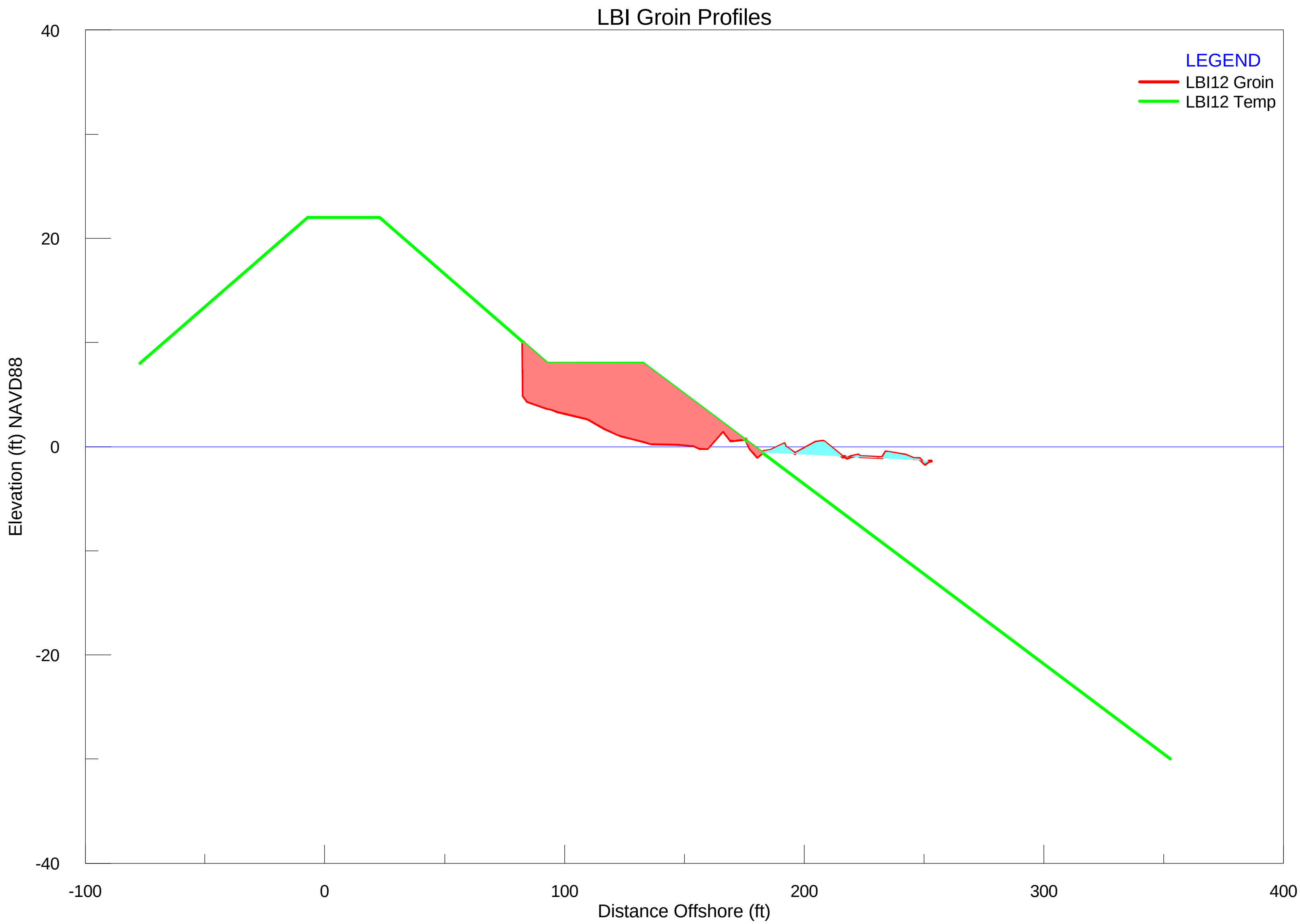

LBI Groin Profiles
LEGEND
LBI09 Groin
LBI09 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
0
100
200
300
400
500
Distance Offshore (ft)

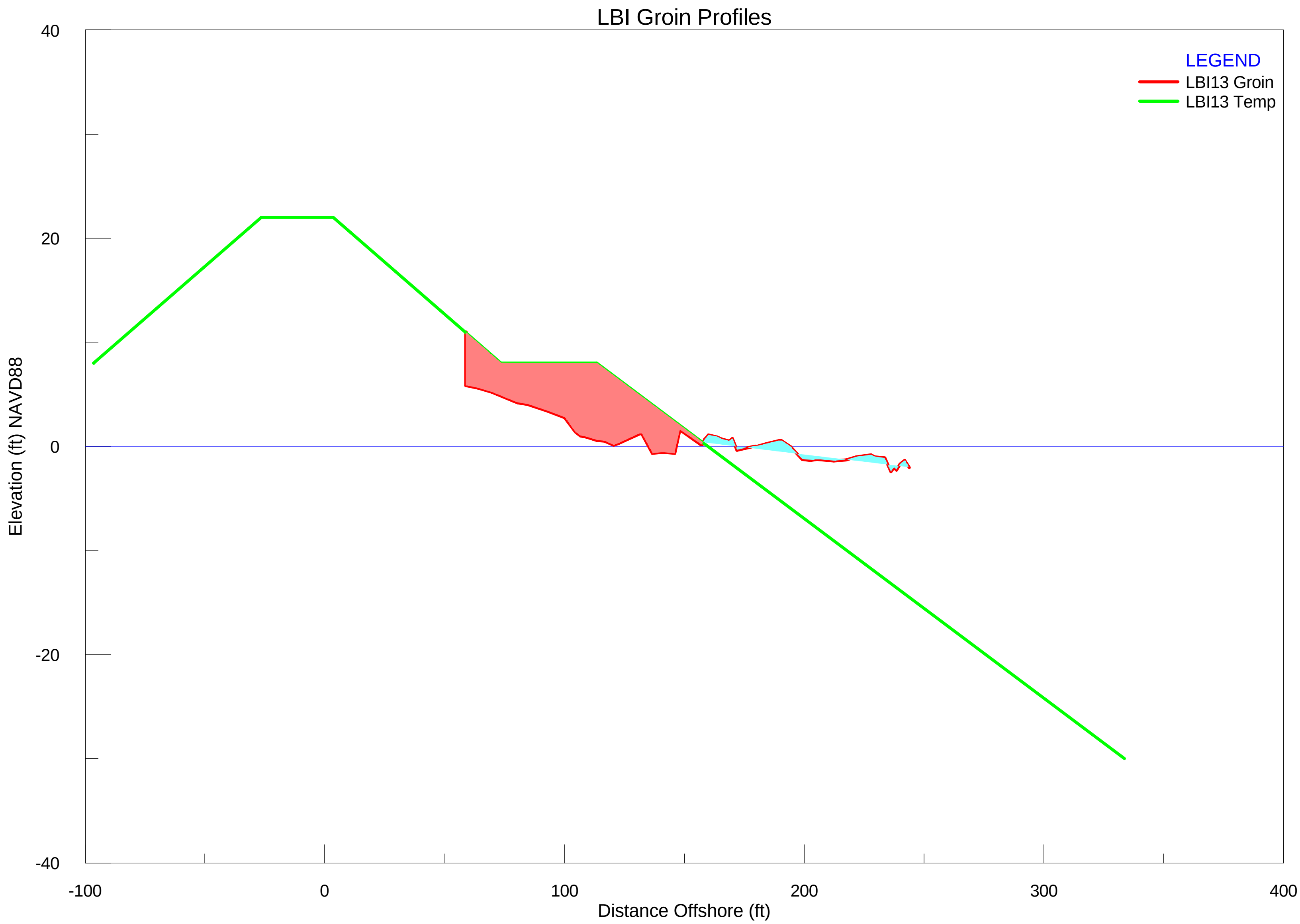


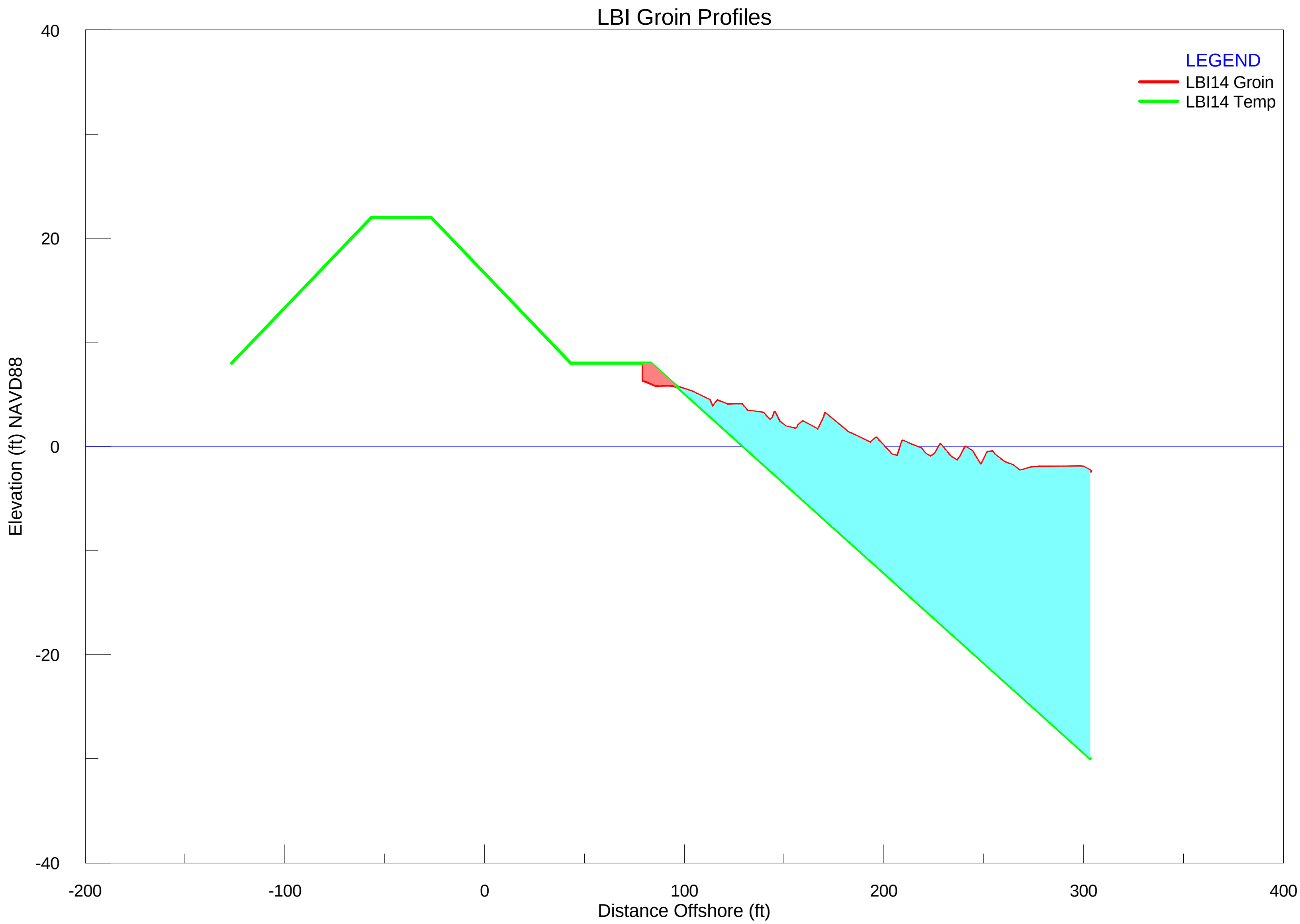
LBI Groin Profiles
LEGEND
LBI10 Groin
LBI10 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)



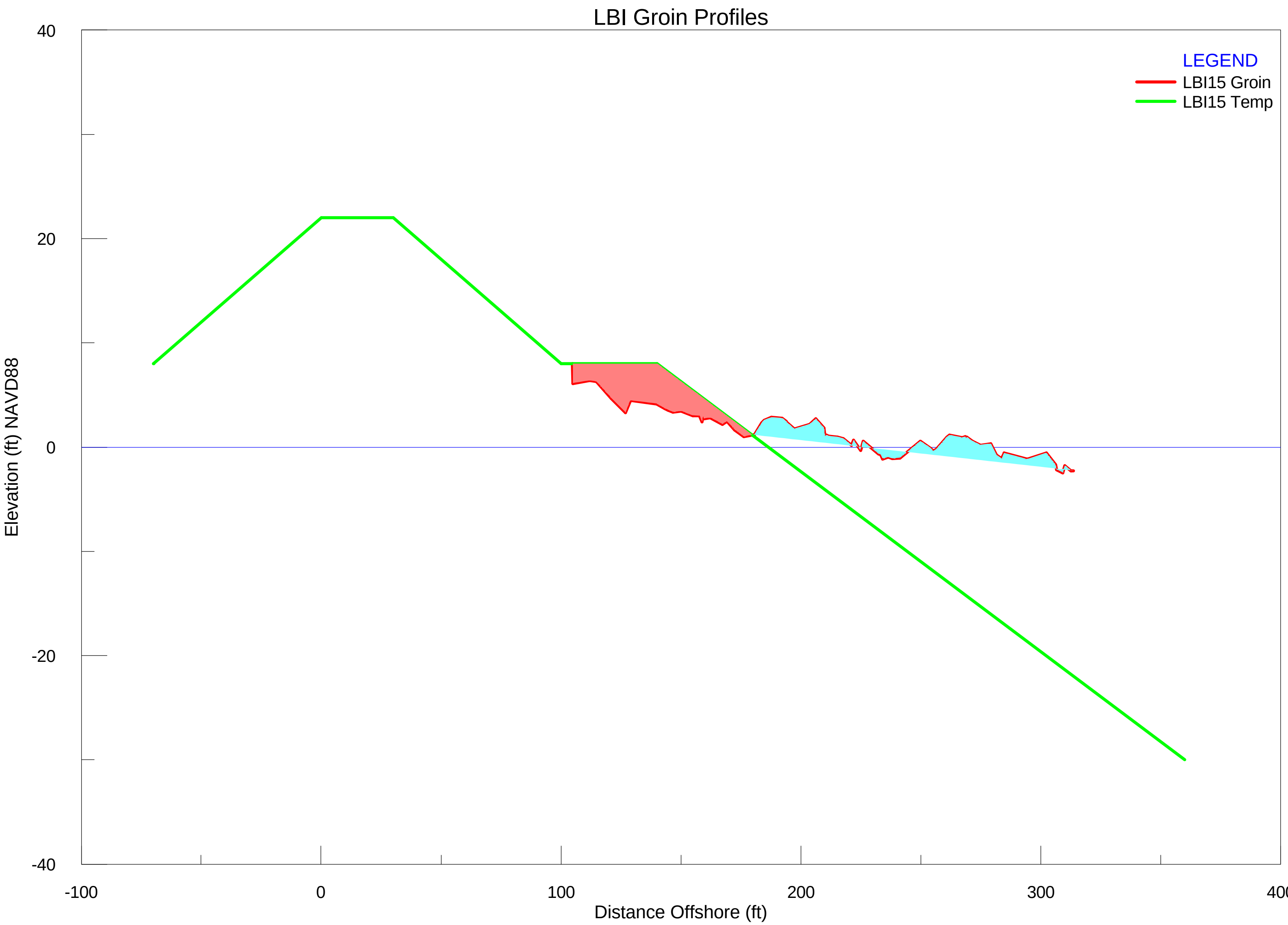
LBI Groin Profiles
LEGEND
LBI11 Groin
LBI11 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

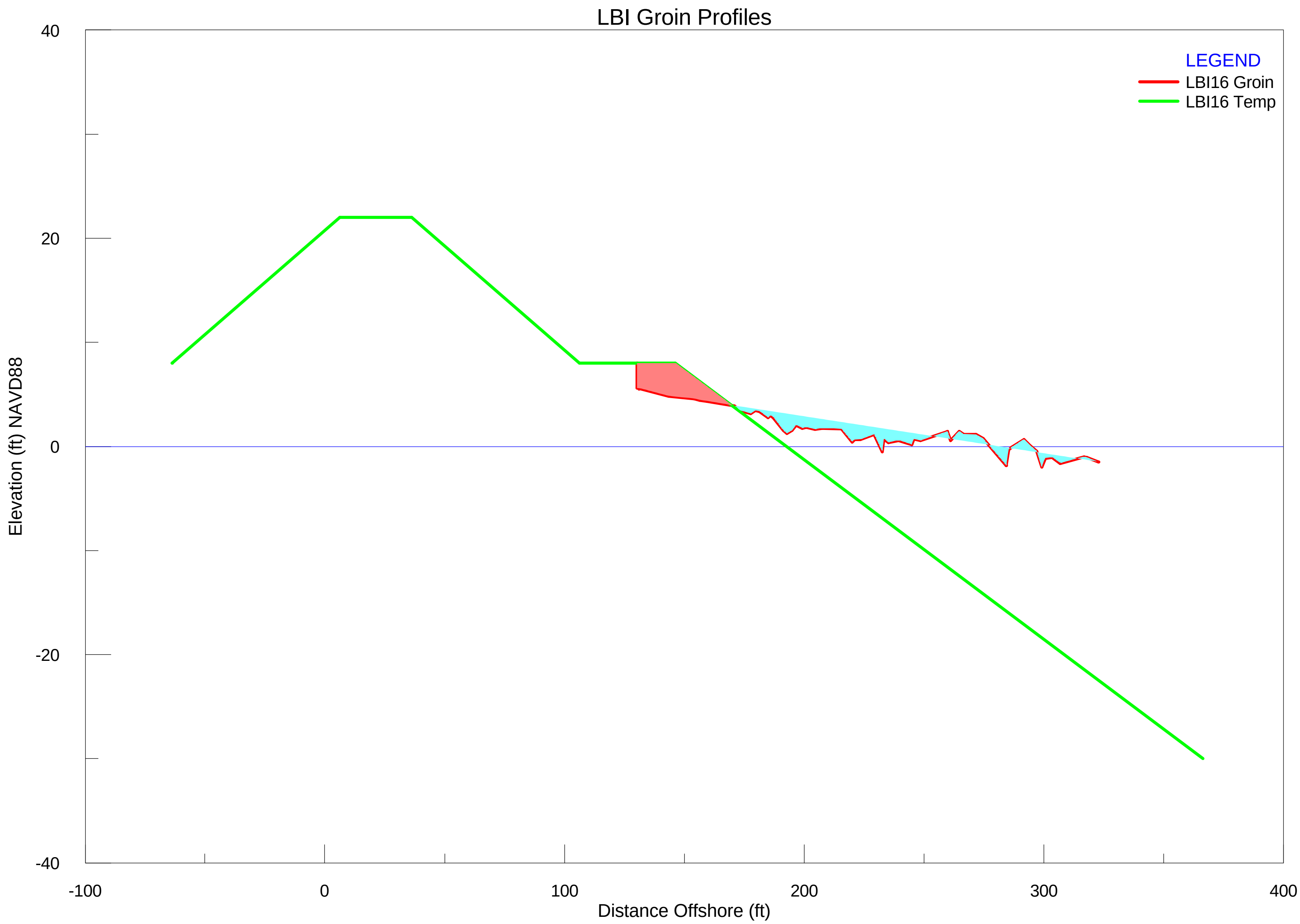

LBI Groin Profiles
LEGEND
LBI12 Groin
LBI12 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

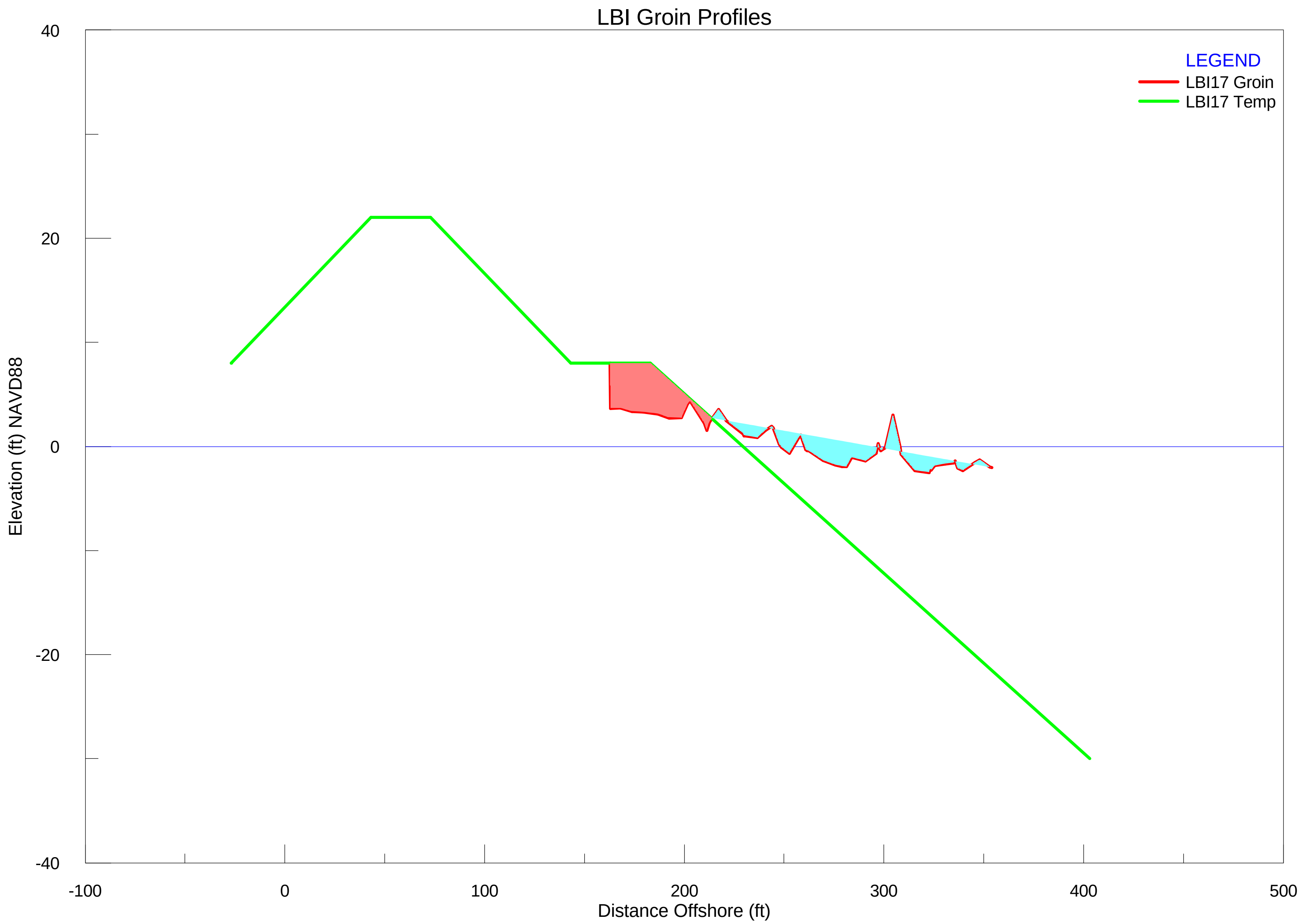

LBI Groin Profiles
LEGEND
LBI13 Groin
LBI13 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



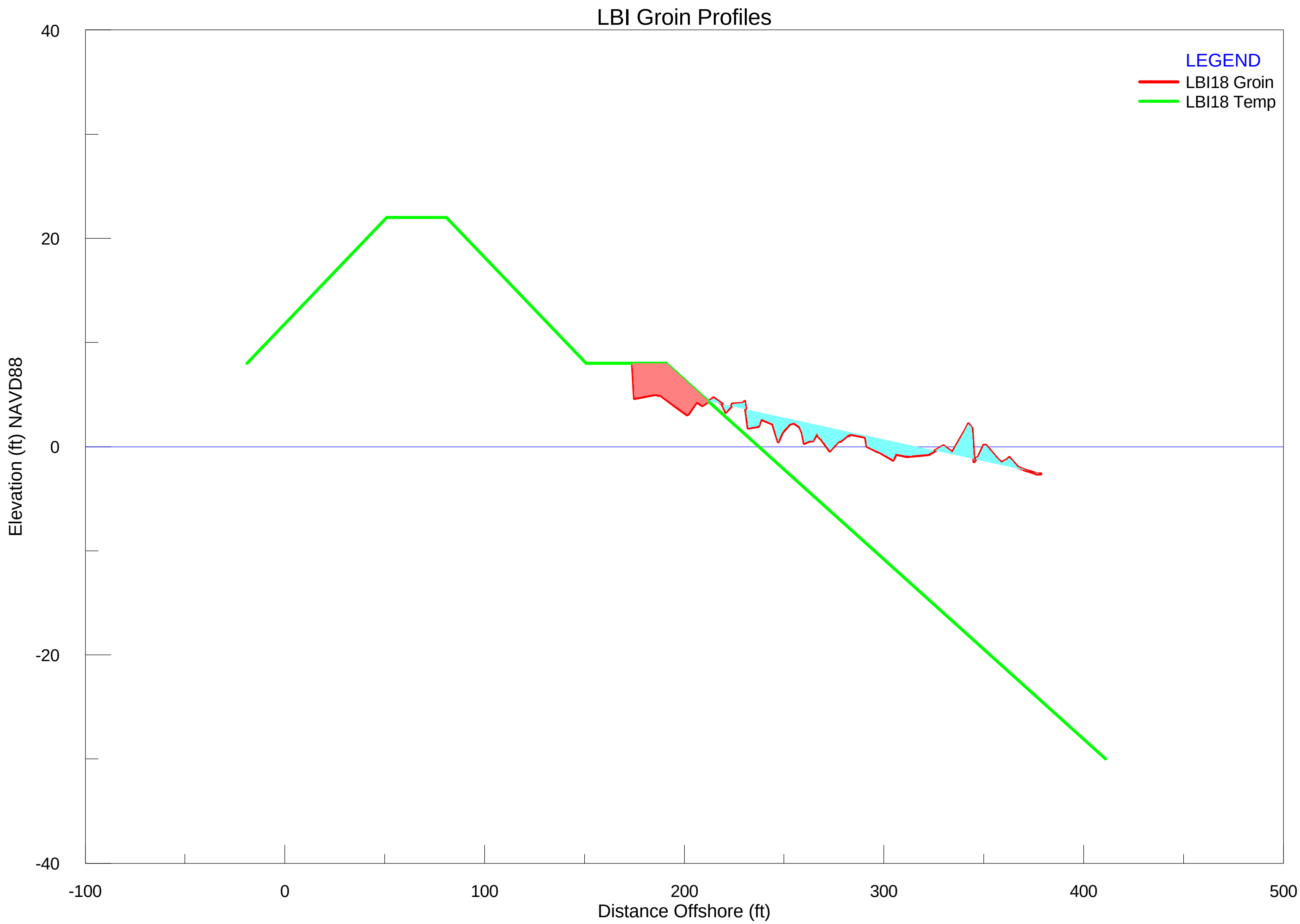
LBI Groin Profiles
LEGEND
LBI14 Groin
LBI14 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-200
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI15 Groin
LBI15 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

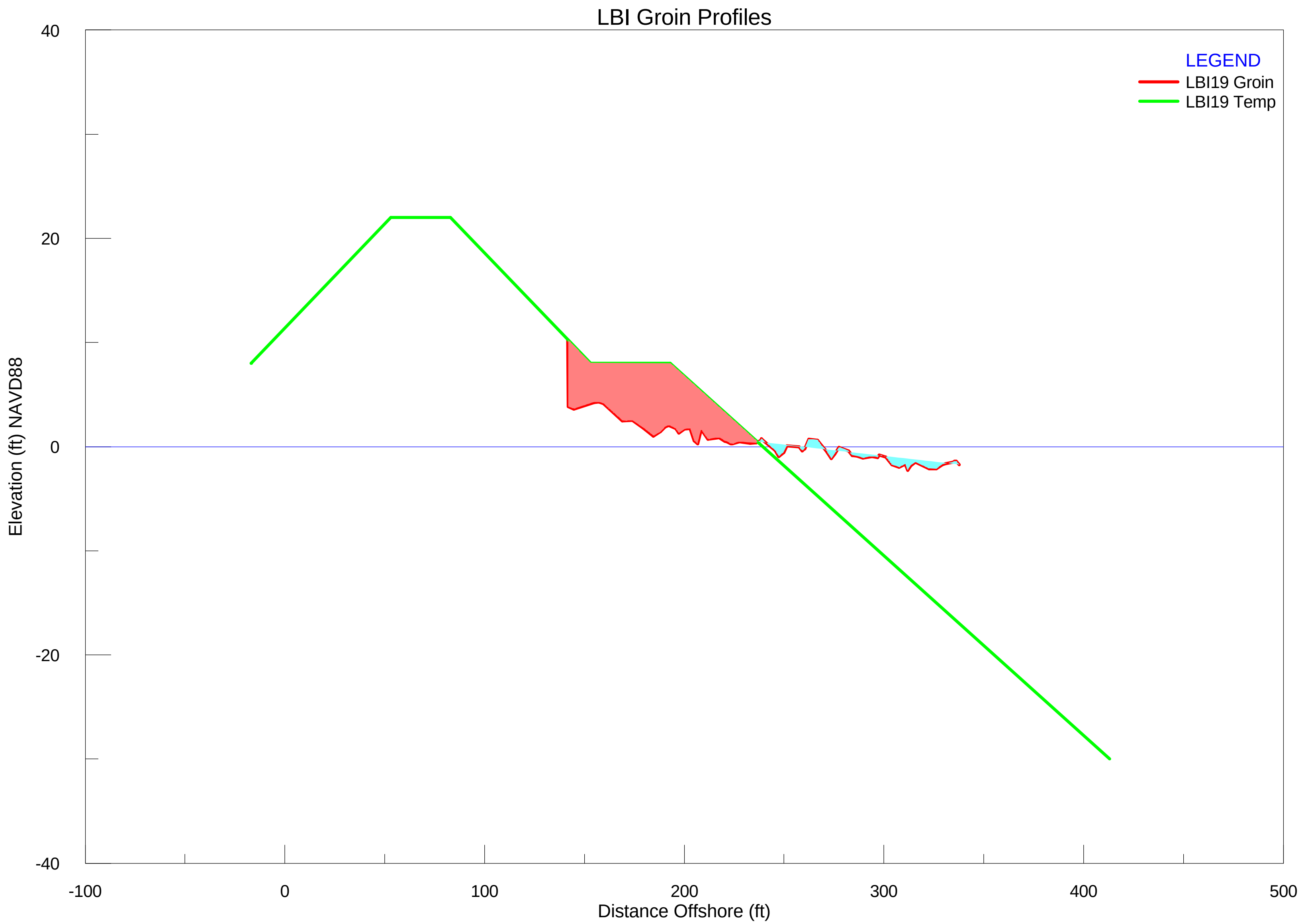

LBI Groin Profiles
LEGEND
LBI16 Groin
LBI16 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



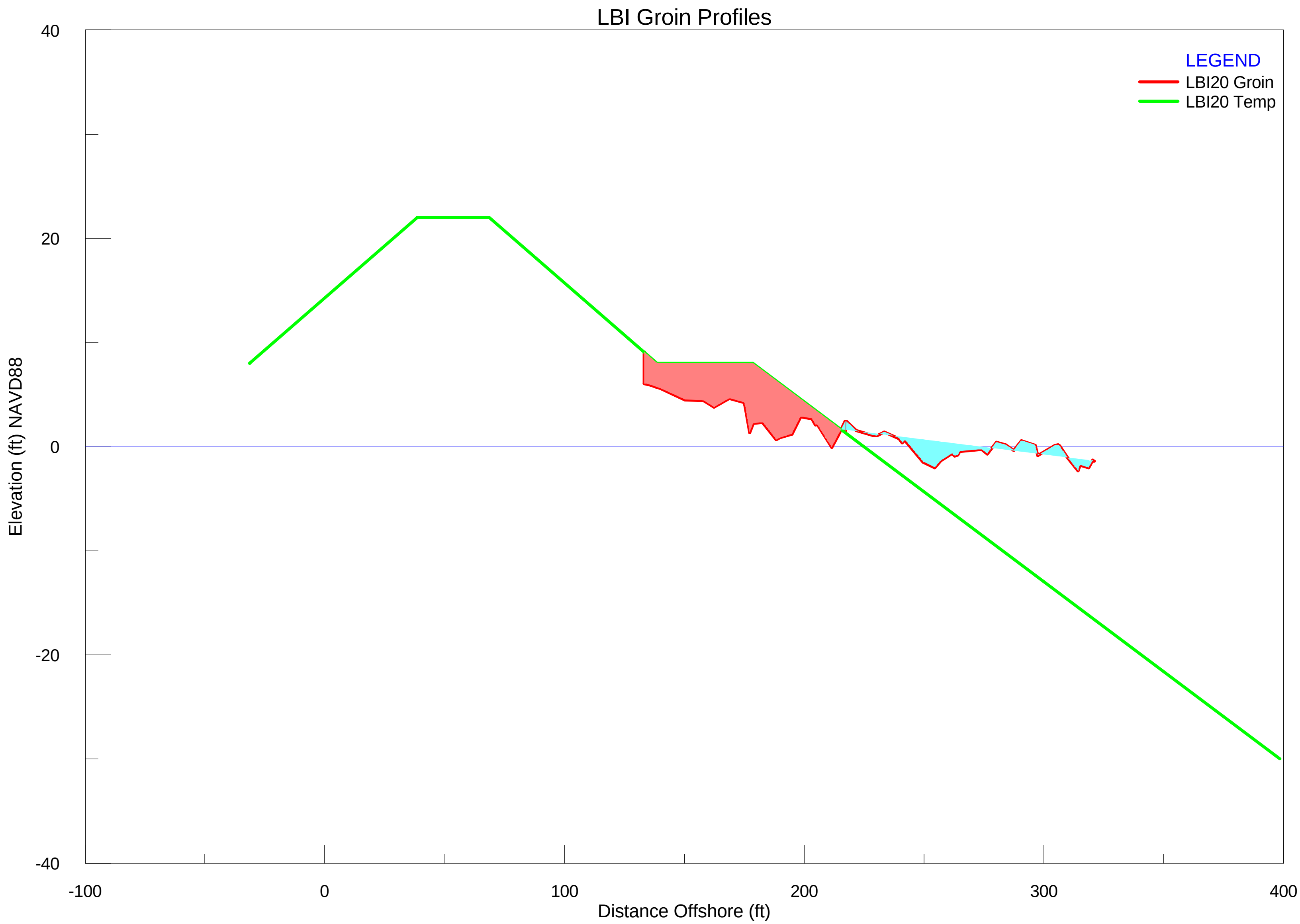
LBI Groin Profiles
LEGEND
LBI17 Groin
LBI17 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)

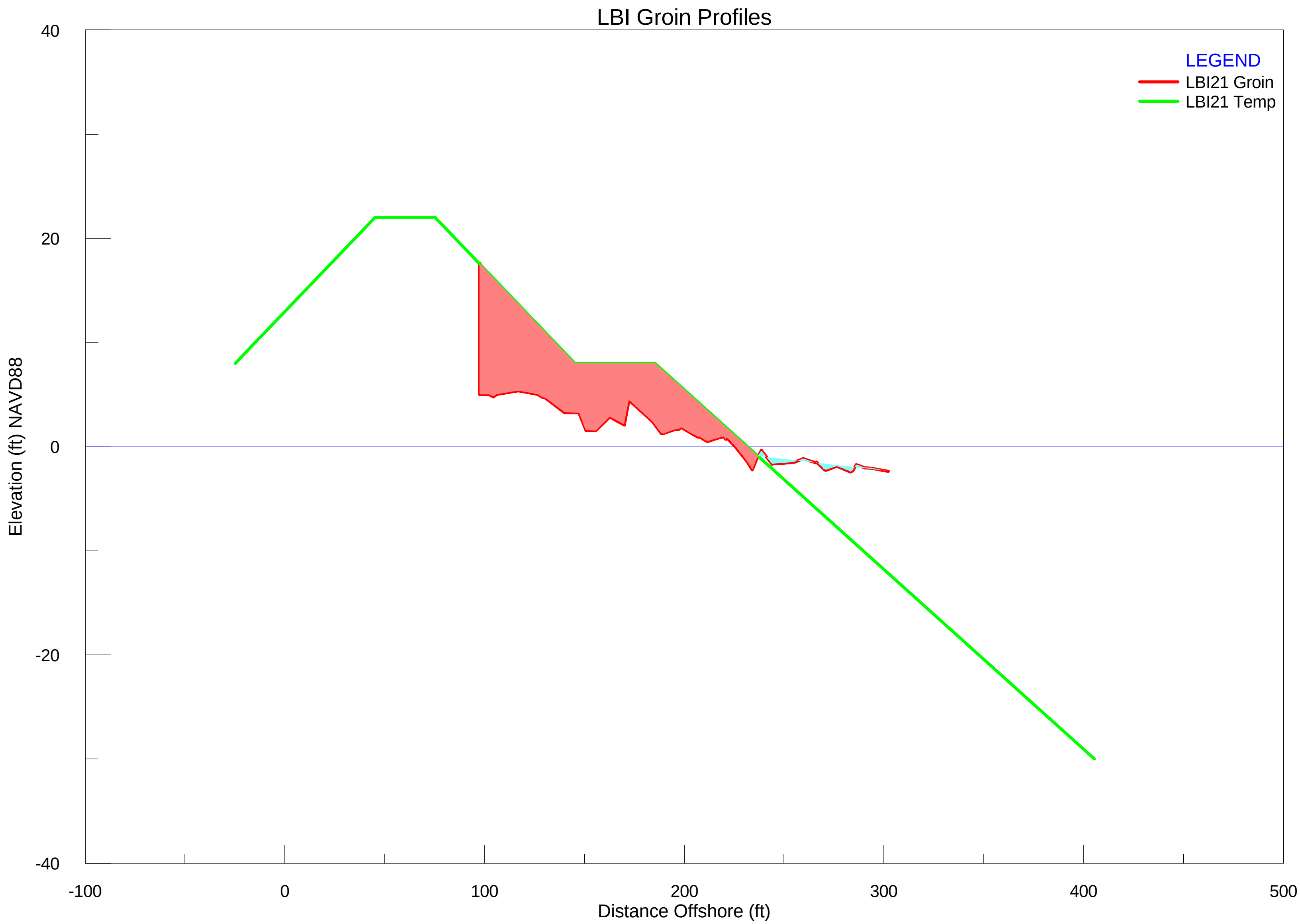


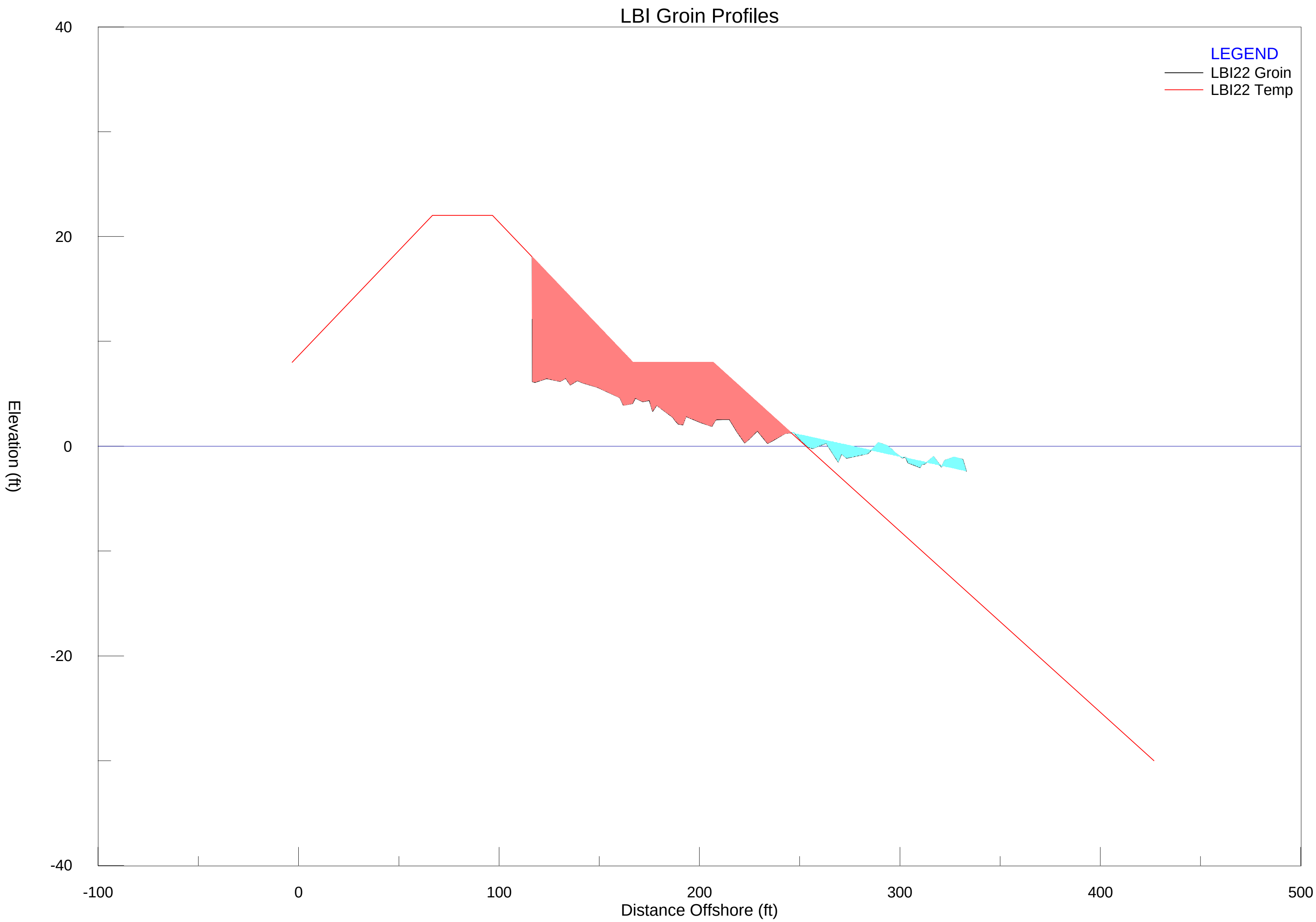
LBI Groin Profiles
LEGEND
LBI18 Groin
LBI18 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)



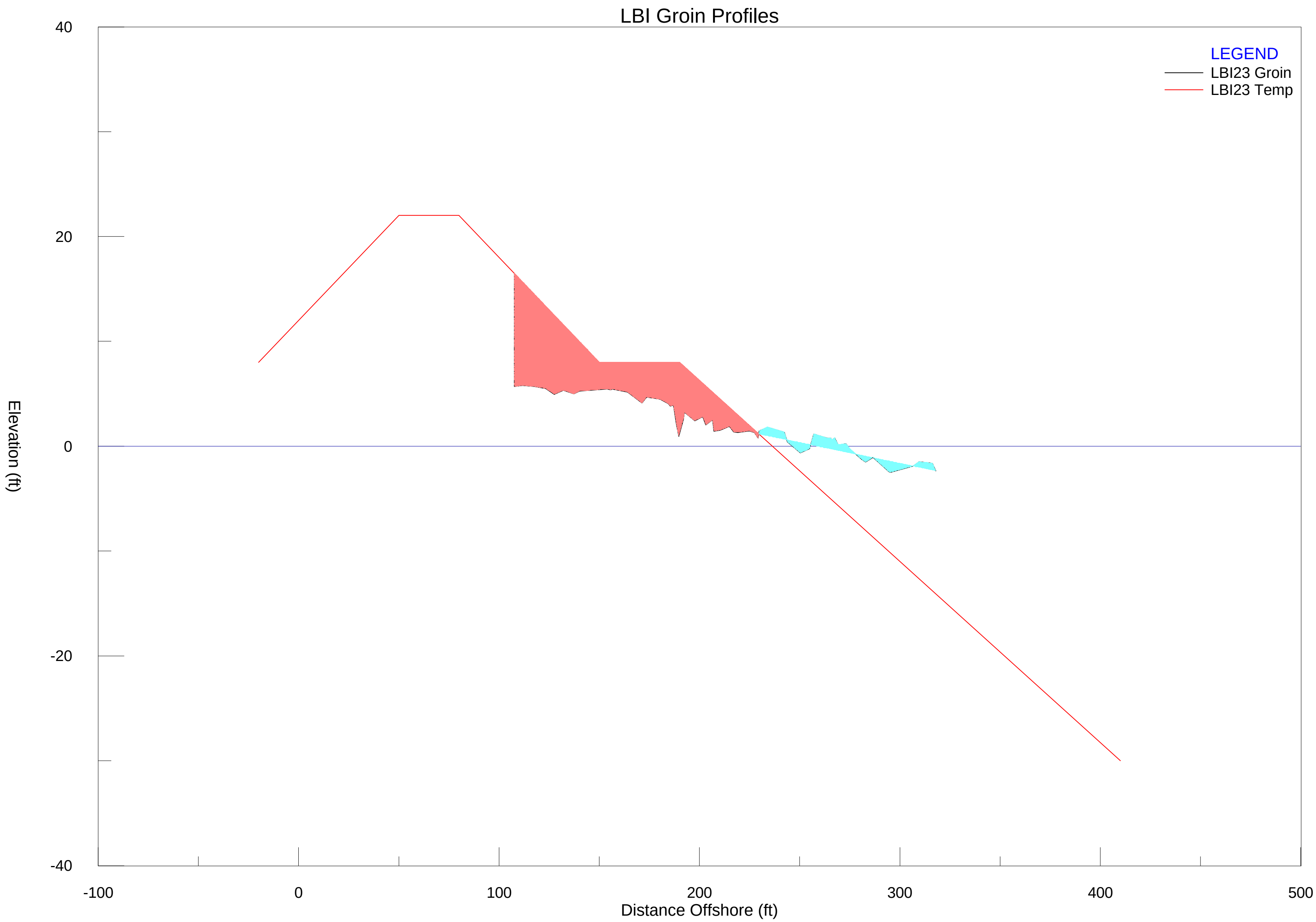
LBI Groin Profiles
LEGEND
LBI19 Groin
LBI19 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI20 Groin
LBI20 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

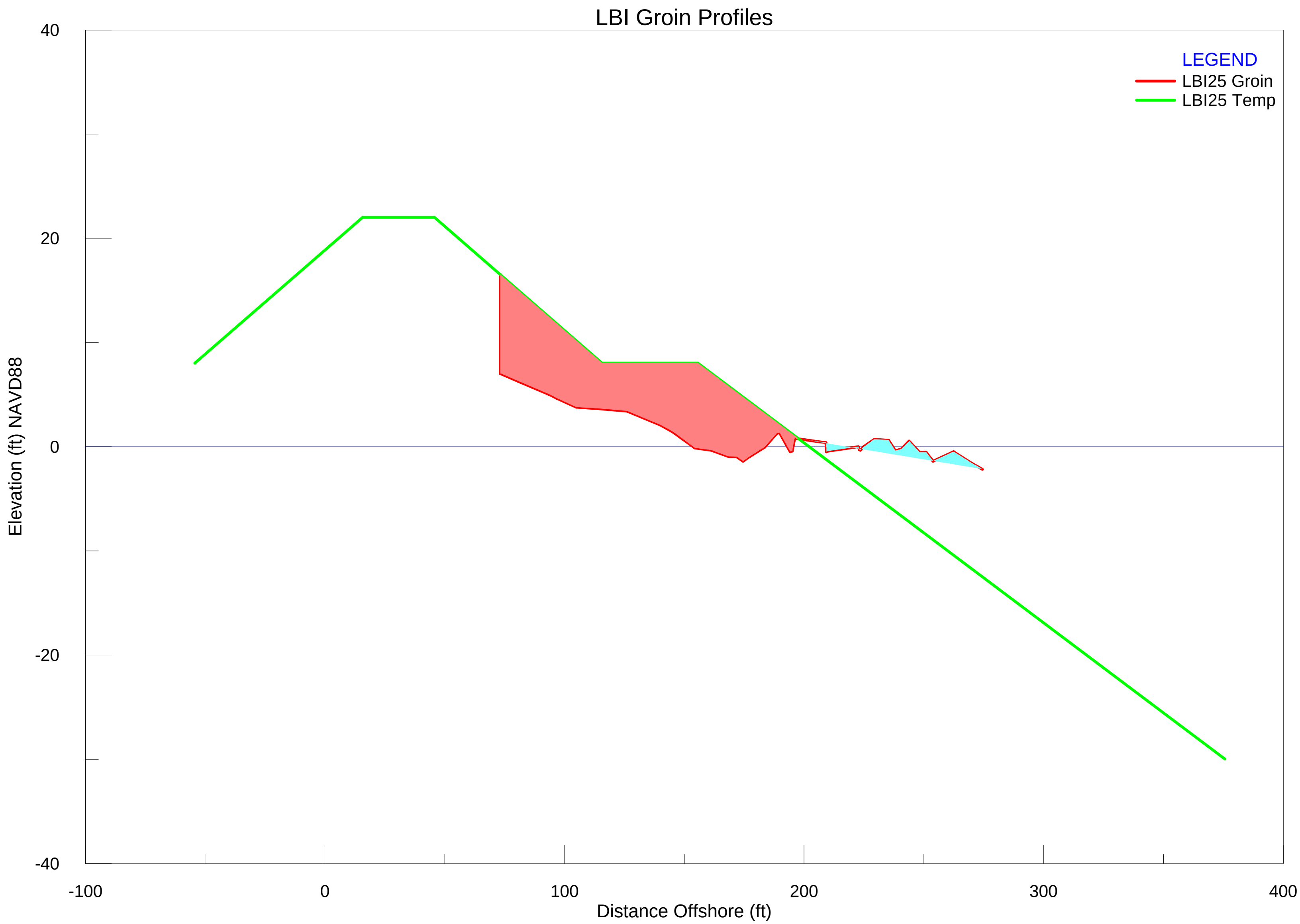

LBI Groin Profiles
LEGEND
LBI21 Groin
LBI21 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

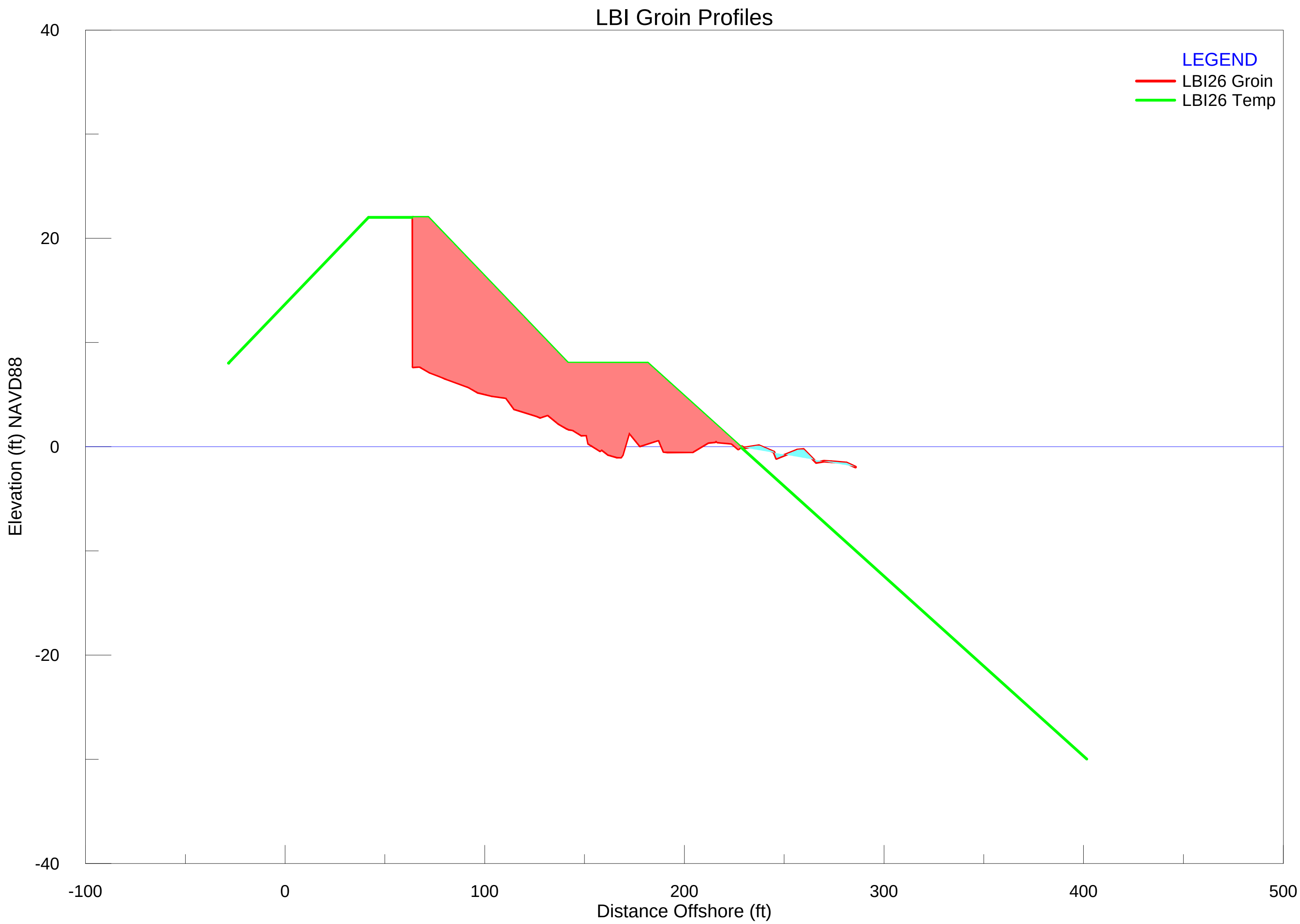


LBI Groin Profiles
LEGEND
LBI22 Groin
LBI22 Temp
40
20
0
-20
-40
Elevation (ft)
-100
0
100
200
300
400
500
Distance Offshore (ft)

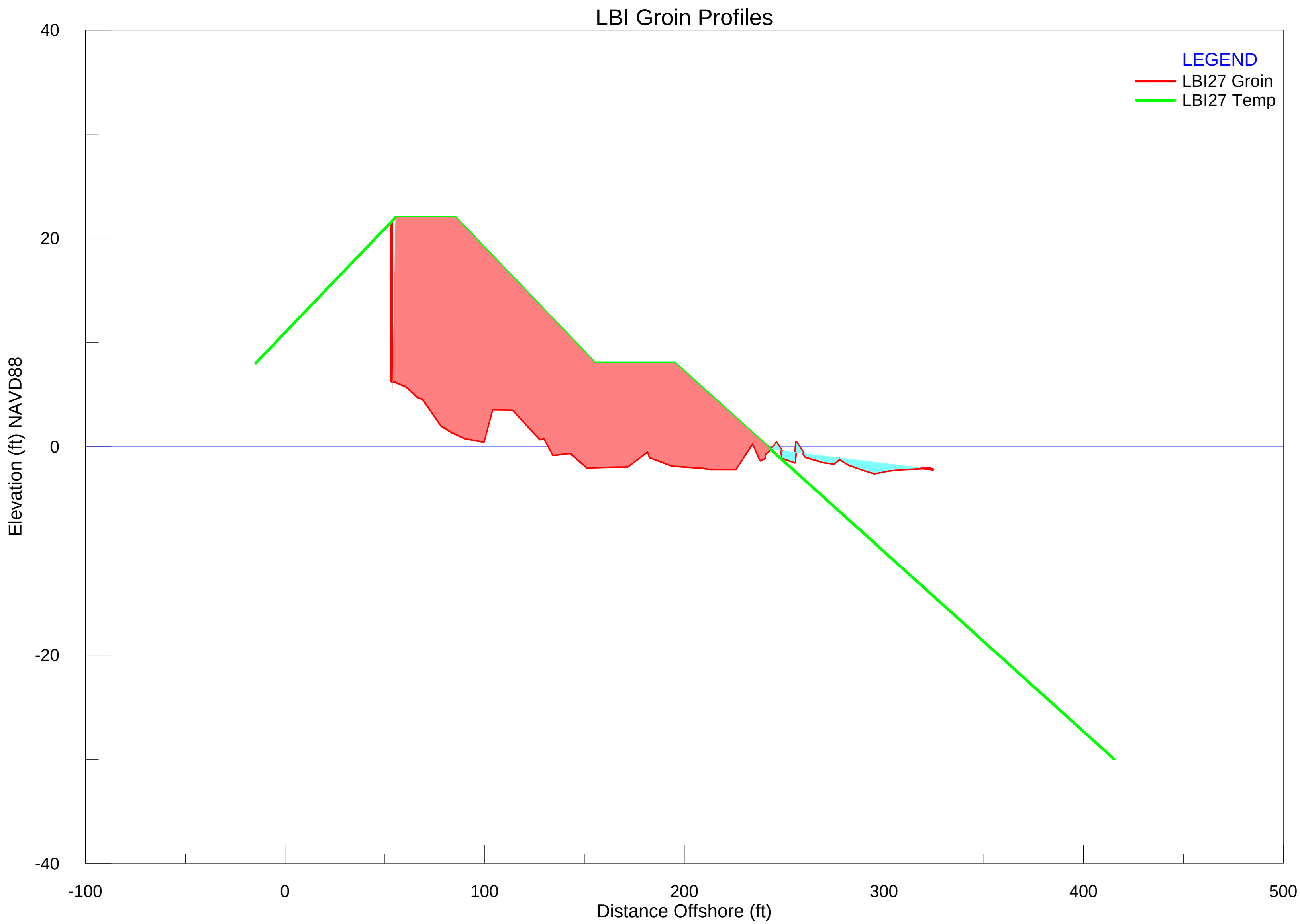


LBI Groin Profiles
LEGEND
LBI23 Groin
LBI23 Temp
Elevation (ft)
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

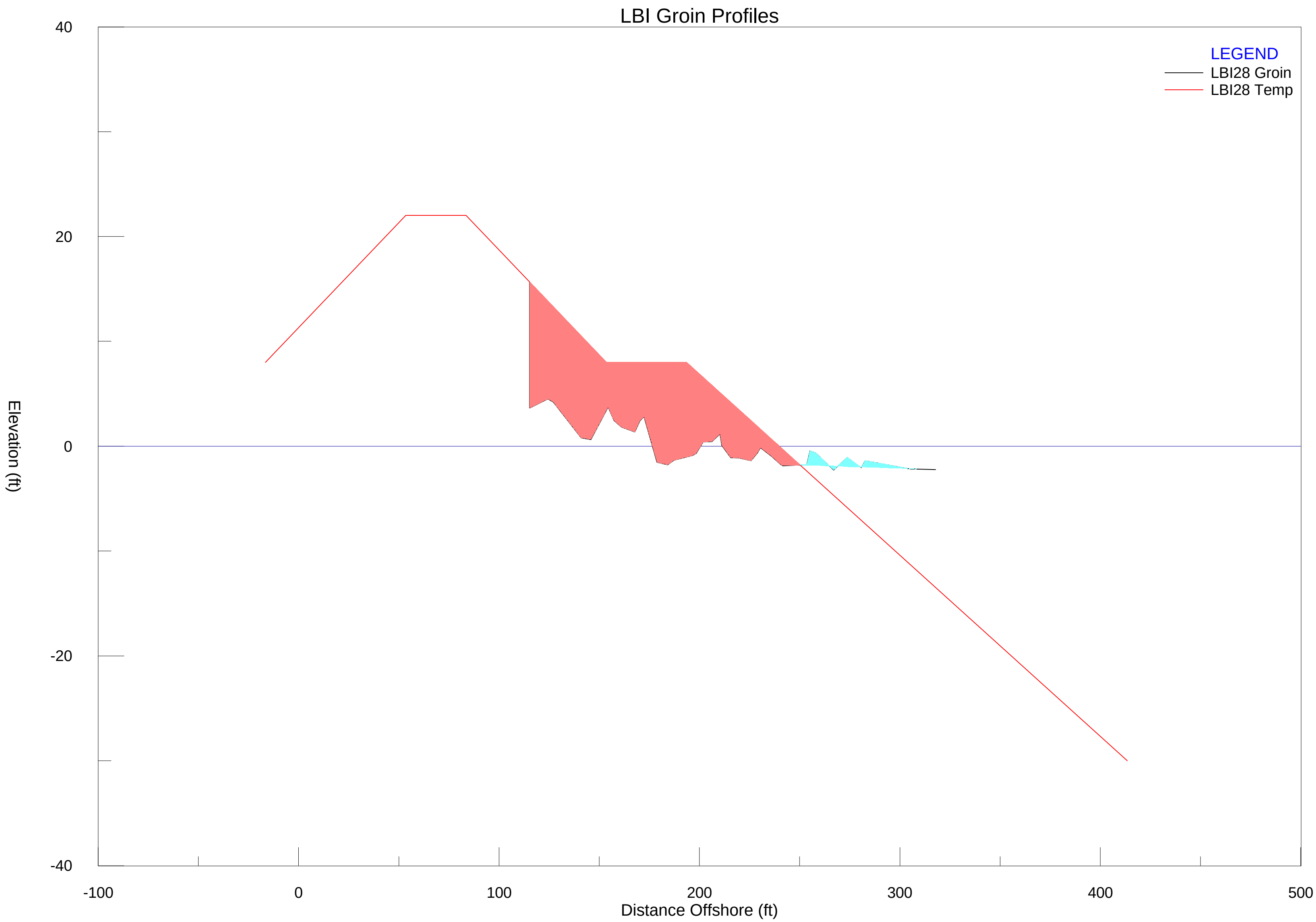

LBI Groin Profiles
LEGEND
LBI25 Groin
LBI25 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



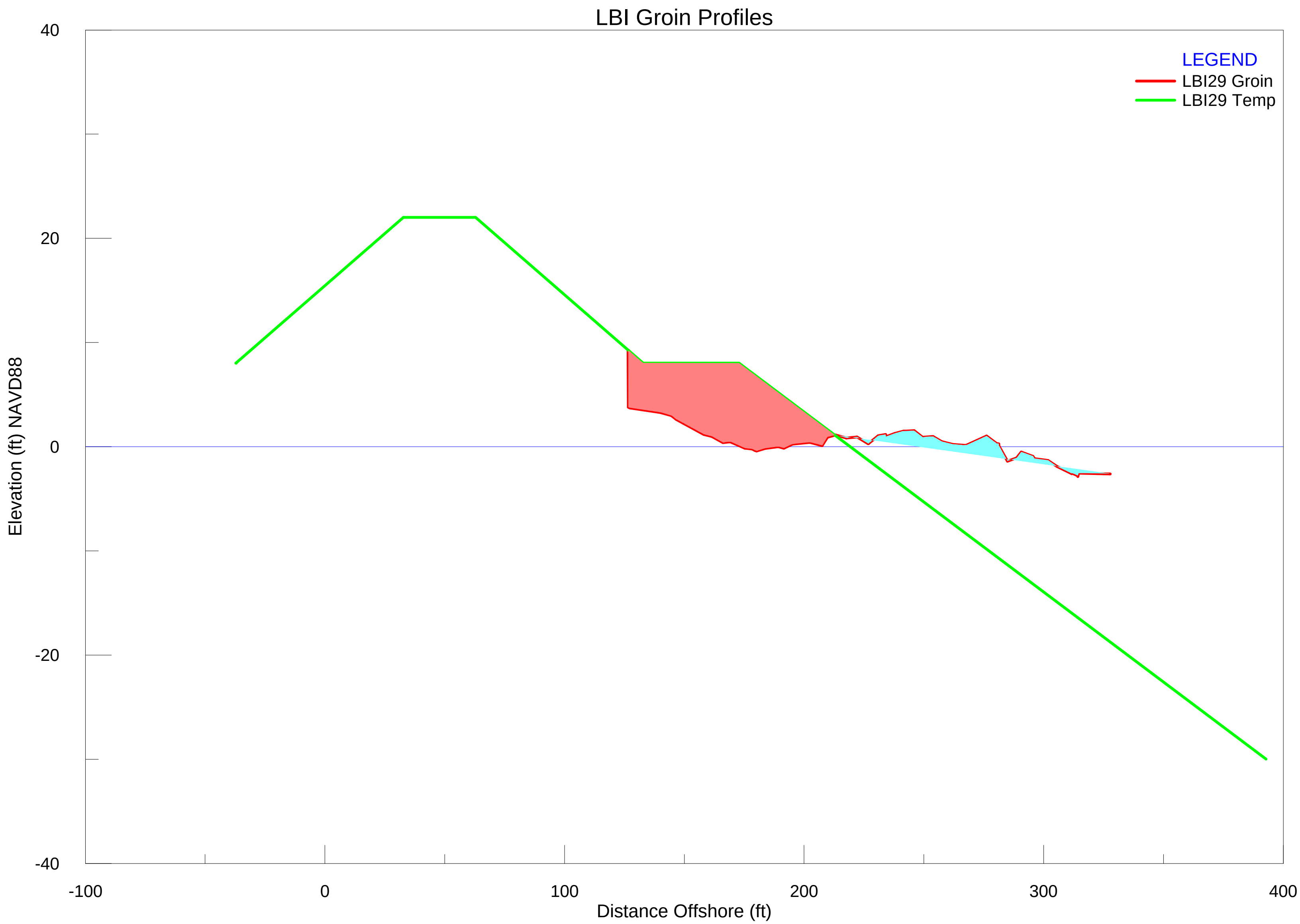
LBI Groin Profiles
LEGEND
LBI26 Groin
LBI26 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)

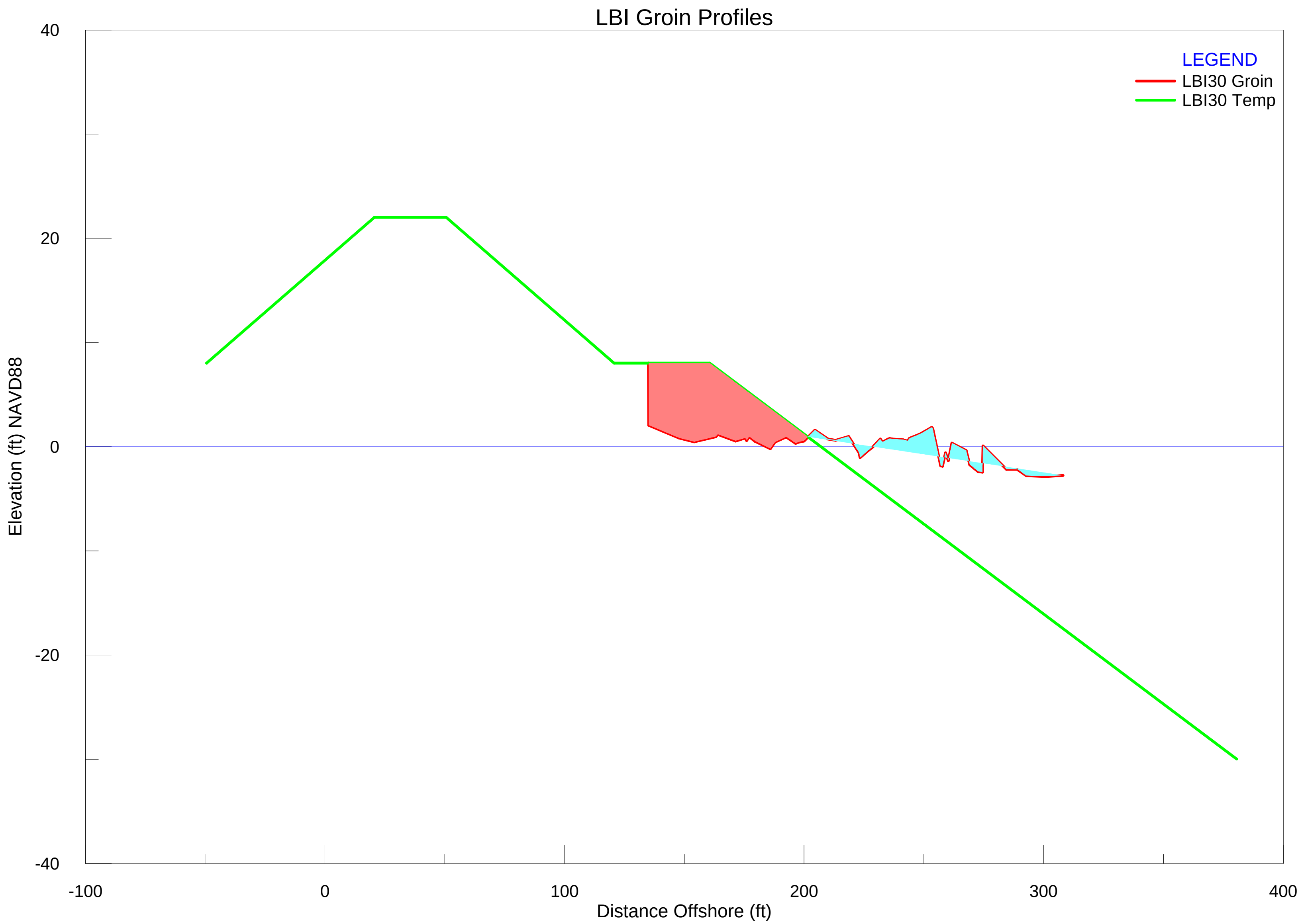


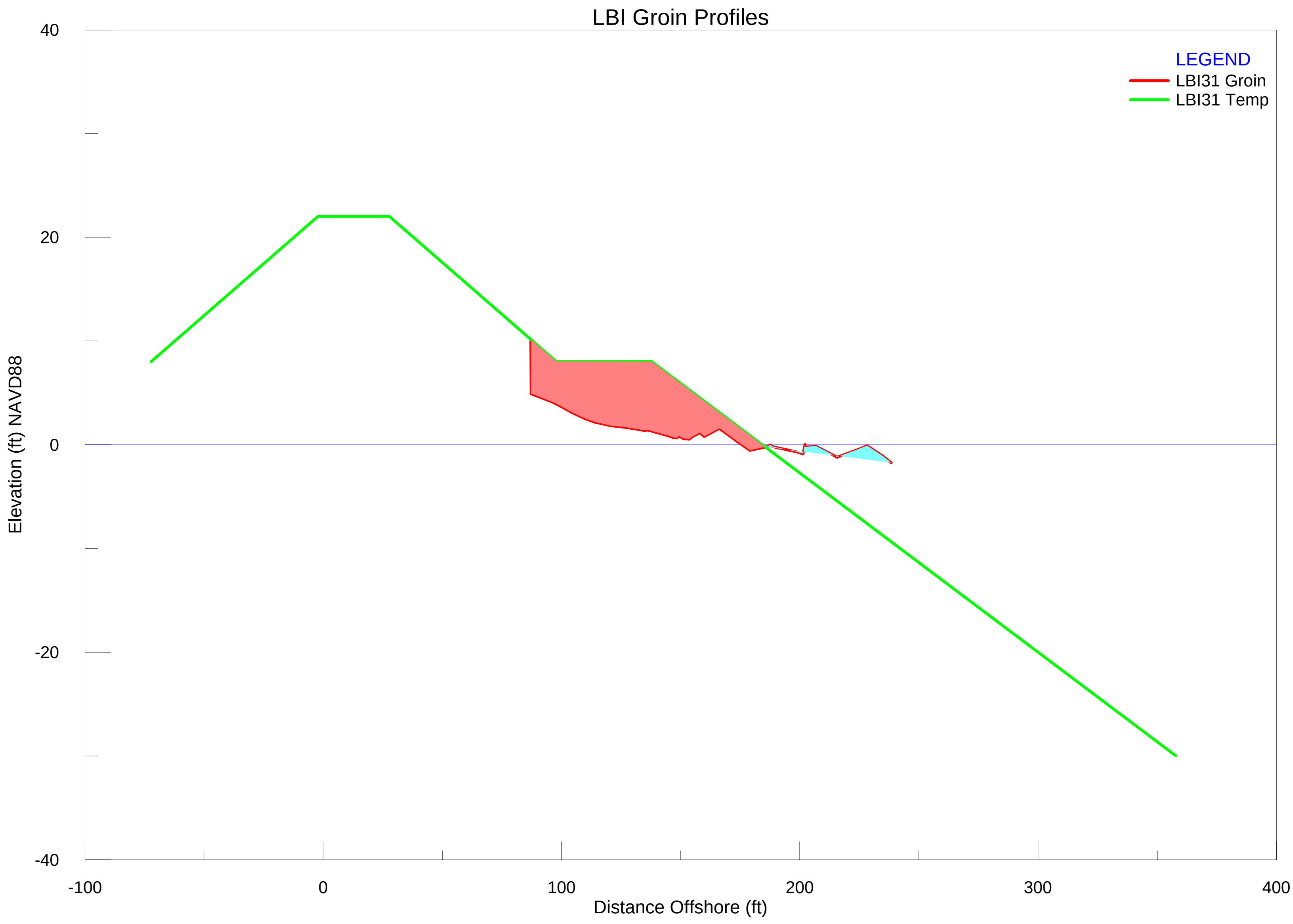
LBI Groin Profiles
LEGEND
LBI27 Groin
LBI27 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

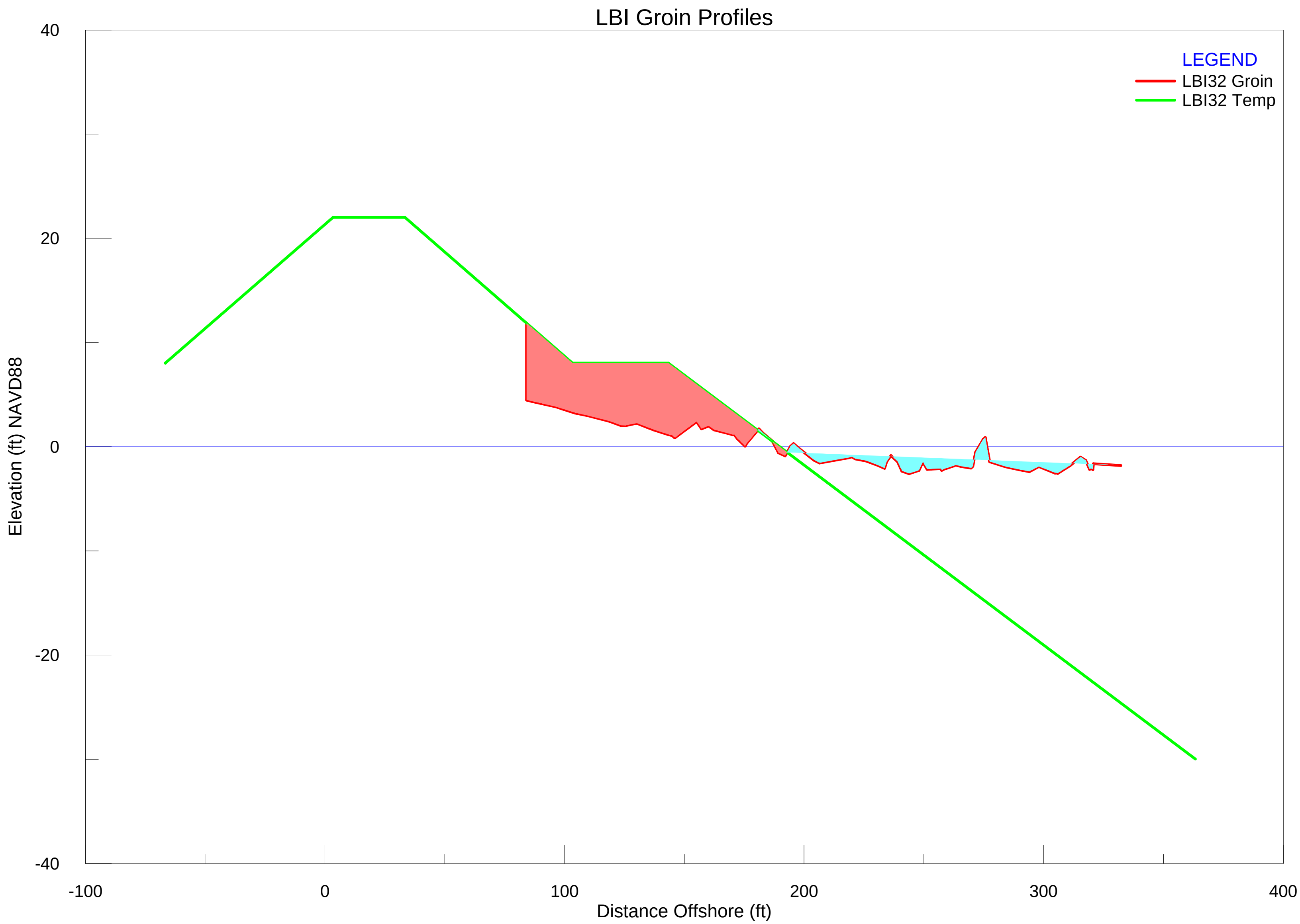


LBI Groin Profiles
LEGEND
LBI28 Groin
LBI28 Temp
Elevation (ft)
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

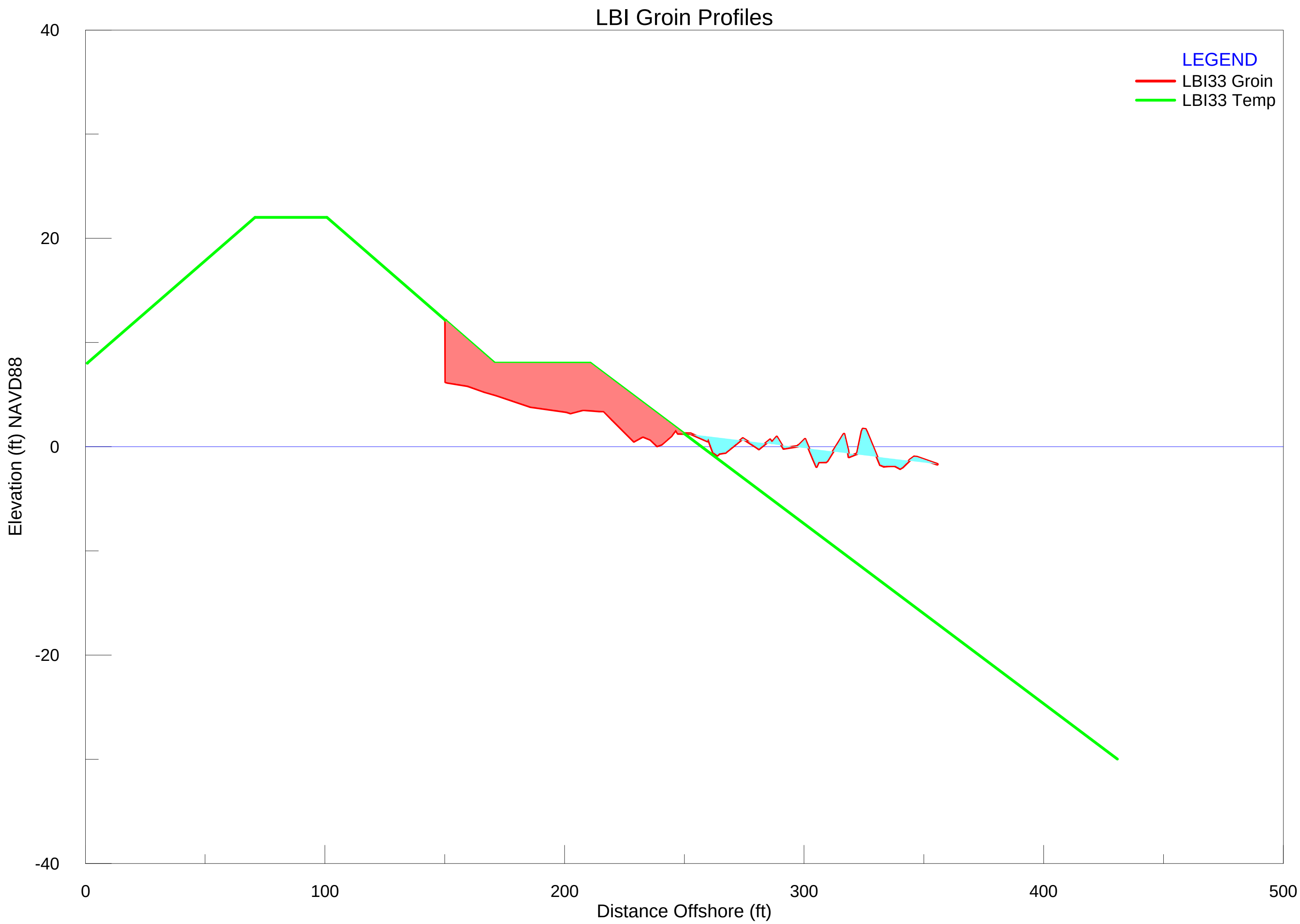

LBI Groin Profiles
LEGEND
LBI29 Groin
LBI29 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI30 Groin
LBI30 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

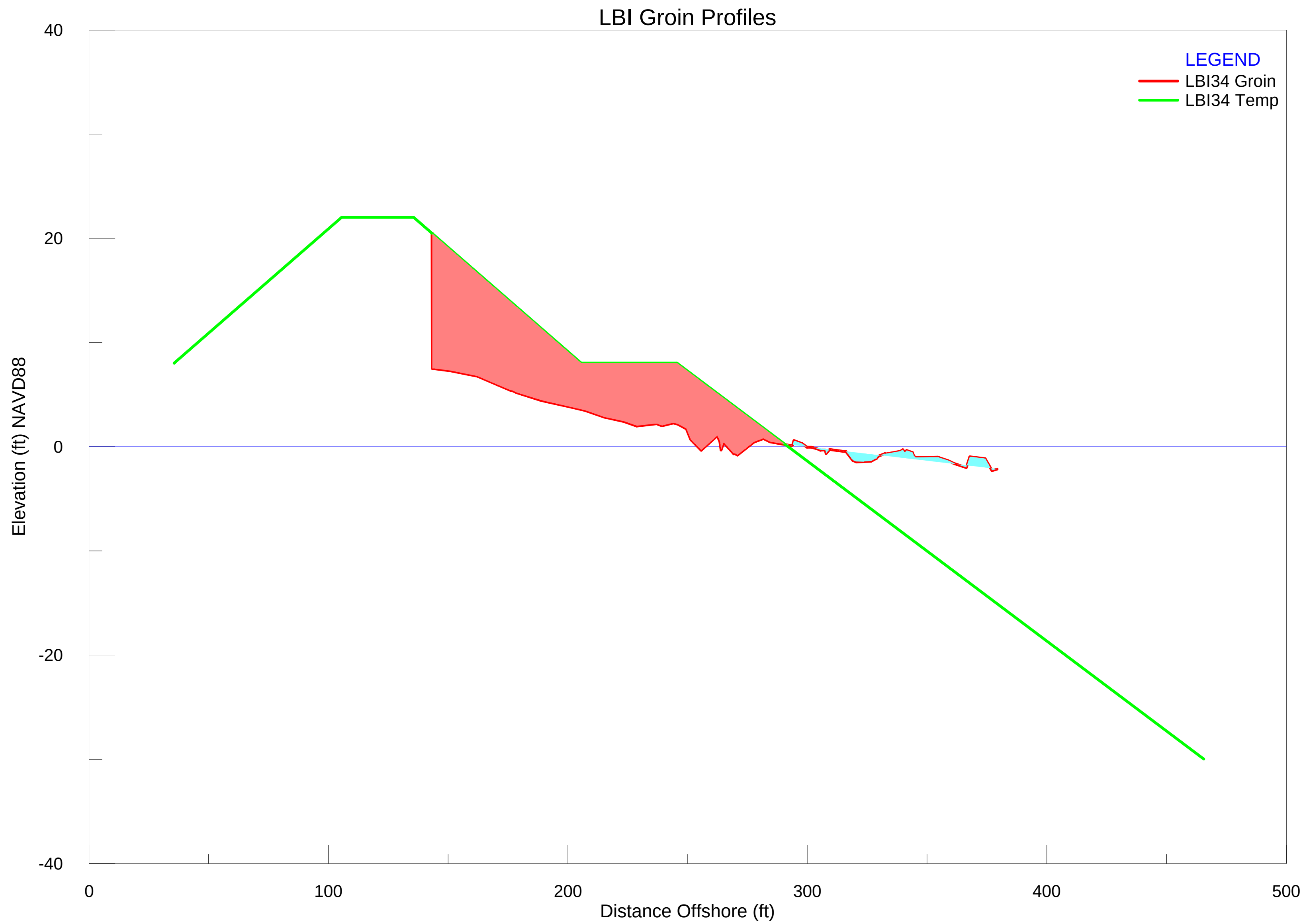

LBI Groin Profiles
LEGEND
LBI31 Groin
LBI31 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

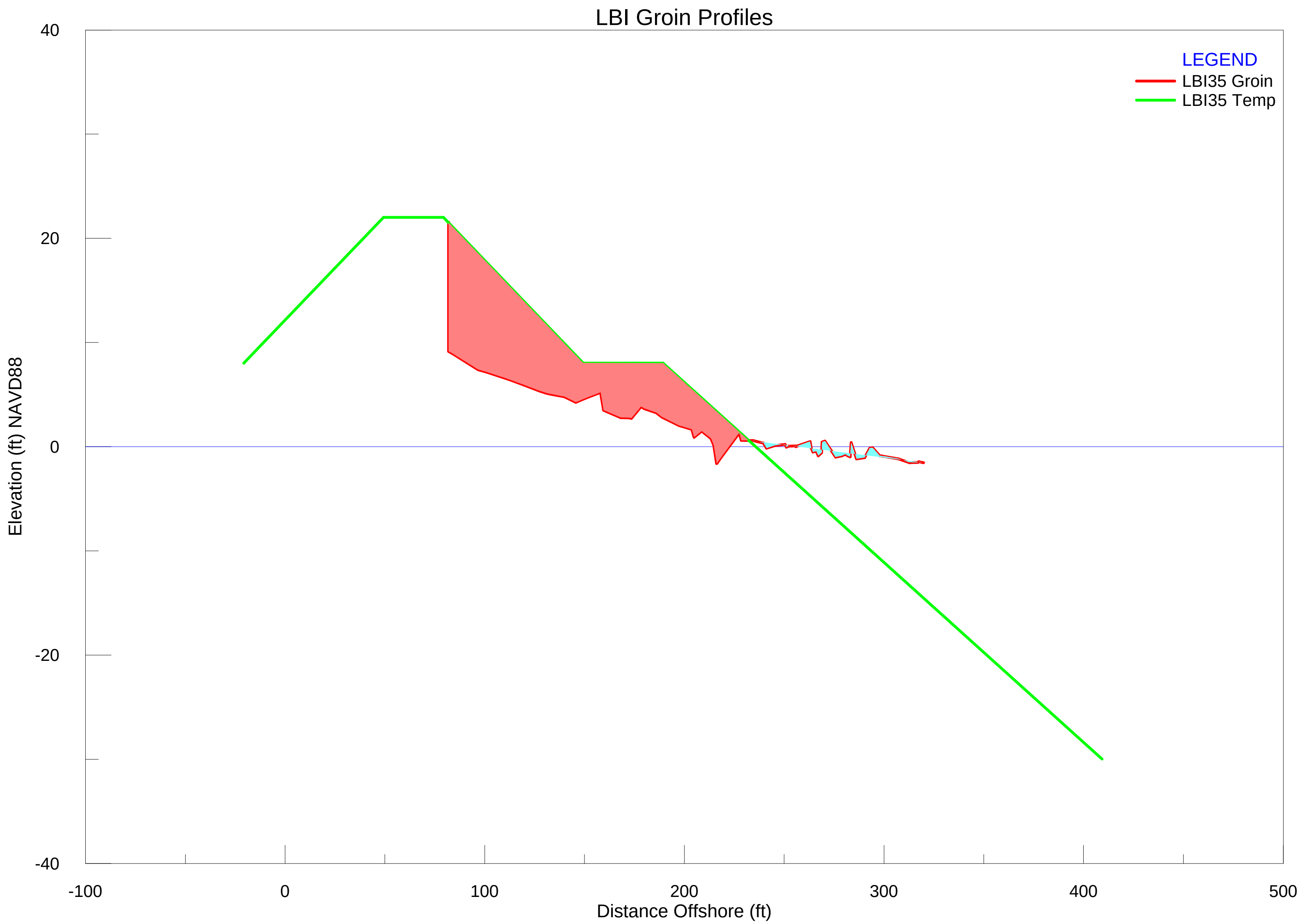


LBI Groin Profiles
LEGEND
LBI32 Groin
LBI32 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

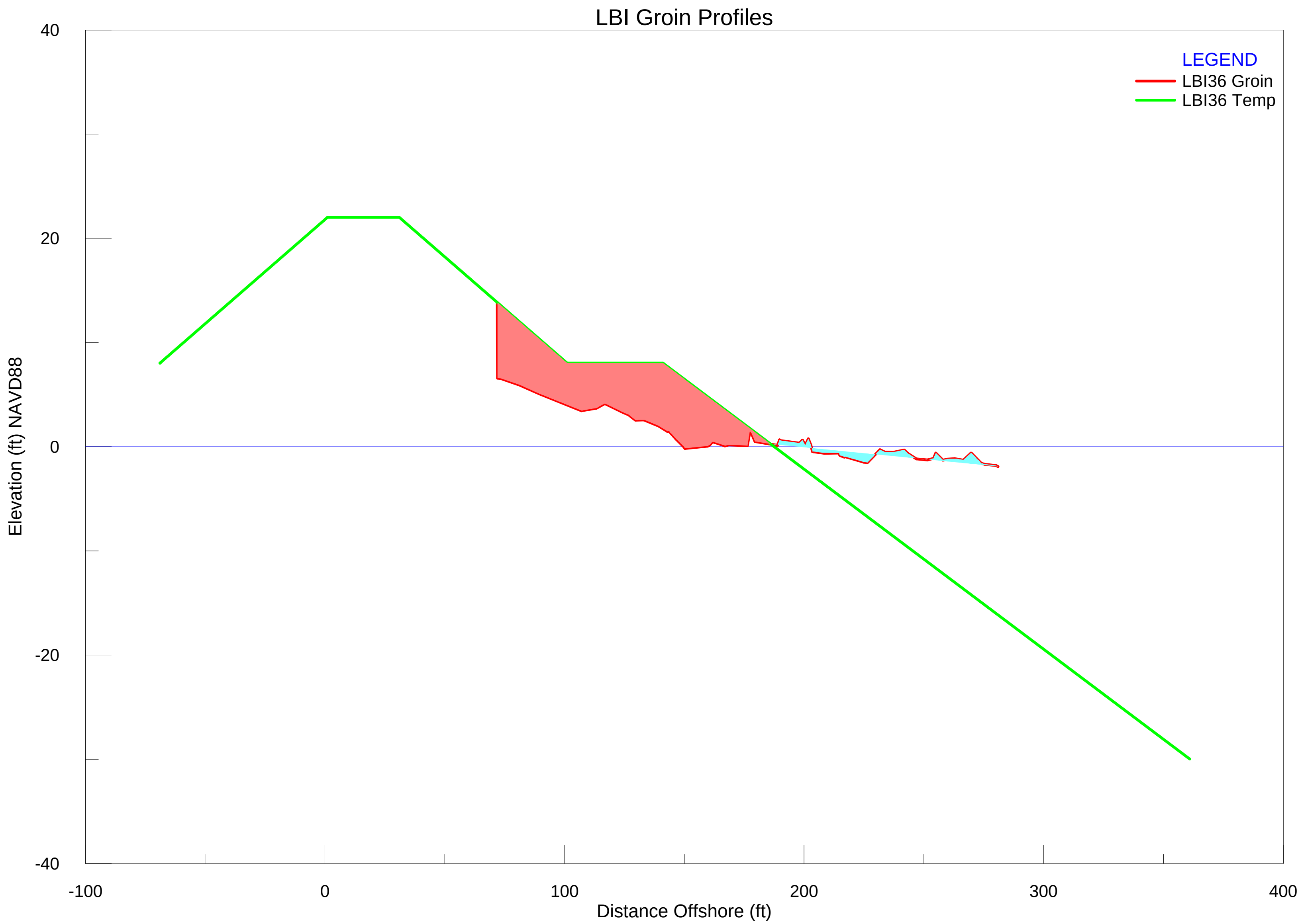


LBI Groin Profiles
LEGEND
LBI33 Groin
LBI33 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
0
100
200
300
400
500
Distance Offshore (ft)

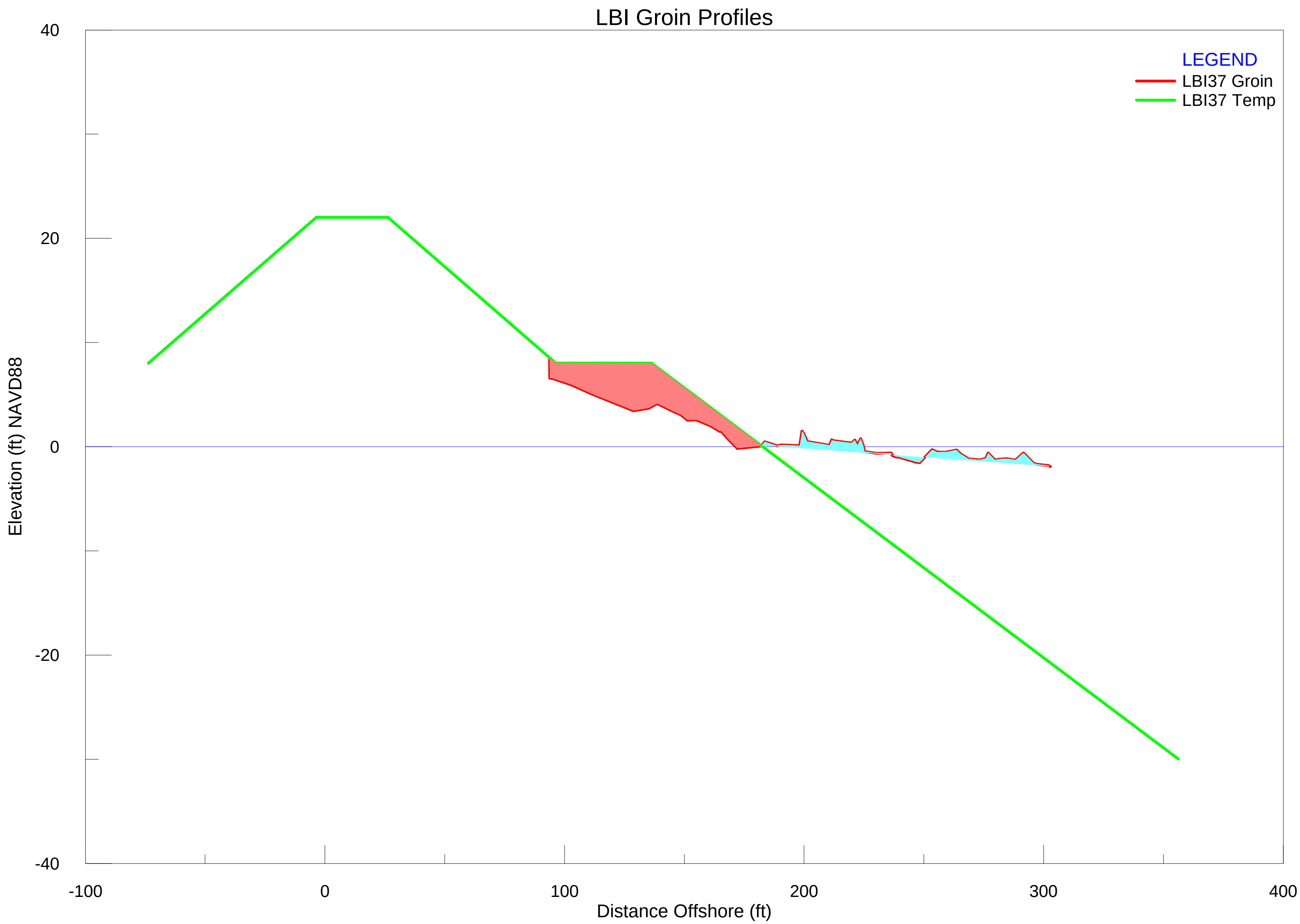

LBI Groin Profiles
LEGEND
LBI34 Groin
LBI34 Temp
Elevation (ft) NAVD88
Distance Offshore (ft)
40
20
0
-20
-40
0
100
200
300
400
500

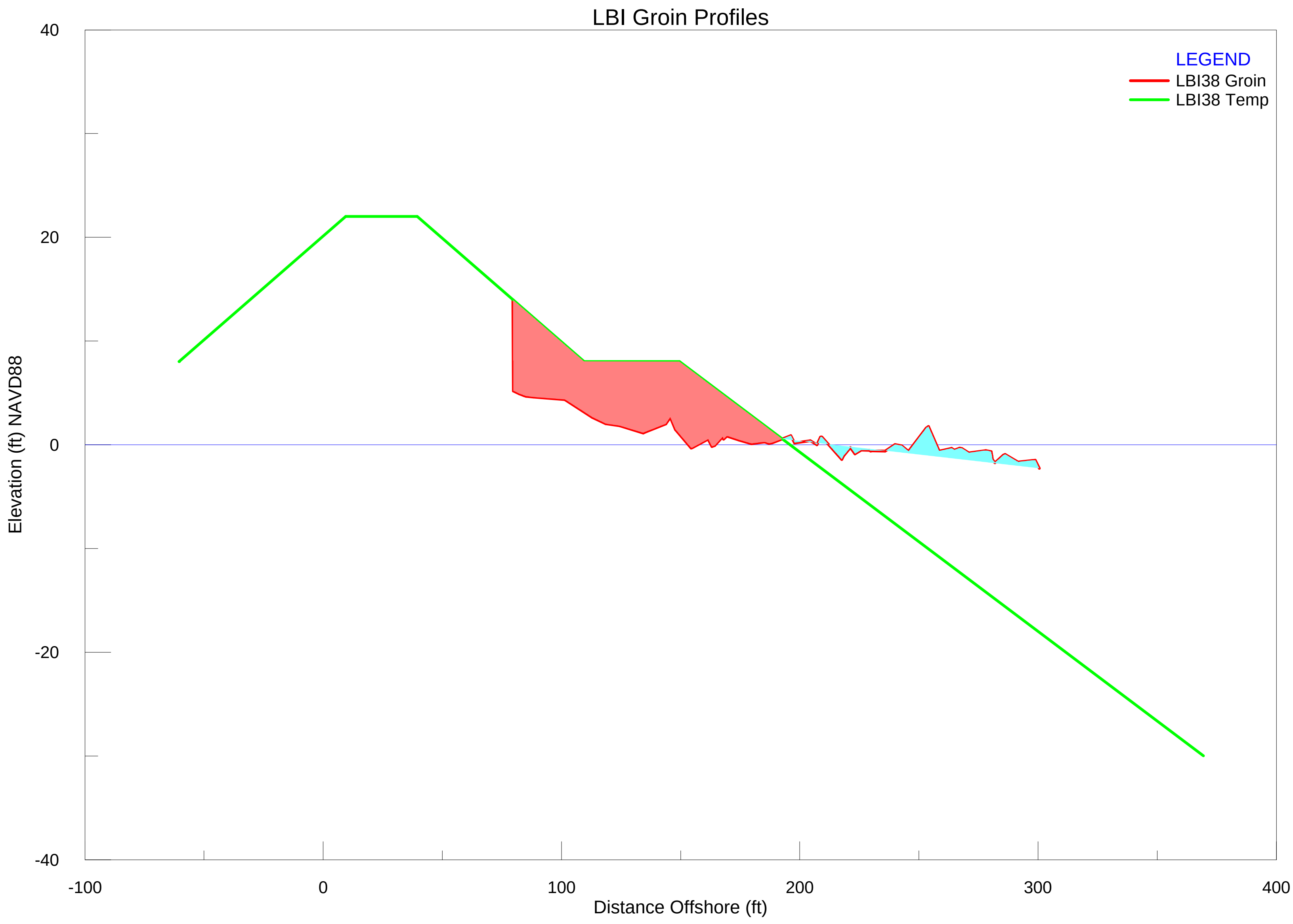


LBI Groin Profiles
LEGEND
LBI35 Groin
LBI35 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)

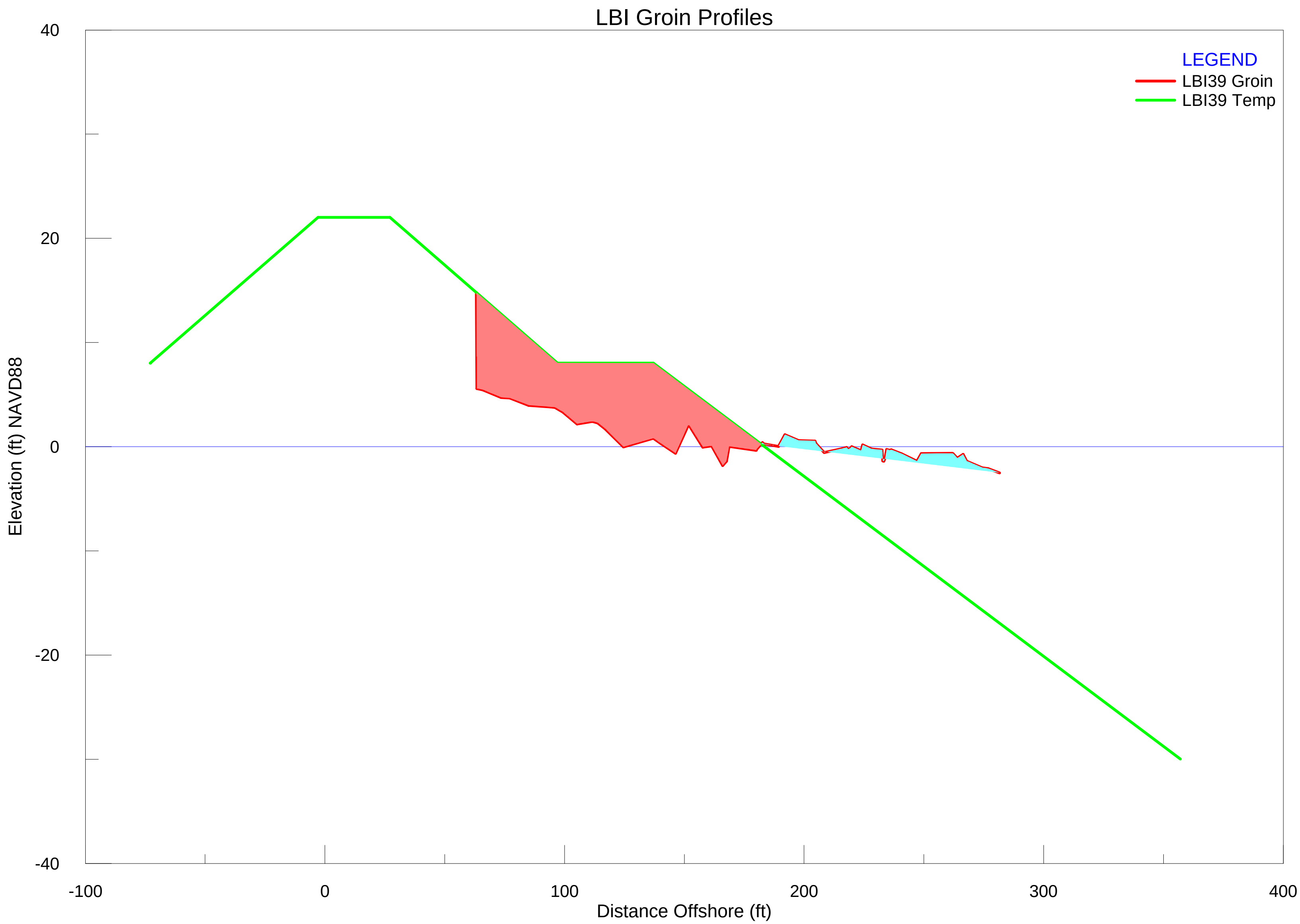


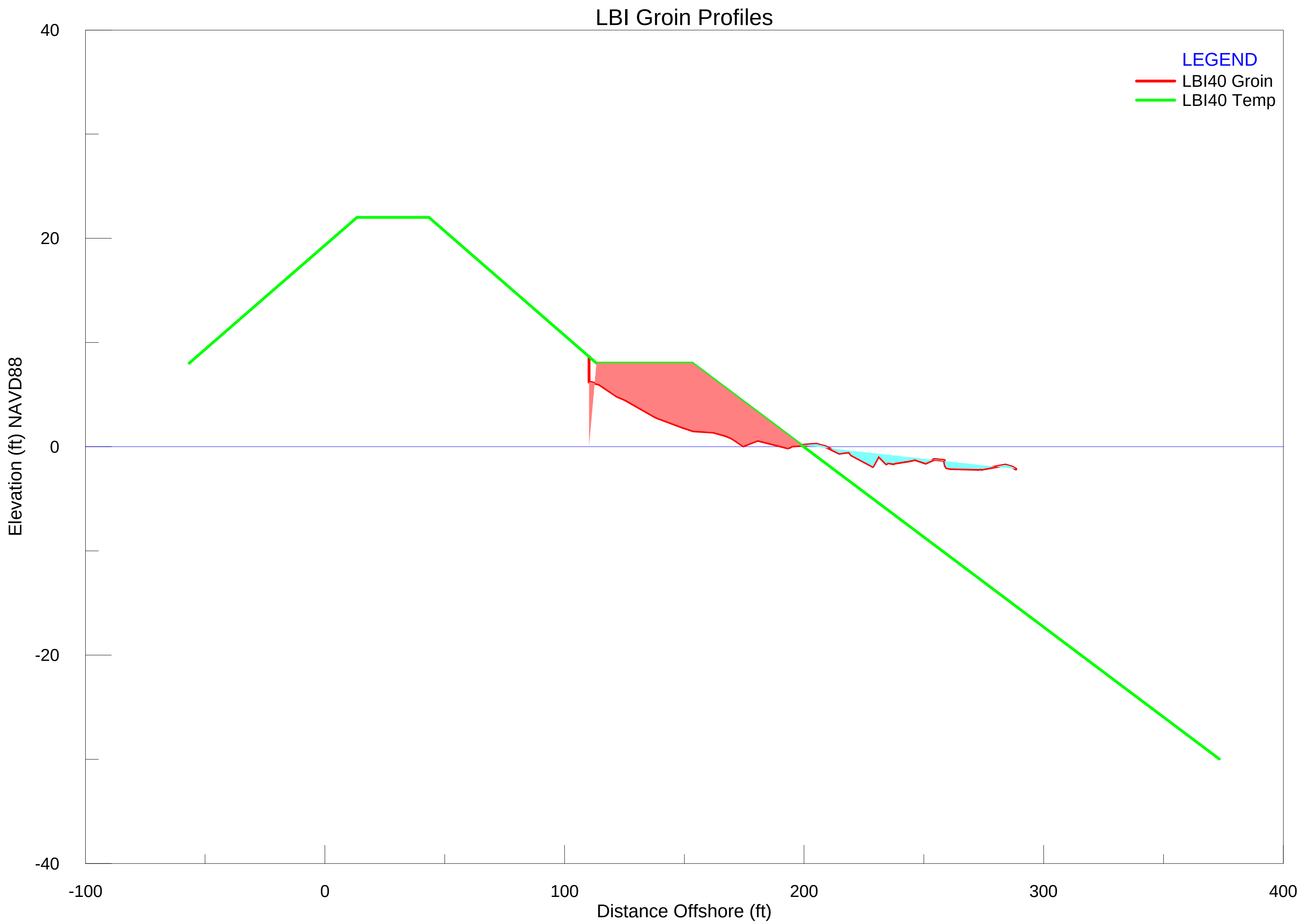
LBI Groin Profiles
LEGEND
LBI36 Groin
LBI36 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI37 Groin
LBI37 Temp
Elevation (ft) NAVD88
Distance Offshore (ft)
40
20
0
-20
-40
-100
0
100
200
300
400

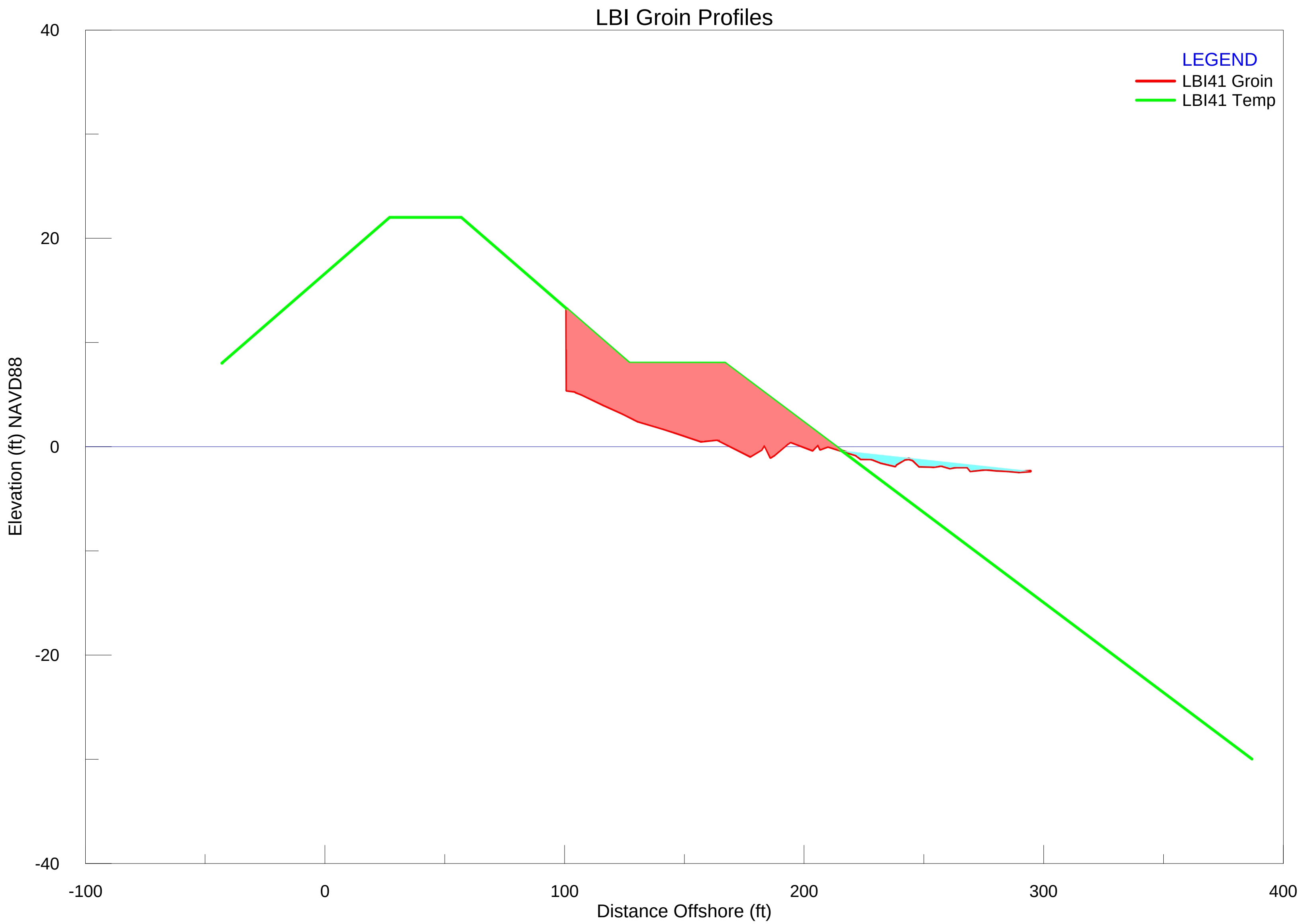


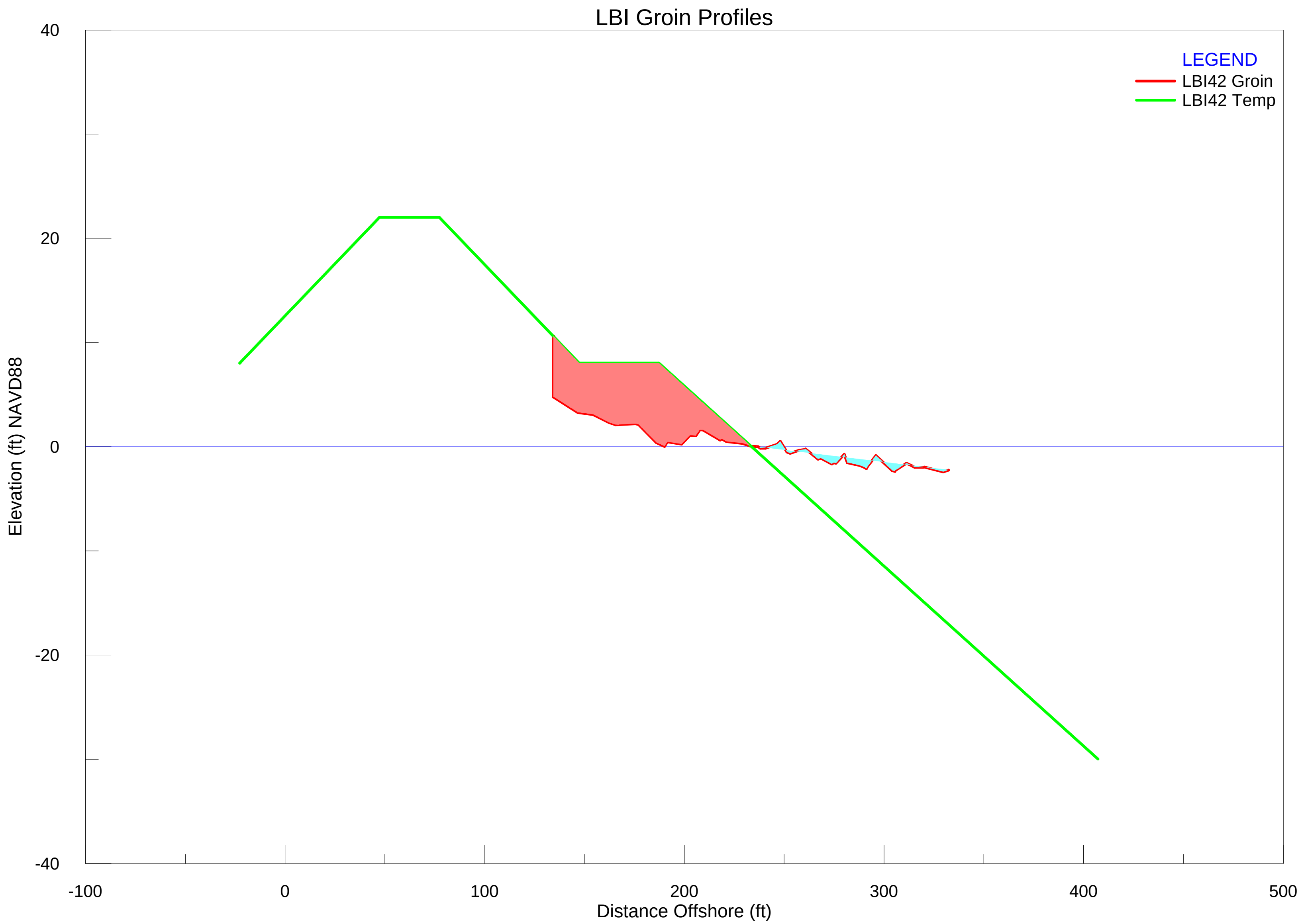
LBI Groin Profiles
LEGEND
LBI38 Groin
LBI38 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI39 Groin
LBI39 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

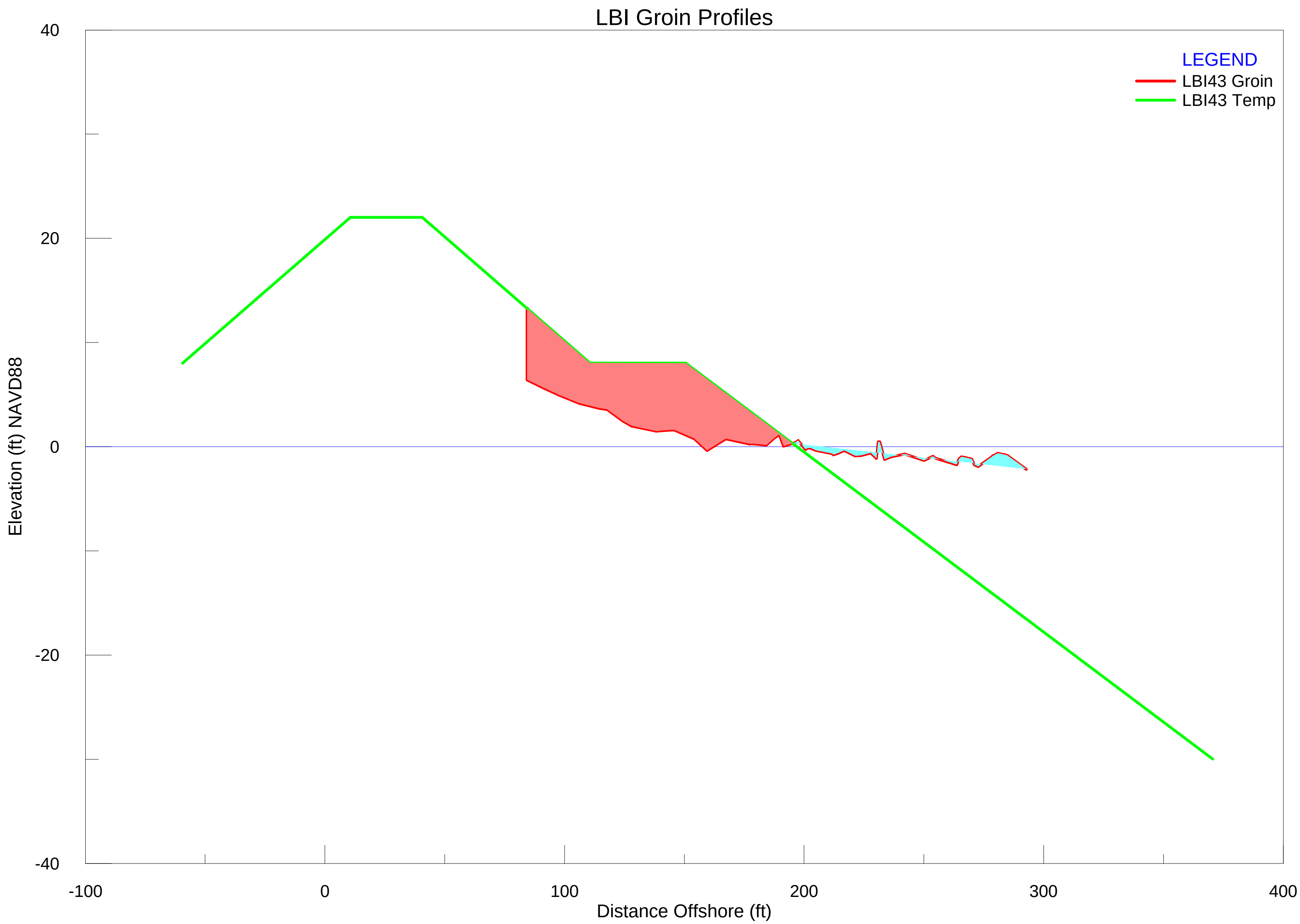


LBI Groin Profiles
LEGEND
LBI40 Groin
LBI40 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

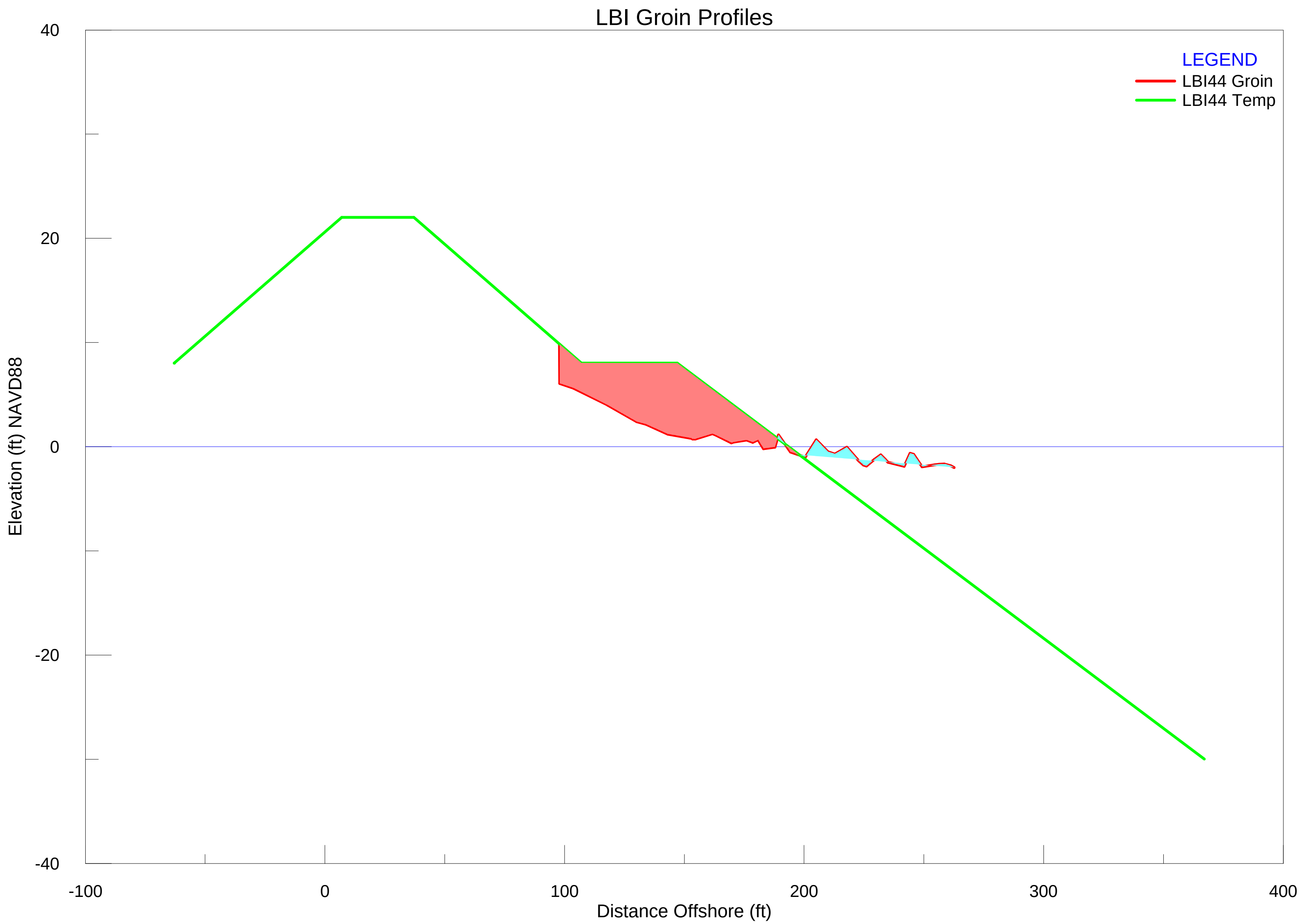

LBI Groin Profiles
LEGEND
LBI41 Groin
LBI41 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



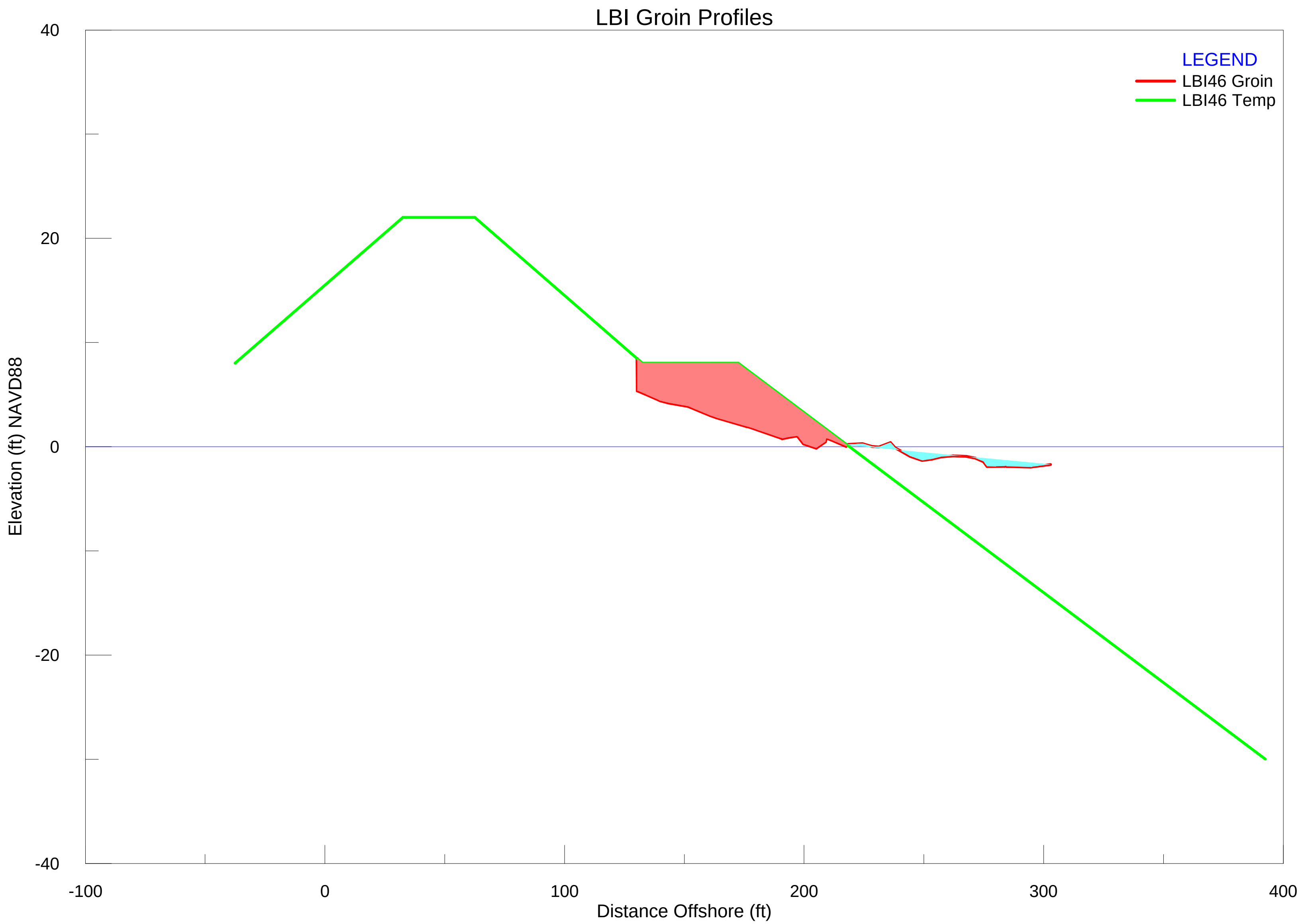
LBI Groin Profiles
LEGEND
LBI42 Groin
LBI42 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)

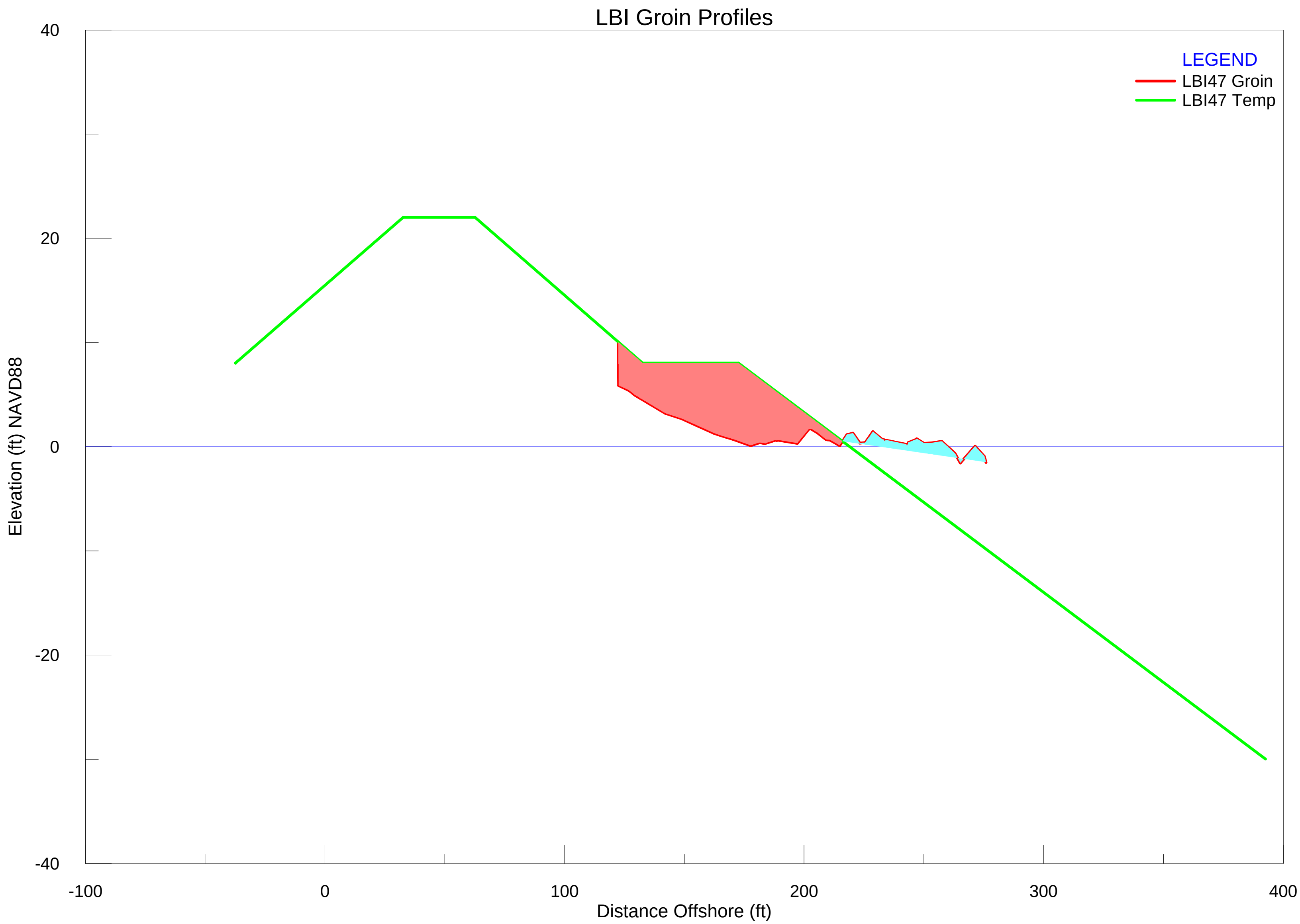


LBI Groin Profiles
LEGEND
LBI43 Groin
LBI43 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

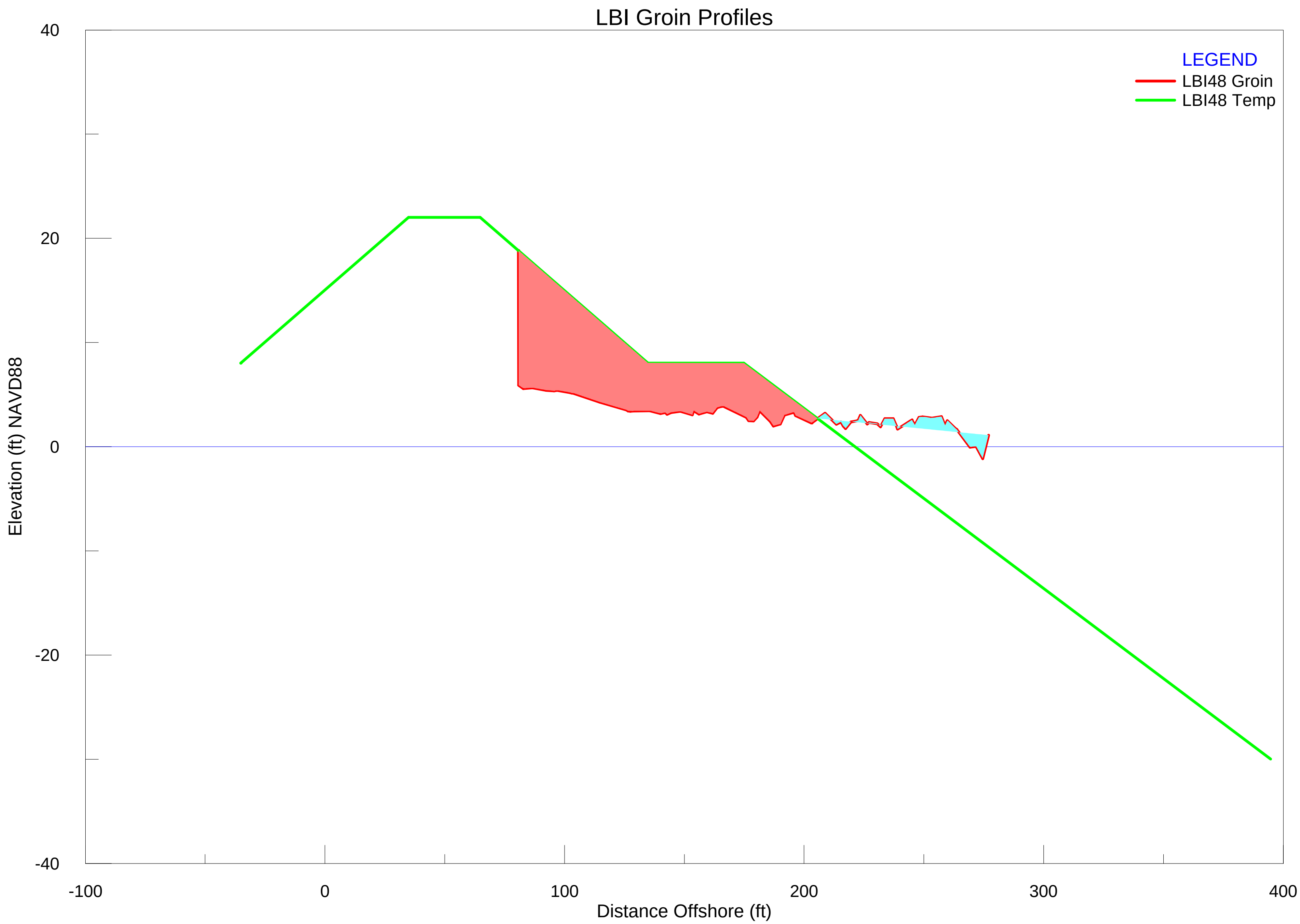


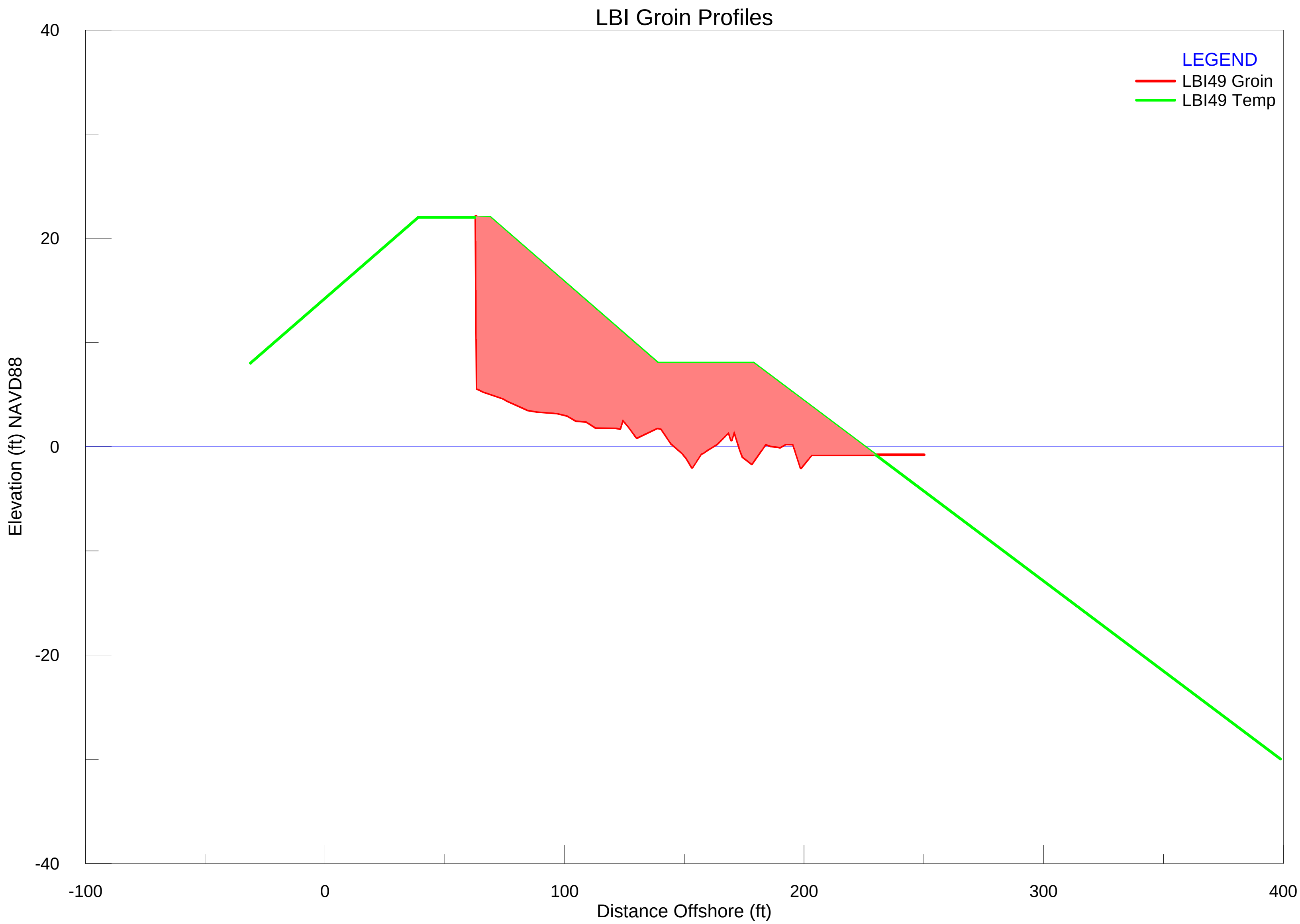
LBI Groin Profiles
LEGEND
LBI44 Groin
LBI44 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI46 Groin
LBI46 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

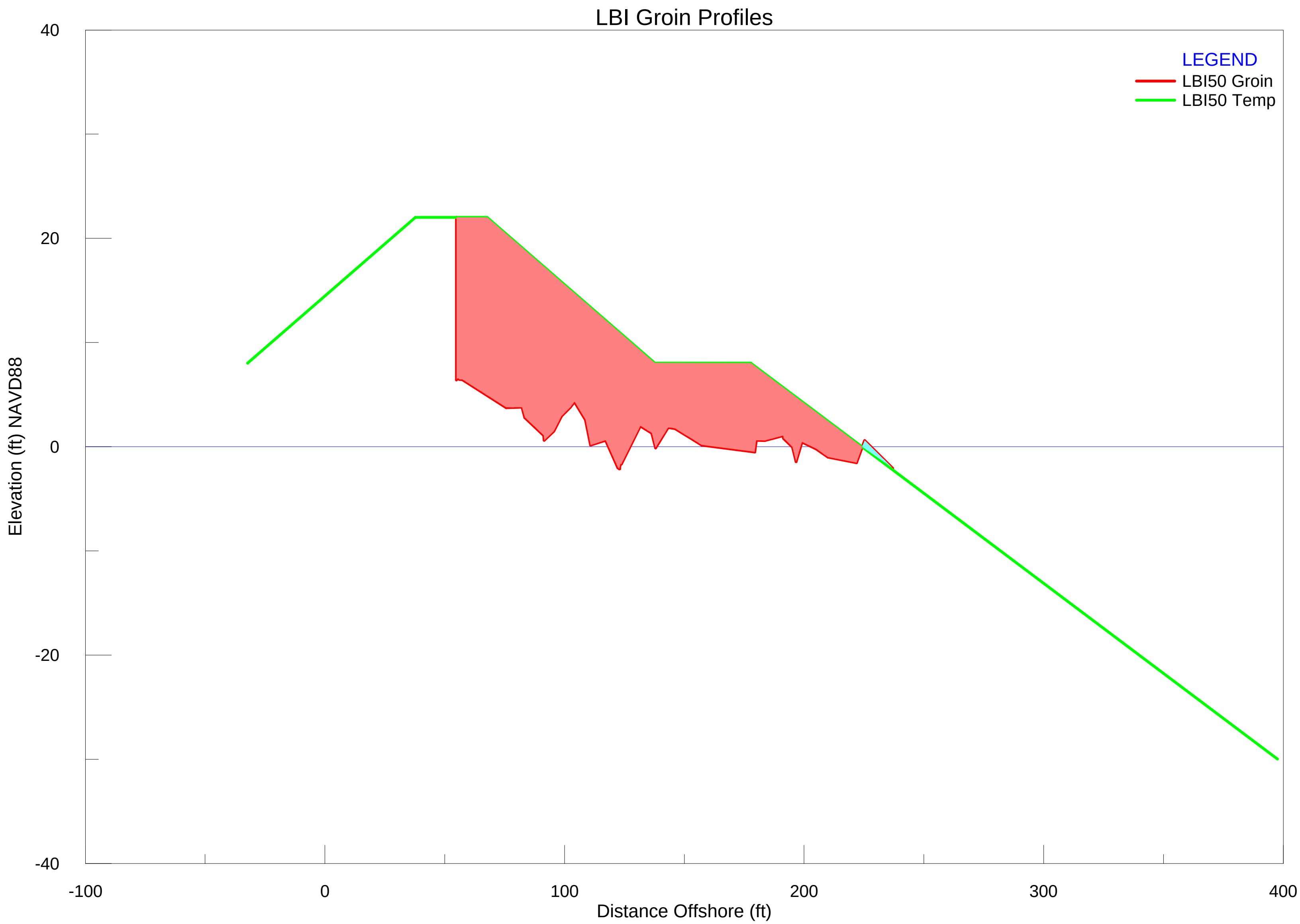


LBI Groin Profiles
LEGEND
LBI47 Groin
LBI47 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI48 Groin
LBI48 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

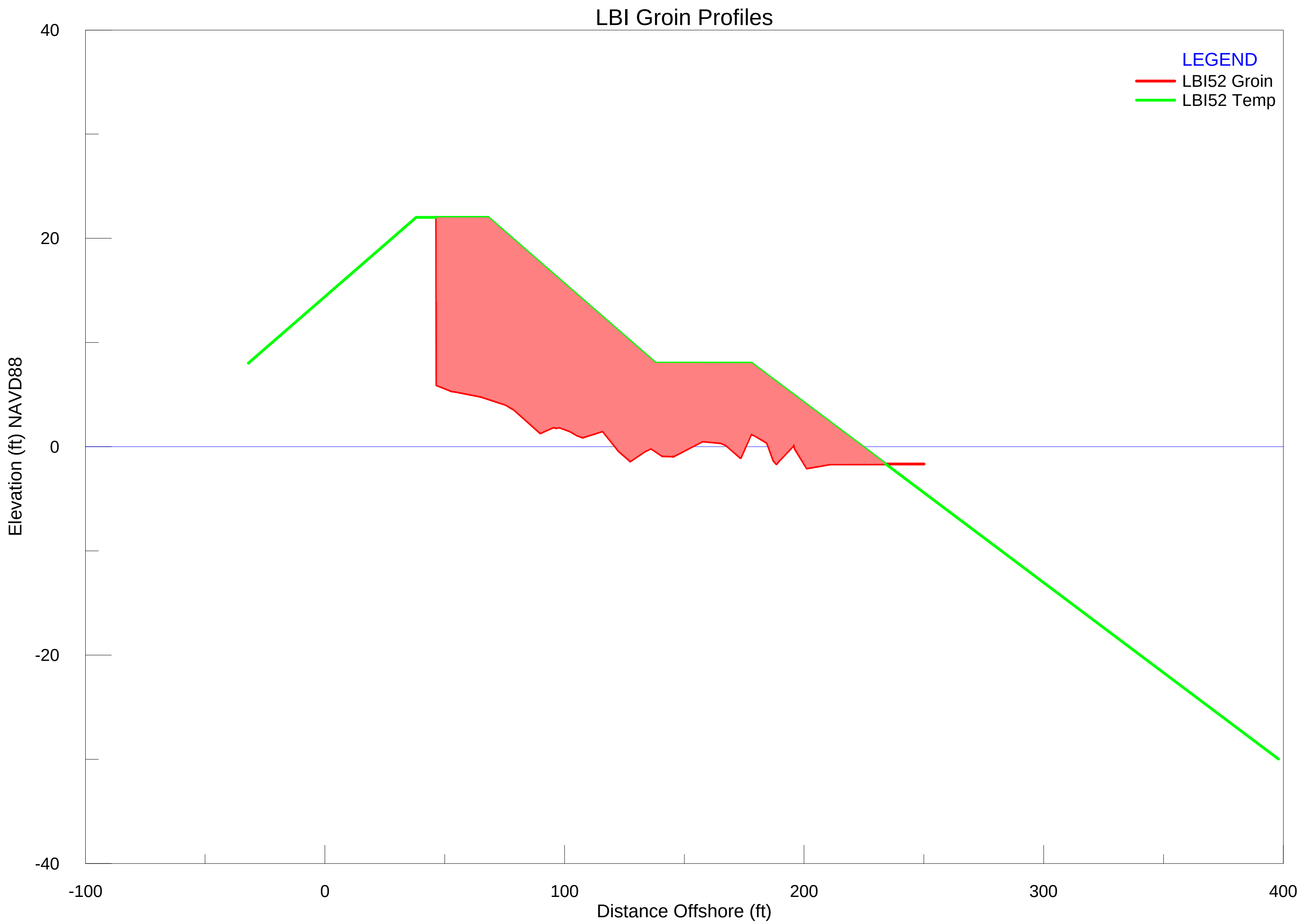


LBI Groin Profiles
LEGEND
LBI49 Groin
LBI49 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

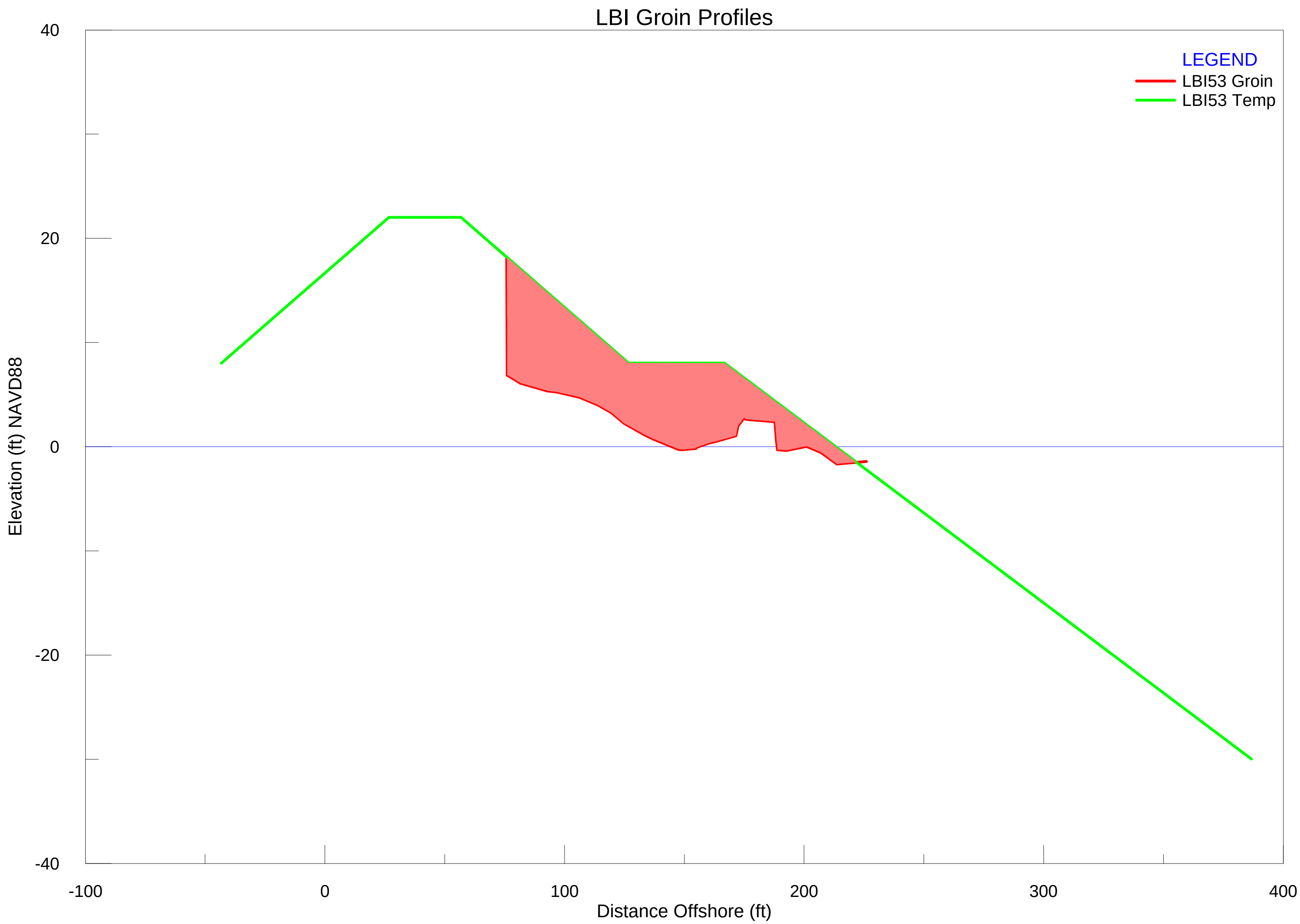


LBI Groin Profiles
LEGEND
LBI50 Groin
LBI50 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

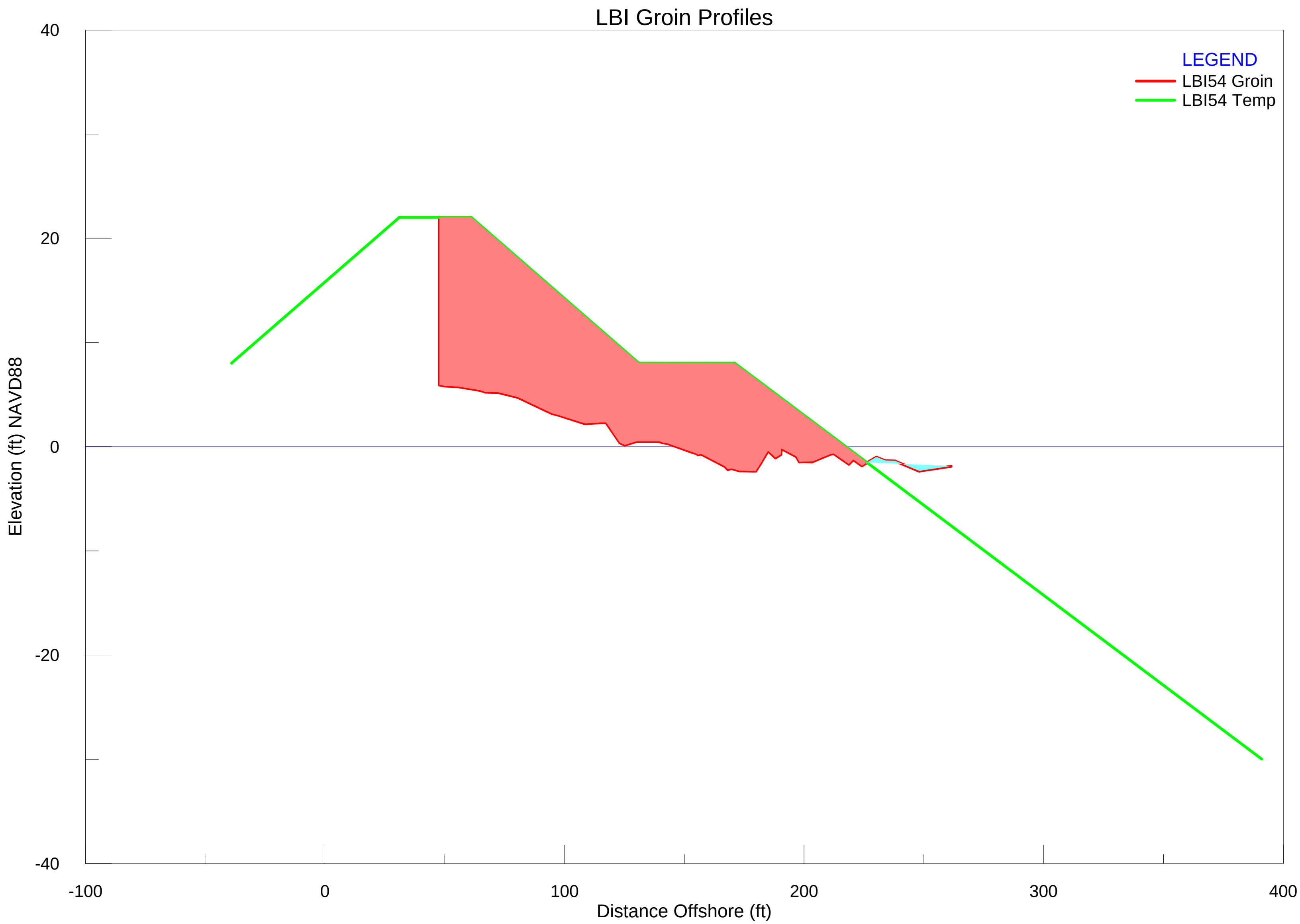
LBI Groin Profiles
LEGEND
LBI51 Groin
LBI51 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

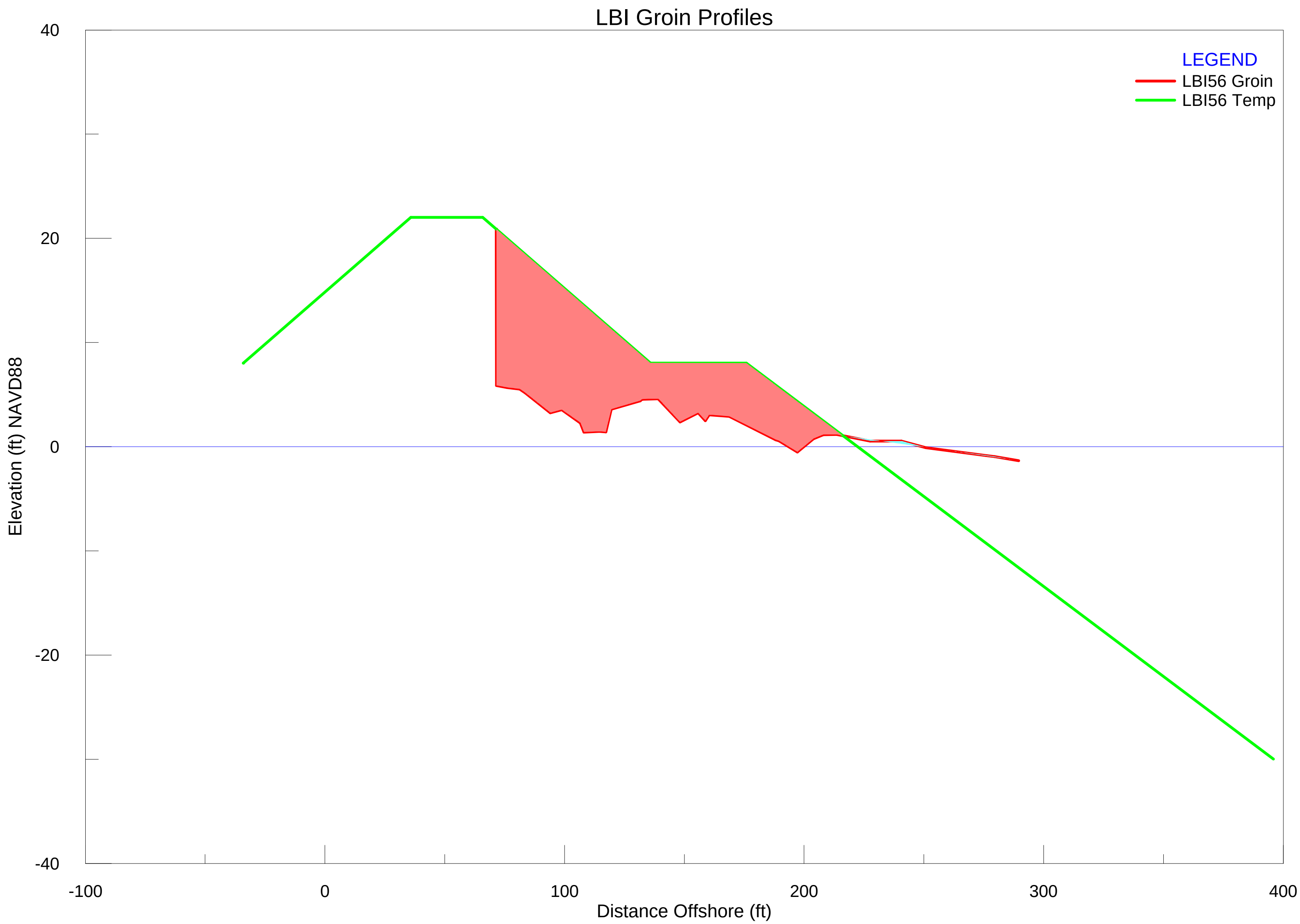


LBI Groin Profiles
LEGEND
LBI52 Groin
LBI52 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

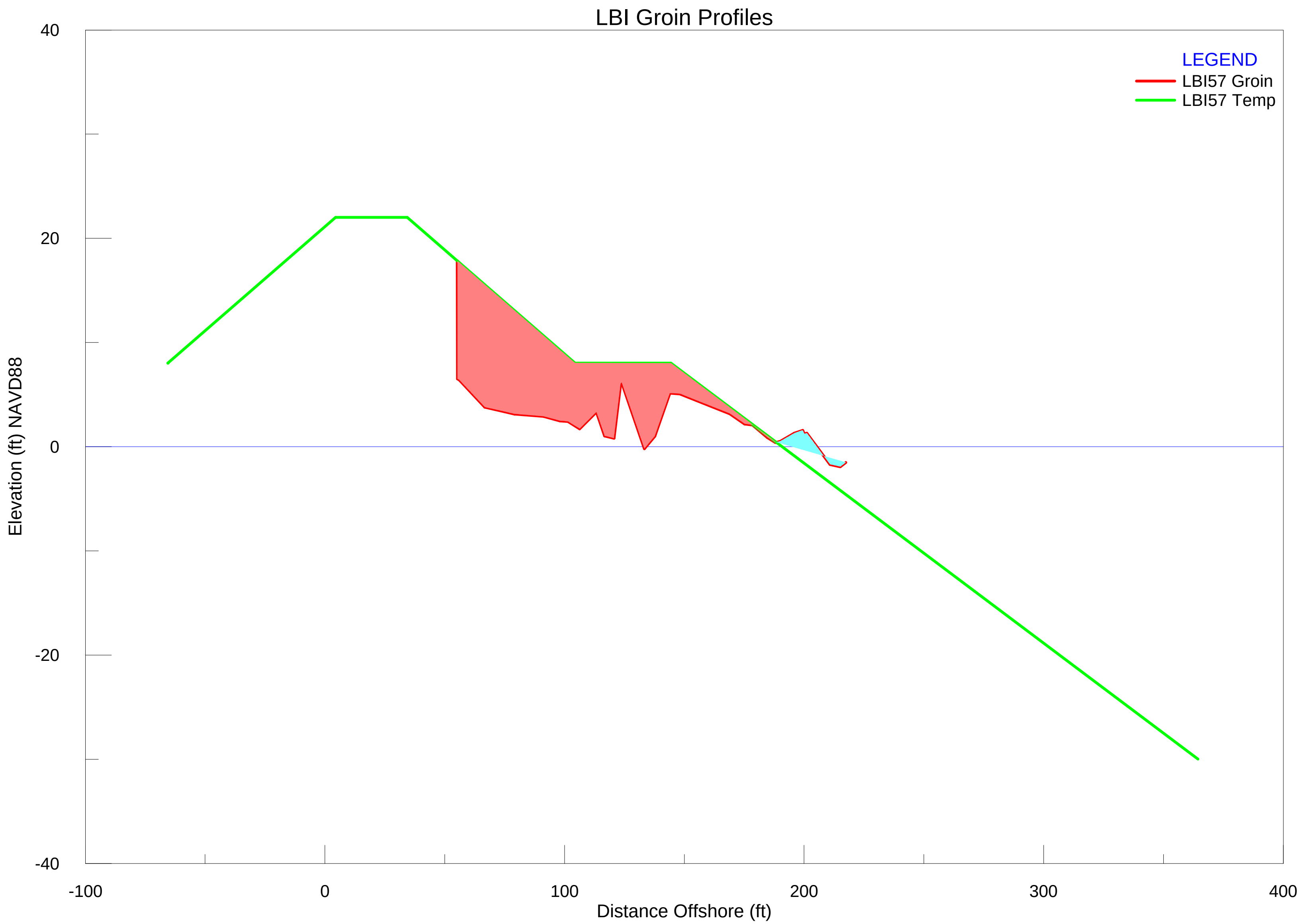


LBI Groin Profiles
LEGEND
LBI53 Groin
LBI53 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

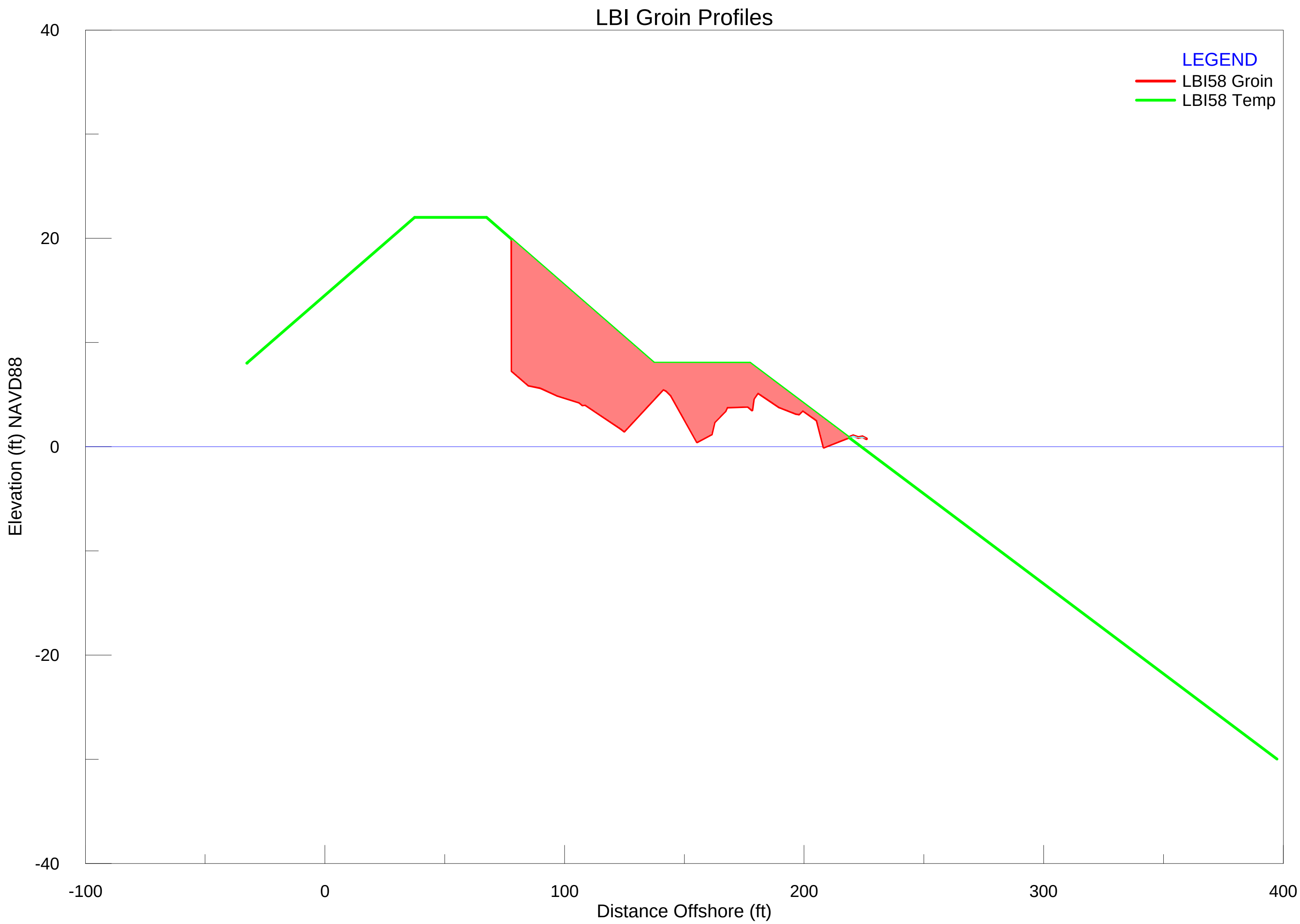

LBI Groin Profiles
LEGEND
LBI54 Groin
LBI54 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



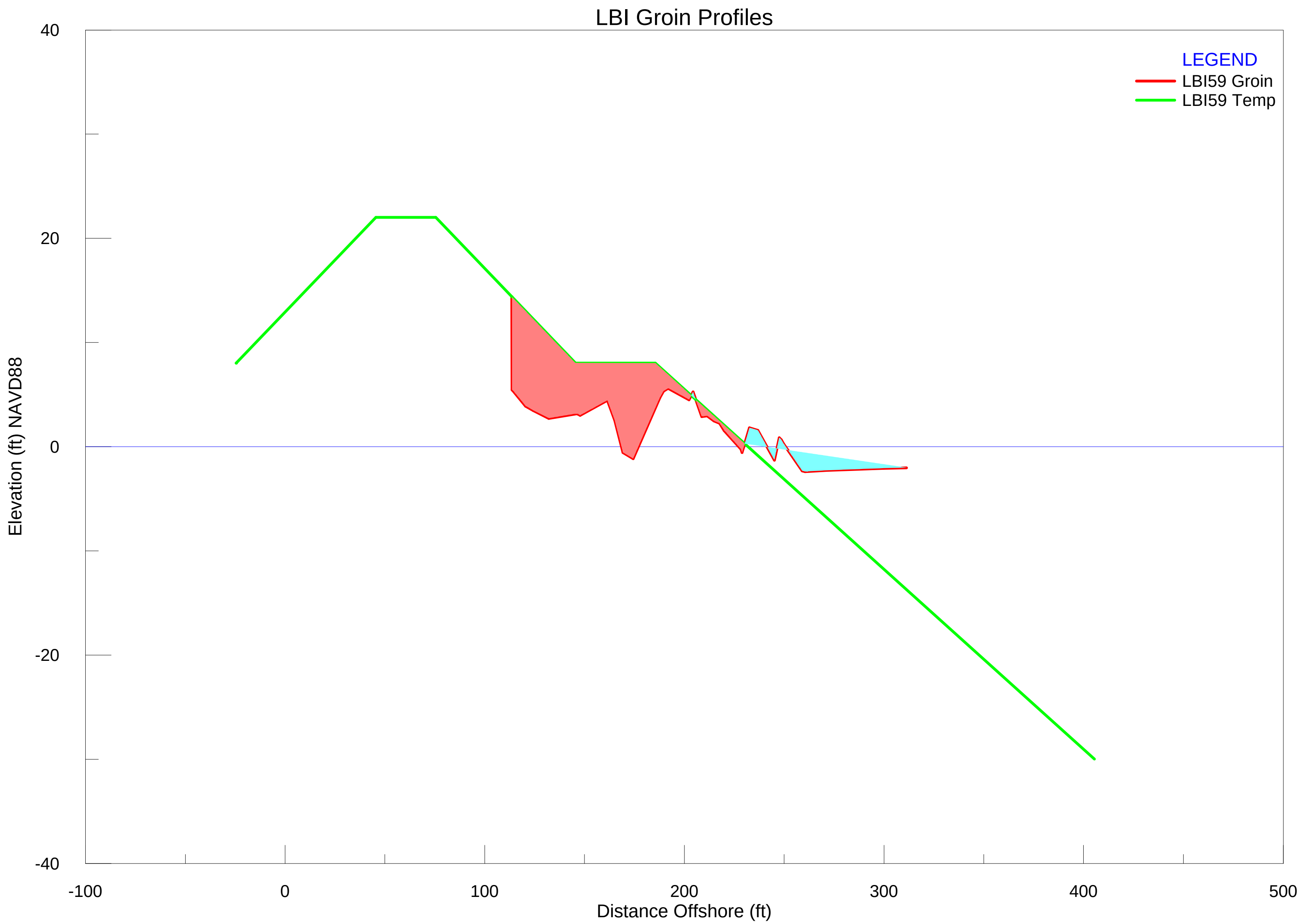
LBI Groin Profiles
LEGEND
LBI56 Groin
LBI56 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



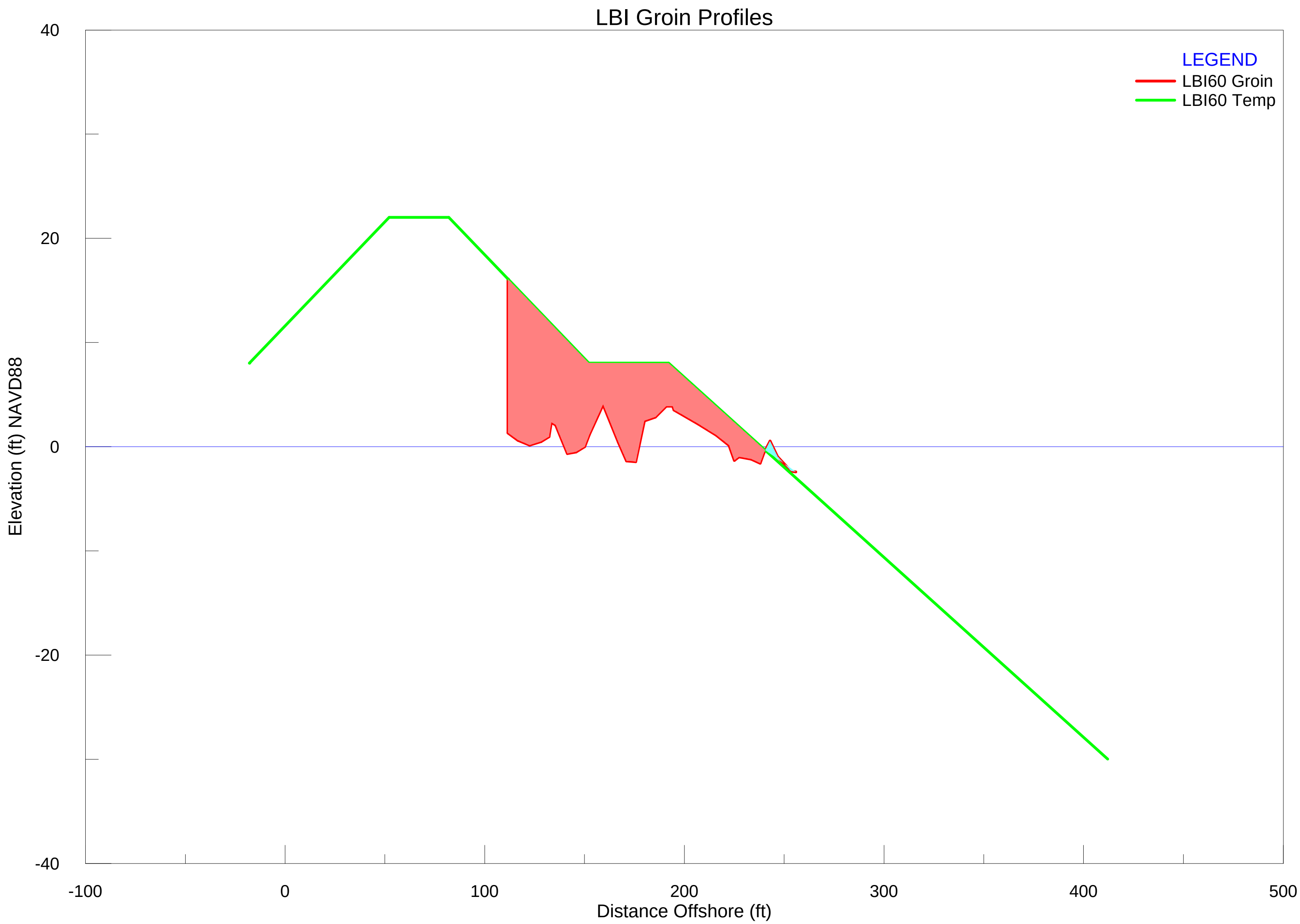
LBI Groin Profiles
LEGEND
LBI57 Groin
LBI57 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



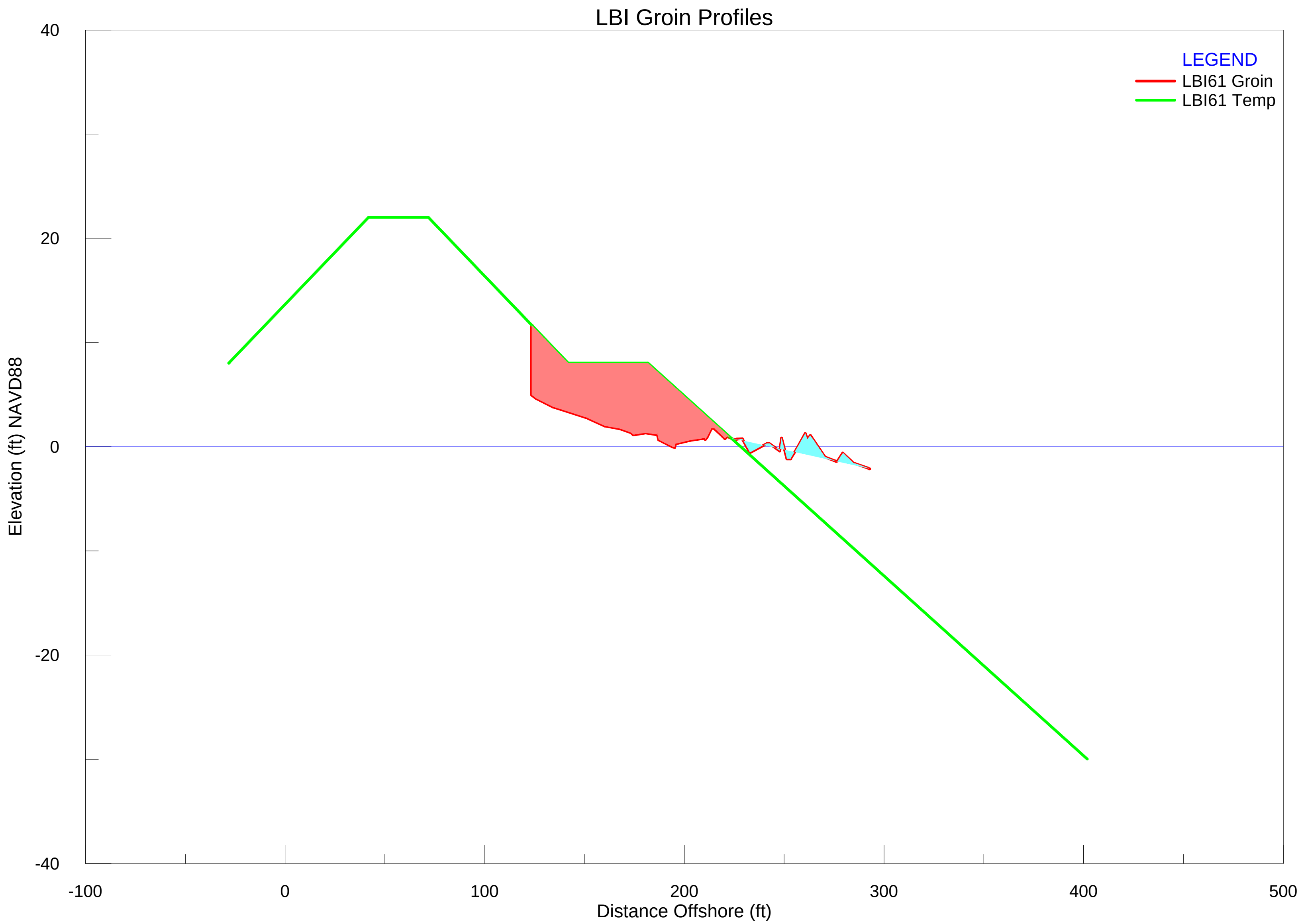
LBI Groin Profiles
LEGEND
LBI58 Groin
LBI58 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

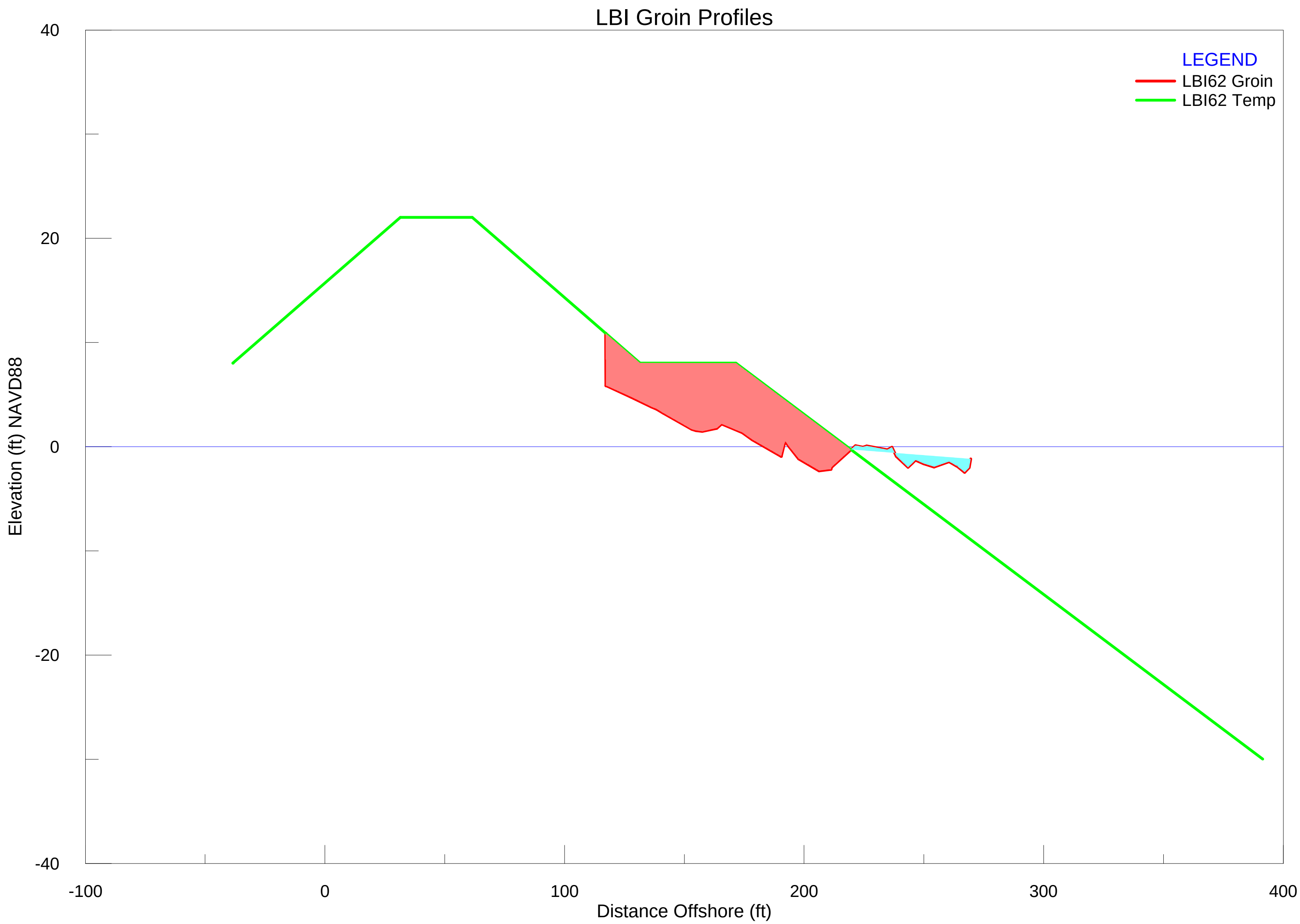


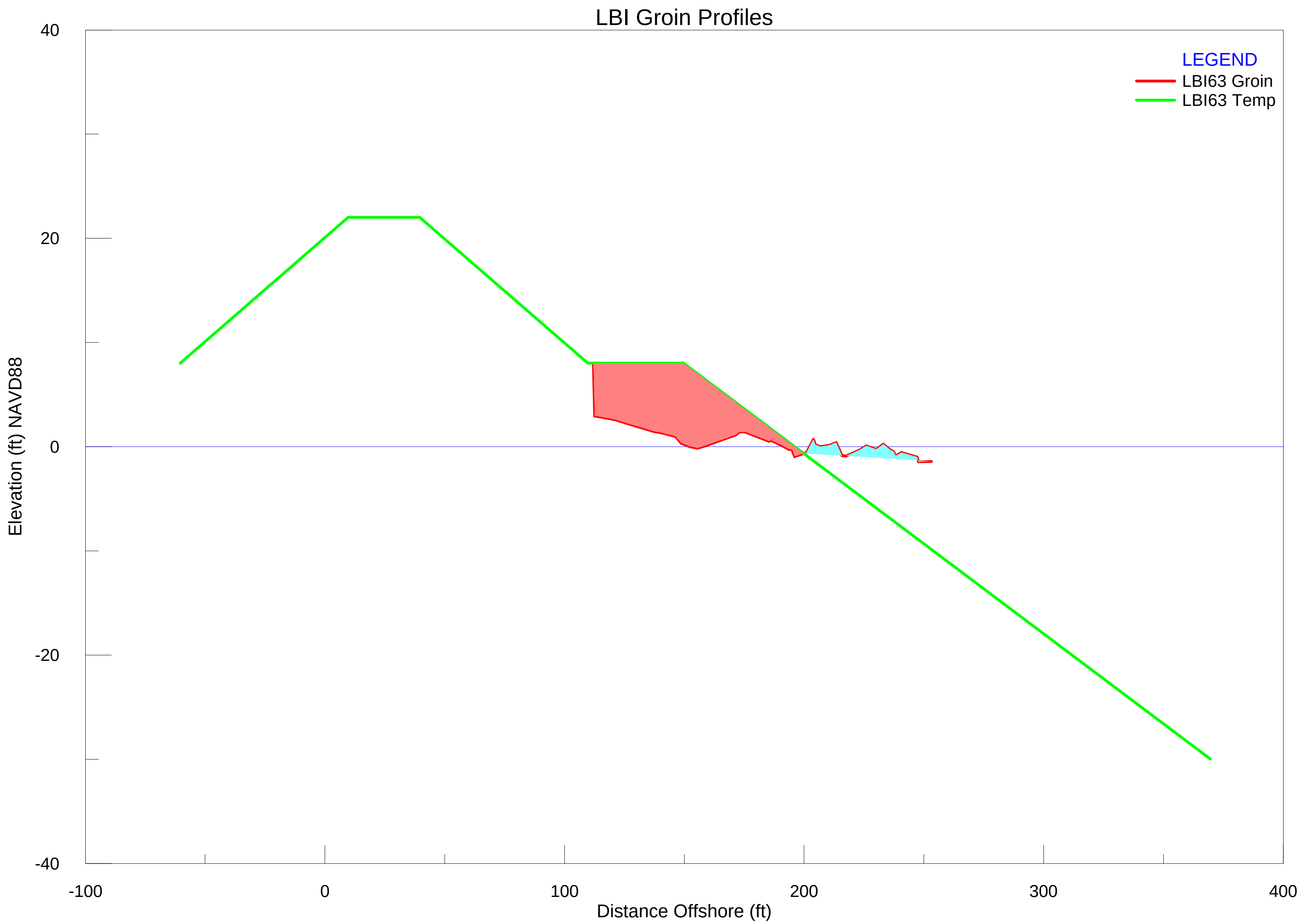
LBI Groin Profiles
LEGEND
LBI59 Groin
LBI59 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

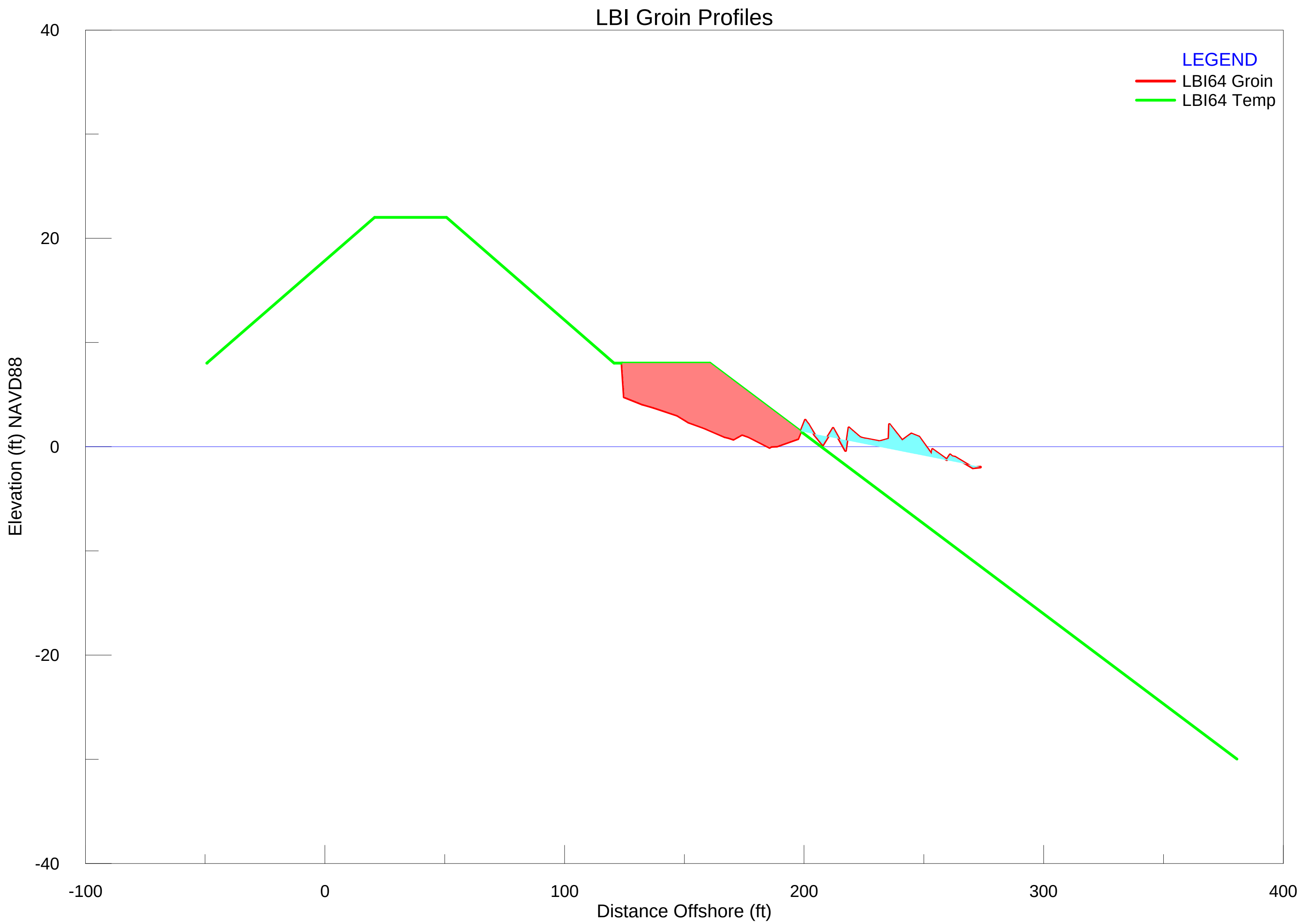


LBI Groin Profiles
LEGEND
LBI60 Groin
LBI60 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

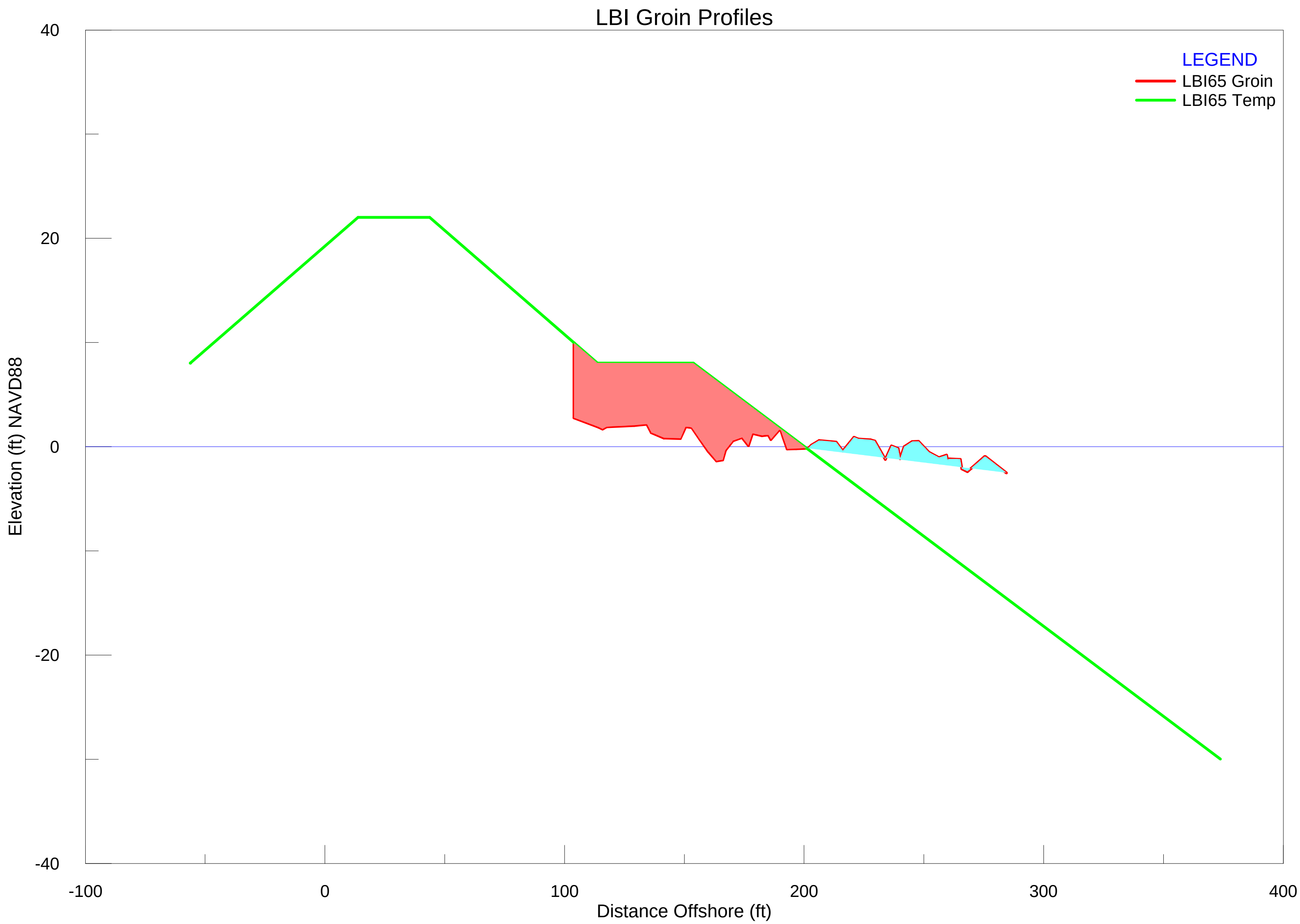

LBI Groin Profiles
LEGEND
LBI61 Groin
LBI61 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI62 Groin
LBI62 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

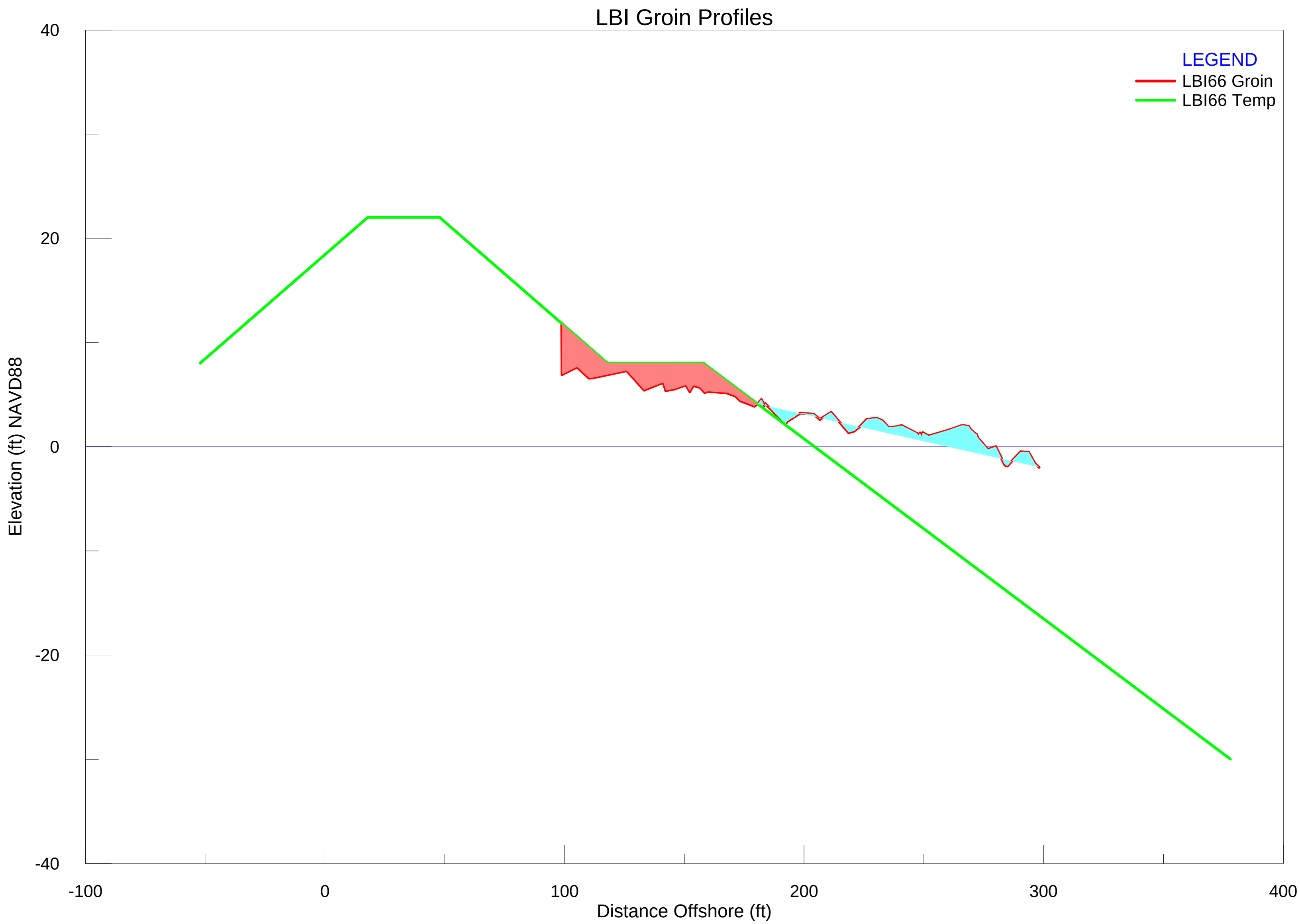

LBI Groin Profiles
LEGEND
LBI63 Groin
LBI63 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



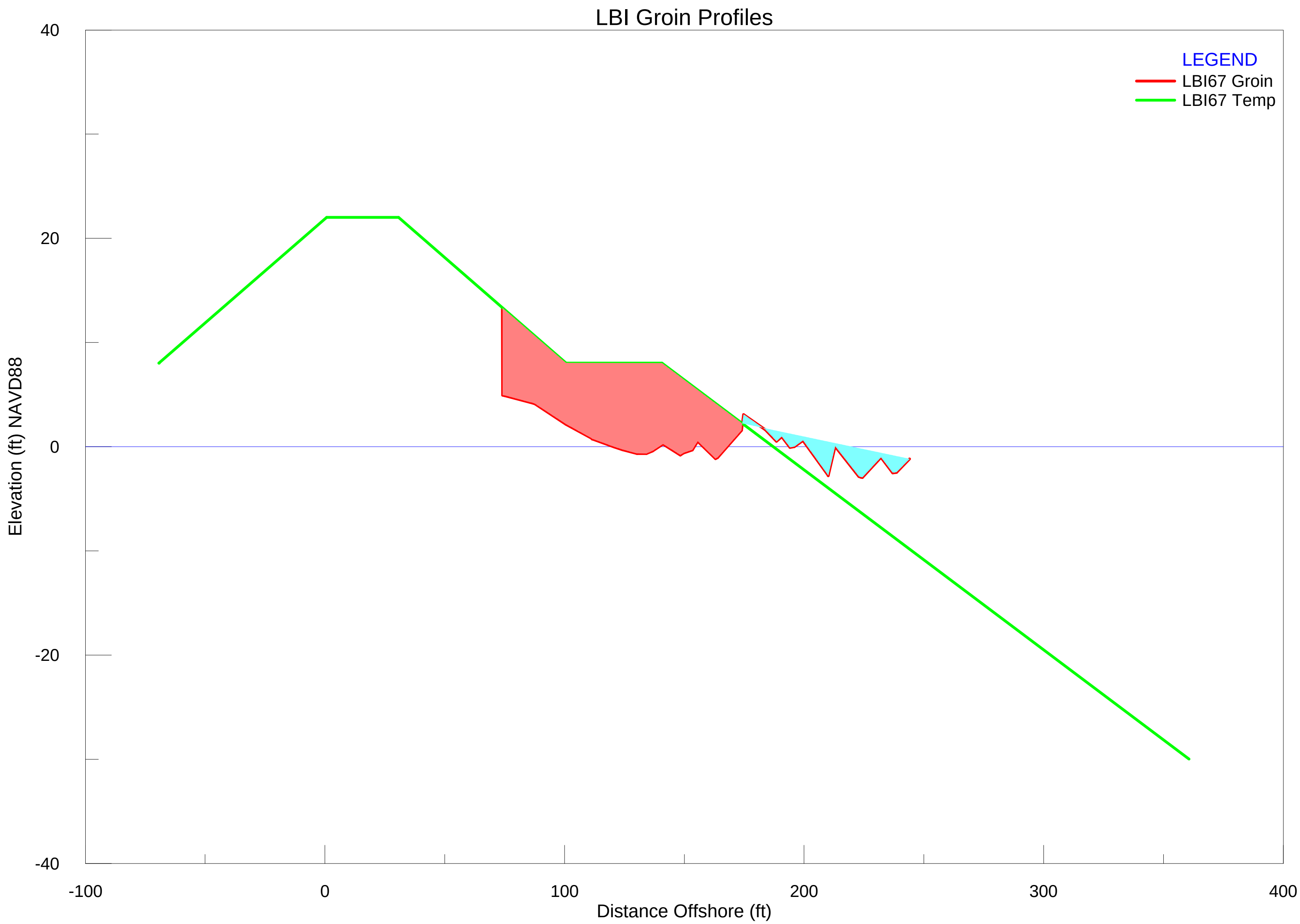
LBI Groin Profiles
LEGEND
LBI64 Groin
LBI64 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

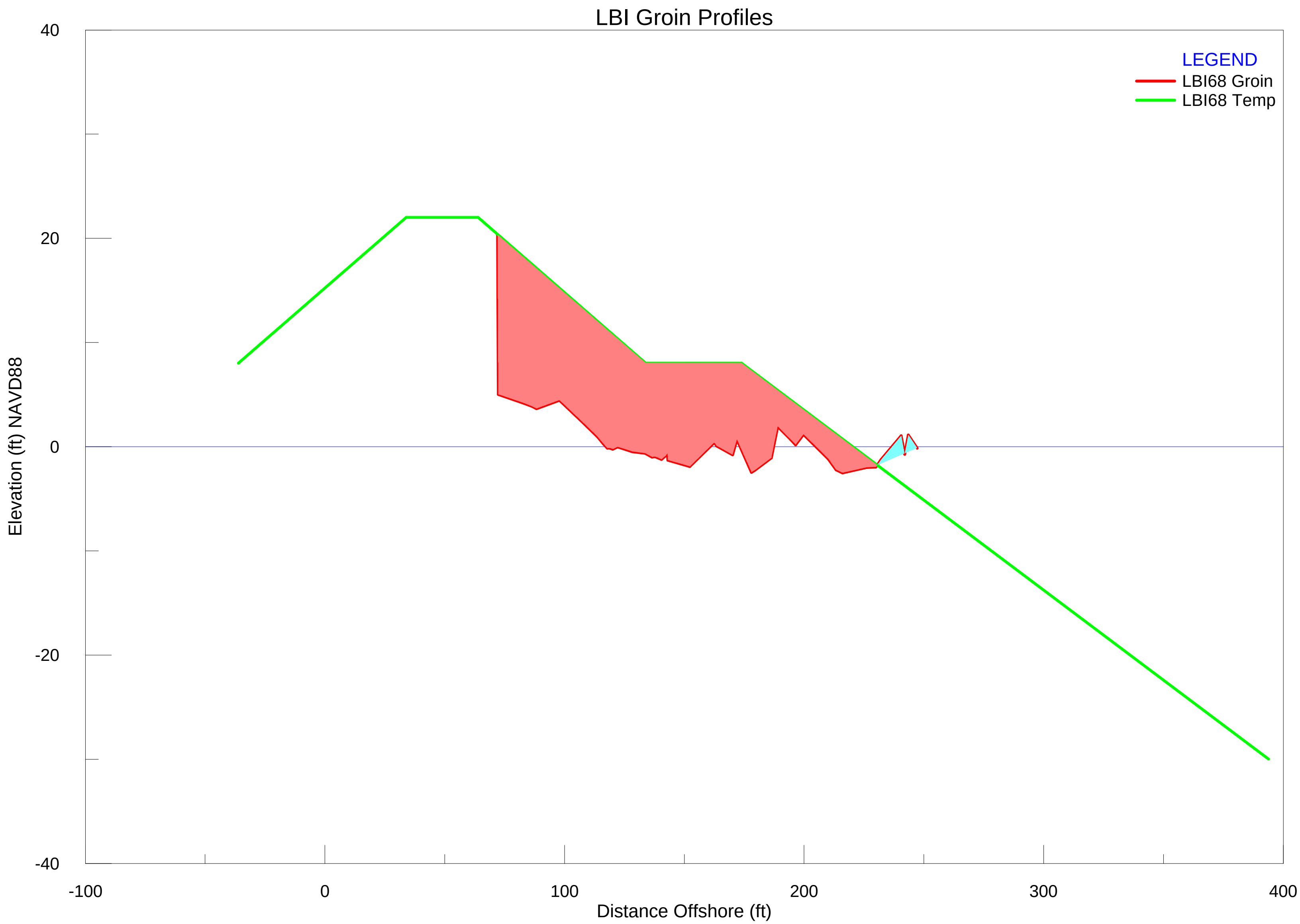


LBI Groin Profiles
LEGEND
LBI65 Groin
LBI65 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

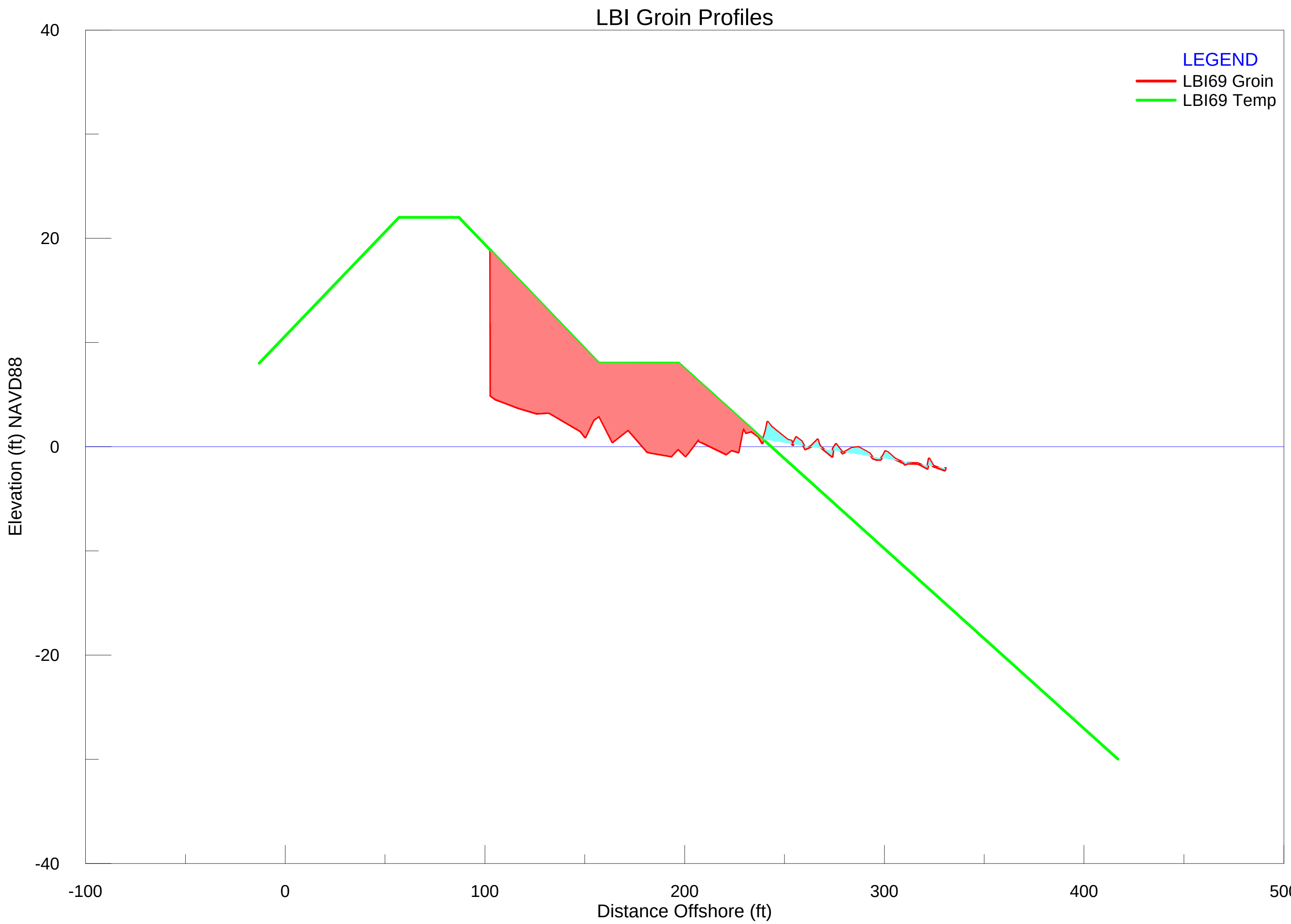


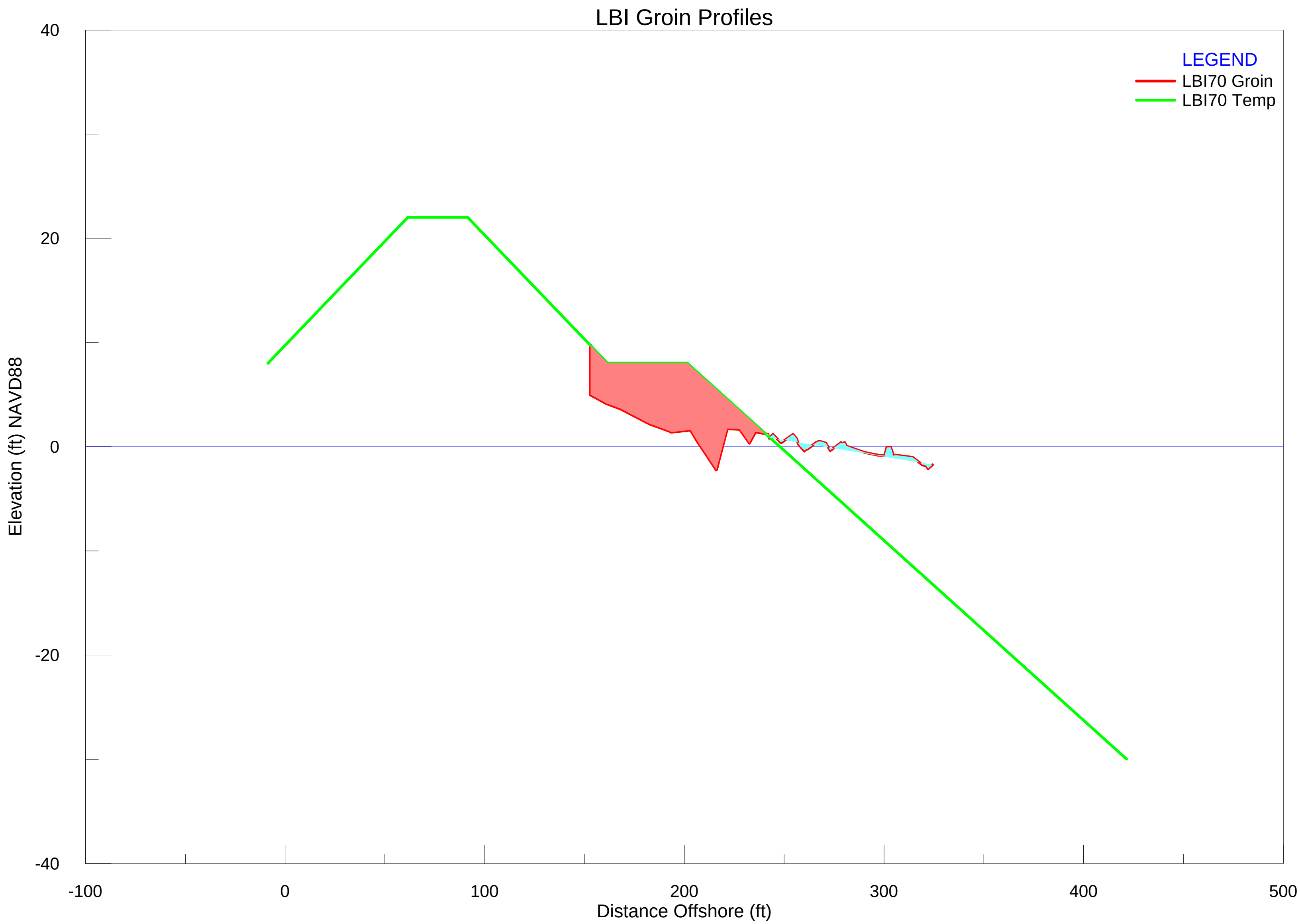
LBI Groin Profiles
LEGEND
LBI66 Groin
LBI66 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI67 Groin
LBI67 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

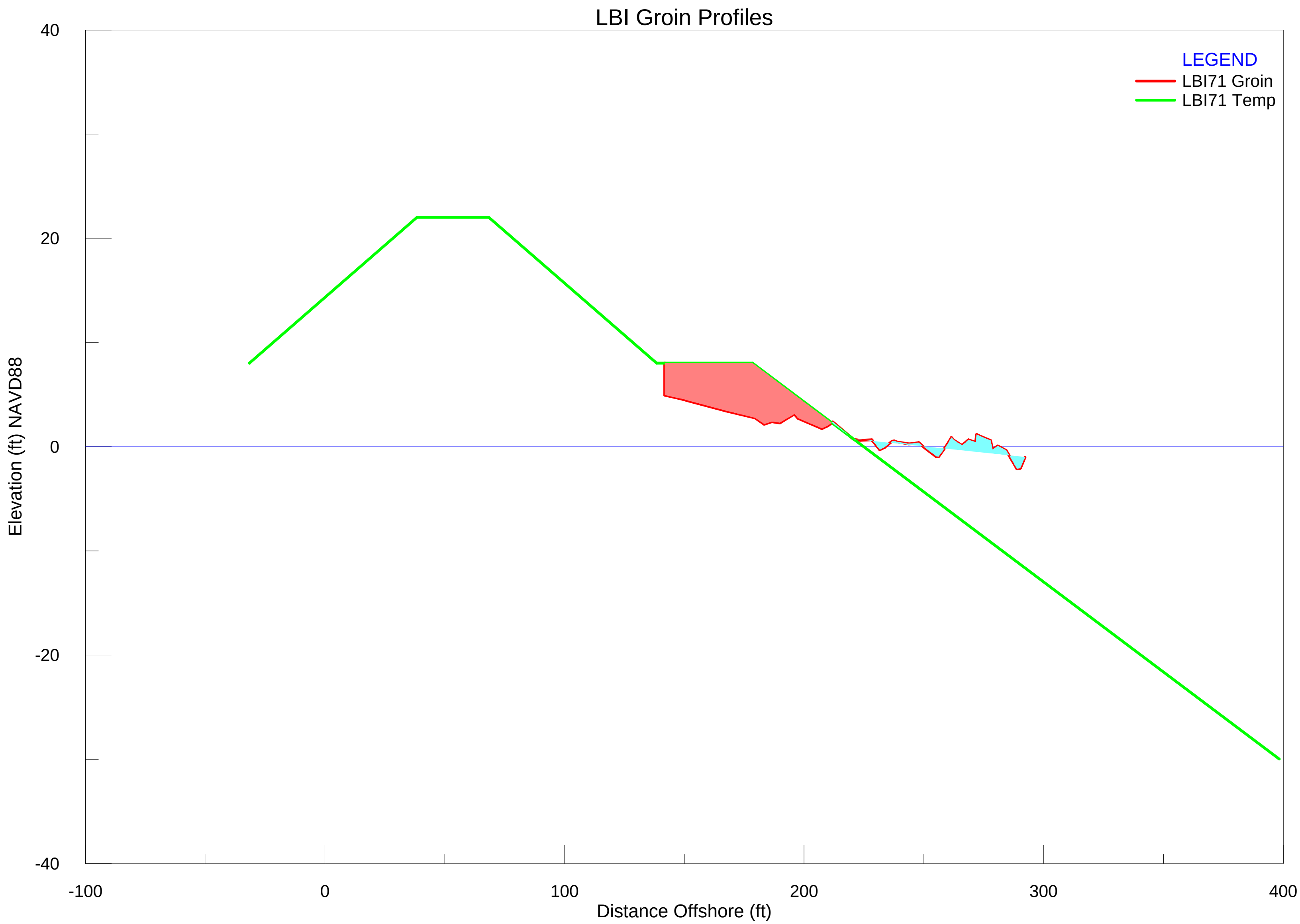


LBI Groin Profiles
LEGEND
LBI68 Groin
LBI68 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

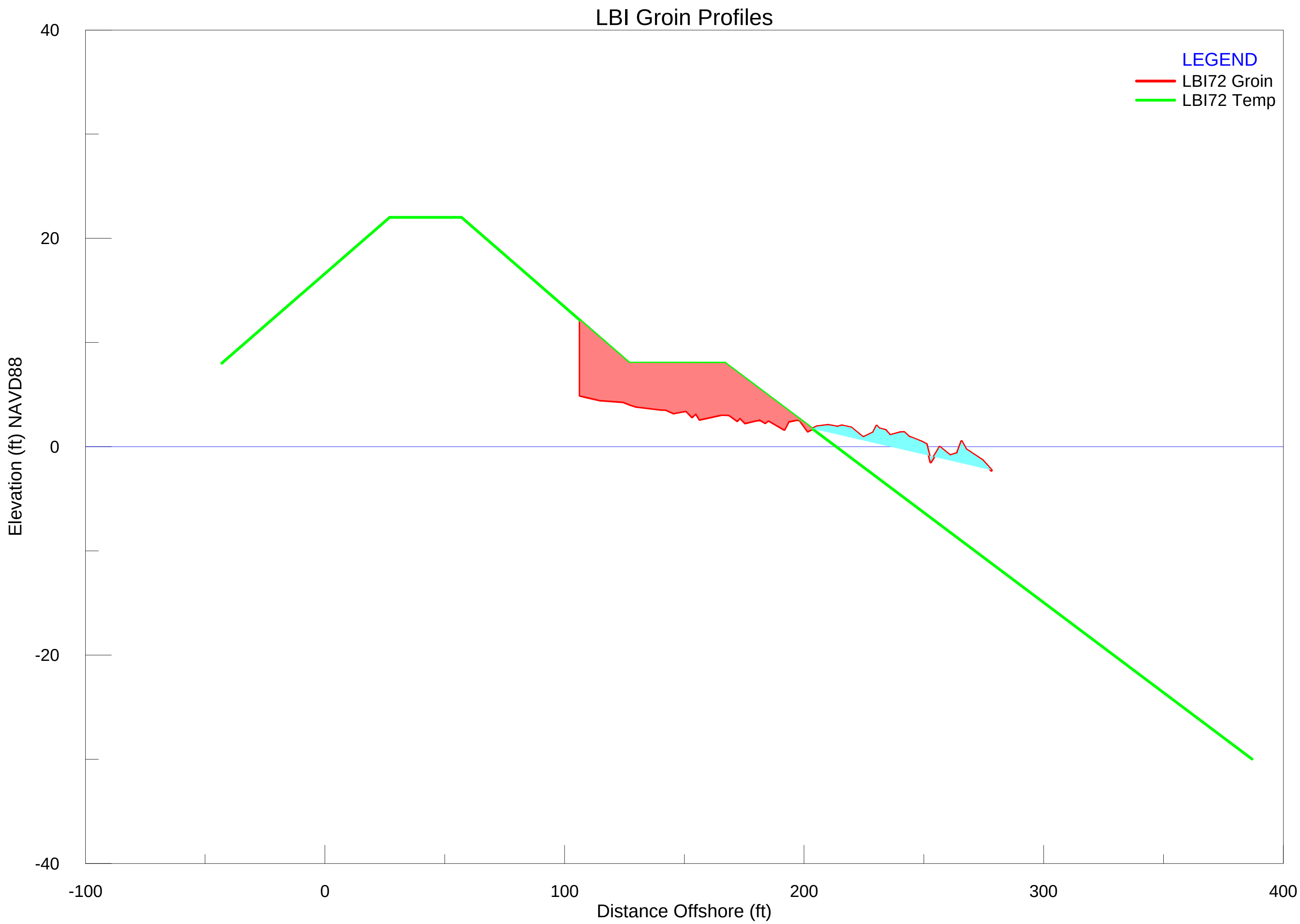

LBI Groin Profiles
LEGEND
LBI69 Groin
LBI69 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)



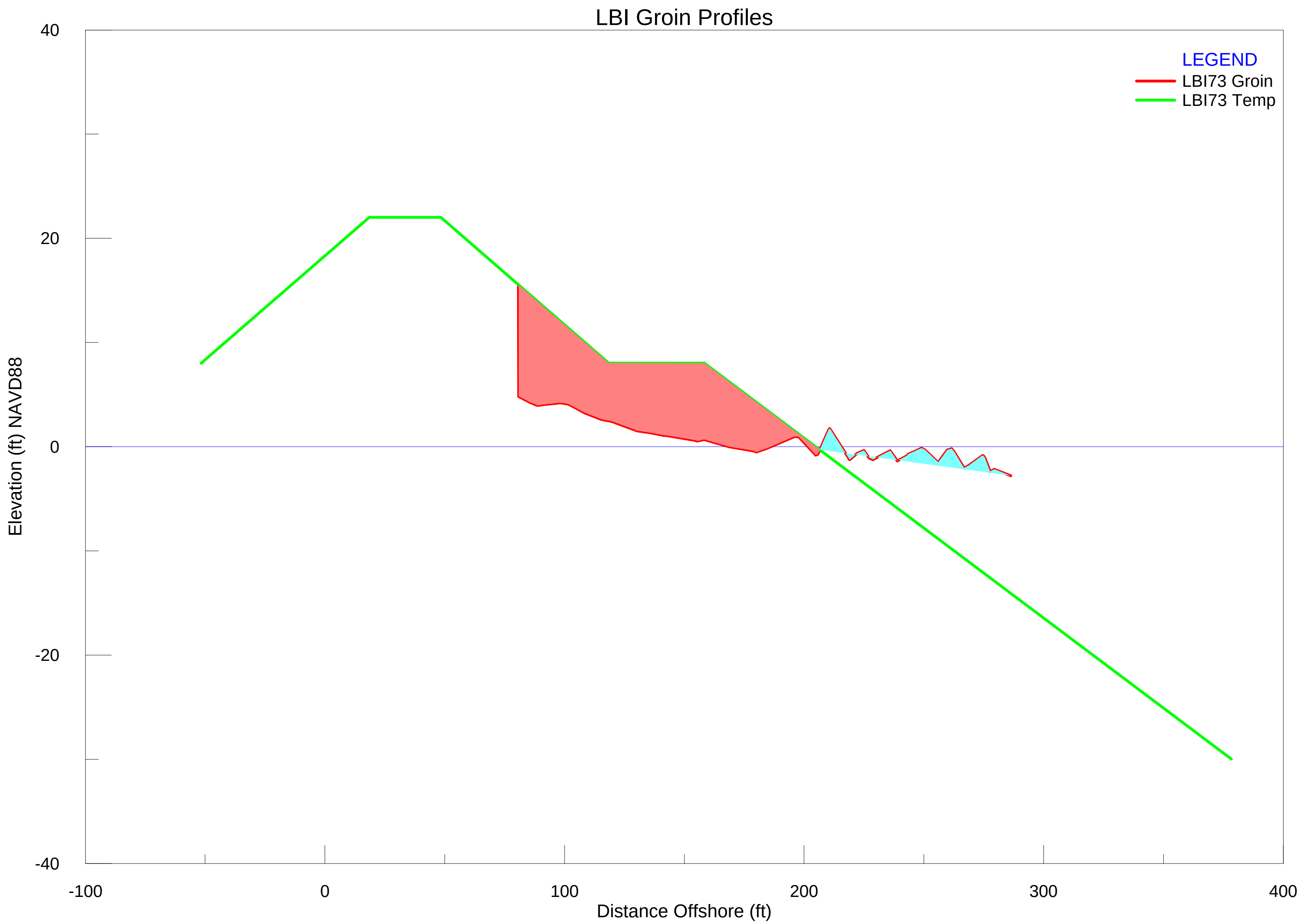
LBI Groin Profiles
LEGEND
LBI70 Groin
LBI70 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
500
Distance Offshore (ft)



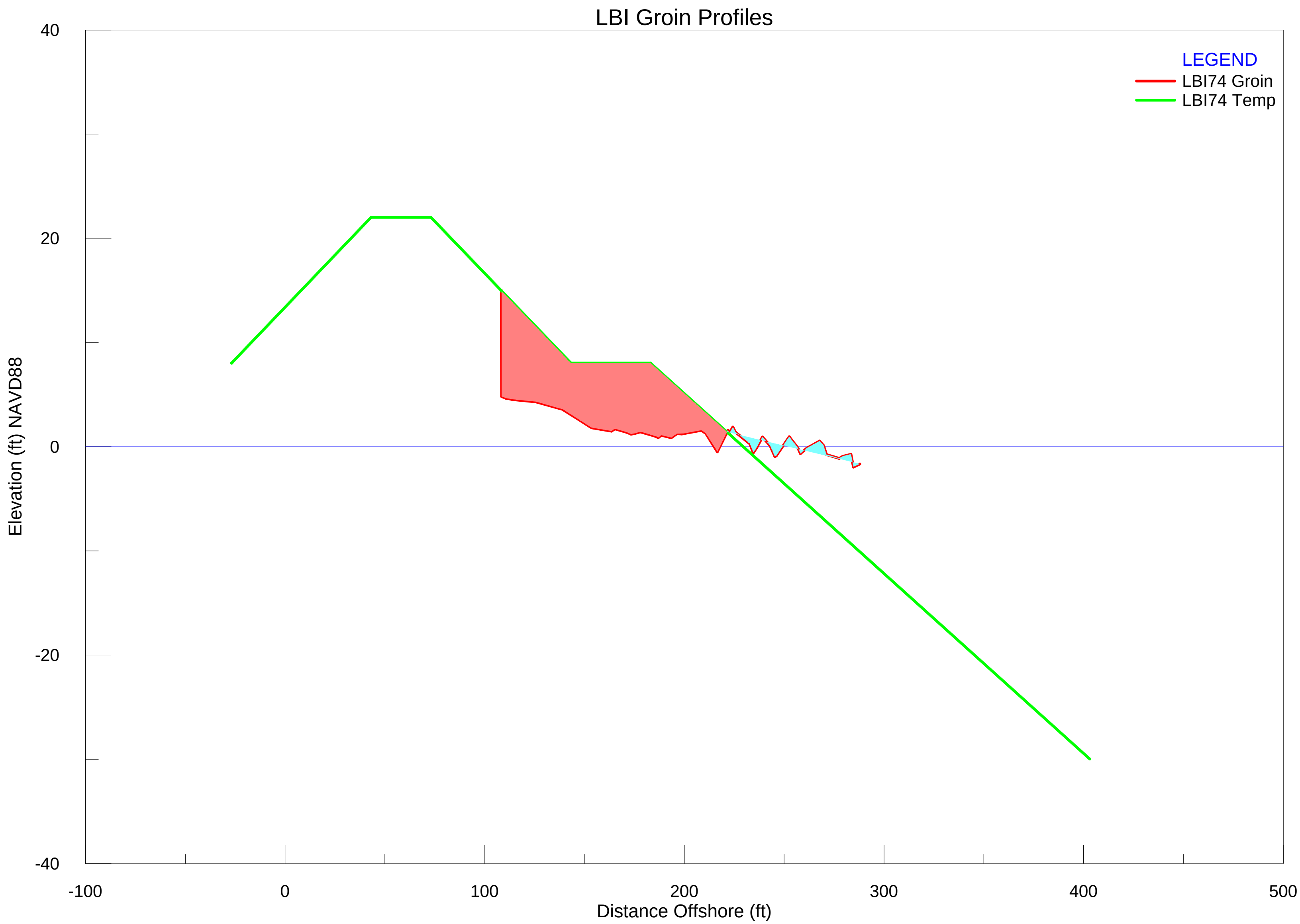
LBI Groin Profiles
LEGEND
LBI71 Groin
LBI71 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

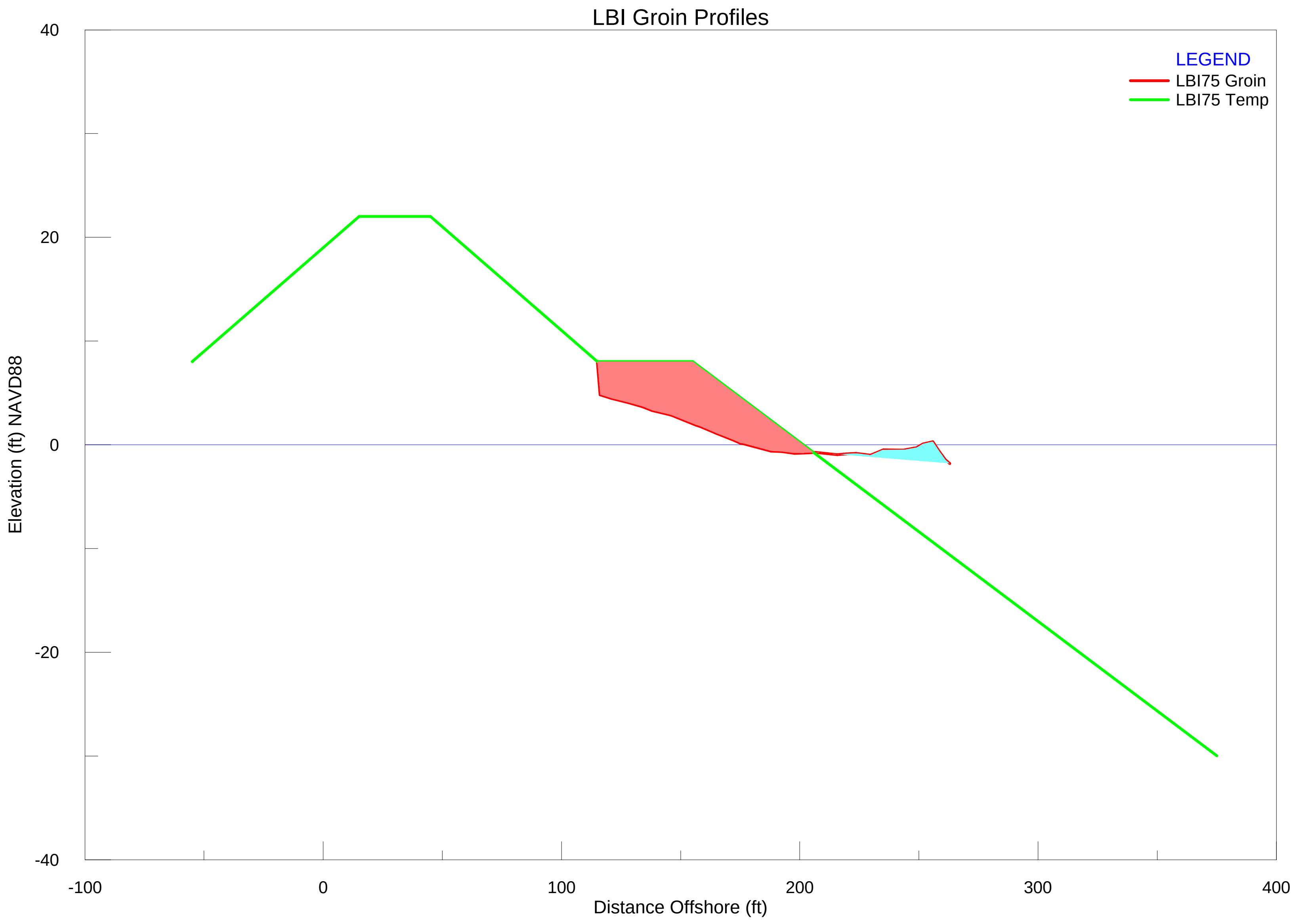


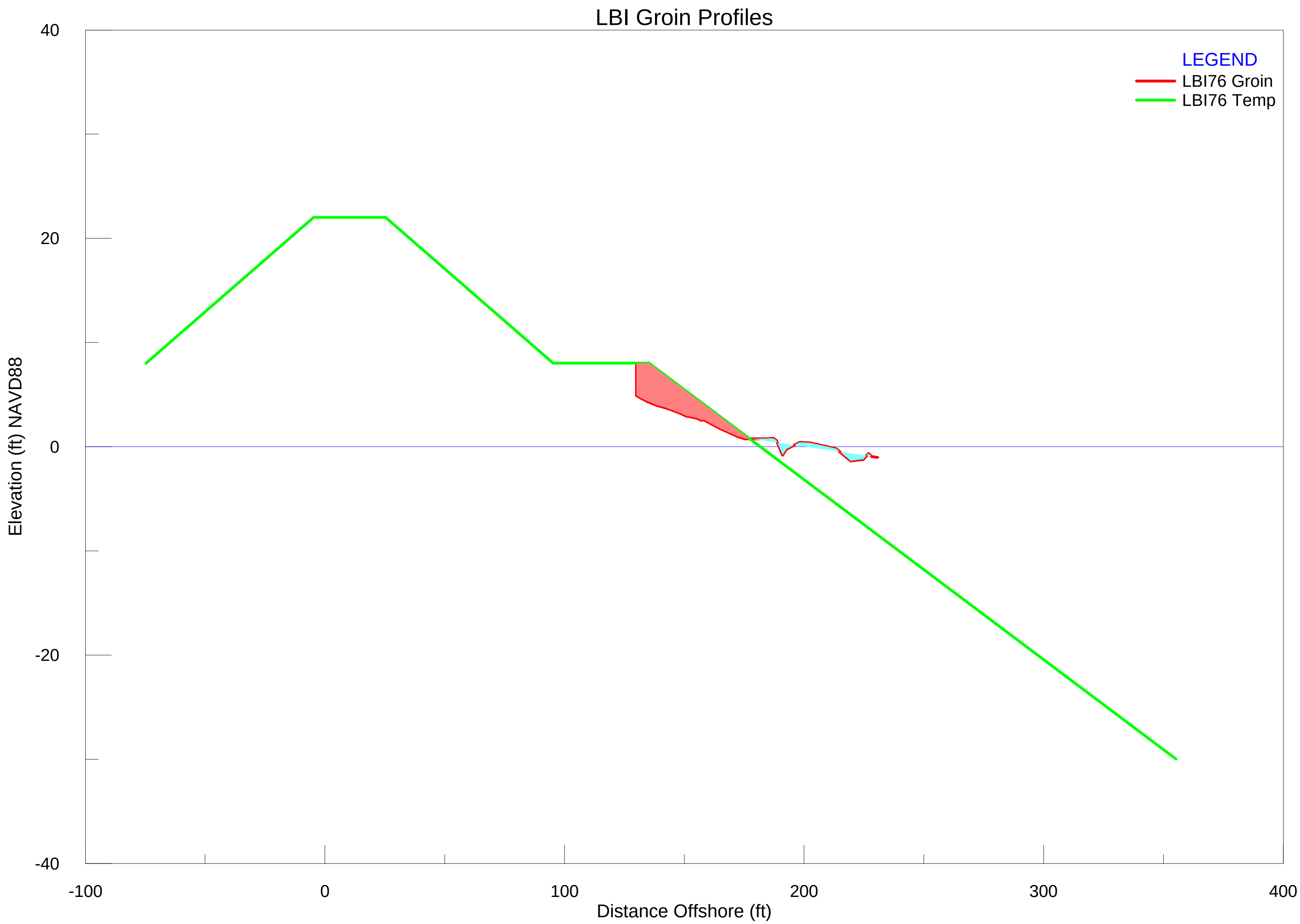
LBI Groin Profiles
LEGEND
LBI72 Groin
LBI72 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



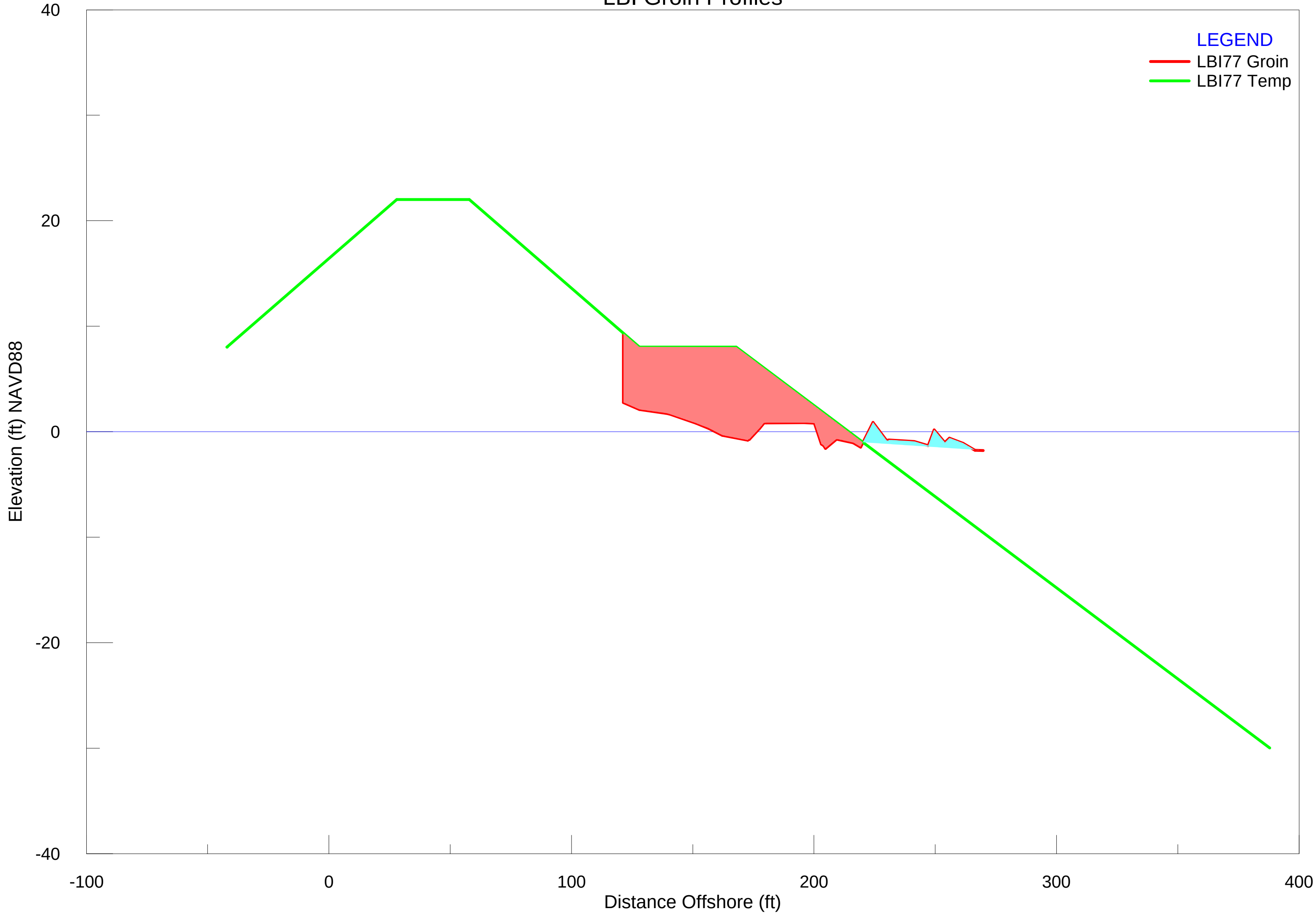
LBI Groin Profiles
LEGEND
LBI73 Groin
LBI73 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

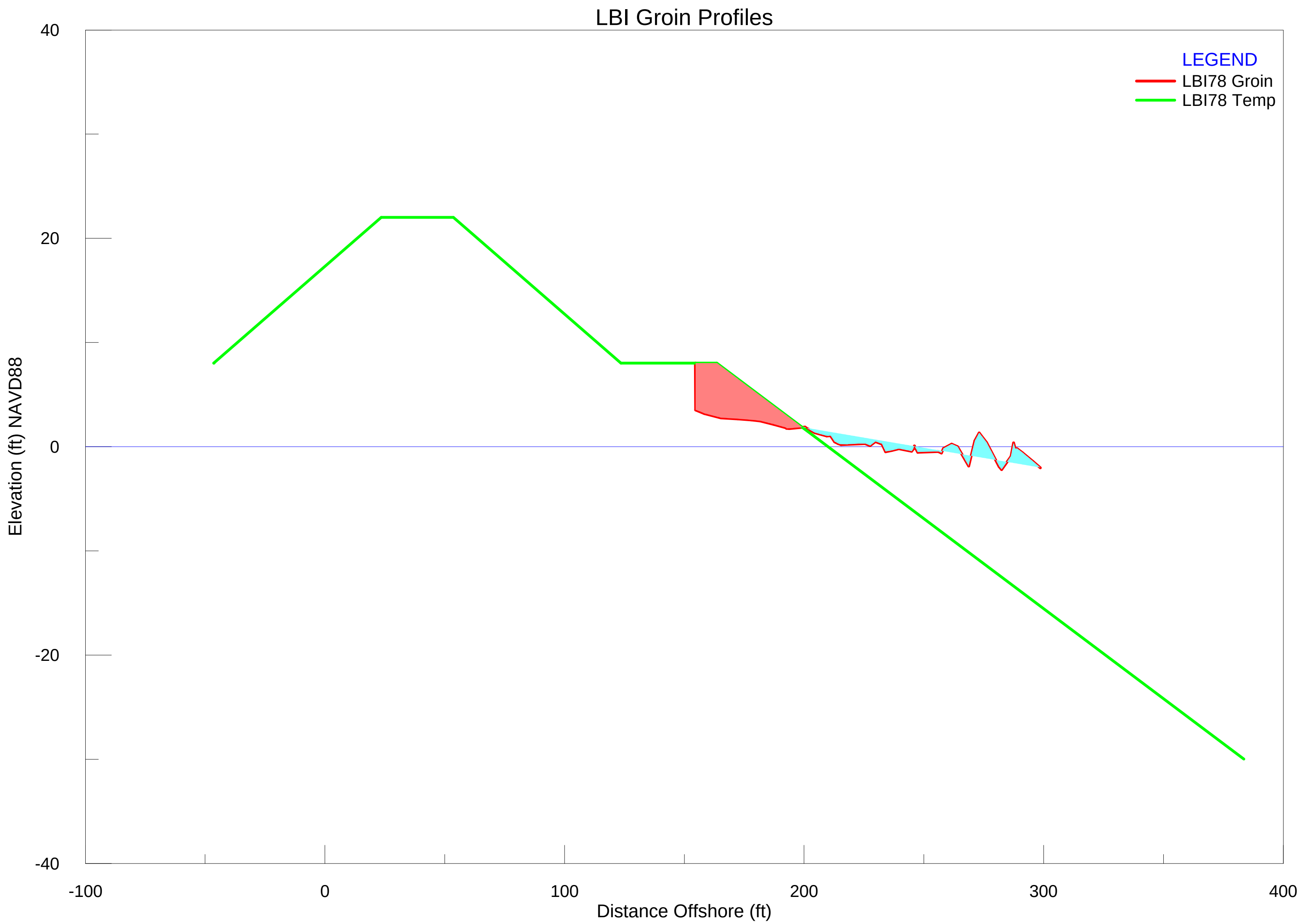

LBI Groin Profiles
LEGEND
LBI74 Groin
LBI74 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

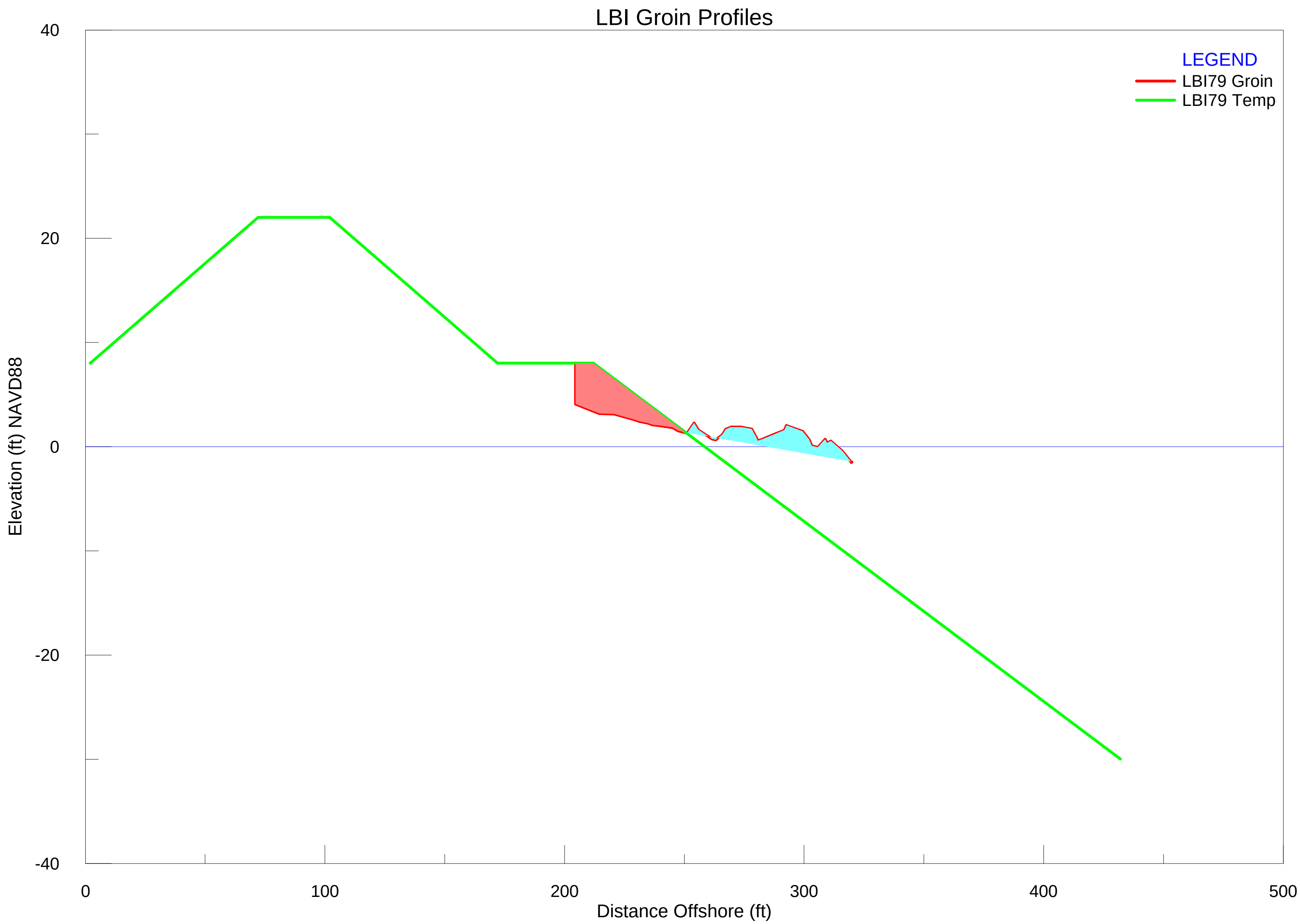

LBI Groin Profiles
LEGEND
LBI75 Groin
LBI75 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

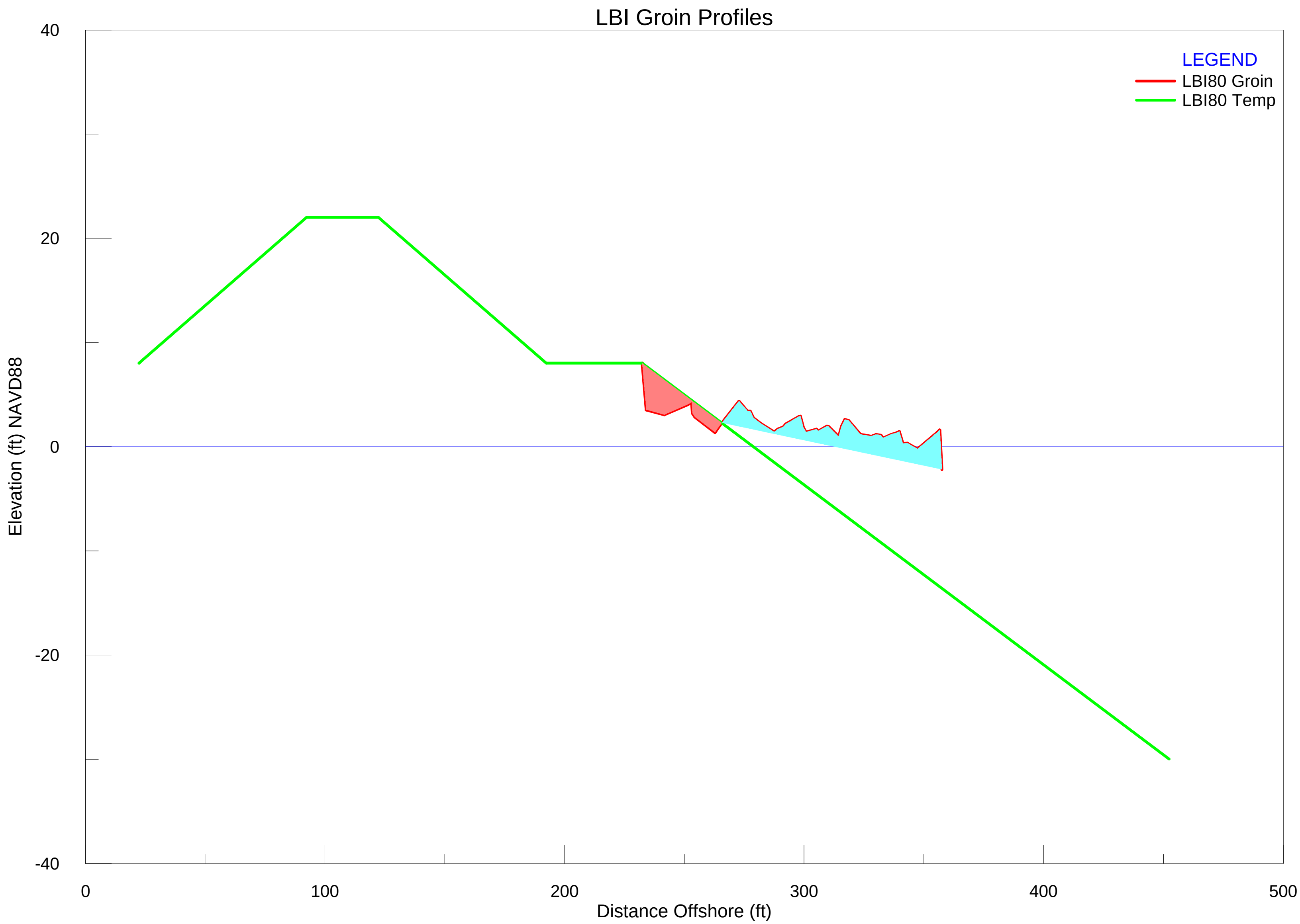

LBI Groin Profiles
LEGEND
LBI76 Groin
LBI76 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

LBI Groin Profiles

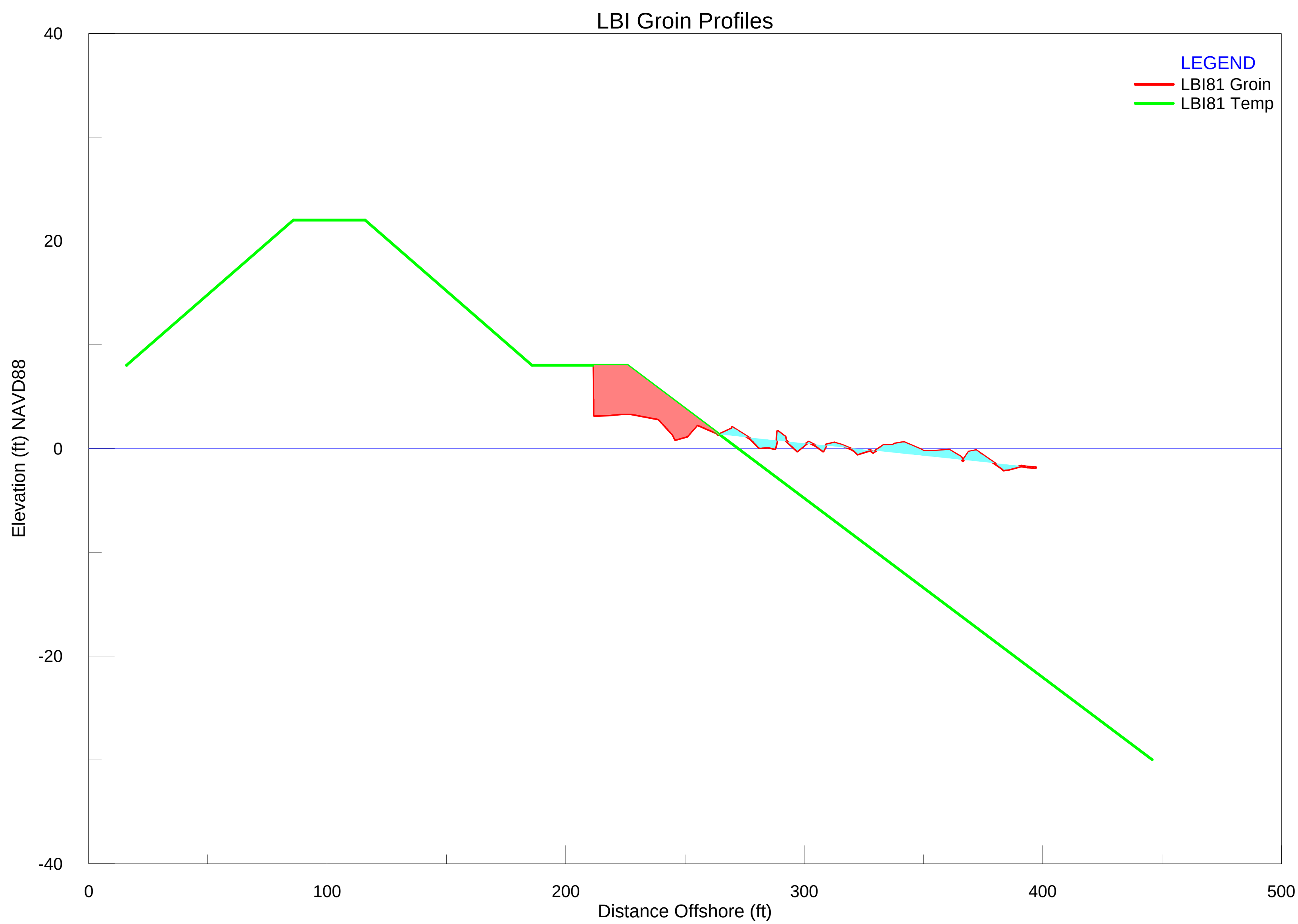


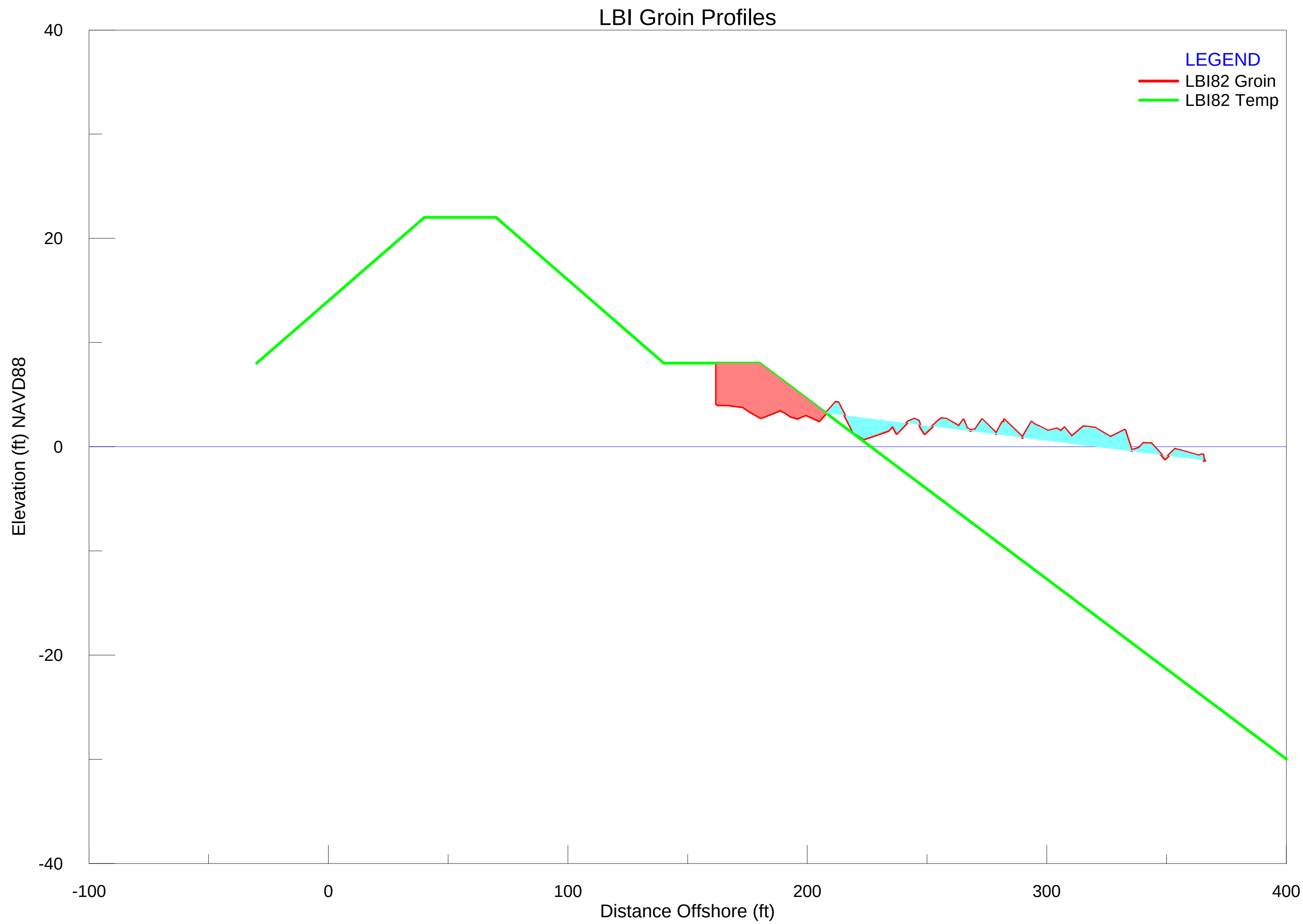

LBI Groin Profiles
LEGEND
LBI78 Groin
LBI78 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI79 Groin
LBI79 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
0
100
200
300
400
500
Distance Offshore (ft)

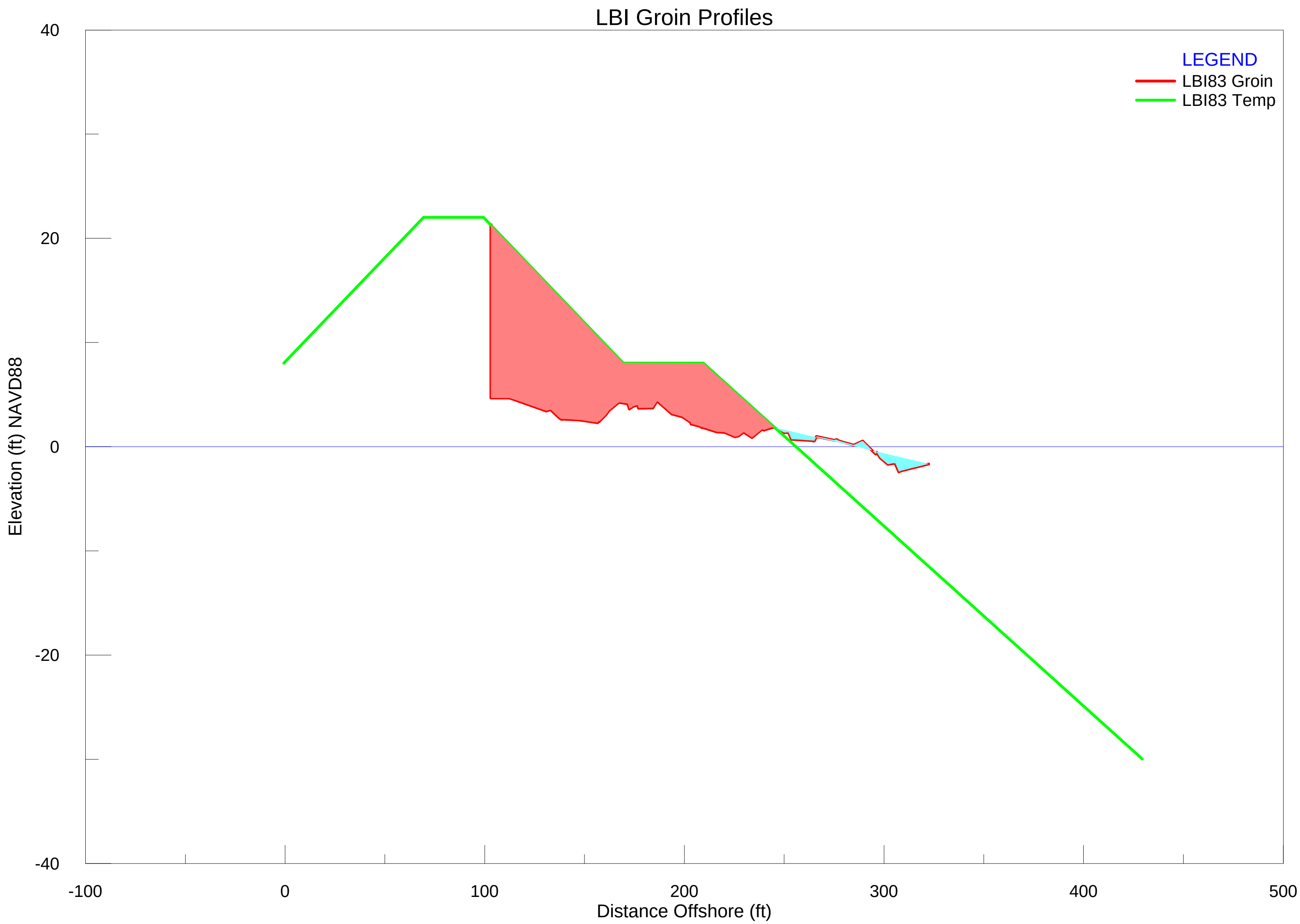


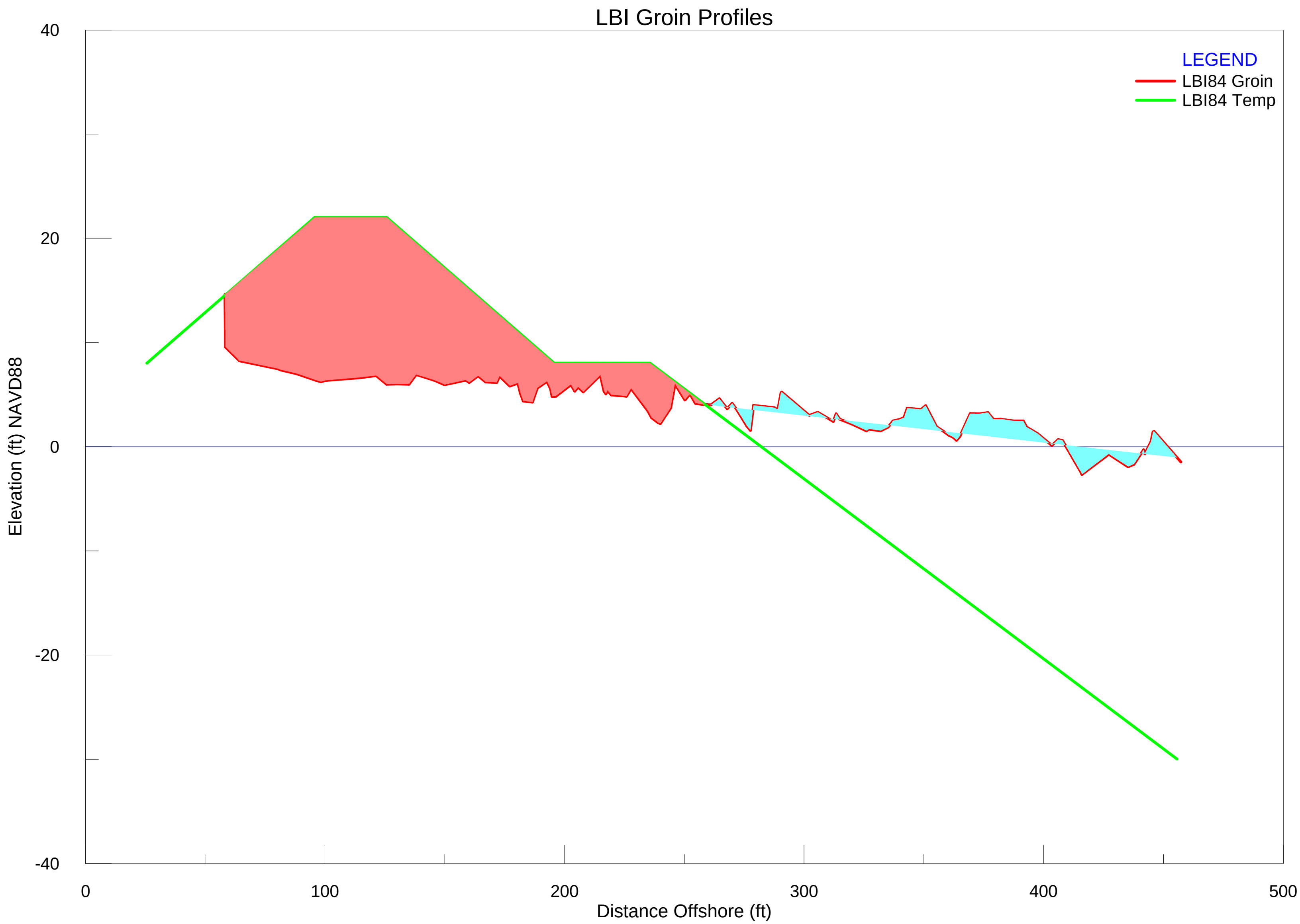
LBI Groin Profiles
LEGEND
LBI80 Groin
LBI80 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
0
100
200
300
400
500
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI81 Groin
LBI81 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
0
100
200
300
400
500
Distance Offshore (ft)

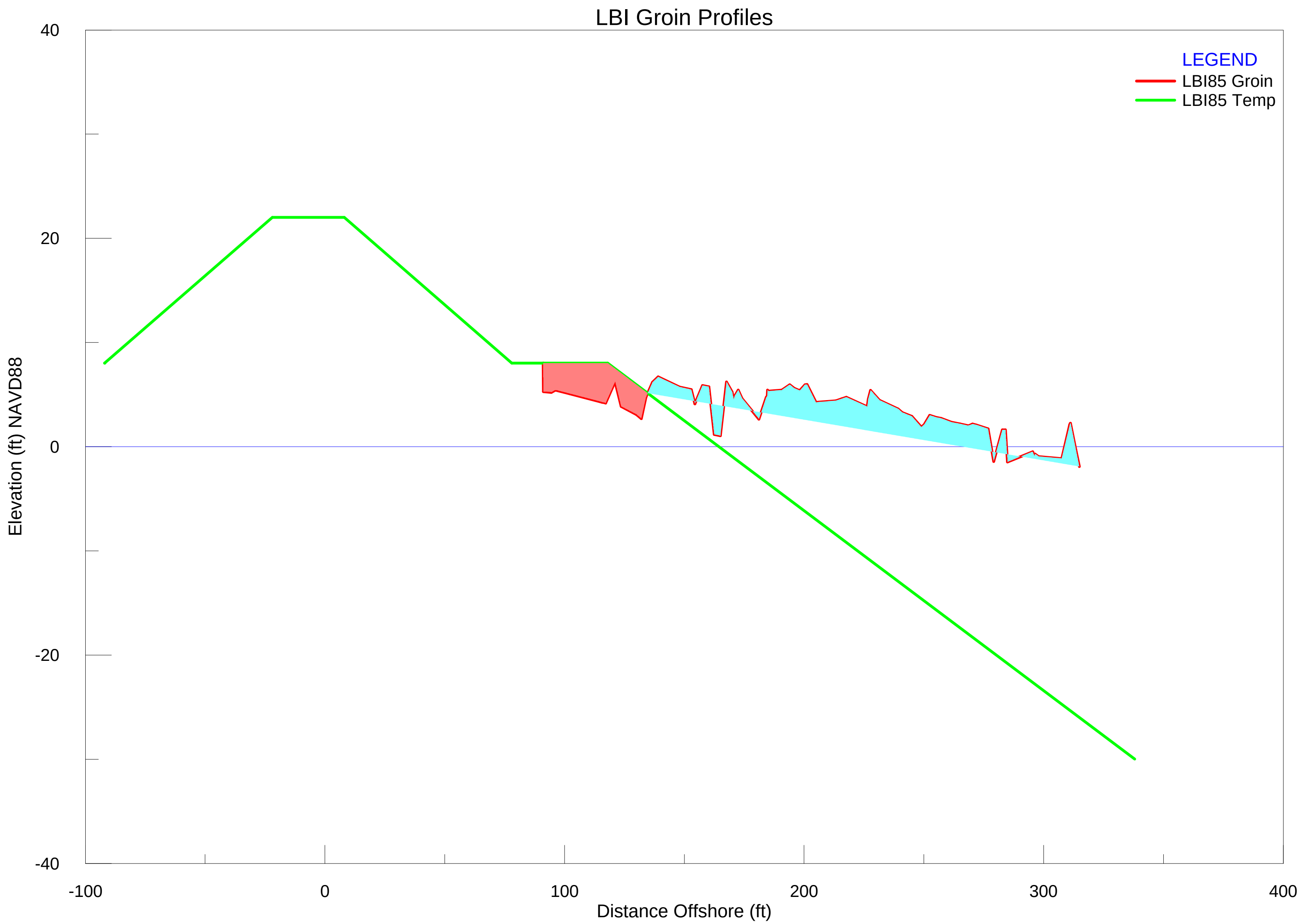


LBI Groin Profiles
LEGEND
LBI82 Groin
LBI82 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

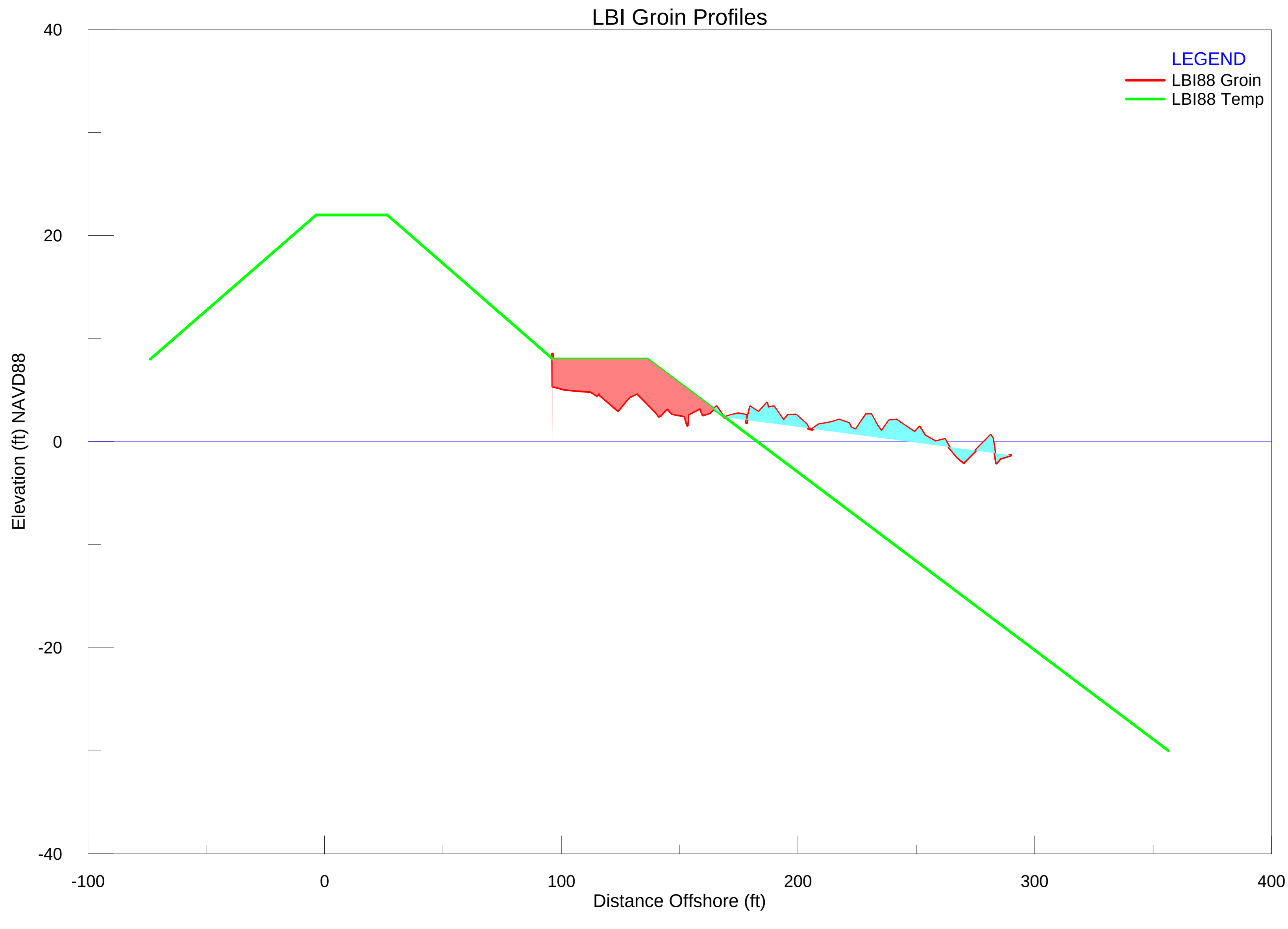

LBI Groin Profiles
LEGEND
LBI83 Groin
LBI83 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
500
Distance Offshore (ft)

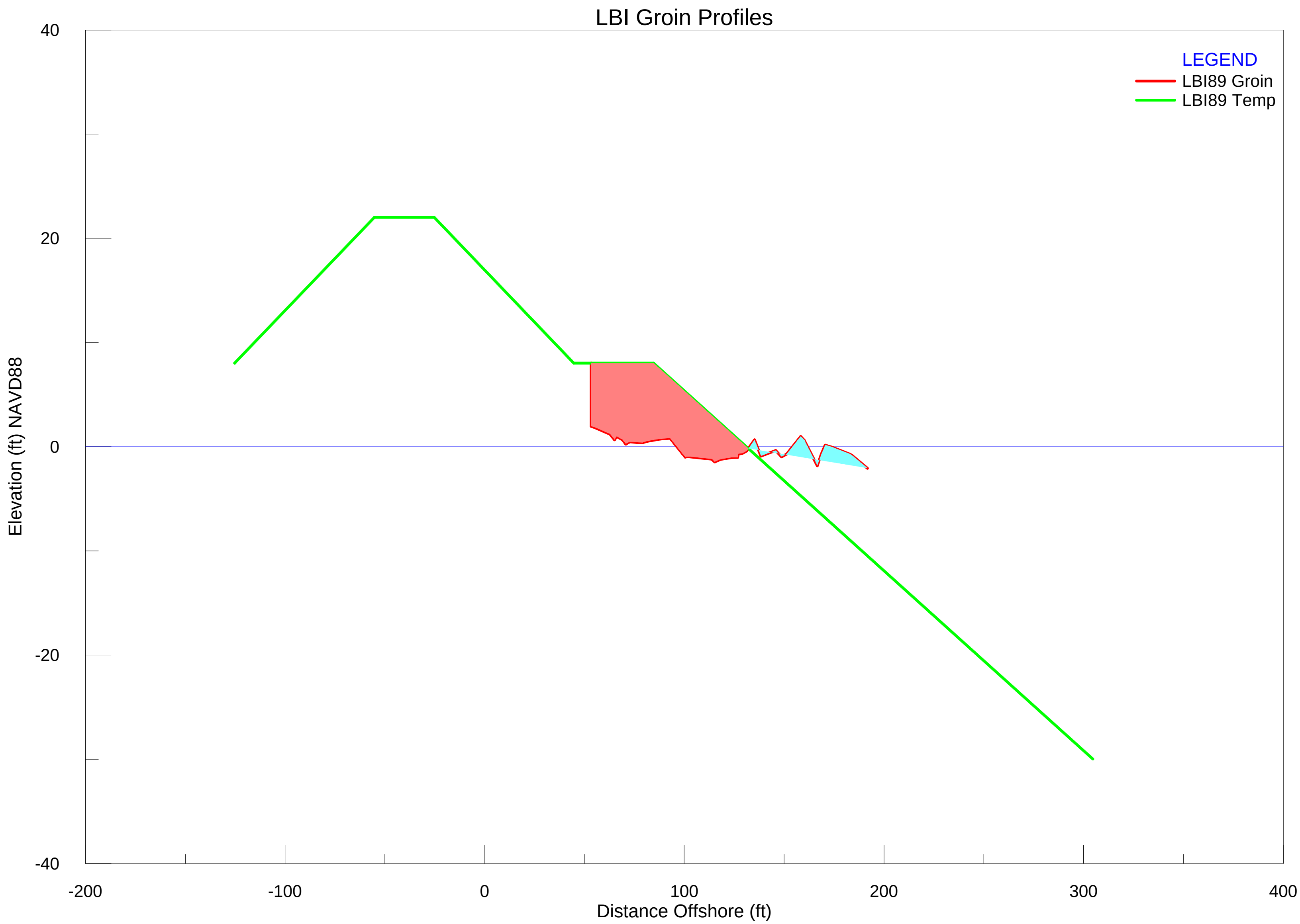


LBI Groin Profiles
LEGEND
LBI84 Groin
LBI84 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
0
100
200
300
400
500
Distance Offshore (ft)

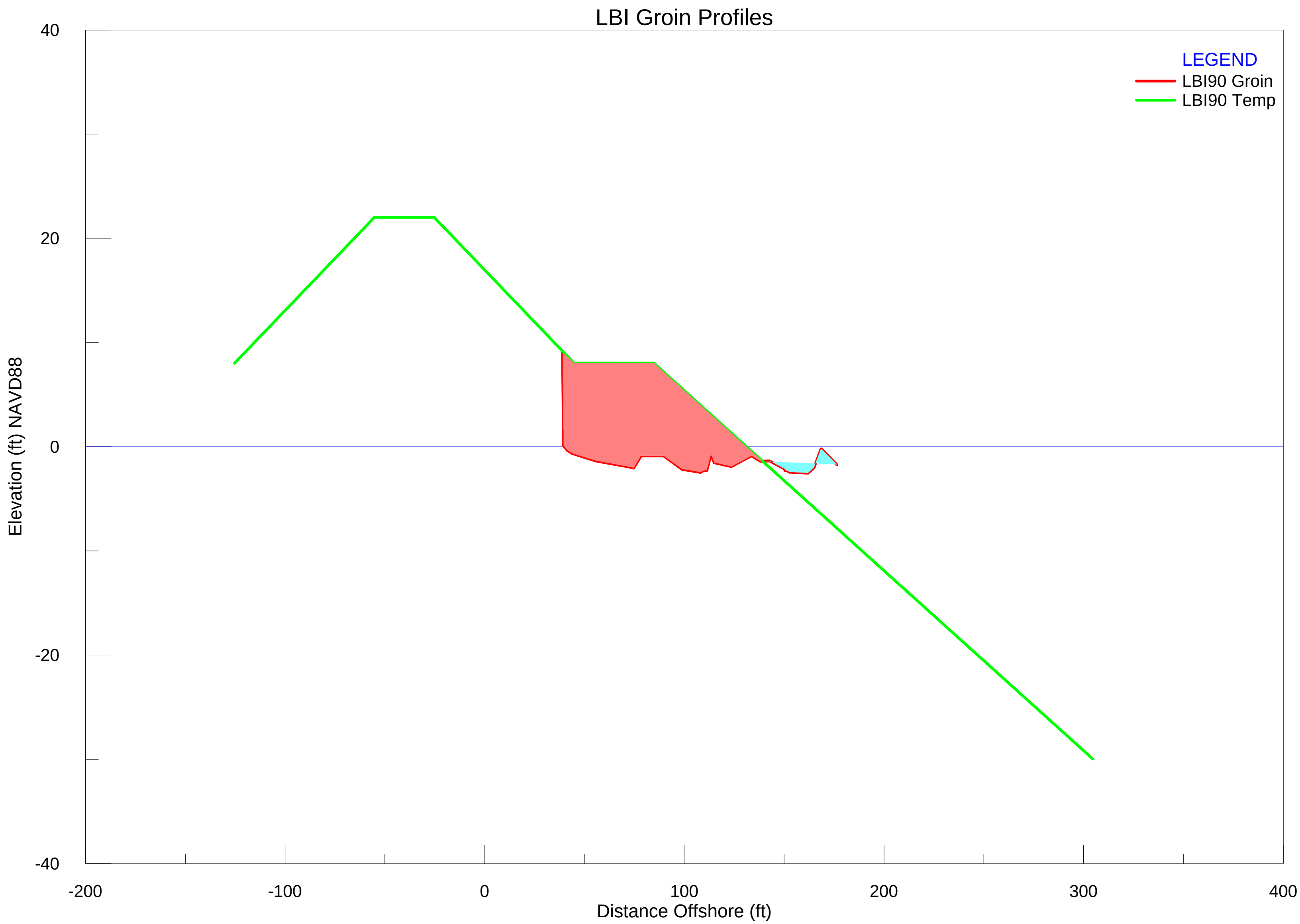


LBI Groin Profiles
LEGEND
LBI85 Groin
LBI85 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)

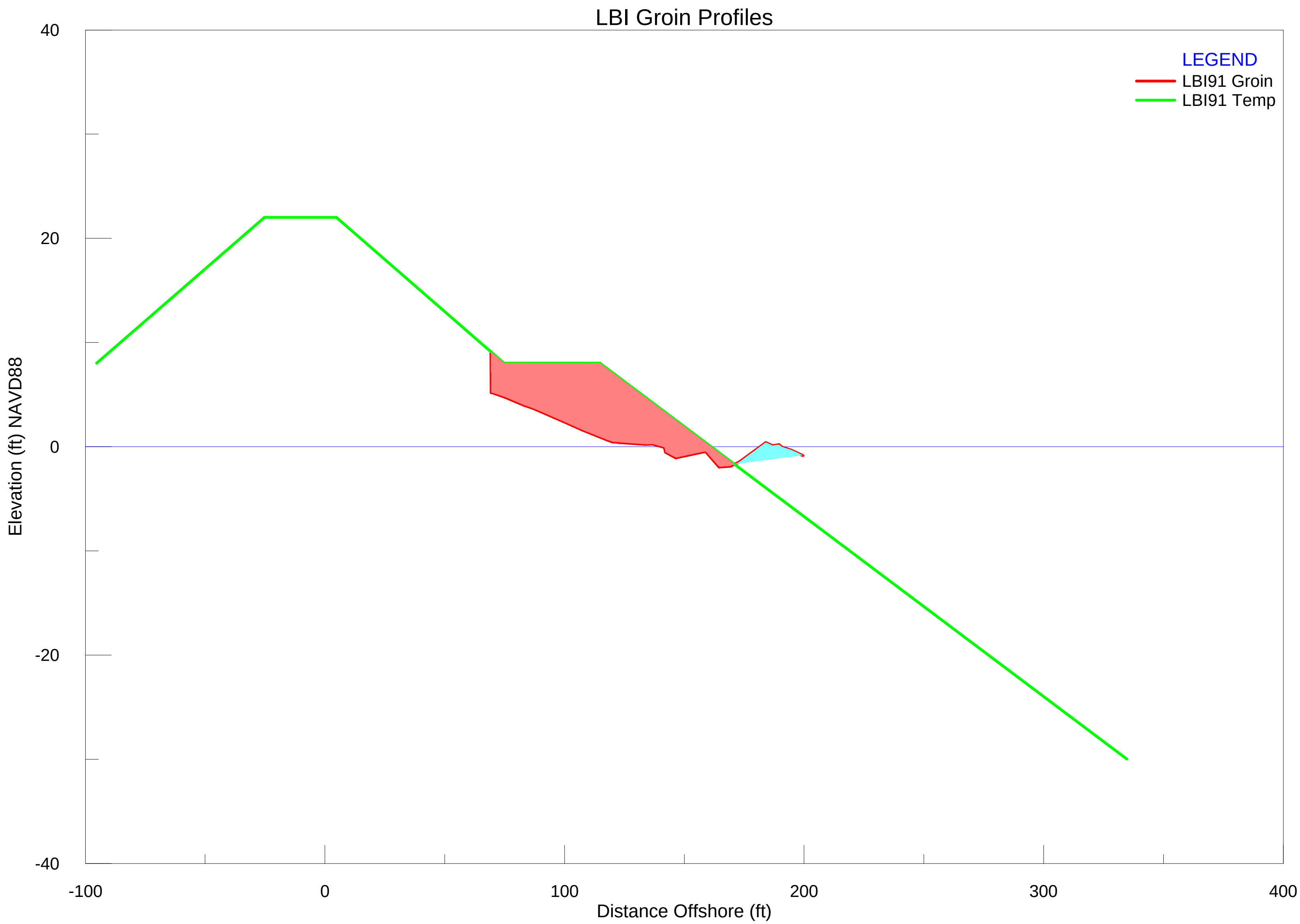

LBI Groin Profiles
LEGEND
LBI88 Groin
LBI88 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



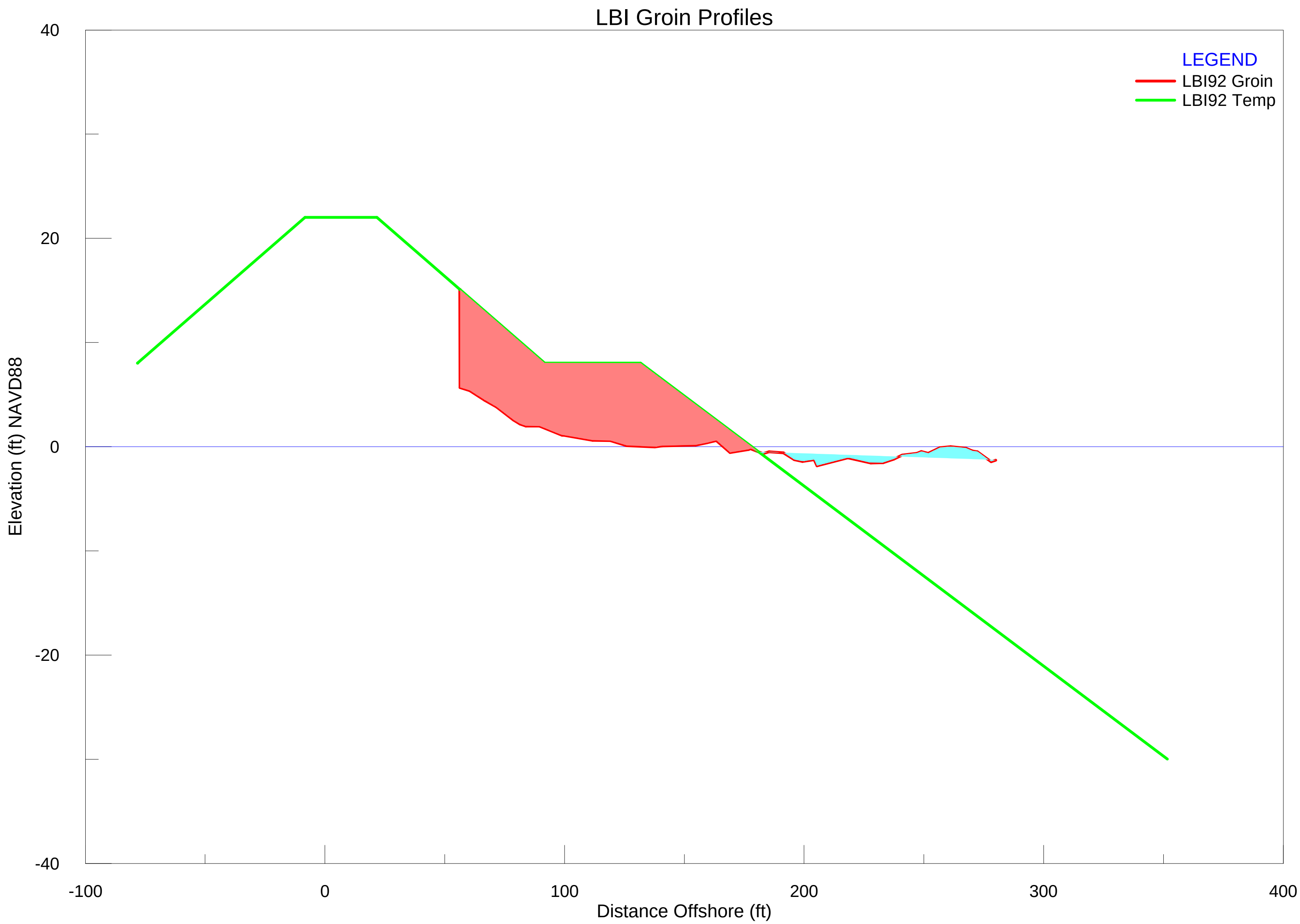
LBI Groin Profiles
LEGEND
LBI89 Groin
LBI89 Temp
Elevation (ft) NAVD88
Distance Offshore (ft)
40
20
0
-20
-40
-200
-100
0
100
200
300
400

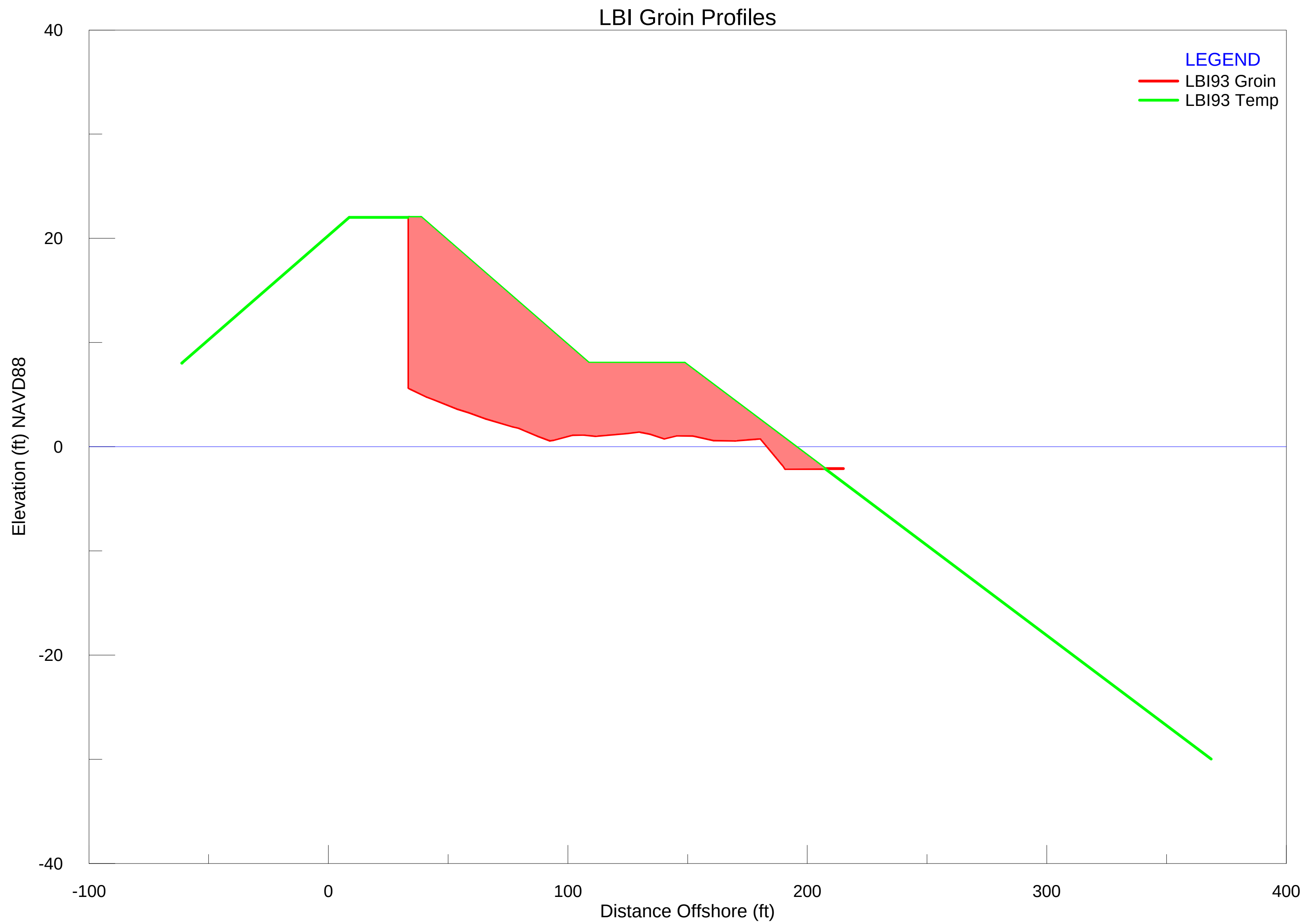


LBI Groin Profiles
LEGEND
LBI90 Groin
LBI90 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-200
-100
0
100
200
300
400
Distance Offshore (ft)

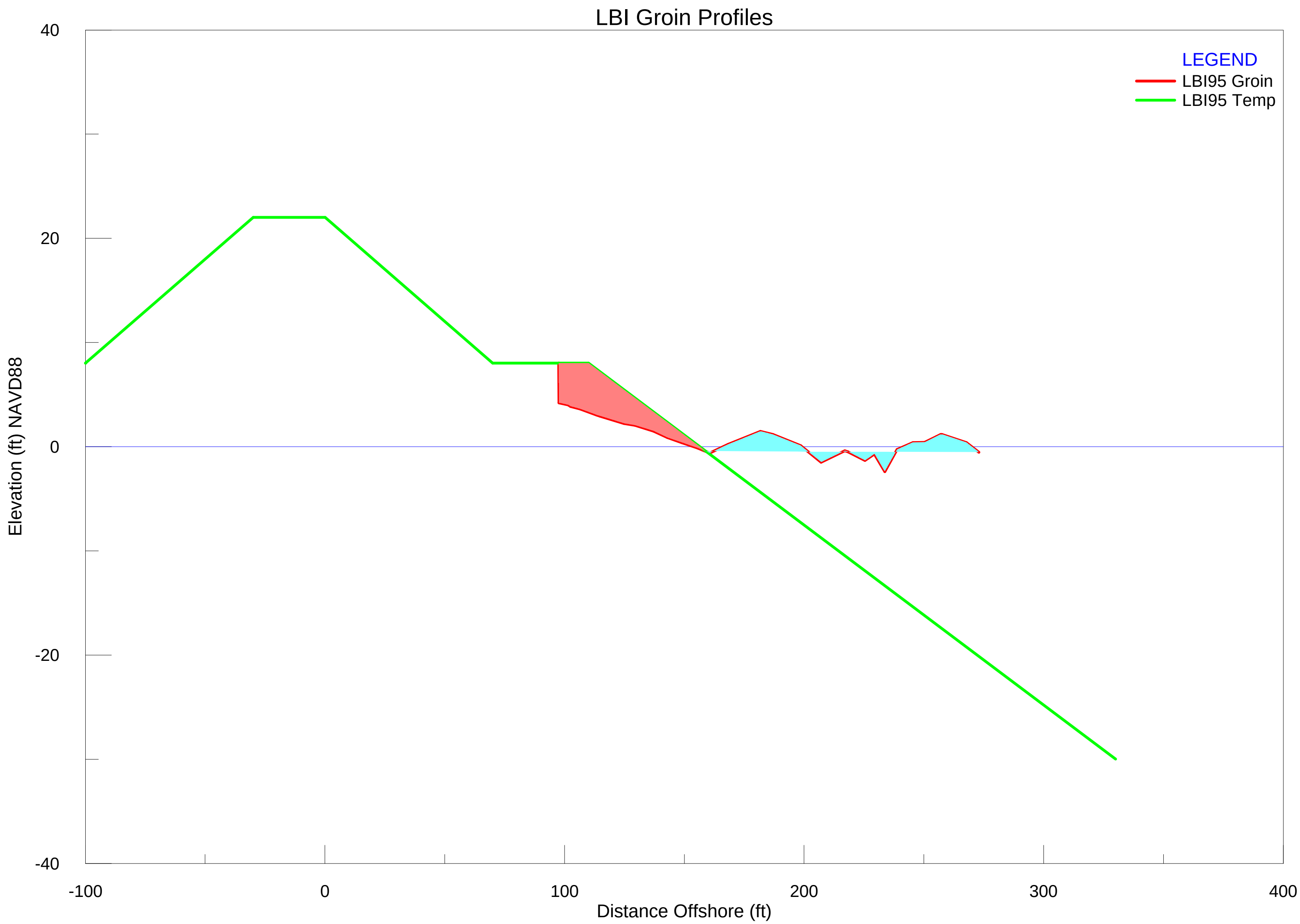


LBI Groin Profiles
LEGEND
LBI91 Groin
LBI91 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)


LBI Groin Profiles
LEGEND
LBI92 Groin
LBI92 Temp
Elevation (ft) NAVD88
40
20
0
-20
-40
-100
0
100
200
300
400
Distance Offshore (ft)



LBI Groin Profiles
LEGEND
LBI93 Groin
LBI93 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)



LBI Groin Profiles
LEGEND
LBI95 Groin
LBI95 Temp
40
20
0
-20
-40
Elevation (ft) NAVD88
-100
0
100
200
300
400
Distance Offshore (ft)

SECTION 7

CONSTRUCTION PROCEDURE AND WATER CONTROL PLAN

The method of construction used by the contractor is not specified beforehand in the contract specifications. However, based on previous beachfill construction in the District, it is anticipated that the contractor will use a hydraulic dredge with a cutterhead to excavate material from the offshore borrow site. The material will then be pumped from the borrow area to the beach through a submerged pipeline. Once on the beach the pipeline will run north-south close to the proposed dune line.

The material will then be worked on the beach by bulldozers and front-end loaders. Pipe will be moved by front-end loaders with grapple arms. Miscellaneous equipment to be stored on the beach will include a light tower, fuel tank with containment, welding machine, and a temporary shanty for personnel.

Water quality monitoring is described in the environmental sections of the main report.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 8

INITIAL RESERVOIR FILLING AND SURVEILLANCE PLAN - N/A

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 9

STORM EMERGENCY PLANS

An emergency plan, New Jersey Hurricane Evacuation Study, 1992, was previously completed by the District in coordination with the New Jersey State Police Office of Emergency Management, the Federal Emergency Management Agency (FEMA) Region III, and the National Oceanic and Atmospheric Administration - National Weather Service (NOAA-NWS).

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 10

CONSTRUCTION MATERIALS

The beachfill material is from an offshore borrow area and is fully compatible with the existing beach sand. The dredged material is clean sand; chemical contamination is not a concern with this type of material. No leaching is expected. For more detailed information on the borrow material, refer to the Geotechnical section of the main report. For more detailed information on the borrow site, refer to the Environmental and Cultural information in Appendices C-E (Volume 3).

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 11

RESERVOIR CLEARING - N/A

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 12

OPERATION AND MAINTENANCE

Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) of the completed initial beachfill project is a non-Federal sponsor responsibility. The non-Federal sponsor will be furnished with an OMRR&R Manual to assist them in carrying out their obligations under ER 1110-2-2902. Some items considered as the non-Federal sponsor's OMRR&R responsibility include the dunes (including dune grass and sand fence), dune crossovers, and some of the project monitoring. Periodic nourishment of the project will be performed on an estimated 7-year cycle, and as part of continuing construction, will be a Federal/non-Federal cost-shared responsibility.

A major replacement of more sand than the normal periodic nourishment quantity is scheduled for year 28 of the 50-year period of analysis. This replacement attempts to account for the likelihood of a major storm eroding a substantial portion of the beach once in the life of the project.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 13

ACCESS ROADS

Most of the work in conjunction with this project will be done offshore or using waterfront access to the beach. The required grading equipment will be transported via local roads in accordance with State and local regulations including a traffic control plan. Exact contractor access to the beach will be determined and coordinated during the plans and specs phase and will include the necessary easements.

For information on public access, refer to Section 15, Project Security and the Public Access Plan (Appendix F, Volume 3)

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 14

CORROSION MITIGATION - N/A

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 15

PROJECT SECURITY

Initial construction and periodic nourishment of the project will necessitate a temporary (approximately one week) restriction/closure of a 1000'-2000' section of beach as filling operations move down the beach. Sand ramps over the dredge pipe on the beach will be provided at public access points during construction.

For security and public safety, temporary fencing along with signage will be required around work areas. Contractor personnel will be required to insure security and public safety. In reference to the submerged pipeline, navigation will not be impeded, and a standard notification to mariners will be issued by the Coast Guard. Typically, the District addresses project security and public access in more detail during the Plans and Specs Phase.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 16

COST ESTIMATE

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

TOTAL PROJECT COST SUMMARY - INITIAL CONSTRUCTION

TOTAL - ALL CONTRACTS

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY STUDY

PROJECT: NEW JERSEY COASTLINE, BARNEGAT INLET TO LITTLE EGG INLET, LONG BEACH ISLAND — DISTRICT: PHILADELPHIA

LOCATION: NJ — P.O.C.: JOSE R. ALVAREZ, P.E., CHIEF, COST ENGINEERING BRANCH

		CURRENT MCACES ESTIMATE PREPARED: JAN 99				AUTHORIZ./BUDGET YEAR: FY-00				FULLY FUNDED ESTIMATE				
		EFFECTIVE PRICING LEVEL: JAN 99				EFFECTIVE PRICING LEVEL: OCT 99								
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB	COST ($K)	CNTG ($K)	TOTAL ($K)	FEATURE MID - PT	OMB	COST ($K)	CNTG ($K)	FULL ($K)
17	BEACH REPLENISHMENT	$40,771.901	$6,371.176	15.63%	$47,143.077	1.027	$41,872.742	$6,543.198	$48,415.940	APR -03	1.124	$47,064.962	$7,354.554	$54,419.517
	TOTAL CONSTRUCTION COST	$40,771.901	$6,371.176	15.63%	$47,143.077		$41,872.742	$6,543.198	$48,415.940			$47,064.962	$7,354.554	$54,419.517
01.	LANDS AND DAMAGES	$578.340	$86.751	15.00%	$665.091	1.027	$593.955	$89.093	$683.048	JAN-02	1.079	$640.878	$96.132	$737.009
30.	PLANNING, ENGINEERING AND DESIGN													
	Plans & Specifications	$650.000	$97.500	15.00%	$747.500	1.000	$650.000	$97.500	$747.500	DEC-02	1.000	$650.000	$97.500	$747.500
	Environmental Coordination	$173.000	$16.150	9.34%	$189.150	1.000	$173.000	$16.158	$189.158	DEC-02	1.000	$173.000	$16.158	$189.158
	Value Engineering	$70.200	$10.500	14.96%	$80.700	1.000	$70.200	$10.502	$80.702	DEC-02	1.000	$70.200	$10.502	$80.702
	PCA Execution	$40.000	$6.000	15.00%	$46.000	1.000	$40.000	$6.000	$46.000	DEC-02	1.000	$40.000	$6.000	$46.000
	Advertise & Award	$5.000	$0.750	15.00%	$5.750	1.000	$5.000	$0.750	$5.750	FEB-03	1.086	$5.430	$0.815	$6.245
	E&D During Construction	$100.000	$15.000	15.00%	$115.000	1.043	$104.300	$15.645	$119.945	APR-03	1.119	$116.712	$17.507	$134.219
	Project Management	$150.000	$22.500	15.00%	$172.500	1.043	$156.450	$23.468	$179.918	APR-03	1.119	$175.068	$26.260	$201.328
	PLANNING, ENGINEERING AND DESIGN TOT/	$1,188.200	$168.400	14.17%	$1,356.600		$1,198.950	$170.023	$1,368.973			$1,230.410	$174.742	$1,405.152
31.	CONSTRUCTION MANAGEMENT (S & I)	$800.000	$120.000	15.00%	$920.000	1.043	$834.400	$125.160	$959.560	APR-03	1.119	$933.694	$140.054	$1,073.748
	TOTAL PROJECT COST	$43,338.441	$6,746.327	15.57%	$50,084.768		$44,500.048	$6,927.474	$51,427.521			$49,869.944	$7,765.482	$57,635.426

EC 11-2-159 — TOTAL COSTS (Rounded) $58,000.000

Cumulative Compounded Percent Rates of Change

	Class 1	Class 2		Class 1	Class 2
Oct 99 - FY 00	1.000	1.000	Oct 02 - FY 03	1.091	1.063
Oct 00 - FY 01	1.044	1.030	Oct 03 - FY 04	1.132	1.096
Oct 01 - FY 02	1.050	1.031			

THIS TPCS REFLECTS A PROJECT COST CHANGE $ ____________

THE TOTAL MAXIMUM PROJECT COST IS $ ____________

DISTRICT APPROVED:

____________ CHIEF, COST ENGINEERING

____________ CHIEF, REAL ESTATE

____________ CHIEF, PLANNING

____________ CHIEF, ENGINEERING & CONSTRUCTION

____________ CHIEF, PROGRAMS MANAGEMENT

____________ PROJECT MANAGER

____________ DDE (PM)

DIVISION APPROVED:

____________ CHIEF, COST ENGINEERING

____________ DIRECTOR, REAL ESTATE

____________ CHIEF, PROGRAMS MANAGEMENT

____________ DIRECTOR OF PPMD

APPROVED DATE: ____________

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Barnegat Inlet to Little Egg Inlet (Long Beach Island) Area Reduction Project

APPENDIX A, SECTION 16 - COST ESTIMATES

LIST OF TABLES

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX A, SECTION 16 - COST ESTIMATE

INITIAL PROJECT CHARGES

1. General: This section presents detailed cost estimates for initial construction, nourishment, maintenance, monitoring and major renourishment resulting in total and annualized project costs for alternative storm damage reduction plans for the subject project. The six alternative plans developed for Long Beach Island include:

Alternative	Description
1	125' wide berm with +20' NAVD dune using 3 Yr. Cycle
2	125' wide berm with +20' NAVD dune using 5 Yr. Cycle
3	125' wide berm with +20' NAVD dune using 7 Yr. Cycle
4	125' wide berm with +22' NAVD dune using 3 Yr. Cycle
5	125' wide berm with +22' NAVD dune using 5 Yr. Cycle
6	125' wide berm with +22' NAVD dune using 7 Yr. Cycle

The top of the berm is at an elevation of +8' NAVD and extends from Seaview Drive in Loveladies to Terminal Groin 98 in Holgate. The dune for each alternative has a 1 on 5 fore slope, a 1 on 10 backslope, and a top width of 30'. The dune extends the same distance as the berm. The initial construction for each of the above plans includes design and advanced nourishment beach fill. Each alternative includes dune grass planting and installation of a sand fence. Also included are provisions for periodic nourishment, beach profile and environmental monitoring, and major renourishment to restore the design beach profile damaged by significant storm events beyond that designed for in the nourishment cycle quantity. The plan layout of the NED plan with typical improved beach sections is shown in the section of the Feasibility Study, Main Report describing the NED Plan.

2. Basis of Cost: Cost estimates presented herein are based on January 1999 price levels. Initial beach fill costs are based on beach surveys taken in March 1996. The unit prices were developed in accordance with the construction procedures outlined herein. All initial construction and nourishment costs presented in this appendix are NED costs.

3. Initial fill costs are based on the assumption that one 30-inch hydraulic cutterhead dredge and two medium size hopper dredges were used for placement of the beach fill. Approximately 3,118,000 c.y. of beach fill from borrow area D1 was placed in BUNDYs 3 thru 8 using a hydraulic dredge. The average pumping distance for the initial beach fill uses an average pipeline length of 25,371 l.f. for BUNDYs 3 thru 5 and an average pipeline length of 27,504 l.f. for BUNDYs 6 thru 8. Approximately 4,080,000 c.y. of beach fill from borrow area D1 was placed in BUNDYs 9 thru 15 using two hopper dredges. The average travel distances for the initial beach fill is 4.8 miles for BUNDYs 9 and 10, 7.7 miles for BUNDYs 11 thru 13 and 11.0 miles for BUNDYs 14 and 15.

4. Periodic nourishment fill costs are based on the assumption that one 30-inch hydraulic cutterhead dredge and one medium size hopper dredge was used for placement of the beach fill. In the nourishment cycle for year 7 approximately 1,184,000 c.y. of beach fill material from borrow area A

was placed in BUNDYs 3 thru 6 and 224,000 c.y. of beach fill material from borrow area D1 was placed in BUNDYs 7 and 8 using a hydraulic dredge. The average pumping distance for the year 7 nourishment cycle uses an average pipeline length of 26,262 l.f. for BUNDYs 3 thru 6 and an average pipeline length of 24,719 l.f. for BUNDYs 7 and 8. Also in the nourishment cycle for year 7, 925,000 c.y. of beach fill material from borrow area D1 was placed in BUNDYs 9 thru 15 using a hopper dredge. The average travel distances for the nourishment cycle in year 7 are 4.8 miles for BUNDYs 9 and 10, 7.7 miles for BUNDYs 11 thru 13, and 11.0 miles for BUNDYs 14 and 15. In the nourishment cycles for years 14, 21, 35, 42 and 49 approximately 739,000 c.y. of beach fill material from borrow area D2 was placed in BUNDYs 3 thru 6 using a hydraulic dredge. The average pumping distance for these nourishment cycles use an average pipeline length of 26,541 l.f. for BUNDYs 3 and 4 and an average pipeline length of 27,875 l.f. for BUNDYs 5 and 6. Also in the nourishment cycles for years 14, 21, 35, 42 and 49 approximately 1,149,000 c.y. of beach fill material from borrow area D2 was placed in BUNDYs 7 thru 15 using a hopper dredge. The average travel distances for these nourishment cycles are 4.6 miles for BUNDYs 7 thru 9, 7.6 miles for BUNDYs 10 thru 12, and 11.5 miles for BUNDYs 13 thru 15.

5. Mobilization and demobilization costs are based on the assumption that beach filling equipment located within 200 miles from the project site will perform the work. The locations of the borrow areas are displayed in the section of the Feasibility Study, Main Report describing the NED Plan.

6. Real estate costs as shown in Table 1 are included as NED costs and reflect acquisition of easements on private beach and include surveys, appraisal, and administrative costs between the limits of beach filling. For more information, refer to the Real Estate Appendix.

7. Alternatives Considered: Alternative plans were developed in two phases for the plan selection process. In the first phase the alternative plans were compared during the Cycle 1 and Cycle 2 screening process. For more information on these plans, refer to the section of the Feasibility Study, Main Report describing the NED Plan. Based on an analysis of these annual costs with their associated benefits, the beach restoration only plan was selected for the second phase for final plan optimization and selection.

8. The costs for the six alternatives as described in paragraph 1 for this second phase of plan selection are displayed in Tables 2A thru 2F.

9. Renourishment Interval Optimization: A comparative cost analysis of renourishment intervals for 3 year, 5 year, 7 year and 10 year cycles was performed to obtain an optimal renourishment cycle. For more information on the renourishment interval optimization that selected the 7-year cycle, refer to the section of the Feasibility Study, Main Report describing the NED plan.

10. Borrow Area Impact Alternative Plans: Due to concerns by the Resource Agencies on impacts to benthic organisms as a result of using certain borrow areas, alternative borrow areas and borrow use methodologies were examined. Four alternative plans; Plan A, Plan B, Plan C and Plan D were investigated. As suggested in the Planning Aid Report, Fish and Wildlife Service recommended avoiding essential fish habitat identified as borrow areas B and E. In accordance with recommendations in the Planning Aid Report and coordination with State resource agencies, the

original NED plan has been revised to alternative Plan B. This will avoid borrow areas B and E. For more information on the borrow area impact alternative plans, refer to the section of the Feasibility Study, Main Report describing the NED Plan.

11. Total First Cost for Selected Plan: The estimated project first cost is for the selected plan; a berm extending seaward 125' from the design line at an elevation of +8 NAVD supporting a dune with a top elevation of +22 NAVD and a top width of 30', and is based on a selected nourishment cycle of 7 years. This includes the placement of 3,118,000 c.y. using a hydraulic dredge and 4,080,000 c.y. using a hopper dredge. All beach fill material is obtained from borrow area D1 and includes design and advance nourishment beach fill. Also included is the placement of 146,800 c.s.f. (337.01 acres) of dune grass, 509,000 l.f. of sand fence and 70 roll-out boardwalks. NED real estate acquisition costs and pertinent contingency, engineering and design and construction management costs are also included. Details of the first cost estimate are shown in Table 1.

ANNUAL CHARGES

12. General: The estimate of annual charges for the selected plan is based on an economic project life of 50 years and an interest rate of 6.875%. The annual charges include annualized first cost and interest during construction, the annualized periodic nourishment costs, post construction monitoring costs, and OMRR&R costs. It is noted that interest during construction was developed for the first cost of the project constructed over a twelve-month period. For the selected plan, the total annualized cost is $5,771,000.

13. Periodic Nourishment: The periodic nourishment volume to be placed at 7 year cycles, subsequent to commencement of construction in year 7 of the 50 year economic life is 1,184,000 c.y. from borrow area A and 1,149,000 c.y. from borrow area D1. One 30-inch hydraulic cutterhead dredge was used for placement of 1,408,000 c.y. of beach fill in BUNDYs 3 thru 8, and one medium size hopper dredge was used for placement of 925,000 c.y. of beach fill in BUNDYs 9 thru 15. The periodic nourishment volume to be placed in years 14, 21, 35, 42 and 49 of the 50 year economic life is 1,888,000 c.y. from borrow area D2. One 30-inch hydraulic cutterhead dredge was used for placement of 739,000 c.y. of beach fill in BUNDYs 3 thru 6, and one medium size hopper dredge was used for placement of 1,149,000 c.y. of beach fill in BUNDYs 7 thru 15. These volumes include overfill and tolerance. The placement of this material will follow the constructability outlines in paragraph 3. For more details on the development of the periodic nourishment quantity refer to the section of the Feasibility Study, Main Report describing the NED Plan. The borrow areas for periodic nourishment are also shown in the section of the Feasibility Study, Main Report describing the NED Plan. Periodic nourishment costs for the selected cycle are developed in Tables 3A and 3B.

14. Major Renourishment Costs: Major renourishment costs are included as an additional cost for significant storm events beyond that designed for in the selected nourishment cycle to restore the design profile. The major renourishment losses are computed as the losses that would occur from the 50% risk event over the project life. For more detail on the development of the major renourishment quantity, refer to the section of the Feasibility Study, Main Report describing the NED Plan. Major renourishment costs are shown in Table 4.

15. Monitoring Costs: Post construction monitoring costs include coastal and environmental monitoring over the 50-year project life. Total annualized monitoring costs are $270,000.

CONTINGENCIES, PRECONSTRUCTION ENGINEERING & DESIGN, AND CONSTRUCTION MANAGEMENT

16. Contingencies: The estimated cost for each major subdivision or feature of the recommended project includes an item for "contingencies". The item for "contingencies" is an allowance against some adverse or unanticipated condition not susceptible to exact evaluation from the data at hand but which must be expressed or represented in the cost estimate. The contingency allowances used in the development of the cost estimate for the selected project were estimated as an appropriate percentage. Fifteen percent was applied to beach placement work to account for concerns about pumping distances, hauling distances and borrow area selection, and to account for larger required beach fill quantities at the time of construction due to future preconstruction erosion. Twelve percent was applied to mobilization, demobilization, and preparatory work to account for concerns about availability of dredges and for variances in the travel distance for the dredge plant. Twenty percent was applied to dune grass, sand fencing, and roll-out boardwalks to account for variances in the beach profile at the dune location due to preconstruction shifting and/or eroding beach conditions.

17. Preconstruction Engineering & Design (P,E & D): Preconstruction Engineering and Design costs include local cooperative agreements, environmental and regulatory activities, general design memorandum, preparation of plans and specifications, engineering during construction, A/E liability actions, cost engineering, construction and supply contract award activities, project management, and the development of the PCA. P, E & D costs were estimated as lump sums of $1,356,600 for the initial beach fill construction, $695,050 for the nourishment cycle, and $838,800 for the major replacement and are based on similar Corps of Engineers projects of the same magnitude. Contingency factors of 14.17%, 13.94%, and 14.12% respectively were included in the P,E & D costs.

18. Construction Management (S & A): Construction Management costs include contract administration, review of shop drawings, inspection and quality assurance, project office operation, contractor initiated claims and litigations, and government initiated claims and litigations. S & A related costs were estimated as lump sums of $920,000 for the initial beach fill construction, $460,000 for the nourishment cycle, and $632,500 for the major replacement and were based on similar Corps of Engineers projects of the same magnitude. A contingency factor of 15% was included in all S & A costs.

CONSTRUCTION AND FUNDING SCHEDULE

19. General: The construction and preconstruction sequence and time schedule of the selected plan is given in Section 17 of this Engineering Technical Appendix. The schedule is based on the timeliness of the report's approval and allocation of funds by Congress, the foregoing construction procedures, and the ability of local interests to implement the necessary items of local cooperation.

Table 1 - Total First Cost - Selected Plan Price Level: Jan 99
Alternative 6 (+22' NAVD Dune/125' Berm using 7 Yr. Cycle)
Plan B (Borrow Area D1)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages						
01.B	Post Authorization Planning						
01.B.2	Required Easements	1	Job	LS	$552,340	$82,851	$635,191
01.B.8	Surveys Appraisal & Admin	1	Job	LS	$26,000	$3,900	$29,900
	Total Lands and Damages				$578,340	$86,751	$665,091
17.	Beach Replacement						
17.00.01	Mobilization, Demob. And Preparatory Work	1	Job	LS	$1,366,281	$163,954	$1,530,235
17.00.16	Pipeline Dredging						
17.00.16.02	Site Work						
17.00.16.02.01	Excavation and Disposal						
17.00.16.02.01.D1	BUNDYs 3 Thru 5	1,081,000	CY	$3.38	$3,653,780	$548,067	$4,201,847
17.00.16.02.01.D1	BUNDYs 6 Thru 8	2,037,000	CY	$3.34	$6,803,580	$1,020,537	$7,824,117
17.00.17	Hopper Dredging						
17.00.17.02	Site Work						
17.00.17.02.01	Excavation and Disposal						
17.00.17.02.01.D1	BUNDYs 9 And 10	1,692,000	CY	$5.18	$8,764,560	$1,314,684	$10,079,244
17.00.17.02.01.D1	BUNDYs 11 Thru 13	1,470,000	CY	$5.77	$8,481,900	$1,272,285	$9,754,185
17.00.17.02.01.D1	BUNDYs 14 And 15	918,000	CY	$6.29	$5,774,220	$866,133	$6,640,353
17.00.99	Associated General Items						
17.00.99.03.01	Sand Fence	509,700	LF	$3.98	$2,028,606	$405,721	$2,434,327
17.00.99.03.02	Dune Grass	146,800	CSF	$19.73	$2,896,364	$579,273	$3,475,637
17.00.99.03.03	Roll-Out Boardwalks	70	Ea.	$14,323	$1,002,610	$200,522	$1,203,132
	Total Beach Replacement				$40,771,901	$6,371,176	$47,143,077
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,188,200	$168,400	$1,356,600
31.	Construction Management (S & A)	1	Job	LS	$800,000	$120,000	$920,000
	Total Project First Cost				$43,338,441	$6,746,327	$50,084,768
	(Rounded)				$43,338,000	$6,746,000	$50,084,000

Dredging quantity includes 7 yr. nourishment cycle.

Table 2A - Total First Cost

Alternative 1 (+20' NAVD Dune, 125' Berm using 3 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	507,869	CY	$2.39	$1,213,807	$182,071	$1,395,878
	BUNDYs 4 Thru 8	1,827,991	CY	$3.44	$6,288,289	$943,243	$7,231,532
	BUNDYs 9 Thru 15	3,208,708	CY	$2.93	$9,401,514	$1,410,227	$10,811,742
	Associated General Items						
	Sand Fence	849,400	LF	$4.02	$3,414,588	$682,918	$4,097,506
	Dune Grass	129,400	CSF	$19.53	$2,527,182	$505,436	$3,032,618
	Total Beach Replacement				$24,049,960	$3,868,445	$27,918,406
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management (S & A)	1	Job	LS	$1,402,757	$210,413	$1,613,170
	Total Project First Cost				$26,552,717	$4,243,858	$30,796,576
	(Rounded)				$26,553,000	$4,244,000	$30,797,000

Dredging quantity includes 3 yr. nourishment cycle.

Table 2B - Total First Cost

Alternative 2 (+20' NAVD Dune, 125' Berm using 5 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	541,409	CY	$2.39	$1,293,968	$194,095	$1,488,063
	BUNDYs 4 Thru 7	1,825,764	CY	$3.44	$6,280,628	$942,094	$7,222,722
	BUNDYs 8 And 9	1,037,601	CY	$3.75	$3,891,004	$583,651	$4,474,654
	BUNDYs 10 Thru 15	2,631,103	CY	$2.93	$7,709,132	$1,156,370	$8,865,502
	Associated General Items						
	Sand Fence	849,400	LF	$4.02	$3,414,588	$682,918	$4,097,506
	Dune Grass	129,400	CSF	$19.53	$2,527,182	$505,436	$3,032,618
	Total Beach Replacement				$26,321,081	$4,209,113	$30,530,194
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management (S & A)	1	Job	LS	$1,578,995	$236,849	$1,815,844
	Total Project First Cost				$29,000,076	$4,610,962	$33,611,038
	(Rounded)				$29,000,000	$4,611,000	$33,611,000

Dredging quantity includes 5 yr. nourishment cycle.

Table 2C - Total First Cost

Alternative 3 (+20' NAVD Dune, 125' Berm using 7 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	588,056	CY	$2.39	$1,405,454	$210,818	$1,616,272
	BUNDYs 4 Thru 7	2,073,635	CY	$3.44	$7,133,304	$1,069,996	$8,203,300
	BUNDYs 8 And 9	1,077,171	CY	$3.75	$4,039,391	$605,909	$4,645,300
	BUNDYs 10 Thru 15	2,861,622	CY	$2.93	$8,384,552	$1,257,683	$9,642,235
	Associated General Items						
	Sand Fence	849,400	LF	$4.02	$3,414,588	$682,918	$4,097,506
	Dune Grass	129,400	CSF	$19.53	$2,527,182	$505,436	$3,032,618
	Total Beach Replacement				$28,109,052	$4,477,309	$32,586,361
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management (S & A)	1	Job	LS	$1,682,326	$252,349	$1,934,675
	Total Project First Cost				$30,891,378	$4,894,658	$35,786,036
	(Rounded)				$30,891,000	$4,895,000	$35,786,000

Dredging quantity includes 7 yr. nourishment cycle.

Table 2D - Total First Cost

Alternative 4 (+22' NAVD Dune, 125' Berm using 3 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	585,605	CY	$2.39	$1,399,596	$209,939	$1,609,535
	BUNDYs 4 Thru 7	1,747,702	CY	$3.44	$6,012,095	$901,814	$6,913,909
	BUNDYs 8 And 9	1,146,815	CY	$3.75	$4,300,556	$645,083	$4,945,640
	BUNDYs 10 Thru 15	2,755,680	CY	$2.93	$8,074,142	$1,211,121	$9,285,264
	Associated General Items						
	Sand Fence	1,018,700	LF	$4.02	$4,095,174	$819,035	$4,914,209
	Dune Grass	146,800	CSF	$19.53	$2,867,004	$573,401	$3,440,405
	Total Beach Replacement				$27,953,147	$4,504,944	$32,458,091
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management (S & A)	1	Job	LS	$1,626,460	$243,969	$1,870,429
	Total Project First Cost				$30,679,607	$4,913,913	$35,593,520
	(Rounded)				$30,680,000	$4,914,000	$35,594,000

Dredging quantity includes 3 yr. nourishment cycle.

Table 2E - Total First Cost

Alternative 5 (+22' NAVD Dune, 125' Berm using 5 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and						
	Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	619,145	CY	$2.39	$1,479,757	$221,963	$1,701,720
	BUNDYs 4 Thru 7	1,965,293	CY	$3.44	$6,760,608	$1,014,091	$7,774,699
	BUNDYs 8 And 9	1,173,165	CY	$3.75	$4,399,369	$659,905	$5,059,274
	BUNDYs 10 Thru 15	2,969,508	CY	$2.93	$8,700,658	$1,305,099	$10,005,757
	Associated General Items						
	Sand Fence	1,018,700	LF	$4.02	$4,095,174	$819,035	$4,914,209
	Dune Grass	146,800	CSF	$19.53	$2,867,004	$573,401	$3,440,405
	Total Beach Replacement				$29,507,150	$4,738,044	$34,245,194
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management						
	(S & A)	1	Job	LS	$1,711,029	$256,655	$1,967,684
	Total Project First Cost				$32,318,179	$5,159,699	$37,477,878
	(Rounded)				$32,318,000	$5,160,000	$37,478,000

Dredging quantity includes 5 yr. nourishment cycle.

Table 2F - Total First Cost

Alternative 6 (+22' NAVD Dune, 125' Berm using 7 Yr. Cycle)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
01.	Lands and Damages	1	Job	LS	$0	$0	$0
17.	Beach Replacement						
	Mobilization, Demob. and Preparatory Work	1	Job	LS	$1,204,580	$144,550	$1,349,130
	Pipeline Dredging						
	Excavation and Disposal						
	BUNDY 3	665,792	CY	$2.39	$1,591,243	$238,686	$1,829,929
	BUNDYs 4 Thru 7	2,213,163	CY	$3.44	$7,613,281	$1,141,992	$8,755,273
	BUNDYs 8 And 9	1,212,735	CY	$3.75	$4,547,756	$682,163	$5,229,920
	BUNDYs 10 Thru 15	3,200,028	CY	$2.92	$9,344,082	$1,401,612	$10,745,694
	Associated General Items						
	Sand Fence	1,018,700	LF	$4.02	$4,095,174	$819,035	$4,914,209
	Dune Grass	146,800	CSF	$19.53	$2,867,004	$573,401	$3,440,405
	Total Beach Replacement				$31,263,120	$5,001,439	$36,264,559
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$1,100,000	$165,000	$1,265,000
31.	Construction Management (S & A)	1	Job	LS	$1,844,485	$276,673	$2,121,158
	Total Project First Cost				$34,207,605	$5,443,112	$39,650,717
	(Rounded)				$34,208,000	$5,443,000	$39,651,000

Dredging quantity includes 7 yr. nourishment cycle.

Table 3A - Periodic Nourishment Costs (Yr. 7)
Plan B (Borrow Areas A and D1)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
17.	Beach Replacement						
17.00.01	Mobilization, Demob. And Preparatory Work	1	Job	LS	$979,882	$117,586	$1,097,468
17.00.16	Pipeline Dredging						
17.00.16.02	Site Work						
17.00.16.02.01	Excavation and Disposal						
17.00.16.02.01.A	BUNDYs 3 Thru 6	1,184,000	CY	$3.34	$3,954,560	$593,184	$4,547,744
17.00.16.02.01.D1	BUNDYs 7 And 8	224,000	CY	$3.69	$826,560	$123,984	$950,544
17.00.17	Hopper Dredging						
17.00.17.02	Site Work						
17.00.17.02.01	Excavation and Disposal						
17.00.17.02.01.D1	BUNDYs 9 And 10	133,000	CY	$5.29	$703,570	$105,536	$809,106
17.00.17.02.01.D1	BUNDYs 11 Thru 13	348,000	CY	$5.83	$2,028,840	$304,326	$2,333,166
17.00.17.02.01.D1	BUNDYs 14 And 15	444,000	CY	$6.34	$2,814,960	$422,244	$3,237,204
	Total Beach Replacement				$11,308,372	$1,666,859	$12,975,231
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$610,000	$85,050	$695,050
31.	Construction Management (S & A)	1	Job	LS	$400,000	$60,000	$460,000
	Total Periodic Nourishment Cost				$12,318,372	$1,811,909	$14,130,281
	(Rounded)				$12,318,000	$1,812,000	$14,130,000

Table 3B - Periodic Nourishment Costs (Yrs. 14, 21, 35, 42 and 49)
Plan B (Borrow Area D2)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
17.	Beach Replacement						
17.00.01	Mobilization, Demob. And						
	Preparatory Work	1	Job	LS	$979,882	$117,586	$1,097,468
17.00.16	Pipeline Dredging						
17.00.16.02	Site Work						
17.00.16.02.01	Excavation and Disposal						
17.00.16.02.01.D2	BUNDYs 3 And 4	192,000	CY	$3.84	$737,280	$110,592	$847,872
17.00.16.02.01.D2	BUNDYs 5 And 6	547,000	CY	$4.09	$2,237,230	$335,585	$2,572,815
17.00.17	Hopper Dredging						
17.00.17.02	Site Work						
17.00.17.02.01	Excavation and Disposal						
17.00.17.02.01.D2	BUNDYs 7 Thru 9	293,000	CY	$5.26	$1,541,180	$231,177	$1,772,357
17.00.17.02.01.D2	BUNDYs 10 Thru 12	376,000	CY	$5.88	$2,210,880	$331,632	$2,542,512
17.00.17.02.01.D2	BUNDYs 13 Thru 15	480,000	CY	$6.51	$3,124,800	$468,720	$3,593,520
	Total Beach Replacement				$10,831,252	$1,595,291	$12,426,543
30.	Planning, Engineering and						
	Design (P,E & D)	1	Job	LS	$610,000	$85,050	$695,050
31.	Construction Management						
	(S & A)	1	Job	LS	$400,000	$60,000	$460,000
	Total Periodic Nourishment Cost				$11,841,252	$1,740,341	$13,581,593
	(Rounded)				$11,841,000	$1,740,000	$13,581,000

Table 4 - Major Renourishment Costs (Yr. 28)
Plan B (Borrow Area D2)

ACCOUNT NUMBER	DESCRIPTION OF ITEM	QUANTITY	UOM	UNIT PRICE	ESTIMATED AMOUNT	CONTIN-GENCY	TOTAL COST
17.	Beach Replacement						
17.00.01	Mobilization, Demob. And Preparatory Work	1	Job	LS	$979,882	$117,586	$1,097,468
17.00.16	Pipeline Dredging						
17.00.16.02	Site Work						
17.00.16.02.01	Excavation and Disposal						
17.00.16.02.01.D2	BUNDYs 3 And 4	263,000	CY	$3.76	$988,880	$148,332	$1,137,212
17.00.16.02.01.D2	BUNDYs 5 And 6	646,000	CY	$4.00	$2,584,000	$387,600	$2,971,600
17.00.17	Hopper Dredging						
17.00.17.02	Site Work						
17.00.17.02.01	Excavation and Disposal						
17.00.17.02.01.D2	BUNDYs 7 Thru 9	409,000	CY	$5.20	$2,126,800	$319,020	$2,445,820
17.00.17.02.01.D2	BUNDYs 10 Thru 12	505,000	CY	$5.84	$2,949,200	$442,380	$3,391,580
17.00.17.02.01.D2	BUNDYs 13 Thru 15	571,000	CY	$6.47	$3,694,370	$554,156	$4,248,526
17.00.99	Associated General Items						
17.00.99.03.01	Sand Fence	509,700	LF	$3.98	$2,028,606	$405,721	$2,434,327
17.00.99.03.02	Dune Grass	146,800	CSF	$19.73	$2,896,364	$579,273	$3,475,637
17.00.99.03.03	Remove Roll-Out Boardwalks	70	Ea.	$823	$57,610	$11,522	$69,132
17.00.99.03.04	Reinstall Roll-Out Boardwalks	70	Ea.	$823	$57,610	$11,522	$69,132
	Total Beach Replacement				$18,363,322	$2,977,111	$21,340,433
30.	Planning, Engineering and Design (P,E & D)	1	Job	LS	$735,000	$103,800	$838,800
31.	Construction Management (S & A)	1	Job	LS	$550,000	$82,500	$632,500
	Total Project First Cost				$19,648,322	$3,163,411	$22,811,733
	(Rounded)				$19,648,000	$3,163,000	$22,811,000

Dredging quantity includes 7 yr. nourishment cycle.

INITIAL CONSTRUCTION COST ESTIMATE
SELECTED PLAN

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Long Beach Island Feas. Study

Selected Plan Costs for
125'Berm/22'Dune w/7 Yr.
Nourish Cycle

Designed By: Luis Alfrado Montes EN-DC
Estimated By: CENAP-EN-EC

Prepared By: Bill Welk

Preparation Date: 09/24/99
Effective Date of Pricing: 02/11/99
Est Construction Time: 365 Days

Sales Tax: 0.00%

1. NARRATIVE: Alternative Plan B consists of placing approximately 7,198,000 cy of beach fill material along approximately 17 miles of the shoreline to create a new beach consisting of a 125' wide berm, at an elevation of +8' NAVD with a 1 on 5 fore slope, a 1 on 10 backslope, and a top width of 30'. The borrow area used for initial construction is borrow area D1 located offshore approximately 15,000'.

2. All quantities were furnished by Hydraulics and Hydrology Section.

3. Used Ocean County, New Jersey labor rates, General Decision Number NJ980009, Mod. No. 3 dated 10/02/98.

4. Jan. 1999 price level.

5. Real estate costs (project feature 01) provided through PL-PC and furnished by Real Estate Division, NAB.

6. P,E&D costs (project feature 30) and S&A costs(project feature 31) provided by EN-MC.

7. Contingencies are based on guidance in EM 1110-2-1301, App. C and are as follows:
   - Beach placement work - 15%
   - Mobilization & demobilization - 12%
   - Dune grass, sand fence, and roll-out boardwalk work - 20%
   - Real estate costs and S&A - 15%
   - P,E&D - 14.17%.

** PROJECT SETTINGS **

ESTIMATE TYPE : A-Crews with Auto Reprice

SALES TAX : 0.00%

DATE OF ESCALATION SCHEDULE : 02/11/99

PROJECT DIRECT COST COLUMNS

Col Type	H	L	E	M	U
Rep Width	8	8	9	9	9
Title	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM

PROJECT INDIRECT COST COLUMNS

Col Type	O	U	P	B	X
Rep Width	10	10	8	8	0
Title	FIELD OH	HOME OFC	PROFIT	BOND	(Unused)

PROJECT OWNER COST COLUMNS

Col Type	C	X	X	X	X
Rep Width	10	0	0	0	0
Title	CONTINGN	(Unused)	(Unused)	(Unused)	(Unused)

PROJECT BREAKDOWN

PROJECT ID	Length	Trail Sep	Level Title	2nd View Order
Level 1 ID :	2	.	Contract	0
Level 2 ID :	2	.	Feature	0
Level 3 ID :	2	.	Sub Feat	0
Level 4 ID :	2	.	Element	0
Level 5 ID :	2	.	Level 5	0
Level 6 ID :	2	.	Level 6	0

Owner Cost Level : 3

** PROJECT SETTINGS **

```
2ND VIEW COLUMNS

        Quantity Column Width : 10

Col Type   X         X         X         X         X
Rep Width   0         0         0         0         0
Title      (Unused)  (Unused)  (Unused)  (Unused)  (Unused)


Shadow     X         X         X         X         X


DETAIL REPORT FORMATTING

PAGE OPTIONS               Page Break Levels : 2
                    Table of Contents Levels : 6

                                               0 1 2 3 4 5 6 7

ROW OPTIONS           Print Titles at Levels :   Y Y Y Y Y Y
                      Print Totals at Levels :   Y Y Y Y Y Y
                       Print Notes at Levels : Y Y Y Y Y Y Y Y
                         Print Unit Cost Row : Y
                           Print Page Footer : Y
                             Show Cost Codes : Y

COLUMNS OPTIONS                Print Crew Id : Y
                                 Crew Output : Y
                                   Unit Cost : Y

UPB TITLES            No. of Levels to Print : 0
                         Bracket Titles With : N N
                        Include titles Notes : N
```

** PROJECT SETTINGS **

OTHER REPORT FORMATTING

COLUMN TITLES FOR SUMMARY REPORTS

```
  Column 1 FIELD OH : Prime Contractor's Field Overhead
  Column 2 HOME OFC : Prime's Home Office Expense
  Column 3 PROFIT   : Prime Contractor's Profit
  Column 4 BOND     : Prime Contractor's Bond
  Column 5 (Unused) : (Unused)

  Column 1 CONTINGN : Contingency
  Column 2 (Unused) :
  Column 3 (Unused) :
  Column 4 (Unused) :
  Column 5 (Unused) :
```

STANDARD COLUMN WIDTHS SUMMARY FEATURES

```
   Quantity Columns : 8     Round Totals Column : N-None
 Total cost Columns : 12      Contingency Notes : Yes
  Unit Cost Columns : 8     Show Project Totals : Yes
```

SPECIAL REPORT FORMATTING OPTIONS

```
               First Alternate ID : (None)
             Show Markup at Level : 0
 Display Indirect/Owner Markup as : A - Unit Costs Only
                CSI Sort at Level : (None)
```

** PROJECT SETTINGS **

REPORT SELECTION

Project Settings : Y Profit Guidelines : N
Contractor Settings : Y
Link Listing : N Measurement Units : U.S.

	REPORT FORMAT TYPE			FOR LEVEL (S)
	Direct	Indirect	Owner	0 1 2 3 4 5 6
Detail :	Y			
Project :	N	N	Y	N N N N N Y
Contractor :	N	N		N N N N N N N
Division :	N	N	N	N N N N N N N
System :	N	N	N	N N N N N N N
2nd View :	N			
Crew :	Y			Y N N N N N N
Labor :	Y			
Equipment :	Y			
Prime Labor Cost Level :	N			

** OWNER, OVERTIME, AND ADJUSTMENTS SETTINGS **

		AMOUNT	PERCENT	*ESCALATN DATE* BEGIN	END	*ESCALATN INDEX* BEGIN	END
01.01.01 Lands & Damages							
Contingency	P		15.00				
17.00.01 Mob, Demob and Preparatory Work							
Contingency	P		12.00				
17.00.01.01.02 Shore Equip. (Berm w/ Dune)							
Contingency	P		12.00				
17.00.01.03.01 Mob & Demob 30" Pipeline Dredge							
Contingency	P		12.00				
17.00.16 Pipeline Dredging							
Contingency	P		15.00				
17.00.17 Hopper Dredging							
Contingency	P		15.00				
17.00.99 Associated General Items							
Contingency	P		20.00				
17.00.99.03.01 Sand Fence							
Contingency	P		20.00				
17.00.99.03.02 Dune Grass							
Contingency	P		20.00				
30.01.01 P,E & D							
Contingency	P		14.17				
31.01.01 S & A							
Contingency	P		15.00				

** CONTRACTOR SETTINGS **

		AMOUNT	PCT	PCT S	RISK	DIFF	SIZE	PERIOD	INVEST	ASSIST	SUBCON
AA Prime Contractor											
Prime Contractor's Field Overhead	P		9.00								
Prime's Home Office Expense	P		2.75								
Prime Contractor's Profit	P		10.00								
Prime Contractor's Bond	P		1.00								

SUMMARY REPORTS SUMMARY PAGE

DETAILED ESTIMATE DETAIL PAGE

BACKUP REPORTS BACKUP PAGE

* * * END TABLE OF CONTENTS * * *

	QUANTY	UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT	NOTES
01 Lands & Damages							
01.01 Lands & Damages							
01.01.01 Lands & Damages							
01.01.01.01 Lands & Damages							
01.01.01.01.01 Lands & Damages			578,340	86,751	665,091		
TOTAL Lands & Damages			578,340	86,751	665,091		
TOTAL Lands & Damages			578,340	86,751	665,091		
TOTAL Lands & Damages			578,340	86,751	665,091		
TOTAL Lands & Damages			578,340	86,751	665,091		
17 Beach Replacement							
17.00 Beachfilling							
17.00.01 Mob, Demob and Preparatory Work							
17.00.01.01 Shore Equipment							
17.00.01.01.02 Shore Equip. (Berm w/ Dune)	1.00	EA	20,136	2,416	22,552	22552	
TOTAL Shore Equipment			20,136	2,416	22,552		
17.00.01.03 Dredge Plant							
17.00.01.03.01 Mob & Demob 30" Pipeline Dredge			586,767	70,412	657,179		
17.00.01.03.02 Mob & Demob 4,000CY HopperDredge			759,369	91,124	850,493		
TOTAL Dredge Plant			1,346,136	161,536	1,507,673		
TOTAL Mob, Demob and Preparatory Work			1,366,272	163,953	1,530,225		
17.00.16 Pipeline Dredging							
17.00.16.02 Site Work							
17.00.16.02.01 Excavation and Disposal							
17.00.16.02.01.01 BUNDYs 3 Thru 5	1081000	CY	3,653,237	547,986	4,201,223	3.89	

	QUANTY UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT	NOTES
17.00.16.02.01.02 BUNDYs 6 Thru 8	2037000 CY	6,802,929	1,020,439	7,823,368	3.84	
TOTAL Excavation and Disposal		10,456,166	1,568,425	12,024,591		
TOTAL Site Work		10,456,166	1,568,425	12,024,591		
TOTAL Pipeline Dredging		10,456,166	1,568,425	12,024,591		
17.00.17 Hopper Dredging						
17.00.17.02 Site Work						
17.00.17.02.01 Excavation and Disposal						
17.00.17.02.01.01 BUNDYs 9 And 10	1692000 CY	8,764,541	1,314,681	10,079,222	5.96	
17.00.17.02.01.02 BUNDYs 11 Thru 13	1470000 CY	8,481,581	1,272,237	9,753,818	6.64	
17.00.17.02.01.03 BUNDYs 14 And 15	918000 CY	5,774,126	866,119	6,640,244	7.23	
TOTAL Excavation and Disposal		23,020,247	3,453,037	26,473,284		
TOTAL Site Work		23,020,247	3,453,037	26,473,284		
TOTAL Hopper Dredging		23,020,247	3,453,037	26,473,284		
17.00.99 Associated General Items						
17.00.99.03 SandFence,DuneGrass,RollOutBrdwk						
17.00.99.03.01 Sand Fence	509700 LF	2,031,266	406,253	2,437,519	4.78	
17.00.99.03.02 Dune Grass	146800 CSF	2,894,962	578,992	3,473,955	23.66	
17.00.99.03.03 Roll-Out Boardwalk	70.00 EA	1,002,602	200,520	1,203,122	17187	
TOTAL SandFence,DuneGrass,RollOutBrdwk		5,928,830	1,185,766	7,114,596		
TOTAL Associated General Items		5,928,830	1,185,766	7,114,596		
TOTAL Beachfilling		40,771,515	6,371,181	47,142,696		
TOTAL Beach Replacement		40,771,515	6,371,181	47,142,696		
30 Preconst. Eng. & Design (P,E &D)						
30.01 P,E & D						
30.01.01 P,E & D		1,188,200	168,368	1,356,567		
TOTAL P,E & D		1,188,200	168,368	1,356,567		

	QUANTY	UOM	CONTRACT	CONTINGN	TOTAL COST	UNIT	NOTES
TOTAL Preconst. Eng. & Design (P,E &D)			1,188,200	168,368	1,356,567		
31 Construction Management (S&A)							
31.01 S & A							
31.01.01 S & A			800,000	120,000	920,000		
TOTAL S & A			800,000	120,000	920,000		
TOTAL Construction Management (S&A)			800,000	120,000	920,000		
TOTAL Long Beach Island Feas. Study	1.00	EA	43,338,055	6,746,300	50,084,355	50084355	

01.01. Lands & Damages	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
01. Lands & Damages											
01.01. Lands & Damages											
01.01.01. Lands & Damages											
01.01.01.01. Lands & Damages											
01.01.01.01.01. Lands & Damages											
USR AA < > Lands and Damages (Real Estate)					0.00	0.00	0.00	0.00	464794	464794.35	
	1.00	EA		0.00	0	0	0	0	464,794	464,794	464794
TOTAL Lands & Damages					0	0	0	0	464,794	464,794	
TOTAL Lands & Damages					0	0	0	0	464,794	464,794	
TOTAL Lands & Damages					0	0	0	0	464,794	464,794	
TOTAL Lands & Damages					0	0	0	0	464,794	464,794	
TOTAL Lands & Damages					0	0	0	0	464,794	464,794	

17.00. Beachfilling	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
17. Beach Replacement											
17.00. Beachfilling											
17.00.01. Mob, Demob and Preparatory Work											
17.00.01.01. Shore Equipment											
17.00.01.01.02. Shore Equip. (Berm w/ Dune)											
L USR AA <01630 0001 > Mob and Demob: (3) Dozer					24.00	943.49	405.05	0.00	0.00	1348.54	
	4.00	DAY	UTDHA1	0.13	96	3,774	1,620	0	0	5,394	1348.54
L USR AA <01630 0001 > Mob and Demob: (3) Dozer					24.00	943.49	405.05	0.00	0.00	1348.54	
	4.00	DAY	UTDHA1	0.13	96	3,774	1,620	0	0	5,394	1348.54
L USR AA <01630 0001 > Mob and Demob: (3) Dozer					24.00	943.49	405.05	0.00	0.00	1348.54	
	4.00	DAY	UTDHA1	0.13	96	3,774	1,620	0	0	5,394	1348.54
TOTAL Shore Equip. (Berm w/ Dune)	1.00	EA			288	11,322	4,861	0	0	16,182	16182
TOTAL Shore Equipment					288	11,322	4,861	0	0	16,182	
17.00.01.03. Dredge Plant											
17.00.01.03.01. Mob & Demob 30" Pipeline Dredge											
USR AA < > Mob & Demob, Dredge Plant					0.00	0.00	0.00	0.00	471567	471567.00	
$586,771 for dredge includes OH, profit and bond. See CEDEP dredging program for costs.	1.00	EA		0.00	0	0	0	0	471,567	471,567	471567
TOTAL Mob & Demob 30" Pipeline Dredge					0	0	0	0	471,567	471,567	
17.00.01.03.02. Mob & Demob 4,000CY HopperDredge											
USR AA < > Mob & Demob, Dredge Plant					0.00	0.00	0.00	0.00	305141	305141.00	
$379,687 for dredge includes OH, profit and bond. See CEDEP dredging program for costs.	1.00	EA		0.00	0	0	0	0	305,141	305,141	305141
USR AA < > Mob & Demob, Dredge Plant					0.00	0.00	0.00	0.00	305141	305141.00	
$379,687 for dredge includes OH, profit and bond. See CEDEP dredging program for costs.	1.00	EA		0.00	0	0	0	0	305,141	305,141	305141
TOTAL Mob & Demob 4,000CY HopperDredge					0	0	0	0	610,282	610,282	

17.00. Beachfilling	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
TOTAL Dredge Plant					0	0	0	0	1081849	1,081,849	
TOTAL Mob, Demob and Preparatory Work					288	11,322	4,861	0	1081849	1,098,031	
17.00.16. Pipeline Dredging											
17.00.16.02. Site Work											
17.00.16.02.01. Excavation and Disposal											
17.00.16.02.01.01. BUNDYs 3 Thru 5											
USR AA < > BUNDYs 3 Thru 5					0.00	0.00	0.00	0.00	2.72	2.72	
$3.38/cy unit price for dredging includes OH, profit and bond. See CEDEP dredging program for costs.	1081000	CY		0.00	0	0	0	0	2935996	2,935,996	2.72
TOTAL BUNDYs 3 Thru 5	1081000	CY			0	0	0	0	2935996	2,935,996	2.72
17.00.16.02.01.02. BUNDYs 6 Thru 8											
USR AA < > BUNDYs 6 Thru 8					0.00	0.00	0.00	0.00	2.68	2.68	
$3.34/cy unit price for dredging includes OH, profit and bond. See CEDEP dredging program for costs.	2037000	CY		0.00	0	0	0	0	5467308	5,467,308	2.68
TOTAL BUNDYs 6 Thru 8	2037000	CY			0	0	0	0	5467308	5,467,308	2.68
TOTAL Excavation and Disposal					0	0	0	0	8403304	8,403,304	
TOTAL Site Work					0	0	0	0	8403304	8,403,304	
TOTAL Pipeline Dredging					0	0	0	0	8403304	8,403,304	
17.00.17. Hopper Dredging											
17.00.17.02. Site Work											
17.00.17.02.01. Excavation and Disposal											
17.00.17.02.01.01. BUNDYs 9 And 10											
USR AA < > BUNDYs 9 And 10					0.00	0.00	0.00	0.00	4.16	4.16	
$5.18/cy unit price for dredging includes OH, profit and bond. See CEDEP dredging	1692000	CY		0.00	0	0	0	0	7043796	7,043,796	4.16

17.00. Beachfilling	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
program for costs.											
TOTAL BUNDYs 9 And 10	1692000	CY			0	0	0	0	7043796	7,043,796	4.16
17.00.17.02.01.02. BUNDYs 11 Thru 13											
USR AA < > BUNDYs 11 Thru 13					0.00	0.00	0.00	0.00	4.64	4.64	
$5.77/cy unit price for dredging includes OH, profit and bond. See CEDEP dredging program for costs.	1470000	CY		0.00	0	0	0	0	6816390	6,816,390	4.64
TOTAL BUNDYs 11 Thru 13	1470000	CY			0	0	0	0	6816390	6,816,390	4.64
17.00.17.02.01.03. BUNDYs 14 And 15											
USR AA < > BUNDYs 14 And 15					0.00	0.00	0.00	0.00	5.06	5.06	
$6.29/cy unit price for dredging includes OH, profit and bond. See CEDEP dredging program for costs.	918000	CY		0.00	0	0	0	0	4640490	4,640,490	5.06
TOTAL BUNDYs 14 And 15	918000	CY			0	0	0	0	4640490	4,640,490	5.06
TOTAL Excavation and Disposal					0	0	0	0	18500676	18,500,676	
TOTAL Site Work					0	0	0	0	18500676	18,500,676	
TOTAL Hopper Dredging					0	0	0	0	18500676	18,500,676	
17.00.99. Associated General Items											
17.00.99.03. SandFence,DuneGrass,RollOutBrdwk											
17.00.99.03.01. Sand Fence											
B CIV AA <02712 6201 > Stl Post, 10'OC f/4' Sand Fence					0.04	1.63	0.02	1.55	0.00	3.20	
Material cost from Means (0283205000).	509700	LF	XLABC	75.00	22,682	832,289	10,653	789,525	0	1,632,467	3.20
TOTAL Sand Fence	509700	LF			22,682	832,289	10,653	789,525	0	1,632,467	3.20

17.00. Beachfilling	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
17.00.99.03.02. Dune Grass											
Dune grass planting was based on information obtained from George Savastano with the City of Ocean City. Planting was 12,576 plants per acre based on 2' o.c. Cost was $0.09 per sprig and $0.10 per sprig for labor. A additional allowance was included for a pickup truck and tools. Planting was 2 sprigs per plant = $0.36 per plant.											
L USR AA <02810 2002 > Dune Grass Seedlings					0.01	0.41	0.03	0.99	0.00	1.43	
	1631095	SY	XTRLB3L	377.66	17,290	668,096	45,344	1613153	0	2,326,594	1.43
TOTAL Dune Grass	146800	CSF			17,290	668,096	45,344	1613153	0	2,326,594	15.85
17.00.99.03.03. Roll-Out Boardwalk											
B USR AA <02712 6201 > Trex 8' Wide x 175' Long At 70					16.00	618.81	42.05	10850.00	0.00	11510.87	
locations. Material cost from Randy based on 175 lf/5' section x 2 wide x $155/section = $10,850. Production rate based on 5 minutes per section.	70.00	EA	XTRLB3L	0.25	1,120	43,317	2,944	759,500	0	805,761	11511
TOTAL Roll-Out Boardwalk	70.00	EA			1,120	43,317	2,944	759,500	0	805,761	11511
TOTAL SandFence,DuneGrass,RollOutBrdwk					41,091	1543703	58,941	3162178	0	4,764,821	
TOTAL Associated General Items					41,091	1543703	58,941	3162178	0	4,764,821	
TOTAL Beachfilling					41,379	1555024	63,801	3162178	27985829	32,766,833	
TOTAL Beach Replacement					41,379	1555024	63,801	3162178	27985829	32,766,833	

30.01. P,E & D	QUANTY UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
30. Preconst. Eng. & Design (P,E &D)										
30.01. P,E & D										
30.01.01. P,E & D										
USR AA < > Preconst., Eng. & Design (P,E&D)				0.00	0.00	0.00	0.00	954920	954920.00	
	1.00 EA		0.00	0	0	0	0	954,920	954,920	954920
TOTAL P,E & D				0	0	0	0	954,920	954,920	
TOTAL P,E & D				0	0	0	0	954,920	954,920	
TOTAL Preconst. Eng. & Design (P,E &D)				0	0	0	0	954,920	954,920	

31.01. S & A	QUANTY	UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
31. Construction Management (S&A)											
31.01. S & A											
31.01.01. S & A											
USR AA < > Construction Management (S&A)					0.00	0.00	0.00	0.00	642936	642936.00	
	1.00	EA		0.00	0	0	0	0	642,936	642,936	642936
TOTAL S & A					0	0	0	0	642,936	642,936	
TOTAL S & A					0	0	0	0	642,936	642,936	
TOTAL Construction Management (S&A)					0	0	0	0	642,936	642,936	
TOTAL Long Beach Island Feas. Study	1.00	EA			41,379	1555024	63,801	3162178	30048479	34,829,483	34829483

SRC	ITEM ID	DESCRIPTION	NO.	UOM	RATE	**** LABOR **** HOURS	COST	**** EQUIP **** HOURS	COST	TOTAL COST
	* UTDHA1	1 B-laborer + 1 Tractor & Lowbed Trailer, 40 To			PROD = 100%				CREW HOURS =	96
MIL *	X-LABORER L	Outside Laborer	1.00	HR	36.62	1.00	36.62			36.62
MIL	X-LABORER F	Outside Laborer	1.00	HR	37.12	1.00	37.12			37.12
MIL	X-TRKDVRHVL	Outside Truck Dr. Heavy-TEAM067	1.00	HR	44.20	1.00	44.20			44.20
MIL	XMIXX020 E	Small Tools	2.46	HR	1.57			2.46	3.86	3.86
MIL	T45XX019 E	TRLR,LOWBOY, 75T, 3 AXLE(ADD TR	1.00	HR	10.30			1.00	10.30	10.30
MIL	T50KE004 E	TRK,HWY, 50,000 GVW, 6X4, 3 AXL	1.00	HR	36.47			1.00	36.47	36.47
	TOTAL					3.00	117.94	4.46	50.63	168.57
	* XLABC	3 X-laborer + Small Tools			PROD = 100%				CREW HOURS =	6796
MIL	XMIXX020 E	Small Tools	1.00	HR	1.57			1.00	1.57	1.57
MIL	X-LABORER L	Laborers, Semi-Skilled LABO0172	3.00	HR	36.62	3.00	109.85			109.85
MIL	X-LABORER F	Outside Laborer (Semi-Skilled)	0.34	HR	37.12	0.34	12.62			12.62
	TOTAL					3.34	122.47	1.00	1.57	124.04
	* XTRLB3L	1X-trkdvrlt+1 3/4 Ton Pickup Truck+3X-laborer			PROD = 100%				CREW HOURS =	4599
MIL	T50FO003 E	TRK,HWY, 8,600GVW,4X2, 3/4T-PKU	1.00	HR	7.37			1.00	7.37	7.37
TWT	X-TRKDVRLTL	Outside Truck Dr. Light	1.00	HR	43.35	1.00	43.35			43.35
MIL	X-LABORER F	Outside Laborer	1.00	HR	37.12	1.00	37.12			37.12
MIL	X-LABORER F	Outside Laborer	2.00	HR	37.12	2.00	74.23			74.23
UPB *	XMIXX020 E	SMALL TOOLS	2.00	HR	1.57			2.00	3.14	3.14
	TOTAL					4.00	154.70	3.00	10.51	165.22

SRC	LABOR ID	DESCRIPTION	BASE	OVERTM	TXS/INS	FRNG	TRVL	RATE	UOM	UPDATE	DEFAULT	**** TOTAL **** HOURS
MIL	X-LABORER	Outside Laborer (Semi-Skilled)	21.75	0.0%	21.5%	10.19	0.00	36.62	HR	05/17/99	11.84	36687
MIL	X-TRKDVRHV	Outside Truck Dr. Heavy-TEAM067A	24.60	0.0%	28.6%	12.58	0.00	44.20	HR	05/17/99	27.58	96
MIL	X-TRKDVRLT	Outside Truck Dr. Light-TEAM0331	24.45	0.0%	26.0%	12.56	0.00	43.35	HR	05/17/99	27.71	4599

SRC	ID.NO.	EQUIPMENT DESCRIPTION	DEPR	FCCM	FUEL	FOG	TR WR	TR REP	EQ REP	TOTAL RATE	** TOTAL ** HOURS
UPB	T45XX019	TRLR,LOWBOY, 75T, 3 AXLE	3.51	1.81		0.50	1.32	0.21	2.95	10.30 HR	96
UPB	T50FO003	TRK,HWY, 8,600GVW,4X2, 3/4T-PKUP	1.71	0.52	2.30	0.69	0.19	0.03	1.93	7.37 HR	4599
UPB	T50KE004	TRK,HWY, 50,000 GVW, 6X4, 3 AXLE	10.19	3.11	9.76	2.92	0.44	0.07	9.98	36.47 HR	96
UPB	XMIXX020	SMALL TOOLS	0.50	0.22	0.16	0.07			0.63	1.57 HR	16230

No errors detected...

* * * END OF ERROR REPORT * * *

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

MOB & DEMOB COST ESTIMATE
(FOR BEACHFILLING)
SELECTED PLAN

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

M MOB & DEMOB BID ITEM 1

DREDGE SIZE 30"

	MOBILIZATION			DEMOBILIZATION		
	# DAYS	$/DAY	TOTAL	# DAYS	$/DAY	TOTAL
1. PREPARE DREDGE FOR TRANSFER	3 x	$13,443 =	$40,330	2 x	$14,193 =	$28,387
2. PREPARE PIPELINE FOR TRANSFER	3 x	$12,717 =	$38,151	2 x	$13,267 =	$26,534
3. TRANSFER ALL PLANT 200 MILES @ 65 miles/day =	3.1 x	$38,071 =	$118,020	200 MILES 3.1 x	$38,071 =	$118,020
4. PERMANENT PERSONNEL & MISC.	L.S.	=	$1,218	L.S.	=	$1,218
5. PREPARE DREDGE AFTER TRANSFER	2 x	$14,193 =	$28,387	1 x	$13,443 =	$13,443
6. PREPARE PIPELINE AFTER TRANSFER	2 x	$13,267 =	$26,534	1 x	$12,717 =	$12,717
7. OTHER	Travel Costs	=	$9,300	Travel Costs	=	$9,300
	SUBTOTAL MOBILIZATION		$261,940	SUBTOTAL DEMOBILIZATION		$209,619

REMARKS

8. SUBTOTAL MOBILIZATION & DEMOBILIZATION		=	$471,559
9. OVERHEAD	12.0%	+	$56,587
	SUBTOTAL	=	$528,146
10. PROFIT	10.0%	+	$52,815
	SUBTOTAL	=	$580,961
11. BOND	1.0%	+	$5,810
12. TOTAL MOBILIZATION & DEMOBILIZATION		=	$586,771

****

M \ 1 MOB & DEMOB BID ITEM 1

****

DREDGE SIZE 30"

1. PREPARE DREDGE FOR TRANSFER				MOBILIZATION	DEMOBILIZATION
Labor:	30 men @	8 hrs/day @	$35.12 per hour =	$8,430	$8,430
Equipment:	Dredge	$73.15 /hr (Standby)			
	Booster(s)	35.95 /hr (Standby)			
		$79.10 /hr x 24 hrs per day =		$1,898	$1,898
Support equipment with operators				$2,415	$2,415
Supplies & small tools				$200	$200
Additional Fuel (plant idle)				$500	$500
Subsistence:	30 men @	$25.00 per day =		----	$750
			COST PER DAY	$13,443	$14,193

2. PREPARE PIPELINE FOR TRANSFER				MOBILIZATION	DEMOBILIZATION
Labor:	22 men @	8 hrs/day @	$35.12 per hour =	$6,182	$6,182
Equipment:	Work Tug	$101.65 /hr			
	Crew Tug	$12.32 /hr			
	Derrick(s)	$20.67 /hr			
	Fuel Barge	$3.74 /hr			
	Work Barge	$4.82 /hr			
		$143.20 /hr x 8 hrs per day =		$1,146	$1,146
	Pipeline	$115.51 /hr (Standby) x 24 hrs per day =		$2,775	$2,775
Support equipment with operators				$2,415	$2,415
Supplies & small tools				$200	$200
Subsistence	22 men @	$25.00 per day =		----	$550
			COST PER DAY	$12,717	$13,267

M \ 2 MOB & DEMOB BID ITEM 1

DREDGE SIZE 30"

3. TRANSFER PLANT

			MOBILIZATION	DEMOBILIZATION
Labor:	26 men/shift (2-12 hr shifts) @	$35.12 per manhour =	$21,918	$21,918
Equipment:	Work Tug(s)	$101.65 /hr		
	Dredge	$73.15 /hr (Standby)		
	Booster(s)	$5.55 /hr (Standby)		
	Crew Tug	$1.06 /hr (Standby)		
	Derrick(s)	$5.64 /hr (Standby)		
	Fuel Barge	$1.33 /hr (Standby)		
	Work Barge	$1.90 /hr (Standby)		
	Unused	$0.00 /hr (Standby)		
	Pipeline	$115.61 /hr (Standby)		
		$306.39 /hr x 24 hrs per day =	$7,353	$7,353
Subsistence	52 men @	$25.00 per day =	$1,300	$1,300
Towing vessel(s):	4000 H.P. Rental Tug @			
	$5,000 per day (towing)			
	$2,500 per day (return to port)			
	$7,500 per day x 1 towing vessel(s) =		$7,500	$7,500
		COST PER DAY	$38,071	$38,071

4. PERMANENT PERSONNEL & MISC.

		MOBILIZATION	DEMOBILIZATION
3 men @	8 hrs/day @ $35.12 per hour @ 1 DAY	$843	$843
Travel Expenses	$125 per man	$375	$375
Local hire		$0	----
	TOTAL	$1,218	$1,218

****

M \ 3 MOB & DEMOB BID ITEM 1

****

DREDGE SIZE 30"

5. PREPARE DREDGE AFTER TRANSFER

				MOBILIZATION	DEMOBILIZATION
Labor:	30 men @	8 hrs/day @	$35.12 per hour =	$8,430	$8,430
Equipment:	Dredge	$73.15 /hr (Standby)			
	Booster(s)	$5.95 /hr (Standby)			
		$79.10 /hr x 24 hrs per day =		$1,898	$1,898
Support equipment with operators				$2,415	$2,415
Supplies & small tools				$200	$200
Additional Fuel (plant idle)				$500	$500
Subsistence	30 men @	$25.00 per day =		$750	----
			COST PER DAY	$14,193	$13,443

6. PREPARE PIPELINE AFTER TRANSFER

				MOBILIZATION	DEMOBILIZATION
Labor:	22 men @	8 hrs/day @	$35.12 per hour =	$6,182	$6,182
Equipment:	Work Tug	$101.85 /hr			
	Crew Tug	$12.32 /hr			
	Derrick(s)	$20.47 /hr			
	Fuel Barge	$3.74 /hr			
	Work Barge	$4.82 /hr			
		$143.20 /hr x 8 hrs per day =		$1,146	$1,146
	Pipeline	$115.61 /hr (Standby) x 24 hrs per day =		$2,775	$2,775
Support equipment with operators				$2,415	$2,415
Supplies & small tools				$200	$200
Subsistence	22 men @	$25.00 per day =		$550	----
			COST PER DAY	$13,267	$12,717

****

M \ 4 MOB & DEMOB BID ITEM 1

****

DREDGE SIZE 30"

		REMARKS
1 EQUIPMENT COSTS - WORKING RATES		RATES TAKEN FROM SHEET D
A. WORK TUG(S)	$101.65 /HR	$48,384 /MO DIVIDED BY 476 HRS/MO
B. CREW/SURVEY TUG	$12.32 /HR	$5,862 /MO DIVIDED BY 476 HRS/MO
C. DERRICK(S)	$20.67 /HR	$9,838 /MO DIVIDED BY 476 HRS/MO
D. FUEL/WATER BARGE	$3.74 /HR	$1,778 /MO DIVIDED BY 476 HRS/MO
E. WORK BARGE	$4.82 /HR	$2,292 /MO DIVIDED BY 476 HRS/MO
2 LABOR COSTS	$35.12 /MHR	FROM SHEET D \ 1
3 EQUIPMENT COSTS - STANDBY RATES		RATES TAKEN FROM SHEET D \ 2
A. DREDGE	$73.15 /HR	1 EA @ $ 73.15 /HR
B. BOOSTER(S)	$5.95 /HR	0.3 EA @ $ 19.84 /HR
C. CREW/SURVEY TUG	$1.06 /HR	1 EA @ $ 1.06 /HR
D. DERRICK(S)	$5.64 /HR	2 EA @ $ 2.82 /HR
E. FUEL/WATER BARGE	$1.43 /HR	1 EA @ $ 1.43 /HR
F. WORK BARGE	$1.90 /HR	2 EA @ $ 0.95 /HR
G. ***Unused***	$0.00 /HR	0 EA @ $ 0.00 /HR
3 PIPELINE COSTS - STANDBY RATES		RATES TAKEN FROM SHEET D \ 3
A. FLOATING PIPELINE	$18.59 /HR	1,430 LF @ $0.013 /HR
B. SUBMERGED PIPELINE	+ $79.47 /HR	15,893 LF @ $0.005 /HR
C. SHORELINE	+ $17.56 /HR	17,556 LF @ $0.001 /HR
D. TOTAL PIPELINE COSTS	= $115.61 /HR	34,879 LF (ON JOB)

M MOB & DEMOB BID ITEM # 1

DREDGE SIZE: 4000 CYD HOPPER DREDGE

	MOBILIZATION			DEMOBILIZATION		
	# DAYS	$/DAY	TOTAL	# DAYS	$/DAY	TOTAL
1. PREPARE DREDGE FOR TRANSFER	2 x	$31,681 =	$63,362	1.5 x	$31,681 =	$47,522
2. TRANSFER ALL PLANT 200 MILES @ 240 miles/day =	0.8 x	$31,681 =	$25,345	200 MILES 0.8 x	$31,681 =	$25,345
3. PERMANENT PERSONNEL & MISC.	L.S.	=	$19,261	L.S.	=	$19,261
4. PREPARE DREDGE AFTER TRANSFER	2 x	$31,681 =	$63,362	1 x	$31,681 =	$31,681
5. OTHER	>	=	$0	L.S. Cleanup	=	$10,000
	SUBTOTAL MOBILIZATION		$171,329	SUBTOTAL DEMOBILIZATION		$133,808

				REMARKS
6. SUBTOTAL MOBILIZATION & DEMOBILIZATION		=	$305,137	
7. OVERHEAD	12.0%	+	$36,616	
	SUBTOTAL..................=		$341,753	
8. PROFIT	10.0%	+	$34,175	
	SUBTOTAL.....................=		$375,928	
9. BOND	1.0%	+	$3,759	
10. TOTAL MOBILIZATION & DEMOBILIZATI		=	$379,687	

M \ 1 MOBIL MONTHLY COST SUMMARY BID ITEM # 1

DREDGE SIZE: 4600 CYD HOPPER DREDGE

			REMARKS
1 LABOR COSTS		$259,496 /MO	FROM SHEET D \ 1
2 EQUIPMENT			
A. DREDGE	+	$446,252 /MO	FROM SHEET D \ 3
PROPULSION TUG	+	self prop/MO	
B. CREW/SURVEY VESSEL	+	$98,000 /MO	
C. BOOSTER	+	$0 /MO	
D. CRANE BARGE	+	$0 /MO	
E. TENDER TUG	+	$10,000 /MO	
F. OTHER MARINE	+	$150,000 /MO	
G. SHORE EQUIPMENT	+	$0 /MO	
3 TOTAL MONTHLY RATE	=	$963,748 /MO	
4 CONVERSION TO DAILY RATE	/	30.42 dys/mo	
5 DAILY RATE	=	$31,681 /day	

PERMANENT PERSONNEL & MISC.

			MOBILIZATION	DEMOBILIZATION
29 men @	8 hrs/day	$33.02 per hour * 1 DAY	$7,661	$7,661
Travel Expenses	$400 per man		$11,600	$11,600
		TOTAL	$19,261	$19,261

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

INITIAL CONSTRUCTION COST ESTIMATE
(FOR BEACHFILLING)
SELECTED PLAN

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT	Barnegat to Little Egg Inlets	DATE OF ESTIMATE	01 Sept 1999
2 LOCATION	Init Const, 125'B/22'D, 7Yr	INVIT. OR CONTR. NO.	Borrow Area D1
3 ESTIMATED BY	Bill Welk	CHECKED BY	
4 TYPE OF DREDGE	30" Cutter-Suction Dredge	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Initial Construction for 125' Berm/22' Dune/7 Yr. Cycle.

Dredge approximately 1,081,000 CY from borrow area D1 and place in BUNDYs 3, 4, and 5.

Initial construction quantity includes one nourishment cycle.

Nourishment cycle quantity includes 1.00 (0%) fill factor for borrow area D1.

6 EXCAVATION

			REMARKS
A. REQUIRED		1,081,000 CY	2,806,442 s.f. of Dredging Area
B. PAY OVERDEPTH	+	0 CY	
C. MAX. PAY YARDAGE	=	1,081,000 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	0 CY	
E. NET PAY YARDAGE	=	1,081,000 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	162,200 CY	1.6 ft overdig
G. GROSS YARDAGE	=	1,243,200 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B DREDGING COST BID ITEM # 2

			REMARKS
1 GROSS YARDAGE		1,243,200 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE	/	457,436 CY/MO	FROM SHEET C, ITEM 8.
3 DREDGING TIME	=	2.72 MONTHS	
4 TOTAL MONTHLY COST	x	$1,080,996	FROM SHEET D, ITEM 5.
SUBTOTAL............	=	$2,940,309	
5 FIXED COSTS	+	$0	FROM SHEET E, ITEM 15.
SUBTOTAL.............	=	$2,940,309	
6 OVERHEAD 12.0%	+	$352,837	
SUBTOTAL...........	=	$3,293,146	
7 PROFIT 10.0%	+	$329,315	
SUBTOTAL.............	=	$3,622,461	
8 BOND 1.0%	+	$36,225	
9 GROSS PRODUCTION COSTS	=	$3,658,686	
10 NET PAY YARDAGE	/	1,081,000 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST	=	$3.38 /CY	
12 MAX PAY YARDAGE	x	1,081,000 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST	=	$3,653,780	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

		REMARKS
1 SIZE OF DREDGE....PIPELINE.........>	30"	
2 POWER OUTPUT......MAIN PUMP........>	9,000 HP	
3 NUMBER OF BOOSTERS IN LINE.........>	0.3	
4 POWER OUTPUT......EACH BOOSTER.....>	5,200 HP	
5 PUMPING DISTANCES		
A. MAXIMUM PIPELINE NEEDED.........>	34,879 LF	
B. AVERAGE PIPELINE................>	25,371 LF	
C. EQUIVALENT ADDITIONAL PIPELINE +	300 LF	
D. PRODUCTION BASED ON =	25,671 LF	
6 GROSS PRODUCTION	961 CY/HR	SEE SHEET C \ 1, ITEM 4 F.
7 OPERATING TIME x	476 HRS/MO	SEE SHEET C \ 1, ITEM 5 E.
		(476 Operating Hrs per Mo / 730 Hrs per Mo of Dredging =
		65.2% Effective Time)
8 PRODUCTION RATE =	457,436 CY/MO	1,081,000 Net Pay CY / 2.72 MO = 397,426 Pay CY/MO

GROSS PRODUCTION

C \ 1 — OPERATING TIME — BID ITEM # 2

			REMARKS
1 SIZE OF DREDGE....PIPELINE.........>		30"	
2 POWER OUTPUT......MAIN PUMP........>		9,000 HP	
3 NUMBER OF BOOSTERS IN LINE		0.3	Each Booster is 5200 Horsepower.
4 PRODUCTION.........(BASED ON)......>		25,671 LF	FROM SHEET C \ 2, ITEM 13.
A. ADJUSTED CHART PRODUCTION		1,079 CY/HR	FROM SHEET C \ 2, ITEM 14.
B. MATERIAL FACTOR	x	0.90	FROM SHEET C \ 3, ITEM 1 B.
C. BANK FACTOR	x	1.10	FROM SHEET C \ 3, ITEM 2 D.
D. OTHER FACTOR	x	0.90	Wave Action
E. CLEANUP FACTOR	x	1.00	0% ADDITIONAL DREDGING TIME
F. GROSS PRODUCTION	=	961 CY/HR	

			REMARKS
5 OPERATING TIME:			
A. BOOSTER FACTOR		0.97	10% LOSS IN PUMPING TIME PER BOOSTER
B. TIME EFFICIENCY	x	67.2%	% OF EFFECTIVE WORKING TIME WITHOUT BOOSTERS
C. NET EFFICIENCY	=	65.2%	% OF EFFECTIVE WORKING TIME INCLUDING BOOSTER LOSSES
D. MAX DREDGE TIME	x	730 HRS/MO	
E. OPERATING TIME	=	476 HRS/MO	

C \ 2 ADJUSTED CHART PRODUCTION BID ITEM # 2

		REMARKS
1 SIZE OF DREDGE....PIPELINE........>	30"	
2 CHART HORSEPOWER..................>	9,000 HP	
3 STANDARD PRODUCTION CHART:		

STANDARD DREDGE PRODUCTION BASED ON CHART HORSEPOWER

UP TO	10,380 L.F. OF PIPE	1800 CY/HR
AT	20,760 L.F. OF PIPE	1170 CY/HR
AT	29,410 L.F. OF PIPE	500 CY/HR

		REMARKS
4 POWER OUTPUT....USED FOR DREDGE....>	9,000 HP	Chart Adjustment Factor = (Available Dredge Horsepower +
5 NUMBER OF BOOSTERS USED...........>	0.3	Number of Boosters x Booster H.P.) / Chart H.P.
6 POWER OUTPUT......EACH BOOSTER.....>	5,200 HP	
7 TOTAL POWER APPLIED TO PIPELINE....>	10,560 HP	= (9000 H.P. + 0 Booster(s) x 5200 HP/Booster)
8 CHART ADJUSTMENT FACTOR (C.A.F)....>	1.17	= (10560 HP / 9000 HP)
9 ADJUSTED PRODUCTION CHART:		

ADJUSTED DREDGE PRODUCTION CHART BASED ON C.A.F.

UP TO	12,145 L.F. OF PIPE	1800 CY/HR
AT	24,289 L.F. OF PIPE	1170 CY/HR
AT	34,410 L.F. OF PIPE	500 CY/HR

10 MAXIMUM LINE LENGTH...............>	34,879 LF	
11 AVERAGE LINE LENGTH...............>	25,371 LF	Actual Pipeline
12 EQUIVALENT ADDITIONAL PIPELINE +	300 LF	Vertical Lift of Discharge Pipe.
13 PIPE USED FOR PRODUCTION =	25,671 LF	Actual Pipeline + Equivalent Feet of Pipe
14 ADJUSTED CHART PRODUCTION	1,079 CY/HR	Interpolated from Chart

MATERIAL FACTOR CALCULATION

C \ 3 BID ITEM # 2

BANK FACTOR CALCULATION

1 MATERIAL FACTOR COMPUTATION:

A. MATERIAL FACTOR CHART:

DESCRIPTION	INPLACE DENSITY		FACTOR	%	QUANTITIES
MUD & SILT	1200	GR/L	3	0%	0 c.y.
MUD & SILT	1300	GR/L	2.5	0%	0 c.y.
MUD & SILT	1400	GR/L	2	0%	0 c.y.
LOOSE SAND	1700	GR/L	1.1	0%	0 c.y.
LOOSE SAND	1900	GR/L	1	0%	0 c.y.
COMP. SAND	2000	GR/L	0.9	100%	1,243,200 c.y.
STIFF CLAY	2000	GR/L	0.6	0%	0 c.y.
COMP. SHELL	2300	GR/L	0.5	0%	0 c.y.
SOFT ROCK	2400	GR/L	0.4	0%	0 c.y.
BLAST. ROCK	2000	GR/L	0.25	0%	0 c.y.

B. MATERIAL FACTOR................> 0.90 100% 1,243,200 c.y. (Computed from Chart)

REMARKS

2 BANK FACTOR COMPUTATION:

A. SIZE OF DREDGE....PIPELINE......> 30"

B. AVERAGE BANK HEIGHT............> 11.96 FT

C. BANK FACTOR CHART:

BANK HEIGHT	1	2	3	4	5	6	7	8	9
FACTOR	NA	0.42	0.53	0.63	0.73	0.83	0.93	1.03	1.1

D. BANK FACTOR....................> 1.10 Interpolated from chart

>

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE 30"

			REMARKS
1 LABOR COSTS		$341,416 /MO	FROM SHEET D \ 1
2 EQUIPMENT COSTS			FROM SHEET D \ 2
A. DREDGE	+	$360,521 /MO	1 EA @ $360,521 /MO
B. WORK TUG(S)	+	$48,384 /MO	2 EA @ $24,192 /MO
C. CREW/SURVEY TUG	+	$5,862 /MO	1 EA @ $5,862 /MO
D. DERRICK(S)	+	$9,838 /MO	2 EA @ $4,919 /MO
E. FUEL/WATER BARGE	+	$1,778 /MO	1 EA @ $1,778 /MO
F. WORK BARGE	+	$2,292 /MO	2 EA @ $1,146 /MO
H. BOOSTER(S)	+	$46,900 /MO	0.3 EA @ $156,333 /MO
G. ***Unused***	+	$0 /MO	0 EA @ $0 /MO
3 PIPELINE COSTS BASED ON PUMPING SAND			34,879 LF (ON JOB) - RATES TAKEN FROM SHEET D \ 3
A. (1) FLOATING PIPE (AVERAGE)	+	$21,622 /MO	1,430 LF @ $15.12 /MO
(2) FLOATING PIPE (REMAINING)	+	$0 /MO	0 LF @ $0.013 /HR X 730 HRS/MO
B. (1) SUBMERGED PIPE (AVERAGE)	+	$80,535 /MO	11,375 LF @ $7.08 /MO
(2) SUBMERGED PIPE (REMAINING)	+	$16,491 /MO	4,518 LF @ $0.005 /HR X 730 HRS/MO
C. (1) SHORE PIPE (AVERAGE)	+	$24,001 /MO	12,566 LF @ $1.91 /MO
(2) SHORE PIPE (REMAINING)	+	$3,643 /MO	4,990 LF @ $0.001 /HR X 730 HRS/MO
4 OTHER MONTHLY COSTS	+	$117,713 /MO	FROM SHEET D \ 4
5 TOTAL MONTHLY COST	=	$1,080,996	

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE: 30"

Overtime (Pay 64 Hrs/Wk)		14.29%
Holidays/Yr	8	2.19%
Vacation		8.00%
COMPOSITE....................		24.48%

Management....

1	CAPTAIN	$6,000
1	CHIEF ENG	5,000
1	CIVIL ENG	4,500
1	OFFICE HELP	2,000
MONTHLY MANAGEMENT COST........		$17,500

Social Security Tax	7.65%
Workman's Compensation	11.60%
State Unemployment Comp.	6.50%
Federal Unemployment Comp.	0.80%
COMPOSITE....................	26.55%

Each Crew Position is Manned: 8 Hrs per Day
x 7 Days per Week
= 56 Hrs per Week
x 4.345 Wks per Month
= 243 Hrs per Month

Last Update...Sep 99

EA	CREW POSITION	BASIC HOURLY WAGE		O.T. VACATION & HOLIDAY 24.48%		SUB-TOTAL		TAXES INSUR 26.55%		SUB-TOTAL		FRINGE BENEFITS $4.68		HRLY COST		HOURS PER MONTH		MONTHLY COST
3	LEVERMAN	$25.18	+	$6.16	=	$31.34	+	$8.32	=	$39.66	+	$5.41	=	$45.07	x	730	=	$32,901
3	WATCH ENG	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	730	=	29,638
2	DRDG MATE	20.35	+	4.98	=	25.33	+	6.73	=	32.06	+	4.41	=	36.47	x	487	=	17,761
2	TUG MASTER	21.48	+	5.26	=	26.74	+	7.10	=	33.84	+	4.41	=	38.25	x	487	=	18,628
3	LAUNCHMAN	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	730	=	22,287
0	MAINT ENG	21.83	+	5.34	=	27.17	+	7.21	=	34.38	+	4.41	=	38.79	x	0	=	0
3	EQUIP OPER	21.29	+	5.21	=	26.50	+	7.04	=	33.54	+	4.41	=	37.95	x	730	=	27,704
1	WELDER	21.47	+	5.25	=	26.72	+	7.09	=	33.81	+	4.41	=	38.22	x	243	=	9,287
1	OILER	17.23	+	4.22	=	21.45	+	5.69	=	27.14	+	4.41	=	31.55	x	243	=	7,667
9	DECKHAND	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	2190	=	66,861
1	ELECTRICIAN	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	243	=	9,866
1	G DUMP FRMN	22.01	+	5.39	=	27.40	+	7.27	=	34.67	+	5.41	=	40.08	x	243	=	9,739
2	DUMP FOREMN	20.17	+	4.94	=	25.11	+	6.67	=	31.78	+	5.41	=	37.19	x	487	=	18,112
6	SHOREMAN	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	1460	=	44,574
0.9	BOOSTER ENG	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	219	=	8,891

38 Total Crew

MONTHLY CREW LABOR COST = $323,916

(Average Gross Wage = $35.12 per manhour)

TOTAL MONTHLY LABOR COST = $341,416

D \ 2 EQUIPMENT COSTS BID ITEM # 2

DREDGE SIZE 30"

	--DREDGE--	----TUGS & TENDERS----		----BARGES----			--BOOSTER--	---OTHER---
1a. Plant Description......	HYDRAULIC	WORK TUG	CREW/SURVEY	DERRICK	FUEL/WATER	WORK	FLOATING	***Unused***
1c. Prime Eng HP...........	9,000	250	100	200	0	0	5,200	0
1d. (1) Dredge El Gen HP...	830	--	--	--	--	--	--	--
1d. Total 2nd Eng HP.......	3,310	50	40	40	10	0	200	0
1e. Plant Value............	$4,955,000	$327,000	$48,000	$244,000	$122,000	$81,000	$2,154,000	$0
1f. Acquis Year............	1978	1991	1991	1985	1985	1985	1980	0
1g. Pres Year..............	1998	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1h. Cost of Money Rate.....	6.750%	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1i. Disc Money Rate:	5.400%	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
1j. Hrs Worked/Mo..........	476	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
2a. LAF....................	1.160	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
2b. Fuel Cost per Gal......	$0.85	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
3a. Ec Index <for Acq Yr>..	2352	4438	4438	3749	3749	3749	2922	0
3b. Ec Index <for 1998>....	5676	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
4a. Mos Available/Year.....	9	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->	- - - ->
5a. Useful Life (in Yrs)...	30	8	8	20	20	20	30	0
5b. Physical Life (in Hrs).	135,000	16,000	16,000	90,000	90,000	90,000	135,000	0
5c. SLV Factor.............	0.10	0.10	0.10	0.10	0.05	0.05	0.10	0.00
5d. Pr Eng Fuel Factor.....	0.045	0.045	0.045	0.011	0.011	0.011	0.045	0
5e. 2nd Eng Fuel Factor....	0.039	0.039	0.039	0.011	0.011	0.011	0.039	0
5f. WLS Factor.............	0.22	0.38	0.38	0.20	0.20	0.20	0.24	0.00
5g. RPR Factor.............	1.30	0.80	0.80	0.70	0.60	0.60	1.20	0.00
6a. Depreciation:	3.00%	11.25%	11.25%	4.50%	4.75%	4.75%	3.00%	0.00%
6b. FCCM:	3.05%	3.27%	3.27%	3.09%	2.96%	2.96%	3.05%	0.00%
6c. Total Ownership/Year:	6.05%	14.52%	14.52%	7.59%	7.71%	7.71%	6.05%	0.00%
7a. Yearly Ownership:	$299,778	$47,480	$6,970	$18,520	$9,406	$6,245	$130,317	$0
7b. Monthly Ownership:	$33,309	$5,276	$774	$2,058	$1,045	$694	$14,480	$0
8a. (1) Hrly Pr Eng Fuel:	$344.25	$9.56	$3.83	$1.87	$0.00	$0.00	$198.90	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$109.73	$1.66	$1.33	$0.37	$0.09	$0.00	$6.63	$0.00
8b. (1) Hrly Pr Eng WLS:	$75.74	$3.63	$1.46	$0.37	$0.00	$0.00	$47.74	$0.00
8b. (2) Hrly 2nd Eng WLS:	$24.14	$0.63	$0.51	$0.07	$0.02	$0.00	$1.59	$0.00
8c. (1) EAF:	2.413	1.279	1.279	1.514	1.514	1.514	1.943	0.000
8c. (2) Hrly Repair:	$133.56	$24.26	$3.56	$3.33	$1.43	$0.95	$43.15	$0.00
8d. Total Hrly Operating:	$687.42	$39.74	$10.69	$6.01	$1.54	$0.95	$298.01	$0.00
8e. Monthly Operating:	$327,212	$18,916	$5,088	$2,861	$733	$452	$141,853	$0
11. MONTHLY RATE:	$360,521	$24,192	$5,862	$4,919	$1,778	$1,146	$156,333	$0
12a. HRLY STANDBY ALLOW:	$45.63	$7.23	$1.06	$2.82	$1.43	$0.95	$19.84	$0.00
12b. Gener Fuel Allowance:	$27.52	--	--	--	--	--	--	--
12c. DREDGE HOURLY STANDBY:	$73.15	--	--	--	--	--	--	--

D \ 3 PIPELINE COSTS BID ITEM # 2

PIPELINE SIZE: 30" MATERIAL PUMPED: SAND

	FLOATING PIPELINE			SUBMERGED PIPELINE		SHOREPIPE
1a. Plant Description......	Pipeline	Joints	Pontoons	Pipeline	Joints	Pipeline
Quantity.............>	100	1	2	400	1	40
Fixed Units Per Item..>	LF	Set	Each	LF	Set	LF
Unit Price...........>	$65.00	$15,000.00	$7,500.00	$65.00	$15,000.00	$25.00
1e. Plant Value:	$6,500.00	$15,000.00	$15,000.00	$26,000.00	$15,000.00	$1,000.00
1f. Acquis Year...........	1992	1992	1992	1992	1992	1992
1g. Pres Year.............	1998	->	->	->	->	->
1h. Cost of Money Rate.....	6.750%	->	->	->	->	->
1i. Disc Money Rate:	5.400%	->	->	->	->	->
1j. Hrs Worked/Mo..........	476	->	->	->	->	->
2a. LAF....................	1.160	->	->	->	->	->
3a. Ec Index <for Acq Yr>..	4611	4611	4611	4611	4611	4611
3b. Ec Index <for 1998>....	5676	->	->	->	->	->
4a. Mos Available/Year.....	9	->	->	->	->	->
5a. Useful Life (in Yrs)...	1.5	3.0	12.0	1.5	3.0	1.5
5b. Physical Life (in Hrs).	6,000	12,000	60,000	6,000	12,000	6,000
5c. SLV Factor............	0.10	0.10	0.10	0.10	0.10	0.10
5g. RPR Factor............	0.05	0.30	0.05	0.05	0.30	0.05
6a. Depreciation:	60.00%	30.00%	7.50%	60.00%	30.00%	60.00%
6b. FCCM:	4.59%	3.78%	3.17%	4.59%	3.78%	4.59%
6c. Total Ownership/Year:	64.59%	33.78%	10.67%	64.59%	33.78%	64.59%
7a. Yearly Ownership:	$4,198.35	$5,067.00	$1,600.50	$16,793.40	$5,067.00	$645.90
7b. Monthly Ownership:	$466.48	$563.00	$177.83	$1,865.93	$563.00	$71.77
8c. (1) EAF:	1.231	1.231	1.231	1.231	1.231	1.231
8c. (2) Hrly Repair:	$0.08	$0.54	$0.02	$0.31	$0.54	$0.01
8e. Monthly Operating:	$38.08	$257.04	$9.52	$147.56	$257.04	$4.76
11. Monthly Rate (EA Item):	$504.56	$820.04	$187.35	$2,013.49	$820.04	$76.53
Monthly Rate Per Section (Sum Of Items):			$1,511.95		$2,833.53	$76.53
/ Section Length (In Linear Feet):			100		400	40
			===========		===========	===========
MONTHLY RATES PER LF OF PIPELINE:			$15.12		$7.08	$1.91
5a. Useful Life (in Yrs)...	3.0	3.0	12.0	3.0	3.0	1.5
6a. Depreciation:	30.00%	30.00%	7.50%	30.00%	30.00%	30.00%
6b. FCCM:	3.78%	3.78%	3.17%	3.78%	3.78%	3.78%
6c. Total Ownership/Year:	33.78%	33.78%	10.67%	33.78%	33.78%	33.78%
7a. Yearly Ownership:	$2,195.70	$5,067.00	$1,600.50	$8,782.80	$5,067.00	$337.80
7b. Monthly Ownership:	$243.97	$563.00	$177.83	$975.87	$563.00	$37.53
12a. HRLY STANDBY ALLOW:	$0.334	$0.771	$0.244	$1.337	$0.771	$0.051
Hrly Standby Rate Per Section (Sum Of Items):			$1.349		$2.108	$0.051
/ Section Length (In Linear Feet):			100		400	40
			===========		===========	===========
HOURLY STANDBY RATES PER LF OF PIPELINE:			$0.013		$0.005	$0.001

D \ 4 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE 30"

			REMARKS
1 Shore crew.		$117,713 /MO	
2	+	/MO	
3 >	+	$0 /MO	
4 >	+	$0 /MO	
5 >	+	$0 /MO	
6 >	+	$0 /MO	
7 >	+	$0 /MO	
8 >	+	$0 /MO	
9 >	+	$0 /MO	
10 >	+	$0 /MO	
11 >	+	$0 /MO	
12 >	+	$0 /MO	
13 >	+	$0 /MO	
14 >	+	$0 /MO	
15 TOTAL OTHER MONTHLY COSTS	=	$117,713 /MO	

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT	Barnegat to Little Egg Inlets	DATE OF ESTIMATE	01 Sept 1999
2 LOCATION	Init Const, 125'B/22'D, 7Yr	INVIT. OR CONTR. NO.	Borrow Area D1
3 ESTIMATED BY	Bill Welk	CHECKED BY	
4 TYPE OF DREDGE	30" Cutter-Suction Dredge	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Initial Construction for 125' Berm/22' Dune/7 Yr. Cycle.

Dredge approximately 2,037,000 CY from borrow area D1 and place in BUNDYs 6, 7, and 8.

Initial construction quantity includes one nourishment cycle.

Nourishment cycle quantity includes 1.00 (0%) fill factor for borrow area D1.

6 EXCAVATION

		REMARKS
A. REQUIRED	2,037,000 CY	5,288,365 s.f. of Dredging Area
B. PAY OVERDEPTH	+ 0 CY	
C. MAX. PAY YARDAGE	= 2,037,000 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	- 0 CY	
E. NET PAY YARDAGE	= 2,037,000 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+ 305,600 CY	1.6 ft overdig
G. GROSS YARDAGE	= 2,342,600 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B DREDGING COST BID ITEM # 2

				REMARKS
1 GROSS YARDAGE			2,342,600 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/	484,511 CY/MO	FROM SHEET C, ITEM 8.
3 DREDGING TIME		=	4.83 MONTHS	
4 TOTAL MONTHLY COST		x	$1,133,415	FROM SHEET D, ITEM 5.
SUBTOTAL............=			$5,474,393	
5 FIXED COSTS		+	$0	FROM SHEET E, ITEM 15.
SUBTOTAL.............=			$5,474,393	
6 OVERHEAD	12.0%	+	$656,927	
SUBTOTAL...........=			$6,131,320	
7 PROFIT	10.0%	+	$613,132	
SUBTOTAL.............=			$6,744,452	
8 BOND	1.0%	+	$67,445	
9 GROSS PRODUCTION COSTS		=	$6,811,897	
10 NET PAY YARDAGE		/	2,037,000 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST		=	$3.34 /CY	
12 MAX PAY YARDAGE		x	2,037,000 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		=	$6,803,580	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

			REMARKS
1 SIZE OF DREDGE....PIPELINE.........>		30"	
2 POWER OUTPUT......MAIN PUMP........>		9,000 HP	
3 NUMBER OF BOOSTERS IN LINE.........>		0.6	
4 POWER OUTPUT......EACH BOOSTER.....>		5,200 HP	
5 PUMPING DISTANCES			
A. MAXIMUM PIPELINE NEEDED.........>		39,115 LF	
B. AVERAGE PIPELINE................>		27,504 LF	
C. EQUIVALENT ADDITIONAL PIPELINE	+	300 LF	
D. PRODUCTION BASED ON	=	27,804 LF	
6 GROSS PRODUCTION		1051 CY/HR	SEE SHEET C \ 1, ITEM 4 F.
7 OPERATING TIME	x	461 HRS/MO	SEE SHEET C \ 1, ITEM 5 E.
			(461 Operating Hrs per Mo / 730 Hrs per Mo of Dredging =
			63.2% Effective Time)
8 PRODUCTION RATE	=	484,511 CY/MO	2,037,000 Net Pay CY / 4.83 MO = 421,739 Pay CY/MO

GROSS PRODUCTION

C \ 1 BID ITEM # 2

OPERATING TIME

			REMARKS
1 SIZE OF DREDGE....PIPELINE.........>		30"	
2 POWER OUTPUT......MAIN PUMP........>		9,000 HP	
3 NUMBER OF BOOSTERS IN LINE		0.6	Each Booster is 5200 Horsepower.
4 PRODUCTION.........(BASED ON)......>		27,804 LF	FROM SHEET C \ 2, ITEM 13.
A. ADJUSTED CHART PRODUCTION		1,180 CY/HR	FROM SHEET C \ 2, ITEM 14.
B. MATERIAL FACTOR	x	0.90	FROM SHEET C \ 3, ITEM 1 B.
C. BANK FACTOR	x	1.10	FROM SHEET C \ 3, ITEM 2 D.
D. OTHER FACTOR	x	0.90	Wave Action
E. CLEANUP FACTOR	x	1.00	0% ADDITIONAL DREDGING TIME
F. GROSS PRODUCTION	=	1,051 CY/HR	

			REMARKS
5 OPERATING TIME:			
A. BOOSTER FACTOR		0.94	10% LOSS IN PUMPING TIME PER BOOSTER
B. TIME EFFICIENCY	x	67.2%	% OF EFFECTIVE WORKING TIME WITHOUT BOOSTERS
C. NET EFFICIENCY	=	63.2%	% OF EFFECTIVE WORKING TIME INCLUDING BOOSTER LOSSES
D. MAX DREDGE TIME	x	730 HRS/MO	
E. OPERATING TIME	=	461 HRS/MO	

C \ 2 ADJUSTED CHART PRODUCTION BID ITEM # 2

			REMARKS
1	SIZE OF DREDGE....PIPELINE.........>	30"	
2	CHART HORSEPOWER...................>	9,000 HP	
3	STANDARD PRODUCTION CHART:		
	STANDARD DREDGE PRODUCTION BASED ON CHART HORSEPOWER		
	UP TO 10,380 L.F. OF PIPE	1800 CY/HR	
	AT 20,760 L.F. OF PIPE	1170 CY/HR	
	AT 29,410 L.F. OF PIPE	500 CY/HR	
4	POWER OUTPUT....USED FOR DREDGE....>	9,000 HP	Chart Adjustment Factor = (Available Dredge Horsepower +
5	NUMBER OF BOOSTERS USED............>	0.6	Number of Boosters x Booster H.P.) / Chart H.P.
6	POWER OUTPUT......EACH BOOSTER.....>	5,200 HP	
7	TOTAL POWER APPLIED TO PIPELINE....>	12,120 HP	= (9000 H.P. + 1 Booster(s) x 5200 HP/Booster)
8	CHART ADJUSTMENT FACTOR (C.A.F)....>	1.35	= (12120 HP / 9000 HP)
9	ADJUSTED PRODUCTION CHART:		
	ADJUSTED DREDGE PRODUCTION CHART BASED ON C.A.F.		
	UP TO 14,013 L.F. OF PIPE	1800 CY/HR	
	AT 28,026 L.F. OF PIPE	1170 CY/HR	
	AT 39,704 L.F. OF PIPE	500 CY/HR	
10	MAXIMUM LINE LENGTH................>	39,115 LF	
11	AVERAGE LINE LENGTH................>	27,504 LF	Actual Pipeline
12	EQUIVALENT ADDITIONAL PIPELINE +	300 LF	Vertical Lift of Discharge Pipe.
13	PIPE USED FOR PRODUCTION =	27,804 LF	Actual Pipeline + Equivalent Feet of Pipe
14	ADJUSTED CHART PRODUCTION	1,180 CY/HR	Interpolated from Chart

MATERIAL FACTOR CALCULATION

C \ 3 BID ITEM # 2

BANK FACTOR CALCULATION

1 MATERIAL FACTOR COMPUTATION:

A. MATERIAL FACTOR CHART:

DESCRIPTION	INPLACE DENSITY		FACTOR	%	QUANTITIES
MUD & SILT	1200	GR/L	3	0%	0 c.y.
MUD & SILT	1300	GR/L	2.5	0%	0 c.y.
MUD & SILT	1400	GR/L	2	0%	0 c.y.
LOOSE SAND	1700	GR/L	1.1	0%	0 c.y.
LOOSE SAND	1900	GR/L	1	0%	0 c.y.
COMP. SAND	2000	GR/L	0.9	100%	2,342,600 c.y.
STIFF CLAY	2000	GR/L	0.6	0%	0 c.y.
COMP. SHELL	2300	GR/L	0.5	0%	0 c.y.
SOFT ROCK	2400	GR/L	0.4	0%	0 c.y.
BLAST. ROCK	2000	GR/L	0.25	0%	0 c.y.

B. MATERIAL FACTOR................> 0.90 100% 2,342,600 c.y. (Computed from Chart)

REMARKS

2 BANK FACTOR COMPUTATION:

A. SIZE OF DREDGE....PIPELINE......> 30"

B. AVERAGE BANK HEIGHT.............> 11.96 FT

C. BANK FACTOR CHART:

BANK HEIGHT	1	2	3	4	5	6	7	8	9
FACTOR	NA	0.42	0.53	0.63	0.73	0.83	0.93	1.03	1.1

D. BANK FACTOR....................> 1.10 Interpolated from chart

>

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE 30"

			REMARKS		
1 LABOR COSTS		$350,308 /MO	FROM SHEET D \ 1		
2 EQUIPMENT COSTS			FROM SHEET D \ 2		
A. DREDGE	+	$350,210 /MO	1 EA	@	$350,210 /MO
B. WORK TUG(S)	+	$47,192 /MO	2 EA	@	$23,596 /MO
C. CREW/SURVEY TUG	+	$5,702 /MO	1 EA	@	$5,702 /MO
D. DERRICK(S)	+	$9,658 /MO	2 EA	@	$4,829 /MO
E. FUEL/WATER BARGE	+	$1,755 /MO	1 EA	@	$1,755 /MO
F. WORK BARGE	+	$2,264 /MO	2 EA	@	$1,132 /MO
H. BOOSTER(S)	+	$91,118 /MO	0.6 EA	@	$151,863 /MO
G. ***Unused***	+	$0 /MO	0 EA	@	$0 /MO
3 PIPELINE COSTS BASED ON PUMPING SAND			39,115 LF (ON JOB) - RATES TAKEN FROM SHEET D \ 3		
A. (1) FLOATING PIPE (AVERAGE)	+	$29,589 /MO	1,970 LF	@	$15.02 /MO
(2) FLOATING PIPE (REMAINING)	+	$0 /MO	0 LF	@	$0.013 /HR X 730 HRS/MO
B. (1) SUBMERGED PIPE (AVERAGE)	+	$77,021 /MO	10,925 LF	@	$7.05 /MO
(2) SUBMERGED PIPE (REMAINING)	+	$18,133 /MO	4,968 LF	@	$0.005 /HR X 730 HRS/MO
C. (1) SHORE PIPE (AVERAGE)	+	$27,903 /MO	14,609 LF	@	$1.91 /MO
(2) SHORE PIPE (REMAINING)	+	$4,849 /MO	6,643 LF	@	$0.001 /HR X 730 HRS/MO
4 OTHER MONTHLY COSTS	+	$117,713 /MO	FROM SHEET D \ 4		
5 TOTAL MONTHLY COST	=	$1,133,415			

D \ 1 LABOR COSTS BID ITEM # 2

DREDGE SIZE: 30"

Overtime(Pay 64 Hrs/Wk)		14.29%
Holidays/Yr	8	2.19%
Vacation		8.00%
COMPOSITE		24.48%

Management....

1	CAPTAIN	$6,000
1	CHIEF ENG	5,000
1	CIVIL ENG	4,500
1	OFFICE HELP	2,000
	MONTHLY MANAGEMENT COST	$17,500

Social Security Tax	7.65%
Workman's Compensation	11.60%
State Unemployment Comp.	6.50%
Federal Unemployment Comp.	0.80%
COMPOSITE	26.55%

Each Crew Position is Manned: 8 Hrs per Day
x 7 Days per Week
= 56 Hrs per Week
x 4.345 Wks per Month
= 243 Hrs per Month

Last Update...Sep 99

EA	CREW POSITION	BASIC HOURLY WAGE		O.T. VACATION & HOLIDAY 24.48%		SUB-TOTAL		TAXES INSUR 26.55%		SUB-TOTAL		FRINGE BENEFITS $4.68		HRLY COST		HOURS PER MONTH		MONTHLY COST
3	LEVERMAN	$25.18	+	$6.16	=	$31.34	+	$8.32	=	$39.66	+	$5.41	=	$45.07	x	730	=	$32,901
3	WATCH ENG	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	730	=	29,638
2	DRDG MATE	20.35	+	4.98	=	25.33	+	6.73	=	32.06	+	4.41	=	36.47	x	487	=	17,761
2	TUG MASTER	21.48	+	5.26	=	26.74	+	7.10	=	33.84	+	4.41	=	38.25	x	487	=	18,628
3	LAUNCHMAN	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	730	=	22,287
0	MAINT ENG	21.83	+	5.34	=	27.17	+	7.21	=	34.38	+	4.41	=	38.79	x	0	=	0
3	EQUIP OPER	21.29	+	5.21	=	26.50	+	7.04	=	33.54	+	4.41	=	37.95	x	730	=	27,704
1	WELDER	21.47	+	5.25	=	26.72	+	7.09	=	33.81	+	4.41	=	38.22	x	243	=	9,287
1	OILER	17.23	+	4.22	=	21.45	+	5.69	=	27.14	+	4.41	=	31.55	x	243	=	7,667
9	DECKHAND	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	2190	=	66,861
1	ELECTRICIAN	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	243	=	9,866
1	G DUMP FRMN	22.01	+	5.39	=	27.40	+	7.27	=	34.67	+	5.41	=	40.08	x	243	=	9,739
2	DUMP FOREMN	20.17	+	4.94	=	25.11	+	6.67	=	31.78	+	5.41	=	37.19	x	487	=	18,112
6	SHOREMAN	16.58	+	4.06	=	20.64	+	5.48	=	26.12	+	4.41	=	30.53	x	1460	=	44,574
1.8	BOOSTER ENG	22.34	+	5.47	=	27.81	+	7.38	=	35.19	+	5.41	=	40.60	x	438	=	17,783

39 Total Crew

MONTHLY CREW LABOR COST = $332,808

(Average Gross Wage = $35.25 per manhour)

TOTAL MONTHLY LABOR COST = $350,308

****

D \ 2 EQUIPMENT COSTS BID ITEM # 2

****

DREDGE SIZE 30"

	--DREDGE--	----TUGS & TENDERS-----		--------------BARGES---------------			--BOOSTER--	---OTHER---
1a. Plant Description......	HYDRAULIC	WORK TUG	CREW/SURVEY	DERRICK	FUEL/WATER	WORK	FLOATING	***Unused***
1c. Prime Eng HP...........	9,000	250	100	200	0	0	5,200	0
1d. (1) Dredge El Gen HP...	830	--	--	--	--	--	--	--
1d. Total 2nd Eng HP.......	3,310	50	40	40	10	0	200	0
1e. Plant Value............	$4,955,000	$327,000	$48,000	$244,000	$122,000	$81,000	$2,154,000	$0
1f. Acquis Year............	1978	1991	1991	1985	1985	1985	1980	0
1g. Pres Year..............	1998	->	->	->	->	->	->	->
1h. Cost of Money Rate.....	6.750%	->	->	->	->	->	->	->
1i. Disc Money Rate:	5.400%	->	->	->	->	->	->	->
1j. Hrs Worked/Mo..........	461	->	->	->	->	->	->	->
2a. LAF....................	1.160	->	->	->	->	->	->	->
2b. Fuel Cost per Gal......	$0.85	->	->	->	->	->	->	->
3a. Ec Index <for Acq Yr>..	2352	4438	4438	3749	3749	3749	2922	0
3b. Ec Index <for 1998>....	5676	->	->	->	->	->	->	->
4a. Mos Available/Year.....	9	->	->	->	->	->	->	->
5a. Useful Life (in Yrs)...	30	8	8	20	20	20	30	0
5b. Physical Life (in Hrs).	135,000	16,000	16,000	90,000	90,000	90,000	135,000	0
5c. SLV Factor.............	0.10	0.10	0.10	0.10	0.05	0.05	0.10	0.00
5d. Pr Eng Fuel Factor.....	0.045	0.045	0.045	0.011	0.011	0.011	0.045	0
5e. 2nd Eng Fuel Factor....	0.039	0.039	0.039	0.011	0.011	0.011	0.039	0
5f. WLS Factor.............	0.22	0.38	0.38	0.20	0.20	0.20	0.24	0.00
5g. RPR Factor.............	1.30	0.80	0.80	0.70	0.60	0.60	1.20	0.00
6a. Depreciation:	3.00%	11.25%	11.25%	4.50%	4.75%	4.75%	3.00%	0.00%
6b. FCCM:	3.05%	3.27%	3.27%	3.09%	2.96%	2.96%	3.05%	0.00%
6c. Total Ownership/Year:	6.05%	14.52%	14.52%	7.59%	7.71%	7.71%	6.05%	0.00%
7a. Yearly Ownership:	$299,778	$47,480	$6,970	$18,520	$9,406	$6,245	$130,317	$0
7b. Monthly Ownership:	$33,309	$5,276	$774	$2,058	$1,045	$694	$14,480	$0
8a. (1) Hrly Pr Eng Fuel:	$344.25	$9.56	$3.83	$1.87	$0.00	$0.00	$198.90	$0.00
8a. (2) Hrly 2nd Eng Fuel:	$109.73	$1.66	$1.33	$0.37	$0.09	$0.00	$6.63	$0.00
8b. (1) Hrly Pr Eng WLS:	$75.74	$3.63	$1.46	$0.37	$0.00	$0.00	$47.74	$0.00
8b. (2) Hrly 2nd Eng WLS:	$24.14	$0.63	$0.51	$0.07	$0.02	$0.00	$1.59	$0.00
8c. (1) EAF:	2.413	1.279	1.279	1.514	1.514	1.514	1.943	0.000
8c. (2) Hrly Repair:	$133.56	$24.26	$3.56	$3.33	$1.43	$0.95	$43.15	$0.00
8d. Total Hrly Operating:	$687.42	$39.74	$10.69	$6.01	$1.54	$0.95	$298.01	$0.00
8e. Monthly Operating:	$316,901	$18,320	$4,928	$2,771	$710	$438	$137,383	$0
11. MONTHLY RATE:	$350,210	$23,596	$5,702	$4,829	$1,755	$1,132	$151,863	$0
12a. HRLY STANDBY ALLOW:	$45.63	$7.23	$1.06	$2.82	$1.43	$0.95	$19.84	$0.00
12b. Gener Fuel Allowance:	$27.52	--	--	--	--	--	--	--
12c. DREDGE HOURLY STANDBY:	$73.15	--	--	--	--	--	--	--

D \ 3 PIPELINE COSTS BID ITEM # 2

PIPELINE SIZE: 30" MATERIAL PUMPED: SAND

	FLOATING PIPELINE			SUBMERGED PIPELINE		SHOREPIPE
1a. Plant Description......	Pipeline	Joints	Pontoons	Pipeline	Joints	Pipeline
Quantity.............>	100	1	2	400	1	40
Fixed Units Per Item..>	LF	Set	Each	LF	Set	LF
Unit Price...........>	$65.00	$15,000.00	$7,500.00	$65.00	$15,000.00	$25.00
1e. Plant Value:	$6,500.00	$15,000.00	$15,000.00	$26,000.00	$15,000.00	$1,000.00
1f. Acquis Year...........	1992	1992	1992	1992	1992	1992
1g. Pres Year.............	1998	->	->	->	->	->
1h. Cost of Money Rate.....	6.750%	->	->	->	->	->
1i. Disc Money Rate:	5.400%	->	->	->	->	->
1j. Hrs Worked/Mo.........	461	->	->	->	->	->
2a. LAF....................	1.160	->	->	->	->	->
3a. Ec Index <for Acq Yr>..	4611	4611	4611	4611	4611	4611
3b. Ec Index <for 1998>....	5676	->	->	->	->	->
4a. Mos Available/Year.....	9	->	->	->	->	->
5a. Useful Life (in Yrs)...	1.5	3.0	12.0	1.5	3.0	1.5
5b. Physical Life (in Hrs).	6,000	12,000	60,000	6,000	12,000	6,000
5c. SLV Factor............	0.10	0.10	0.10	0.10	0.10	0.10
5g. RPR Factor............	0.05	0.30	0.05	0.05	0.30	0.05
6a. Depreciation:	60.00%	30.00%	7.50%	60.00%	30.00%	60.00%
6b. FCCM:	4.59%	3.78%	3.17%	4.59%	3.78%	4.59%
6c. Total Ownership/Year:	64.59%	33.78%	10.67%	64.59%	33.78%	64.59%
7a. Yearly Ownership:	$4,198.35	$5,067.00	$1,600.50	$16,793.40	$5,067.00	$645.90
7b. Monthly Ownership:	$466.48	$563.00	$177.83	$1,865.93	$563.00	$71.77
8c. (1) EAF:	1.231	1.231	1.231	1.231	1.231	1.231
8c. (2) Hrly Repair:	$0.08	$0.54	$0.02	$0.31	$0.54	$0.01
8e. Monthly Operating:	$36.88	$248.94	$9.22	$142.91	$248.94	$4.61
11. Monthly Rate (EA Item):	$503.36	$811.94	$187.05	$2,008.84	$811.94	$76.38
Monthly Rate Per Section (Sum Of Items):			$1,502.35		$2,820.78	$76.38
/ Section Length (In Linear Feet):			100		400	40
MONTHLY RATES PER LF OF PIPELINE:			$15.02		$7.05	$1.91
5a. Useful Life (in Yrs)...	3.0	3.0	12.0	3.0	3.0	1.5
6a. Depreciation:	30.00%	30.00%	7.50%	30.00%	30.00%	30.00%
6b. FCCM:	3.78%	3.78%	3.17%	3.78%	3.78%	3.78%
6c. Total Ownership/Year:	33.78%	33.78%	10.67%	33.78%	33.78%	33.78%
7a. Yearly Ownership:	$2,195.70	$5,067.00	$1,600.50	$8,782.80	$5,067.00	$337.80
7b. Monthly Ownership:	$243.97	$563.00	$177.83	$975.87	$563.00	$37.53
12a. HRLY STANDBY ALLOW:	$0.334	$0.771	$0.244	$1.337	$0.771	$0.051
Hrly Standby Rate Per Section (Sum Of Items):			$1.349		$2.108	$0.051
/ Section Length (In Linear Feet):			100		400	40
HOURLY STANDBY RATES PER LF OF PIPELINE:			$0.013		$0.005	$0.001

D \ 4 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE 30"

				REMARKS
1	Shore crew.		$117,713 /MO	
2		+	/MO	
3	>	+	$0 /MO	
4	>	+	$0 /MO	
5	>	+	$0 /MO	
6	>	+	$0 /MO	
7	>	+	$0 /MO	
8	>	+	$0 /MO	
9	>	+	$0 /MO	
10	>	+	$0 /MO	
11	>	+	$0 /MO	
12	>	+	$0 /MO	
13	>	+	$0 /MO	
14	>	+	$0 /MO	
15	TOTAL OTHER MONTHLY COSTS	=	$117,713 /MO	

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT	Barnegat to Little Egg Inlets	DATE OF ESTIMATE	02 Sep 99
2 LOCATION	Init Const, 125'B/22'D, 7Yr	INVIT. OR CONTR. NO.	Borrow Area D1
3 ESTIMATED BY	Bill Welk	CHECKED BY	Jose Alvarez
4 TYPE OF DREDGE	4000 CYD HOPPER DREDGE	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Initial Construction for 125' Berm/25' Dune/7 Yr. Cycle.

Dredge approximately 1,692,000 CY of material obtained from borrow area D1 and deposit it in BUNDYs 9 and 10.

Mooring barge located 1,663' off BUNDY 9.

Includes 1.00 (0%) FF for Area D1.

6 EXCAVATION

			REMARKS
A. REQUIRED		1,692,000 CY	
B. PAY OVERDEPTH	+	0 CY	
C. MAX. PAY YARDAGE	=	1,692,000 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	0 CY	
E. NET PAY YARDAGE	=	1,692,000 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	338,400 CY	20.0 % of Net Pay
G. GROSS YARDAGE	=	2,030,400 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B	DREDGING COST	BID ITEM #	2

			REMARKS
1 GROSS YARDAGE		2,030,400 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/ 393,080 CY/MO	FROM SHEET C, ITEM 9.
3 DREDGING TIME		= 5.17 MONTHS	
4 TOTAL MONTHLY COST		x $1,360,056	FROM SHEET D
SUBTOTAL............=		$7,031,487	
5 FIXED COSTS		+ $10,000	FROM SHEET E
SUBTOTAL..............=		$7,041,487	
6 OVERHEAD	12.0%	+ $844,978	
SUBTOTAL............=		$7,886,465	
7 PROFIT	10.0%	+ $788,647	
SUBTOTAL..............=		$8,675,112	
8 BOND	1.0%	+ $86,751	
9 GROSS PRODUCTION COSTS		= $8,761,863	
10 NET PAY YARDAGE		/ 1,692,000 CY	FROM SHEET A, ITEM 6 E.

11 UNIT COST		= $5.18 /CY	
12 MAX PAY YARDAGE		x 1,692,000 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		= $8,764,560	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

			REMARKS
1 AVERAGE UNADJUSTED CYCLE TIME		271 min/load	SEE SHEET C \ 1, ITEM 3.
2 CLEANUP FACTOR	/	1.00	0% ADDITIONAL DREDGING TIME (100% / 10%)
3 AVERAGE CYCLE TIME		271 min/load	
4 CONVERSION TO HOURS		60 min/hr	
5 AVERAGE CYCLE TIME	/	271 min/load	THIS SHEET, ITEM 3.
6 EFFECTIVE HOPPER CAPACITY	x	2,800 cy/load	
7 GROSS PRODUCTION	=	620 CY/HR	

			REMARKS
8 OPERATING TIME:			
A. TIME EFFICIENCY		86.9%	% OF EFFECTIVE WORKING TIME
B. MAX DREDGE TIME	x	730 HRS/MO	
C. OPERATING TIME	=	634 HRS/MO	
9 PRODUCTION RATE	=	393,080 CY/MO	1,692,000 Net Pay CY / 5.17 MO = 327,273 Pay CY/MO
10 LOADS PER DAY		4.6	(1440 MIN/DAY / 271 MIN/LOAD) X 86.9% EWT
11 PROJECT DURATION		5.17 MONTHS	

PRODUCTION WORK SHEET

C \ 1 BID ITEM # 2

CYCLE TIME

1 DREDGE USED:

A. DESCRIPTION OF DREDGE 4000 CYD HOPPER DREDGE

B. EFFECTIVE HOPPER CAPACITY 2,800 cy/load

2 TIME PER AVERAGE LOAD CYCLE:

			REMARKS
A. EXCAVATING		117 min	(2,800 cy / 1,440 cy/hr) x 60 min/hr.
B. TURNING	+	10 min	1 turns at 10 minutes per turn.
C. TO DISPOSAL OR MOORING	+	29 min	(4.8 miles / 9.8 mph) x 60 min/hr.
D. DUMPING OR CONNECT TO PIPELINE	+	20 min	TYPE OF DISPOSAL----> PUMPOUT
E. PUMPOUT THROUGH PIPELINE	+	70 min	(2,800 cy / 2,400 cy/hr) x 60 min/hr.
F. FROM DISPOSAL OR MOORING	+	25 min	(4.8 miles / 11.7 mph) x 60 min/hr.
3 AVERAGE UNADJUSTED CYCLE TIME	=	271 min/load	

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1 LABOR COSTS		$349,496 /MO	FROM SHEET D \ 1
2 EQUIPMENT			
A. DREDGE	+	$712,244 /MO	FROM SHEET D \ 2
PROPULSION TUG	+	self prop./MO	
B. CREW/SURVEY VESSEL	+	$8,000 /MO	
C. BOOSTER	+	$0 /MO	
D. CRANE BARGE	+	$0 /MO	
E. TENDER TUG	+	$10,000 /MO	
F. OTHER MARINE	+	$150,000 /MO	Mooring Barge
G. SHORE EQUIPMENT	+	$0 /MO	
3 TRAVEL EXPENSE	+	$12,603 /MO	(30.42 dys/mo / 28 dys x $400 rt x 29 ea)
4 OTHER MONTHLY COSTS	+	$117,713 /MO	FROM SHEET D \ 3
5 TOTAL MONTHLY COST	=	$1,360,056	

****

D \ 1 LABOR COSTS BID ITEM # 2

****

Last Update...Oct 99

DREDGE SIZE: 4000 CYD HOPPER DREDGE

		Social Security Tax	7.65%
		Employ. Liability Tax	11.00%
Overtime %	28.00%	Workers comp.	2.40%
Vacation & Holiday %	8.64%	Unemployment tax	5.13%
	--------		--------
COMPOSITE.................	36.64%	COMPOSITE....................	26.18%

EA	CREW	BASIC HOURLY WAGE		O.T. VACATION & HOLIDAY 36.64% AMOUNT		SUB-TOTAL AMOUNT		TAXES INSUR 26.18% AMOUNT		SUB-TOTAL AMOUNT		FRINGE BENEFITS $3.11 AMOUNT		HRLY COST AMOUNT		HOURS PER MONTH		MONTHLY COST
	Dredgecrew...																	
1	CAPTAIN	41.50	+	15.21	=	56.71	+	14.84	=	71.55	+	3.11	=	74.66	x	365	=	$27,251
1	CHIEF ENG	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	ENGINEER	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	MATE	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	365	=	$12,983
2	DRAGTENDER	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	730	=	$25,966
2	WATCH AB	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	730	=	$22,718
1	COOK	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	365	=	$11,359
1	STEWARD	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	365	=	$10,465
4	SEAMAN AB	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	1460	=	$41,858
2	AB WIPER	13.08	+	4.79	=	17.87	+	4.68	=	22.55	+	3.11	=	25.66	x	730	=	$18,732
2	LAUNCHMAN	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	730	=	$15,805
1	TURTLE MON.	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	365	=	$7,902
----																		===========
19	Crew on Dredge									TOTAL DREDGE MONTHLY LABOR COST =								$223,421
	Shorecrew...																	
1	SUPERINT	21.79	+	7.98	=	29.77	+	7.79	=	37.56	+	3.11	=	40.67	x	365	=	$14,845
3	DUMP FOREMN	20.35	+	7.46	=	27.81	+	7.28	=	35.09	+	3.11	=	38.20	x	1095	=	$41,829
0	EQUIP OPER	25.62	+	9.39	=	35.01	+	9.16	=	44.17	+	3.11	=	47.28	x	0	=	$0
6	SHOREMAN	16.58	+	6.07	=	22.65	+	5.93	=	28.58	+	3.11	=	31.69	x	2190	=	$69,401
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0

29 Total Crew TOTAL MONTHLY LABOR COST = $349,496

(Average Gross Wage = $33.02 per manhour)

****

D \ 2 DREDGE OWNERSHIP & OPERATING COST SUMMARY BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1. OWNERSHIP COSTS:

		RATES		MOB/DEMOB RATES
Ownership Elements	$	151,440 /MO	$	151,440 /MO
Facilities Capitol Cost of Money (FCCM)	$	61,212 /MO	$	61,212 /MO
TOTAL..	$	212,652 /MO	$	212,652 /MO

2. OPERATING COSTS:

		RATES		MOB/DEMOB RATES
Fuel	$	227.00 /HR	$	281.10 /HR
Lubricants	$	19.00 /HR	$	19.00 /HR
Repairs and Maintenance	$	300.00 /HR		
Pump and Pipe Wear & Repairs	$	218.90 /HR		
Provisions and Supplies	$	23.00 /HR	$	20.00 /HR
SUBTOTAL (For Mobilization)	$	788 /HR	$	320 /HR
Effective Working Time = (730 HRS/MO x 86.9% EWT)	x	634 HRS/MO		
Calendar Time per Month (Mob/Demob uses Calendar Time)			x	730 HRS/MO
TOTAL..	$	499,592 /MO	$	233,600 /MO

3. TOTAL OWNERSHIP & OPERATING COSTS:

		RATES		MOB/DEMOB RATES
Total Ownership Costs	$	212,652 /MO	$	212,652 /MO
Total Operating Costs	$	499,592 /MO	$	233,600 /MO
TOTAL..	$	712,244 /MO	$	446,252 /MO

****

D \ 2A DREDGE OWNERSHIP COSTS BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

ACQUISITION COST (A):	$18,000,000
CAPITAL IMPROVEMENTS (I) @ 10% OF (A):	$1,800,000
(A + I)	$19,800,000

COST OF MONEY RATE (FULL RATE):	6.750%	USE MONTHS PER YEAR (UMPY):	10 months
DISCOUNTED MONEY RATE:	5.400%	MARINE INSURANCE (MI):	1.50%
SALVAGE VALUE FACTOR (S):	10%	TAXES (TA):	1.00%
ECONOMIC LIFE (N):	20 yrs	LAYUP (LU):	$48,000 per layup month
YEAR COMMISSIONED:	1987	YARD COST (Y):	$6,700 per month

CALCULATIONS

1. OWNERSHIP ELEMENTS:

A. DEPRECIATION = (A+I)*[1-S]/N	= ($19,800,000) x [1 - 10%] / 20 yrs	= $	891,000	/YR
B. MARINE INSURANCE = MI(A+I)	= 1.50% x ($19,800,000)	= $	297,000	/YR
C. TAXES = TA(A+I)	= 1.00% x ($19,800,000)	= $	198,000	/YR
E. LAYUP = (LU)(12-1-UMPY)	= ($48,000 per mo) x (12 mo/yr - 1 mo - 10 mo	= $	48,000	/YR
F. YARD = 12(Y)	= 12 mo x ($6,700 per mo)	= $	80,400	/YR
G. YEARLY OWNERSHIP	= (Sum of Items 1.a. thru 1.f.)	= $	1,514,400	/YR
H. MONTHLY OWNERSHIP = (yrly Ownership / UMPY)	= ($1,514,400 / 10 mo)	= $	151,440	/MO

2. FACILITIES CAPITAL COST OF MONEY (FCCM):

A. YEARLY FCCM = (A+I)[(N-1)(1+S)+2] x Discounted Money Rate / 2N

= ($19,800,000) [(20 yrs - 1)(1 + 10%) + 2] x (5.40%) / [(2)(20 yrs)] = $ 612,117 /YR

B. MONTHLY FCCM = (yrly FCCM / UMPY) = ($612,117 / 10 mo) = $ 61,212 /MO

D \ 2B OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL

A. TABLE A. FUEL CONSUMPTION FACTORS:

F U E L F A C T O R (G A L / B H P - H R)

	Propulsion		Pumps		Aux & Misc	
Type of Work	%	factor	%	factor	%	factor
Excavating	45	0.024	50	0.027	30	0.016
Haul and Return	80	0.042	0	0.000	25	0.013
Pumpout	0	0.000	80	0.042	25	0.013
Non-Effective	0	0.000	0	0.000	25	0.013

B. POWER REQUIREMENTS FOR FUEL CONSUMPTION FOR THE DREDGE (From Database):

	SUMMARY OF RATED HP (1)		TOTAL REQUIRED HP (2)
DESCRIPTION	ELECTRIC	DIESEL	DIESEL
Propulsion	6,000	0	7,415
Dredge Pump(s)	2,000	0	2,470
Jet Pump	1,000	0	1,235
Pumpout Pump(s)	4,400	0	5,440
Auxillary & Misc	1,200	0	1,485

(1). Rated hp is the output power of drive engines or motors or equivalent hp of other misc electrical loads.

(2). Total required hp is the rated bhp of engines when the type of power is diesel, or the rated bhp of generator engines providing the power when the type of power is electric.

****

D \ 2C OPERATING COSTS - FUEL BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL (CONT.)

C. FUEL USE DURING DREDGING: F U E L U S E C O N S U M P T I O N S U M M A R Y

DESCRIPTION	EXCAVATING	TURNING, SAILING & DISPOSAL	PUMPOUT	TOTAL NON-EFFECTIVE TIME	TOTALS	JET @ 100% OF EXCAV TIME
Cycle Time In Min.	117	84	70	41	312	117
% Of Total Cycle Time	37.5%	26.9%	22.4%	13.1%	99.9%	37.5%
FUEL CONSUMPTION IN GAL/HR (1)						
Propulsion	66.7	83.8	0.0		150.5	
Pumps (2 dragheads used)	25.0	0.0	23.2		48.2	12.5
Auxillary & Misc.	8.9	5.2	4.3	2.5	20.9	
Subtotals:	100.6	89.0	27.5	2.5	219.6	12.5

Average Hourly Fuel Consumption (Effective and Non-Effective Time): 232.1 GAL/HR

Historical Fuel Consumption DATA Not Available or Not Used.......

Average Hourly Fuel Cost @ $0.85 per gallon = $ 197.29 /HR

FUEL RATE (Adjusted to Effective Time Basis: $197.29 / 86.9%) = $ 227.00 /HR

D. DURING MOB & DEMOB OPERATION:

Propulsion = (Propulsion hp x Propulsion factor during sailing) = 311.4 GAL/HR

Aux. & Misc. = (Aux. & Misc. hp x Aux. & Misc. factor during Mob & Demob) = 19.3 GAL/HR

Average Hourly Fuel Consumption (During Mob & Demob): 330.7 GAL/HR

FUEL RATE (Average Hourly Fuel Cost @ $0.85 per gallon) = $ 281.10 /HR

NOTES: (1). Computations = (% of Total Cycle Time) x (Fuel Factor from Table A.) x (Horsepower).

D \ 2D OPERATING COSTS - LUBRICANTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Base Price Level (Cost in Tables B & C)	1988
Base Index (EP 1110-1-8, App E, EK 105)	3920
Current Price Level (Cost in Tables B & C)	1998
Current Index (EP 1110-1-8, App E, EK 105)	5676

TABLE B. LUBRICANTS, REPAIRS AND MAINTENANCE.

TOTAL INSTALLED HP OF DREDGE	LUBE $/HR (1)	REPAIRS & MAINTENANCE $/HR (2)
0 - 3999 HP	$6.40	$158.00
4000 - 4999 HP	$8.20	$177.00
5000 - 5999 HP	$10.00	$195.00
6000 - 6999 HP	$11.80	$219.00
7000 - 7999 HP	$13.60	$239.00
8000 - 8999 HP	$15.40	$259.00
9000 - 9999 HP	$17.20	$279.00
10000 - 10999 HP	$19.00	$300.00
11000 - 11999 HP	$20.90	$320.00
12000 - 12999 HP	$22.70	$340.00
13000 - 13999 HP	$24.50	$361.00
14000 - 14999 HP	$26.30	$382.00
15000 - 15999 HP	$28.10	$400.00
16000 - 16999 HP	$29.90	$423.00
17000 - 17999 HP	$31.70	$443.00

(1) LUBRICANTS Includes materials only.

(2) Includes all repairs and maintenance to all components except pumps and discharge piping for pumpout, including parts, labor, small tools, equipment and drydocking.

2 LUBRICANTS (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 19.00 /HR

3 REPAIRS AND MAINTENANCE (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 300.00 /HR

D \ 2E OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

	DREDGED QUANTITIES:		PUMPOUT QUANTITIES:	
TYPE	%	TOTAL CY	%	TOTAL CY
Mud:	0%	0	100%	0
Sand:	100%	2,030,400	100%	2,030,400
Gravel:	0%	0	100%	0
Combined:	100%	2,030,400	100%	2,030,400

TABLE C. COST DATA FOR PUMP & PIPE WEAR AND REPAIRS

PUMP WEAR COST / CY OF MATERIAL PUMPED

DISCHARGE DIAM.	MUD	SAND	GRAVEL
16	$0.013	$0.041	$0.116
18	$0.014	$0.046	$0.132
20	$0.016	$0.054	$0.148
24	$0.020	$0.065	$0.180
28	$0.023	$0.078	$0.210
34	$0.029	$0.097	$0.258

PUMPOUT PIPE WEAR COST PER (CY PUMPED x LF OF PUMPOUT PIPE)

DISCHARGE DIAM.	MUD	SAND	GRAVEL
12	$0.000029	$0.000038	$0.000058
14	$0.000026	$0.000033	$0.000051
16	$0.000022	$0.000029	$0.000045
18	$0.000020	$0.000026	$0.000039
22	$0.000017	$0.000023	$0.000035
27	$0.000016	$0.000020	$0.000030
30	$0.000014	$0.000016	$0.000026

D \ 2F OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

4 PUMP AND PIPE WEAR AND REPAIRS

DESCRIPTION	TOTAL WEAR AND REPAIRS COST		
	MUD	SAND	GRAVEL
PUMP SIZE: 27''			
QUANTITY DREDGED (CY)	0 CY	2,030,400 CY	0 CY
% PUMPOUT	100%	100%	100%
PUMPS: (From Table C.)			
Dredge Pumps	$ 0	$ 131,976	$ 0
Pumpout Pumps	$ 0	$ 131,976	$ 0
SUBTOTALS: PUMPS -	0	263,952	$ 0
TOTAL PUMP WEAR.......................................			$ 263,952
DISCHARGE PIPES:			
Pumpout Line Length	11,180 LF	11,180 LF	11,180 LF
Pipe Wear Cost	$ 0	$ 453,997	$ 0
SUBTOTALS: DISCHARGE PIPES -	$ 0	$ 453,997	$ 0
TOTAL PIPE WEAR.......................................			$ 453,997

TOTAL COST FOR PUMP AND PIPE WEAR AND REPAIRS: $ 717,949 TOTAL

AVERAGE COST PER CY EXCAVATED: $ 0.35 /CY

TOTAL COST/HR = TOTAL WEAR COST/(TOTAL JOB EFFECTIVE HRS) =
= $717,949 / (5.17 mo x 730 hrs/mo x 86.9% EWT) = $ 218.90 /HR

5 PROVISIONS & SUPPLIES

ACTUAL CREW = 29 EA

GOVERNMENT PERSONNEL ON DREDGE = 3 EA

TOTAL PROVISIONS @ ($15.00/ MAN-DAY x 32 ea) / 24 HRS/DAY = $ 20.00 /HR

PROV & SUPPL RATE (Adjusted to Effective Time Basis: $20.00 / 86.9%) = $ 23.00 /HR

****

D \ 2G DREDGE INFO FROM DATABASE BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Name Of Plant - - - - - - - - - - ->	R. N. WEEKS
Acquistion Cost - - - - - - - - - ->	$18,000,000
Capital Improvements - - - - - - ->	10% Added Cost
Year Commisioned - - - - - - - - ->	1987
Economic Life - - - - - - - - - - ->	20 years
Salvage Factor - - - - - - - - - ->	0.10
Propulsion Tug Needed ? - - - - ->	NO
Propulsion Tug Cost - - - - - - ->	self prop.
Marine Insurance - - - - - - - - ->	1.5 %
Taxes - - - - - - - - - - - - - - ->	1 %
Layup Cost - - - - - - - - - - - ->	$48,000 /mo
Yard Cost - - - - - - - - - - - ->	$6,700 /mo
Water Volume of Hopper - - - - - ->	4,000 cy
Max. Safe Load (Sand) - - - - - ->	2,800 cy
Mud Capacity of Hopper - - - - - ->	1,200 cy
Sand Capacity of Hopper - - - - ->	2,000 cy
Gravel Capacity of Hopper - - - ->	1,600 cy
Mud Production Rate - - - - - - ->	2,400 cy/hr
Sand Production Rate - - - - - - ->	1,440 cy/hr
Gravel Production Rate - - - - - ->	480 cy/hr
# Of Dragheads Available - - - - ->	2
Suction Pipe Diam. - - - - - - - ->	27 inches
Discharge Pipe Diam. - - - - - - ->	27 inches
Min. Digging Depth - - - - - - - ->	NA ft
Max. Digging Depth - - - - - - - ->	70 ft
Draft Loaded - - - - - - - - - - ->	19.5 ft
Speed Loaded (knots) - - - - - - ->	10 (11.5 mph)
Speed Light (knots) - - - - - - ->	12 (13.8 mph)
Pumpout Available - - - - - - - ->	YES
Pumpout Pipe Diam. - - - - - - - ->	27 inches
Max. Pumpout Length - - - - - - ->	20,000 lf
Pumpout Rate - - - - - - - - - - ->	2,400 cy/hr
Total Installed Horsepower - - - ->	10,300
Propulsion Horsepower - - - - - ->	6000 (Electric)
Dredge Pump Horsepower - - - - - ->	2000 (Electric)
Pumpout Horsepower - - - - - - - ->	4400 (Electric)
Jet Pump Horsepower - - - - - - ->	1000 (Electric)
Auxiliary Engine Horsepower - - ->	1200 (Electric)
Auxiliary Engine Horsepower - - ->	0 (Diesel)
Main Generator Horsepower - - - ->	10300 (Diesel)
Survey Vessel Cost - - - - - - - ->	$0 /mo
Pumpout Booster Cost - - - - - - ->	$125,000 /mo
Crane Barge Cost - - - - - - - - ->	$7,000 /mo
Tender Tug Cost - - - - - - - - ->	$0 /mo
Crew Size - - - - - - - - - - - ->	23

D \ 3 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1	>Shore crew.	$117,713 /MO	
2	>	+ $0 /MO	
3	>	+ $0 /MO	
4	>	+ $0 /MO	
5	>	+ $0 /MO	
6	>	+ $0 /MO	
7	>	+ $0 /MO	
8	>	+ $0 /MO	
9	>	+ $0 /MO	
10	>	+ $0 /MO	
11	>	+ $0 /MO	
12	>	+ $0 /MO	
13	>	+ $0 /MO	
14	>	+ $0 /MO	
15	TOTAL OTHER MONTHLY COSTS	= $117,713 /MO	

E FIXED COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1 Cutterhead mod for seaturtles.		$10,000	
2 >	+	$0	
3 >	+	$0	
4 >	+	$0	
5 >	+	$0	
6 >	+	$0	
7 >	+	$0	
8 >	+	$0	
9 >	+	$0	
10 >	+	$0	
11 >	+	$0	
12 >	+	$0	
13 >	+	$0	
14 >	+	$0	
15 FIXED COSTS	=	$10,000	

****

A DESCRIPTION AND QUANTITY SUMMARY

****

1 PROJECT	Barnegat to Little Egg Inlets	DATE OF ESTIMATE	01 Sep 99
2 LOCATION	Init Const, 125'B/22'D, 7Yr	INVIT. OR CONTR. NO.	Borrow Area D1
3 ESTIMATED BY	Bill Welk	CHECKED BY	
4 TYPE OF DREDGE	4000 CYD HOPPER DREDGE	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Initial Construction for 125' Berm/25' Dune/7 Yr. Cycle.

Dredge approximately 1,470,000 CY of material obtained from borrow area D1 and

deposit it in BUNDYs 11, 12, and 13.

Mooring barge located 3,150' off BUNDY 11.

Includes 1.00 (0%) FF for Area D1.

6 EXCAVATION

			REMARKS
A. REQUIRED		1,470,000 CY	
B. PAY OVERDEPTH	+	0 CY	
C. MAX. PAY YARDAGE	=	1,470,000 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	0 CY	
E. NET PAY YARDAGE	=	1,470,000 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	294,000 CY	20.0 % of Net Pay
G. GROSS YARDAGE	=	1,764,000 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B DREDGING COST BID ITEM # 2

				REMARKS
1 GROSS YARDAGE			1,764,000 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/	351,236 CY/MO	FROM SHEET C, ITEM 9.
3 DREDGING TIME		=	5.02 MONTHS	
4 TOTAL MONTHLY COST		x	$1,356,252	FROM SHEET D
SUBTOTAL............=			$6,808,383	
5 FIXED COSTS		+	$10,000	FROM SHEET E
SUBTOTAL.............=			$6,818,383	
6 OVERHEAD	12.0%	+	$818,206	
SUBTOTAL............=			$7,636,589	
7 PROFIT	10.0%	+	$763,659	
SUBTOTAL.............=			$8,400,248	
8 BOND	1.0%	+	$84,002	
9 GROSS PRODUCTION COSTS		=	$8,484,250	
10 NET PAY YARDAGE		/	1,470,000 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST		=	$5.77 /CY	
12 MAX PAY YARDAGE		x	1,470,000 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		=	$8,481,900	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

			REMARKS
1 AVERAGE UNADJUSTED CYCLE TIME		303 min/load	SEE SHEET C \ 1, ITEM 3.
2 CLEANUP FACTOR	/	1.00	0% ADDITIONAL DREDGING TIME (100% / 10%)
3 AVERAGE CYCLE TIME		303 min/load	
4 CONVERSION TO HOURS		60 min/hr	
5 AVERAGE CYCLE TIME	/	303 min/load	THIS SHEET, ITEM 3.
6 EFFECTIVE HOPPER CAPACITY	x	2,800 cy/load	
7 GROSS PRODUCTION	=	554 CY/HR	

			REMARKS
8 OPERATING TIME:			
A. TIME EFFICIENCY		86.9%	% OF EFFECTIVE WORKING TIME
B. MAX DREDGE TIME	x	730 HRS/MO	
C. OPERATING TIME	=	634 HRS/MO	
9 PRODUCTION RATE	=	351,236 CY/MO	1,470,000 Net Pay CY / 5.02 MO = 292,829 Pay CY/MO
10 LOADS PER DAY		4.1	(1440 MIN/DAY / 303 MIN/LOAD) X 86.9% EWT
11 PROJECT DURATION		5.02 MONTHS	

PRODUCTION WORK SHEET

C \ 1 BID ITEM # 2

CYCLE TIME

1 DREDGE USED:

A. DESCRIPTION OF DREDGE 4000 CYD HOPPER DREDGE

B. EFFECTIVE HOPPER CAPACITY 2,800 cy/load

			REMARKS
2 TIME PER AVERAGE LOAD CYCLE:			
A. EXCAVATING		117 min	(2,800 cy / 1,440 cy/hr) x 60 min/hr.
B. TURNING	+	10 min	1 turns at 10 minutes per turn.
C. TO DISPOSAL OR MOORING	+	47 min	(7.7 miles / 9.8 mph) x 60 min/hr.
D. DUMPING OR CONNECT TO PIPELINE	+	20 min	TYPE OF DISPOSAL----> PUMPOUT
E. PUMPOUT THROUGH PIPELINE	+	70 min	(2,800 cy / 2,400 cy/hr) x 60 min/hr.
F. FROM DISPOSAL OR MOORING	+	39 min	(7.7 miles / 11.7 mph) x 60 min/hr.

3 AVERAGE UNADJUSTED CYCLE TIME = 303 min/load

****

D MONTHLY COST SUMMARY BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1 LABOR COSTS		$349,496 /MO	FROM SHEET D \ 1
2 EQUIPMENT			
A. DREDGE	+	$708,440 /MO	FROM SHEET D \ 2
PROPULSION TUG	+	self prop./MO	
B. CREW/SURVEY VESSEL	+	$8,000 /MO	
C. BOOSTER	+	$0 /MO	
D. CRANE BARGE	+	$0 /MO	
E. TENDER TUG	+	$10,000 /MO	
F. OTHER MARINE	+	$150,000 /MO	Mooring Barge
G. SHORE EQUIPMENT	+	$0 /MO	
3 TRAVEL EXPENSE	+	$12,603 /MO	(30.42 dys/mo / 28 dys x $400 rt x 29 ea)
4 OTHER MONTHLY COSTS	+	$117,713 /MO	FROM SHEET D \ 3
5 TOTAL MONTHLY COST	=	$1,356,252	

****

D \ 1 LABOR COSTS BID ITEM # 2

Last Update...Oct 99

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Overtime %	28.00%	Social Security Tax	7.65%
Vacation & Holiday %	8.64%	Employ. Liability Tax	11.00%
		Workers comp.	2.40%
		Unemployment tax	5.13%
COMPOSITE.................	36.64%	COMPOSITE....................	26.18%

EA	CREW	BASIC HOURLY WAGE		O.T. VACATION & HOLIDAY 36.64% AMOUNT		SUB-TOTAL AMOUNT		TAXES INSUR 26.18% AMOUNT		SUB-TOTAL AMOUNT		FRINGE BENEFITS $3.11 AMOUNT		HRLY COST AMOUNT		HOURS PER MONTH		MONTHLY COST
	Dredgecrew...																	
1	CAPTAIN	41.50	+	15.21	=	56.71	+	14.84	=	71.55	+	3.11	=	74.66	x	365	=	$27,251
1	CHIEF ENG	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	ENGINEER	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	MATE	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	365	=	$12,983
2	DRAGTENDER	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	730	=	$25,966
2	WATCH AB	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	730	=	$22,718
1	COOK	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	365	=	$11,359
1	STEWARD	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	365	=	$10,465
4	SEAMAN AB	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	1460	=	$41,858
2	AB WIPER	13.08	+	4.79	=	17.87	+	4.68	=	22.55	+	3.11	=	25.66	x	730	=	$18,732
2	LAUNCHMAN	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	730	=	$15,805
1	TURTLE MON.	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	365	=	$7,902
19	Crew on Dredge											TOTAL DREDGE MONTHLY LABOR COST =						$223,421
	Shorecrew...																	
1	SUPERINT	21.79	+	7.98	=	29.77	+	7.79	=	37.56	+	3.11	=	40.67	x	365	=	$14,845
3	DUMP FOREMN	20.35	+	7.46	=	27.81	+	7.28	=	35.09	+	3.11	=	38.20	x	1095	=	$41,829
0	EQUIP OPER	25.62	+	9.39	=	35.01	+	9.16	=	44.17	+	3.11	=	47.28	x	0	=	$0
6	SHOREMAN	16.58	+	6.07	=	22.65	+	5.93	=	28.58	+	3.11	=	31.69	x	2190	=	$69,401
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
29	Total Crew											TOTAL MONTHLY LABOR COST =						$349,496

(Average Gross Wage = $33.02 per manhour)

D \ 2 DREDGE OWNERSHIP & OPERATING COST SUMMARY BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

		RATES		MOB/DEMOB RATES
1. OWNERSHIP COSTS:				
Ownership Elements	$	151,440 /MO	$	151,440 /MO
Facilities Capitol Cost of Money (FCCM)	$	61,212 /MO	$	61,212 /MO
TOTAL	$	212,652 /MO	$	212,652 /MO
2. OPERATING COSTS:				
Fuel	$	233.00 /HR	$	281.10 /HR
Lubricants	$	19.00 /HR	$	19.00 /HR
Repairs and Maintenance	$	300.00 /HR		
Pump and Pipe Wear & Repairs	$	207.10 /HR		
Provisions and Supplies	$	23.00 /HR	$	20.00 /HR
SUBTOTAL (For Mobilization)	$	782 /HR	$	320 /HR
Effective Working Time = (730 HRS/MO x 86.9% EWT)	x	634 HRS/MO		
Calendar Time per Month (Mob/Demob uses Calendar Time)			x	730 HRS/MO
TOTAL	$	495,788 /MO	$	233,600 /MO
3. TOTAL OWNERSHIP & OPERATING COSTS:				
Total Ownership Costs	$	212,652 /MO	$	212,652 /MO
Total Operating Costs	$	495,788 /MO	$	233,600 /MO
TOTAL	$	708,440 /MO	$	446,252 /MO

****

D \ 2A DREDGE OWNERSHIP COSTS BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

ACQUISITION COST (A):	$18,000,000
CAPITAL IMPROVEMENTS (I) @ 10% OF (A):	$1,800,000
(A + I)	$19,800,000

COST OF MONEY RATE (FULL RATE):	6.750%	USE MONTHS PER YEAR (UMPY):	10 months
DISCOUNTED MONEY RATE:	5.400%	MARINE INSURANCE (MI):	1.50%
SALVAGE VALUE FACTOR (S):	10%	TAXES (TA):	1.00%
ECONOMIC LIFE (N):	20 yrs	LAYUP (LU):	$48,000 per layup month
YEAR COMMISSIONED:	1987	YARD COST (Y):	$6,700 per month

CALCULATIONS

1. OWNERSHIP ELEMENTS:

A. DEPRECIATION = (A+I)*[1-S]/N	= ($19,800,000) x [1 - 10%] / 20 yrs	= $	891,000	/YR
B. MARINE INSURANCE = MI(A+I)	= 1.50% x ($19,800,000)	= $	297,000	/YR
C. TAXES = TA(A+I)	= 1.00% x ($19,800,000)	= $	198,000	/YR
E. LAYUP = (LU)(12-1-UMPY)	= ($48,000 per mo) x (12 mo/yr - 1 mo - 10 mo	= $	48,000	/YR
F. YARD = 12(Y)	= 12 mo x ($6,700 per mo)	= $	80,400	/YR
G. YEARLY OWNERSHIP	= (Sum of Items 1.a. thru 1.f.)	= $	1,514,400	/YR
H. MONTHLY OWNERSHIP = (yrly Ownership / UMPY)	= ($1,514,400 / 10 mo)	= $	151,440	/MO

2. FACILITIES CAPITAL COST OF MONEY (FCCM):

A. YEARLY FCCM = (A+I)[(N-1)(1+S)+2] x Discounted Money Rate / 2N

= ($19,800,000) [(20 yrs - 1)(1 + 10%) + 2] x (5.40%) / [(2)(20 yrs)] = $ 612,117 /YR

B. MONTHLY FCCM = (yrly FCCM / UMPY) = ($612,117 / 10 mo) = $ 61,212 /MO

D \ 2B OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL

A. TABLE A. FUEL CONSUMPTION FACTORS:

F U E L F A C T O R (G A L / B H P - H R)

Type of Work	Propulsion %	Propulsion factor	Pumps %	Pumps factor	Aux & Misc %	Aux & Misc factor
Excavating	45	0.024	50	0.027	30	0.016
Haul and Return	80	0.042	0	0.000	25	0.013
Pumpout	0	0.000	80	0.042	25	0.013
Non-Effective	0	0.000	0	0.000	25	0.013

B. POWER REQUIREMENTS FOR FUEL CONSUMPTION FOR THE DREDGE (From Database):

DESCRIPTION	SUMMARY OF RATED HP (1) ELECTRIC	SUMMARY OF RATED HP (1) DIESEL	TOTAL REQUIRED HP (2) DIESEL
Propulsion	6,000	0	7,415
Dredge Pump(s)	2,000	0	2,470
Jet Pump	1,000	0	1,235
Pumpout Pump(s)	4,400	0	5,440
Auxillary & Misc	1,200	0	1,485

(1). Rated hp is the output power of drive engines or motors or equivalent hp of other misc electrical loads.

(2). Total required hp is the rated bhp of engines when the type of power is diesel, or the rated bhp of generator engines providing the power when the type of power is electric.

D \ 2C OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL (CONT.)

C. FUEL USE DURING DREDGING: F U E L U S E C O N S U M P T I O N S U M M A R Y

DESCRIPTION	EXCAVATING	TURNING, SAILING & DISPOSAL	PUMPOUT	TOTAL NON-EFFECTIVE TIME	TOTALS	JET @ 100% OF EXCAV TIME
Cycle Time In Min.	117	116	70	46	349	117
% Of Total Cycle Time	33.5%	33.2%	20.1%	13.2%	100.0%	33.5%
FUEL CONSUMPTION IN GAL/HR (1)						
Propulsion	59.6	103.4	0.0		163.0	
Pumps (2 dragheads used)	22.3	0.0	20.9		43.2	11.2
Auxillary & Misc.	8.0	6.4	3.9	2.5	20.8	
Subtotals:	89.9	109.8	24.8	2.5	227.0	11.2

Average Hourly Fuel Consumption (Effective and Non-Effective Time): 238.2 GAL/HR

Historical Fuel Consumption DATA Not Available or Not Used........

Average Hourly Fuel Cost @ $0.85 per gallon = $ 202.47 /HR

FUEL RATE (Adjusted to Effective Time Basis: $202.47 / 86.9%) = $ 233.00 /HR

D. DURING MOB & DEMOB OPERATION:

Propulsion = (Propulsion hp x Propulsion factor during sailing) = 311.4 GAL/HR

Aux. & Misc. = (Aux. & Misc. hp x Aux. & Misc. factor during Mob & Demob) = 19.3 GAL/HR

Average Hourly Fuel Consumption (During Mob & Demob): 330.7 GAL/HR

FUEL RATE (Average Hourly Fuel Cost @ $0.85 per gallon) = $ 281.10 /HR

NOTES: (1). Computations = (% of Total Cycle Time) x (Fuel Factor from Table A.) x (Horsepower).

****

D \ 2D OPERATING COSTS - LUBRICANTS BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Base Price Level (Cost in Tables B & C)	1988
Base Index (EP 1110-1-8, App E, EK 105)	3920
Current Price Level (Cost in Tables B & C)	1998
Current Index (EP 1110-1-8, App E, EK 105)	5676

TABLE B. LUBRICANTS, REPAIRS AND MAINTENANCE.

TOTAL INSTALLED HP OF DREDGE	LUBE $/HR (1)	REPAIRS & MAINTENANCE $/HR (2)
0 - 3999 HP	$6.40	$158.00
4000 - 4999 HP	$8.20	$177.00
5000 - 5999 HP	$10.00	$195.00
6000 - 6999 HP	$11.80	$219.00
7000 - 7999 HP	$13.60	$239.00
8000 - 8999 HP	$15.40	$259.00
9000 - 9999 HP	$17.20	$279.00
10000 - 10999 HP	$19.00	$300.00
11000 - 11999 HP	$20.90	$320.00
12000 - 12999 HP	$22.70	$340.00
13000 - 13999 HP	$24.50	$361.00
14000 - 14999 HP	$26.30	$382.00
15000 - 15999 HP	$28.10	$400.00
16000 - 16999 HP	$29.90	$423.00
17000 - 17999 HP	$31.70	$443.00

(1) LUBRICANTS Includes materials only.

(2) Includes all repairs and maintenance to all components except pumps and discharge piping for pumpout, including parts, labor, small tools, equipment and drydocking.

2 LUBRICANTS (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 19.00 /HR

3 REPAIRS AND MAINTENANCE (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 300.00 /HR

****

D \ 2E OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

	DREDGED QUANTITIES:		PUMPOUT QUANTITIES:	
TYPE	%	TOTAL CY	%	TOTAL CY
Mud:	0%	0	100%	0
Sand:	100%	1,764,000	100%	1,764,000
Gravel:	0%	0	100%	0
Combined:	100%	1,764,000	100%	1,764,000

TABLE C. COST DATA FOR PUMP & PIPE WEAR AND REPAIRS

PUMP WEAR COST / CY OF MATERIAL PUMPED

DISCHARGE DIAM.	MUD	SAND	GRAVEL
16	$0.013	$0.041	$0.116
18	$0.014	$0.046	$0.132
20	$0.016	$0.054	$0.148
24	$0.020	$0.065	$0.180
28	$0.023	$0.078	$0.210
34	$0.029	$0.097	$0.258

PUMPOUT PIPE WEAR COST PER (CY PUMPED x LF OF PUMPOUT PIPE)

DISCHARGE DIAM.	MUD	SAND	GRAVEL
12	$0.000029	$0.000038	$0.000058
14	$0.000026	$0.000033	$0.000051
16	$0.000022	$0.000029	$0.000045
18	$0.000020	$0.000026	$0.000039
22	$0.000017	$0.000023	$0.000035
27	$0.000016	$0.000020	$0.000030
30	$0.000014	$0.000016	$0.000026

D \ 2F OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

4 PUMP AND PIPE WEAR AND REPAIRS

DESCRIPTION		TOTAL WEAR AND REPAIRS COST MUD		SAND		GRAVEL
PUMP SIZE: 27''						
QUANTITY DREDGED (CY)		0 CY		1,764,000 CY		0 CY
% PUMPOUT		100%		100%		100%
PUMPS: (From Table C.)						
Dredge Pumps	$	0	$	114,660	$	0
Pumpout Pumps	$	0	$	114,660	$	0
SUBTOTALS: PUMPS -		0		229,320	$	0
TOTAL PUMP WEAR..					$	229,320
DISCHARGE PIPES:						
Pumpout Line Length		12,197 LF		12,197 LF		12,197 LF
Pipe Wear Cost	$	0	$	430,310	$	0
SUBTOTALS: DISCHARGE PIPES -	$	0	$	430,310	$	0
TOTAL PIPE WEAR..					$	430,310

TOTAL COST FOR PUMP AND PIPE WEAR AND REPAIRS: $ 659,630 TOTAL

AVERAGE COST PER CY EXCAVATED: $ 0.37 /CY

TOTAL COST/HR = TOTAL WEAR COST/(TOTAL JOB EFFECTIVE HRS) =
= $659,630 / (5.02 mo x 730 hrs/mo x 86.9% EWT) = $ 207.10 /HR

5 PROVISIONS & SUPPLIES

ACTUAL CREW = 29 EA

GOVERNMENT PERSONNEL ON DREDGE = 3 EA

TOTAL PROVISIONS @ ($15.00/ MAN-DAY x 32 ea) / 24 HRS/DAY = $ 20.00 /HR

PROV & SUPPL RATE (Adjusted to Effective Time Basis: $20.00 / 86.9%) = $ 23.00 /HR

****

D \ 2G DREDGE INFO FROM DATABASE BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Name Of Plant - - - - - - - - - - ->	R. N. WEEKS
Acquistion Cost - - - - - - - - - ->	$18,000,000
Capital Improvements - - - - - - - ->	10% Added Cost
Year Commisioned - - - - - - - - - ->	1987
Economic Life - - - - - - - - - - ->	20 years
Salvage Factor - - - - - - - - - - ->	0.10
Propulsion Tug Needed ? - - - - - ->	NO
Propulsion Tug Cost - - - - - - - ->	self prop.
Marine Insurance - - - - - - - - - ->	1.5 %
Taxes - - - - - - - - - - - - - - ->	1 %
Layup Cost - - - - - - - - - - - - ->	$48,000 /mo
Yard Cost - - - - - - - - - - - - ->	$6,700 /mo
Water Volume of Hopper - - - - - - ->	4,000 cy
Max. Safe Load (Sand) - - - - - - ->	2,800 cy
Mud Capacity of Hopper - - - - - - ->	1,200 cy
Sand Capacity of Hopper - - - - - ->	2,000 cy
Gravel Capacity of Hopper - - - - ->	1,600 cy
Mud Production Rate - - - - - - - ->	2,400 cy/hr
Sand Production Rate - - - - - - - ->	1,440 cy/hr
Gravel Production Rate - - - - - - ->	480 cy/hr
# Of Dragheads Available - - - - - ->	2
Suction Pipe Diam. - - - - - - - - ->	27 inches
Discharge Pipe Diam. - - - - - - - ->	27 inches
Min. Digging Depth - - - - - - - - ->	NA ft
Max. Digging Depth - - - - - - - - ->	70 ft
Draft Loaded - - - - - - - - - - - ->	19.5 ft
Speed Loaded (knots) - - - - - - - ->	10 (11.5 mph)
Speed Light (knots) - - - - - - - ->	12 (13.8 mph)
Pumpout Available - - - - - - - - ->	YES
Pumpout Pipe Diam. - - - - - - - - ->	27 inches
Max. Pumpout Length - - - - - - - ->	20,000 lf
Pumpout Rate - - - - - - - - - - - ->	2,400 cy/hr
Total Installed Horsepower - - - - ->	10,300
Propulsion Horsepower - - - - - - ->	6000 (Electric)
Dredge Pump Horsepower - - - - - - ->	2000 (Electric)
Pumpout Horsepower - - - - - - - - ->	4400 (Electric)
Jet Pump Horsepower - - - - - - - ->	1000 (Electric)
Auxiliary Engine Horsepower - - - ->	1200 (Electric)
Auxiliary Engine Horsepower - - - ->	0 (Diesel)
Main Generator Horsepower - - - - ->	10300 (Diesel)
Survey Vessel Cost - - - - - - - - ->	$0 /mo
Pumpout Booster Cost - - - - - - - ->	$125,000 /mo
Crane Barge Cost - - - - - - - - - ->	$7,000 /mo
Tender Tug Cost - - - - - - - - - ->	$0 /mo
Crew Size - - - - - - - - - - - - - ->	23

D \ 3 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

				REMARKS
1	>Shore crew.		$117,713 /MO	
2	>	+	$0 /MO	
3	>	+	$0 /MO	
4	>	+	$0 /MO	
5	>	+	$0 /MO	
6	>	+	$0 /MO	
7	>	+	$0 /MO	
8	>	+	$0 /MO	
9	>	+	$0 /MO	
10	>	+	$0 /MO	
11	>	+	$0 /MO	
12	>	+	$0 /MO	
13	>	+	$0 /MO	
14	>	+	$0 /MO	
15	TOTAL OTHER MONTHLY COSTS	=	$117,713 /MO	

E FIXED COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1 Cutterhead mod for seaturtles.		$10,000	
2 >	+	$0	
3 >	+	$0	
4 >	+	$0	
5 >	+	$0	
6 >	+	$0	
7 >	+	$0	
8 >	+	$0	
9 >	+	$0	
10 >	+	$0	
11 >	+	$0	
12 >	+	$0	
13 >	+	$0	
14 >	+	$0	
15 FIXED COSTS	=	$10,000	

A DESCRIPTION AND QUANTITY SUMMARY

1 PROJECT	Barnegat to Little Egg Inlets	DATE OF ESTIMATE	01 Sep 99
2 LOCATION	Init Const, 125'B/22'D, 7Yr	INVIT. OR CONTR. NO.	Borrow Area D1
3 ESTIMATED BY	Bill Welk	CHECKED BY	
4 TYPE OF DREDGE	4000 CYD HOPPER DREDGE	TYPE OF ESTIMATE	Planning Estimate

5 DESCRIPTION OF WORK

Initial Construction for 125' Berm/25' Dune/7 Yr. Cycle.

Dredge approximately 918,000 CY of material obtained from borrow area D1 and deposit it in BUNDYs 14 and 15.

Mooring barge located 2,217' off BUNDY 14.

Includes 1.00 (0%) FF for Area D1.

6 EXCAVATION

			REMARKS
A. REQUIRED		918,000 CY	
B. PAY OVERDEPTH	+	0 CY	
C. MAX. PAY YARDAGE	=	918,000 CY	(YARDAGE USED ON BID FORM)
D. O.D. NOT DREDGED	-	0 CY	
E. NET PAY YARDAGE	=	918,000 CY	(YARDAGE USED TO FIGURE UNIT PRICE PER C.Y.)
F. NON-PAY YARDAGE	+	183,600 CY	20.0 % of Net Pay
G. GROSS YARDAGE	=	1,101,600 CY	(YARDAGE USED TO FIGURE PRODUCTION TIME & COST)

B	DREDGING COST		BID ITEM # 2

			REMARKS
1 GROSS YARDAGE		1,101,600 CY	FROM SHEET A, ITEM 6 G.
2 PRODUCTION RATE		/ 313,196 CY/MO	FROM SHEET C, ITEM 9.
3 DREDGING TIME		= 3.52 MONTHS	
4 TOTAL MONTHLY COST		x $1,315,042	FROM SHEET D
SUBTOTAL............=		$4,628,946	
5 FIXED COSTS		+ $10,000	FROM SHEET E
SUBTOTAL..............=		$4,638,946	
6 OVERHEAD	12.0%	+ $556,674	
SUBTOTAL............=		$5,195,620	
7 PROFIT	10.0%	+ $519,562	
SUBTOTAL..............=		$5,715,182	
8 BOND	1.0%	+ $57,152	
9 GROSS PRODUCTION COSTS		= $5,772,334	
10 NET PAY YARDAGE		/ 918,000 CY	FROM SHEET A, ITEM 6 E.
11 UNIT COST		= $6.29 /CY	
12 MAX PAY YARDAGE		x 918,000 CY	FROM SHEET A, ITEM 6 C.
13 DREDGING COST		= $5,774,220	

C MONTHLY PRODUCTION SUMMARY BID ITEM # 2

			REMARKS
1 AVERAGE UNADJUSTED CYCLE TIME		340 min/load	SEE SHEET C \ 1, ITEM 3.
2 CLEANUP FACTOR	/	1.00	0% ADDITIONAL DREDGING TIME (100% / 10%)
3 AVERAGE CYCLE TIME		340 min/load	
4 CONVERSION TO HOURS		60 min/hr	
5 AVERAGE CYCLE TIME	/	340 min/load	THIS SHEET, ITEM 3.
6 EFFECTIVE HOPPER CAPACITY	x	2,800 cy/load	
7 GROSS PRODUCTION	=	494 CY/HR	

			REMARKS
8 OPERATING TIME:			
A. TIME EFFICIENCY		86.9%	% OF EFFECTIVE WORKING TIME
B. MAX DREDGE TIME	x	730 HRS/MO	
C. OPERATING TIME	=	634 HRS/MO	
9 PRODUCTION RATE	=	313,196 CY/MO	918,000 Net Pay CY / 3.52 MO = 260,795 Pay CY/MO
10 LOADS PER DAY		3.7	(1440 MIN/DAY / 340 MIN/LOAD) X 86.9% EWT
11 PROJECT DURATION		3.52 MONTHS	

PRODUCTION WORK SHEET

C \ 1 BID ITEM # 2

CYCLE TIME

1 DREDGE USED:

A. DESCRIPTION OF DREDGE 4000 CYD HOPPER DREDGE

B. EFFECTIVE HOPPER CAPACITY 2,800 cy/load

			REMARKS
2 TIME PER AVERAGE LOAD CYCLE:			
A. EXCAVATING		117 min	(2,800 cy / 1,440 cy/hr) x 60 min/hr.
B. TURNING	+	10 min	1 turns at 10 minutes per turn.
C. TO DISPOSAL OR MOORING	+	67 min	(11.0 miles / 9.8 mph) x 60 min/hr.
D. DUMPING OR CONNECT TO PIPELINE	+	20 min	TYPE OF DISPOSAL----> PUMPOUT
E. PUMPOUT THROUGH PIPELINE	+	70 min	(2,800 cy / 2,400 cy/hr) x 60 min/hr.
F. FROM DISPOSAL OR MOORING	+	56 min	(11.0 miles / 11.7 mph) x 60 min/hr.
3 AVERAGE UNADJUSTED CYCLE TIME	=	340 min/load	

D MONTHLY COST SUMMARY BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1 LABOR COSTS		$349,496 /MO	FROM SHEET D \ 1
2 EQUIPMENT			
A. DREDGE	+	$667,230 /MO	FROM SHEET D \ 2
PROPULSION TUG	+	self prop./MO	
B. CREW/SURVEY VESSEL	+	$8,000 /MO	
C. BOOSTER	+	$0 /MO	
D. CRANE BARGE	+	$0 /MO	
E. TENDER TUG	+	$10,000 /MO	
F. OTHER MARINE	+	$150,000 /MO	Mooring Barge
G. SHORE EQUIPMENT	+	$0 /MO	
3 TRAVEL EXPENSE	+	$12,603 /MO	(30.42 dys/mo / 28 dys x $400 rt x 29 ea)
4 OTHER MONTHLY COSTS	+	$117,713 /MO	FROM SHEET D \ 3
5 TOTAL MONTHLY COST	=	$1,315,042	

D \ 1 LABOR COSTS BID ITEM # 2

Last Update...Oct 99

DREDGE SIZE: 4000 CYD HOPPER DREDGE

		Social Security Tax	7.65%
		Employ. Liability Tax	11.00%
Overtime %	28.00%	Workers comp.	2.40%
Vacation & Holiday %	8.64%	Unemployment tax	5.13%
COMPOSITE.................	36.64%	COMPOSITE....................	26.18%

EA	CREW	BASIC HOURLY WAGE		O.T. VACATION & HOLIDAY 36.64% AMOUNT		SUB-TOTAL AMOUNT		TAXES INSUR 26.18% AMOUNT		SUB-TOTAL AMOUNT		FRINGE BENEFITS $3.11 AMOUNT		HRLY COST AMOUNT		HOURS PER MONTH		MONTHLY COST
	Dredgecrew...																	
1	CAPTAIN	41.50	+	15.21	=	56.71	+	14.84	=	71.55	+	3.11	=	74.66	x	365	=	$27,251
1	CHIEF ENG	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	ENGINEER	20.75	+	7.60	=	28.35	+	7.42	=	35.77	+	3.11	=	38.88	x	365	=	$14,191
1	MATE	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	365	=	$12,983
2	DRAGTENDER	18.83	+	6.90	=	25.73	+	6.73	=	32.46	+	3.11	=	35.57	x	730	=	$25,966
2	WATCH AB	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	730	=	$22,718
1	COOK	16.25	+	5.95	=	22.20	+	5.81	=	28.01	+	3.11	=	31.12	x	365	=	$11,359
1	STEWARD	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	365	=	$10,465
4	SEAMAN AB	14.83	+	5.43	=	20.26	+	5.30	=	25.56	+	3.11	=	28.67	x	1460	=	$41,858
2	AB WIPER	13.08	+	4.79	=	17.87	+	4.68	=	22.55	+	3.11	=	25.66	x	730	=	$18,732
2	LAUNCHMAN	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	730	=	$15,805
1	TURTLE MON.	10.75	+	3.94	=	14.69	+	3.85	=	18.54	+	3.11	=	21.65	x	365	=	$7,902
19	Crew on Dredge									TOTAL DREDGE MONTHLY LABOR COST =								$223,421
	Shorecrew...																	
1	SUPERINT	21.79	+	7.98	=	29.77	+	7.79	=	37.56	+	3.11	=	40.67	x	365	=	$14,845
3	DUMP FOREMN	20.35	+	7.46	=	27.81	+	7.28	=	35.09	+	3.11	=	38.20	x	1095	=	$41,829
0	EQUIP OPER	25.62	+	9.39	=	35.01	+	9.16	=	44.17	+	3.11	=	47.28	x	0	=	$0
6	SHOREMAN	16.58	+	6.07	=	22.65	+	5.93	=	28.58	+	3.11	=	31.69	x	2190	=	$69,401
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
0	OTHER	0.00	+	0.00	=	0.00	+	0.00	=	0.00	+	3.11	=	3.11	x	0	=	$0
29	Total Crew									TOTAL MONTHLY LABOR COST =								$349,496

(Average Gross Wage = $33.02 per manhour)

D \ 2 DREDGE OWNERSHIP & OPERATING COST SUMMARY BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

		RATES		MOB/DEMOB RATES
1. OWNERSHIP COSTS:				
Ownership Elements	$	151,440 /MO	$	151,440 /MO
Facilities Capitol Cost of Money (FCCM)	$	61,212 /MO	$	61,212 /MO
TOTAL	$	212,652 /MO	$	212,652 /MO
2. OPERATING COSTS:				
Fuel	$	238.80 /HR	$	281.10 /HR
Lubricants	$	19.00 /HR	$	19.00 /HR
Repairs and Maintenance	$	300.00 /HR		
Pump and Pipe Wear & Repairs	$	136.10 /HR		
Provisions and Supplies	$	23.00 /HR	$	20.00 /HR
SUBTOTAL (For Mobilization)	$	717 /HR	$	320 /HR
Effective Working Time = (730 HRS/MO x 86.9% EWT)	x	634 HRS/MO		
Calendar Time per Month (Mob/Demob uses Calendar Time)			x	730 HRS/MO
TOTAL	$	454,578 /MO	$	233,600 /MO
3. TOTAL OWNERSHIP & OPERATING COSTS:				
Total Ownership Costs	$	212,652 /MO	$	212,652 /MO
Total Operating Costs	$	454,578 /MO	$	233,600 /MO
TOTAL	$	667,230 /MO	$	446,252 /MO

****

D \ 2A DREDGE OWNERSHIP COSTS BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

ACQUISITION COST (A):	$18,000,000
CAPITAL IMPROVEMENTS (I) @ 10% OF (A):	$1,800,000
(A + I)	$19,800,000

COST OF MONEY RATE (FULL RATE):	6.750%	USE MONTHS PER YEAR (UMPY):	10 months
DISCOUNTED MONEY RATE:	5.400%	MARINE INSURANCE (MI):	1.50%
SALVAGE VALUE FACTOR (S):	10%	TAXES (TA):	1.00%
ECONOMIC LIFE (N):	20 yrs	LAYUP (LU):	$48,000 per layup month
YEAR COMMISSIONED:	1987	YARD COST (Y):	$6,700 per month

CALCULATIONS

1. OWNERSHIP ELEMENTS:

A. DEPRECIATION = (A+I)*[1-S]/N	=	($19,800,000) x [1 - 10%] / 20 yrs	= $	891,000	/YR
B. MARINE INSURANCE = MI(A+I)	=	1.50% x ($19,800,000)	= $	297,000	/YR
C. TAXES = TA(A+I)	=	1.00% x ($19,800,000)	= $	198,000	/YR
E. LAYUP = (LU)(12-1-UMPY)	=	($48,000 per mo) x (12 mo/yr - 1 mo - 10 mo	= $	48,000	/YR
F. YARD = 12(Y)	=	12 mo x ($6,700 per mo)	= $	80,400	/YR
G. YEARLY OWNERSHIP	=	(Sum of Items 1.a. thru 1.f.)	= $	1,514,400	/YR
H. MONTHLY OWNERSHIP = (yrly Ownership / UMPY)	=	($1,514,400 / 10 mo)	= $	151,440	/MO

2. FACILITIES CAPITAL COST OF MONEY (FCCM):

A. YEARLY FCCM = (A+I)[(N-1)(1+S)+2] x Discounted Money Rate / 2N

= ($19,800,000) [(20 yrs - 1)(1 + 10%) + 2] x (5.40%) / [(2)(20 yrs)] = $ 612,117 /YR

B. MONTHLY FCCM = (yrly FCCM / UMPY) = ($612,117 / 10 mo) = $ 61,212 /MO

D \ 2B OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL

A. TABLE A. FUEL CONSUMPTION FACTORS:

F U E L F A C T O R (G A L / B H P - H R)

	Propulsion		Pumps		Aux & Misc	
Type of Work	%	factor	%	factor	%	factor
Excavating	45	0.024	50	0.027	30	0.016
Haul and Return	80	0.042	0	0.000	25	0.013
Pumpout	0	0.000	80	0.042	25	0.013
Non-Effective	0	0.000	0	0.000	25	0.013

B. POWER REQUIREMENTS FOR FUEL CONSUMPTION FOR THE DREDGE (From Database):

	SUMMARY OF RATED HP (1)		TOTAL REQUIRED HP (2)
DESCRIPTION	ELECTRIC	DIESEL	DIESEL
Propulsion	6,000	0	7,415
Dredge Pump(s)	2,000	0	2,470
Jet Pump	1,000	0	1,235
Pumpout Pump(s)	4,400	0	5,440
Auxillary & Misc	1,200	0	1,485

(1). Rated hp is the output power of drive engines or motors or equivalent hp of other misc electrical loads.

(2). Total required hp is the rated bhp of engines when the type of power is diesel, or the rated bhp of generator engines providing the power when the type of power is electric.

D \ 2C OPERATING COSTS - FUEL BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

1 FUEL (CONT.)

C. FUEL USE DURING DREDGING: F U E L U S E C O N S U M P T I O N S U M M A R Y

DESCRIPTION	EXCAVATING	TURNING, SAILING & DISPOSAL	PUMPOUT	TOTAL NON-EFFECTIVE TIME	TOTALS	JET @ 100% OF EXCAV TIME
Cycle Time In Min.	117	153	70	51	391	117
% Of Total Cycle Time	29.9%	39.1%	17.9%	13.0%	99.9%	29.9%
FUEL CONSUMPTION IN GAL/HR (1)						
Propulsion	53.2	121.8	0.0		175.0	
Pumps (2 dragheads used)	19.9	0.0	18.6		38.5	10.0
Auxillary & Misc.	7.1	7.5	3.5	2.5	20.6	
Subtotals:	80.2	129.3	22.1	2.5	234.1	10.0

Average Hourly Fuel Consumption (Effective and Non-Effective Time): 244.1 GAL/HR

Historical Fuel Consumption DATA Not Available or Not Used........

Average Hourly Fuel Cost @ $0.85 per gallon = $ 207.49 /HR

FUEL RATE (Adjusted to Effective Time Basis: $207.49 / 86.9%) = $ 238.80 /HR

D. DURING MOB & DEMOB OPERATION:

Propulsion = (Propulsion hp x Propulsion factor during sailing) = 311.4 GAL/HR

Aux. & Misc. = (Aux. & Misc. hp x Aux. & Misc. factor during Mob & Demob) = 19.3 GAL/HR

Average Hourly Fuel Consumption (During Mob & Demob): 330.7 GAL/HR

FUEL RATE (Average Hourly Fuel Cost @ $0.85 per gallon) = $ 281.10 /HR

NOTES: (1). Computations = (% of Total Cycle Time) x (Fuel Factor from Table A.) x (Horsepower).

D \ 2D OPERATING COSTS - LUBRICANTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Base Price Level (Cost in Tables B & C)	1988
Base Index (EP 1110-1-8, App E, EK 105)	3920
Current Price Level (Cost in Tables B & C)	1998
Current Index (EP 1110-1-8, App E, EK 105)	5676

TABLE B. LUBRICANTS, REPAIRS AND MAINTENANCE.

TOTAL INSTALLED HP OF DREDGE	LUBE $/HR (1)	REPAIRS & MAINTENANCE $/HR (2)
0 - 3999 HP	$6.40	$158.00
4000 - 4999 HP	$8.20	$177.00
5000 - 5999 HP	$10.00	$195.00
6000 - 6999 HP	$11.80	$219.00
7000 - 7999 HP	$13.60	$239.00
8000 - 8999 HP	$15.40	$259.00
9000 - 9999 HP	$17.20	$279.00
10000 - 10999 HP	$19.00	$300.00
11000 - 11999 HP	$20.90	$320.00
12000 - 12999 HP	$22.70	$340.00
13000 - 13999 HP	$24.50	$361.00
14000 - 14999 HP	$26.30	$382.00
15000 - 15999 HP	$28.10	$400.00
16000 - 16999 HP	$29.90	$423.00
17000 - 17999 HP	$31.70	$443.00

(1) LUBRICANTS Includes materials only.

(2) Includes all repairs and maintenance to all components except pumps and discharge piping for pumpout, including parts, labor, small tools, equipment and drydocking.

2 LUBRICANTS (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 19.00 /HR

3 REPAIRS AND MAINTENANCE (From Table B.)

TOTAL INSTALLED POWER = 10,300 HP $ 300.00 /HR

D \ 2E OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

	DREDGED QUANTITIES:		PUMPOUT QUANTITIES:	
TYPE	%	TOTAL CY	%	TOTAL CY
Mud:	0%	0	100%	0
Sand:	100%	1,101,600	100%	1,101,600
Gravel:	0%	0	100%	0
Combined:	100%	1,101,600	100%	1,101,600

TABLE C. COST DATA FOR PUMP & PIPE WEAR AND REPAIRS

PUMP WEAR COST / CY OF MATERIAL PUMPED

DISCHARGE DIAM.	MUD	SAND	GRAVEL
16	$0.013	$0.041	$0.116
18	$0.014	$0.046	$0.132
20	$0.016	$0.054	$0.148
24	$0.020	$0.065	$0.180
28	$0.023	$0.078	$0.210
34	$0.029	$0.097	$0.258

PUMPOUT PIPE WEAR COST PER (CY PUMPED x LF OF PUMPOUT PIPE)

DISCHARGE DIAM.	MUD	SAND	GRAVEL
12	$0.000029	$0.000038	$0.000058
14	$0.000026	$0.000033	$0.000051
16	$0.000022	$0.000029	$0.000045
18	$0.000020	$0.000026	$0.000039
22	$0.000017	$0.000023	$0.000035
27	$0.000016	$0.000020	$0.000030
30	$0.000014	$0.000016	$0.000026

D \ 2F OPERATING COSTS - PUMP & PIPELINE BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

4 PUMP AND PIPE WEAR AND REPAIRS

DESCRIPTION	TOTAL WEAR AND REPAIRS COST MUD	SAND	GRAVEL
PUMP SIZE: 27''			
QUANTITY DREDGED (CY)	0 CY	1,101,600 CY	0 CY
% PUMPOUT	100%	100%	100%
PUMPS: (From Table C.)			
Dredge Pumps	$ 0	$ 71,604	$ 0
Pumpout Pumps	$ 0	$ 71,604	$ 0
SUBTOTALS: PUMPS -	0	143,208	$ 0
TOTAL PUMP WEAR...			$ 143,208
DISCHARGE PIPES:			
Pumpout Line Length	7,299 LF	7,299 LF	7,299 LF
Pipe Wear Cost	$ 0	$ 160,812	$ 0
SUBTOTALS: DISCHARGE PIPES -	$ 0	$ 160,812	$ 0
TOTAL PIPE WEAR...			$ 160,812

TOTAL COST FOR PUMP AND PIPE WEAR AND REPAIRS: $ 304,020 TOTAL

AVERAGE COST PER CY EXCAVATED: $ 0.28 /CY

TOTAL COST/HR = TOTAL WEAR COST/(TOTAL JOB EFFECTIVE HRS) =
= $304,020 / (3.52 mo x 730 hrs/mo x 86.9% EWT) = $ 136.10 /HR

5 PROVISIONS & SUPPLIES

ACTUAL CREW = 29 EA

GOVERNMENT PERSONNEL ON DREDGE = 3 EA

TOTAL PROVISIONS @ ($15.00/ MAN-DAY x 32 ea) / 24 HRS/DAY = $ 20.00 /HR

PROV & SUPPL RATE (Adjusted to Effective Time Basis: $20.00 / 86.9%) = $ 23.00 /HR

****

D \ 2G DREDGE INFO FROM DATABASE BID ITEM # 2

****

DREDGE SIZE: 4000 CYD HOPPER DREDGE

Name Of Plant - - - - - - - - - - ->	R. N. WEEKS
Acquistion Cost - - - - - - - - - ->	$18,000,000
Capital Improvements - - - - - - ->	10% Added Cost
Year Commisioned - - - - - - - - ->	1987
Economic Life - - - - - - - - - - ->	20 years
Salvage Factor - - - - - - - - - - ->	0.10
Propulsion Tug Needed ? - - - - ->	NO
Propulsion Tug Cost - - - - - - - ->	self prop.
Marine Insurance - - - - - - - - - ->	1.5 %
Taxes - - - - - - - - - - - - - - ->	1 %
Layup Cost - - - - - - - - - - - - ->	$48,000 /mo
Yard Cost - - - - - - - - - - - - ->	$6,700 /mo
Water Volume of Hopper - - - - - ->	4,000 cy
Max. Safe Load (Sand) - - - - - ->	2,800 cy
Mud Capacity of Hopper - - - - - ->	1,200 cy
Sand Capacity of Hopper - - - - ->	2,000 cy
Gravel Capacity of Hopper - - - ->	1,600 cy
Mud Production Rate - - - - - - - ->	2,400 cy/hr
Sand Production Rate - - - - - - ->	1,440 cy/hr
Gravel Production Rate - - - - - ->	480 cy/hr
# Of Dragheads Available - - - - ->	2
Suction Pipe Diam. - - - - - - - ->	27 inches
Discharge Pipe Diam. - - - - - - ->	27 inches
Min. Digging Depth - - - - - - - ->	NA ft
Max. Digging Depth - - - - - - - ->	70 ft
Draft Loaded - - - - - - - - - - - ->	19.5 ft
Speed Loaded (knots) - - - - - - ->	10 (11.5 mph)
Speed Light (knots) - - - - - - - ->	12 (13.8 mph)
Pumpout Available - - - - - - - - ->	YES
Pumpout Pipe Diam. - - - - - - - ->	27 inches
Max. Pumpout Length - - - - - - - ->	20,000 lf
Pumpout Rate - - - - - - - - - - - ->	2,400 cy/hr
Total Installed Horsepower - - - ->	10,300
Propulsion Horsepower - - - - - ->	6000 (Electric)
Dredge Pump Horsepower - - - - - ->	2000 (Electric)
Pumpout Horsepower - - - - - - - ->	4400 (Electric)
Jet Pump Horsepower - - - - - - ->	1000 (Electric)
Auxiliary Engine Horsepower - - ->	1200 (Electric)
Auxiliary Engine Horsepower - - ->	0 (Diesel)
Main Generator Horsepower - - - ->	10300 (Diesel)
Survey Vessel Cost - - - - - - - ->	$0 /mo
Pumpout Booster Cost - - - - - - ->	$125,000 /mo
Crane Barge Cost - - - - - - - - - ->	$7,000 /mo
Tender Tug Cost - - - - - - - - - ->	$0 /mo
Crew Size - - - - - - - - - - - - - ->	23

D \ 3 OTHER MONTHLY COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

				REMARKS
1	>Shore crew.		$117,713 /MO	
2	>	+	$0 /MO	
3	>	+	$0 /MO	
4	>	+	$0 /MO	
5	>	+	$0 /MO	
6	>	+	$0 /MO	
7	>	+	$0 /MO	
8	>	+	$0 /MO	
9	>	+	$0 /MO	
10	>	+	$0 /MO	
11	>	+	$0 /MO	
12	>	+	$0 /MO	
13	>	+	$0 /MO	
14	>	+	$0 /MO	
15	TOTAL OTHER MONTHLY COSTS	=	$117,713 /MO	

E FIXED COSTS BID ITEM # 2

DREDGE SIZE: 4000 CYD HOPPER DREDGE

			REMARKS
1	Cutterhead mod for seaturtles.	$10,000	
2	>	+ $0	
3	>	+ $0	
4	>	+ $0	
5	>	+ $0	
6	>	+ $0	
7	>	+ $0	
8	>	+ $0	
9	>	+ $0	
10	>	+ $0	
11	>	+ $0	
12	>	+ $0	
13	>	+ $0	
14	>	+ $0	
15	FIXED COSTS	= $10,000	

BACKUP DATA

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

17.00. Beachfilling	QUANTY UOM	CREW ID	OUTPUT	MANHRS	LABOR	EQUIPMNT	MATERIAL	LUMP SUM	TOTAL COST	UNIT
17. Beach Replacement										
17.00. Beachfilling										
17.00.70. Beach Fill (MonthlyCosts)										
17.00.70.02. Site Work (Monthly Costs)										
17.00.70.02.03. Grading (w/ Dune)										
L USR AA <01050 1012 > Survey Crew (3 people)				24.00	936.22	111.38	0.00	0.00	1047.60	
Ch., Party + 2-Inst Man	21.00 DAY	USURA1	0.13	504	19,661	2,339	0	0	22,000	1047.60
L USR AA <02226 1005 > Berm Fill/Move Shore Pipe,				24.00	1214.49	1891.96	0.00	0.00	3106.45	
(2) D-9H Dozer w/U-Blade, 410 HP, Move 150' and Stockpile	21.00 DAY	CODTN_2	0.13	504	25,504	39,731	0	0	65,235	3106.45
L USR AA <02226 1005 > Dune Fill, D-9H Dozer				10.00	505.37	945.98	0.00	0.00	1451.35	
w/U-Blade 410 HP, Drag 500' Stockpile	21.00 DAY	CODTN	0.13	210	10,613	19,866	0	0	30,478	1451.35
TOTAL Grading (w/ Dune)	1.00 MO			1,218	55,778	61,936	0	0	117,713	117713
TOTAL Site Work (Monthly Costs)				1,218	55,778	61,936	0	0	117,713	
TOTAL Beach Fill (MonthlyCosts)				1,218	55,778	61,936	0	0	117,713	

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 17

SCHEDULE FOR DESIGN AND CONSTRUCTION

Refer to the PED through construction schedule and project funding stream that follows on the next page. The plans and specs (P&S) phase is scheduled to take place over a 12-month period in FY -02 from environmental investigations (refer to Section 18, Special Studies) to P&S completion. The PCA coordination will start in FY -02 with execution occurring in FY - 01. The Real Estate work will occupy the first half of FY -01. Approximately 15 months (last 3 months of FY -01 and all of FY 00) will be allotted for initial construction from contract award to contract closeout.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

LONG BEACH ISLAND, NEW JERSEY FUNDING SCHEDULE BY TASK
INITIAL CONSTRUCTION
JANUARY 1999 PRICE LEVEL

TASK	FY -4 (O N D J F M A M J J A S)	FY -3 (O N D J F M A M J J A S)	FY -2 (O N D J F M A M J J A S)	FY -1 (O N D J F M A M J J A S)	FY 0 (O N D J F M A M J J A S)	TOTALS BY TASK
Plans & Specs	$101,000	$373,515				$474,515
Prepare IGE		$34,500				$34,500
Environmental Coordination	$40,000	$159,150				$199,150
Value Engineering	$30,700					$30,700
BCOE Review		$10,000				$10,000
PCA Coordination	$15,000	$31,000				$46,000
Real Estate Acquisition		$216,450	$396,850			$613,300
Certification of LERRD			$51,800			$51,800
Advertise & Award				NTP $5,750		$5,750
Construction				$38,000,000	$9,143,075	$47,143,075
E&D During Construction				$176,500	$116,985	$293,485
Construction Mgmt (S&A)				$613,000	$287,000	$900,000
Project Physical Completion					$20,000	$20,000
Project Fiscal Completion					$15,000	$15,000
Project Turnover to L.S.					$5,000	$5,000
Project Management	$80,000	$24,685	$73,120	$43,130	$21,560	$242,495
TOTALS BY FY	FY -04 = $266,700	FY -03 = $849,300	FY -02 = $521,770	FY -1 = $38,838,380	FY 0 = $9,608,620	INITIAL CONSTRUCTION TOTAL = $50,084,770

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SECTION 18

SPECIAL STUDIES

Final environmental coordination with various resource agencies will be completed during the P&S Phase. An updated Section 7 Endangered Species Act consultation will be necessary during P&S for initial construction and for each periodic nourishment. A Water Quality Certificate will be required from the State of New Jersey for initial construction and for each periodic nourishment. Consistency with the New Jersey Coastal Zone Management Program must be assured. No compensatory mitigation is required with the project. Monitoring for commercial densities of surfclams is required during plans & specs. Benthic and surfclam monitoring will be required prior to each periodic nourishment.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX B

Economic Analysis

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

New Jersey Shore Protection Feasibility Study
Barnegat Inlet to Little Egg Inlet
Economic Appendix

GENERAL:

The purpose of the economic feasibility study is to investigate conditions and effects of hurricane and storm damages for the study area and evaluate the net benefits associated with potential project solutions. The study area, located on the middle Atlantic coast of New Jersey in Ocean County extends approximately 20 miles from Barnegat Inlet to Little Egg Inlet. The two inlets confine the barrier island known as Long Beach Island. This island has 18 miles of developed shoreline and is subject to extensive storm damage as evidenced by major storms that occurred in 1944, 1962, 1984, 1985, 1991, and January and December of 1992.

The optimization for the economic analysis was conducted at the 7 1/8% discount rate, the FY98 discount rate prevalent at the time of the optimization analysis. For the final selected plan the FY99 discount rate of 6 7/8% was used.

Economic Area

Ocean County is located in the Atlantic Coastal Plain in central New Jersey. The second largest county in the state in terms of size, with a land area of approximately 636 miles, Ocean County is one of four New Jersey counties with an Atlantic Ocean coastline. The county has 45 miles of oceanfront and more than 150 miles of bay shore and estuaries. Toms River, in Dover Township, serves as the County Seat and is centrally located within Ocean County. The County lies on the periphery of two of the nations largest metropolitan centers. New York City is located approximately 60 miles to the north and Philadelphia lies 50 miles to the west from the County seat.

The County was created from lands divided from Monmouth County in 1850. For much of its early history, the County was a rural, agricultural and fishing center. During the latter part of the 1800's and through the 1900's, the resort industry of the New Jersey Shore was developed, and the commercial activities associated with the seasonal resorts quickly became the County's major economic base.

Ocean and Monmouth Counties, together, constitute a Primary Metropolitan Statistical Area (PMSA). It is one of the 336 metropolitan statistical areas recognized by the Office of Management and Budget (OMB) for federal statistical purposes. These defined areas are part of an economic nodal area that serve as a center of economic activity. Functional nodal areas are defined by the Bureau of Economic Analysis (BEA). In all BEA has identified 183 such centers. Commuting patterns are a major factor used in determining the economic relationship among counties. The Monmouth-Ocean, New Jersey PMSA is part of the New York, New York BEA Economic Area. This metropolitan region consists of southern Connecticut, southeastern New York State, and Northeastern New Jersey.

Major roads crossed in the Monmouth-Ocean PMSA are the Garden State Parkway, U.S. Highway 9, and Interstate 195. As per 1988 New Jersey Facts listing, Ocean County had a total of 2,368 public road mileage of which nine were Interstate mileage, 135 State highway, 559 County road, 1,629 Municipal road, and 36 other mileage. At the start of 1995, according to the New Jersey Department of Transportation, Bureau of Transportation Data Development, Ocean County had a total of 2,742 miles of roadway, a total increase of over 370 miles. The breakdown is as follows: 126 State highway, 620 County road, 1,958 Municipal road, and 38 Garden State Parkway miles.

Regional Population, Personal Income and Earning

Table 1 displays "Population, Personal Income, and Earnings, 1973-1988 and Projected 1995-2040" and "Employment by Place of Work" (for the same time frame) for the New York, New York BEA area. It also displays all of the MSA's and PMSA's that are part of those economic defined areas. The population for the area is expected to steadily increase, by about 10% from 1995 to 2040. Per Capita income is expected to increase by about 40% and earnings by about 42%. Employment is expected to increase from about 11.1 million in 1995 to about 11.8 million in 2010 then to decrease by about 2.2% from the 1995 level in 2040. Most of this decline is attributed to manufacturing. Productivity gains in that sector will result in more earnings with fewer people.

Table 2 displays the same for the Monmouth-Ocean PMSA. The population for this area is 5.5% of the BEA population. It is expected to increase by 23% from 1995 to 2040, at a higher rate than the BEA area. Per Capita income is expected to increase by about 34% and earnings by about 57%. Employment for the PMSA is about 4.3% of the BEA area. It is expected to increase from about 474,000 in 1995 to about 540,000 in 2010, then decrease to 522,000 in 2040, a net increase of about 10% from the 1995 level. Though employment for manufacturing is expected to drop by about the same magnitude in both areas for 1995 to 2040, the service industry in the PMSA population is expected to increase by about 22%, while the BEA by only about 7%.

Local Development and Population

Development in Ocean County has traditionally focused along the coastal beaches and in urban and suburban concentrations in the corridor formed by the Garden State Parkway and U.S. Routes 9. Inland areas west of the Garden State Parkway are for the most part sparsely developed with large tracts of open space, forested and agricultural lands. Generally, development has occurred in the north-south direction along the Parkway and Route 9 Corridor. In addition, major interchanges along the Garden State Parkway have encouraged secondary east-west growth corridors. These include Routes 526 and 528 from Brick Township to Lakewood Township, Route 37 from Dover Township to Manchester Township and Lakehurst Borough and Route 72 in Stafford Township. I-95, which traverses the northern portion of the county, is emerging as a major east-west corridor as well.

The population in Ocean County according to the 1990 Census count was about 433,000. In each of the last four decades, the County has led the State in population growth. In the ten years since 1980, the County grew by over 25 percent, adding 87,165 new residents. The increase in the population has been predominantly in the northeastern and central regions, and along the barrier islands. Only a small percent of this growth is due to the natural increase of the County's resident population. Most of the increase was attributed to migration from the northern portion of New Jersey.

The permanent population along the Long Beach Island has also experienced historical increases. The long established communities that encompass Long Beach Island (north to south) are Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, Beach Haven, and Long Beach Township. Long Beach Township collectively governs the communities of Loveladies, North Beach, Brant Beach, Holgate, and several other small areas to make up approximately 10 of the 18 miles of developed land. The 1997 (permanent) population of Long Beach Island was about 8,900. Long Beach Township with 39% of the inhabitants comprises the largest municipal population of the island. Table 3 shows the decennial historical population trend for the municipalities since 1930 and the percent increase in 1996 from that of 1990 and from 1995 to 1997. The population of Long Beach Island fluctuates seasonally, increasing during the summer season. According to the Ocean County Planning Board the ratio of the seasonal population to the permanent population for the coastal beach communities in Long Beach Island, per count available for the 1980's, has been estimated to be 10:1.

Acreage and Population Density for LBI

Table 4 shows the square mileage, acreage, ocean front mileage, bay front mileage, and population densities for the six municipalities of LBI. The total incorporated municipalities are 7.91 square miles, or 5,062 acres with about 20.6 miles of ocean frontage and 37.2 miles of bay frontage. The population density for the incorporated municipalities of LBI is 1,126 per square mile.

Other than the municipalities mentioned above there are also major State and Federal land holdings on Long Beach Island. Barnegat Inlet State Park, about 32 acres, managed by New Jersey Parks and Forestry bounds the north end of the island and borders Barnegat Inlet. The Holgate Unit of the Edwin B. Forsyth National Wildlife Refuge, nearly two miles of undeveloped beach, forms the southern tip of the island and borders Beach Haven Inlet. The refuge is managed by the U.S. Department of Interior, Fish and Wildlife Service.

Tourism

Tourists dollars contribute directly and indirectly to the regional economy. In 1997, the New Jersey Travel Research Program reported that travel and tourism generated about 400,000 jobs in the state with a total payroll of $6.7 billion, and $2.2 billion in state and local taxes. Tourism and recreation data for Ocean County was extracted from the New Jersey Travel Research Program, 1997 Travel Year, conducted by the Center for Survey and Marketing Research/ Longwoods International. Table 5 displays the total expenditure by county and the number of jobs generated by travel and tourism.

Travel and tourism expenditures in Ocean County totaled $1.73 billion in 1997, up from $1.65 billion in 1996. As a result, the county ranked 3rd in New Jersey in terms of the dollars spent by travelers, up from 7th in 1993. This figure includes money spent by both day and overnight visitors, and those renting shore cottages. For 1994, shore cottage rentals accounted for 14% of all expenditures in Ocean County, for a total of nearly $179 million. Shore rentals include only those registered with realtors and cover just the 10-week summer high season. This figure is estimated to capture between 75% and 95% of the total.

The total figure of $1.65 billion breaks down as follows: restaurant meals, $509 million; retail, $505 million; lodging, $262 million; automobile expenses, $230 million; recreational activities, $132 million, and local transportation, $10 million. Tourism in the county, including shore rentals, generated almost about 40,000 jobs with a payroll totaling $619 million, making it the 6th largest county in terms of tourism employment. These figures include just those employed directly as a result of tourism. When including the indirect employment that results as tourism expenditures ripple through the economy, these figures rise to about 35,900 jobs with a payroll of almost $504 million.

Ocean County's tourism infrastructure included hotels, motels and resorts with a combined inventory of 4,097 rooms, with an annual occupancy rate of 54.0% (for 1997). There were also 1,166 campsites in the county, which operates an annual occupancy of 47.5%. An estimated 1.6 million travelers stayed overnight in Ocean County in 1994, not including those staying with friends or relatives. These figures include approximately 739,000 visitors from out-of-state. Long Beach Island was the most popular place to visit for overnight travelers in Ocean County, followed by Seaside Heights, the Six Flags Great Adventure theme park and the Pine Barrens.

In addition to providing employment in Ocean County itself, the county's travel and tourism industry also generated significant state taxes: a total of over $75 million attributable directly to tourism and $131 million when direct impacts are considered. Local taxes attributable to indirect tourism impacts totaled over $58 million. These figures include taxes generated by shore rentals.

Local Business and Employment

There is a broad spectrum of industry in Ocean County. They include agriculture, construction, transportation, wholesale trade, retail trade, finance, insurance, and real estate, and services. As of 1995 data, industries employing over 4,000 people are Health Care Services (18,259), Eating and Drinking Places (9,076), Food Stores (6,581), and Amusement and Recreational Services (4,951). Industries with more than 400 businesses are Special Trade Contractor's (982), Health Services (849), Eating and Drinking Places (717), and General Building Contractors (481).

From 1990 to 1994, the number of jobs within Ocean County increased by 7.8%, to 121,900 jobs. This increase was the second highest growth rate in New Jersey. Employment projections by the New Jersey Department of Labor show Ocean County as one of the fastest growing employment areas of the State. Job growth within the county is projected to increase by 27,000 jobs, or 22.5%, from 1994 to 2005. Growth will continue primarily in the service occupations and professional and technical fields.

Table 6 shows the labor force and unemployment rate for the municipalities on Long Beach Island from 1991 to 1996. The average unemployment rate for Long Beach Island was 4.6% for both 1995 and 1996. The county average was 6.2% for both 1995 and 1996 -- the state average, 6.4% and 6.2%. The U.S. average for 1995 and 1996 was 5.6% and 5.4% respectively. In accordance with Economic Guidance, "Areas Eligible for NED Benefits from employment of Previously Unemployed Labor Resources for Fiscal Year 1997", Ocean County does not qualify as an area of "substantial and persistent unemployment".

Structure Occupancy in Long Beach Island

The communities of Long Beach Island have structure units that are occupied seasonally and those that are occupied year round. Table 7 displays the total units from 1990 and the change from 1980. The total units of the island increased from 16,624 in 1980 to 18,279 in 1990, an increase of about 10%. Occupied units increased from 4,062 units in 1980 to 4,136, about a 2% increase in 1990. Under a third of the structures per the 1990 census are occupied year round. Housing units that are actually occupied are referred to as households. Households are classified as married couple families, single persons, non-families, and other families. The first three classifications are self explanatory; Nonfamilies includes two or more unrelated householders living together; Other families refer to two or more householders related by blood, without children.

Table 8 shows ownership status of occupied housing structures by units for the municipalities of Long Beach Island for both owner occupied and renter occupied units. Detached units are the most prevalent housing units on the island comprising about three-quarters of the structures. Table 9 displays the median value of specified owner occupied housing units in Long Beach Island by classified value ranges and municipality. The County median value for owner occupied housing units for 1990 was $126,000. The median owner occupied values of housing units for the six municipalities on LBI range from $198,700 to $317,300, 1.6 to 2.5 times above the County median. Table 10 displays the contract rent (monthly) of specified renter occupied units for Long Beach Island by $250 dollar classification ranges. About one half of the structures are in the $500 to $749 rental range. About 2% are above the $1,000 range.

Household sizes are calculated by dividing the number of persons in households by the number of households. Table 11 displays the persons per household for Long Beach Island. The person per households ratio has decreased for each of the boroughs and township from 1980 to 1990. The average person to household ratio decreased from 2.26 as per the 1980 census to 2.08 for 1990. The Ocean County average for the same period declined from 2.67 to 2.54. Table 12 displays the median household, median family, and per capita income for the municipalities of Long Beach Island from the 1990 Census. Per Capita for the six municipalities ranged from $15,907 to $25,973. On a per capita basis all the municipalities show a higher per capita than the county is per capita average of $15,598.

STUDY AREA DEFINITION

The study area is approximately 18 miles of developed shoreline that extends from Barnegat Light to Beach Haven Inlet. There are 99 groin compartments within this area. Based on the hydrologic and hydraulic characteristics and development of the shoreline of the study area, groin compartments were aggregated into sections with "area identifications" numbered 1 to 15, starting at Barnegat Light and ending at the Beach Haven Inlet. In the main report these areas are also referred to as BUNDY's (Beach Unit Nomenclature for Distance Y parallel to the beach). A unique reference line was established for each section. All structures were measured from this reference line, which served as the "zero point" from which erosion, wave, and inundation effects were measured for a without and with project conditions. Table 13 shows the definitions and the station boundaries of the reference line parameters.

STRUCTURE INVENTORY

The structures within the delineated sections were inventoried during the summer of 1996. The structures inventoried were selected based on the assessment of damage susceptibility to oceanfront storm damages. It was not necessary to include structures not subject to storm damages, or those subject to backbay flooding only. Two thousand and three structures comprised the structure inventory. Table 14 displays the number of structures in the inventory by section. The Marshall and Swift Residential Estimator was used to estimate replacement cost less depreciation using a December 1996 price level. Guidance in ER 1105-2-100 allows the use of a 50% content to structure value without use of a detailed survey. The associated content value of residential structures was estimated to be 30% of the structural replacement cost based on field survey. Commercial content values varied based on the activity ranging from fifty to eighty percent of structure value.

Table 15 shows the average, standard deviation, minimum, maximum and median replacement values for the structure inventory by section. For each section the beachfront structure replacement value is shown side by side to the near shore structures in the inventory. In all cases the mean (and median) beachfront property value is higher than that of the near shore property. Table 16 shows the commercial replacement value for the twenty-one commercial structures in the inventory. The mean and median values for the commercial structures for the beachfront structures is also higher than those in the near shore.

STORM DAMAGES METHODOLOGY

Without project condition damages were calculated for eight frequency storm events (2, 5, 10, 20, 50, 100, 200 and 500 year events) for erosion, wave and inundation damage to structures, infrastructure and improved property. The calculations for the structural property storm damages were performed using COSTDAM (Coastal Storm Damage Assessment Model), a Fortran program model that computes storm damages for coastal storm processes. Data for the structures in the study area are coded in a 'Structure' ASCII file that contains information on a structure by structure basis gathered from the field inventory, photogrammetric mapping, AutoCAD, and structure evaluation. Table 17 displays an excerpt for the setup requirement for the Structure database with a brief description of the model parameters (columns). Each record (line) represents a structure in the study area.

COSTDAM concurrently reads an ASCII ‘Control’ file, which contains the frequency parameters for the representative hydraulic profiles. COSTDAM checks if a structure has been damaged by wave attack, based on the relationship between the structure's fist floor elevation and the total wave elevation that sustains a wave in the wave zone. Then COSTDAM checks for erosion damage at a structure. Finally, COSTDAM calculates inundation damages if the water elevation is higher than the first floor elevation based on Federal Insurance Administration (FIA) depth-damage curves adjusted for increased salt-water damagability. To avoid double counting, if damage occurs by more than one mechanism, COSTDAM takes the maximum damage of any one given mechanism (wave, erosion, or inundation) and disregards the rest of the damages from the structure's total damages.

EROSION DAMAGES

The distance between the reference line and the oceanfront and back walls of structures were measured from AutoCAD and input into the Structure file. It was assumed that a structure is destroyed at the point that the land below the structure is eroded halfway through the structure if the structure is not on a pile foundation. If the structure is on piles, erosion needs to retreat entirely through the footprint before total damage is claimed. Before total failure for both foundation types, the percent damage claimed is equal to the proportion of erosion under the structure's footprint compared to the total footprint.

WAVE-INUNDATION DAMAGES

A structure is considered to be damaged by a wave when there is sufficient force in the total water elevation to destroy a structure. Partial wave damages are not calculated; instead the structure is subject to inundation damages. A flood can potentially cause damages to property and their contents through several mechanisms. The predominant damage-inducing mechanisms, as typical to riverine flooding, are depth and duration of flooding. However, ocean flooding has been shown to cause more damages than inundation in fresh water for the same depth. Also, the depth and velocity of the floodwater may be sufficient to result in structural damage and ultimately failure.

Depth damage curves were used to estimate the damage to structures. The distinguishing characteristics of these curves were foundation type and the number of stories in the structure. For commercial structures, the business activity was also a distinguishing factor for content. The depth-damage curves encode the percent damaged at various depths relative to the first floor. Examples of depth-damage curves are displayed in Table 18.

WITHOUT PROJECT CONDITION DAMAGES

The without project conditions was computed based on the hydrologic and hydraulic profiles and housing characteristics of the study areas. At the time of the analysis and through the optimization phase of the study the FY98 discount (7.125%) rate was in affect. Damages under a without project condition are the expected value of the losses that would be anticipated to result from ocean flooding and beach erosion. The expected value is calculated by estimating the losses that would result from each of a series of events of different return periods, or exceedance probabilities. Discounting this stream of losses (at the FY98 7.125% discount rate) over the anticipated life of the project (50 years) gives the present value of the damages under existing conditions reflecting a December 1996 price level. The present value of the damages is then annualized using the appropriate capital recovery factor.

Table 19 displays the cumulative residential and commercial structure distribution by frequency zone for the defined sections of Long Beach Island. There are a total of 1,744 structures in the 500-yr. storm zone of the defined study area of which twenty-one are commercial structures. Table 20 displays the damage per frequency by damage mechanism and by section by section. Table 21 displays the expected average annual damage (EAD) for without project existing conditions for the structures and infrastructure. The EAD for erosion, inundation, and wave are $2,839,000, $1,449,000, and $6,000 respectively. The EAD for infrastructure and cost of fill is $228,000 and $1,313,000 respectively. The total EAD for without project existing base conditions is $5,835,000.

FUTURE DAMAGES

Due to the affects of long term erosion resulting in a receding shoreline an additional model was set up to evaluate the damage affect of long term erosion which includes the impact of sea level rise. Long term erosion is a dynamic process, however. From a historical perspective this process is checked at a certain point through local intervention to preclude further erosion as the natural erosion process approaches the structure footprint. For modeling purposes the natural long-term erosion process is assumed not to retreat beyond the seaward toe of the dune. The limit of this condition is realized approximately fifteen years from the base year. This retreat occurs at different rates in different sections of Long Beach Island and was taken into account in the analysis. The additional modeling allowed assessing expected average annual (EAD) damages for the 50-year period of analysis, weighing in future damages for the range of exceedance probabilities in the computation of EAD. Table 22 displays the structure distribution under future hydraulic conditions for the study area. Long term erosion potential is most pronounced in Bundy's 5, 6, 7, 11, 13, 14 and 15. Table 23 displays the dollar damages for this condition by frequency. With the inclusion of future damages under a without project scenario the EAD is $8,459,000. Total EAD structure damage is $6,315,000; infrastructure damages of $340,000 and cost of fill damages of $1,804,000 account for the remaining damages. Table 24 displays these results on a section by section basis.

PLAN PROPOSALS

The following six plan alternatives were considered and analyzed under a with project scenario:
Alternative 1: 20 ft. dune, 125 ft. berm
Alternative 2: 20 ft. dune, 150 ft. berm
Alternative 3: 20 ft. dune, 175 ft. berm
Alternative 4: 22 ft. dune, 125 ft. berm
Alternative 5: 22 ft. dune, 150 ft. berm
Alternative 6: 22 ft. dune, 175 ft. berm

INITIAL SCREENING -- BUNDY 9 ANALYSIS

A detailed analysis for Bundy 9, the highest damage area was conducted, using all alternatives for these two categories. The purpose of this analysis was to determine weather or not there was a federal interest in pursuing further with this study, and if so, then to determine if the proposed plan needs further bracketing so to select the optimal plan. A detailed analysis was also conducted to include infrastructure and private land erosion to this analysis. Table 25 displays the damages and damage reductions (benefits) for these alternatives. It also shows the marginal increase in benefits between each alternative for the infrastructure and cost of fill categories.

The initial cost and nourishment cost was then determined for each of these analyses with a 3, 5, and 7-year nourishment cycle. Table 26 shows a sample table for a 125-ft. berm, 22-ft. dune, with a three years cycle. Table 27 summarizes the annualized benefits and annualized costs for these alternatives. This precursory analysis indicated that there was a federal interest in pursuing this analysis on a grander scale as benefit cost ratios (BCR's) for all the alternatives were favorable.

SECONDARY SCREENING -- AREA SAMPLING

The analysis for Bundy 9 included the benefits attributed to infrastructure and private land erosion. This analysis revealed that the benefits derived for these two categories increase marginally between plans (as displayed in Table 25) and would not impact the selection for plan candidates for this stage of the analysis. For the second screening stage alternatives were analyzed to filter plan candidates for the determination of the optimal plan. For each alternative a representative stratified sample of the study areas comprising of Bundy's 3, 6, 7, 9, 11, and 14 was analyzed. The Bundy samples of these alternatives serve as a basis to determine the optimal plan. These Bundy's were analyzed to determine the with project damages and damage reduced for the structure database. Table 28 displays the damages and damage reduction for each of the alternatives for this screening. Infrastructure and fill for private land erosion are to be computed only for plan candidates to be considered for plan selection, a product of this process .

First cost and nourishment was then computed for these same sample areas. Dune grass and dune fencing has been included in this phase of the analysis. Table 29 shows a sample for the first cost of a 125-ft. berm, 22-ft. dune, and a seven-year nourishment cycle. Table 30 summarizes the annualized benefits, annualized costs, benefit to cost ratios for the above alternatives for the 3, 5, and 7 and 10 year nourishment cycles. This analysis eliminated the 175 ft. berm, 22 ft. dune plan because of negative net benefits; the 20 ft. dune plan has negative net benefits for the three year cycle, and relatively low net benefits for the five and ten year cycle. All the 150-ft. berm and 125 ft. berm plans had positive net benefits. However, it is the 125' berm, 20 ft. dune and 22 ft. that had the highest ranges, inclusively for all nourishment cycles -- all having net benefits, at this level of detail, of over a million dollars per annum. It is for these two plans that higher detail analysis, i.e., to include all Bundy's and the outstanding benefit categories of infrastructure and private land erosion that are to be analyzed.

LOCAL COST FOREGONE

Under a with project condition the municipalities of LBI would not have to incur the costs associated with the maintenance of the existing condition, primarily, the maintenance of a dune system. From the base year to year 15, the cost of dune maintenance through trucking of sand would be foregone. This was analytically depicted as a cyclical three-year maintenance from year 1 to year 15, continuous, each year providing for one third of the island. Beyond year 15, a future representative without project profile is in place. This eroded profile requires maintenance at the near shore profile of the dunes to the depth of closure at the berm. At this point the quantity of material is significant enough that it would require sand through offshore dredging. This maintenance is projected for a seven-year cycle. Table 31 shows an example of how this analysis was performed for a selected BUNDY (BUNDY 5). Table 32 shows the summary analysis for all of LBI. The annualized local cost foregone for LBI is estimated at about $1.02 million per year.

FINAL SCREENING

Damages and damage reduction for all areas were evaluated for the 125 ft. berm, 20 ft. dune and 22 ft. dune alternatives. Table 33 displays the with project damages for the 20 ft. dune, 125 ft. berm plan and Table 34 displays the with project damages for the 22 ft. dune, 125 ft. berm plan by section, damage category, and total. Tables 35 and 36 display the damage reduction benefits by the same plans ($8,077,000 and $8,639,000, respectively). The first costs and nourishment cycles were analyzed as displayed in tables 37 through 42 for the three, five, and seven year cycles. The risk and uncertainty in the engineering and implementation of a ten year cycle plan excluded this cycle from the final screening. Table 43 displays the summary for the benefits, costs, benefit to cost ratios, and net benefits for the six scenarios as noted in the main report. For this screening the 125-ft. berm with the 22-ft. dune and the 7-year nourishment cycle has the highest net benefits (BCR of 2.15 to 1, with net benefits of $4.6 million). It is the federal recommended plan that will be the focus of a more detailed analysis.

RECREATION ANALYSIS

The beaches in New Jersey are consistently the number one travel destination within the state. Tourist dollars contribute directly and indirectly to the regional economy, as previously discussed. The number of visitors and the willingness to pay determines the value inherent to this type of recreation.

A contingent valuation method survey was completed by the Rutgers State University for the New Jersey Department of Environmental Protection and Energy and the U.S. Army Corps of Engineers to determine willingness to pay for the existing beach and an enhanced beach. This was done by sampling on a regional basis, encompassing the major beach communities of Atlantic City, Ventor, Margate and Longport. It consisted of 1,063 interviews of a random sample of recreational beach users. The interviews were conducted in person on the beach during the summer of 1994.

Beachgoers were asked to indicate how important different factors were in deciding whether to visit a New Jersey beach. The primary factors of consideration were the quality of the beach scenery, how well maintained the beach was, the width of the beach, the number of lifeguards, and how family oriented was the beach.

The survey also used a density measure developed in cooperation with the Corps to determine if crowding was a problem. It was found that over 60% of the time there was at least several yards of space between beach towels or blankets, and only 7% of the time it was very crowded (only 2 feet between towels). Further, it was determined that crowding was not considered a very important issue to the majority of beachgoers by asking respondents how important being alone is and how important is it to be with a large number of people. As might be expected, areas with more crowding tended to be frequented by people who like large numbers. People who like to be alone frequented areas that tended to have little crowding.

To estimate the value of the beach as it exists currently, an iterative bidding process was applied. Beachgoers were first asked if a day at the beach would be worth $4.00 to each member of their household. Based on their answers, they were then asked progressively higher or lower amounts until the amount they value the beach was determined. Using this method it was found that the average value of a day at the beach is $4.22.

The beachgoers were asked how much more they were willing to pay if the beach were widened. While the majority were unwilling to pay extra, 16% were willing to pay, on average, $2.92 more per visit. This would be equivalent to an average of $0.47 for all beachgoers. For the purpose of this study this value was indexed to an October 1998 price level.

The number of visitor days for the municipalities of Long Beach Island was collected from the respective boroughs and township. Long Beach Township Beach Patrol, which oversees twelve miles of beach actually tracts and tabulates head counts. For the remainder of the municipalities the number of visitor days was estimated by multiplying the number of beach tag sales by the number of days the tags are usable. To include for inclement weather and days of non-use it was estimated that beach seasonal beach tags on average would be used 45 days for the season of approximately a 100 day season (it already pays to purchase a seasonal badge for a stay of over two weeks) , a weekly badge for 5 days (out of 7), and daily badges counted for a one day use. This was then multiplied by 1.062 to capture the percentage of people who use the beach without buying a beach tag, based on estimates from previous studies.

Benefits were not computed to accrue from increased capacity because based on a daily seasonal average day crowding was found not to be a significant factor. However, benefits do arise from an increase in the value of the recreational experience. Benefits resulting from this increase in recreational experience were calculated by multiplying $0.50 by the number of visitors days within the project area or about 3,846,000 per annum. The recreational benefits is for about $1,923,000 per year. A breakdown of estimated beach use for each community are as follows:

Barnegat Light……………………………………...289,000
Harvey Cedars.......................................…..….......295,000
Surf City.....................................………….........742,000
Ship Bottom...............................………..…..........880,000
Long Beach Township.......................…................1,006,000
Beach Haven.......................................……….........634,000

PROPOSED PROJECT DIMENSIONS

The selected plan for this feasibility study consists of placement of beachfill and dune construction. Beachfill would be placed on various stretches of Long Beach Island where the existing berm and dune are below the minimum measurements of the design profile. Dune elevations are at 19 ft on average while berm width averages are 111 feet. Average dune widths are at 29 feet. The plan will provide for a dune with a 1V:5 H back slope with a crest width of 30 feet at elevation +22 NAVD. The dune will have a fore slope of 1V:5H. This will produce a beach width of approximately 125-ft from centerline of dune to MHW. Depth of closure is equal to -29.0 ft. NAVD. This plan will require 4.95 million cubic yards of sand for initial berm placement, and 2.45 million cubic yards for dune placement. Approximately 1.9 million cubic yards will be needed for periodic nourishment every 7 years over a 50-year period of analysis. In addition, the first cycle of periodic nourishment would be placed at the time of the initial construction. This project will result in a continuous dune line extending the length of the island. The Barnegat Light (northern end of the study area) is not included in the project because of low erosion and healthy beaches. For the southern end, the Holgate Unit of the Edwin B. Forsythe National Wildlife refuge, the US Fish and Wildlife Service stated that they do not consider nourishment for this area to be necessary. Major renourishment would be implemented in year 28.

PLAN SELECTION (Original Plan A)

Based on the foregone analysis the optimal plan for shore protection for Long Beach Island is the 125-ft. berm with the 22-ft dune, and the 7-year nourishment cycle. It is the federal recommended plan. It has a Planning, Engineering, and Design (PED) of 18 months and construction duration of 12 months. At the 7 1/8% price level the first cost for this plan is about $38,500,000 with an average annual cost of $2,834,000. The interest during construction (idc) is $1,390,000, for an annualized cost of $102,000. Table 44 displays a summary cost analysis, which includes PED, Real estate, and idc. The annualized nourishment cost for this plan is $1,775,000 as displayed in Table 45. The plan has hydrologic and geotechnical monitoring features for and annualized cost of $263,000 and $8,000 as displayed in Tables 46 and 47, respectively. Operations and maintenance costs is estimated at $110,000 per annum. The total annualized cost for this plan is $5,092,000. The BCR for the selected plan is 2.07 to 1, with net benefits of $5,470 ,000, as displayed in Table 48.

Table 49 displays the adjustments for the benefits and costs using the 6 7/8% discount rate, which became applicable later in the analysis during FY99. The total annualized benefits for this discount rate is $10,615,000; total annualized costs are $4,939 ,000. The benefit to cost ratio is 2.15 to 1, with about $5,676,000 of net benefits.

PLAN SELECTION REVISED (PLAN B)

The above plan (Plan A) was later refined as a result of a coordination meeting held November 18, 1998 between the US Army Corps of Engineers and resource agencies as outlined in Section 4.14 of the main report. The plan was modified as not to impact state prime fishing areas or Federal essential fish habitat (EFH). Of the five borrow areas, two main borrow areas are avoided requiring a greater reliance of the other three borrow areas. This requires pumping sand over greater distances and thereby changing the cost structure of the plan. This revised plan is the most economical plan with the least environmental impacts. The first cost for this plan is about $50,084,000 with an average annual cost of $3,572,000. The interest during construction (idc) is $1,702,000, for an annualized cost of $121,000. Table 50 displays a summary cost analysis, which includes PED, Real estate, and idc. The annualized nourishment cost for this plan is $1,698,000 as displayed in Table 51. The plan has hydrologic and geotechnical monitoring features for and annualized cost of $262,000 and $8,000 as displayed in Tables 52 and 53, respectively, the same as for Plan A at the 6 7/8% discount rate. Operations and maintenance cost is estimated at $110,000 per annum. The total annualized cost for this plan is $5,771,000. As displayed in Table 54 the BCR for the selected plan is 1.84 to 1, with net benefits of $4,844,000.

RISK AND UNCERTAINTY ANALYSIS

The reduction of the affect of the discount rate from the FY98 rate of 7 1/8 % to the 6 7/8 % of FY 99 has been displayed for the recommended plan. A decrease in the discount rate has resulted in an increase to the benefit to cost ratio. It is recognized that over time there is variation in economic conditions as well as hydraulic and hydrological parameters. As part of a feasibility analysis detailed information has been collected to the extent defined by the scope of work. The analysis used statistical modeling techniques that took into account probability of occurrence of storm events, mechanism of storm damages, and resources that take into account regional labor and construction rates.

The benefits were recalculated with a ten percent variation from the calculated expected mean as assessed in the storm damage reduction analysis. The following tables in the next two pages show the results with the 7 1/8% and 6 7/8% discount rates.

NED BENEFITS AT 7 1/8% DISCOUNT RATE WITH 10% VARIATION (PLAN A)

The NED plan was recomputed to show the affects of a change of the benefit stream values +\- 10 percent for Plan A. The results are displayed below.

($ in 000's)

SENSITIVITY ANALYSIS NED Benefits Changes	
-10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$9,506
Average Annual Costs:*	$5,092
Benefit-Cost Ratio:	1.87
Net Benefits:	$4,414

+10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$11.6 18
Average Annual Costs:*	$5.092
Benefit-Cost Ratio:	2.28
Net Benefits:	$6.526

* Includes monitoring and interest during construction

NED BENEFITS AT 6 7/8% DISCOUNT RATE WITH 10% VARIATION (PLAN A)
The NED plan was recomputed to show the affects of a change of the benefit stream values +\- 10 percent at the 6 7/8% discount rate for Plan A. The results are displayed below.

($ in 000's)

SENSITIVITY ANALYSIS NED Benefits Changes	
-10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$9.554
Average Annual Costs:*	$4.939
Benefit-Cost Ratio:	1.93
Net Benefits:	$4.615
+10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$11.677
Average Annual Costs:*	$4.939
Benefit-Cost Ratio:	2.36
Net Benefits:	$6.738

* Includes monitoring and interest during construction

NED BENEFITS AT 6 7/8% DISCOUNT RATE WITH 10% VARIATION (PLAN B)
The NED plan was recomputed to show the affects of a change of the benefit stream values +\- 10 percent at the 6 7/8% discount rate for Plan B. The results are displayed below.

($ in 000's)

SENSITIVITY ANALYSIS Benefits Changes	**NED**
-10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$9.554
Average Annual Costs:*	$5.771
Benefit-Cost Ratio:	1.66
Net Benefits:	$3.783
+10% IN BENEFIT CATEGORIES:	
Average Annual Benefits	$11.677
Average Annual Costs:*	$5.771
Benefit-Cost Ratio:	2.02
Net Benefits:	$5.906

* Includes monitoring and interest during construction

BENEFITS

The benefits of any coast protection project result from the difference between the losses that will be experienced without the project compared to the same losses occurring at some time into the future with the project. The expected value of losses are then also calculated for the with project condition. The average annual benefit is then the area between the two curves. (If the event losses are then plotted against the reciprocal of the return period of the events, then the area under this curve is the expected value of the losses). Table 16 displays the with project (residual) damages for the proposed plan which equals $6,130,000 on an average annual basis. Table 17 presents the damage reduced for the proposed project for the entire island. The total damage reduction benefits attributed to approximately 18 miles of the island is about $7,822,000 per annum as displayed in Table 17.

The affect of coastal erosion can result in an economic loss of land and property. Buildings, including the land integral to the property, infrastructure, and non-built up land may all be lost to the sea. This raises two additional complexities in assessing the benefits of coastal protection arising from the frequent association between flood risk and coastal erosion. One affect of erosion is that the risk of flooding to areas further inland increases over time as the land recedes. The other is if erosion is unchecked, land that is now at risk of flooding will first become unusable because of the frequency with which it is flooded, and will eventually be lost through erosion. So for the first part of the time horizon the benefit of protecting a property arises from reduction or elimination of flood losses, and as erosion occurs, a one time capital loss. However, local intervention on a periodic basis will prevent the gradual (long term) erosion from claiming property. This expenditure will not be incurred under a with project condition. The estimate for local cost foregone for beach maintenance for Long Beach Island is estimated at $251,000 annually. Total average annual benefits equal to $8,073,000.

ANNUALIZATION OF COSTS & BENEFIT TO COST RATIO (BCR)

Initial costs, cyclical maintenance costs, and major rehabilitation costs were provided for the period of analysis plan design. The first cost was estimated at about $35,794,000 for the proposed plan using a March 1995 price level. A cyclical maintenance cost of $9,565,000 is expected every three years, including $200,000 a year, for years 1 through 6 for district monitoring. A major rehabilitation cost of about $18,547,000 is estimated for year 24 of the 50 year project cycle. Table 18 presents the annualization of these costs. Interest during construction was calculated for a twenty-four months construction period as displayed in Table 19, estimated at about $2,930,000. Table 20 summarizes the total average annual cost for the proposed plan estimated at $6,337,000. The BCR for the proposed plan is 1.3 to 1 with net benefits of $1,736,000 per year.

TABLE 2-A

BEA REGIONAL PROJECTIONS TO 2040

New York, NY [BEA Economic Area 012]

Population, Personal Income, and Earnings, 1973–1988, and Projected, 1995–2040

	1973[1]	1979	1983	1988	1995	2000	2005	2010	2020	2040
Population as of July 1 (thousands)	18,443	17,931	18,108	18,513	19,157	19,528	19,886	20,249	20,873	21,101
Per capita personal income (1982 dollars)	12,907	13,483	14,587	17,687	19,182	20,246	21,113	21,866	23,125	26,799
	Millions of 1982 dollars									
Total personal income (place of residence)	238,051.3	241,763.2	264,137.1	327,426.2	367,472.5	395,368.7	419,868.2	442,763.5	482,678.7	565,486.4
By place of work										
Total earnings[3]	182,235.0	178,671.1	190,308.0	245,388.7	275,171.6	296,599.3	314,737.0	329,984.3	347,876.9	390,691.2
Farm	276.0	243.9	242.2	290.8	273.7	276.0	277.1	277.8	275.1	282.4
Nonfarm	181,959.0	178,427.2	190,065.8	245,097.9	274,897.9	296,323.3	314,459.9	329,706.5	347,601.8	390,408.8
Private	155,176.2	154,213.9	164,882.9	213,884.3	241,878.1	261,739.0	278,582.7	292,751.1	309,532.7	348,948.3
Agricultural services, forestry, fisheries, and other[4]	573.1	572.3	605.2	909.1	1,109.7	1,244.5	1,357.3	1,451.2	1,569.3	1,821.8
Mining	375.7	624.8	(D)	374.8	403.0	428.2	443.3	457.4	471.0	511.7
Construction	9,874.0	7,429.3	8,261.6	13,529.6	14,408.6	15,130.2	15,712.0	18,195.7	16,689.6	18,187.1
Manufacturing	40,879.2	38,896.3	37,161.4	37,879.9	38,787.6	39,920.9	40,876.3	41,773.7	42,551.8	45,656.6
Nondurable goods	21,144.4	19,827.7	19,404.6	20,162.2	20,889.8	21,702.7	22,327.8	22,867.9	23,368.8	25,195.5
Durable goods	19,734.8	19,070.6	17,756.8	17,717.6	17,897.7	18,218.1	18,548.7	18,905.7	19,183.0	20,461.1
Transportation and public utilities	16,060.2	16,425.5	15,886.3	17,324.4	18,906.5	20,051.2	20,950.1	21,745.7	22,616.8	24,947.6
Wholesale trade	14,455.2	15,651.5	(D)	20,379.2	22,368.4	23,772.1	25,101.6	26,343.2	27,815.0	31,316.9
Retail trade	16,877.9	14,982.9	15,097.4	18,751.9	21,186.3	22,987.3	24,459.8	25,635.9	27,022.5	30,367.4
Finance, insurance, and real estate	17,225.0	18,861.8	23,048.3	35,680.3	40,201.7	43,301.1	46,067.8	48,636.5	51,747.7	58,795.5
Services	38,855.7	40,767.4	48,212.6	69,055.3	84,506.4	94,905.7	103,614.7	110,511.8	119,049.1	137,343.9
Government and government enterprises	26,782.8	24,213.3	25,182.9	31,213.6	33,019.7	34,584.3	35,877.2	36,955.4	38,069.1	41,460.4
Federal, civilian	4,850.8	4,551.8	4,458.2	4,683.3	4,853.3	5,014.7	5,144.7	5,251.9	5,337.8	5,698.4
Federal, military	692.7	437.6	496.2	521.0	558.3	586.0	614.0	642.4	702.8	837.5
State and local	21,439.3	19,223.9	20,228.4	26,009.3	27,507.6	28,983.6	30,118.6	31,061.1	32,028.7	34,924.6

Employment by Place of Work, by Industry, 1973–1988, and Projected, 1995–2040

[Thousands of jobs]

	1973[1]	1979	1983	1988	1995	2000	2005	2010	2020	2040
Total employment	8,572.1	8,792.5	9,210.3	10,423.4	11,078.2	11,480.4	11,696.2	11,767.7	11,405.9	10,836.9
Farm	18.2	19.4	19.2	15.9	15.0	14.5	14.0	13.5	12.3	10.6
Nonfarm	8,553.9	8,773.2	9,191.1	10,407.4	11,063.1	11,465.9	11,682.2	11,754.2	11,393.6	10,826.2
Private	7,241.9	7,474.7	7,922.8	9,011.6	9,642.1	10,026.5	10,241.4	10,323.3	10,028.7	9,557.8
Agricultural services, forestry, fisheries, and other[4]	35.1	40.9	50.5	66.3	80.6	89.3	95.4	99.4	100.8	101.6
Mining	8.8	9.8	(D)	13.3	13.4	13.8	13.6	13.5	12.8	11.8
Construction	353.5	293.7	331.2	491.8	504.0	512.1	513.6	510.6	486.9	452.5
Manufacturing	1,765.7	1,646.3	1,488.0	1,358.4	1,304.5	1,282.3	1,254.1	1,225.2	1,141.4	1,028.7
Nondurable goods	943.4	862.2	790.7	730.1	709.6	703.7	691.2	676.6	632.0	571.6
Durable goods	822.3	784.1	697.3	628.3	594.9	578.6	562.9	548.6	509.4	457.1
Transportation and public utilities	571.2	555.7	551.1	597.0	623.3	638.0	642.5	842.2	616.9	579.1
Wholesale trade	545.5	614.3	(D)	699.5	735.4	754.8	768.7	779.0	762.3	733.3
Retail trade	1,205.9	1,230.8	1,284.2	1,450.8	1,557.8	1,832.1	1,672.7	1,686.9	1,640.6	1,568.4
Finance, insurance, and real estate	756.4	805.8	916.1	1,099.8	1,166.4	1,208.9	1,234.3	1,248.8	1,219.1	1,168.3
Services	1,999.7	2,277.5	2,656.5	3,234.7	3,656.6	3,895.6	4,046.5	4,117.7	4,048.0	3,914.2
Government and government enterprises	1,312.0	1,298.5	1,268.3	1,395.8	1,421.0	1,439.3	1,440.9	1,430.9	1,365.0	1,268.4
Federal, civilian	182.7	177.6	169.6	184.2	182.1	181.4	179.2	175.9	164.9	149.4
Federal, military	97.6	72.4	62.2	68.8	68.7	68.7	68.7	68.7	68.7	68.7
State and local	1,031.7	1,048.5	1,036.4	1,142.8	1,170.2	1,189.2	1,193.0	1,186.3	1,131.3	1,050.3

Constituent counties:[5]

Bergen–Passaic, NJ (PMSA–0875)
Bergen, NJ
Passaic, NJ

Bridgeport–Stamford–Norwalk–Danbury, CT (PMSA–1169)
Fairfield, CT

Jersey City, NJ (PMSA–3640)
Hudson, NJ

Middlesex–Somerset–Hunterdon, NJ (PMSA–5015)
Hunterdon, NJ
Middlesex, NJ
Somerset, NJ

Monmouth–Ocean, NJ (PMSA–5190)
Monmouth, NJ
Ocean, NJ

Nassau–Suffolk, NY (PMSA–5380)
Nassau, NY
Suffolk, NY

New York, NY (PMSA–5600)
Bronx, NY
Kings, NY
New York, NY
Putnam, NY
Queens, NY
Richmond, NY
Rockland, NY
Westchester, NY

Newark, NJ (PMSA–5640)
Essex, NJ
Morris, NJ
Sussex, NJ
Union, NJ

Orange County, NY (PMSA–5950)
Orange, NY

Poughkeepsie, NY (MSA–6460)
Dutchess, NY

Nonmetropolitan portion
Sullivan, NY
Ulster, NY
Pike, PA

TABLE 2-B

BEA REGIONAL PROJECTIONS TO 2040

Monmouth–Ocean, NJ (PMSA–5190)

Population, Personal Income, and Earnings, 1973–1988, and Projected, 1995–2040

	1973 [1]	1979	1983	1988	1995	2000	2005	2010	2020	2040
Population as of July 1 (thousands)	750	842	878	969	1,049	1,100	1,146	1,189	1,251	1,295
Per capita personal income (1982 dollars)	11,403	12,625	14,560	17,782	18,962	19,884	20,604	21,186	22,186	25,376
	Millions of 1982 dollars									
Total personal income (place of residence)	8,547.6	10,625.9	12,787.8	17,239.4	19,889.5	21,888.9	23,613.7	25,184.4	27,730.5	32,855.9
By place of work										
Total earnings [3]	4,381.0	4,882.7	5,194.1	7,681.8	8,948.0	9,885.4	10,697.2	11,382.6	12,236.5	14,050.4
Farm	32.6	20.2	23.6	30.5	26.4	25.9	25.4	25.0	24.1	23.9
Nonfarm	4,348.3	4,862.5	5,170.4	7,831.4	8,921.6	9,859.6	10,671.8	11,357.6	12,212.4	14,026.5
Private	3,231.1	3,685.6	3,973.5	8,165.1	7,329.3	8,165.4	8,890.1	9,500.8	10,266.4	11,864.0
Agricultural services, forestry, fisheries, and other [4]	33.6	39.4	36.7	72.4	88.7	99.8	109.2	117.2	127.0	146.6
Mining	15.7	22.8	22.9	13.4	14.9	15.9	18.8	17.5	18.3	20.1
Construction	442.0	378.4	365.6	761.2	805.2	844.6	877.3	905.2	932.8	1,010.7
Manufacturing	550.8	628.2	614.0	880.1	691.1	707.4	721.8	736.0	747.1	797.5
Nondurable goods	260.2	285.1	268.1	288.3	292.4	300.0	305.4	309.9	313.2	334.5
Durable goods	290.6	343.1	345.9	391.8	398.7	407.4	416.4	426.0	434.0	463.0
Transportation and public utilities	235.5	254.1	291.1	533.3	608.6	861.8	706.3	746.0	793.6	896.8
Wholesale trade	114.7	175.9	214.4	388.0	474.6	534.5	590.9	643.3	710.3	832.4
Retail trade	652.4	703.7	713.9	979.5	1,156.8	1,288.2	1,400.2	1,493.2	1,608.7	1,849.3
Finance, insurance, and real estate	195.1	287.4	229.1	404.5	485.0	542.0	591.0	634.7	690.9	811.5
Services	991.1	1,197.7	1,485.9	2,332.9	3,004.8	3,471.3	3,876.6	4,207.8	4,637.9	5,499.2
Government and government enterprises	1,117.2	1,176.9	1,198.9	1,466.3	1,592.3	1,694.1	1,781.6	1,856.7	1,945.9	2,162.5
Federal, civilian	350.3	413.5	414.3	449.5	473.0	494.0	511.6	525.4	540.3	582.6
Federal, military	185.1	76.6	102.7	112.4	121.2	127.6	134.1	140.7	154.4	184.8
State and local	581.9	686.8	679.9	904.3	998.1	1,072.5	1,135.9	1,189.6	1,251.3	1,395.3

Employment by Place of Work, by Industry, 1973–1988, and Projected, 1995–2040

[Thousands of jobs]

	1973 [1]	1979	1983	1988	1995	2000	2005	2010	2020	2040
Total employment	255.2	299.1	332.7	424.9	473.8	505.2	528.6	539.6	535.4	521.7
Farm	1.8	2.1	1.8	1.5	1.5	1.4	1.4	1.3	1.2	1.1
Nonfarm	253.4	297.0	330.8	423.4	472.4	503.7	525.3	538.2	534.2	520.7
Private	194.7	234.0	268.5	353.7	399.3	428.3	448.5	460.9	458.9	449.1
Agricultural services, forestry, fisheries, and other [4]	2.5	3.1	3.9	6.3	7.7	8.6	9.3	9.7	9.9	10.0
Mining	.5	.4	.5	.6	.6	.8	.6	.6	.6	.6
Construction	18.8	16.9	18.3	31.2	32.0	32.6	32.9	32.8	31.3	29.0
Manufacturing	29.4	32.0	31.3	30.5	29.1	28.5	27.8	27.1	25.1	22.6
Nondurable goods	14.7	14.7	14.2	13.7	13.4	13.3	13.0	12.8	11.9	10.8
Durable goods	14.7	17.3	17.1	16.8	15.7	15.2	14.7	14.3	13.2	11.8
Transportation and public utilities	10.2	10.7	12.3	20.2	22.3	23.5	24.3	24.8	24.5	23.6
Wholesale trade	8.0	9.9	13.0	17.8	20.7	22.4	23.8	25.0	25.5	25.5
Retail trade	52.6	63.7	69.5	85.8	95.8	102.9	107.6	110.4	109.7	107.0
Finance, insurance, and real estate	14.8	20.9	23.2	33.9	38.3	41.2	43.3	44.8	45.0	44.4
Services	59.8	76.3	96.5	127.7	152.8	167.9	178.9	185.7	187.2	186.4
Government and government enterprises	58.6	63.0	62.3	69.7	73.1	75.5	76.8	77.3	76.3	71.6
Federal, civilian	12.9	13.0	14.2	15.6	15.9	16.2	18.2	16.2	15.4	14.2
Federal, military	13.1	7.1	7.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
State and local	32.7	42.9	40.3	45.2	48.4	50.5	51.8	52.4	51.1	48.6

Constituent counties:

Monmouth, NJ
Ocean, NJ

Footnotes:

(D) Not shown to avoid disclosure of confidential information; estimates are included in higher level totals.
1. Earnings and employment estimates for 1973 are based on the 1967 Standard Industrial Classification (SIC); estimates and projections for all other years are based on the 1972 SIC.
2. Footnote not applicable.
3. Earnings by place of work consists of wage and salary disbursements, other labor income, and proprietor's income.
4. "Other" consists of wages and salaries, or employment, of U.S. residents working for international organizations and foreign embassies and consulates located in the United States.
5. PMSA refers to "Primary Metropolitan Statistical Area."

5

TABLE 3

Historical Population Trends in Municipalities of Long Beach Island

Municipality	Incorporation Date	1930	1940	1950	1960	1970	1980	1990	July 1995	July 1996	July 1997	% Change 1990-97
Barnegat Light Borough	1904	144	225	227	287	554	619	675	690	697	701	3.9%
Beach Haven Borough	1890	715	746	1,050	1,041	1,488	1,714	1,475	1,500	1,501	1501	1.8%
Harvey Cedars Borough	1894	53	74	106	134	314	363	362	380	382	382	5.5%
Long Beach Township	1899	355	425	840	1,561	2,910	3,488	3,407	3,518	3,535	3538	3.8%
Ship Bottom Borough	1925	277	396	533	717	1,079	1,427	1,352	1,358	1,361	1364	0.9%
Surf City Borough	1884	76	129	291	419	1,129	1,571	1,375	1,409	1,413	1420	3.3%
TOTAL		1,620	1,995	3,047	4,159	7,474	9,182	8,646	8,855	8,889	8,906	3.0%

Sources:

1) 1990 Census of Population and Housing, Historical Population Counts and STF-1A (Profile 1). Ocean County Historical Survey, 1991

2) Ocean County Planning Department

TABLE 4

Acreage and Population Density for Long Beach Island

Municipality	Square Miles	Acres	Ocean Frontage	Bay Frontage	Population Density
Barnegat Light Borough	0.70	448	2.14	8.00	970.06
Beach Haven Borough	1.00	640	1.92	2.61	1,531.61
Harvey Cedars Borough	0.55	352	2.02	3.72	692.74
Long Beach Township	4.30	2,752	11.74	18.64	666.07
Ship Bottom Borough	0.71	454	1.33	2.15	1,965.30
Surf City Borough	0.65	416	1.43	2.12	1,960.81
TOTAL	7.91	5,062	20.58	37.24	1,126.00(AVG.)

Ocean County Planning Department

TABLE 5

STATE OF NEW JERSEY TOURISM EXPENDITURE
1997 TRAVEL YEAR
Ranking by Expenditure

County	$ Billion	Employment (000's of jobs)
Atlantic	8.24	124.1
Cape May	2.32	38.8
Ocean	1.73	53.2
Monmouth	1.68	45.2
Bergen	1.62	52.2
Middlesex	1.29	42.6
Essex	1.33	42.3
Morris	1.15	32.2
Hudson	0.81	26.2
Union	0.82	24.8
Burlington	0.81	20.9
Camden	0.76	25.9
Mercer	0.82	24.0
Somerset	0.61	17.8
Passaic	0.42	16.1
Sussex	0.28	7.7
Gloucester	0.25	10.5
Hunterdon	0.15	4.9
Cumberland	0.14	5.5
Warren	0.14	4.6
Salem	0.09	3.4

SOURCE: New Jersey Travel Research Program
Center for Survey and Marketing Research
Longwood International

TABLE 6

Municipal Labor Force Estimates for Long Beach Island and Ocean County

Municipality	Labor Force 1991	1992	1993	1994	1995	1996	Employment 1991	1992	1993	1994	1995	1996
Barnegat Light Borough	365	308	309	313	324	333	335	304	305	310	321	330
Beach Haven Borough	944	734	725	735	756	777	852	666	668	680	704	724
Harvey Cedars Borough	238	173	171	173	177	183	217	154	155	158	163	168
Long Beach Township	1,905	1,662	1,652	1,676	1,729	1,777	1,723	1,565	1,571	1,598	1,655	1,702
Ship Bottom Township	869	636	630	638	658	676	802	588	590	600	622	639
Surf City Borough	913	600	598	607	628	646	816	578	580	590	611	629
TOTAL FOR LONG BEACH ISLAND	5,234	4,113	4,085	4,142	4,272	4,392	4,745	3,855	3,869	3,936	4,076	4,192
TOTAL FOR OCEAN COUNTY	186,248	194,878	192,742	195,254	201,143	206,724	172,404	178,377	179,054	182,095	188,633	193,996

Municipality	Unemployment 1991	1992	1993	1994	1995	1996	Unemployment Rate 1991	1992	1993	1994	1995	1996
Barnegat Light Borough	30	4	4	3	3	3	8.2%	1.3%	1.3%	1.0%	0.9%	0.9%
Beach Haven Borough	92	68	57	55	52	53	9.7%	9.3%	7.9%	7.5%	6.9%	6.8%
Harvey Cedars Borough	21	19	16	15	14	15	8.8%	11.0%	9.4%	8.7%	7.9%	8.2%
Long Beach Township	182	97	81	78	74	75	9.6%	5.8%	4.9%	4.7%	4.3%	4.2%
Ship Bottom Township	67	48	40	38	36	37	7.7%	7.5%	6.3%	6.0%	5.5%	5.5%
Surf City Borough	97	22	18	17	17	17	10.6%	3.7%	3.0%	2.8%	2.7%	2.6%
TOTAL FOR LONG BEACH ISLAND	489	258	216	206	196	200	9.3%	6.3%	5.3%	5.0%	4.6%	4.6%
TOTAL FOR OCEAN COUNTY	13,844	16,501	13,688	13,159	12,510	12,728	7.4	8.5	7.1%	6.7%	6.2%	6.2%

Source: NJ Department of Labor, State Data Center, Office of Demographic and Economic Analysis, Bureau of Labor Force Statistics, Local Area Unemployment Statistics, 1993.

TABLE 7

Comparison of Total and Occupied Housing Units, 1980 and

Municipality	Total Units 1980	Total Units 1990	Total Units Change
Barnegat Light Borough	1084	1187	8.7%
Beach Haven Borough	2379	2569	7.4%
Harvey Cedars Borough	1194	1121	-6.5%
Long Beach Township	7836	8836	11.3%
Ship Bottom Borough	1781	2084	14.5%
Surf City Borough	2350	2482	5.3%

Municipality	Occupied Units 1980	Occupied Units 1990	Occupied Units Change
Barnegat Light Borough	260	330	21.2%
Beach Haven Borough	789	659	-19.7%
Harvey Cedars Borough	166	176	5.7%
Long Beach Township	1530	1661	7.9%
Ship Bottom Borough	608	649	6.3%
Surf City Borough	709	661	-7.3%

Municipality	Percent Occupied (Year Round Only) 1980	Percent Occupied (Year Round Only) 1990
Barnegat Light Borough	24.0%	27.8%
Beach Haven Borough	33.2%	25.7%
Harvey Cedars Borough	13.9%	15.7%
Long Beach Township	19.5%	18.8%
Ship Bottom Borough	34.1%	31.1%
Surf City Borough	30.2%	26.6%

Source: 1990 Census of Population and Housing, STF-1A (Profile 1)

TABLE 8

Occupied Housing Units by Ownership Status and Number of Units in Structure

Municipality	Detached Units	One unit (Attached)	Two Units	3-4 Units	5+ Units	Mobl. Home or Trailer
Owner Occupied						
Barnegat Light Borough	233	1	29	1	4	0
Beach Haven Borough	402	20	46	10	8	1
Harvey Cedars Borough	121	4	18	0	0	0
Long Beach Township	1,172	15	163	6	0	6
Ship Bottom Borough	406	9	51	5	3	0
Surf City Borough	400	7	84	1	2	0
Total	2,734	56	391	23	17	7
Renter Occupied						
	Detached Units	One Unit (Attached)	Two Units	3-4 Units	5+ Units	Mobl. Home or Trailer
Barnegat Light Borough	37	6	14	1	0	0
Beach Haven Borough	66	8	41	28	10	0
Harvey Cedars Borough	22	1	4	3	1	0
Long Beach Township	119	4	117	22	3	1
Ship Bottom Borough	56	3	81	14	8	0
Surf City Borough	50	0	100	2	0	0
Total	350	22	357	70	22	1

Source: 1990 Census of population and Housing, STF-1A (Profile 8).

TABLE 9

Value of Specified Owner Occupied Housing Units in Long Beach Island

Municipality	Total Units	less than $50,000	$50,000 to $99,000	$100,000 to $149,999	$150,000 to $199,999	$200,000 to $299,999	$300,000 or more	Median
Barnegat Light Borough	206	1	2	8	24	105	66	$258,900
Beach Haven Borough	395	1	18	45	69	141	121	$236,200
Harvey Cedars Borough	119	0	0	4	7	44	64	$317,300
Long Beach Township	1,113	4	9	74	211	422	393	$254,100
Ship Bottom Borough	391	2	12	58	127	139	53	$198,700
Surf City Borough	384	4	13	39	113	159	56	$210,500
Total for specified units	2,608	12	54	228	551	1,010	753	

Source: 1990 Census of Population and Housing, STF-1A (Profile 7).

TABLE 10

Contract Rent of Specified Renter Occupied Housing Units in Long Beach Island, 1990

Municipality	Rental units with cash rent	Less than $250	$250 to $499	$500 to $749	$750 to $999	$1,000 or more
Barnegat Light Borough	44	2	9	28	5	0
Beach Haven Borough	131	8	61	54	6	2
Harvey Cedars Borough	23	2	8	13	0	0
Long Beach Township	244	8	106	110	12	8
Ship Bottom Borough	159	14	56	81	5	3
Surf City Borough	138	10	41	80	7	0
Total for specified units	739	44	281	366	35	13

Source: 1990 Census of Population and Housing, STF-1A (Profile 7).

TABLE 11

Changes in Persons per Household, 1980 and 1990

1990 CENSUS

Municipality	Total Units	Occupied Units	Persons	Persons/ Household
Barnegat Light Borough	1,187	330	657	1.99
Beach Haven Borough	2,569	659	1,460	2.22
Harvey Cedars Borough	1,121	176	362	2.06
Long Beach Township	8,836	1,661	3,407	2.05
Ship Bottom Borough	2,084	649	1,352	2.08
Surf City Borough	2,482	661	1,375	2.08
Total	18,279	4,136	8,613	2.08

1980 CENSUS

Municipality	Total Units	Occupied Units	Persons	Persons/ Household
Barnegat Light Borough	1,084	260	604	2.32
Beach Haven Borough	2,379	789	1,799	2.28
Harvey Cedars Borough	1,194	166	365	2.20
Long Beach Township	7,836	1,530	3,416	2.23
Ship Bottom Borough	1,781	608	1,430	2.35
Surf City Borough	2,350	709	1,569	2.21
Total	16,624	4,062	9,183	2.26

Source: 1990 Census of Population and Housing, STF-1A (Profiles 1&5)

TABLE 12

1990 Census Income Characteristics for Long Beach Island

Income in 1989

Municipality	Median Household	Median Family	Per Capita
Barnegat Light Borough	$37,955	$44,643	$25,973
Beach Haven Borough	31,371	41,458	18,527
Harvey Cedars Borough	35,781	42,143	21,482
Long Beach Township	31,775	41,453	21,545
Ship Bottom Borough	29,205	35,268	17,782
Surf City Borough	28,009	34,861	15,907
Ocean County	$33,110	$39,797	$15,598

Source: 1990 Census, Census of Population and Housing, STF-3, 1990 CPH-L-81, Table 3.

BASELINE

TABLE 13

ECONOMIC REFERENCE DELINEATION
FOR STUDY AREA

AREA ID	SECTION	GROIN COMPARTMENTS AGGREGATION	STATION BOUNDARIES	SECTION LENGTH (ft)
			-28+19.91	
1	Barnegat Light	1		6,910
			40+90.21	
2	Barnegat Light/Loveladies 1	2-3		4,298
			83+88.39	
3	Loveladies 2	4-12		7,664
			160+52.50	
4	Harvey Cedars 1	13-17		4,491
			205+43.17	
5	Harvey Cedars 2	18-22		4,551
			250+94.50	
6	North Beach	23-33		9,815
			349+09.57	
7	Surf City	34-39		6,426
			413+35.10	
8	Ship Bottom	40-44		5,285
			466+19.96	
9	Brant Beach	45-55		9,252
			558+71.59	
10	Beach Haven Crest to Beach Haven Park	56-66		9,199
			650+70.24	
11	Haven Beach to Beach Haven Gardens	67-73		6,438
			715+08.71	
12	Spray Beach to Beach Haven Borough 1	74-80		7,260
			787+69.14	
13	Beach Haven Borough	81-84		4,761
			835+29.91	
14	Beach Haven Borough 2	85-89		3,156
			866+85.63	
15	Beach Haven Borough, Holgate	90-99		6,646
			933+31.17	-----------------
			TOTAL (FT)	96,152

TABLE 14

ECONOMIC REFERENCE DELINEATION
FOR STUDY AREA

AREA ID	SECTION	STRUCTURES IN INVENTORY
1	Barnegat Light	79
2	Barnegat Light/Loveladies 1	34
3	Loveladies 2	176
4	Harvey Cedars 1	137
5	Harvey Cedars 2	139
6	North Beach	290
7	Surf City	139
8	Ship Bottom	74
9	Brant Beach	280
10	Beach Haven Crest to Beach Haven Park	149
11	Haven Beach to Beach Haven Gardens	114
12	Spray Beach to Beach Haven Borough 1	124
13	Beach Haven Borough	67
14	Beach Haven Borough 2	64
15	Beach Haven Borough, Holgate	137
	TOTAL INVENTORY	2003

STRREPL
qpw

TABLE 15

STRUCTURE REPLACEMENT VALUE

SECTION 1

AVERAGE (MEAN) –	AVG	$199,488	AVG	$173,076
STANDARD DEVIATION –	STD	$102,948	STD	$102,459
MAXIMUM –	MAX	$531,778	MAX	$395,053
MINIMIUM –	MIN	$70,805	MIN	$32,514
MEDIAN –	MED	$171,070	MEDIAN	$166,724
	BEACHFRONT COUNT =	68	NEAR SHORE COUNT =	11

SECTION 2

AVG	$427,135	AVG	$292,107
STD	$256,202	STD	$139,389
MAX	$1,076,373	MAX	$525,112
MIN	$108,349	MIN	$99,481
MED	$468,309	MEDIAN	$273,752
BEACH FRONT COUNT =	13	NEAR SHORE COUNT =	21

SECTION 3

AVG	$395,801	AVG	$216,382
STD	$244,142	STD	$111,406
MAX	$1,024,699	MAX	$642,948
MIN	$83,585	MIN	$39,987
MED	$334,707	MEDIAN	$179,716
BEACHFRONT COUNT =	63	NEAR SHORE COUNT =	112

SECTION 4

AVG	$251,636	AVG	$158,931
STD	$164,378	STD	$75,924
MAX	$164,378	MAX	$401,930
MIN	$78,285	MIN	$60,300
MED	$218,864	MEDIAN	$133,537
BEACHFRONT COUNT=	37	NEAR SHORE COUNT =	100

SECTION 5

AVG	$201,841	AVG	$143,396
STD	$97,145	STD	$77,266
MAX	$498,105	MAX	$554,359
MIN	$53,416	MIN	$57,529
MED	$180,505	MEDIAN	$118,990
BEACHFRONT COUNT =	50	NEAR SHORE COUNT =	89

SECTION 6

AVG	$256,500	AVG	$180,548
STD	$146,136	STD	$91,080
MAX	$914,272	MAX	$534,481
MIN	$64,596	MIN	$37,890
MED	$214,663	MEDIAN	$171,332
BEACHFRONT COUNT =	109	NEAR SHORE COUNT =	175

TABLE 15
(continued)

STRUCTURE REPLACEMENT VALUE

SECTION 7

AVG	$200,258	AVG	$105,714
STD	$120,489	STD	$51,111
MAX	$722,050	MAX	$300,216
MIN	$77,798	MIN	$28,419
MED	$157,271	MEDIAN	$101,845
BEACHFRONT COUNT =	89	NEAR SHORE COUNT =	50

SECTION 8

AVG	$165,826	AVG	$107,282
STD	$82,650	STD	$44,057
MAX	$449,991	MAX	$266,399
MIN	$69,982	MIN	$46,975
MED	$138,420	MEDIAN	$98,554
BEACHFRONT COUNT =	46	NEAR SHORE COUNT =	25

SECTION 9

AVG	$178,826	AVG	$143,784
STD	$80,395	STD	$73,835
MAX	$523,475	MAX	$561,940
MIN	$66,200	MIN	$60,528
MED	$158,176	MEDIAN	$130,952
BEACHFRONT COUNT =	115	NEAR SHORE COUNT =	165

SECTION 10

AVG	$182,412	AVG	$129,508
STD	$109,335	STD	$40,930
MAX	$660,549	MAX	$280,619
MIN	$56,839	MIN	$69,097
MED	$141,451	MEDIAN	$125,060
BEACHFRONT COUNT =	115	NEAR SHORE COUNT =	34

SECTION 11

AVG	$235,500	AVG	$150,017
STD	$139,185	STD	$52,685
MAX	$683,015	MAX	$276,434
MIN	$42,985	MIN	$74,865
MED	$169,972	MEDIAN	$148,013
BEACHFRONT COUNT =	73	NEAR SHORE COUNT =	41

TABLE 15
(continued)

STRUCTURE REPLACEMENT VALUE

SECTION 12

AVG	$184,437	AVG	$156,602
STD	$77,705	STD	$99,208
MAX	$394,176	MAX	$435,039
MIN	$71,442	MIN	$52,772
MED	$158,777	MEDIAN	$118,823
BEACH FRONT COUNT =	77	NEAR SHORE COUNT =	45

SECTION 13

AVG	$318,136	AVG	$250,974
STD	$349,083	STD	$180,567
MAX	$1,874,439	MAX	$925,709
MIN	$76,489	MIN	$77,750
MED	$214,996	MEDIAN	$189,895
BEACHFRONT COUNT =	38	NEAR SHORE COUNT =	24

SECTION 14

AVG	$182,955	AVG	$154,785
STD	$122,053	STD	$56,665
MAX	$772,108	MAX	$318,453
MIN	$35,470	MIN	$51,874
MED	$159,539	MEDIAN	$150,790
BEACH FRONT COUNT =	37	NEAR SHORE COUNT =	27

SECTION 15

AVG	$188,083	AVG	$88,806
STD	$76,643	STD	$57,423
MAX	$480,385	MAX	$260,908
MIN	$63,241	MIN	$17,564
MED	$166,477	MEDIAN	$91,779
BEACHFRONT COUNT =	88	NEAR SHORE COUNT =	46

TABLE 16

Commercial Structure Value

BEACH FRONT STRUCTURES

AVG	$1,306,233
STD	$943,680
MAX	$2,943,710
MIN	$58,667
MEDIAN	$1,162,169

BEACHFRONT COUNT = 9

NEAR SHORE STRUCTURES

AVG	$351,626
STD	$323,354
MAX	$1,338,585
MIN	$36,252
MEDIAN	$231,695

NEAR SHORE COUNT = 12

TABLE 17

STRUCTURE FILE EXCERPT

4HC001A	605.6	629.1	11.7	9.0	123	37	S05S06	3-1
4HC002B	686.9	705.7	9.8	8.2	395	118	S05S06	3-1
4HC003C	743.3	757.2	8.5	3.0	218	65	S03S04	3-1
4HC004D	786.4	806.4	8.2	2.9	183	55	S03S04	1-1
4HC005D	790.2	807.5	8.0	3.6	130	39	S03S04	3-1
4HC006C	738.5	755	9.5	2.1	186	56	S03S04	3-1
4HC007B	691.3	711	9.8	2.9	300	90	S03S04	3-1
4HC008A	604	625.3	10.6	2.7	255	76	S03S04	3-1
4HC009A	579.4	592.7	12.6	4.6	238	71	S03S04	3-1
4HC010B	619.9	635.8	11.9	8.4	122	37	S05S06	3-1
4HC011C	670	687.5	9.8	8.3	206	62	S03S04	3-1
4HC012D	719.9	738.2	8.9	8.4	225	68	S03S04	3-1
4HC013E	780.3	794.4	6.7	8.0	127	38	S05S06	3-1

Model Parameters:

Columns	1-3	contain the study area ID
Columns	4-9	contains the structure ID
Columns	10-19	are blank
Columns	20-27	contain the distance to the front of the structure (ft) from reference line
Columns	28-35	contain the distance to the middle of the structure (ft) from reference line
Columns	36-40	contain the ground elevation (NAVD)
Columns	41-44	contain the distance between the first floor and the ground (ft)
Columns	45-53	contain the structure replacement cost value ($000)
Columns	54-62	contain the content replacement cost value ($000)
Columns	63-65	contain the structure depth damage curve (stage ft -- percent damage)
Columns	66-68	contain the content depth damage curve (stage ft-- percent damage)
Columns	69-70	contain a code to make structure "active"
Columns	71-72	contain the damage category

TABLE 18

DEPTH DAMAGE CURVES

S03 (2 story, no basement, residential structure)
# of Rows (free format)
13

Depth	Damage (expressed as a decimal) (free format)
-2	0
-1	0.01
0	0.10
1	0.24
2	0.30
3	0.36
4	0.39
5	0.42
6	0.47
7	0.49
8	0.56
9	0.64
10	0.67

S15 (1 story, masonry, no basement, commercial structure)
# of Rows (free format)
13

Depth	Damage (expressed as a decimal) (free format)
-2	0
-1	0.01
0	0.05
1	0.21
2	0.29
3	0.38
4	0.46
5	0.48
6	0.53
7	0.55
8	0.59
9	0.67
10	0.73

stormd
wk4/A

TABLE 19

STRUCTURE COUNT BY FREQUENCY
AND DAMAGE ZONE
WITHOUT PROJECT CONDITION

SECTION 1

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	0	0	0	0	0	0	0

SECTION 2

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	4	4	0	0	0	0	4

SECTION 3

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	2	0	2	0	0	0	0	2
10 YR	0	2	0	2	0	0	0	0	2
20 YR	0	7	5	12	0	0	0	0	12
50 YR	0	25	13	38	0	0	2	2	40
100 YR	0	41	36	77	0	0	2	2	79
200 YR	0	52	43	95	0	0	2	2	97
500 YR	0	94	65	159	0	0	2	2	161

SECTION 4

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	1	0	1	0	0	0	0	1
20 YR	0	1	1	2	0	0	0	0	2
50 YR	0	5	4	9	0	0	0	0	9
100 YR	0	18	28	46	0	0	0	0	46
200 YR	0	22	41	63	0	0	0	0	63
500 YR	0	66	50	116	0	0	0	0	116

SECTION 5

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	1	1	0	0	0	0	1
20 YR	0	1	3	4	0	0	0	0	4
50 YR	0	43	7	50	0	0	0	0	50
100 YR	0	50	11	61	0	0	0	0	61
200 YR	0	52	17	69	0	0	0	0	69
500 YR	0	65	26	91	0	0	0	0	91

2 YR. FREQUENCY = (0.5 exceedance probability)
5 YR. FREQUENCY = (0.2 exceedance probability)
10 YR. FREQUENCY = (0.1 exceedance probability)
20 YR. FREQUENCY = (.05 exceedance probability)
50 YR. FREQUENCY = (.02 exceedance probability)
100 YR. FREQUENCY = (.01 exceedance probability)
200 YR. FREQUENCY = (.005 exceedance probability)
500 YR. FREQUENCY = (.002 exceedance probability)

TABLE 19
(Continued)

STRUCTURE COUNT BY FREQUENCY
AND DAMAGE ZONE
WITHOUT PROJECT CONDITION

SECTION 6

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	1	0	1	0	0	0	0	1
10 YR	0	1	0	1	0	0	0	0	1
20 YR	0	1	1	2	0	0	0	0	2
50 YR	0	28	44	72	0	0	3	3	75
100 YR	0	61	55	116	0	0	3	3	119
200 YR	0	88	83	171	0	0	5	5	176
500 YR	0	106	166	272	0	0	6	6	278

SECTION 7

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	1	0	1	0	0	0	0	1
100 YR	0	1	25	26	0	0	0	0	26
200 YR	0	12	32	44	0	0	0	0	44
500 YR	0	21	101	122	0	0	0	0	122

SECTION 8

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	19	19	0	0	1	1	20
200 YR	0	1	20	21	0	0	1	1	22
500 YR	0	37	23	60	0	2	1	3	63

SECTION 9

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	17	0	17	0	0	0	0	17
10 YR	0	17	0	17	0	0	0	0	17
20 YR	0	56	52	108	0	0	0	0	108
50 YR	0	103	94	197	0	0	0	0	197
100 YR	0	114	135	249	0	0	0	0	249
200 YR	0	143	114	257	0	0	0	0	257
500 YR	0	214	60	274	0	0	0	0	274

SECTION 10

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	27	37	64	0	0	0	0	64
100 YR	0	69	44	113	0	0	0	0	113
200 YR	0	128	17	145	0	0	0	0	145
500 YR	0	145	4	149	0	0	0	0	149

TABLE 19
(Continued)

STRUCTURE COUNT BY FREQUENCY
AND DAMAGE ZONE
WITHOUT PROJECT CONDITION

SECTION 11

ZONE	RESIDENTIAL WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	3	3	0	0	0	0	3
50 YR	0	6	19	25	0	0	0	0	25
100 YR	0	73	34	107	0	0	0	0	107
200 YR	0	77	35	112	0	0	0	0	112
500 YR	0	111	3	114	0	0	0	0	114

SECTION 12

ZONE	RESIDENTIAL WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	1	0	1	0	0	0	0	1
10 YR	0	1	0	1	0	0	0	0	1
20 YR	0	1	0	1	0	0	0	0	1
50 YR	0	3	0	3	0	0	0	0	3
100 YR	0	32	11	43	0	0	0	0	43
200 YR	0	35	35	70	0	0	1	1	71
500 YR	0	86	28	114	0	2	0	2	116

SECTION 13

ZONE	RESIDENTIAL WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	4	17	21	0	0	0	0	21
100 YR	0	12	24	36	0	1	0	1	37
200 YR	0	27	18	45	0	3	1	4	49
500 YR	0	43	17	60	0	4	1	5	65

SECTION 14

ZONE	RESIDENTIAL WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	2	3	5	0	0	0	0	5
10 YR	0	2	3	5	0	0	0	0	5
20 YR	0	14	6	20	0	0	0	0	20
50 YR	0	14	16	30	0	0	0	0	30
100 YR	0	16	24	40	0	0	0	0	40
200 YR	0	22	27	49	0	0	0	0	49
500 YR	15	32	12	59	0	0	0	0	59

SECTION 15

ZONE	RESIDENTIAL WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	20	14	34	0	0	1	1	35
200 YR	0	26	68	94	0	0	3	3	97
500 YR	0	72	57	129	0	0	3	3	132

STORMD
B

TABLE 20

STRUCTURE DAMAGE BY FREQUENCY
DAMAGE ZONE
WITHOUT PROJECT CONDITION

(DAMAGES IN $000)

SECTION 1

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	0	0	0	0	0	0	0

SECTION 2

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	4	4	0	0	0	0	4

SECTION 3

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	7	7	14	0	0	0	0	14
10 YR	0	7	7	14	0	0	0	0	14
20 YR	0	583	627	1,210	0	0	26	26	1,236
50 YR	0	3,490	1,451	4,941	0	0	255	255	5,196
100 YR	0	10,710	3,763	14,473	0	0	866	866	15,339
200 YR	0	15,143	5,242	20,385	0	0	877	877	21,262
500 YR	0	31,934	8,626	40,560	0	0	1,009	1,009	41,569

SECTION 4

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	3	3	0	0	0	0	3
10 YR	0	2	15	17	0	0	0	0	17
20 YR	0	2	83	85	0	0	0	0	85
50 YR	0	95	498	593	0	0	0	0	593
100 YR	0	1,945	2,886	4,831	0	0	0	0	4,831
200 YR	0	2,289	4,483	6,772	0	0	0	0	6,772
500 YR	0	12,095	5,869	17,964	0	0	0	0	17,964

SECTION 5

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	19	19	0	0	0	0	19
20 YR	0	0	203	203	0	0	0	0	203
50 YR	0	3,764	890	4,654	0	0	0	0	4,654
100 YR	0	7,452	1,169	8,621	0	0	0	0	8,621
200 YR	0	10,318	1,226	11,544	0	0	0	0	11,544
500 YR	0	13,945	2,458	16,403	0	0	0	0	16,403

2 YR. FREQUENCY = (0.5 exceedance probability)
5 YR. FREQUENCY = (0.2 exceedance probability)
10 YR. FREQUENCY = (0.1 exceedance probability)
20 YR. FREQUENCY = (.05 exceedance probability)
50 YR. FREQUENCY = (.02 exceedance probability)
100 YR. FREQUENCY = (.01 exceedance probability)
200 YR. FREQUENCY = (.005 exceedance probability)
500 YR. FREQUENCY = (.002 exceedance probability)

TABLE 20
(continued)

STRUCTURE DAMAGE BY FREQUENCY
DAMAGE ZONE
WITHOUT PROJECT CONDITION

SECTION 6

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	4	4	0	0	0	0	4
10 YR	0	0	14	14	0	0	0	0	14
20 YR	0	0	134	134	0	0	0	0	134
50 YR	0	1,603	4,514	6,117	0	0	193	193	6,310
100 YR	0	7,807	6,441	14,248	0	0	371	371	14,619
200 YR	0	18,281	9,376	27,657	0	0	1,160	1,160	28,817
500 YR	0	29,727	18,228	47,955	0	0	1,590	1,590	49,545

SECTION 7

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	15	15	0	0	0	0	15
50 YR	0	64	0	64	0	0	0	0	64
100 YR	0	0	1,340	1,340	0	0	0	0	1,340
200 YR	0	686	2,156	2,842	0	0	0	0	2,842
500 YR	0	2,312	10,570	12,882	0	0	0	0	12,882

SECTION 8

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	847	847	0	0	56	56	903
200 YR	0	0	993	993	0	0	78	78	1,071
500 YR	0	3,108	1,698	4,806	0	560	175	735	5,541

SECTION 9

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	530	14	544	0	0	0	0	544
10 YR	0	525	39	564	0	0	0	0	564
20 YR	0	3,796	2,665	6,461	0	0	0	0	6,461
50 YR	0	17,809	5,278	23,087	0	0	0	0	23,087
100 YR	0	25,080	8,940	34,020	0	0	0	0	34,020
200 YR	0	27,913	9,526	37,439	0	0	0	0	37,439
500 YR	0	40,886	7,444	48,330	0	0	0	0	48,330

SECTION 10

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	1,705	2,762	4,467	0	0	0	0	4,467
100 YR	0	8,632	4,149	12,781	0	0	0	0	12,781
200 YR	0	24,045	1,994	26,039	0	0	0	0	26,039
500 YR	0	29,627	798	30,425	0	0	0	0	30,425

TABLE 20
(continued)

STRUCTURE DAMAGE BY FREQUENCY
DAMAGE ZONE
WITHOUT PROJECT CONDITION

SECTION 11

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	462	462	0	0	0	0	462
50 YR	0	224	1,960	2,184	0	0	0	0	2,184
100 YR	0	14,270	2,082	16,352	0	0	0	0	16,352
200 YR	0	21,247	3,186	24,433	0	0	0	0	24,433
500 YR	0	27,970	1,197	29,167	0	0	0	0	29,167

SECTION 12

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	51	0	51	0	0	0	0	51
10 YR	0	51	0	51	0	0	0	0	51
20 YR	0	51	14	65	0	0	0	0	65
50 YR	0	181	52	233	0	0	0	0	233
100 YR	0	2,454	1,327	3,781	0	0	0	0	3,781
200 YR	0	4,330	2,538	6,868	0	0	239	239	7,107
500 YR	0	14,842	2,683	17,525	0	706	425	1,131	18,656

SECTION 13

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	262	2,940	3,202	0	0	0	0	3,202
100 YR	0	1,973	4,733	6,706	0	25	0	25	6,731
200 YR	0	6,107	5,533	11,640	0	1,294	5	1,299	12,939
500 YR	0	11,490	5,266	16,756	0	5,602	108	5,710	22,466

SECTION 14

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	21	135	156	0	0	0	0	156
10 YR	0	21	194	215	0	0	0	0	215
20 YR	0	2,175	296	2,471	0	0	0	0	2,471
50 YR	0	2,175	1,123	3,298	0	0	0	0	3,298
100 YR	0	2,517	1,594	4,111	0	0	0	0	4,111
200 YR	0	3,434	1,990	5,424	0	0	0	0	5,424
500 YR	2,229	5,376	1,104	8,709	0	0	0	0	8,709

SECTION 15

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	1,190	913	2,103	0	0	63	63	2,166
200 YR	0	1,740	3,520	5,260	0	0	1,576	1,576	6,836
500 YR	0	11,855	4,412	16,267	0	0	2,047	2,047	18,314

TABLE 21

WITHOUT PROJECT DAMAGES FOR EXISTING CONDITIONS
FOR STRUCTURE AND INFRASTRUCTURE

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	**EROSION**	**INUNDATION**	**WAVE**	**INFRA-STRUCTURE**	**FILL**	**TOTAL FOR SECTION**
1	0	0	0	0	0	0
2	0	1	0	0	1	2
3	316	145	0	8	236	705
4	56	69	0	22	7	154
5	207	47	0	29	9	292
6	238	244	0	16	98	596
7	10	46	0	1	47	104
8	9	16	0	1	11	37
9	1055	385	0	67	266	1773
10	269	96	0	24	84	473
11	266	89	0	26	168	549
12	94	34	0	13	192	333
13	91	133	0	9	14	247
14	182	98	6	9	118	413
15	46	46	0	3	62	157
	----------------	-	-	-	-	-
	$2,839	$1,449	$6	$228	$1,313	**$5,835**

TOTAL FOR STRUCTURE DAMAGES:	$4,294
ADD: INFRASTRUCTURE DAMAGE:	228
COST OF FILL	1,313
EXPECTED AVERAGE ANNUAL DAMAGE	**$5,835**

STORMD

C
wk4
COUNTFU

TABLE 22

STRUCTURE COUNT BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

SECTION 1

	RESIDENTIAL								
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	0	0	0	0	0	0	0

SECTION 2

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	4	4	0	0	0	0	4

SECTION 3

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	2	0	2	0	0	0	0	2
10 YR	0	6	5	11	0	0	0	0	11
20 YR	0	14	8	22	0	0	2	2	24
50 YR	0	42	24	66	0	0	2	2	68
100 YR	0	59	42	101	0	0	2	2	103
200 YR	0	80	41	121	0	0	2	2	123
500 YR	0	114	58	172	0	0	2	2	174

SECTION 4

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	5	0	5	0	0	0	0	5
10 YR	0	5	0	5	0	0	0	0	5
20 YR	0	7	0	7	0	0	0	0	7
50 YR	0	9	27	36	0	0	0	0	36
100 YR	0	37	34	71	0	0	0	0	71
200 YR	0	44	50	94	0	0	0	0	94
500 YR	0	85	50	135	0	0	0	0	135

SECTION 5

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	28	0	28	0	0	0	0	28
10 YR	0	28	1	29	0	0	0	0	29
20 YR	0	49	5	54	0	0	0	0	54
50 YR	0	50	16	66	0	0	0	0	66
100 YR	0	57	18	75	0	0	0	0	75
200 YR	0	75	23	98	0	0	0	0	98
500 YR	0	124	14	138	0	0	0	0	138

2 YR. FREQUENCY = (0.5 exceedance probability)
5 YR. FREQUENCY = (0.2 exceedance probability)
10 YR. FREQUENCY = (0.1 exceedance probability)
20 YR. FREQUENCY = (.05 exceedance probability)
50 YR. FREQUENCY = (.02 exceedance probability)
100 YR. FREQUENCY = (.01 exceedance probability)
200 YR. FREQUENCY = (.005 exceedance probability)
500 YR. FREQUENCY = (.002 exceedance probability)

TABLE 22
(continued)

STRUCTURE COUNT BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

SECTION 6

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	28	0	28	0	0	0	0	28
10 YR	0	28	1	29	0	0	0	0	29
20 YR	0	52	41	93	0	0	3	3	96
50 YR	0	88	68	156	0	0	5	5	161
100 YR	0	100	70	170	0	0	5	5	175
200 YR	0	171	61	232	0	1	5	6	238
500 YR	0	230	53	283	0	2	4	6	289

SECTION 7

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	1	0	1	0	0	0	0	1
10 YR	0	1	0	1	0	0	0	0	1
20 YR	0	1	0	1	0	0	0	0	1
50 YR	0	8	29	37	0	0	0	0	37
100 YR	0	12	35	47	0	0	0	0	47
200 YR	0	20	64	84	0	0	0	0	84
500 YR	0	37	78	115	0	0	0	0	115

SECTION 8

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	20	20	0	0	1	1	21
100 YR	0	1	20	21	0	0	2	2	23
200 YR	0	1	20	21	0	0	2	2	23
500 YR	0	46	20	66	0	2	1	3	69

SECTION 9

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	46	0	46	0	0	0	0	46
10 YR	0	46	40	86	0	0	0	0	86
20 YR	0	87	51	138	0	0	0	0	138
50 YR	0	110	94	204	0	0	0	0	204
100 YR	0	139	114	253	0	0	0	0	253
200 YR	0	170	89	259	0	0	0	0	259
500 YR	0	221	57	278	0	0	0	0	278

SECTION 10

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	2	0	2	0	0	0	0	2
10 YR	0	2	0	2	0	0	0	0	2
20 YR	0	2	0	2	0	0	0	0	2
50 YR	0	39	41	80	0	0	0	0	80
100 YR	0	81	27	108	0	0	0	0	108
200 YR	0	129	15	144	0	0	0	0	144
500 YR	0	149	0	149	0	0	0	0	149

TABLE 22
(continued)

STRUCTURE COUNT BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

SECTION 11

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	2	0	2	0	0	0	0	2
20 YR	0	4	11	15	0	0	0	0	15
50 YR	0	61	23	84	0	0	0	0	84
100 YR	0	77	31	108	0	0	0	0	108
200 YR	0	93	20	113	0	0	0	0	113
500 YR	0	114	0	114	0	0	0	0	114

SECTION 12

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	1	0	1	0	0	0	0	1
10 YR	0	2	0	2	0	0	0	0	2
20 YR	0	2	1	3	0	0	0	0	3
50 YR	0	8	23	31	0	0	0	0	31
100 YR	0	32	40	72	0	0	0	0	72
200 YR	0	38	53	91	0	0	1	1	92
500 YR	0	86	35	121	0	2	0	2	123

SECTION 13

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	5	0	5	0	0	0	0	5
10 YR	0	5	0	5	0	0	0	0	5
20 YR	0	5	13	18	0	0	0	0	18
50 YR	0	12	22	34	0	1	0	1	35
100 YR	0	33	23	56	0	3	0	3	59
200 YR	0	46	14	60	0	4	1	5	65
500 YR	0	53	9	62	0	4	1	5	67

SECTIN 14

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	6	1	7	0	0	0	0	7
10 YR	0	8	7	15	0	0	0	0	15
20 YR	0	41	5	46	0	0	0	0	46
50 YR	0	55	3	58	0	0	0	0	58
100 YR	0	56	2	58	0	0	0	0	58
200 YR	0	59	4	63	0	0	0	0	63
500 YR	18	42	4	64	0	0	0	0	64

SECTION 15

ZONE	RESIDENTIAL WAVE	RESIDENTIAL EROSION	RESIDENTIAL INUNDATION	RESIDENTIAL TOTAL	COMMERCIAL WAVE	COMMERCIAL EROSION	COMMERCIAL INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	2	2	0	0	0	0	2
50 YR	0	7	2	9	0	0	0	0	9
100 YR	0	43	40	83	0	0	3	3	86
200 YR	0	73	45	118	0	0	3	3	121
500 YR	28	77	47	152	0	0	3	3	155

stormd wk4
countfu

TABLE 23

STRUCTURE DAMAGE BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

Undiscounted Damages
(DAMAGES IN $000)

SECTION 1

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	0	0	0	0	0	0	0

SECTION 2

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	0	0	0	0	0	0	0
100 YR	0	0	0	0	0	0	0	0	0
200 YR	0	0	0	0	0	0	0	0	0
500 YR	0	0	438	438	0	0	0	0	438

SECTION 3

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	7	7	14	0	0	0	0	14
10 YR	0	255	598	853	0	0	30	30	883
20 YR	0	1,926	941	2,867	0	0	30	30	2,897
50 YR	0	11,450	2,649	14,099	0	0	775	775	14,874
100 YR	0	19,750	4,421	24,171	0	0	900	900	25,071
200 YR	0	25,165	5,653	30,818	0	0	903	903	31,721
500 YR	0	40,415	7,705	48,120	0	0	1,046	1,046	49,166

SECTION 4

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	149	4	153	0	0	0	0	153
10 YR	0	138	41	179	0	0	0	0	179
20 YR	0	377	52	429	0	0	0	0	429
50 YR	0	600	2,465	3,065	0	0	0	0	3,065
100 YR	0	5,033	3,667	8,700	0	0	0	0	8,700
200 YR	0	7,207	5,369	12,576	0	0	0	0	12,576
500 YR	0	17,188	6,674	23,862	0	0	0	0	23,862

SECTION 5

	RESIDENTIAL			RESIDENTIAL	COMMERCIAL			COMMERICAL	CUMULATIVE TOTAL
ZONE	WAVE	EROSION	INUNDATION	TOTAL	WAVE	EROSION	INUNDATION	TOTAL	PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	1,806	0	1,806	0	0	0	0	1,806
10 YR	0	1,806	95	1,901	0	0	0	0	1,901
20 YR	0	6,158	809	6,967	0	0	0	0	6,967
50 YR	0	9,190	1,100	10,290	0	0	0	0	10,290
100 YR	0	13,208	1,699	14,907	0	0	0	0	14,907
200 YR	0	14,747	2,288	17,035	0	0	0	0	17,035
500 YR	0	24,207	1,975	26,182	0	0	0	0	26,182

2 YR FREQUENCY = (0 5 exceedance probability)
5 YR FREQUENCY = (0.2 exceedance probability)
10 YR FREQUENCY = (0 1 exceedance probability)
20 YR. FREQUENCY = (05 exceedance probability)
50 YR. FREQUENCY = (.02 exceedance probability)
100 YR FREQUENCY = (.01 exceedance probability)
200 YR. FREQUENCY = (.005 exceedance probability)
500 YR FREQUENCY = (002 exceedance probability)

TABLE 23
(continued)

STRUCTURE DAMAGE BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

(DAMAGES IN $000)

SECTION 6

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	6	6	0	0	0	0	6
5 YR	0	1,846	19	1,865	0	0	0	0	1,865
10 YR	0	1,809	93	1,902	0	0	0	0	1,902
20 YR	0	6,022	4,460	10,482	0	0	202	202	10,684
50 YR	0	18,607	7,014	25,621	0	0	1,051	1,051	26,672
100 YR	0	27,229	7,339	34,568	0	0	1,121	1,121	35,689
200 YR	0	45,208	6,524	51,732	0	0	1,632	1,632	53,364
500 YR	0	56,596	10,175	66,771	0	65	1,909	1,974	68,745

SECTION 7

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	64	0	64	0	0	0	0	64
10 YR	0	64	0	64	0	0	0	0	64
20 YR	0	90	0	90	0	0	0	0	90
50 YR	0	327	1,779	2,106	0	0	0	0	2,106
100 YR	0	655	2,202	2,857	0	0	0	0	2,857
200 YR	0	2,223	4,725	6,948	0	0	0	0	6,948
500 YR	0	8,230	6,806	15,036	0	0	0	0	15,036

SECTION 8

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	0	0	0	0	0	0	0	0
20 YR	0	0	0	0	0	0	0	0	0
50 YR	0	0	918	918	0	0	57	57	975
100 YR	0	0	1,097	1,097	0	0	180	180	1,277
200 YR	0	24	1,340	1,364	0	0	437	437	1,801
500 YR	0	1,581	1,686	3,267	0	1,239	182	1,421	4,688

SECTION 9

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	7	7	0	0	0	0	7
5 YR	0	2,443	35	2,478	0	0	0	0	2,478
10 YR	0	2,386	2,302	4,688	0	0	0	0	4,688
20 YR	0	12,185	3,007	15,192	0	0	0	0	15,192
50 YR	0	22,788	5,963	28,751	0	0	0	0	28,751
100 YR	0	27,499	8,881	36,380	0	0	0	0	36,380
200 YR	0	31,359	7,949	39,308	0	0	0	0	39,308
500 YR	0	42,066	7,599	49,665	0	0	0	0	49,665

SECTION 10

	RESIDENTIAL				COMMERCIAL				
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	CUMULATIVE TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	26	0	26	0	0	0	0	26
10 YR	0	26	2	28	0	0	0	0	28
20 YR	0	26	7	33	0	0	0	0	33
50 YR	0	2,613	3,215	5,828	0	0	0	0	5,828
100 YR	0	10,443	2,560	13,003	0	0	0	0	13,003
200 YR	0	24,673	1,760	26,433	0	0	0	0	26,433
500 YR	0	32,992	0	32,992	0	0	0	0	32,992

TABLE 23
(continued)

STRUCTURE DAMAGE BY
FREQUENCY DAMAGE ZONE
FUTURE WITHOUT PROJECT CONDITION

(DAMAGES IN $000)

SECTION 11

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	136	1.	137	0	0	0	0	137
10 YR	0	33	336	369	0	0	0	0	369
20 YR	0	5,610	2,142	7,752	0	0	0	0	7,752
50 YR	0	26,970	935	27,905	0	0	0	0	27,905
100 YR	0	30,353	0	30,353	0	0	0	0	30,353
200 YR	0	30,353	0	30,353	0	0	0	0	30,353
500 YR	0	30,353	0	30,353	0	0	0	0	30,353

SECTION 12

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	51	0	51	0	0	0	0	51
10 YR	0	110	27	137	0	0	0	0	137
20 YR	0	0	209	209	0	0	0	0	209
50 YR	0	521	2,044	2,565	0	0	0	0	2,565
100 YR	0	2,179	4,173	6,352	0	0	0	0	6,352
200 YR	0	5,154	4,494	9,648	0	0	220	220	9,868
500 YR	0	14,478	4,815	19,293	0	706	1,439	2,145	21,438

SECTION 13

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	567	0	567	0	0	0	0	567
10 YR	0	567	0	567	0	0	0	0	567
20 YR	0	855	2,612	3,467	0	0	0	0	3,467
50 YR	0	1,972	4,195	6,167	0	25	0	25	6,192
100 YR	0	8,053	4,435	12,488	0	2,353	0	2,353	14,841
200 YR	0	12,691	3,972	16,663	0	6,548	24	6,572	23,235
500 YR	0	18,441	2,023	20,464	0	8,792	267	9,059	29,523

SECTION 14

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	2	2	0	0	0	0	2
5 YR	0	535	91	626	0	0	0	0	626
10 YR	0	1,059	323	1,382	0	0	0	0	1,382
20 YR	0	5,836	311	6,147	0	0	0	0	6,147
50 YR	0	11,388	265	11,653	0	0	0	0	11,653
100 YR	0	11,927	346	12,273	0	0	0	0	12,273
200 YR	0	12,451	339	12,790	0	0	0	0	12,790
500 YR	2,865	10,286	397	13,548	0	0	0	0	13,548

SECTION 15

	RESIDENTIAL				COMMERCIAL				CUMULATIVE
ZONE	WAVE	EROSION	INUNDATION	RESIDENTIAL TOTAL	WAVE	EROSION	INUNDATION	COMMERICAL TOTAL	TOTAL PER FREQUENCY
2 YR	0	0	0	0	0	0	0	0	0
5 YR	0	0	0	0	0	0	0	0	0
10 YR	0	17	0	17	0	0	0	0	17
20 YR	0	17	80	97	0	0	0	0	97
50 YR	0	436	174	610	0	0	0	0	610
100 YR	0	5,474	1,658	7,132	0	0	1,077	1,077	8,209
200 YR	0	13,600	2,514	16,114	0	0	1,579	1,579	17,693
500 YR	6,378	13,220	3,059	22,657	0	0	2,321	2,321	24,978

TABLE 24

WITHOUT PROJECT DAMAGES FOR EXISTING CONDITIONS
WITH LONG TERM EROSION

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	EROSION	INUNDATION	WAVE	INFRA-STRUCTURE	COST OF FILL	TOTAL FOR SECTION
1	0	0	0	0	0	0
2	0	1	0	0	1	2
3	436	179	0	11	262	888
4	96	86	0	24	13	219
5	521	61	0	36	15	633
6	703	324	0	23	223	1,273
7	28	59	0	2	115	204
8	13	24	0	1	21	59
9	1388	436	0	79	348	2,251
10	286	94	0	29	111	520
11	318	99	0	86	191	694
12	98	62	0	14	211	385
13	212	171	0	15	48	446
14	393	88	6	15	143	645
15	77	51	5	5	102	240
	$4,569	$1,735	$11	$340	$1,804	**$8,459**

TOTAL FOR STRUCTURE DAMAGES:	$6,315
ADD: INFRASTRUCTURE DAMAGE:	340
COST OF FILL	1,804
EXPECTED AVERAGE ANNUAL DAMAGE	**$8,459**

h:\LBIOPT1.WB1/bundy9
C

TABLE 25

LONG BEACH ISLAND
SECTION 9 ANALYSIS FOR ALL ALTERNATIVES
TO INCLUDE INFRASTRUCTURE AND PRIVATE LAND EROSION

(values in $000)

	WITHOUT PROJECT DAMAGE	ALT 1 with project damage	ALT 1 damage reduced	ALT 2 damage	ALT 2 damage reduced	ALT 3 damage	ALT 3 damage reduced	ALT 4 damage	ALT 4 damage reduced	ALT 5 damage	ALT 5 damage reduced	ALT 6 damage	ALT 6 damage reduced
STRUCTURE	1824	133	**1691**	101	**1723**	67	**1757**	117	**1707**	98	**1726**	65	**1759**
INFRASTRUCTURE	79	10	69	4	75	2	77	9	70	3	76	2	77
FILL	348	44	304	33	315	22	326	30	318	28	320	21	327
	2251	187	**2064**	138	**2113**	91	**2160**	156	**2095**	129	**2122**	88	**2163**
Difference in benefits due to infrastructure and fill.			**373**		**390**		**403**		**388**		**396**		**404**

Marginal Increase with Dune fixed, berm vary

	20 ft. dune (ALT2 - ALT 1)	20 ft. dune (ALT3 - ALT 2)	22 ft. dune (ALT5 - ALT4)	22 ft. dune (ALT6 - ALT5)
infrastructure	6	2	6	1
cost of fill (private land erosion)	11	11	2	7
total	17	13	8	8

Marginal Increase with Berm fixed, dune vary

	(ALT4 - ALT1) 125' BERM	(ALT5 - ALT2) 150' BERM	(ALT6 - ALT3) 175' BERM
infrastructure	1	1	0
cost of fill (private land erosion)	14	5	1
total	15	6	1

Alternative	Dune height	Berm width
ALT 1	20 ft dune	125 ft berm
ALT 2	20 ft dune	150 ft berm
ALT 3	20 ft dune	175 ft berm
ALT 4	22 ft dune	125 ft berm
ALT 5	22 ft dune	150 ft berm
ALT 6	22 ft dune	175 ft berm

LBINOUR9
D

TABLE 26

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 3 YEAR CYCLE
BUNDY 9
125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	4,149,565	1.000000000	4,149,565
1	0	0.933488915	0
2	0	0.871401554	0
3	205,111	0.813443691	166,846
4	0	0.759340668	0
5	0	0.708836097	0
6	205,111	0.661690639	135,720
7	0	0.617680876	0
8	0	0.576598251	0
9	205,111	0.538248075	110,401
10	0	0.502448612	0
11	0	0.469030209	0
12	205,111	0.437834501	89,805
13	0	0.408713653	0
14	0	0.381529665	0
15	205,111	0.356153713	73,051
16	0	0.332465543	0
17	0	0.310352899	0
18	205,111	0.289710991	59,423
19	0	0.270441998	0
20	0	0.252454608	0
21	205,111	0.235663578	48,337
22	0	0.219989337	0
23	0	0.205357608	0
24	205,111	0.191699050	39,320
25	0	0.178948939	0
26	0	0.167046850	0
27	205,111	0.155936383	31,984
28	0	0.145564885	0
29	0	0.135883207	0
30	205,111	0.126845467	26,017
31	0	0.118408837	0
32	0	0.110533337	0
33	205,111	0.103181645	21,164
34	0	0.096318922	0
35	0	0.089912646	0
36	205,111	0.083932458	17,215
37	0	0.078350019	0
38	0	0.073138874	0
39	205,111	0.068274329	14,004
40	0	0.063733329	0
41	0	0.059494356	0
42	205,111	0.055537322	11,391
43	0	0.051843474	0
44	0	0.048395309	0
45	205,111	0.045176484	9,266
46	0	0.042171747	0
47	0	0.039366858	0
48	205,111	0.036748526	7,538
49	0	0.034304342	0
50	0	0.032022723	0

TOTAL PRESENT WORTH 5,011,047

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $368,800

LBINOUR9
BCR
T

TABLE 27

BUNDY 9 ANALYSIS

SUMMARY BCR

ALT 1
125 FT. BERM
20 FT. DUNE

CYCLE		PLAN BCR	NET BENEFITS
BENEFITS:	$2,064,000		
3 YR.	$315,300	6.55	$1,748,700
5 YR.	$315,600	6.54	$1,748,400
7 YR.	$344,200	6.00	$1,719,800

ALT 4
125 FT. BERM
22 FT. DUNE

CYCLE		PLAN BCR	NET BENEFITS
BENEFITS:	$2,095,000		
3 YR.	$368,800	5.68	$1,726,200
5 YR.	$369,500	5.67	$1,725,500
7 YR.	$393,600	5.32	$1,701,400

ALT. 2
150 FT. BERM
20 FT. DUNE

BENEFITS:	$2,113,000		
3 YR.	$585,900	3.61	$1,527,100
5 YR.	$568,100	3.72	$1,544,900
7 YR.	$597,000	3.54	$1,516,000

ALT. 5
150 FT. BERM
22 FT. DUNE

BENEFITS:	$2,122,000		
3 YR.	$643,000	3.30	$1,479,000
5 YR.	$618,900	3.43	$1,503,100
7 YR.	$642,700	3.30	$1,479,300

ALT 3
175 FT. BERM
20 FT. DUNE

BENEFITS:	$2,160,000		
3 YR.	$807,800	2.67	$1,352,200
5 YR.	$806,400	2.68	$1,353,600
7 YR.	$812,200	2.66	$1,347,800

ALT. 6
175 FT. BERM
22 FT. DUNE

BENEFITS:	$2,163,000		
3 YR.	$853,200	2.54	$1,309,800
5 YR.	$849,900	2.55	$1,313,100
7 YR.	$853,200	2.54	$1,309,800

TABLE 28

LONG BEACH ISLAND
INITIAL OPTIMIZATION FOR SIX PLAN ALTERNATIVES
BUNDY'S 3, 6, 7, 9, 11 AND 14

BUNDY	WITHOUT PROJECT DAMAGE	ALT 1 damage	damage reduced	ALT 2 damage	damage reduced	ALT 3 damage	damage reduced	ALT 4 damage	damage reduced	ALT 5 damage	damage reduced	ALT 6 damage	damage reduced
3	615	104	**511**	51	**564**	39	**576**	57	**558**	44	**571**	34	**581**
6	1027	445	**582**	260	**767**	155	**872**	291	**736**	196	**831**	155	**872**
7	87	32	**55**	25	**62**	11	**76**	32	**55**	25	**62**	11	**76**
9	1824	133	**1691**	101	**1723**	67	**1757**	117	**1707**	98	**1726**	65	**1759**
11	417	81	**336**	41	**376**	29	**388**	58	**359**	36	**381**	29	**388**
14	487	30	**457**	18	**469**	9	**478**	16	**471**	11	**476**	7	**480**
TOTAL			**3,632**		**3,961**		**4,147**		**3,886**		**4,047**		**4,156**

	(ft)	(ft)
ALT 1	20 dune	125 berm
ALT 2	20 dune	150 berm
ALT 3	20 dune	175 berm
ALT 4	22 dune	125 berm
ALT 5	22 dune	150 berm
ALT 6	22 dune	175 berm

OPTIMIZ
F

TABLE 29

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 7 YEAR CYCLE
(SELECTED BUNDY'S 3,6,7,9,11, AND 14)
125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	22,567,180	1.000000000	22,567,180
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	0	0.708836097	0
6	0	0.661690639	0
7	7,075,354	0.617680876	4,370,311
8	0	0.576598251	0
9	0	0.538248075	0
10	0	0.502448612	0
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	7,075,354	0.381529665	2,699,457
15	0	0.356153713	0
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	7,075,354	0.235663578	1,667,403
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	7,075,354	0.145564885	1,029,923
29	0	0.135883207	0
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	7,075,354	0.089912646	636,164
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	7,075,354	0.055537322	392,946
43	0	0.051843474	0
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	7,075,354	0.034304342	242,715
50	0	0.032022723	0

TOTAL PRESENT WORTH 33,606,100

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $2,473,600

TABLE 30

INITIAL COST AND NOURISHMENT CYLCE
SELECTED BUNDY'S -- 3,6,7,9,11, AND 14

SUMMARY BCR

CYCLE	ALT 1 125 FT. BERM 20 FT. DUNE	PLAN BCR	NET BENEFITS	ALT 4 125 FT. BERM 22 FT. DUNE	PLAN BCR	NET BENEFITS
BENEFITS:	$3,632,000			$3,886,000		
3 YR.	$2,594,700	1.40	$1,037,300	$2,723,700	1.43	$1,162,300
5 YR.	$2,369,100	1.53	$1,262,900	$2,501,100	1.55	$1,384,900
7 YR.	$2,347,900	1.55	$1,284,100	$2,473,600	1.57	$1,412,400
10 YR.	$2,481,800	1.46	$1,150,200	$2,589,800	1.50	$1,296,200

CYCLE	ALT. 2 150 FT. BERM 20 FT. DUNE	PLAN BCR	NET BENEFITS	ALT. 5 150 FT. BERM 22 FT. DUNE	PLAN BCR	NET BENEFITS
BENEFITS:	$3,961,000			$4,047,000		
3 YR.	$3,397,000	1.17	$564,000	$3,532,300	1.15	$514,700
5 YR.	$3,142,700	1.26	$818,300	$3,270,000	1.24	$777,000
7 YR.	$3,098,100	1.28	$862,900	$3,351,700	1.21	$695,300
10 YR.	$3,410,700	1.16	$550,300	$3,509,700	1.15	$537,300

CYCLE	ALT 3 175 FT. BERM 20 FT. DUNE	PLAN BCR	NET BENEFITS	ALT. 6 175 FT. BERM 22 FT. DUNE	PLAN BCR	NET BENEFITS
BENEFITS:	$4,147,000			$4,156,000		
3 YR.	$4,231,100	0.98	($84,100)	$4,369,100	0.95	($213,100)
5 YR.	$4,054,500	1.02	$92,500	$4,189,000	0.99	($33,000)
7 YR.	$4,029,700	1.03	$117,300	$4,159,700	1.00	($3,700)
10 YR.	$4,131,900	1.00	$15,100	$4,349,500	0.96	($193,500)

NOTE: ABOVE BENEFITS DO NOT INCLUDE LOCAL COST FOREGONE
INFRASTRUCTURE, AND IMPROVED PROPERTY (COST OF FILL)

TABLE 31

CYCLICAL MAINTENANCE EXPENDITURE
FOREGONE UNDER WITH PROJECT CONDITION
FOR BUNDY 5

DISCOUNT RATE = 7.125%

YEAR	CYCLE AMOUNT	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	225,584	0.933488915	210,580
2	0	0.871401554	0
3	0	0.813443691	0
4	225,584	0.759340668	171,295
5	0	0.708836097	0
6	0	0.661690639	0
7	225,584	0.617680876	139,339
8	0	0.576598251	0
9	0	0.538248075	0
10	225,584	0.502448612	113,344
11	0	0.469030209	0
12	0	0.437834501	0
13	225,584	0.408713653	92,199
14	0	0.381529665	0
15	0	0.356153713	0
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	0	0.235663578	0
22	1,063,462	0.219989337	233,950
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	0	0.145564885	0
29	1,063,462	0.135883207	144,507
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	0	0.089912646	0
36	1,063,462	0.083932458	89,259
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	0	0.055537322	0
43	1,063,462	0.051843474	55,134
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	0	0.034304342	0
50	1,063,462	0.032022723	34,055

TOTAL PRESENT WORTH 1,283,662

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDE $94,500

LCFGONE2
TOTAL

TABLE 32

CYCLICAL MAINTENANCE EXPENDITURE
FOREGONE UNDER WITH PROJECT CONDITION
GRAND TOTAL FOR ALL BUNDY'S

DISCOUNT RATE = 7.125%

YEAR	CYCLE AMOUNT	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	1,114,651	0.933488915	1,040,514
2	841,408	0.871401554	733,204
3	932,640	0.813443691	758,650
4	1,114,651	0.759340668	846,400
5	841,408	0.708836097	596,420
6	932,640	0.661690639	617,119
7	1,114,651	0.617680876	688,499
8	841,408	0.576598251	485,154
9	932,640	0.538248075	501,992
10	1,114,651	0.502448612	560,055
11	841,408	0.469030209	394,646
12	932,640	0.437834501	408,342
13	1,114,651	0.408713653	455,573
14	841,408	0.381529665	321,022
15	932,640	0.356153713	332,163
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	0	0.235663578	0
22	9,704,992	0.219989337	2,134,995
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	0	0.145564885	0
29	9,704,992	0.135883207	1,318,745
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	0	0.089912646	0
36	9,704,992	0.083932458	814,564
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	0	0.055537322	0
43	9,704,992	0.051843474	503,141
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	0	0.034304342	0
50	9,704,992	0.032022723	310,780

TOTAL PRESENT WORTH 13,821,979

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $1,017,400

TABLE 33

WITH PROJECT DAMAGES FOR PLAN ALTERNATIVE
FOR STRUCTURE AND INFRASTRUCTURE

20 FT. DUNE, 125 FT. BERM

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	EROSION	INUNDATION	WAVE	INFRA-STRUCTURE	COST OF FILL	TOTAL FOR SECTION
1	0	0	0	0	0	0
2	0	1	0	0	0	1
3	35	34	0	1	9	79
4	28	41	0	12	4	85
5	112	61	0	26	6	205
6	123	291	0	7	26	447
7	4	24	0	0	6	34
8	4	16	0	1	4	25
9	55	56	0	4	8	123
10	22	21	0	3	8	54
11	41	24	0	1	5	71
12	35	27	0	6	9	77
13	36	69	0	6	9	120
14	2	15	0	0	3	20
15	30	17	0	2	9	58
	$527	$697	$0	$69	$106	$1,399

TOTAL FOR STRUCTURE DAMAGES:	$1,224
ADD: INFRASTRUCTURE DAMAGE:	69
COST OF FILL	106
EXPECTED AVERAGE ANNUAL DAMAGE	$1,399

TABLE 34

WITH PROJECT DAMAGES FOR PLAN ALTENATIVES
FOR STRUCTURE AND INFRASTRUCTURE

22 FT. DUNE, 125 FT. BERM

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	EROSION	INUNDATION	WAVE	INFRA-STRUCTURE	PRIVATE LAND EROSION	TOTAL FOR SECTION
1	0	0	0	0	0	0
2	0	1	0	0	0	1
3	13	32	0	1	7	53
4	23	42	0	9	4	78
5	43	55	0	21	3	122
6	61	101	0	4	12	178
7	4	24	0	0	6	34
8	0	13	0	0	0	13
9	32	66	0	2	8	108
10	7	7	0	3	8	25
11	26	26	0	1	5	58
12	15	27	0	4	7	53
13	12	41	0	3	4	60
14	3	11	0	0	3	17
15	9	20	0	1	7	37
	$248	$466	$0	$49	$74	$837

TOTAL FOR STRUCTURE DAMAGES:	$714
ADD: INFRASTRUCTURE DAMAGE:	49
COST OF FILL	74
EXPECTED AVERAGE ANNUAL DAMAGE	$837

TABLE 35

WITH PROJECT DAMAGE REDUCTION (BENEFITS) FOR PLAN ALTERNATIVE
FOR STRUCTURE AND INFRASTRUCTURE
20 FT DUNE, 125 FT BERM

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	EROSION	INUNDATION	WAVE	INFRA-STRUCTURE	COST OF FILL	TOTAL FOR SECTION
1	0	0	0	0	0	0
2	0	0	0	0	1	1
3	401	145	0	10	253	809
4	68	45	0	12	9	134
5	409	0	0	10	9	428
6	580	33	0	16	197	826
7	24	35	0	2	109	170
8	9	8	0	0	17	34
9	1333	380	0	75	340	2128
10	264	73	0	26	103	466
11	277	75	0	85	186	623
12	63	35	0	8	202	308
13	176	102	0	9	39	326
14	391	73	6	15	140	625
15	47	34	5	3	93	182
	$4,042	$1,038	$11	$271	$1,698	$7,060

BENEFITS

TOTAL FOR STRUCTURE :	$5,091
ADD: INFRASTRUCTURE :	271
COST OF FILL	1,698
LOCAL COST FOREGONE	1,017
EXPECTED AVERAGE ANNUAL BENEFITS	$8,077

TABLE 36

WITH PROJECT DAMAGE REDUCTION (BENEFITS) FOR PLAN ALTERNATIVE
FOR STRUCTURE AND INFRASTRUCTURE
22 FT DUNE, 125 FT BERM

EXPECTED AVERAGE ANNUAL BASIS
($000)

SECTION	EROSION	INUNDATION	WAVE	INFRA-STRUCTURE	PRIVATE LAND EROSION	TOTAL FOR SECTION
1	0	0	0	0	0	0
2	0	0	0	0	1	1
3	423	147	0	10	255	835
4	73	44	0	15	9	141
5	478	6	0	15	12	511
6	642	223	0	19	211	1095
7	24	35	0	2	109	170
8	13	11	0	1	21	46
9	1356	370	0	77	340	2143
10	279	87	0	26	103	495
11	292	73	0	85	186	636
12	83	35	0	10	204	332
13	200	130	0	12	44	386
14	390	77	6	15	140	628
15	68	31	5	4	95	203
	$4,321	$1,269	$11	$291	$1,730	$7,622

BENEFITS

TOTAL FOR STRUCTURE :	$5,601
ADD: INFRASTRUCTURE :	291
COST OF FILL	1,730
LOCAL COST FOREGONE	1,017
EXPECTED AVERAGE ANNUAL BENEFITS	$8,639

SELECT
A

TABLE 37

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 3 YEAR CYCLE

125' BERM WITH 20 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	30,796,573	1.000000000	30,796,573
1	0	0.933488915	0
2	0	0.871401554	0
3	5,521,723	0.813443691	4,491,611
4	0	0.759340668	0
5	0	0.708836097	0
6	5,521,723	0.661690639	3,653,672
7	0	0.617680876	0
8	0	0.576598251	0
9	5,521,723	0.538248075	2,972,057
10	0	0.502448612	0
11	0	0.469030209	0
12	5,521,723	0.437834501	2,417,601
13	0	0.408713653	0
14	0	0.381529665	0
15	5,521,723	0.356153713	1,966,582
16	0	0.332465543	0
17	0	0.310352899	0
18	5,521,723	0.289710991	1,599,704
19	0	0.270441998	0
20	0	0.252454608	0
21	5,521,723	0.235663578	1,301,269
22	0	0.219989337	0
23	0	0.205357608	0
24	5,521,723	0.191699050	1,058,509
25	0	0.178948939	0
26	0	0.167046850	0
27	5,521,723	0.155936383	861,038
28	0	0.145564885	0
29	0	0.135883207	0
30	5,521,723	0.126845467	700,406
31	0	0.118408837	0
32	0	0.110533337	0
33	5,521,723	0.103181645	569,740
34	0	0.096318922	0
35	0	0.089912646	0
36	5,521,723	0.083932458	463,452
37	0	0.078350019	0
38	0	0.073138874	0
39	5,521,723	0.068274329	376,992
40	0	0.063733329	0
41	0	0.059494356	0
42	5,521,723	0.055537322	306,662
43	0	0.051843474	0
44	0	0.048395309	0
45	5,521,723	0.045176484	249,452
46	0	0.042171747	0
47	0	0.039366858	0
48	5,521,723	0.036748526	202,915
49	0	0.034304342	0
50	0	0.032022723	0

TOTAL PRESENT WORTH 53,988,234

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736070997

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $3,973,900

select
B

TABLE 38

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 5 YEAR CYCLE

125' BERM WITH 20 FT. DUNE

DISCOUNT RATE =	7.125%		PRESENT WORTH
YEAR	CYCLE	PW FACTOR	
0	33,611,040	1.000000000	33,611,040
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	7,479,710	0.708836097	5,301,888
6	0	0.661690639	0
7	0	0.617680876	0
8	0	0.576598251	0
9	0	0.538248075	0
10	7,479,710	0.502448612	3,758,170
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	0	0.381529665	0
15	7,479,710	0.356153713	2,663,926
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	7,479,710	0.252454608	1,888,287
21	0	0.235663578	0
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	7,479,710	0.178948939	1,338,486
26	0	0.167046850	0
27	0	0.155936383	0
28	0	0.145564885	0
29	0	0.135883207	0
30	7,479,710	0.126845467	948,767
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	7,479,710	0.089912646	672,521
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	7,479,710	0.063733329	476,707
41	0	0.059494356	0
42	0	0.055537322	0
43	0	0.051843474	0
44	0	0.048395309	0
45	7,479,710	0.045176484	337,907
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	0	0.034304342	0
50	7,479,710	0.032022723	239,521
TOTAL PRESENT WORTH			51,237,221
CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.)			0.0736071
AVERAGE ANNUAL FOREGONE COST (ROUNDED)			$3,771,400

select
C

TABLE 39

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 7 YEAR CYCLE

125' BERM WITH 20 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	35,786,039	1.000000000	35,786,039
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	0	0.708836097	0
6	0	0.661690639	0
7	9,576,717	0.617680876	5,915,355
8	0	0.576598251	0
9	0	0.538248075	0
10	0	0.502448612	0
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	9,576,717	0.381529665	3,653,802
15	0	0.356153713	0
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	9,576,717	0.235663578	2,256,883
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	9,576,717	0.145564885	1,394,034
29	0	0.135883207	0
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	9,576,717	0.089912646	861,068
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	9,576,717	0.055537322	531,865
43	0	0.051843474	0
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	9,576,717	0.034304342	328,523
50	0	0.032022723	0

TOTAL PRESENT WORTH 50,727,569

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736070997

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $3,733,900

lect

TABLE 40

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 3 YEAR CYCLE

125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	35,593,518	1.000000000	35,593,518
1	0	0.933488915	0
2	0	0.871401554	0
3	5,521,723	0.813443691	4,491,611
4	0	0.759340668	0
5	0	0.708836097	0
6	5,521,723	0.661690639	3,653,672
7	0	0.617680876	0
8	0	0.576598251	0
9	5,521,723	0.538248075	2,972,057
10	0	0.502448612	0
11	0	0.469030209	0
12	5,521,723	0.437834501	2,417,601
13	0	0.408713653	0
14	0	0.381529665	0
15	5,521,723	0.356153713	1,966,582
16	0	0.332465543	0
17	0	0.310352899	0
18	5,521,723	0.289710991	1,599,704
19	0	0.270441998	0
20	0	0.252454608	0
21	5,521,723	0.235663578	1,301,269
22	0	0.219989337	0
23	0	0.205357608	0
24	5,521,723	0.191699050	1,058,509
25	0	0.178948939	0
26	0	0.167046850	0
27	5,521,723	0.155936383	861,038
28	0	0.145564885	0
29	0	0.135883207	0
30	5,521,723	0.126845467	700,406
31	0	0.118408837	0
32	0	0.110533337	0
33	5,521,723	0.103181645	569,740
34	0	0.096318922	0
35	0	0.089912646	0
36	5,521,723	0.083932458	463,452
37	0	0.078350019	0
38	0	0.073138874	0
39	5,521,723	0.068274329	376,992
40	0	0.063733329	0
41	0	0.059494356	0
42	5,521,723	0.055537322	306,662
43	0	0.051843474	0
44	0	0.048395309	0
45	5,521,723	0.045176484	249,452
46	0	0.042171747	0
47	0	0.039366858	0
48	5,521,723	0.036748526	202,915
49	0	0.034304342	0
50	0	0.032022723	0

TOTAL PRESENT WORTH 58,785,179

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $4,327,000

select
E

TABLE 41

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 5 YEAR CYCLE

125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	37,477,877	1.000000000	37,477,877
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	7,479,710	0.708836097	5,301,888
6	0	0.661690639	0
7	0	0.617680876	0
8	0	0.576598251	0
9	0	0.538248075	0
10	7,479,710	0.502448612	3,758,170
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	0	0.381529665	0
15	7,479,710	0.356153713	2,663,926
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	7,479,710	0.252454608	1,888,287
21	0	0.235663578	0
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	7,479,710	0.178948939	1,338,486
26	0	0.167046850	0
27	0	0.155936383	0
28	0	0.145564885	0
29	0	0.135883207	0
30	7,479,710	0.126845467	948,767
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	7,479,710	0.089912646	672,521
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	7,479,710	0.063733329	476,707
41	0	0.059494356	0
42	0	0.055537322	0
43	0	0.051843474	0
44	0	0.048395309	0
45	7,479,710	0.045176484	337,907
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	0	0.034304342	0
50	7,479,710	0.032022723	239,521

TOTAL PRESENT WORTH 55,104,058

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $4,056,000

ect

TABLE 42

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 7 YEAR CYCLE

125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 7.125%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	39,650,719	1.000000000	39,650,719
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	0	0.708836097	0
6	0	0.661690639	0
7	9,576,717	0.617680876	5,915,355
8	0	0.576598251	0
9	0	0.538248075	0
10	0	0.502448612	0
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	9,576,717	0.381529665	3,653,802
15	0	0.356153713	0
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	9,576,717	0.235663578	2,256,883
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	9,576,717	0.145564885	1,394,034
29	0	0.135883207	0
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	9,576,717	0.089912646	861,068
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	9,576,717	0.055537322	531,865
43	0	0.051843474	0
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	9,576,717	0.034304342	328,523
50	0	0.032022723	0

TOTAL PRESENT WORTH 54,592,249

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.0736071

AVERAGE ANNUAL FOREGONE COST (ROUNDED) $4,018,400

TABLE 43

BCR Analysis of 125 ft. Berm with 20 ft. and 22 ft. Dune
All Bundy's

		125 FT. BERM 20 FT. DUNE Annualized Benefits $8,077,000				125 FT. BERM 22 FT. DUNE Annualized Benefits $8,639,000		
	CYCLE	Annualized Costs	PLAN BCR	NET BENEFITS		Annualized Costs	PLAN BCR	NET BENEFITS
ALT 1a	3 YR.	$3,973,900	2.03	$4,103,100	ALT 4a	$4,327,000	2.00	$4,312,000
ALT 2b	5 YR.	$3,771,400	2.14	$4,305,600	ALT 4b	$4,056,000	2.13	$4,583,000
ALT 1c	7 YR.	$3,733,900	2.16	$4,343,100	ALT 4c	$4,018,400	2.15	$4,620,600

Table 44

INTEREST DURING CONSTRUCTION (IDC)

LONG BEACH ISLAND
SELECTED PLAN

DISCOUNT RATE 7.125%
P/L = JAN 99
MONTHS = 30

PED =	$1,356,600
Real Estate =	$665,091
Construction =	$36,476,655
	$38,498,346
CRF (i=.07125, n=50)	0.073607
Expected Average Annual Cost	**$2,833,752**

CONSTRUCTION PERIOD -- 24 MONTHS

	MONTH	MONTHLY PAYMENTS	FUTURE VALUE FACTOR	INVESTMENT COST
PED begins	1	75,367	1.1809627	89,005
	2	75,367	1.1742087	88,496
	3	75,367	1.1674933	87,990
	4	75,367	1.1608162	87,487
	5	75,367	1.1541774	86,987
	6	75,367	1.1475766	86,489
	7	75,367	1.1410135	85,994
	8	75,367	1.1344879	85,503
	9	75,367	1.1279996	85,014
	10	75,367	1.1215485	84,527
	11	75,367	1.1151343	84,044
	12	75,367	1.1087567	83,563
	13	75,367	1.1024156	83,085
	14	75,367	1.0961108	82,610
	15	75,367	1.0898420	82,138
	16	75,367	1.0836091	81,668
	17	75,367	1.0774118	81,201
PED ends	18	75,367	1.0712500	80,737
Construction	19	3,704,812	1.0651234	3,946,082
Begins	20	3,039,721	1.0590319	3,219,162
	21	3,039,721	1.0529752	3,200,751
	22	3,039,721	1.0469531	3,182,446
	23	3,039,721	1.0409655	3,164,245
	24	3,039,721	1.0350121	3,146,148
	25	3,039,721	1.0290927	3,128,155
	26	3,039,721	1.0232073	3,110,265
	27	3,039,721	1.0173554	3,092,477
	28	3,039,721	1.0115371	3,074,791
	29	3,039,721	1.0057520	3,057,206
	30	3,039,721	1.0000000	3,039,721
		$38,498,346		$39,887,986 TOTAL INV. COST
				38,498,346 MINUS FIRST COST
INTEREST DURING CONSTRUCTION (IDC)				1,389,640
CRF (i=.07125, n=50)				0.073607
IDC annualized				$102,287

TABLE 45

PERIODIC NOURISHMENT

DISCOUNT RATE = 7.125%
p/l = Jan 99
CURRENT

YEAR	$	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	0	0.759340668	0
5	0	0.708836097	0
6	0	0.661690639	0
7	14,141,527	0.617680876	8,734,951
8	0	0.576598251	0
9	0	0.538248075	0
10	0	0.502448612	0
11	0	0.469030209	0
12	0	0.437834501	0
13	0	0.408713653	0
14	14,141,527	0.381529665	5,395,412
15	0	0.356153713	0
16	0	0.332465543	0
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	0	0.252454608	0
21	14,141,527	0.235663578	3,332,643
22	0	0.219989337	0
23	0	0.205357608	0
24	0	0.191699050	0
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	26,920,508	0.145564885	3,918,681
29	0	0.135883207	0
30	0	0.126845467	0
31	0	0.118408837	0
32	0	0.110533337	0
33	0	0.103181645	0
34	0	0.096318922	0
35	15,187,855	0.089912646	1,365,580
36	0	0.083932458	0
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	0	0.063733329	0
41	0	0.059494356	0
42	15,187,855	0.055537322	843,493
43	0	0.051843474	0
44	0	0.048395309	0
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	0	0.036748526	0
49	15,187,855	0.034304342	521,009
50	0	0.032022723	0
	TOTAL PRESENT WORTH		24,111,769

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.073607

AVERAGE ANNUAL MONITORING COST (ROUNDED) $1,774,800 nonithh

TABLE 46

H&H MONITORING COSTS

DISCOUNT RATE = 7.125%
p/l = Jan 99
CURRENT

YEAR	$	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	350,750	0.933488915	327,421
2	379,500	0.871401554	330,697
3	270,250	0.813443691	219,833
4	270,250	0.759340668	205,212
5	241,500	0.708836097	171,184
6	276,000	0.661690639	182,627
7	218,500	0.617680876	134,963
8	247,250	0.576598251	142,564
9	247,250	0.538248075	133,082
10	247,250	0.502448612	124,230
11	218,500	0.469030209	102,483
12	276,000	0.437834501	120,842
13	218,500	0.408713653	89,304
14	247,250	0.381529665	94,333
15	247,250	0.356153713	88,059
16	247,250	0.332465543	82,202
17	218,500	0.310352899	85,657
18	276,000	0.289710991	63,302
19	218,500	0.270441998	59,092
20	247,250	0.252454608	62,419
21	247,250	0.235663578	58,268
22	247,250	0.219989337	54,392
23	218,500	0.205357608	44,871
24	276,000	0.191699050	52,909
25	218,500	0.178948939	39,100
26	247,250	0.167046850	41,302
27	247,250	0.155936383	38,555
28	247,250	0.145564885	35,991
29	218,500	0.135883207	29,690
30	276,000	0.126845467	35,009
31	218,500	0.118408837	25,872
32	247,250	0.110533337	27,329
33	247,250	0.103181645	25,512
34	247,250	0.096318922	23,815
35	218,500	0.089912646	19,646
36	276,000	0.083932458	23,165
37	218,500	0.078350019	17,119
38	247,250	0.073138874	18,084
39	247,250	0.068274329	16,881
40	247,250	0.063733329	15,758
41	218,500	0.059494356	13,000
42	276,000	0.055537322	15,328
43	218,500	0.051843474	11,328
44	247,250	0.048395309	11,966
45	247,250	0.045176484	11,170
46	247,250	0.042171747	10,427
47	218,500	0.039366858	8,602
48	276,000	0.036748526	10,143
49	218,500	0.034304342	7,495
50	247,250	0.032022723	7,918
	TOTAL PRESENT WORTH		3,570,152

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.073607

AVERAGE ANNUAL MONITORING COST (ROUNDED) **$262,800**

TABLE 47

GEOTECH MONITORING

DISCOUNT RATE = 7.125%
p/l = Jan 99
CURRENT

YEAR	$	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	0	0.933488915	0
2	0	0.871401554	0
3	0	0.813443691	0
4	33,465	0.759340668	25,411
5	0	0.708836097	0
6	0	0.661690639	0
7	0	0.617680876	0
8	33,465	0.576598251	19,296
9	0	0.538248075	0
10	0	0.502448612	0
11	0	0.469030209	0
12	33,465	0.437834501	14,652
13	0	0.408713653	0
14	0	0.381529665	0
15	0	0.356153713	0
16	33,465	0.332465543	11,126
17	0	0.310352899	0
18	0	0.289710991	0
19	0	0.270441998	0
20	33,465	0.252454608	8,448
21	0	0.235663578	0
22	0	0.219989337	0
23	0	0.205357608	0
24	33,465	0.191699050	6,415
25	0	0.178948939	0
26	0	0.167046850	0
27	0	0.155936383	0
28	33,465	0.145564885	4,871
29	0	0.135883207	0
30	0	0.126845467	0
31	0	0.118408837	0
32	33,465	0.110533337	3,699
33	0	0.103181645	0
34	0	0.096318922	0
35	0	0.089912646	0
36	33,465	0.083932458	2,809
37	0	0.078350019	0
38	0	0.073138874	0
39	0	0.068274329	0
40	33,465	0.063733329	2,133
41	0	0.059494356	0
42	0	0.055537322	0
43	0	0.051843474	0
44	33,465	0.048395309	1,620
45	0	0.045176484	0
46	0	0.042171747	0
47	0	0.039366858	0
48	33,465	0.036748526	1,230
49	0	0.034304342	0
50	0	0.032022723	0
TOTAL PRESENT WORTH			101,710

CAPITAL RECOVERY FACTOR (50 YEARS @ 7. 125 %.) 0.073607

AVERAGE ANNUAL MONITORING COST (ROUNDED) $7,500

)cr

TABLE 48

BENEFIT AND COST SUMMARY AND BENEFIT TO COST RATIO OF SELECTED PLAN

($ IN 000'S)

Discount Rate = 7.125%

		DAMAGE REDUCED (BENEFITS) WITH PROJECT PLANS EXPECTED AVERAGE ANNUAL DOLLARS
BENEFITS BY CATEGORY		
STORM DAMAGE REDUCTION		
STRUCTURE	5,601	
INFRASTRUCTURE	291	
IMPROVED PROPERTY	1,730	
SUBTOTAL :		7,622
LOCAL COST FOREGONE		1,017
RECREATION		1,923
TOTAL BENEFITS		$10,562
- update to Jan 1999 p/l (insignificant)		$10,562
ANNUALIZED COSTS (@Jan 1999 p/l)		
CONSTRUCTION (includes PED and Real Estate)		2,834
INTEREST DURING CONSTRUCTION		102
NOURISHMENT		1,775
MONITORING – H&H		263
MONITORING -- GEOTECH		8
O & M COSTS		110
TOTAL ANNUALIZED COST OF SELECTED PLAN		5,092
BENEFIT TO COST RATIO		2.07
NET BENEFITS		$5,470

TABLE 49

BENEFIT AND COST SUMMARY AND BENEFIT TO COST
RATIO OF SELECTED PLAN
UPDATED DISCOUNT RATE

($ IN 000'S)

Discount Rate = 6.875%

DAMAGE REDUCED (BENEFITS)
WITH PROJECT PLANS

EXPECTED AVERAGE ANNUAL DOLLARS

BENEFITS BY CATEGORY		
STORM DAMAGE REDUCTION		
STRUCTURE	5,670	
INFRASTRUCTURE	289	
IMPROVED PROPERTY	1,747	
SUBTOTAL :		7,706
LOCAL COST FOREGONE		986
RECREATION		1,923
TOTAL BENEFITS		$10,615
- update to Jan 1999 p/l (insignificant)		$10,615
ANNUALIZED COSTS (@Jan 1999 p/l)		
CONSTRUCTION (includes PED and Real Estate)		2,746
INTEREST DURING CONSTRUCTION		96
NOURISHMENT		1,717
MONITORING -- H&H		262
MONITORING -- GEOTECH		8
O & M COSTS		110
TOTAL ANNUALIZED COST OF SELECTED PLAN		**4,939**
BENEFIT TO COST RATIO		**2.15**
NET BENEFITS		$5,676

TABLE 50

INTEREST DURING CONSTRUCTION (IDC)
(PLAN B)

LONG BEACH ISLAND
SELECTED PLAN

DISCOUNT RATE = 6.875%
P/L = JAN 99
MONTHS = 30

PED =	$1,357,000
Real Estate =	$665,000
Construction =	$48,062,000
	$50,084,000
CRF (i=.06875, n=50)	0.071317
Expected Average Annual Cost	**$3,571,829**

CONSTRUCTION PERIOD -- 24 MONTHS

	MONTH	MONTHLY PAYMENTS	FUTURE VALUE FACTOR	INVESTMENT COST
PED begins	1	75,389	1.1743133	88,530
	2	75,389	1.1678246	88,041
	3	75,389	1.1613718	87,555
	4	75,389	1.1549547	87,071
	5	75,389	1.1485730	86,590
	6	75,389	1.1422266	86,111
	7	75,389	1.1359152	85,635
	8	75,389	1.1296387	85,162
	9	75,389	1.1233969	84,692
	10	75,389	1.1171896	84,224
	11	75,389	1.1110166	83,758
	12	75,389	1.1048777	83,295
	13	75,389	1.0987727	82,835
	14	75,389	1.0927014	82,378
	15	75,389	1.0866637	81,922
	16	75,389	1.0806594	81,470
	17	75,389	1.0746882	81,020
PED ends	18	75,389	1.0687500	80,572
Construction	19	4,670,167	1.0628446	4,963,662
Begins	20	4,005,167	1.0569719	4,233,349
	21	4,005,167	1.0511316	4,209,957
	22	4,005,167	1.0453236	4,186,695
	23	4,005,167	1.0395477	4,163,562
	24	4,005,167	1.0338037	4,140,556
	25	4,005,167	1.0280914	4,117,677
	26	4,005,167	1.0224107	4,094,925
	27	4,005,167	1.0167614	4,072,299
	28	4,005,167	1.0111433	4,049,797
	29	4,005,167	1.0055562	4,027,420
	30	4,005,167	1.0000000	4,005,167
		$50,084,000		$51,785,926 TOTAL INV. COST
				50,084,000 MINUS FIRST COST
INTEREST DURING CONSTRUCTION (IDC)				1,701,926
CRF (i=.07125, n=50)				0.071317
IDC annualized				**$121,376**

PLANB
NOUR
C

TABLE 51

FIRST COST AND NOURISHMENT
INITIAL CONSTRUCTION AND 7 YEAR CYCLE
(PLAN B)

125' BERM WITH 22 FT. DUNE

DISCOUNT RATE = 6.875%

YEAR	CYCLE	PW FACTOR	PRESENT WORTH
0	0	1.000000000	0
1	0	0.935672515	0
2	0	0.875483055	0
3	0	0.819165431	0
4	0	0.766470579	0
5	0	0.717165454	0
6	0	0.671032004	0
7	14,130,000	0.627866202	8,871,749
8	0	0.587477148	0
9	0	0.549686221	0
10	0	0.514326288	0
11	0	0.481240972	0
12	0	0.450283950	0
13	0	0.421318316	0
14	13,581,000	0.394215968	5,353,847
15	0	0.368857046	0
16	0	0.345129400	0
17	0	0.322928093	0
18	0	0.302154941	0
19	0	0.282718074	0
20	0	0.264531531	0
21	13,581,000	0.247514883	3,361,500
22	0	0.231592873	0
23	0	0.216695086	0
24	0	0.202755636	0
25	0	0.189712875	0
26	0	0.177509123	0
27	0	0.166090408	0
28	22,811,000	0.155406229	3,544,971
29	0	0.145409337	0
30	0	0.136055520	0
31	0	0.127303411	0
32	0	0.119114303	0
33	0	0.111451979	0
34	0	0.104282554	0
35	13,581,000	0.097574319	1,325,157
36	0	0.091297608	0
37	0	0.085424663	0
38	0	0.079929509	0
39	0	0.074787845	0
40	0	0.069976931	0
41	0	0.065475491	0
42	13,581,000	0.061263617	832,021
43	0	0.057322683	0
44	0	0.053635259	0
45	0	0.050185037	0
46	0	0.046956760	0
47	0	0.043936150	0
48	0	0.041109848	0
49	13,581,000	0.038465355	522,398
50	0	0.035990975	0

TOTAL PRESENT WORTH 23,811,644

CAPITAL RECOVERY FACTOR (50 YEARS @ 6. 875 %.) 0.07131676

AVERAGE ANNUAL COST (ROUNDED) **$1,698,200**

TABLE 52

H&H MONITORING COSTS
(PLAN B)

DISCOUNT RATE = 0.06875
p/l = Jan 99
CURRENT

YEAR	$	PW FACTOR	PRESENT WORTH
0	$0	1.000000	$0
1	350,750	0.935673	328,187
2	379,500	0.875483	332,246
3	270,250	0.819165	221,379
4	270,250	0.766471	207,139
5	241,500	0.717165	173,195
6	276,000	0.671032	185,205
7	218,500	0.627866	137,189
8	247,250	0.587477	145,254
9	247,250	0.549686	135,910
10	247,250	0.514326	127,167
11	218,500	0.481241	105,151
12	276,000	0.450284	124,278
13	218,500	0.421318	92,058
14	247,250	0.394216	97,470
15	247,250	0.368857	91,200
16	247,250	0.345129	85,333
17	218,500	0.322928	70,560
18	276,000	0.302155	83,395
19	218,500	0.282718	61,774
20	247,250	0.264532	65,405
21	247,250	0.247515	61,198
22	247,250	0.231593	57,261
23	218,500	0.216695	47,348
24	276,000	0.202756	55,961
25	218,500	0.189713	41,452
26	247,250	0.177509	43,889
27	247,250	0.16609	41,066
28	247,250	0.155406	38,424
29	218,500	0.145409	31,772
30	276,000	0.136056	37,551
31	218,500	0.127303	27,816
32	247,250	0.119114	29,451
33	247,250	0.111452	27,557
34	247,250	0.104283	25,784
35	218,500	0.097574	21,320
36	276,000	0.091298	25,198
37	218,500	0.085425	18,665
38	247,250	0.07993	19,763
39	247,250	0.074788	18,491
40	247,250	0.069977	17,302
41	218,500	0.065475	14,306
42	276,000	0.061264	16,909
43	218,500	0.057323	12,525
44	247,250	0.053635	13,261
45	247,250	0.050185	12,408
46	247,250	0.046957	11,610
47	218,500	0.043936	9,600
48	276,000	0.04111	11,346
49	218,500	0.038465	8,405
50	247,250	0.035991	8,899
	TOTAL PRESENT WORTH		$ 3,676,034

CAPITAL RECOVERY FACTOR (50 YEARS @ 6. 875 %.) 0.07131676

AVERAGE ANNUAL MONITORING COST (ROUNDED) $ 262,200

PlanB
monitge2

TABLE 53

GEOTECH MONITORING
(PLAN B)

DISCOUNT RATE = 0.06875
p/I = Jan 99
CURRENT

YEAR	$	PW FACTOR	PRESENT WORTH
0	0	1.000000	-
1	0	0.935673	-
2	0	0.875483	-
3	0	0.819165	-
4	$33,465	0.766471	25,650
5	0	0.717165	-
6	0	0.671032	-
7	0	0.627866	-
8	33,465	0.587477	19,660
9	0	0.549686	-
10	0	0.514326	-
11	0	0.481241	-
12	33,465	0.450284	15,069
13	0	0.421318	-
14	0	0.394216	-
15	0	0.368857	-
16	33,465	0.345129	11,550
17	0	0.322928	-
18	0	0.302155	-
19	0	0.282718	-
20	33,465	0.264532	8,853
21	0	0.247515	-
22	0	0.231593	-
23	0	0.216695	-
24	33,465	0.202756	6,785
25	0	0.189713	-
26	0	0.177509	-
27	0	0.16609	-
28	33,465	0.155406	5,201
29	0	0.145409	-
30	0	0.136056	-
31	0	0.127303	-
32	33,465	0.119114	3,986
33	0	0.111452	-
34	0	0.104283	-
35	0	0.097574	-
36	33,465	0.091298	3,055
37	0	0.085425	-
38	0	0.07993	-
39	0	0.074788	-
40	33,465	0.069977	2,342
41	0	0.065475	-
42	0	0.061264	-
43	0	0.057323	-
44	33,465	0.053635	1,795
45	0	0.050185	-
46	0	0.046957	-
47	0	0.043936	-
48	33,465	0.04111	1,376
49	0	0.038465	-
50	0	0.035991	-
	TOTAL PRESENT WORTH		$ 105,321

CAPITAL RECOVERY FACTOR (50 YEARS @ 6. 875 %.) 0.07131676

AVERAGE ANNUAL MONITORING COST (ROUNDED) $ 7,500

-

PlanB
BCR2

TABLE 54

BENEFIT AND COST SUMMARY AND BENEFIT TO COST RATIO OF SELECTED PLAN (Plan B)

($ IN 000'S)

Discount Rate = 6.875%

		DAMAGE REDUCED (BENEFITS) WITH PROJECT PLANS EXPECTED AVERAGE ANNUAL DOLLARS
BENEFITS BY CATEGORY		
STORM DAMAGE REDUCTION		
STRUCTURE	5,670	
INFRASTRUCTURE	289	
IMPROVED PROPERTY	1,747	
SUBTOTAL :		7,706
LOCAL COST FOREGONE		986
RECREATION		1,923
TOTAL BENEFITS		$10,615
- update to Jan 1999 p/l (insignificant)		$10,615
ANNUALIZED COSTS (@Jan 1999 p/l)		
CONSTRUCTION (includes PED and Real Estate)		$3,572
INTEREST DURING CONSTRUCTION		121
NOURISHMENT		1,698
MONITORING -- H&H		262
MONITORING -- GEOTECH		8
O & M COSTS		110
TOTAL ANNUALIZED COST OF SELECTED PLAN		5,771
BENEFIT TO COST RATIO		**1.84**
NET BENEFITS		$4,844

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix C

Environmental Analysis

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

AN EVALUATION AND COMPARISON OF BENTHIC COMMUNITY ASSEMBLAGES WITH POTENTIAL OFFSHORE SAND BORROW SITE(S) FOR THE BARNEGAT INLET TO LITTLE EGG INLET (LONG BEACH ISLAND), NEW JERSEY FEASIBILITY STUDY

Prepared for

U.S. Army Corps of Engineers
Philadelphia District 100 Penn
Square East Philadelphia, PA
19107

Prepared by

Lisa C. Scott
Frederick S. Kelley

Versar, Inc. 9200
Rumsey Road
Columbia, MD 21045

Contract No. DACW61-95-D-0011
Delivery Order No. 0046

Prepared Under the Supervision of

William H. Burton
Principal Investigator

November 1998

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

FOREWORD

This report entitled *An Evaluation and Comparison of Benthic Community Assemblages with Potential Offshore Sand Borrow Site(s) for the Barnegat Inlet to Little Egg Inlet (Long Beach Island), New Jersey Feasibility Study* was prepared by Versar, Inc., for Mr. Nathan Dayan, Environmental Resources Branch, U.S. Army Corps of Engineers, Philadelphia District, under Contract No. DACW61-95-D-0011, delivery order No. 0039. Cove Corporation provided taxonomic expertise as a subcontractor for completion of the macrobenthic samples for this report. EBA Engineering, Inc., was used as a subcontractor for the completion of most of the sediment grain size samples.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

Erosion of portions of the New Jersey coastline and its barrier islands is occurring from storms and other disturbances. The U.S. Army Corps of Engineers, Philadelphia District (PCOE), is conducting feasibility studies to investigate the possibility of beach replenishment to protect and enhance coastline habitats along the New Jersey coastline. PCOE is currently conducting a feasibility study to investigate Federal interest in shore protection along approximately 18 miles of the Long Beach Island shoreline between Barnegat Inlet and Little Egg Inlet.

PCOE identified four potential offshore borrow sources along an 18-mile stretch of Long Beach Island. The purpose of this study is to investigate the macrobenthic and surf clam resources of each borrow area. This baseline data will provide PCOE a benthic community inventory to provide recent biological data on benthic species within the borrow areas. This information will be used to provide baseline benthic data for these areas and to define any immediate or long-range impacts to the benthic biota and its habitat. Monitoring survey data may then be correlated with pre-dredge information to assess the recovery of the habitat after disturbance and can be used to establish future monitoring needs.

To accomplish these objectives, a stratified random design was used to select sampling stations within each borrow area and in areas outside the borrow boundaries to be used as a nearby reference area. The benthic resource data and sediment characterization data within the borrows were described and statistically compared to data collected from nearby reference stations and to data collected from regional reference areas. An adult surf clam survey was also conducted at randomly selected stations within each borrow area. The clam data for each borrow area were described and compared to data collected by New Jersey in 1994 and reported in their 1995 annual report on surf clam resources on the Atlantic Coast (NJDEP 1995).

Data on the benthic community composition and surf clam populations suggest that the borrow areas will fully recover from dredging operations within a few years. Other borrow areas along New Jersey that have been used as a sand source for beach nourishment and replenishment activities have displayed the ability to rapidly recover (i.e., within 2 years) even after multiple dredging operations (Scott and Kelley, 1998). The data from this study suggest that the benthic community of the four borrow sites are typical of the New Jersey coastline and the surf clam populations within the borrow areas have a good potential for recruitment and growth that will most likely continue after dredging is complete.

The macrobenthic data indicate that each borrow area has a good chance of rapid recovery to existing conditions if dredging operations were to occur within the site. Most of the dominant taxa of the four borrow areas were smaller organisms such as the polychaetes, *Polygordius* spp., *Mediomastus ambiseta*, and *Parapionosyllis longicirrata,* the small tanaid, *Tanaissus psammophilus*, and the small bivalves, *Donax variabilis*, *Petricola pholadiformis*, and

Tellina agilis. These species could easily recolonize after dredging operations. The mean number of large organisms within each borrow area was not significantly higher than the reference areas, indicating that each site has good potential for reaching conditions similar to those that exists before dredging operations. Additionally, the four borrow areas do not appear to contain a unique or rare macroinvertebrate community that would preclude its use as a sand borrow source for beach nourishment and replenishment activities along Long Beach Island. The community composition of the borrow areas were similar to the surrounding reference area so recruitment after dredging activities should result in similar community patterns provided that substantial changes in depth and sediment composition is minimized.

The surf clam community of the four borrow areas contained a mix of juvenile, small adult, and adult surf clams. The mean abundance of juvenile and small adult clams among borrow a reas ranged between 183/m^2 and 568/m^2, while the density estimates for adults averaged between 0.4 clams/100 sq. ft. to 64 clams /100 sq. ft (0.04 to 6.9 m^2). These numbers suggest that the borrow areas contain conditions conducive to good clam recruitment and subsequent growth to maturity and marketable size. Harvesting of the clams before dredging operations could remove the majority of the adult clams before dredging operations begin.

Evidence from a dredged area near Ocean City, NJ, indicate that surf clam populations are resilient and should be able to successfully recruit each borrow area even after multiple dredging operations (Scott and Kelley, 1998). Data from that study indicated that good clam recruitment is occurring and that the clams in the area are reaching mature and harvestable sizes. Since surveys of the surrounding areas of Long Beach Island indicated good populations of mature adults, it can be assumed that these clams will provide a strong recruitment base after dredging occurs.

TABLE OF CONTENTS

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

1.0 INTRODUCTION

Erosion of portions of the New Jersey coastline and its barrier islands is occurring from storms and other disturbances. The U.S. Army Corps of Engineers, Philadelphia District (PCOE), is conducting feasibility studies to investigate the possibility of beach replenishment to protect and enhance coastline habitats along the New Jersey coastline. PCOE is currently conducting a feasibility study to investigate Federal interest in shore protection along approximately 18 miles of the Long Beach Island shoreline between Barnegat Inlet and Little Egg Inlet. Beach nourishment activities to protect and enhance the coastline habitats requires the use of an offshore sand borrow area as a source of material. A critical component of the feasibility study is the selection and evaluation of potential offshore sand borrow sources for the nourishment activities.

A part of the offshore borrow site evaluation is the need to address living resource issues in the borrow area. An environmental concern with beach replenishment activities is the direct effect of dredging on the borrow's macrobenthic resources by removing existing communities and food resources and the potential disruption of commercial and recreational fisheries. Other possible effects of dredging include borrow habitat modification, disruption of natural recruitment patterns of macroinvertebrate fauna, and changing the community mix from an older, established community with large, deep dwelling organisms to one with high abundances of small, surface dwelling, opportunist taxa.

PCOE identified four potential offshore borrow sources along an 18-mile stretch of Long Beach Island (Figure 1-1). The purpose of this study is to investigate the macrobenthic and surf clam resources of each borrow area. This baseline data will provide PCOE a benthic community inventory to provide recent biological data on benthic species within the borrow areas. This information will be used to provide baseline benthic data for these areas and to define any immediate or long-range impacts to the benthic biota and its habitat. Monitoring survey data may then be correlated with pre-dredge information to assess the recovery of the habitat after disturbance and can be used to establish future monitoring needs.

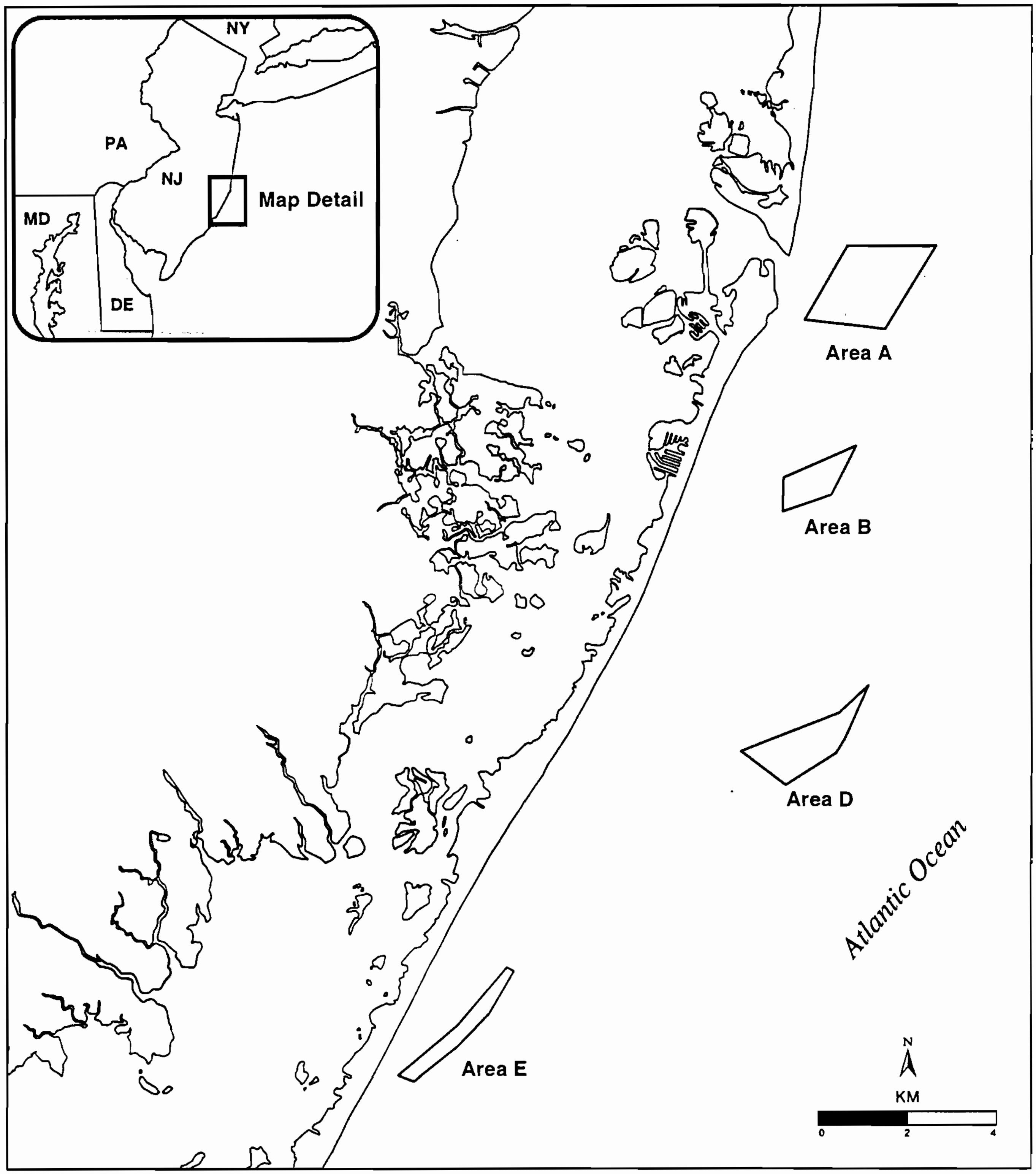


Figure 1-1. Proposed borrow areas near Long Beach Island, NJ

2.0 METHODS

2.1 SAMPLE DESIGN

A stratified random design was used to select stations for benthic macroinvertebrate sampling within each of the four Long Beach Island (LBI) borrow areas (Figure 1-1). Random selection of station locations allows valid statements to be made about the benthic community condition within the borrow area since all potential sampling sites had an equal probability of being sampled. Replicate samples at each randomly selected site is not necessary as the purpose is to characterize the community and variance within the entire potential borrow area not between sampling sites within a borrow area. The number of samples selected within each borrow area was proportional to the total area of the site. Borrow A, about 845.9 acres in size, had 55 sampling sites; Borrow B, about 272.8 acres in size, had 18 sampling sites; Borrow D, about 509.7 acres in size, had 33 sampling sites; Borrow E, about 273.1 acres in size, had 20 sampling sites (Figure 2-1). This spacial coverage resulted in about one sample per 13 to 15 acres. An additional two samples were randomly selected from locations near each borrow area for a total of 8 reference samples, which collectively will be referred to as the LBI reference area.

2.2 BENTHIC SAMPLE COLLECTION METHODS

2.2.1 Station Positioning

Station locations within each LBI borrow area and in the reference area were randomly selected by a GIS random selection program before field sampling. Once selected, stations were located in the field using a Trimble NT200D Differential Global Positioning System (DGPS), which is accurate to within 10 m. After positioning the vessel on station, the exact position coordinates were obtained from the DGPS and were recorded on a field data sheet. Benthic sampling was conducted in two phases. Borrows D and E were sampled on September 17-18, 1997 and Borrows A and B were sampled on October 2-3, 1997. Appendix B lists the location coordinates for each station.

2.2.2 Sample Collection

Benthic and sediment samples were collected with a 0.044-m^2 stainless steel, Young grab sampler. Samples collected for benthic macroinvertebrates were sieved through a 0.5-mm screen and preserved in a 10% solution of buffered formaldehyde stained with rose bengal. Sediment samples for analysis of grain-size and total organic content (TOC) were collected from a second grab and frozen until laboratory processing.

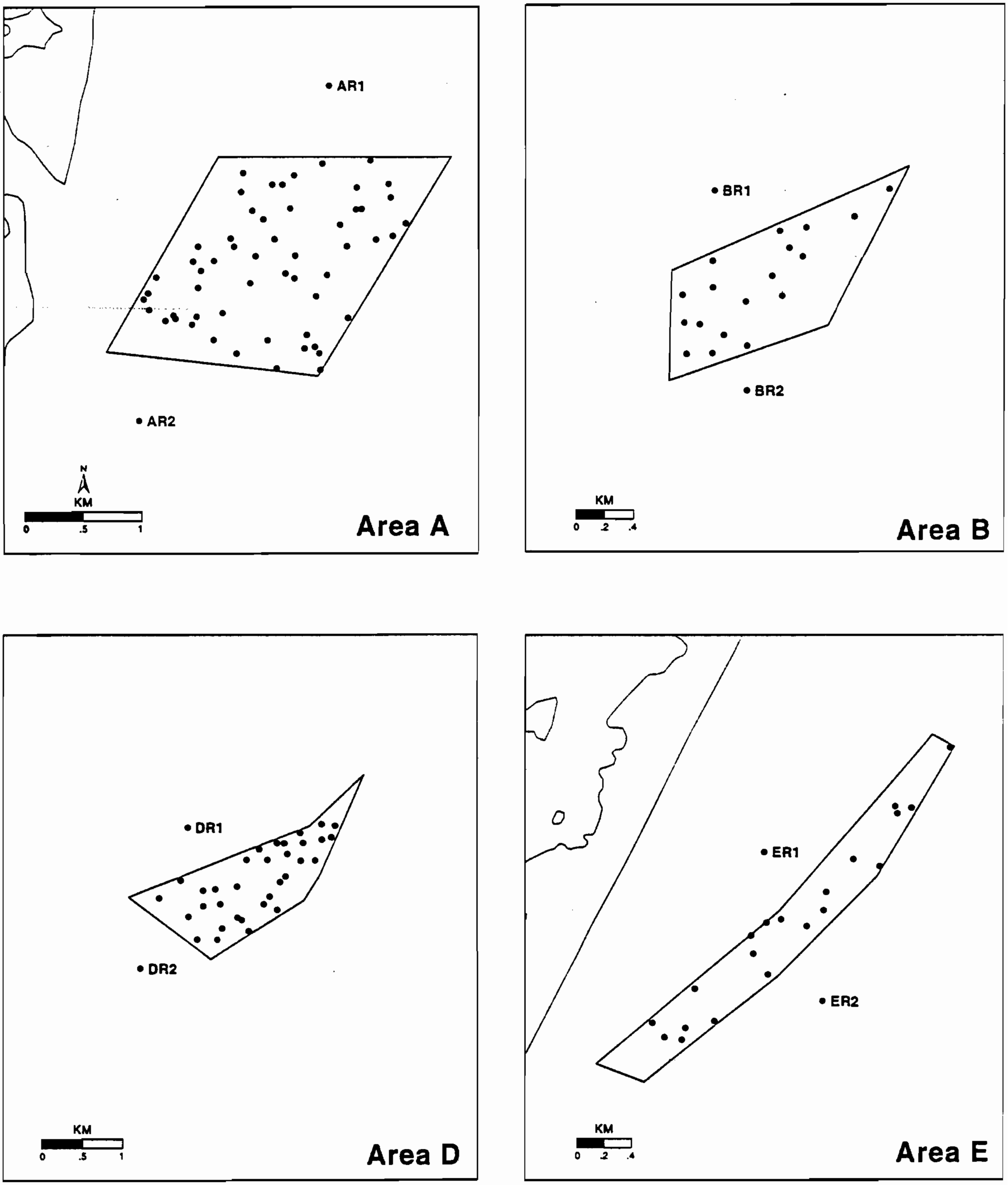


Figure 2-1. Benthic sampling stations within each LBI borrow area and the location of the reference stations (identified with an "R")

Since water quality throughout the borrow area was considered ubiquitous, surface and bottom measurements were taken at one sampling site during each sampling period. A Hydrolab Surveyor II was used to measure dissolved oxygen concentration (DO), salinity, conductivity, temperature, and pH. Depth measurements were recorded at each station using the vessel's electronic depth meter.

2.3 ADULT SURF CLAM COLLECTION METHODS

2.3.1 Station Selection and Positioning

Commercial hydraulic clam dredging was conducted at 40 locations randomly selected within the 4 LBI borrow areas (Figure 2-2; Appendix B). The number of clam dredge tows conducted within each borrow area was allocated according to areal size and resulted in one dredge per 39 to 55 acres of area. One clam dredge tow was conducted at each location. In the field, starting tow locations were recorded with a Trimble NT200D Differential Global Positioning System.

2.3.2 Sample Collection

The commercial surf clam stocks of the four LBI borrow areas were surveyed on 15 and 16 September, 1997. The survey methods closely followed those employed by New Jersey's Division of Fish, Game, and Wildlife (NJDEP) in their yearly inventory of surf clam resources along the Atlantic coast from Shrewsbury Rocks to Cape May. The surveys were conducted on the 65 ft, commercial hydraulic clam dredging vessel, "Elizabeth C II." Clams were collected by towing a conventional hydraulic clam dredge for five minute transects. The clam dredge was fitted with a 183-mm (72") knife and adjusted to retain clams that are 7.6-cm (3") in size or larger.

For each tow, the volume of surf clams collected was measured in U.S. standard bushels. Three bushels of clams from each tow were counted to estimate the mean number of clams per bushel. All surf clams were counted for tows that collected less than 3 bushels. To determine length frequency distributions for surf clam stocks, for each clam dredge tow, 50 randomly selected surf clams were measured to the nearest mm. For tows collecting less than 50 surf clams, all of the surf clams were measured. All additional benthic or epifaunal species collected by the dredge were identified in the field (common names) and counted.

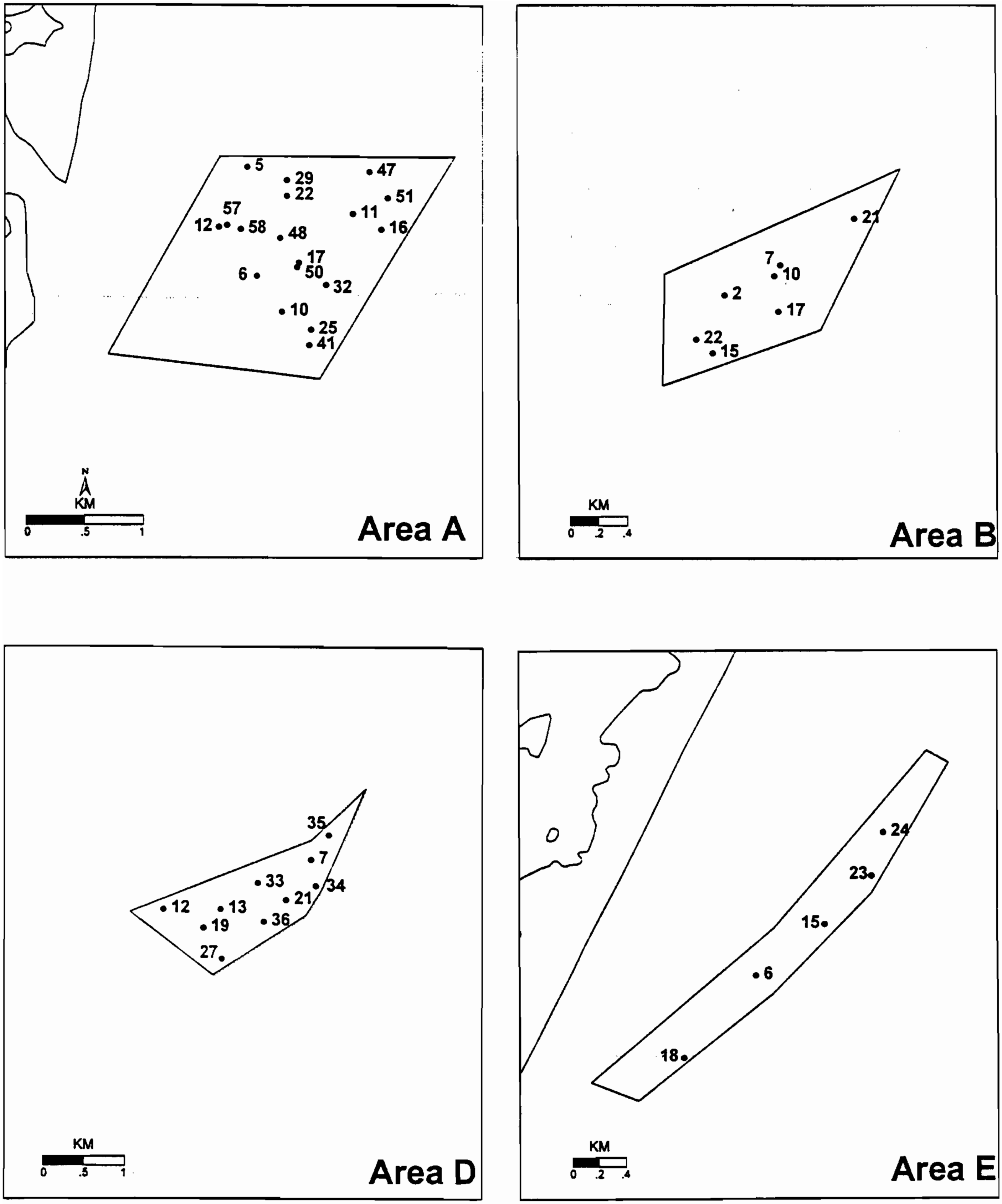


Figure 2-2. Adult surf clam survey start locations within each LBI borrow area

2.4 LABORATORY SAMPLE PROCESSING

2.4.1 Benthic Macroinvertebrates

Benthic organisms were sorted from debris using a dissecting microscope, identified to the lowest practical taxonomic category, and counted. Epifaunal organisms were identified and counted, but were eliminated from the analyses because they are not sampled quantitatively with the Young grab. The number of organisms longer than 2 cm for each taxa was also counted. Organisms were grouped according to the lowest taxonomic level to determine taxa specific ash-free dry weight (AFDW) biomass. This was a deviation from the Scope of Work (Appendix A) which requested dry weight biomass for five major taxonomic categories. AFDW provides a more accurate measure of the carbon available to higher trophic levels and was consistent with the biomass methods of the regional surveys used as reference areas. AFDW biomass was determined by drying each taxon to a constant weight at 60°C, ashing in a muffle furnace at 500°C for 4 hours, and weighing the remains.

When completing taxonomic identifications in the laboratory, some organisms cannot be completely identified to the species level, particularly if they are immature/juveniles or in poor shape. The taxonomist made a note in the database when it was the opinion of the taxonomist that such an organism should not be considered a separate taxon when tallying total number of taxa. All of the statistical analyses and calculation of diversity indices accounted for these taxonomic identification notations.

2.4.2 Grain-size and Total Organic Content

Grain-size analysis was performed according to ASTM Method D422-63. Sieve sizes ranged from 4.25 mm (U.S. Standard Sieve No. 4) to 63 μm (U.S. Standard Sieve No. 230). Sediments were categorized by Wentworth's classifications (Table 2-2). Total organic content (TOC) was measured by weight loss upon ignition at 500°C for 4 hours.

2.5 DATA ANALYSIS

The benthic macroinvertebrate community and surf clam population as measured in the grab samples at the four LBI borrow areas were described and statistically compared with four reference areas sampled on the New Jersey coast. The results of the adult surf clam dredge survey were described and visually compared with data obtained from the NJDEP as part of their yearly inventory of surf clam resources along the Atlantic Coast.

Table 2-2. Sieve sizes used for sediment particle distribution and the Wentworth sediment size categories (Buchanan 1984)		
Sieve Number	**Sieve Size**	**Wentworth Size Category**
4	4.75-mm	Pebble
10	2.00-mm	Granule
20	850-µm	Very Coarse Sand
40	425-µm	Coarse Sand
60	250-µm	Medium Sand
140	106-µm	Fine Sand
200	75-µm	Undefined
230	63-µm	Very Fine Sand
	< 63-µm	Silt-Clay

2.5.1 Benthic Community Comparisons

Macrobenthic resources from four reference areas were used as a comparison to the resources from the four LBI borrow areas. The reference stations sampled near the four LBI borrow areas (as stated in Section 2-1 above) were combined to create an LBI reference area. Three additional macroinvertebrate studies conducted from undisturbed sites along the New Jersey coast (Appendix H) were also included in the statistical comparisons with the four LBI borrow areas. (1) Stations within Borrows A, C, D and the corresponding reference stations from the Brigantine I study conducted in October 1995 (Chaillou and Scott 1997) were combined to create the Brigantine I reference area. (2) Stations within Borrows E, F, G, and the corresponding reference stations from the Townsends Inlet area sampled in October 1995 (Scott and Chaillou 1997) were combined to create the Brigantine II reference area. (3) Stations within Borrows P1, P2, and the corresponding reference stations near Cape May Meadows sampled in September 1996 (Scott 1997) were combined to create the Cape May Meadows reference area. Laboratory and field methods for the reference area collections were the same as in this study so adjustments to the data were not required.

One-way analysis of variance (ANOVA) was conducted on selected sediment and benthic assemblage parameters to determine if conditions at the four LBI borrow areas were statistically different ($p < 0.05$) than conditions in the reference areas and to determine whether the borrow areas contained any unique community or population parameters. ANOVAs were performed on mean condition within each sampling area for each selected parameter. Data for each parameter were log-transformed before analysis to meet requirements for normality. Duncan's Multiple Range Test was performed to determine statistical differences between class variables.

Sediment parameters analyzed included percent silt-clay, percent TOC, and depth. Three measures of biological condition were used to compare the habitats from the benthic grab data: diversity, abundance, and biomass. Diversity was measured in three ways: (1) number of taxa (i.e., taxa richness), (2) Shannon-Wiener Diversity Index, which includes measures of taxa richness and evenness; and (3) Simpson's Dominance Index (scaled from 0 to 1), which calculates the probability of randomly selecting two organisms that are different taxa (Shannon and Weaver 1949; Krebs 1978). To maintain consistency in analysis approach and to remove subjectivity as to which organisms are not quantitatively sampled, all epifaunal organisms were eliminated from the database before statistical analysis.

The formula for the calculation of the Shannon-Wiener Index is:

$$H = -\sum_{i=1}^{s} (p_i)(\log_2 p_i)$$

where

H = index of species diversity
S = number of species
p_i = proportion of total sample belonging to ith species

The formula for the calculation of the Simpson's Dominance Index is:

$$D = 1 - \sum_{i=1}^{s} (p_i)^2$$

where

D = Simpson's index of diversity
p_i = proportion of individuals of species i in the community

2.5.2 Adult Surf Clam Survey

The number of clams collected per dredge tow was estimated by the product of the number of bushels collected and the mean number of clams per bushel among 3 counted. The area sampled by each tow was calculated by determining the distance traveled by the dredging vessel (using the start and end DGPS locations) and multiplying the result by 6 ft., the dimension of the dredge's knife. To estimate clam densities for each dredge tow, the total number of clams collected was divided by the area sampled in standard units of 100 sq. ft. To calculate the overall standing stock within each borrow area, mean clam density was multiplied by the area comprising borrow area; 95% confidence intervals were also calculated.

Length-frequency plots for each borrow area were determined by pooling all of the clam lengths measured for all dredge tows. As the clam dredge was adjusted, to collect clams

Length-frequency plots for each borrow area were determined by pooling all of the clam lengths measured for all dredge tows. As the clam dredge was adjusted, to collect clams greater than 3", the small percentage of clams within smaller size categories (< 76-mm) should not be given too much emphasis since they were not sampled quantitatively.

Surf clam data collected from the four LBI borrow areas were compared with those collected by New Jersey in 1994 and reported in their 1995 annual report on surf clam resources on the Atlantic Coast (NJDEP 1995). The inventory extends along the Atlantic Coast from Shrewsbury to Cape May, but is stratified from north to south and by distance from shore. Data from the strata extending from Barnegat Inlet to Absecon Inlet were the most comparable to this study and were used to compare dredge tow result and size distribution of clams. The New Jersey report listed the number of bushels collected for each tow. The number of bushels/tow and the average clam size for the LBI borrow areas were compared to the NJDEP data.

3.0 RESULTS

3.1 HABITAT CHARACTERISTICS

3.1.1 Size, Location, and Depth

The four LBI borrow areas are located along the coastline of Long Beach Island (Figure 1-1). Borrow A was the furthest north and is located off Barnegat Inlet. Borrow A was the largest of the borrow areas with a size of about 846 acres. This area was also the closest to the shoreline. Borrows B and E were similar in size (about 273 acres) but were very different in shape (Figures 1-1 and 2-1). Both borrows were considered to have the same approximate depth by PCOE but sampling stations at Borrow E averaged less than stations sampled at Borrow B (Table 3-1, Appendix C). Borrow D had an approximate size of 510 acres and was located the furthest offshore (about 4 miles). Borrow D was also the deepest area with a sampling station mean depth of 12.5 m (Table 3-1). The mean depths of the sampling stations within the borrow areas were generally deeper (by up to 7 m) than the regional areas used for comparison (Table 3-2).

Table 3-1. Means of sediment parameters and station depth for the LBI borrow areas. Standard error of estimate in parentheses.

	Borrow A	Borrow B	Borrow D	Borrow E
Depth (m)	10.3 (0.4)	10.5 (0.3)	12.5 (0.3)	8.9 (0.5)
Silt-clay Content (% < 63μm)	2.42 (0.59)	1.03 (0.09)	0.79 (0.06)	1.22 (0.49)
Total Organic Content (%)	0.75 (0.22)	0.30 (0.03)	0.26 (0.02)	0.22 (0.01)

3.1.2 Water Quality

Water quality of the LBI borrow areas was homogeneous throughout the water column with no evidence of stratification. Surface and bottom water quality measures were nearly identical. Both surface and bottom temperatures on September 17 were 22 °C whereas on October 2, temperatures had cooled to 18 °C. Surface and bottom pH ranged between 8.0 and 8.3 while surface and bottom salinity ranged between 31 and 32 ppt. Surface dissolved oxygen concentration (DO) ranged between 7.2 and 7.6 mg/l, while bottom DO ranged between 5.7 and 6.8 mg/l.

Table 3-2. Means of sediment parameters and station depth for the LBI reference area and other regional areas. Standard error of estimate in parentheses. Capital letters indicate which borrow area is significantly different from the reference area.

Parameter	LBI Reference Area		Brigantine I		Brigantine II		Cape May Meadows	
Depth (m)	11.7 (0.7)	E	3.5 (0.4)	A,B,D,E	6.6 (0.5)	A,B,D,E	9.7 (0.3)	D
Silt-clay Content (% < 63μm)	2.49 (0.82)	B,D,E	1.16 (0.07)		1.08 (0.07)	A	2.10 (0.48)	B.D.E
Total Organic Content (%)	0.41 (0.04)	E	0.27 (0.01)	A	0.32 (0.06)	A	0.42 (0.03)	E

3.1.3 Sediment Characteristics

Sediments within the four LBI borrow areas were very sandy with mean silt-clay content ranging between 0.8 and 2.4% (Table 3-1). Mean silt/clay content of the four LBI borrow areas were similar to sediments in the other regional areas. Differences in silt/clay percentage between the borrow and reference areas examined were within a range considered biologically inconsequential to benthic resources (Table 3-2; Weisberg et al. 1997). According to the Wentworth classification, most of the sediments within the borrow areas were between the coarse and fine sands categories (Appendix D). Station B-18 within Borrow B and reference Stations BR-1 and DR-1 had a higher percentage of gravel sized particles while Station A-43 within Borrow A had 30.7% silt/clay (Appendices C and D).

Mean percentage of total organic carbon content (TOC) of the sediments in the four LBI borrow areas ranged between 0.2 and 0.7% (Table 3-1). TOC of the sediments in the borrow areas was similar to TOC of the reference area sediments and statistical differences are considered to be within a range that is biologically inconsequential to benthic resources (Table 3-2).

3.2 BORROW AREA BENTHIC COMMUNITY DESCRIPTIONS

3.2.1 Community Composition and Dominance

The community composition of the 4 LBI borrow areas and the LBI reference area were similar. The areas were dominated by polychaete worms followed by molluscs and arthropods (specifically crustaceans) (Figure 3-1). Oligochaete worms also contributed substantially to

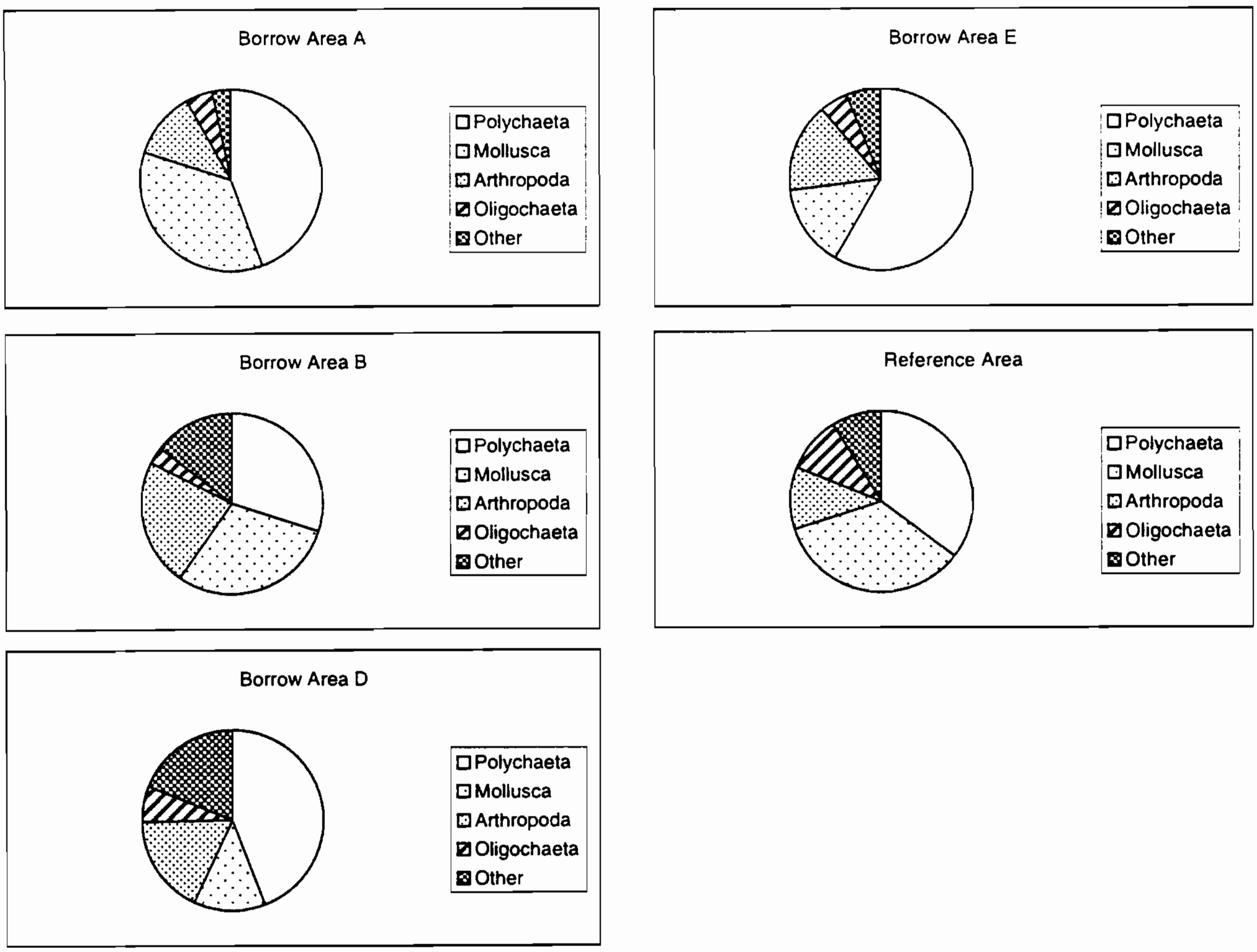


Figure 3-1. Benthic community composition at the four LBI borrow areas and the LBI reference area

the faunal composition of the areas. The mean abundance of the top 10 dominant taxa of each borrow area contributed to 69% of the total mean abundance at Area B to more than 88% at Area E (Table 3-3). In general, the dominate polychaetes were small, surface dwelling organisms. The small bristle worm, *Polygordius* spp., was either the first or second most dominant polychaete in each area (Table 3-3). Other dominant polychaetes included the small capitellid, *Mediomastus ambiseta,* and the small syllid, *Parapionosyllis longicirrata,* (Table 3-3). The dominant crustacean was the very small (<5 mm as an adult) tanaid, *Tanaissus psammophilus* (Table 3-3). The majority of the molluscs were also dominated by the small bivalves *Donax variabilis*, *Petricola pholadiformis*, and *Tellina agilis* (Table 3-3). Another dominant bivalve, the surf clam *Spisula solidissima*, had some clams that reached lengths greater than 2 cm in all four areas (Table 3-3). Station specific taxonomic, abundance, and biomass data are presented in Appendix E.

3.2.2 Diversity

The total number of taxa identified from each LBI borrow area ranged from 57 at Area E to 121 at Area A (Table 3-4). As expected, more taxa were identified from the larger borrow areas where more samples were collected. Taxa richness as measured by mean number of taxa was generally high for the four borrow areas and ranged from 16.1 to 22.7 (Table 3-4). The highest mean number of species was also found at Area A (22.7) and at Area D (19.6).

Diversity indices, as measured by the Shannon Wiener Index and the Simpson's Dominance Index, indicate a relatively diverse, evenly distributed community structure within the four LBI borrow areas. Shannon Wiener Diversity Index (*H*), which includes a measure of taxa evenness, ranged from a low of 2.6 at Area E to a high of 3.4 at Area D (Table 3-4). Simpson's Dominance Index (*D*) followed the same pattern as *H* where the lowest value, 0.70, occurred at Area E and the highest value, 0.86, occurred at Area D (Table 3-4).

The macrobenthic assemblages present in the LBI borrow areas were similar to the assemblages of the LBI reference area and the other regional studies. More than 80% of the taxa present in the four borrow areas were also present in at least one of the LBI reference or regional areas (Appendix F). This indicates that none of the proposed borrow areas contain a unique or rare benthic assemblage and the faunal assemblage of the borrow areas is common to the New Jersey coast.

A total of 39 unique taxa classified as epifaunal were collected in the grab samples from the four LBI borrow areas (Appendix G). Borrow A contained the most epifauna taxa (34) and Borrow E contained the least (9), which is related to the number of samples taken from each borrow. The epifaunal taxa collected from the LBI reference area were similar to those collected from the four borrow areas (Appendix G).

Table 3-3. Mean abundance (#/m^2) of the 10 most abundant taxa in each LBI borrow area and the LBI reference area

Taxon	Area A	Area B	Area D	Area E	LBI Reference Area
Nemertinea					
Nemertinea	197.5	56.8	77.8	120.5	161.9
Annelida : Polychaeta					
Aricidea cerrutii	67.4	174.2	98.5	2.3	11.4
Asabellides oculata	471.5	1.3	3.4		34.1
Caulleriella sp. B (Blake)	322.7	5.1	29.6	72.7	39.8
Hesionura elongata	13.6	16.4	124.0	17.1	36.9
Mediomastus ambiseta	766.5	27.8	7.6	2.3	289.8
Parapionosyllis longicirrata	25.6	53.0	308.5	130.7	159.1
Polygordius spp.	1072.3	118.7	225.2	2408.0	204.5
Sigalionidae	2.9	112.4	11.0	5.78	2.8
Spiophanes bombyx	86.0	82.1	33.8	26.1	71.0
Annelida : Oligochaeta					
Oligochaeta	401.2	90.9	197.0	252.3	522.7
Mollusca : Bivalvia					
Donax variabilis	186.4	2.5	0.7	235.2	
Petricola pholadiformis	1898.3	159.1	117.1	14.8	761.4
Spisula solidissima	474.8	568.2	183.2	442.0	349.4
Tellina agilis	305.8	79.6	37.9	1.1	519.9
Arthropoda : Tanaidacea					
Tanaissus psammophilus	367.4	334.6	417.4	513.6	250.0
Arthropoda : Isopoda					
Chiridotea coeca	43.0	11.4	6.2	109.1	5.7
Arthropoda : Amphipoda					
Protohaustorius wigleyi	25.2	107.3	31.7	8.0	28.4
Echinodermata : Echinoidea					
Echinoidea	36.4	328.3	424.2	172.7	210.2

Table 3-4. Mean condition (except for total number of taxa) of the benthic macroinvertebrate community at the four LBI borrow areas. Standard error of estimate in parenthesis.

Parameter	Area A	Area B	Area D	Area E
Total number of taxa	121	69	92	57
Number of Taxa (#/Sample)	22.69 (1.11)	18.06 (1.04)	19.61 (0.95)	16.10 (1.43)
Shannon-Wiener Index	2.89 (0.11)	3.22 (0.09)	3.44 (0.06)	2.57 (0.18)
Simpson's Dominance Index	0.74 (0.02)	0.83 (0.01)	0.86 (0.01)	0.70 (0.04)
Total Abundance (#/m^2)	8147 (1038)	2903 (496)	3112 (467)	5084 (1168)
Amphipod Abundance (#/m^2)	516 (92)	269 (45)	128 (25)	170 (45)
Bivalve Abundance (#/m^2)	2897 (452)	843 (108)	376 (98)	709 (131)
Polychaete Abundance (#/m^2)	3611 (764)	869 (326)	1377 (317)	2964 (1017)
Total Biomass (g/m^2) AFDW	32.70 (14.95)	3.04 (1.26)	3.38 (0.67)	4.61 (1.27)
Amphipod Biomass AFDW (g/m^2)	0.12 (0.02)	0.20 (0.04)	0.12 (0.03)	0.25 (0.06)
Bivalve Biomass AFDW (g/m^2)	29.32 (14.98)	1.49 (0.51)	1.14 (0.27)	3.88 (1.24)
Polychaete Biomass AFDW (g/m^2)	0.97 (0.23)	0.33 (0.13)	0.40 (0.16)	0.28 (0.08)

3.3BENTHIC COMMUNITY REGIONAL COMPARISONS

3.3.1 Biodiversity

The total number of taxa identified from the four LBI borrow areas ranged between 57 and 121 (Table 3-4). The total number of taxa identified from the four reference areas used for comparison ranged between 37 and 100 (Table 3-5). In general, the mean number of taxa within the four LBI borrow areas were intermediate of the four reference areas (Tables 3-4 and 3-5). Mean number of taxa at both Brigantine reference areas were significantly lower than most of the borrow areas, whereas the Long Beach Island and Cape May Meadows reference areas were generally not significantly different from the borrow areas (Table 3-5).

Table 3-5. Mean condition (except for total number of taxa) of benthic macroinvertebrate community attributes for the LBI reference area and nearby regional areas. Standard error is in parenthesis. Capital letters indicate which borrow area is significantly different from the reference area.

Parameter	LBI Reference Area		Brigantine I		Brigantine II		Cape Meadows	
Number of taxa (#/Sample)	23.13 (2.01)	E	7.04 (0.54)	A,B,D,E	14.21 (0.94)	A,B,D	23.66 (1.32)	E
Shannon-Wiener Index	3.40 (0.07)	A,E	1.85 (0.12)	A,B,D,E	2.24 (0.11)	A,B,D	2.47 (0.15)	B,D
Simpson's Dominance Index	0.85 (0.12)	A,E	0.60 (0.03)	A,B,D	0.64 (0.02)	A,B,D	0.70 (0.03)	B,D
Total Abundance (#/m^2)	5310 (1198)		1288 (220)	A,B,D,E	4867 (475)		13656 (2608)	B,D,E
Amphipod Abundance (#/m^2)	315 (64)	D	1036 (215)	D,E	2736 (416)	D,E	203 (57)	A,B
Bivalve Abundance (#/m^2)	1827 (504)	D,E	115 (27)	A,B,D,E	103 (39)	A,B,D,E	868 (134)	A,D
Polychaete Abundance (#/m^2)	1869 (518)		103 (20)	B,D,E	469 (241)		12106 (2603)	A,B,D,E
Total Biomass (g/m^2) AFDW	3.82 (1.61)		39.51 (10.91)	E	2.41 (1.79)	A	10.41 (2.63)	B
Amphipod Biomass AFDW (g/m^2)	0.11 (0.05)	E	0.12 (0.02)	B,D,E	0.15 (0.02)		0.07 (0.04)	B,E
Bivalve Biomass AFDW (g/m^2)	1.39 (0.75)	A	39.03 (10.88)	B,D,E	1.91 (1.79)	A	6.48 (1.82)	
Polychaete Biomass AFDW (g/m^2)	2.01 (1.69)	B,D,E	0.06 (0.02)	A	0.29 (0.04)	A	1.08 (0.21)	B,D,E

Diversity measures such as Shannon-Wiener and Simpson's Dominance Index were relatively high in the four LBI borrow areas and were mostly significantly higher than the diversity measures of the reference areas to the south (Table 3-5). This indicates that the more northerly positioned LBI borrow areas contain a relatively diverse benthic community with a relatively even distribution of abundance among taxa. It appears however, that these higher measures of diversity are common to the area as the diversity measures at the Long Beach Island reference area were also high and not significantly lower than any of the four borrow areas (Table 3-5).

3.3.2 Abundance

Mean total abundance ranged between 2903 and 8147/m^2 at the four LBI borrow areas (Table 3-4). This range was intermediate of the regional reference areas which ranged between 1288 and 13,656/m^2 (Table 3-5). The ANOVA results substantiated this fact in that Brigantine I, which had the lowest total abundance, was significantly lower than all the LBI borrow areas. Cape May Meadows, which had the highest total abundance, was significantly higher than three of the LBI borrow areas (Table 3-5).

3.3.3 Biomass

Mean total ash-free dry weight biomass within the four borrow areas ranged between 3.04 at Borrow B and 32.70 g/m^2 at Borrow A (Table 3-4). The larger biomass in Borrow A was mainly due to the presence of large numbers of surf clams (*Spisula solidissima*) greater than 2 cm in length. These larger clams were present in more than 25% of the samples in Borrow A (Appendix E). The mean biomass of the four borrow areas was again intermediate relative to the regional reference areas (Table 3-5). Borrows B, D, and E, for the most part, were not significantly different from the Long Beach Island, Brigantine II, and Cape May Meadows reference areas. Borrow A was not significantly different from the Long Beach Island, Brigantine I and Cape May Meadows reference areas (Table 3-5).

3.3.4 Large Organisms

Sites containing many large individuals generally suggest a long-lived, established benthic community that will require a longer period to recover from stress (Warwick 1986; Dauer 1993). A total of 28 unique taxa with individuals longer than 2 cm were collected from the 126 stations sampled within the four LBI borrow areas. The highest percentage of individuals longer than 2 cm were observed among the polychaetes, including *Dispio uncinata, Nephtys bucera,* and *Sigalion arenicola* (Table 3-6). Twenty-one of the 28 taxa with individuals longer than 2 cm belonged to the polychaete group. The surf clam, *Spisula solidissima*, also had a large percentage of individuals longer than 2 cm in Borrows A and E while the razor clam, *Ensis directus*, had a large percentage of individuals longer than 2 cm in the LBI reference area (Table 3-6).

Borrow Area A had the most taxa with individuals longer than 2 cm, followed by Borrow Area E, B, and D (Table 3-6). Since the total number of taxa with large individuals can be related to the number of samples collected within each borrow area, the mean number of taxa with large individuals is the preferred method for comparing sites. Only the Cape May Meadows reference area had a higher mean number of large organisms than the four LBI borrow areas; the mean was statistically higher than Borrows D and E (Table 3-7).

Table 3-6. Percentage of organisms greater than 2 cm at the LBI borrow and LBI reference areas. Stations where smaller specimens were found are indicated with zeros; taxa for which no specimen longer than 2 cm were found are not listed.

Taxon	Area A	Area B	Area D	Area E	LBI Reference Area
Nemertinea					
Nemertinea	3.64	0.00	1.89	0.93	0.00
Annelida : Polychaeta					
Asabellides oculata	0.03	0.00	0.00		0.00
Capitellidae	0.00		0.00		12.50
Cirriformia grandis	0.00	0.00	1.63	0.00	12.29
Diopatra cuprea	4.00	5.56	0.43		0.00
Dispio uncinata	2.64	25.56	0.00	0.00	0.00
Drilonereis longa	1.82				
Glycera americana	2.45	5.56			0.00
Glycera dibranchiata	1.82				
Hemipodus roseus	0.10	0.00	0.38	2.92	0.00
Leitoscoloplos robustus			3.03		
Macroclymene zonalis					12.50
Neanthes succinea	0.06				0.48
Nephtys bucera	43.64	16.64	9.09	20.00	15.63
Nephtys picta	10.91		8.33		0.00
Notocirrus spiniferus	3.64	0.00	3.03		
Notomastus luridus		5.56			
Onuphis eremita	2.73				0.00
Orbinia americana	1.82			5.00	
Orbiniidae	1.82				
Pherusa affinis	3.64		0.00		12.50
Phyllodoce arenae	11.82	0.00	0.00	0.00	0.00
Scoletoma acicularum	3.64	5.56	3.03		
Sigalion arenicola	5.45	5.56	21.97	2.50	12.50
Spio setosa					12.50
Spiochaetoptrus costarum	5.45	0.00	0.00		0.00
Spiophanes bombyx	0.00	5.56	0.00	0.00	0.00
Mollusca : Gastropoda					
Polinices heros	5.45	2.78	0.00	0.00	0.00
Mollusca : Bivalvia					
Ensis directus	3.64	0.00	3.03		14.29
Spisula solidissima	19.07	4.20	0.20	12.08	0.86
Echinodermata : Echinoidea					
Echinarachnius parma	0.00	0.00	15.15		
Mellita quinquiesperforata	1.82		3.03		

Table 3-6. (Continued)

Taxon	Area A	Area B	Area D	Area E	LBI Reference Area
Echinodermata : Holothuroidea *Leptosynapta tenuis*	0.00				6.25
Chordata : Cephalochordata *Branchiostoma caribaeum*	0.00		3.03		
Total Number of Taxa	24	10	15	6	11
Mean Number of Taxa	1.75	1.39	0.97	0.90	1.63

Table 3-7. Total number and mean number of taxa with individuals longer than 2 cm at the LBI reference area and other regional areas. Capital letters indicate which borrow area is significantly different from the reference area.

Parameter	LBI Reference Area	Brigantine I	Brigantine II	Cape May Meadows
Total number of taxa (number of samples)	11 (8)	8 (27)	19 (38)	25 (29)
Mean number of taxa	1.63	1.11	1.29	2.24 D,E

3.4 SURF CLAM POPULATIONS

The Atlantic surf clam, *Spisula solidissima*, was collected from all the LBI borrow areas using both the Young grab sampler and the hydraulic clam dredge. For statistical analysis, the number and biomass of clams collected with the Young grab (henceforth referred to as juvenile and small adult clams) were compared with Young grab data from other regional surveys. The clam data collected with the hydraulic clam dredge (henceforth referred to as adult clams) were compared with NJDEP regional clam dredge data.

3.4.1 Young Grab Samples

Juvenile and small adult surf clams were collected in more than 92% of the stations in the LBI borrow areas. Clams were collected in 49 of 55 stations in Borrow A, all 18 stations of Borrow B, 31 of 33 stations of Borrow D, and 19 of 20 stations of Borrow E (Appendix E). Mean abundance of surf clams collected ranged from 183/m^2 at Borrow D to 568/m^2 at Borrow A (Table 3-8). The abundance of clams greater than 2 cm in length also varied by borrow area. Borrow A had the greatest mean number of larger clams, 156/m², and had the greatest frequency of larger clams per grab, 38% (Table 3-8, Appendix E). Borrow D had the lowest mean number of larger clams, 0.9/m², and had the lowest frequency of larger clams per grab, 3% (Table 3-8, Appendix E). Biomass followed the same pattern as number of larger clams in that Borrow A had the greatest mean biomass (29g/m²) and Borrow D had the lowest (0.9g/m², Table 3-8).

Table 3-8. Mean abundance and biomass of the surf clam in grab samples from the four LBI borrow areas. Standard error of estimate in parenthesis.

Parameter	Area A	Area B	Area D	Area E
Mean abundance (#/m²)	474.8 (7.05)	568.2 (103.0)	183.2 (42.9)	442.0 (120.9)
Mean abundance of clams longer than 2 cm (#/m²)	29.1 (49.8)	1.4 (5.3)	0.9 (0.7)	3.9 (13.3)
Mean Biomass (g/m²) (AFDW)	155.8 (14.98)	12.6 (0.50)	0.7 (0.27)	34.1 (1.24)

Borrows A, B, and E had a higher mean number of clams than the other regional studies but only Borrow B was statistically higher than all the reference areas (Table 3-9). Mean abundance of clams from Borrows A, D, and E were not statistically different from the LBI or Cape May reference areas but were statistically higher than the two Brigantine reference areas (Table 3-9).

Table 3-9. Mean abundance and biomass of surf clams in grab samples from the LBI reference area and other regional areas. Capital letters indicate which borrow area is significantly different from the reference area.

Parameter	LBI Reference Area		Brigantine I		Brigantine II		Cape May Meadows	
Mean abundance (#/m²)	349.4	B	83.3	A,B,D,E	17.3	A,B,D,E	202.2	B
Mean abundance of clams longer than 2 cm (#/m²)	5.7	A	62.3	B,D,E	0.6	A,E	46.2	D
Mean Biomass (g/m²)	1.15		39.03	B,D,E	1.80	B	6.01	

Mean abundance of clams greater than 2 cm in length at all the LBI borrow areas were intermediate relative to the means for the reference areas. Every reference area was statistically similar to at least two of the LBI borrow areas (Tables 3-8 and 3-9). This same pattern was detected in the biomass analysis, where the LBI borrow areas were intermediate relative to the reference areas and were statistically similar to at least two reference areas (Tables 3-8 and 3-9).

3.4.2 Hydraulic Dredge Adult Clam Survey

The adult surf clam populations of the four LBI borrow areas are characterized individually below. For each borrow area, surf clam data were used to calculate an overall mean density and standing stock with 95% confidence intervals. The surf clam size distributions for each borrow area is presented with means for the tows conducted in the borrow area, and as a length frequency plot combining all of the clams measured from a borrow area. In the final sections, the borrow areas are placed in perspective with regional data collected by the New Jersey's annual surf clam survey.

3.4.2.1 Borrow A

Borrow A, the largest of the Long Beach Island areas, had the greatest percentage of dredge tows that collected adult clams (94%; Table 3-10). In total, more than 370 bushels of surf clams were collected in the borrow area from a combined 18 dredge tows. The estimated number of surf clams collected per tow averaged nearly 1500 and ranged as high as 3960 clams (Station 43). Density estimates for the borrow area averaged 33 clams/100 sq. ft. and ranged to 89 clams/100 sq. ft (Station 43). Overall, the standing stock of adult surf clams of Borrow A was estimated to be 12 million clams (Table 3-11).

The length distribution of surf clams in Borrow A was relatively broad, ranging from 96 to 168-mm (Figure 3-2). Several smaller clams were also collected ranging from 45 to 51-mm, but were considered anomalous, as the smaller size classes were not efficiently sampled by the dredge. The peak size frequency class among all of the clams measured (126-mm) closely approximated the grand mean for tows that collected surf clams (128-mm; Table 3-10).

3.4.2.2 Borrow B

Among the 4 LBI borrow areas, Borrow B contained the fewest number of adult surf clams. Only four of the seven dredge tows contained adult clams (Table 3-10). Further, at the stations where clams were present, less than 3 bushels of clams were collected. Total counts averaged only 21 clams/tow and ranged to 93 clams (Station 11). Density estimates averaged 0.4 clams/100 sq. ft. and ranged to 1.4 clams/100 sq. ft. (Station 17). Overall, the standing stock of adult surf clams of Borrow B was estimated to be 50,000 clams (Table 3-11).

Table 3-10. Surf clams (*Spisula solidissima*) collected at the four LBI borrow areas. NA = not applicable.

Station	# of Bushels/ Tow	Mean # of Clams/ Bushel*	Estimated # of Clams/Tow	Area Sampled (sq. ft.)	Density (Clams/100 sq. ft.)	Mean Clam Size (mm)
Borrow A						
3	0	0	0	1584	0.00	0
6	18	61	1098	2851	38.51	130
9	<1	NA	33	3802	0.87	128
10	18.6	77	1423	4435	32.08	131
12	11	31	345	1267	27.20	135
15	30	31	940	3485	26.97	142
16	25	95	2375	4752	49.98	107
18	8	19	149	4118	3.63	141
20	60	51	3080	5386	57.19	121
22	15	83	1240	5702	21.75	132
25			31	3485	0.89	130
27	25	92	2308	4118	56.05	142
31	16	92	1467	6336	23.15	120
32	16.3	75	1223	4435	27.56	136
35	13	57	737	5386	13.68	132
40	34	65	2210	5386	41.04	122
41	43	91	3927	5069	77.48	114
43	40	99	3960	4435	89.29	111
		Mean	1474	4224	32.63	128
Borrow B						
2	<1	NA	7	3485	0.20	137
5	0	0	0	1584	0.00	0
7	0	0	0	2534	0.00	0
8	<1	NA	1	5702	0.02	152
11	<1	NA	93	7603	1.22	146
15	0	0	0	1584	0.00	0
17	<1	NA	45	3168	1.42	145
		Mean	21	3666	0.41	145

Table 3-10. (Continued)

Station	# of Bushels/ Tow	Mean # of Clams/ Bushel*	Estimated # of Clams/Tow	Area Sampled (sq. ft.)	Density (Clams/100 sq. ft.)	Mean Clam Size (mm)
Borrow D						
2	<1	NA	39	5069	0.77	144
6	<1	NA	153	6019	2.54	143
7	<1	NA	105	6653	1.58	143
13	0	0	0	634	0.00	0
15	<1	NA	4	4435	0.09	158
18	0	0	0	6336	0.00	0
25	<1	NA	95	6336	1.50	146
28	17.3	59	1021	4118	24.78	139
30	10.7	56	599	5386	11.13	168
32	0	0	0	634	0.00	0
		Mean	202	4562	4.24	149
Borrow E						
3	0	0	0	1267	0.00	0
6	30	125	3760	3168	118.69	111
7	6	91	544	4752	11.45	118
13	24	185	4432	2534	174.87	97
19	<1	NA	220	950	23.15	130
		Mean	1791	2534	65.63	114

* Calculated as the mean of 3 bushels counted; for tows collecting less than 3 bushels, all clams were counted

Table 3-11. Summary of adult surf clam stocks of the four LBI borrow areas

Borrow Area	Area (acres)	# of Dredge Tows	Mean # of Clams/Tow	Mean Area Dredged/ Tow (sq. ft.)	Mean Density (Clams/100 sq. ft.)	Total Surf Clam Stock (million)
A	845.86	18	1475	4224	32.6	12.0 ± 4.4
B	272.78	7	21	4305	0.4	0.05 ± 0.06
D	509.69	11	198	4118	4.1	0.9 ± 1.1
E	273.08	5	1791	3951	65.6	7.8 ± 8.0

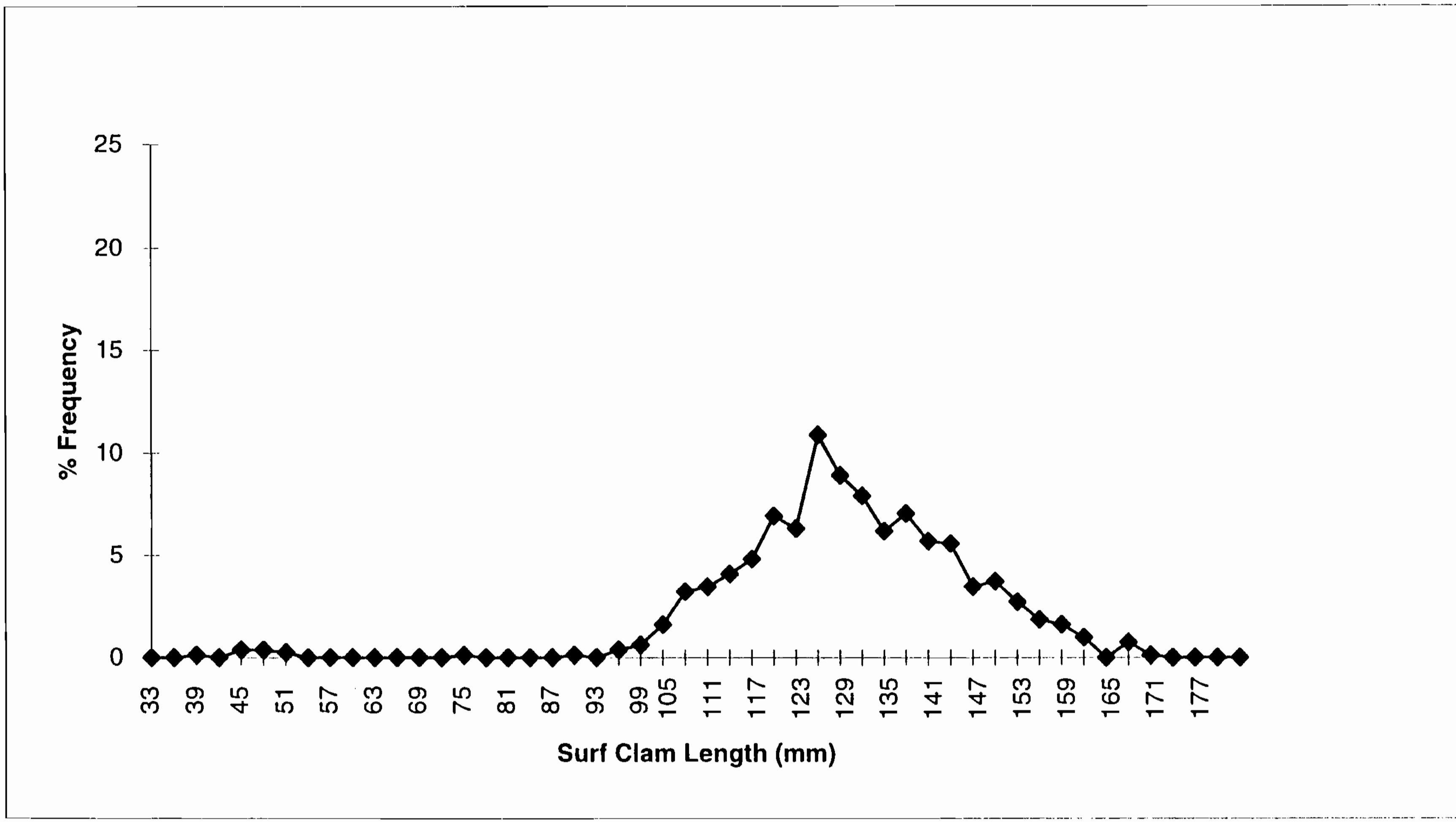


Figure 3-2. Length frequencies of surf clams collected by dredge tows in Borrow Area A of the Long Beach Island areas

The length distribution of surf clams in Borrow B was among the narrowest of the LBI borrow areas (Figure 3-3). The measurement extremes among surf clams ranged only 45-mm (120 to 165-mm). The peak frequency among all surf clams measured from the borrow area (150-mm) was slightly higher than the grand mean for all dredge tows (145-mm; Table 3-10).

3.4.2.3 Borrow D

Borrow D had dredge tows that collected surf clams 70% of the time. In total, only about 30 bushels were collected from the 11 dredge tows conducted in the borrow area (Table 3-10). On average, 200 clams were collected per tow and ranged to as high as 1,021 clams (Station 28). Density estimates averaged 4.2 clams/100 sq. ft. and ranged to 24.78 clams/ 100 sq. ft. (Station 28). Overall, the standing stock of adult surf clams of Borrow Area D was estimated to be 4.1 million clams (Table 3-11).

Sizes of surf clams from Borrow D were among the largest for the four LBI borrow areas. The peak frequency of length from all of the surf clams measured in the borrow area was 147-mm (Figure 3-4), while the grand mean for all dredge tows was slightly greater at 149-mm (Table 3-10). Overall, the distribution of surf clam size ranged from 105 to 174-mm.

3.4.2.4 Borrow E

Borrow E had surf clams present in 4 of the 5 dredge tows. In total, about 60 bushels were collected from the area (Table 3-10). On average, approximately 1,800 surf clams were collected per tow and the greatest number of clams collected was 4,432 (Station 13). Density estimates averaged 64 clams/100 sq. ft., and ranged to 175 clams/100 sq. ft. (Station 13). Overall, the standing stock of adult surf clams of Borrow Area E was estimated to be 7.8 million clams (Table 3-11).

The sizes of surf clams from Borrow E tended to be somewhat smaller than in the other borrow areas. The peak frequency among all clams measured was 117-mm (Figure 3-5). The grand mean for all dredge tows was slightly less at 114-mm (Table 3-10). Overall the distribution of clam size was broad ranging from 66 to 168-mm.

3.4.2.5 Regional Comparison

The average number of bushels collected from the four LBI borrow areas were variable relative to the regional surveys conducted by NJDEP (Figure 3-6). The average number of bushels for Borrow A, which had the greatest average number of bushels collected per tow, was about 70% greater than the regional average. The average number of bushels collected from Borrows B and D were less than a third of the regional average. Borrow Area E most closely approximated the regional average of about 12 bushels collected/tow.

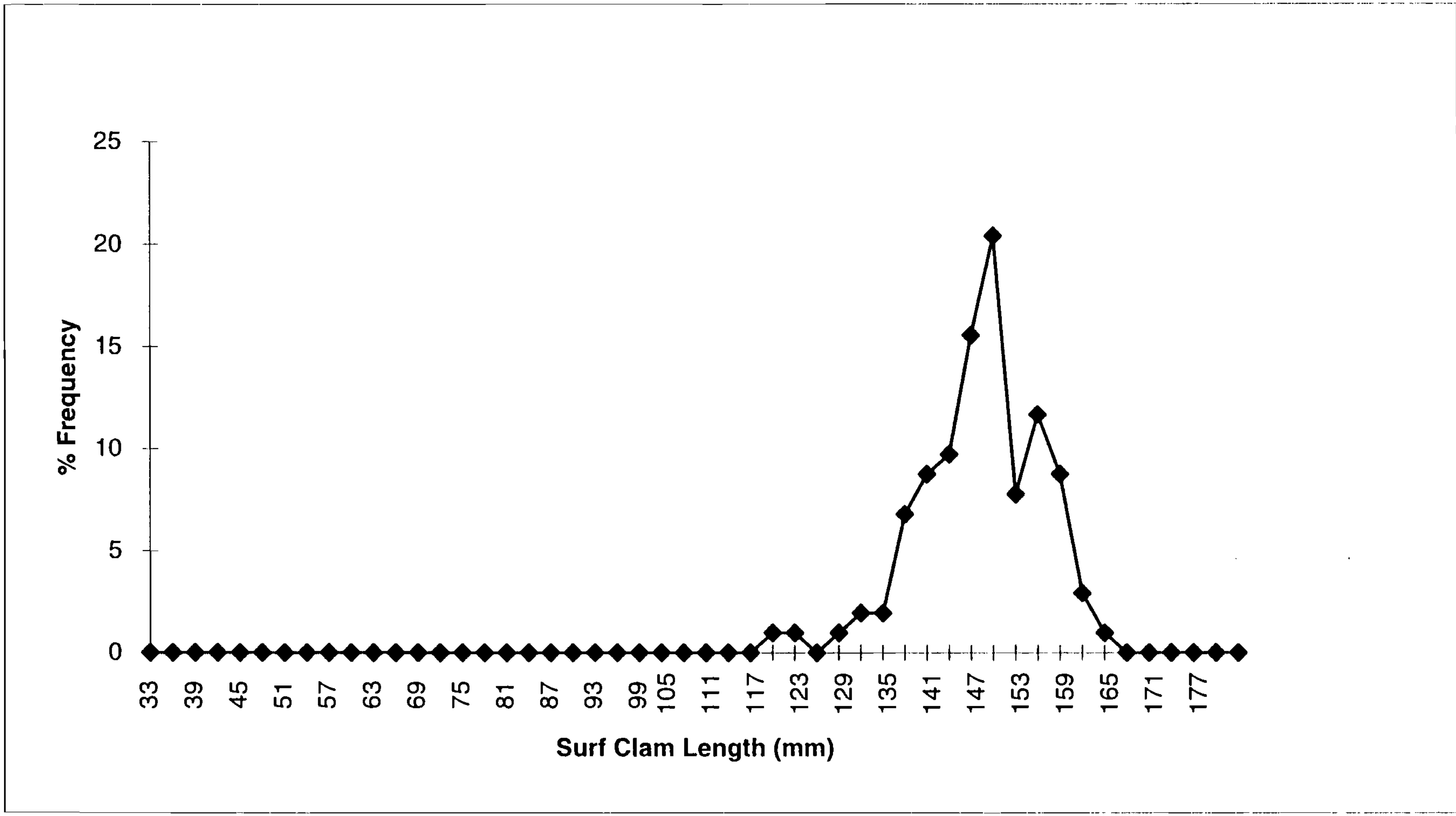


Figure 3-3. Length frequencies of surf clams collected by dredge tow in Borrow Area B of the Long Beach island areas

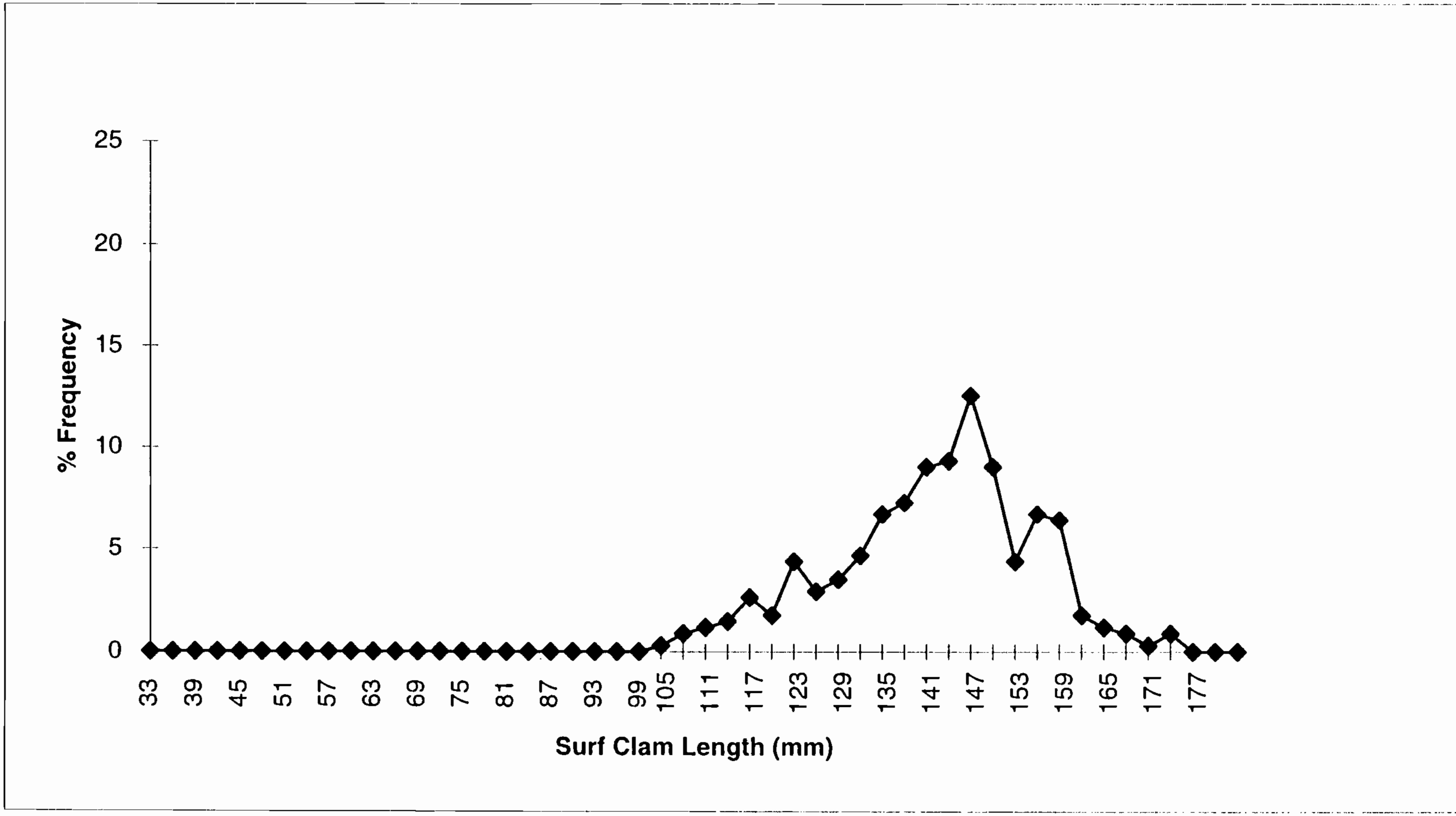


Figure 3-4. Length frequencies of surf clams collected by dredge tow in Borrow Area D of the Long Beach island areas

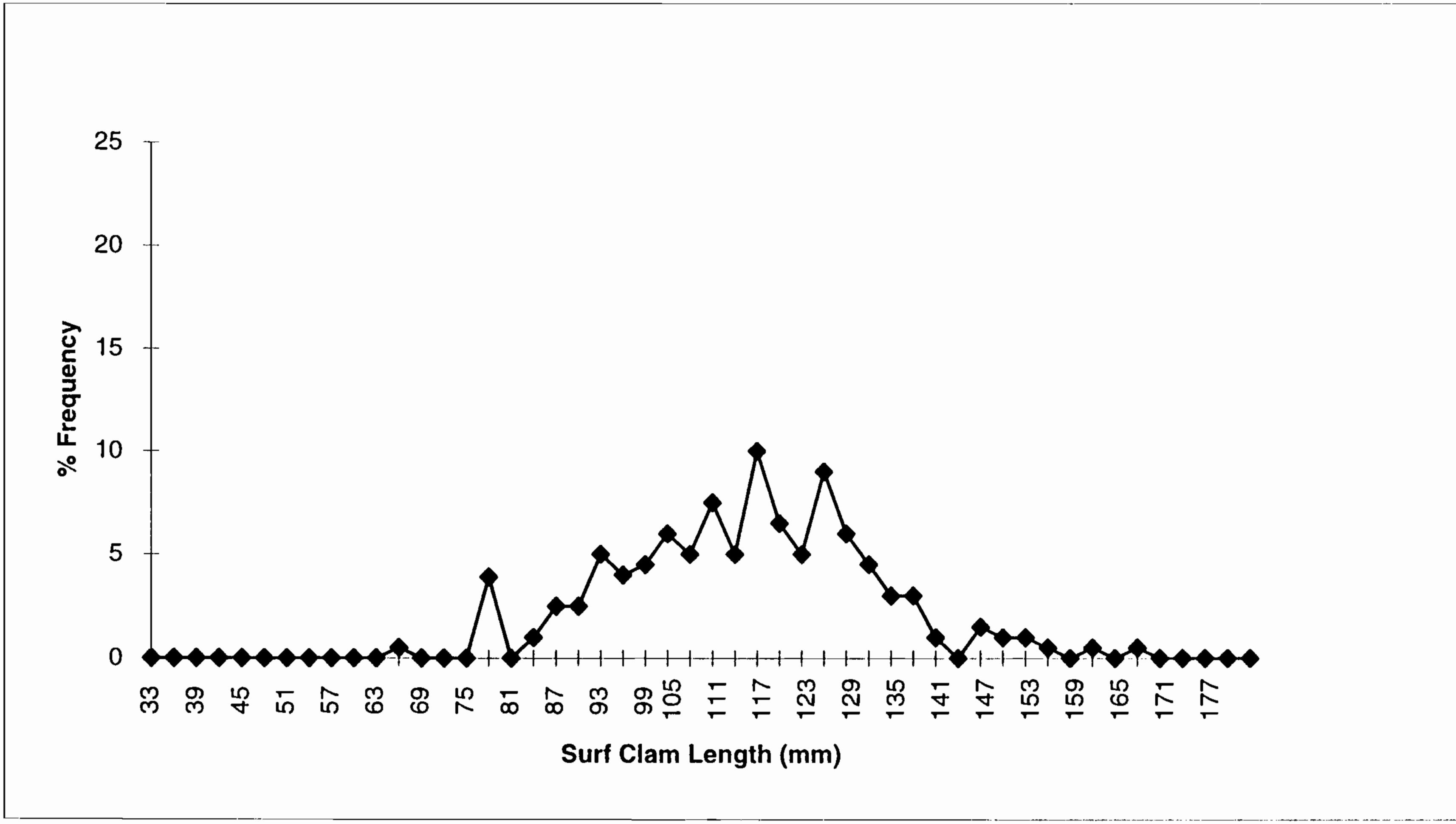


Figure 3-5. Length frequencies of surf clams collected by dredge tow in Borrow Area E of the Long Beach island areas

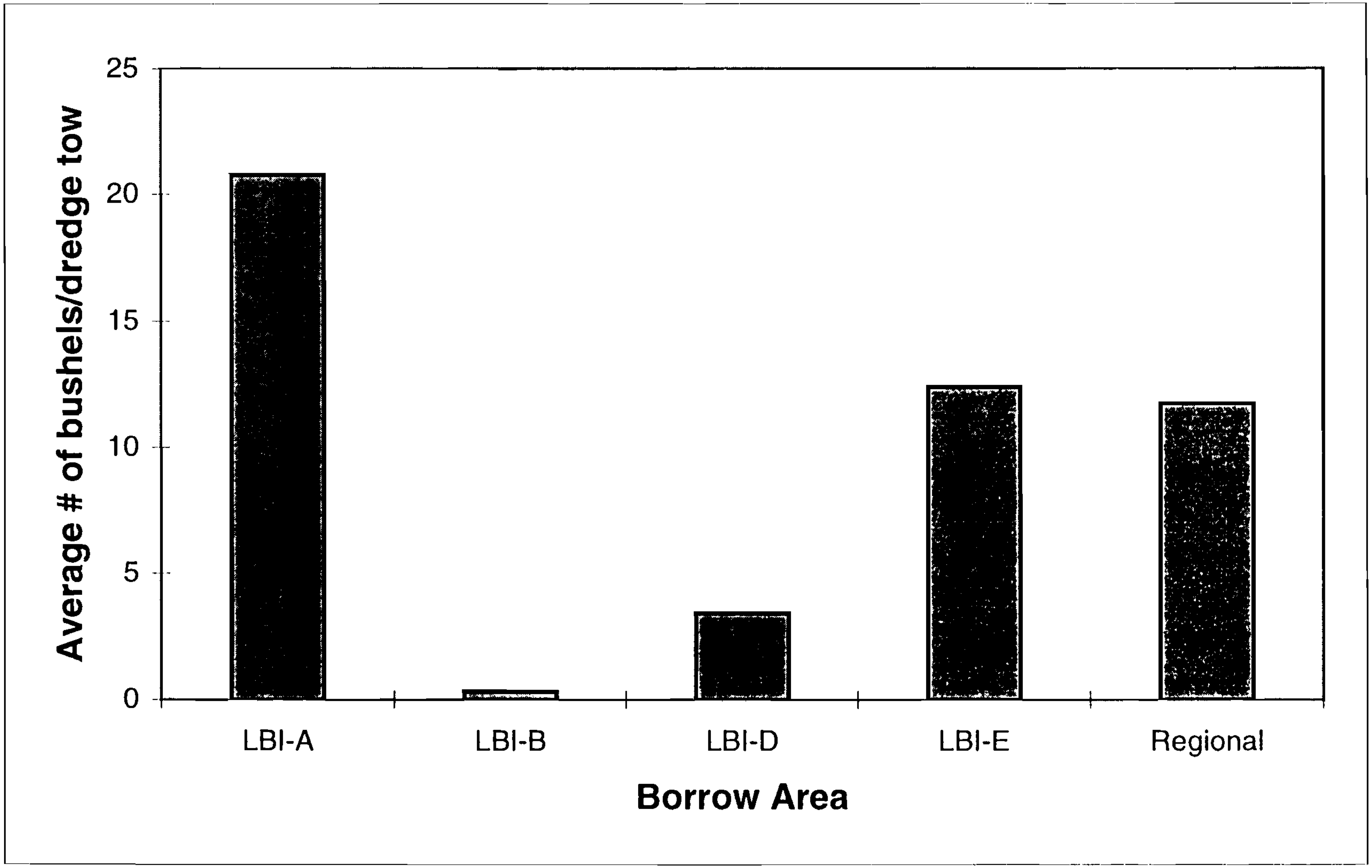


Figure 3-6. Average number of bushels of surf clams collected per dredge tow for the Long Beach Island Borrow Areas and the Regional Atlantic Coast from Barnegat to Absecon Inlets

Surf clams of the four LBI borrow areas were of comparable size relative to those of the regional Atlantic Coast. The range of the length frequency means from dredge tows conducted by New Jersey from Barnegat Inlet to Absecon Inlet (Figure 3-7) overlapped considerably with frequency plots for the individual borrow areas (Figures 3-2 to 3-5). Given the much greater area sampled, the distribution of New Jersey means was expectedly broader, and generally ranged from 72 to 156-mm.

3.4.2.6 Additional Macroinvertebrates

Ten additional mega and macroinvertebrate taxa were collected by the clam dredge tows (Table 3-12). The most frequently collected invertebrate was the moon snail, and was present in 70% of all tows. All other invertebrates were collected at frequencies less than 40% for all tows.

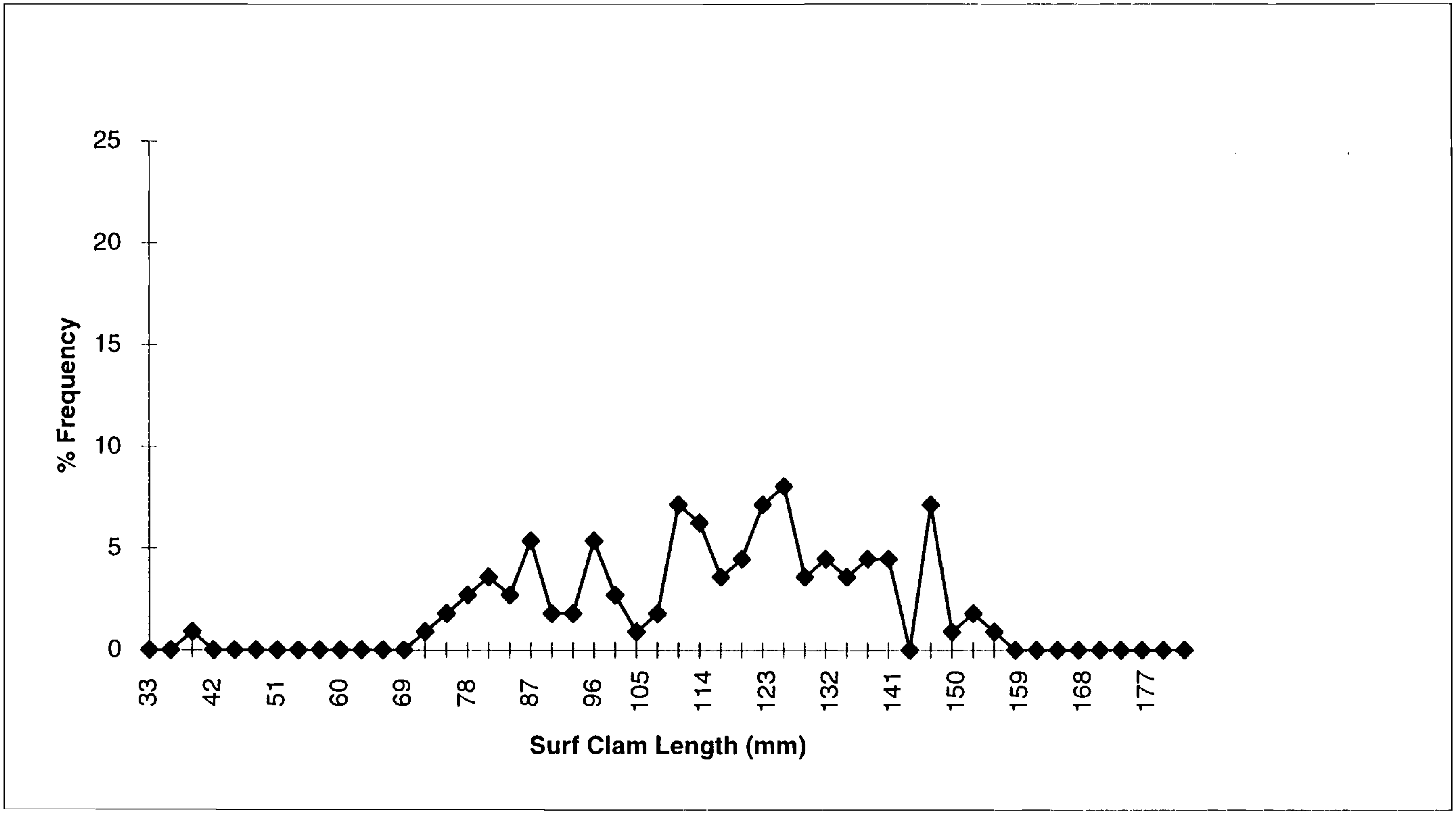


Figure 3-7. Length frequencies of surf clams collected by dredge tows conducted for the Regional Atlantic Coast from Barnegat to Absecon Inlets

Table 3-12. Additional macroinvertebrates collected in dredge tows conducted at the LBI borrow areas

Station	Moon Snail	Horse-shoe Crab	Lady Crab	Hermit Crab	Green Crab	Spider Crab	Star-fish	San-dollar	Jelly-fish	Tube-worm
Borrow A										
3										
6	30	5	8				5			
9	22	1	5						2	
10	30		3			1	15			
12	10		2				13			
15	1									
16	1		1	1		1	1			1
18	5			1		1	5			
20	6	1	3				7			
22	1	25	1		2	3	1			1
25	1			1			1			1
27	5								1	
31	1	1	1	1	1	1	1			
32		1	1				1			
35	1	20				1	1			1
40	1	1	1			1	1			
41	1						1			1
43		1					1			
Borrow B										
2	1									
5										
7										
8	1									
11	1		2							1
15										
17	1					2				
Borrow D										
2	1		1			1				
6							1	1		
7	1		1	1						
13										
15	1		1			1				
18	1					1	1		1	
25	1		1			1				
28	1					1				
30	1		1			1				
32										
Borrow E										
3										
6		1				1				
7										
13										
19	1	1				1				

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

4.0 DISCUSSION

Dredging of sediments from an offshore borrow area can have immediate localized effects on the benthic macroinvertebrate community and clam populations of the area. The most direct effect is the removal of the existing natural, established communities. Survival of organisms during dredging varies widely. Mechanical disturbance of the substrate may generate suspended sediments and increase turbidity near the dredging operation (Naqvi and Pullen 1982). Reduced penetration of light through the water can affect settlement of larvae by delaying their final descent and subjecting them to increased predation (Thorson 1964). Depth and tidal currents influence the spread of sediments and turbidity.

Another potential effect is habitat modification through alteration of the sediment substrate. Removal of the original substrate by dredging may uncover sediments that are different in composition and potentially unsuitable for the existing benthic community. Dredging could also alter the hydrodynamics of the area that could affect sediment accumulation or scouring rates. Changing from a coarse sand sediment to a muddy sediment, for example, will significantly change the composition of the benthic assemblage at a site (Maurer et al. 1978). The effect of changing from a muddy-sand to a sandy-mud would be less severe (Maurer et al. 1978). It is unclear from the data collected in this study whether changes in the sediment composition will occur as a result of dredging. It is also unclear whether any potential sediment changes will affect the macrobenthic community. Data from the few stations that had a coarser grain size (B-18, BR-1 and DR-1) and Station A-43 that had a higher silt/clay content than other stations suggest that the benthic communities from these sites were not different from other sites within the borrows with the more common substrate types.

Additional habitat modification could occur if the dredging design allows for the creation of deep borrow pits. Dredging of these pits in some locales may create areas of summer hypoxia which currently do not exist in the area. These pockets of low DO waters could have an adverse impact on the macroinvertebrate community. This could be avoided by designing an adequate dredging plan that avoids the creation of deep borrow pits.

Besides the physically disruptive effects of dredging, a long-term environmental concern is the recolonization and resettling of the dredged area. The benthic community is decimated initially but resettling and recolonization can be fairly rapid, typically taking from three months to a few years for complete recovery (Saloman et al. 1982; Van Dolah et al. 1984; Hirsch et al. 1978). Highly mobile organisms such as amphipods can escape to the water column and can directly resettle after dredging operations are complete (Conner and Simon 1979). Mobile polychaetes are intermediate of amphipods and bivalves, in their capacity to resettle directly after dredging. The least mobile organisms, such as bivalves, may initially be the most affected by dredging operations, although pelagic larvae of these species can cause high recruitment peaks depending on the timing of the dredging operations.

The disturbed area is initially recolonized by larval recruitment and horizontal migration from adjacent, unaffected areas (Van Dolah et al. 1984; Oliver et al. 1977). Initial recoloni-zation is dominated by opportunistic taxa, whose reproductive capacity is large and flexible environmental requirements allow them to occupy disturbed areas (Boesch and Rosenberg 1981; McCall 1977). Recruitment of organisms with pelagic larvae that have one spring spawn a year can also be rapid but is dependant on the timing of the dredging activity. With time (several months to several years) and if environmental conditions permit, the initial surface-dwelling opportunistic species will be replaced by benthic species that represent a more mature community (Bonsdorff 1983).

Most of the dominant taxa of the four LBI borrow areas were smaller organisms such as the polychaetes, *Polygordius* spp., *Mediomastus ambiseta*, and *Parapionosyllis longicirrata,* the small tanaid, *Tanaissus psammophilus*, and the small bivalves, *Donax variabilis*, *Petricola pholadiformis*, and *Tellina agilis* which could easily recolonize after dredging operations. The mean number of large organisms within each LBI borrow area was not significantly higher that the reference areas, indicating that each site has good potential for reaching conditions similar to those occurring before dredging operations.

Additionally, the four LBI borrow areas do not appear to contain a unique or rare macroinvertebrate community that would preclude its use as a sand borrow source for beach nourishment and replenishment activities along the Long Beach Island coastline. The community composition of the borrow areas were similar to the surrounding reference area so recruitment after dredging activities should result in similar community patterns. Additionally, though diversity at the four borrow areas was relatively high compared to the more southerly located reference areas, the community diversity in the borrow areas was not significantly different than the nearby LBI reference area.

The direct effect of dredging operations on the commercial shellfish of the region is of great concern to natural resource managers. The Atlantic surf clam (*Spisula solidissima*) harvest along New Jersey's coastal waters account for more than 80% of the total Mid-Atlantic catch (NJDEP 1995). Annual commercial surf clam surveys conducted by the New Jersey Division of Fish, Game, and Wildlife indicate that the vast majority of commercial surf clam beds in New Jersey waters are located between Atlantic City and Shrewsbury Rocks including the Long Beach Island area. Dredging sand for beach replenishment has potential environmental effects on these resources. An immediate effect is the removal of existing shellfish communities. Furthermore, potential alteration of the substrate composition may affect important nursery habitats which could hinder surf clam recruitment success.

The surf clam community of the four LBI borrow areas contained a mix of juvenile, small adult, and adult surf clams. The mean abundance of juvenile and small adult clams ranged between 183/m^2 (Borrow D) and 568/m^2 (Borrow A), while the density estimates for adults averaged between 0.4 clams/100 sq. ft. (0.04 clams/m^2; Borrow B) to 64 clams /100 sq. ft.

(6.9 clams/m^2; Borrow E). These numbers suggest that the borrow areas contain conditions conducive to good clam recruitment and subsequent growth to maturity and marketable size. Harvesting of the clams before dredging operations could remove the majority of the adult clams before dredging operations begin.

It is unknown whether dredging operations will alter the substrate composition of the borrow area to preclude surf clam recolonization after dredging. Evidence from a dredged area near Ocean City, NJ, seems to indicate that the surf clam populations are resilient and will be able to successfully recruit even after multiple dredging operations (Scott and Kelley, 1998). Data from that study indicated that good clam recruitment is occurring and that the clams in the area are reaching mature and harvestable sizes. Since surveys of the surrounding areas of Long Beach Island indicated good populations of mature adults, it can be assumed that these clams will provide a strong recruitment base for clams if dredging occurs.

Based on the benthic community composition and surf clam populations of the four LBI borrow areas, there is no reason to believe that these areas will not fully recover from dredging operations in time. Other borrow areas along New Jersey that have been used as a sand source for beach nourishment and replenishment activities have displayed the ability to rapidly recover (i.e., within 2 years) even after multiple dredging operations (Scott and Kelley, 1998). The data from this study suggest that the benthic community of the four borrow sites are typical of the New Jersey coastline and the surf clam populations within the borrow areas have a good potential for recruitment and growth that will most likely continue after dredging is complete.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

5.0 REFERENCES

Boesch, D.F., and R. Rosenberg. 1981. Response to stress in marine benthic communities. Pages 179-200. *In*: G.W. Barret and R. Rosenberg, eds. Stress Effects on Natural Ecosystems. New York: John Wiley and Sons.

Bonsdorff, E. 1983. Recovery potential of macrozoobenthos from dredging in shallow brackish waters. Presented at Proceedings 17th European Marine Biology Symposium, *Oceanol. Acta*, 27 September-1 October 1982.

Buchanan, J.B. 1984. Sediment analysis. *In*: Methods for Study of Marine Benthos. IBP Handbook No. 16. 2nd Edition, 41-65. N.A. Holme and A.D. McIntyre, eds. Oxford, England: Blackwell Scientific Publications.

Chaillou, J.C. and L.C. Scott. 1997. Evaluation of benthic macrofaunal resources at potential sand borrow sources: Brigantine Inlet to Great Egg Harbor Inlet; Atlantic County, New Jersey. Prepared for U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA by Versar, Inc., Columbia, MD.

Conner, W.G. and J.L. Simon. 1979. The effects of oyster shell dredging on an estuarine benthic community. *Estuarine and Coastal Marine Science* 9:749-578.

Hirsch, N.D., L.H. DiSalvo, and R. Peddicord. 1978. Effects of dredging and disposal on aquatic organisms. Technical Report DS-79-5. 41 p. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Krebs, C.J. 1978. Ecology: The Experimental Analysis of Distribution and Abundance. New York: Harper & Row.

Maurer, D.L., R.T. Keck, J.C. Tinsman, W.A. Leathem, C.A. Wethe, M. Huntzinger, C. Lord, T.M. Church. 1978. Vertical migration of benthos in simulated dredged material overburdens. Vol 1: Marine Benthos. Technical Report D-78-35. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

McCall, P.L. 1977. Community patterns and adaptive strategies of the infaunal benthos of Long Island Sound. *J. Mar. Res.* 35:221-265.

Naqvi, S.M., and E.J. Pullen. 1982. Effects of beach nourishment and borrowing on marine organisms. Miscellaneous Report 82-14. 43 p. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, VA.

NJDEP. 1995. Inventory of New Jersey's surf clam (*Spisula solidissima*) resources. Prepared by New Jersey Department of Environmental Protection for National Oceanic and Atmospheric Administration.

Oliver, J.S., P.N. Slattery, L..W. Hulberg and J.N. Nybakken. 1977. Patterns of succession in benthic infaunal communities following dredging and dredged material disposal in Monterey Bay. Technical Report D-77-27. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Saloman, C.H., Naughton, S.P., and J.L. Taylor. 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida. Miscellaneous Report 82-3. U.S. Army Corps of Engineers, Coastal Engineering Research Center, Fort Belvoir, VA.

Scott, L.C. 1997. An evaluation and assessment of the benthic macroinvertebrate resources of the proposed sand borrow areas for Lower Cape May Meadows, New Jersey. Prepared for U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA by Versar, Inc., Columbia, MD.

Scott, L.C. and J.C. Chaillou. 1997. Evaluation of benthic macrofaunal resources at potential sand borrow sources: Townsends Inlet to Cape May Inlet; Cape May County, New Jersey. Prepared for U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA by Versar, Inc., Columbia, MD.

Scott, L.C. and F.S. Kelley. 1998 draft. An evaluation and comparison of benthic community assemblages and surf clam populations within the offshore sand borrow site for the Great Egg Harbor Inlet and Peck Beach, Ocean City, New Jersey Project. Prepared for U.S. Army Corps of Engineers, Philadelphia District, Philadelphia, PA by Versar, Inc., Columbia, MD.

Shannon, C.E., and W. Weaver. 1949. The Mathematical Theory of Communication. Urbana: University of Illinois Press.

Thorson, G. 1964. Light as an ecological factor in the dispersal and settlement of larvae of marine bottom invertebrates. *Ophelia* 1(1) :167-208.

Van Dolah, R.F., D.R. Calder, and D.M. Knott. 1984. Effects of dredging and open-water disposal on benthic macroinvertebrates in a South Carolina estuary. *Estuaries*. 7(1):28- 37.

Weisberg, S.B., J.A. Ranasinghe, D.M. Dauer, L.C. Schaffner, R.J. Diaz, and J.B. Frithsen. 1997. An estuarine Benthic Index of Biotic Integrity (B-IBI) for Chesapeake Bay. *Estuaries* 20(1):149-158.

APPENDIX A

SCOPE OF WORK

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

SCOPE OF WORK
Benthic Assessment of Sand Borrow Site
Barnegat Inlet to Little Egg Inlet
Ocean County, New Jersey

Project Name: An Evaluation and Comparison of Benthic Community Assemblages within Potential Offshore Sand Borrow Site(s) for the Barnegat Inlet to Little Egg Inlet, New Jersey Feasibility Study.

Corps District and Contact: Philadelphia District Corps of Engineers, Wanamaker Building, 100 Penn Square East, Philadelphia, PA 19107-3390. Project Biologist: Nathan Dayan, Environmental Resources Branch, by phone at (215) 656-6562 or by E-mail at Nathan.S.Dayan@usace.army.mil .

Contractor: Versar, Inc., 9200 Rumsey Road, Columbia Maryland 21045-1934. POC: William Burton, (410)964-9200.

Project Description: The study area is located along the New Jersey's coast between Barnegat Inlet and Little Egg Inlet which constitutes Long Beach Island(LBI) (Figure 1). The purpose of the feasibility study is to investigate Federal interest in shore protection and coastal erosion problems along approximately 18 miles of Long Beach Island shoreline. This study includes substantial data acquisition and analysis to define existing coastal processes and conditions along this section of coast. The New Jersey Department of Environmental Protection is the non-federal sponsor for this study.

A critical component of this feasibility study is the evaluation and selection of potential offshore sand borrow sources for beach nourishment. Several issues have been identified during the Reconnaissance Study that need to be addressed such as potential disruption of commercial/recreational and ecological important benthic communities within the borrow sources, and generation of baseline benthic data for these areas in order to determine potential impact to these benthic habitats. A benthic community inventory is necessary to provide recent biological data on benthic species within the borrow area(s). This information will then be considered the baseline benthic data for these areas, and would define any immediate or long-range impacts to the benthic biota and its habitat, while helping to establish future monitoring needs. Monitoring survey data may then be correlated with pre-dredge information to assess the recovery of the habitat after disturbance.

Four potential Borrow Sources, labeled A, B, D, E on figure 1, have been identified. Table 1 shows specifics for each site. Appendix A contains a listing of the areas and their coordinates.

Data and Information: The Corps will provide upon contractor's request, readily available district project information including any previous benthic investigations.

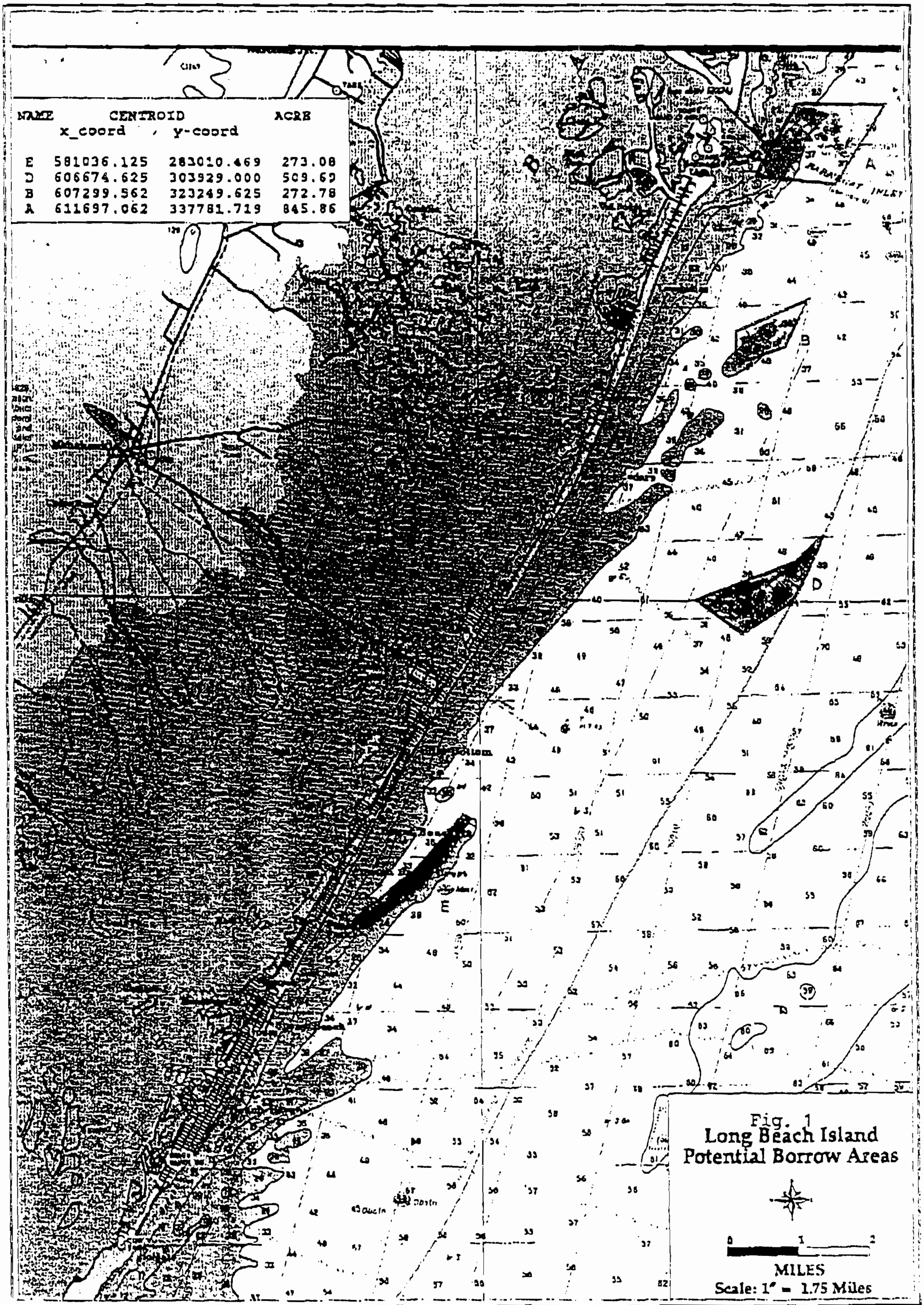


Fig. 1
Long Beach Island
Potential Borrow Areas

Table 1: Potential Borrow Sites - Long Beach Island					
Site	Distance From Shore (miles)	Depth of Water (feet)	Acres	Centroid	
				Latitude	Longitude
A	0.25	34	845.86	39 45 36.01	074 04 28.74
B	1.70	33	272.78	39 43 12.58	074 05 25.90
D	4.00	39	509.69	39 40 01.65	074 05 35.02
E	1.00	33	273.08	39 36 35.92	074 11 03.85

State Agency Coordination: The Contractor must obtain any required collector's permits from the state of New Jersey before proceeding with the field survey efforts.

Purpose: The purpose of the benthic study is to characterize the benthic community within the proposed borrow area(s) utilizing standard sampling techniques. The data and analyses generated from the sampling effort will: 1) evaluate the existing benthic macrofauna and community structure, 2) assist in determining potential ecological impacts from dredging activities in offshore borrow area(s), 3) determine the presence and viability of commercially important benthic species, including surf clams, 4) help define feasible alternatives to disturbance of the proposed borrow area(s), 5) provide baseline biological data for future monitoring surveys, 6) obtain a snapshot of the benthic profile before dredging, so that subsequent monitoring efforts can reveal changes in sediment accretion or erosion, which may relate to patterns of benthic community reestablishment, and compare the benthic communities between the alternative borrow areas, and/or in adjacent areas.

Electronic Position to Locate Work Area: The Contractor shall establish and record sample positions with a Trimble NT200D global positioning system unit with built-in differential capability. The Contractor will take 180 position fixes with a precision of thousandths of a minute (1 per second) using differential corrections and an on-board lap-top computer. These 180 fixes will be averaged in order to report station position.

Benthic Sampling: The cumulative area being considered for borrow (1901.41 acres) shall be divided into eighty (126) cells of approximately the same size (approximately 15 acres each). A benthic sampling station shall be randomly placed within each cell. At each sampling station, one sample shall be collected using a 0.4 m^2, stainless steel, Young-modified Van Veen Grab Sampler. In addition, two control samples shall be taken outside the boundary of each of the four proposed borrow sites (for a total of 8 control samples) in areas that exhibit similar depth and substrate characteristics. Each "grab" will be at least 50% full and show no evidence of surface washout.

Benthic macroinvertebrates will be sieved in the field using 500 um mesh and preserved (isopropyl, ethanol or 5% buffered formalin) for laboratory processing. No samples will be composite, all will be handled individually.

Surf Clam Sampling: Forty (40) of the sample sites will have a 5 minute tow using a conventional hydraulic surf clam dredge with a 72-inch knife and with the cage "closed up" to retain clams as small as 3 inches. The adult clam sampling stations will be divided between the 4 borrow areas based on the size of the borrow area. Within each borrow area, the clam sampling locations will be randomly selected from among the benthic sampling stations. The longitude and Latitude of the beginning and end of each tow will be recorded and later marked on borrow site maps.

Grain size Analysis: A sediment core sample for substrate particle size and organic content analysis will be collected at each sample station using the same equipment. This sample will be place in its entirety in a container from which excess water will be decanted following a short period of settling, frozen, and then transported to the laboratory for analysis. In the laboratory sediment samples will be analyzed for grain size using ASTM D2487. Classification will be take down to the U.S. standard sieve No. 200; the hydrometer portion of the ASTM test will not be run. A grain size curve will be generated for each sample tested. Samples will be measured for total organic carbon (TOC) as measured by loss on ignition.

Laboratory Analysis: Macroinvertebrates will be sorted from sample residue, identified, enumerated, and weighed. The top ten taxa as measured by numerical count and/or biomass will be identified to species; others will be grouped by class or phylum. Length of all specimens relative to 2 cm (i.e. < or > 2 cm) will be recorded. All surf clams (*Spisula solidissima*) shall be measured and weighed separately from other mollusks.

Noting that benthic macroinvertebrate community composition is strongly correlated with the nature of substrate conditions, the substrate particle size and organic content, these data will be examined for each sampling station. If, in the opinion of the contractor, these data are similar for all measurements made at all borrow areas sample stations, then the biological data will be grouped for the purpose of data analysis. If two or more distinct groups of substrate condition data are recognized, the biological data will be grouped similarly. In effect, this is data stratification on the basis of substrate conditions.

Each of the top ten species (as measured by numerical count and/or biomass) shall be counted and dry-weighted separately. Each group shall be weighted to within 0.001 grams. Biomass determination shall be completed on each sample within the same day to avoid sample degradation.

Physical Data Collection: The following information shall be recorded for each station: date, time of day, depth (meters), weather conditions (height of sea, overcast/sunny), Secchi disk reading and latitude and longitude coordinates (differential global positioning system). In addition, the following parameters will be measured at the surface and as close to the substrate as possible: pH, dissolved oxygen, salinity (x.x ppt), and water temperature (°C). The time of high and low tide for that geographic location shall be recorded.

Benthic Invertebrate Data Analysis: A publishable report shall be prepared presenting the data, analysis, and discussions of the benthic sampling survey. The report will describe, in detail, all methods that were used and the data obtained. Maps will be included to show the project area and sample locations. Data will be compiled and stored in SAS data sets (Windows Version 6.12). Separate files will be maintained for benthic invertebrate abundance, benthic invertebrate biomass, sediment grain size, and clam survey results. The horizontal grid will based on a standard latitude and longitude coordinate system. Data will be delivered on a high density 3.5 inch disk.

For benthic macroinvertebrate data, the identity and number of individuals for the top ten species (as measured by numerical count and/or biomass) will be reported in terms of mean numbers per square meters of benthos. The identity and numbers of all individuals with length > 2 cm will be reported by species. Biomass Data will be reported by taxon as mean value per square meter of benthos. The number of surf clams (*Spisula solidissima*) will be reported in terms of mean numbers per square meters of benthos, calculated separately for the grabs and tows as well as by size classes (recruits, juveniles, and adults). Data collected by the Young-modified Van Veen Grab Sampler and Surf Clam Tows will be reported on tables and/or graphs and fully summarized. Data collected from this study will be compared to data that has been collected in other similar studies in the area (i.e.. Absecon, New Jersey, etc.).

Biological data will be discussed in terms of species composition and population density which may be impacted through burial by beach nourishment activities, suffocation by turbidity, or excavation by dredging. The report should also include a discussion of re-colonization potential. Taxonomic groups will be described in terms of their accessibility and desirability as a food source for water and shorebirds, fish, blue crabs, horseshoe crabs, surf clams and other commercial, recreational, or ecological important species, as well as whether the benthic communities found indicate a healthy or stressed environment. This information shall be presented in a type-written scientific report, including sections describing the objective, methods, results, discussion, and conclusions. The results and analyses shall include but not be limited to graphical, tabular, and chart presentations of the data and findings. The conclusions section shall evaluate the potential for recovery of the benthic community based on the species found, as well as comparison of the results of this study with other similar benthic studies done in the area. Original data sheets shall be provided in the appendices of the report.

The following information shall be presented in the report:

-Maps showing locations of sample stations.
-Latitude/longitude and Loran coordinates of sample stations
-All stations shall have recorded depth measurements.
-Dry weight biomass of major taxonomic groups per sample
-Taxonomic distribution per sample
-Abundance and sizes of important commercial species (surf clams) per sample
-Abundance of opportunistic species per sample
-Physical/chemical parameters at each station
-Sediment grain sizes of each station

<u>Data and Statistical Analysis</u>: The data and statistical analysis shall compare the benthic community, defined by species abundance, biomass, and diversity at a minimum, with respect to the water depth, habitat type and grain size distribution at that station to that of other stations. Data and statistical analysis shall include, but not be limited to abundance and/or densities (i.e. biomass/unit area, numbers of organisms/unit area etc.), benthic community structure and diversity (i.e. Shannon-Weiner Index, Simpson's Dominance, species richness, evenness, and station similarity/dissimilarity. Data analysis shall be presented in graphical or tabular form to provide easy comparisons between stations.

<u>Report Text</u>: The report shall include written discussions of, but not be limited to, the following sections:

-Purpose/Objective of the Benthic Study
-Summary of findings
-Methodology
-Results
-Comparisons with other areas
-Discussion
-Conclusions/recommendations

The discussion and/or conclusions shall include information resulting from a survey of appropriate applicable literature/reports to 1) evaluate the benthic community with regard to various qualifying characteristics including depth, sediment and energy regimes, 2) compare with other similar coastal benthic studies, 3) assess potential short-term and long-term effects on the benthic community and commercial fishery resources in the borrow areas resulting from dredging activities, 4) assess the ability of the borrow site to become recolonized or recover from dredging disturbance, 5) provide a discussion on means (e.g. type of dredge, restriction of dredging operation according to specific depth, etc.) to avoid or minimize adverse impacts to the benthic community and associated shellfish resources from dredging within the proposed sand borrow sites. 6) discuss seasonal alternatives that may minimize short/long-term impacts on shellfish standing stock by enabling fishermen to deplete the harvest before dredging occurs.

<u>Appendices</u>: All figures, tables, maps, and charts shall be presented in the appendices, as appropriate. Appendices shall

include original (dated) field data sheets.

Miscellaneous: If the report has been written by someone other than the contract principal investigator, the cover and title page of the publishable report shall bear the inscription Prepared Under the Supervision of (Name), Principal Investigator. The principal investigator is required to sign the original copy of the report. In addition, the principal investigator must prepare a forward describing the overall research context of the report, the significance of the work and any other related background circumstances relating to the manner in which the work was undertaken.

The TITLE PAGE of the report shall include the date (month and year) the report was submitted, the project name, the author, organization and/or client, and contract number.

A TABLE OF CONTENTS, including a list of all Figures and Tables shall be presented in the report.

PAGE SIZE AND FORMAT. The report shall be produced on 8 1/2" X 11" paper, single-spaced, with double spacing between paragraphs. Figures shall be 8 1/2" X 11" or folded 11" X 17" format sheet size. All text pages (including appendices) shall be consecutively numbered. Text print quality must be at least letter quality and equal or larger than 10 pt.

All references shall be properly cited in a bibliography at the end of the report text.

Submittal and Schedules:

A. Field sampling shall be completed no later than September 1, 1997.

B. The Contractor shall provide 3 copies of the draft report to the Philadelphia District U.S. Army Corps of Engineers within 90 calendar days from the completion of the sample collection.

C. The Corps will provide comments to the Contractor within 30 calendar days of receipt of the draft report. The contractor is responsible for incorporating any changes to the draft document.

D. The Contractor shall provide 5 bound copies, 1 unbound, reproducible, and 1 digital (MS Word format) original copy of the final report to the Philadelphia District Corps of Engineers within 21 calendar days of the receipt of the review comments on the draft report.

Appendix A
LBI Borrow Area Coordinates

	Latitude	Longitude
Area A	39 46 01.53	074 03 30.87
	39 46 01.54	074 03 37.91
	39 46 01.59	074 04 17.48
	39 46 01.62	074 04 54.75
	39 45 59.59	074 04 56.32
	39 45 40.98	074 03 47.47
	39 45 33.95	074 05 15.70
	39 45 15.82	074 04 07.79
	39 45 08.35	074 05 35.07
	39 45 06.54	074 05 14.18
	39 45 03.24	074 04 36.01
	39 45 01.67	074 04 19.13
Area B	39 43 37.91	074 04 46.55
	39 43 33.27	074 05 00.42
	39 43 21.92	074 04 57.16
	39 43 21.46	074 05 35.64
	39 43 14.87	074 05 55.32
	39 43 02.63	074 05 09.95
	39 43 01.79	074 05 55.70
	39 43 00.04	074 05 19.73
	39 42 50.40	074 05 56.03
Area D	39 40 44.83	074 04 34.84
	39 40 25.42	074 05 02.09
	39 40 24.95	074 05 02.75
	39 40 17.79	074 04 50.59
	39 40 14.53	074 05 37.71
	39 40 05.59	074 04 57.69
	39 40 03.85	074 06 13.50
	39 39 57.24	074 06 35.64
	39 39 55.82	074 05 05.68
	39 39 50.48	074 06 23.91
	39 39 40.04	074 05 38.16
	39 39 32.75	074 05 53.15
Area E	39 37 21.00	074 10 18.47
	39 37 18.12	074 10 11.63
	39 37 16.85	074 10 23.13
	39 37 02.57	074 10 23.70
	39 36 54.44	074 10 48.24
	39 36 47.52	074 10 35.39
	39 36 39.24	074 11 05.27
	39 36 38.90	074 10 46.36
	39 36 33.18	074 11 14.79
	39 36 23.76	074 11 05.63
	39 36 18.61	074 11 14.21
	39 36 14.33	074 11 44.38
	39 36 03.23	074 12 01.80
	39 36 00.44	074 11 44.51
	39 35 58.92	074 11 47.05

APPENDIX B

LATITUDE/LONGITUDE COORDINATES FOR INDIVIDUAL STATION LOCATIONS

Appendix Table B-1. Station coordinates for benthic sample locations of the four LBI borrow areas				
Station	**Latitude**		**Longitude**	
Borrow A				
1	39E	46.0104	74E	4.0065
2	39E	45.9970	74E	4.2947
3	39E	45.9427	74E	4.4626
4	39E	45.9006	74E	4.5921
5	39E	45.9532	74E	4.7648
6	39E	45.8670	74E	4.7780
7	39E	45.7824	74E	4.7108
8	39E	45.7425	74E	4.6431
9	39E	45.7915	74E	4.4849
10	39E	45.8878	74E	4.0885
11	39E	45.9038	74E	3.8956
12	39E	45.8419	74E	3.8821
13	39E	45.7891	74E	4.0591
14	39E	45.7873	74E	4.0922
15	39E	45.7181	74E	4.1875
16	39E	45.7237	74E	3.7900
17	39E	45.6674E	74E	3.8687
18	39E	45.6500	74E	3.9718
19	39E	45.6196	74E	4.1473
20	39E	45.6519	74E	4.5781
22	39E	45.5767	74E	4.4553
23	39E	45.5744	74E	4.6898
24	39E	45.6184	74E	4.8194
25	39E	45.6558	74E	4.8383
26	39E	45.6192	74E	5.0343
27	39E	45.5500	74E	5.0664
28	39E	45.5534	74E	4.9393
29	39E	45.5076	74E	5.0171
30	39E	45.4318	74E	5.0355
31	39E	45.4517	74E	4.7226
32	39E	45.4949	74E	4.5133
33	39E	45.4733	74E	4.4599
34	39E	45.4889	74E	4.2653
35	39E	45.3913	74E	4.3305
36	39E	45.2937	74E	4.1405
37	39E	45.0560	74E	4.3052

38	39E	45.1312	74E	4.3117

Appendix Table B-1. (Continued)

Station	Latitude		Longitude	
Borrow A (Continued)				
39	39E	45.1611	74E	4.3384
40	39E	45.1535	74E	4.4005
41	39E	45.2153	74E	4.3866
42	39E	45.0633	74E	4.5644
43	39E	45.1906	74E	4.6180
44	39E	45.1300	74E	4.8022
45	39E	45.3151	74E	4.8871
46	39E	45.1924	74E	4.9407
47	39E	45.2989	74E	5.0446
48	39E	45.2628	74E	5.0711
49	39E	45.2901	74E	5.1711
50	39E	45.3048	74E	5.1833
51	39E	45.2792	74E	5.2312
52	39E	45.3296	74E	5.3289
53	39E	45.3778	74E	5.3607
54	39E	45.4051	74E	5.3344
55	39E	45.4781	74E	5.2854
Borrow B				
1	39E	43.5484	74E	4.8726
2	39E	43.4467	74E	5.0401
3	39E	43.4070	74E	5.2712
4	39E	43.2988	74E	5.2877
5	39E	43.3312	74E	5.3527
6	39E	43.3934	74E	5.3971
7	39E	43.2263	74E	5.4361
8	39E	43.1530	74E	5.3880
9	39E	43.1316	74E	5.5628
10	39E	42.9678	74E	5.5559
11	39E	43.0082	74E	5.6695
12	39E	42.9405	74E	5.7239
13	39E	42.9389	74E	5.8494
14	39E	43.0475	74E	5.7831
15	39E	43.0543	74E	5.8582
16	39E	43.1566	74E	5.8682
17	39E	43.1843	74E	5.7216
18	39E	43.2826	74E	5.7233

Appendix Table B-1. (Continued)

Station	Latitude		Longitude	
Borrow D				
1	39E	40.4190	74E	4.8285
2	39E	40.4287	74E	4.9429
3	39E	40.3439	74E	4.8607
4	39E	40.3281	74E	4.9413
5	39E	40.3698	74E	5.1247
6	39E	40.3062	74E	5.1023
7	39E	40.1931	74E	4.9982
8	39E	40.1896	74E	5.1198
9	39E	40.2335	74E	5.2334
10	39E	40.3030	74E	5.2596
11	39E	40.3045	74E	5.3212
12	39E	40.2651	74E	5.4706
13	39E	40.1966	74E	5.5797
14	39E	40.1971	74E	5.4015
15	39E	40.0880	74E	5.2499
16	39E	40.0502	74E	5.2932
17	39E	39.8695	74E	5.3186
18	39E	39.9072	74E	5.4307
19	39E	39.9558	74E	5.3816
20	39E	40.0199	74E	5.6582
21	39E	39.7302	74E	5.5598
22	39E	39.8018	74E	5.6187
23	39E	39.8195	74E	5.6564
24	39E	39.7479	74E	5.7875
25	39E	39.6751	74E	5.8301
26	39E	39.6767	74E	6.0073
27	39E	39.8257	74E	6.0804
28	39E	39.8940	74E	5.9517
29	39E	39.9085	74E	5.8056
30	39E	40.0035	74E	5.8483
31	39E	39.9947	74E	5.9556
32	39E	39.9464	74E	6.3301
33	39E	40.0625	74E	6.1478

Appendix Table B-1. (Continued)		
Station	**Latitude**	**Longitude**
Borrow E		
1	39E 37.2998	74E 10.2148
2	39E 37.0620	74E 10.4142
3	39E 37.0682	74E 10.4977
4	39E 37.0408	74E 10.4865
5	39E 36.8321	74E 10.5774
6	39E 36.8601	74E 10.7105
7	39E 36.7296	74E 10.8481
8	39E 36.6574	74E 10.8613
9	39E 36.5945	74E 10.9472
10	39E 36.6222	74E 11.0781
11	39E 36.6090	74E 11.1525
12	39E 36.5579	74E 11.2315
13	39E 36.4857	74E 11.2204
14	39E 36.4035	74E 11.1463
15	39E 36.3481	74E 11.5205
16	39E 36.2210	74E 11.4204
17	39E 36.1939	74E 11.5697
18	39E 36.1478	74E 11.5882
19	39E 36.1581	74E 11.6780
20	39E 36.2135	74E 11.7414
Reference Area		
A1	39E 46.34850	74E 4.25538
A2	39E 44.82468	74E 5.38878
B1	39E 43.54368	74E 5.71134
B2	39E 42.80238	74E 5.55492
D1	39E 40.40844	74E 6.08808
D2	39E 39.48630	74E 6.49314
E1	39E 36.88782	74E 11.1654
E2	39E 36.29874	74E 10.8672

Appendix Table B-2. Locations of commercial hydraulic clam dredging at the LBI borrow areas conducted during September 1997. NM = not measured.

Station	Depth	Start Location Lat/Long		End Location Lat/Long		Distance Dredged (miles)	Area Dredged (sq. ft.)
Borrow A							
3	NM	39E	45.92'	39E	45.96'	0.05	1584
		74E	4.51'	74E	4.51'		
6	NM	39E	45.98'	39E	46.06'	0.09	2851
		74E	4.75'	74E	4.73'		
9	NM	39E	45.85'	39E	45.95'	0.12	3802
		74E	4.51'	74E	4.47'		
10	26	39E	45.96'	39E	46.08'	0.14	4435
		74E	4.02'	74E	4.01'		
12	NM	39E	45.84'	39E	45.87'	0.04	1267
		74E	3.91'	74E	3.88'		
15	NM	39E	45.77'	39E	45.86'	0.11	3485
		74E	4.12'	74E	4.08'		
16	21	39E	45.72'	39E	45.83'	0.15	4752
		74E	4.87'	74E	4.79'		
18	NM	39E	45.70'	39E	45.81'	0.13	4118
		74E	3.95'	74E	3.91'		
20	25	39E	45.66'	39E	45.79'	0.17	5386
		74E	4.55'	74E	4.47'		
22	22	39E	45.55'	39E	45.66'	0.18	5702
		74E	4.44'	74E	4.30'		
25	22	39E	45.70'	39E	45.79'	0.11	3485
		74E	4.79'	74E	4.74'		
27	20	39E	45.71'	39E	45.81'	0.13	4118
		74E	4.92'	74E	4.86'		
31	20	39E	45.49'	39E	45.58'	0.20	6336
		74E	4.69'	74E	4.50'		
32	24	39E	45.53'	39E	45.65'	0.14	4435
		74E	4.45'	74E	4.40'		
35	30	39E	45.45'	39E	45.58'	0.17	5386
		74E	4.28'	74E	4.20'		
40	34	39E	45.18'	39E	45.31'	0.17	5386
		74E	4.38'	74E	4.28'		
41	30	39E	45.25'	39E	45.39'	0.16	5069
		74E	4.37'	74E	4.36'		

43	22	39E	45.33'	39E	45.43'	0.14	4435
		74E	4.54'	74E	4.46'		

Appendix Table B-2. (Continued)							
Station	Depth	Start Location Lat/Long		End Location Lat/Long		Distance Dredged (miles)	Area Dredged (sq. ft.)
Borrow B							
2	39	39E	43.45'	39E	43.54'	0.11	3485
		74E	5.00'	74E	4.95'		
5	38	39E	43.28'	39E	43.29'	0.05	1584
		74E	5.36'	74E	5.30'		
7	40	39E	43.24'	39E	43.25'	0.08	2534
		74E	5.39'	74E	5.38'		
8	29	39E	43.11'	39E	42.95'	0.18	5702
		74E	5.37'	74E	5.39'		
11	28	39E	42.96'	39E	42.80'	0.24	7603
		74E	5.69'	74E	5.52'		
15	38	39E	43.01'	39E	42.97'	0.05	1584
		74E	5.77'	74E	5.77'		
17	35	39E	43.17'	39E	43.08'	0.10	3168
		74E	5.63'	74E	5.63'		
Borrow D							
2	43	39E	40.45'	39E	40.38'	0.16	5069
		74E	4.90'	74E	4.74'		
6	44	39E	40.29'	39E	40.16'	0.19	6019
		74E	5.05'	74E	4.91'		
7	33	39E	40.12'	39E	39.97'	0.21	6653
		74E	5.01'	74E	5.05'		
13	NM	39E	40.14'	39E	40.16'	0.02	634
		74E	5.50'	74E	5.51'		
15	36	39E	40.03'	39E	39.94'	0.14	4435
		74E	5.26'	74E	5.37'		
18	32	39E	39.89'	39E	39.73'	0.20	6336
		74E	5.45'	74E	5.55'		
25	35	39E	39.65'	39E	39.58'	0.20	6336
		74E	5.81'	74E	5.60'		
28	43	39E	39.85'	39E	39.74'	0.13	4118
		74E	5.97'	74E	5.99'		
30	44	39E	39.97'	39E	39.82'	0.17	5386
		74E	5.82'	74E	5.80'		
32	44	39E	39.97'	39E	39.95'	0.02	634
		74E	6.31'	74E	6.32'		

Appendix Table B-2. (Continued)

Station	Depth	Start Location Lat/Long		End Location Lat/Long		Distance Dredged (miles)	Area Dredged (sq. ft.)
Borrow E							
3	32	39E	37.03'	39E	37.06'	0.04	1267
		74E	10.53'	74E	10.54'		
6	25	39E	36.86	39E	36.22'	0.10	3168
		74E	10.59'	74E	10.56'		
7	31	39E	36.67'	39E	36.55'	0.15	4752
		74E	10.83'	74E	10.89'		
13	24	39E	36.47'	39E	36.40'	0.08	2534
		74E	11.18'	74E	11.21'		
19	18	39E	36.15'	39E	36.14'	0.03	950
		74E	11.55'	74E	11.58'		

APPENDIX C

PERCENT SILT/CLAY AND DEPTH OF EACH MACROINVERTEBRATE SAMPLING STATION

Appendix Table C-1.

Station	% S/C	Depth (ft)	Station	% S/C	Depth (ft)
Borrow A					
A1	3.6	46.5	A29	1.1	23
A2	7.5	46	A30	0.9	18
A3	2	44.5	A31	3.5	40
A4	12.3	42.9	A32	2.3	42
A5	0.5	26.2	A33	1.6	42.3
A6	2.5	39.6	A34	1.8	41
A7	4.9	37.6	A35	1.8	41.9
A8	2.4	37	A36	0.7	38
A9	1.2	40.6	A37	0.8	36
A10	2.8	45.9	A38	0.7	37
A11	1.1	44.1	A39	0.7	36
A12	0.8	42	A40	0.8	36
A13	0.9	42	A41	1	39
A14	1.1	43	A42	1.2	38
A15	1.2	41.3	A43	30.7	44.2
A16	1	41.9	A44	7	41
A17	0.8	41	A45	2.2	28
A18	0.7	40	A46	1.4	28
A19	1.4	42	A47	2.2	13.5
A20	1.7	38.2	A48	1	14.5
A21	1.4	39.4	A49	0.9	15
A22	5.5	44.2	A50	0.5	15.3
A23	2	35.4	A51	1	14.1
A24	0.8	32.6	A52	0.8	15
A25	1.2	31	A53	0.8	15.7
A26	0.2	27	A54	0.8	17
A27	0.8	22	A55	1.3	16.6
A28	1.2	25			

Appendix Table C-1. (Continued)					
Station	**% S/C**	**Depth (ft)**	**Station**	**% S/C**	**Depth (ft)**
Borrow B					
B1	1.1	40	B10	1.5	35
B2	0.8	35.6	B11	1.8	33
B3	1.1	36.2	B12	0.9	32.3
B4	0.8	32.6	B13	1.4	31.1
B5	0.7	33.6	B14	1.1	30
B6	1.3	40	B15	1.1	32
B7	0.5	30	B16	1	38
B8	0.9	35.6	B17	0.7	31.9
B9	1.4	30	B18	0.4	44.7
Borrow D					
D1	0.9	46	D18		40
D2	1	46.5	D19	0.8	33.8
D3	0.8	42.3	D20	0.4	33.8
D4	0.7	43	D21		56
D5	0.7	44.6	D22		40.6
D6	0.5	42	D23	0.5	35.3
D7	1	41	D24	0.3	40
D8	0.8	41	D25	0.8	46
D9	0.6	40.5	D26	1	38.5
D10	0.5	41	D27	0.5	33
D11	0.5	40.5	D28	0.6	33.9
D12	1	43	D29	0.6	32
D13	0.4	43.5	D30		37
D14		37.2	D31	0.7	35.9
D15	0.6	37.5	D32	0.8	42.3
D16	0.5	37	D33	0.4	46.8
D17		60			

Appendix Table C-1. (Continued)					
Station	**% S/C**	**Depth (ft)**	**Station**	**% S/C**	**Depth (ft)**
Borrow E					
E1	1	43	E11	10.4	35.8
E2	0.8	35	E12	0.7	35
E3	2.4	37	E13	0.7	26
E4	0.9	36	E14	0.5	21.6
E5	0.6	28.6	E15	0.3	28
E6	0.6	34.2	E16	0.7	21
E7	0.5	30.4	E17	0.5	19.2
E8	0.3	26	E18	0.6	20
E9	0.6	26	E19	0.6	20.4
E10	1	32	E20	0.7	28.4
Reference Area					
AR1	1.4	32.4	DR1	0.7	48.3
AR2	5	30	DR2	2	39.7
BR1	7	43.6	ER1	0.3	31.3
BR2	1.6	43.7	ER2	1.9	38.5

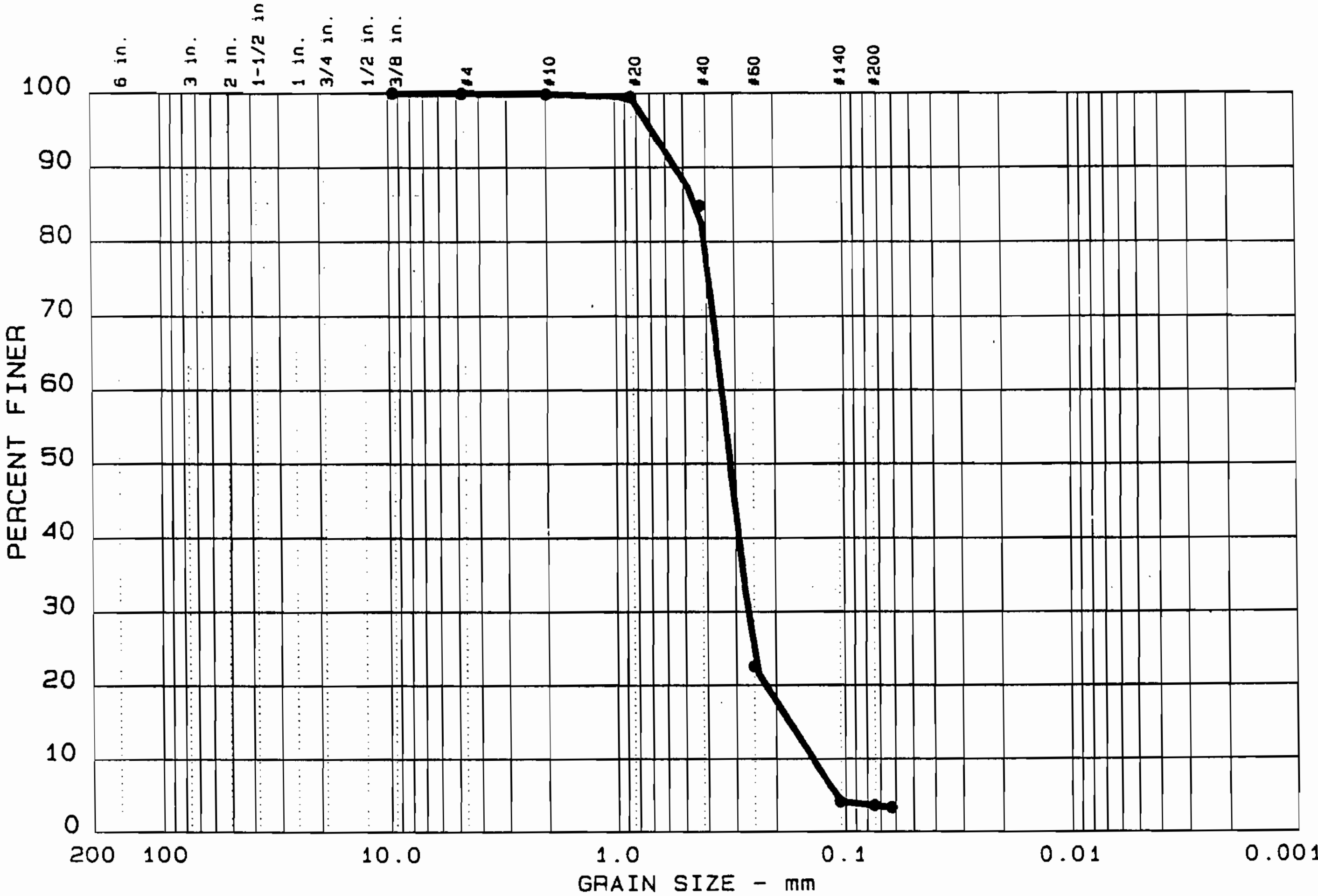
THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX D

SEDIMENT GRAIN SIZE CURVES

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.1	96.3	3.6		SP	-	-

SIEVE inches size	PERCENT FINER ●		
0.375	100.0		

	GRAIN SIZE		
D_{60}	0.34		
D_{30}	0.27		
D_{10}	0.13		

	COEFFICIENTS		
C_c	1.48		
C_u	2.5		

SIEVE number size	PERCENT FINER ●		
4	99.9		
10	99.8		
20	99.5		
40	84.8		
60	22.6		
140	4.1		
200	3.6		
230	3.3		

Sample information:

● A-1
Tan poorly graded SAND

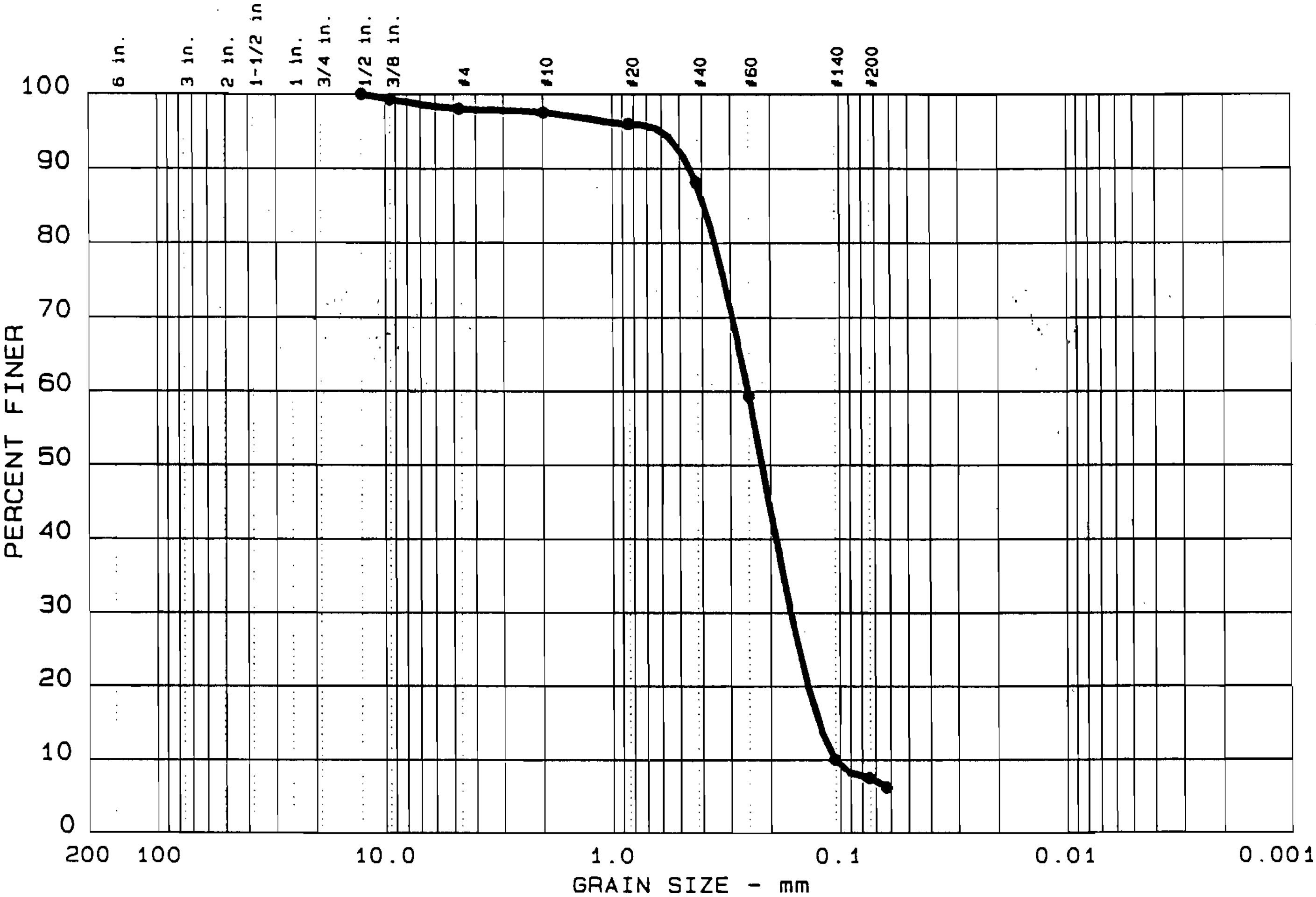
Remarks:
Natural Moisture: 18.9%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.

Date: 03/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	2.0	90.5	7.5		SP-SM	-	-

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	99.3		
	GRAIN SIZE		
D_{60}	0.25		
D_{30}	0.16		
D_{10}	0.10		
	COEFFICIENTS		
C_c	1.01		
C_u	2.4		

SIEVE number size	PERCENT FINER ●		
4	98.0		
10	97.5		
20	96.0		
40	88.2		
60	59.3		
140	10.0		
200	7.5		
230	6.2		

Sample information:

● A-2
Brown poorly graded
SAND with silt.

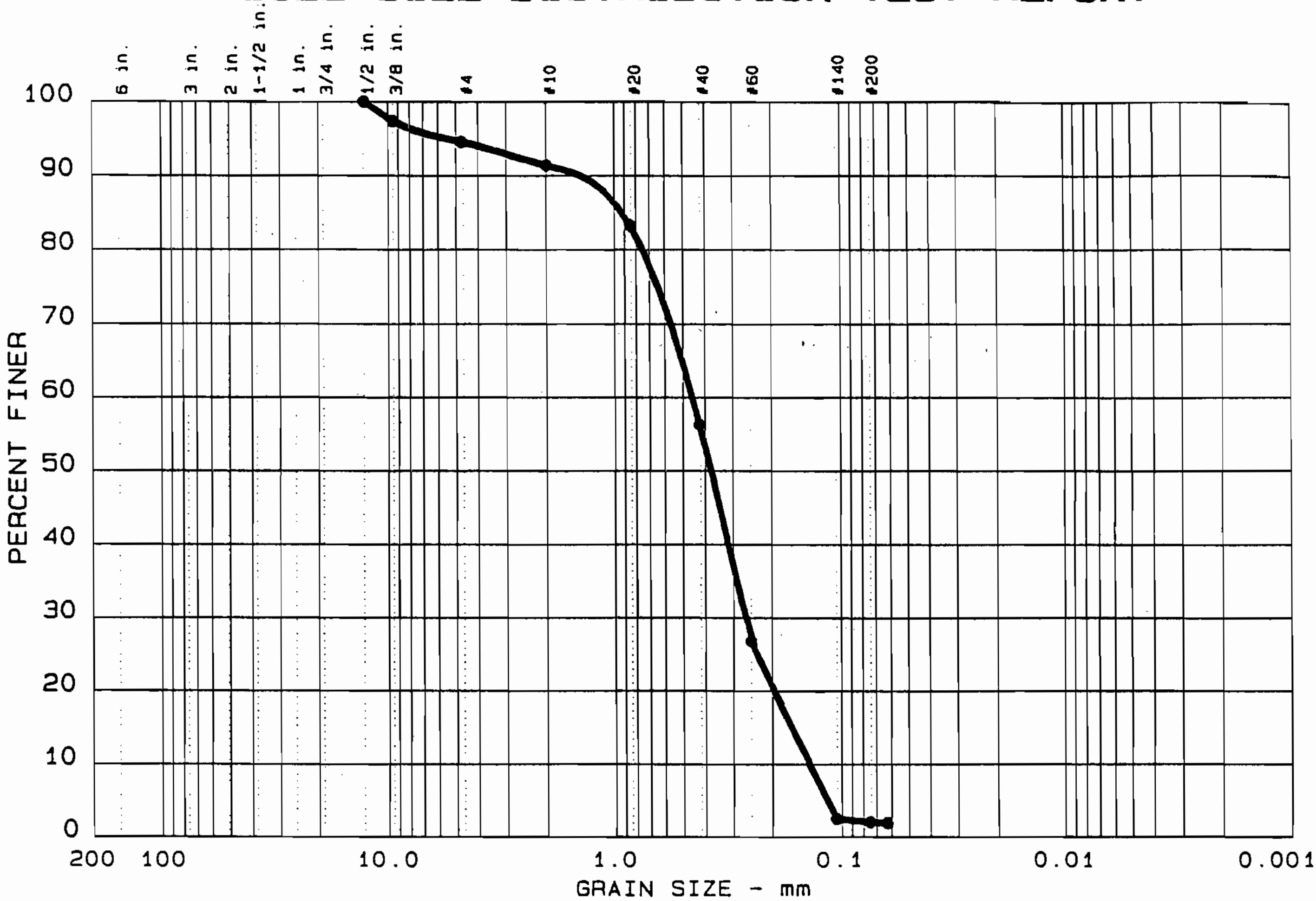
Remarks:
Natural Moisture: 20.4%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.

Date: 03/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	5.4	92.6	2.0		SP	-	-

SIEVE inches size	PERCENT FINER ●		
0.5	100.0		
0.375	97.4		

	GRAIN SIZE		
D_{60}	0.46		
D_{30}	0.26		
D_{10}	0.13		

	COEFFICIENTS		
C_c	1.11		
C_u	3.3		

SIEVE number size	PERCENT FINER ●		
4	94.6		
10	91.4		
20	83.3		
40	56.3		
60	26.8		
140	2.5		
200	2.0		
230	1.9		

Sample information:

● A-3
Brown poorly graded
SAND.

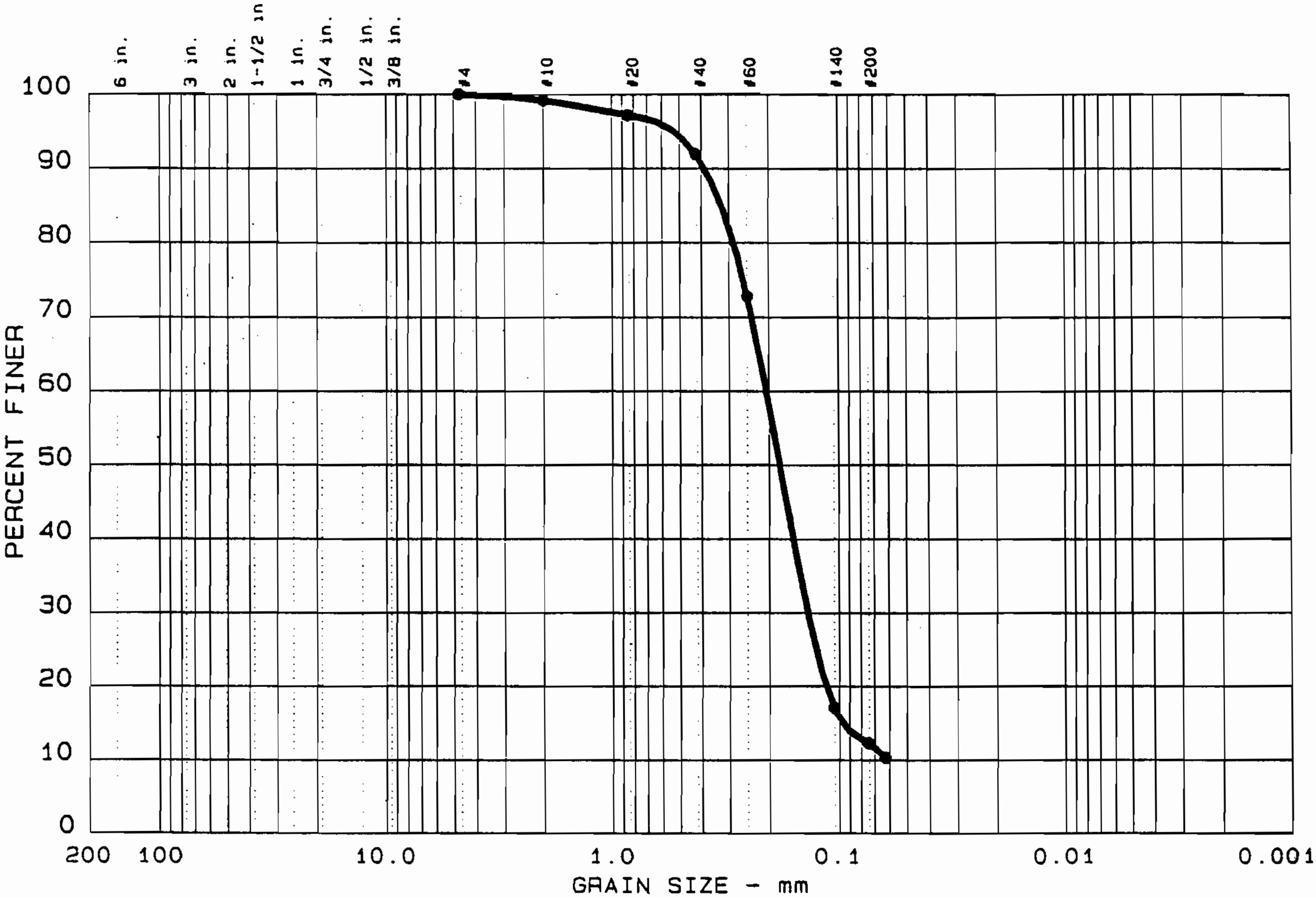
Remarks:
Natural Moisture: 15.7%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.

Date: 03/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	87.7	12.3		SM	-	-

SIEVE inches size	PERCENT FINER ●		
	GRAIN SIZE		
D_{60}	0.21		
D_{30}	0.14		
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ●		
4	100.0		
10	99.1		
20	97.2		
40	91.9		
60	72.8		
140	17.1		
200	12.3		
230	10.3		

Sample information:

● A-4
Brown silty SAND

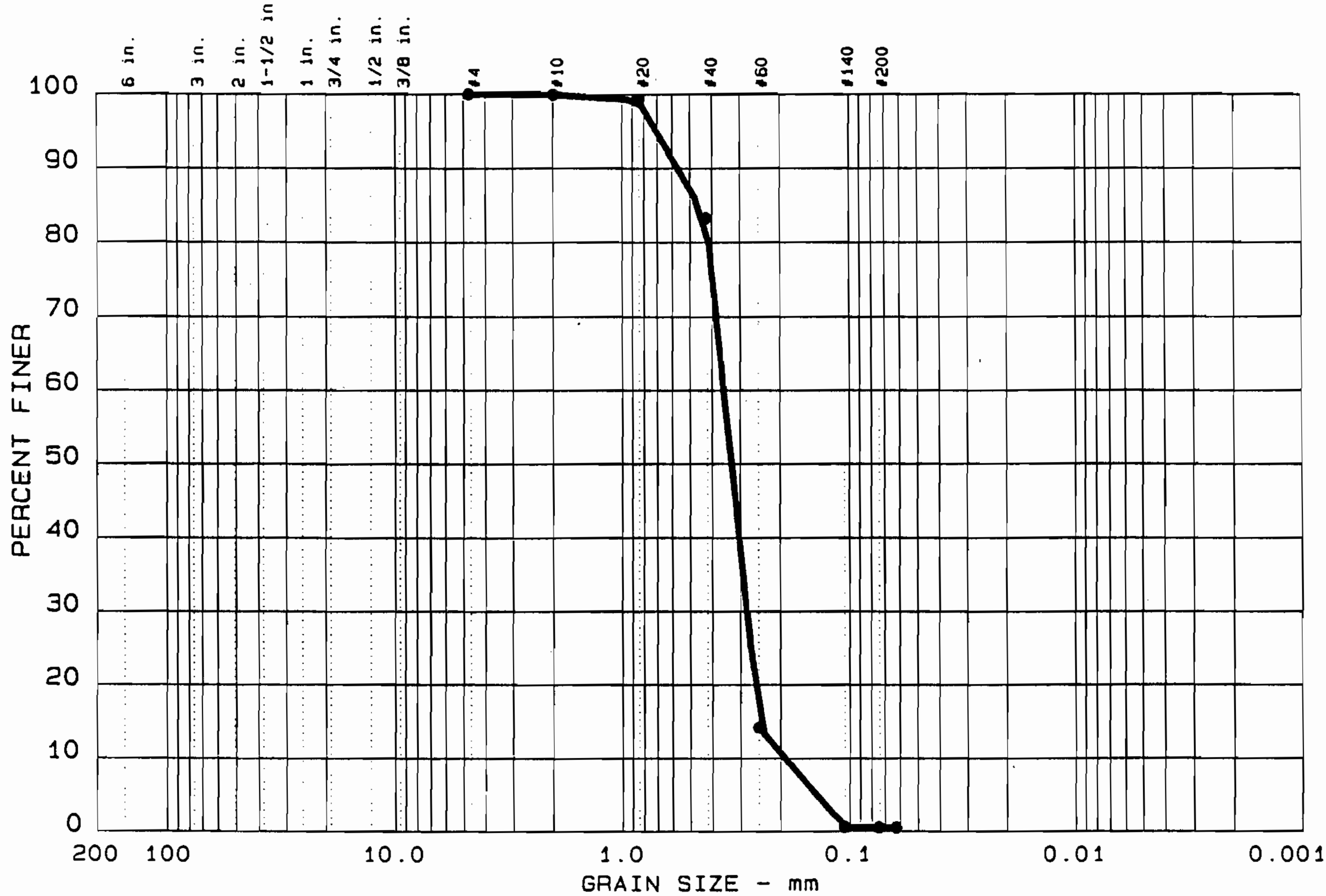
Remarks:
Natural Moisture: 28.8%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.

Date: 03/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	99.5	0.5		SP	-	-

SIEVE inches size	PERCENT FINER ●		

	GRAIN SIZE		
D_{60}	0.36		
D_{30}	0.28		
D_{10}	0.19		

	COEFFICIENTS		
C_c	1.17		
C_u	1.9		

SIEVE number size	PERCENT FINER ●		
4	100.0		
10	99.9		
20	99.2		
40	83.3		
60	14.2		
140	0.6		
200	0.5		
230	0.5		

Sample information:

● A-5
Tan poorly graded SAND

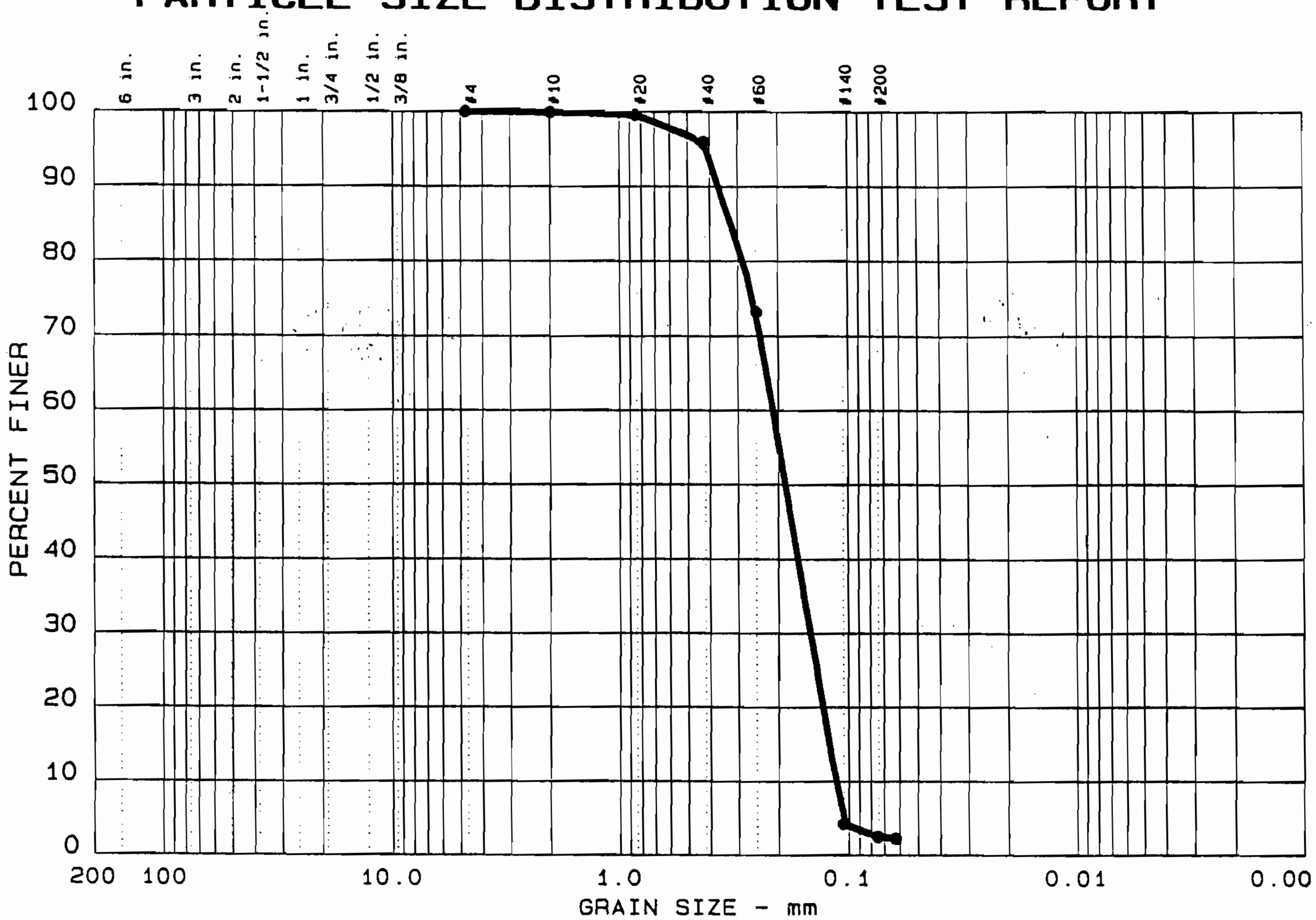
Remarks:
Natural Moisture: 20.2%
Checked By: WDF
Test By: DA\Disturbed
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 2218Z0139
Project: Long Beach Islan, Versar

Date: 3/25/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.0	97.5	2.5		SP	-	-

SIEVE inches size	PERCENT FINER ●		
	GRAIN SIZE		
D_{60}	0.21		
D_{30}	0.15		
D_{10}	0.11		
	COEFFICIENTS		
C_c	0.88		
C_u	1.9		

SIEVE number size	PERCENT FINER ●		
4	100.0		
10	99.9		
20	99.6		
40	96.0		
60	73.2		
140	4.3		
200	2.5		
230	2.3		

Sample information:

● A-6
Tan poorly graded SAND

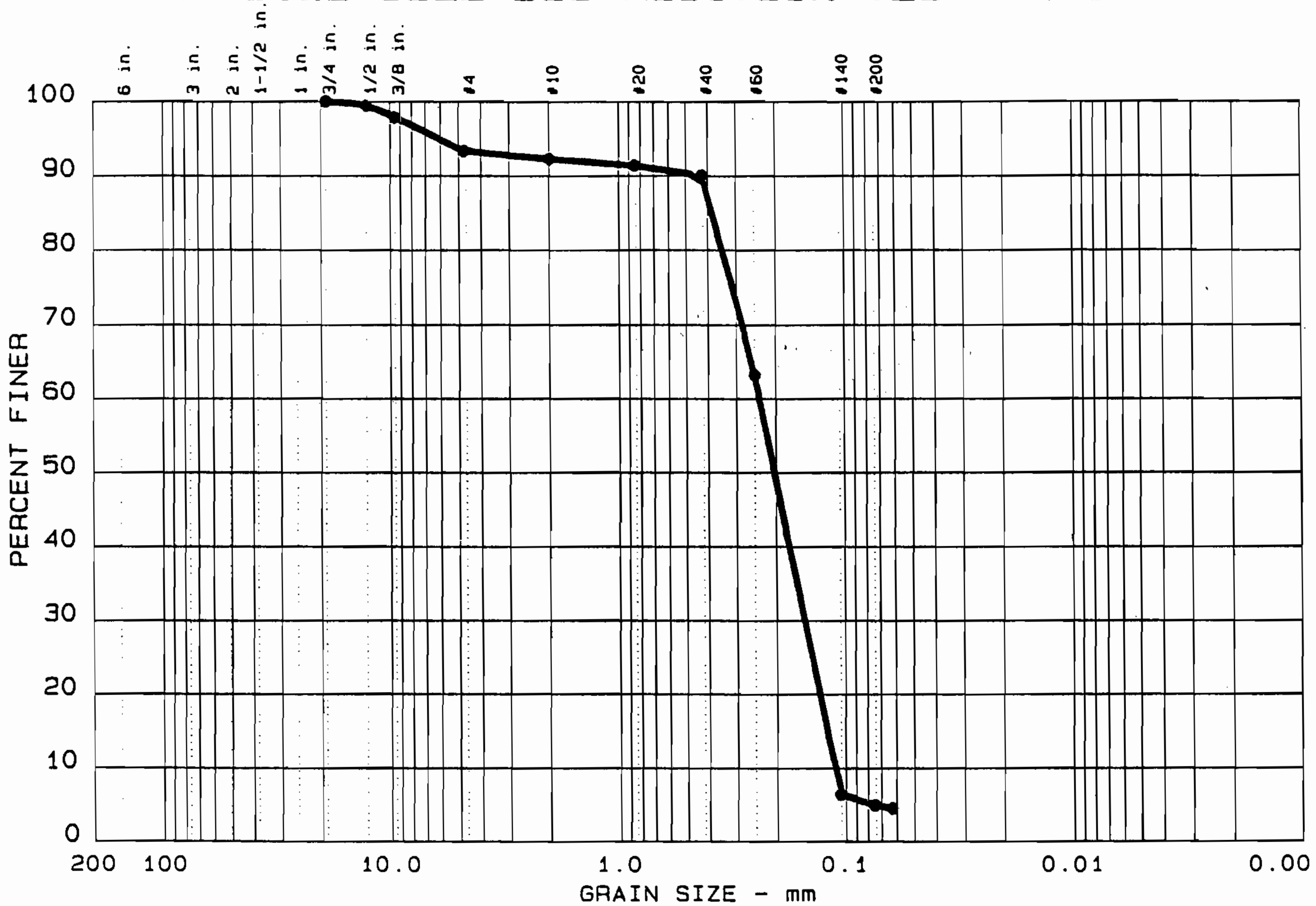
Remarks:
Natural Moisture: 20.8%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.

Date: 3/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	6.7	88.4	4.9		SP	-	-

SIEVE inches size	PERCENT FINER ●		
0.75	100.0		
0.5	99.4		
0.375	97.8		
	GRAIN SIZE		
D_{60}	0.24		
D_{30}	0.15		
D_{10}	0.11		
	COEFFICIENTS		
C_c	0.86		
C_u	2.1		

SIEVE number size	PERCENT FINER ●		
4	93.3		
10	92.3		
20	91.4		
40	90.1		
60	63.2		
140	6.4		
200	4.9		
230	4.5		

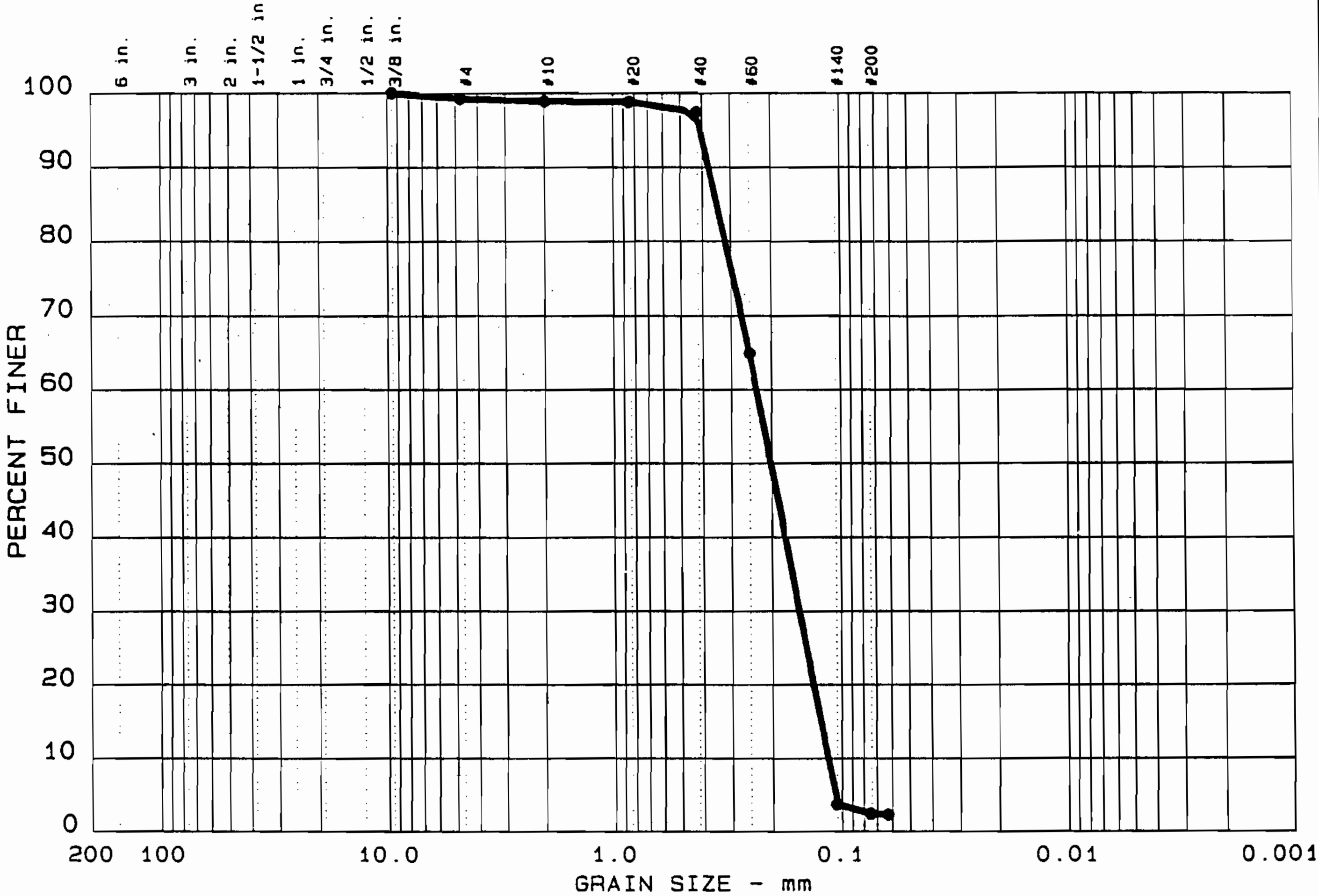
Sample information:
● A-7
Tan poorly graded SAND

Remarks:
Natural Moisture: 21.5%
Sample: Disturbed
Test By: NL
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 221801399
Project: Long Beach Island, Versar, Inc.
Date: 3/06/98 Data Sheet No. 1

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% +3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PI
●	0.0	0.8	96.8	2.4		SP	-	-

SIEVE inches size	PERCENT FINER ●		
0.375	100.0		
	GRAIN SIZE		
D_{60}	0.23		
D_{30}	0.15		
D_{10}	0.11		
	COEFFICIENTS		
C_c	0.87		
C_u	2.0		

SIEVE number size	PERCENT FINER ●		
4	99.2		
10	98.9		
20	98.8		
40	97.4		
60	64.9		
140	3.7		
200	2.4		
230	2.3		

Sample information:

● A-8
Tan poorly graded SAND

Remarks:
Natural Moisture: 20.8%
Checked By: WDF
Test By: DA\Disturbed
Form No. 6 6/93

EBA Engineering, Inc.

Project No.: 2218Z0139
Project: Long Beach Islan, Versar
Date: 3/25/98 Data Sheet No. 1

APPENDIX E

STATION-SPECIFIC ABUNDANCE AND BIOMASS DATA

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Benthic Macroinvertebrate Abundance and Biomass (Ash-Free Dry Weight) Data
Long Beach Island

LOCATION : Borrow Area A   STATION : A1   SAMPLING GEAR : Young-Modified Van Veen
SAMPLED AREA : 0.044 sq.m   SAMPLING DATE : October 2, 1997

BENTHOS	Abundance (#/m2)		Biomass (g/m2)
	Total	>= 2cm	Total
Annelida : Polychaeta			
Amastigos caperatus	23		0.00455
Ampharetidae	23		0.00114
Caulleriella sp. B (Blake)	386		0.15909
Dispio uncinata	23		0.00455
Glycera americana	23		0.00227
Magelona spp.	227		0.11136
Nephtyidae	409		0.03864
Nephtys picta	45	45	0.12045
Phyllodoce arenae	23	23	0.00682
Polygordius spp.	1727		0.06818
Spiophanes bombyx	136		0.04318
Tharyx sp. A Morris	23		0.00114
Arthropoda : Amphipoda			
Acanthohaustorius similis	545		0.31136
Protohaustorius wigleyi	341		0.06818
Pseudunciola obliquua	2864		0.13636
Rhepoxynius hudsoni	659		0.11136
Arthropoda : Decapoda			
Pagurus spp.	45		0.00114
Arthropoda : Mysidacea			
Neomysis americana	23		0.01591
Arthropoda : Tanaidacea			
Tanaissus psammophilus	91		0.00114
Echinodermata : Echinoidea			
Echinarachnius parma	45		0.07727
Echinoidea	23		0.00114
Moira atropos	23		0.00114
Mollusca : Bivalvia			
Nucula annulata	23		0.00114
Petricola pholadiformis	1909		0.03409

Continued . . .

Benthic Macroinvertebrate Abundance and Biomass (Ash-Free Dry Weight) Data
Long Beach Island

(Station: A1 - Contd.)

BENTHOS	Abundance (#/m2) Total	Abundance (#/m2) >= 2cm	Biomass (g/m2) Total
Spisula solidissima	1159		0.03864
Tellina agilis	795		1.02954
Mollusca : Gastropoda			
Epitonium greenlandicum	23		0.00909
Polinices heros	23		0.16136
Turbonilla interrupta	23		0.00114
Nemertinea			
Nemertinea	23		0.00114
Platyhelminthes : Turbellaria			
Turbellaria	23		0.02273
Total	11727	68	2.58522
Number of Taxa	29		

Benthic Macroinvertebrate Abundance and Biomass (Ash-Free Dry Weight) Data
Long Beach Island

LOCATION : Borrow Area A — STATION : A2 — SAMPLING GEAR : Young-Modified Van Veen
SAMPLED AREA : 0.044 sq.m — SAMPLING DATE : October 2, 1997

BENTHOS	Abundance (#/m2) Total	Abundance (#/m2) >= 2cm	Biomass (g/m2) Total
Annelida : Oligochaeta			
Oligochaeta	545		0.01818
Annelida : Polychaeta			
Amastigos caperatus	114		0.00455
Ampharetidae	68		0.00114
Aricidea catherinae	23		0.00114
Asabellides oculata	68		0.12045
Capitellidae	23		0.00114
Caulleriella sp. B (Blake)	23		0.00227
Diopatra cuprea	23	23	4.39317
Glycera americana	91	45	0.13182
Glycinde solitaria	23		0.00455
Mediomastus ambiseta	3432		0.11818
Nephtys picta	23	23	0.05909
Nephtys spp.	114		0.00909
Orbiniidae	23	23	0.19318
Pectinaria gouldii	23		0.00114
Pherusa affinis	23	23	1.90454
Polygordius spp.	23		0.00114
Spiochaetopterus costarum	68		0.04091
Spiophanes bombyx	23		0.02273
Tharyx sp. A Morris	1159		0.09091
Arthropoda : Amphipoda			
Ampelisca abdita	45		0.00227
Rhepoxynius hudsoni	23		0.00909
Unciola spp.	23		0.00114
Cnidaria : Anthozoa			
Anthozoa	68		0.04091
Mollusca : Bivalvia			
Mulinia lateralis	23		0.00114
Petricola pholadiformis	15500		0.40682

Continued . . .

Benthic Macroinvertebrate Abundance and Biomass (Ash-Free Dry Weight) Data
Long Beach Island

(Station: A2 - Contd.)

BENTHOS	Abundance (#/m2) Total	Abundance (#/m2) >= 2cm	Biomass (g/m2) Total
Tellina agilis	364		0.15454
Mollusca : Gastropoda			
Crepidula spp.	45		0.00114
Cylichnella bidentata	23		0.00455
Nemertinea			
Nemertinea	2682		0.35000
Total	24704	136	8.09088
Number of Taxa	28		

APPENDIX F

LIST OF TAXA COLLECTED FROM THE FOUR LBI BORROW AREAS AND THE OTHER REFERENCE AREAS

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Cnidaria : Anthozoa	Anthozoa	X	X	X	X	X		X	X
	Ceriantheopsis americanus	X		X					
Nemertinea	Nemertinea	X	X	X	X	X	X	X	X
Annelida : Polychaeta	Amastigos caperatus	X	X	X		X	X	X	X
	Ampharete arctica			X		X			X
	Ampharetidae	X	X	X	X	X			X
	Ancistrosyllis hartmanae		X	X		X			X
	Ancistrosyllis spp.								X
	Aphelochaeta spp.	X		X				X	X
	Apoprionospio pygmaea	X	X			X	X	X	
	Arabellidae							X	
	Aricidea catherinae	X		X	X	X		X	X
	Aricidea cerrutii	X	X	X	X	X		X	X
	Aricidea wassi	X				X			
	Asabellides oculata	X	X	X		X			
	Bhawania heteroseta								X
	Brania wellfleetensis	X	X	X	X	X		X	X
	Capitellidae	X		X		X			
	Carazziella hobsonae			X					
	Caulleriella sp. B (Blake)	X	X	X	X	X		X	X
	Cirratulidae			X			X	X	
	Cirriformia grandis	X	X	X	X	X			X
	Clymenella torquata								X
	Diopatra cuprea	X	X	X		X		X	X
	Dispio uncinata	X	X	X	X	X	X	X	X
	Dorvilleidae sp. A Hilbig								X
	Drilonereis longa	X							X
	Drilonereis magna							X	
	Eteone foliosa								X
	Eteone heteropoda								X
	Eumida sanguinea	X		X		X			X
	Exogone dispar							X	
	Exogone hebes	X		X					
	Glycera americana	X	X			X		X	X
	Glycera dibranchiata	X					X	X	X
	Glycera spp.	X				X		X	X
	Glycinde solitaria	X							
	Goniadella gracilis	X		X	X				
	Goniadidae						X		
	Hemipodus roseus	X	X	X	X	X		X	X
	Hesionura elongata	X	X	X	X	X		X	

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Annelida : Polychaeta	Leitoscoloplos robustus			X				X	
	Leitoscoloplos spp.	X						X	X
	Loimia medusa	X							
	Lumbrineridae	X							
	Lumbrinerides dayi							X	
	Macroclymene zonalis					X		X	
	Magelona spp.	X	X	X		X	X	X	X
	Maldanidae			X				X	X
	Mediomastus ambiseta	X	X	X	X	X		X	X
	Microphthalmus fragilis	X	X	X	X	X			X
	Microphthalmus listensis	X		X					
	Microphthalmus sczelkowii	X		X					
	Microphthalmus similis	X	X	X	X	X		X	X
	Monticellina baptisteae	X	X	X	X			X	
	Mooreonuphis spp.			X					
	Neanthes arenaceodentata	X		X			X	X	X
	Neanthes succinea	X				X			X
	Nephtyidae	X	X	X	X	X	X	X	
	Nephtys bucera	X	X	X	X	X	X	X	
	Nephtys picta	X		X		X		X	X
	Nephtys spp.	X		X		X			
	Nereididae	X		X	X	X			X
	Notocirrus spiniferus	X	X	X				X	X
	Notomastus luridus		X				X		X
	Notomastus spp.	X				X			X
	Onuphidae			X	X			X	
	Onuphis eremita	X				X	X	X	X
	Ophelia denticulata			X					X
	Opheliidae	X	X	X	X			X	
	Ophryotrocha spp.			X	X				X
	Orbinia americana	X			X			X	
	Orbiniidae	X						X	X
	Owenia fusiformis	X	X	X	X	X		X	X
	Paradoneis sp. A Morris	X				X		X	
	Paradoneis sp. B Morris	X						X	
	Paranaitis speciosa	X							X
	Paraonis fulgens	X	X	X	X	X		X	X
	Paraonis pygoenigmatica	X		X		X		X	
	Parapionosyllis longicirrata	X	X	X	X	X		X	X
	Parougia caeca	X	X	X	X	X		X	X
	Pectinaria gouldii	X	X	X					
	Pherusa affinis	X		X		X			
	Phyllodoce arenae	X	X	X	X	X		X	X

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Annelida : Polychaeta	Pisione remota		X	X	X	X		X	X
	Pista cristata	X							
	Podarke obscura					X			
	Polychaeta: Unidentified & fragments	X							
	Polycirrus eximius			X					X
	Polycirrus spp.							X	
	Polydora cornuta	X						X	X
	Polydora socialis	X		X		X		X	X
	Polydora spp.	X						X	
	Polygordius spp.	X	X	X	X	X	X	X	X
	Prionospio perkinsi							X	
	Prionospio spp.	X							
	Protodorvillea kefersteini		X	X				X	
	Sabellidae								X
	Scolelepis spp.							X	
	Scolelepis squamata							X	
	Scolelepis texana						X		
	Scoletoma acicularum	X	X	X			X		
	Scoletoma tenuis	X				X			
	Sigalion arenicola	X	X	X	X	X		X	X
	Sigalionidae	X	X	X	X	X		X	
	Sphaerodoropsis spp.								X
	Sphaerosyllis spp.	X							
	Spio setosa					X			
	Spiochaetopterus costarum	X	X	X		X		X	X
	Spionidae	X		X				X	
	Spiophanes bombyx	X	X	X	X	X	X	X	X
	Sthenelais boa	X		X				X	
	Sthenelais limicola					X			
	Sthenelais spp.								X
	Streblospio benedicti					X		X	X
	Streptosyllis arenae	X	X	X	X	X		X	
	Streptosyllis pettiboneae	X	X	X	X	X		X	X
	Streptosyllis spp.	X		X					
	Streptosyllis varians	X	X	X					
	Syllidae	X	X	X	X	X		X	X
	Syllides spp.	X							
	Syllides verrilli								X
	Terebellidae	X							
	Tharyx sp. A Morris	X	X	X	X	X		X	X
	Travisia sp. A Morris	X							
Annelida : Oligochaeta	Oligochaeta	X	X	X	X	X	X	X	X

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Mollusca : Gastropoda	Caecum spp.					X			
	Nassarius trivittatus	X		X	X	X	X	X	X
	Natica pusilla	X	X	X	X	X			
	Naticidae	X		X	X	X			
	Polinices duplicata								X
	Polinices heros	X	X	X	X	X			
	Polinices spp.					X			
Mollusca : Bivalvia	Aligena elevata								X
	Anadara spp.	X							
	Anadara transversa	X		X				X	X
	Astarte castanea		X	X					
	Astarte spp.	X							
	Barnea truncata							X	X
	Bivalvia: Unidentified	X	X	X	X	X			
	Bushia elegans	X							
	Cyclocardia borealis							X	X
	Donax variabilis	X	X	X	X		X	X	X
	Ensis directus	X	X	X		X			X
	Gemma gemma	X							
	Lyonsia arenosa		X						X
	Lyonsia spp.	X			X			X	X
	Mercenaria mercenaria								X
	Mulinia lateralis	X	X			X			
	Mysella planulata			X		X			X
	Nucula annulata	X	X	X	X	X		X	X
	Pandora gouldiana								X
	Pandora spp.							X	X
	Periploma fragile			X					
	Petricola pholadiformis	X	X	X	X	X	X	X	X
	Pitar morrhuanus	X				X		X	
	Spisula solidissima	X	X	X	X	X	X	X	X
	Tellina	X	X	X	X				
	Tellina agilis	X	X	X	X	X	X	X	X
	Tellina tenella	X		X	X	X			
	Thraciidae							X	
	Veneridae								X
Arthropoda : Stomatopoda	Lysiosquillidae	X							
Arthropoda : Cumacea	Leucon americanus	X							
	Mancocuma stellifera						X	X	X
	Oxyurostylis smithi	X	X	X		X		X	X

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Arthropoda : Tanaidacea	Tanaissus psammophilus	X	X	X	X	X	X	X	X
Arthropoda : Isopoda	Ancinus depressus						X	X	X
	Chiridotea coeca	X	X	X	X	X	X	X	X
	Chiridotea spp.							X	
	Chiridotea tuftsi	X	X	X		X	X	X	X
Arthropoda : Amphipoda	Acanthohaustorius millsi	X					X	X	X
	Acanthohaustorius shoemakeri			X	X	X			
	Acanthohaustorius similis	X	X	X	X	X	X		X
	Acanthohaustorius spp.	X				X	X	X	X
	Ampelisca abdita	X				X			
	Ampelisca spp.							X	X
	Ampelisca vadorum	X				X		X	X
	Ampelisca verrilli	X							
	Amphiporeia virginiana		X		X				
	Bathyporeia parkeri								X
	Bathyporeia quoddyensis	X					X	X	
	Bathyporeia spp.						X	X	
	Eobrolgus spinosus								X
	Haustoriidae				X			X	
	Liljeborgia sp. A Morris								X
	Listriella barnardi	X							
	Lysianopsis alba					X			X
	Parahaustorius attenuatus	X	X	X	X	X	X	X	
	Parahaustorius holmesi	X			X				X
	Parahaustorius longimerus	X			X		X	X	X
	Parahaustorius spp.	X			X		X	X	X
	Phoxocephalus holbolli							X	
	Protohaustorius cf. deichmannae	X	X			X	X	X	
	Protohaustorius spp.	X	X						X
	Protohaustorius wigleyi	X	X	X	X	X		X	X
	Pseudohaustorius borealis						X		
	Pseudunciola obliquua	X	X	X		X		X	
	Rhepoxynius epistomus						X		
	Rhepoxynius hudsoni	X	X	X		X	X	X	
	Synchelidium americanum	X		X			X	X	
	Unciola dissimilis							X	
	Unciola irrorata	X	X	X	X	X		X	
	Unciola serrata	X				X			X
	Unciola spp.	X	X	X		X		X	X
Arthropoda : Decapoda	Albunea paretii	X							

Taxa Distribution at Long Beach Borrow and Reference Areas

SPECIES GROUP	SPECIES NAME	LBI-A	LBI-B	LBI-D	LBI-E	LBI-REF	BRIG-1	BRIG-2	CAPE MAY
Arthropoda : Decapoda	Callianassa setimanus								X
	Emerita talpoida	X				X			
	Euceramus praelongus							X	
	Pinnixa chaetopterana			X					
	Pinnixa spp.	X	X	X				X	X
	Upogebia affinis	X	X		X				X
	Thalassinidea		X						
Sipuncula	Sipuncula								X
Phoronida	Phoronis spp.			X					
Echinodermata : Ophiuroidea	Ophiuroidea								X
Echinodermata : Echinoidea	Echinarachnius parma	X	X	X					
	Echinoidea	X	X	X	X	X			X
	Mellita quinquiesperforata	X		X					
	Moira atropos	X	X	X	X	X			
Echinodermata : Holothuroidea	Holothuroidea	X							
	Leptosynapta tenuis	X				X		X	X
Hemichordata	Saccoglossus kowalevskii							X	X
Chordata : Cephalochordata	Branchiostoma caribaeum	X		X				X	X

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX G

LIST OF TAXA CLASSIFIED AS EPIFAUINA THAT WERE COLLECTED FROM THE FOUR LBI BORROW AREAS AND THE LBI REFERENCE AREA

Appendix Table G-1. Mean abundance of epifaunal taxa collected during macroinvertebrate sampling at the four LBI borrow area and LBI reference areas

Taxon	Area A	Area B	Area D	Area E	LBI Reference Area
Platyhelminthes : Turbellaria					
Stylochus ellipticus	2.9				
Turbellaria	1.2	1.3	0.7		
Annelida : Polychaeta					
Harmothoe extenuata					5.7
Lepidonotus spp.		1.3	0.7		
Lepidonotus sublevis	3.3	1.3	4.1		2.9
Polydora commensalis	6.2				
Polydora websteri	0.4				
Proceracea cornuta					17.1
Sabellaria vulgars Spirorbis	4.1	5.1			173.3
spp.	3.7		1.4		2.9
Mollusca : Gastropoda					
Astyris lunata Crepidula plana		8.8			2.8
Crepidula spp. *Cylichnella*	8.3	29.0	20.7		25.6
bidentata Doridella obscura	16.5			1.1	119.3
Epitonium greenlandicum	0.4				
Epitonium spp. *Gastropoda*	0.8		0.7	1.1	
Nudibranchia Odostomia	1.7				
engonia Odostomia spp.	0.8	2.5	2.1	1.1	
Turbonilla *interrupta Turbonilla*	0.8	1.3	2.1		17.1
spp. Turbonilla stricta	0.8		4.1		
Vitrinellidae	0.4				5.7
	14.9		7.6		
	1.2	1.3			
			0.7		
	9.9	11.4	0.7		8.5
				1.1	
Mollusca : Bivalvia					
Anomia simplex					2.8
Mytilus edulis	1.2				76.7
Arthropoda : Mysidacea					
Mysidopsis bigelowi	91.	1.3			5.7
Neomysis americana	7.9			1.1	
Arthropoda : Isopoda					
Edotea triloba Idotea	43.0	2.5			36.9
balthica Politolana	2.0				
concharum	5.8	138.9	39.3	180.7	5.7

Appendix Table H-1. (Continued)

Taxon	Area A	Area B	Area D	Area E	LBI Reference Area
Arthropoda : Amphipoda					
Cerapus tubularis	1.7				
Corophium spp.					5.7
Corophium Tuberculatum	2.5	5.1	9.6		28.4
Elasmopus laevis	9.1				11.4
Erichthonius Brasiliensis	2.5				17.1
Microprotopus raneyi	4.1	1.3			
Paracaprella tenuis	0.4				
Parametopella cypris			0.7		
Stenothoe minuta	0.4				
Anthropoda : Decapoda					
Crangon Septemspinosa	1.2				
Pagurus longicarpus	5.4		2.1		
Pagurus spp.	19.8	20.2	4.8	4.6	71.0
Palaemonetes pugio	0.4				
Xanthidae		2.5			14.2
Bryozoa					
Alcyonidium spp.	0.4				
Echinodermata : Asteroidea					
Asterias forbesi	2.9				8.5
Asteroidea		2.5	7.6	47.7	14.2
Chordata : Ascidiacea					
Ascidiacea	11.2	82.1	15.8	200.0	

APPENDIX H

SAMPLING LOCATIONS OF OTHER REFERENCE AREAS

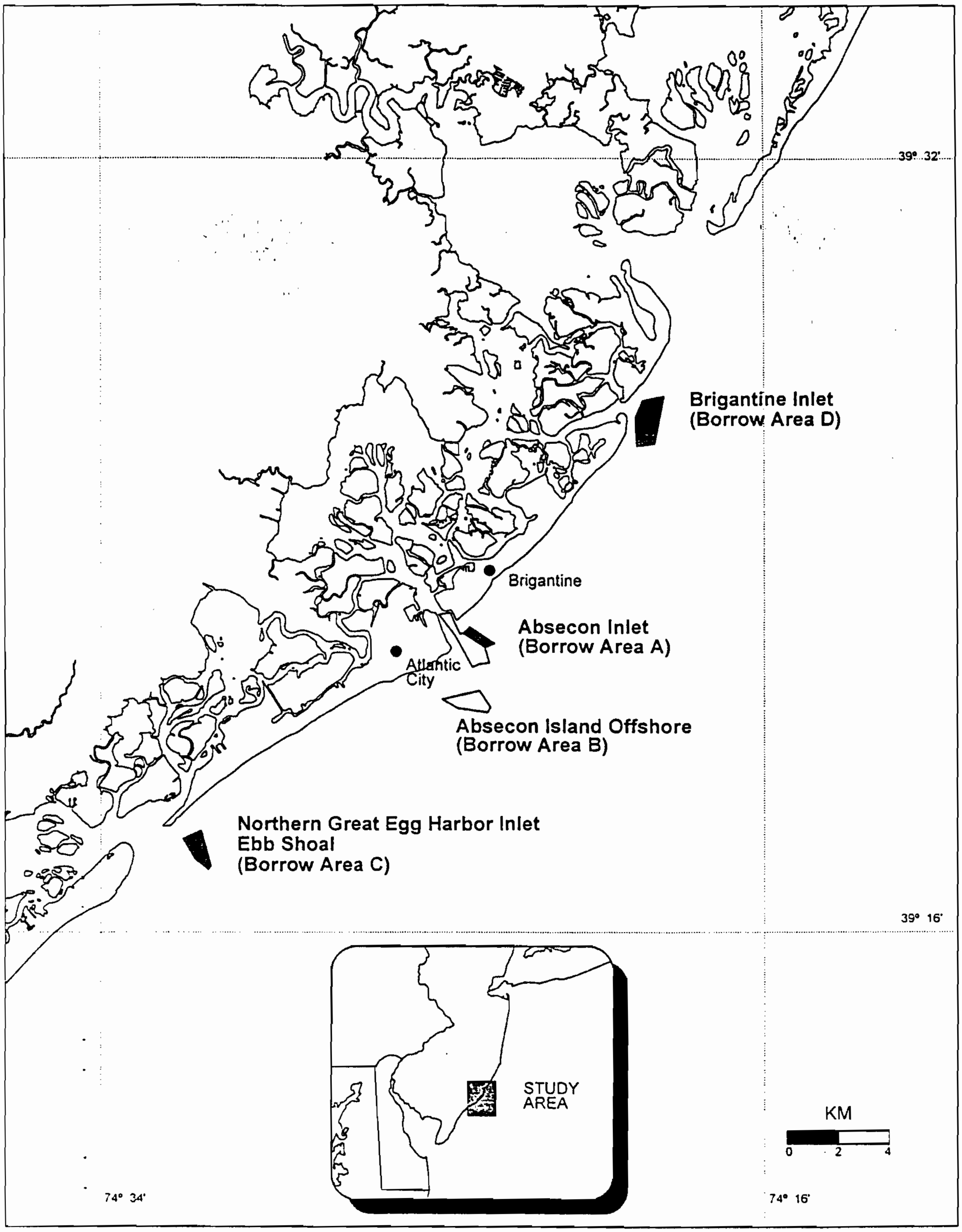


Figure H-1. Borrow areas (A, C, and D) combined become the Brigantine I reference area (from Chaillou and Scott 1997)

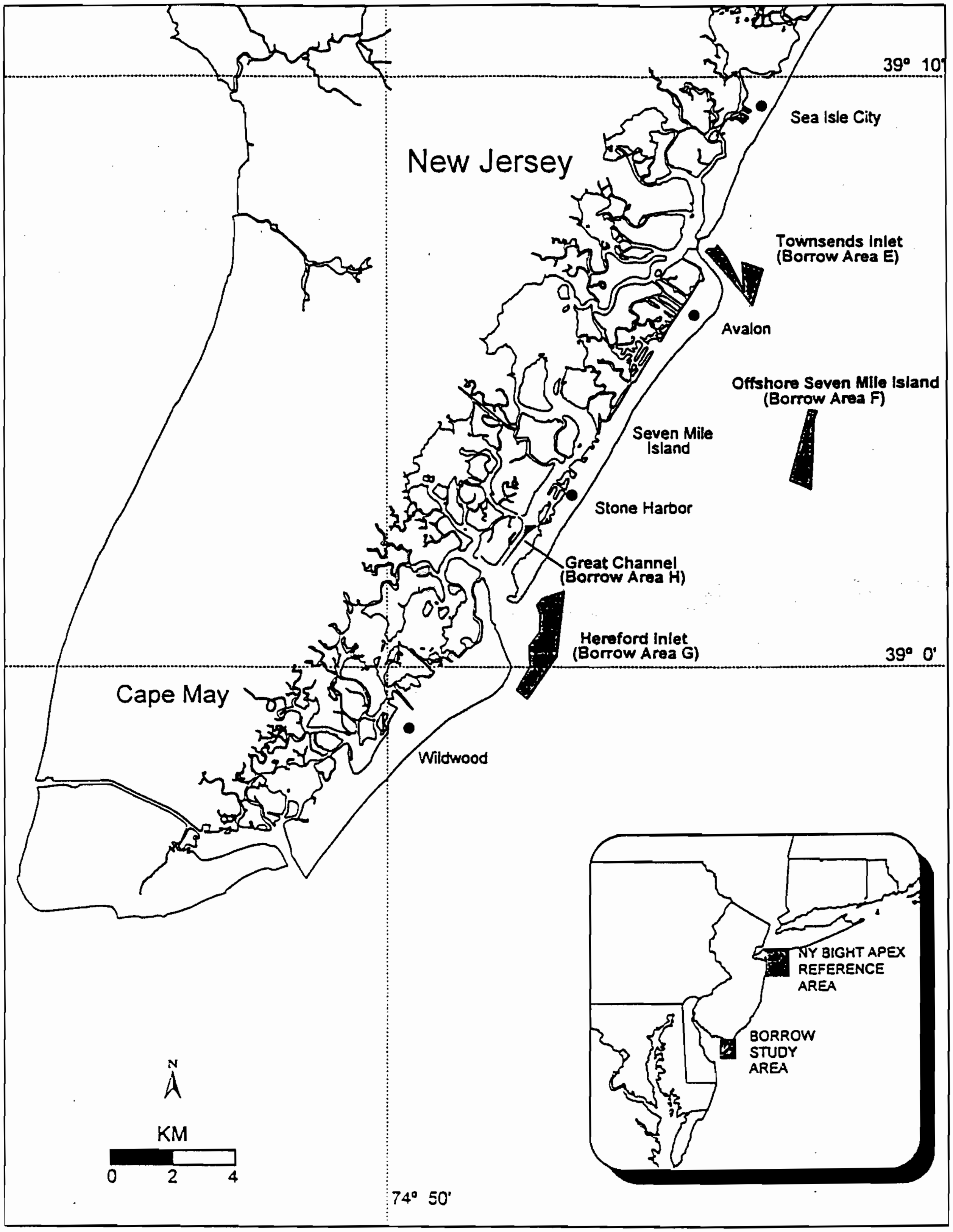


Figure H-2. Borrow areas (E, F, and G) combined to become the Brigantine II reference area (from Scot and Chaillou 1997)

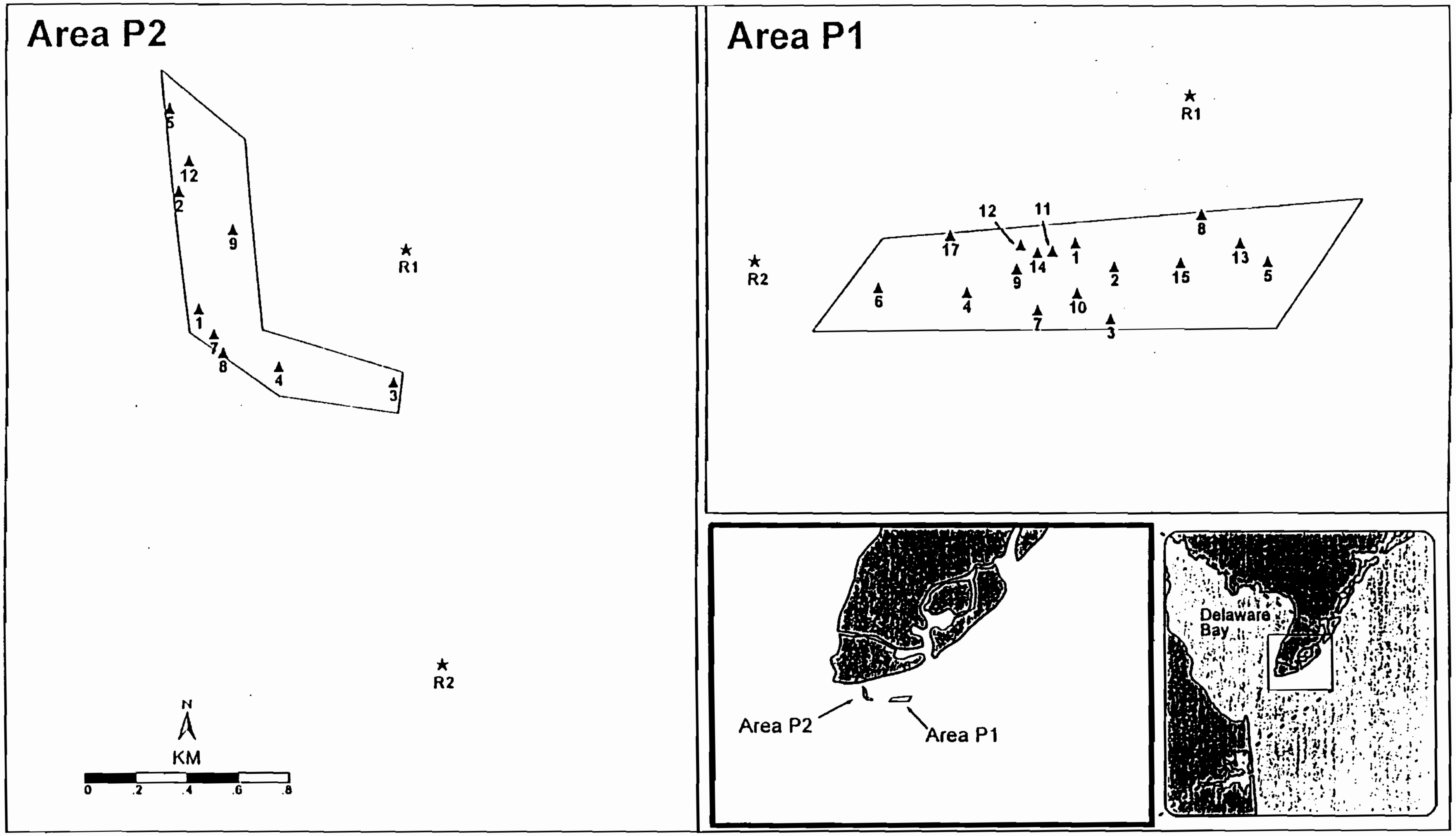


Figure H-3. Borrow areas P1, P2, and reference stations combined to become the Cape May Meadows reference area (Scott 1997)

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

FISH AND WILDLIFE COORDINATION ACT
SECTION 2(b) REPORT

BARNEGAT INLET TO LITTLE EGG INLET
FEASIBILITY STUDY
OCEAN COUNTY, NEW JERSEY

Prepared by:

U.S. Fish and Wildlife Service
Ecological Services, Region 5
New Jersey Field Office
Pleasantville, New Jersey 08232

August 1999

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

FP-99/39

August 30, 1999

Lt. Colonel Debra M. Lewis
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Lewis:

This is the final report of the U.S. Fish and Wildlife Service (Service) regarding anticipated impacts on fish and wildlife resources from the U.S. Army Corps of Engineers (Corps) proposed Barnegat Inlet to Little Egg Inlet Feasibility Study, Ocean County, New Jersey. This report was prepared pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq*.).

This report is provided in accordance with our Fiscal Year-1998 scope-of-work agreement and is based on plans and information provided in the Corps June 1999 Barnegat Inlet to Little Egg Inlet Revised Draft Feasibility Report and Integrated Environmental Impact Statement. The Service (1996) previously provided a Planning Aid Report entitled, "Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey."

The federally listed (threatened) piping plover (*Charadrius melodus*) nests in two locations within the proposed project area. Piping plovers nest on the beaches of Barnegat Light, and between Harvey Cedars and Loveladies. Piping plovers also nest on the beaches adjacent to the proposed project area within the Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge. Piping plovers nest on sandy beaches above the high tide line on mainland coastal beaches, sand flats, and barrier island coastal beaches. The proposed project, via construction activities or use of the restored beach by humans, may affect piping plovers.

In addition, the project may create habitat for the seabeach amaranth (*Amaranthus pumilus*), a federally listed (threatened) plant. The seabeach amaranth is an annual plant, endemic to Atlantic coastal plain beaches, primarily occurring on overwash flats at the accreting ends of barrier beach islands and lower foredunes of non-eroding beaches. The species occasionally establishes small temporary populations in other areas, including bayside beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment or dredge spoil. Although no extant occurrences of the seabeach amaranth are known within the proposed project area, the species has recently naturally recolonized coastal sites within New York and Maryland. Therefore, it is possible that the seabeach amaranth may become naturally reestablished within the project area during the project life.

The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment, if the proposal is a major construction project that requires an Environmental Impact Statement and if the proposal may affect a federally listed species. Therefore, the Corps must prepare a Biological Assessment to address potential project-related impacts to the piping plover and seabeach amaranth. The assessment should contain information concerning the piping plover and seabeach amaranth within the action area and an analysis of any potential effects of the proposed action on these species. The Service understands that the Corps is currently preparing a Biological Assessment for all of the currently proposed shoreline stabilization projects in New Jersey that may affect piping plovers.

To minimize impacts to piping plovers associated with proposed beach nourishment and renourishment activities, the Corps has agreed to implement several project modifications suggested by the Service including: seasonal restrictions; further consultation prior to initial nourishment and all subsequent renourishment activities; monitoring; and compliance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act," dated April 15, 1994 (Appendix A).

Additionally, to minimize impacts to seabeach amaranth associated with the proposed beach nourishment and renourishment activities, the Corps has agreed to conduct surveys for seabeach amaranth prior to initiation of construction activities (U.S. Army Corps of Engineers, 1999). If seabeach amaranth is identified in the project area we recommend modifying the project to establish a protective zone around any seabeach amaranth sites identified and avoid: construction-related pedestrian and vehicular traffic; placement, movement, or maintenance of pipelines; stockpiling of construction materials and equipment; and pumping, placement, or distribution of sand within such zones.

Other than the piping plover, seabeach amaranth, and an occasional transient bald eagle (*Haliaeetus leucocephalus*), no other federally listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area.

The federally listed (endangered) Kemp's Ridley turtle (*Lepidochelys kempii*), hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*) and the federally listed (threatened) green turtle (*Chelonia midas*) and loggerhead turtle (*Caretta caretta*) occur in the

Atlantic Ocean immediately adjacent to the proposed project area. Except for nesting habitat for sea turtles, principal responsibility for marine turtles and marine mammals is under the jurisdiction of the National Marine Fisheries Service. Additional information regarding this report can be provided by John Staples or Lisa Arroyo of my staff.

Sincerely,

Clifford G. Day
Supervisor

References

U.S. Army Corps of Engineers. 1999. Barnegat Inlet to Little Egg Inlet, Revised Draft Feasibility Report and Integrated Environmental Impact Statement. U.S. Department of the Army, Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania.

U.S. Fish and Wildlife Service. 1996. Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey. Planning Aid Report. U.S. Department of the Interior, Fish and Wildlife Service, New Jersey Field Office, Pleasantville, New Jersey. 23 pp. + appendices.

Enclosure

cc: NJFO (2)
PARD, ES
GARD, North
NJDEP,
FG&W

ES:NJFO:LArroyo:spr:8/26/99

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

FISH AND WILDLIFE COORDINATION ACT
SECTION 2(b) REPORT

BARNEGAT INLET TO LITTLE EGG INLET FEASIBILITY STUDY OCEAN COUNTY, NEW JERSEY

Prepared for:

U.S. Army Corps of Engineers Philadelphia District
Philadelphia, Pennsylvania 19107-3390

Prepared by:

U.S. Fish and Wildlife Service Ecological
Services, Region 5 New Jersey Field
Office Pleasantville, New Jersey 08232

Preparer: Lisa P. Arroyo Assistant Project Leader:
John C. Staples Project Leader: Clifford G. Day

August 1999

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers, Philadelphia District (Corps) initiated the New Jersey Shore Protection Study, incorporating the Long Beach Island Project, under the authority of resolutions adopted by the Committee on Public Works and Transportation of the U.S. House of Representatives and the Committee on Environment and Public Works of the U.S. Senate in December 1987. The Long Beach Island Project area is located on Long Beach Island and includes Long Beach Township and the Boroughs of Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven, Ocean County, New Jersey.

The Long Beach Island Project is designed to reduce the threat of storm damage and mitigate the effects of, or prevent, long-term erosion. The Long Beach Island Project involves the creation of a 125-foot-wide berm for approximately 17 miles along the Atlantic Ocean. The proposed project also involves the construction of a dune with a top width of 22 feet. The proposed berm and dune system would be renourished every 7 years for the life of the project (i.e., 50 years). Sand fencing and American beachgrass (*Ammophila breviligulata*) would be established along the constructed dunes to entrap and maintain sand. The Corps proposes to obtain the necessary beach nourishment material from four borrow areas located offshore of the project area (U.S. Army Corps of Engineers, 1999).

The Service has concerns regarding potential impacts on shellfish and other benthic organisms at the proposed borrow areas, and potential use of the project area by beach nesting birds. Project-related adverse impacts to fish and wildlife could be minimized by avoiding the use of Borrow Areas B and E, reevaluating and using alternative borrow areas such as Barnegat Inlet, and incorporating several additional recommendations including rotational dredging, hydraulic dredging during the period of lowest biological activity, deed-restricting the project area, and monitoring the project area for shorebirds.

The U.S. Fish and Wildlife Service (Service) is concerned about potential adverse impacts on the federally listed (threatened) piping plover (*Charadrius melodus*) and seabeach amaranth (*Amaranthus pumilus*), a federally listed (threatened) plant, that may result directly from the proposed project. The Service is also concerned about indirect impacts due to human use of the project area that would be supported by the proposed beach renourishment. Specifically, the Service is concerned about construction-related adverse impacts, off-road vehicle use, and other recreational activities on the proposed beach that may interfere with nesting piping plovers. To minimize impacts associated with proposed beach nourishment and renourishment activities, the Corps (1999) has agreed to implement several project modifications recommended by the Service including: seasonal restrictions on project activities, further consultation with the Service prior to initial nourishment and all subsequent renourishment activities, monitoring, and compliance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act," dated April 15, 1994 (Appendix A).

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

APPENDICES

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

I. INTRODUCTION

This constitutes the U.S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (48 Stat. 401; 16 U.S.C. 661 *et seq*.), Section 2(b) report describing the fish and wildlife resources and supporting ecosystems in the area of the U.S. Army Corps of Engineers, Philadelphia District (Corps) proposed Long Beach Island Project, which is associated with the Corps Barnegat Inlet to Little Egg Inlet Feasibility Study. This report is provided in accordance with a Fiscal Year-1998 scope-of-work agreement with the Corps. The information presented in this report documents the fish and wildlife resources in the project area, identifies potential adverse impacts to those resources, and provides recommendations to minimize adverse impacts. The project area is located on Long Beach Island and incorporates six political jurisdictions in Ocean County, New Jersey including: Long Beach Township and the Boroughs of Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven (Figure 1).

The New Jersey Shore Protection Study, which incorporates the Long Beach Island Project, was authorized by resolutions adopted by the Committee on Public Works and Transportation of the U.S. House of Representatives and the Committee on Environment and Public Works of the U.S. Senate in December 1987. The authorization calls for defining coastal area problems and identifying potential solutions; identifying costs, environmental and social impacts of potential solutions; and presenting an optimized National Economic Development Plan.

The Service requests that no part of this report be used out of context and if the report is reproduced, it should appear in its entirety. Furthermore, any data, opinions, figures, recommendations, or conclusions excerpted from the report should be properly cited and include the page number from which the information was taken. This report should be cited as follows:

Arroyo, L.P. 1999. Assessment of the Barnegat Inlet to Little Egg Inlet Feasibility Study, Ocean County, New Jersey. Fish and Wildlife Coordination Act Section 2(b) Report, U.S. Department of the Interior, Fish and Wildlife Service, New Jersey Field Office, Pleasantville, New Jersey. 22 pp. + appendices.

Questions or comments regarding this report are welcomed by the Service. Written inquiries should be addressed to:

Supervisor
New Jersey Field Office
Ecological Services
U.S. Fish and Wildlife Service
927 North Main Street, Building D-1
Pleasantville, New Jersey 08232

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

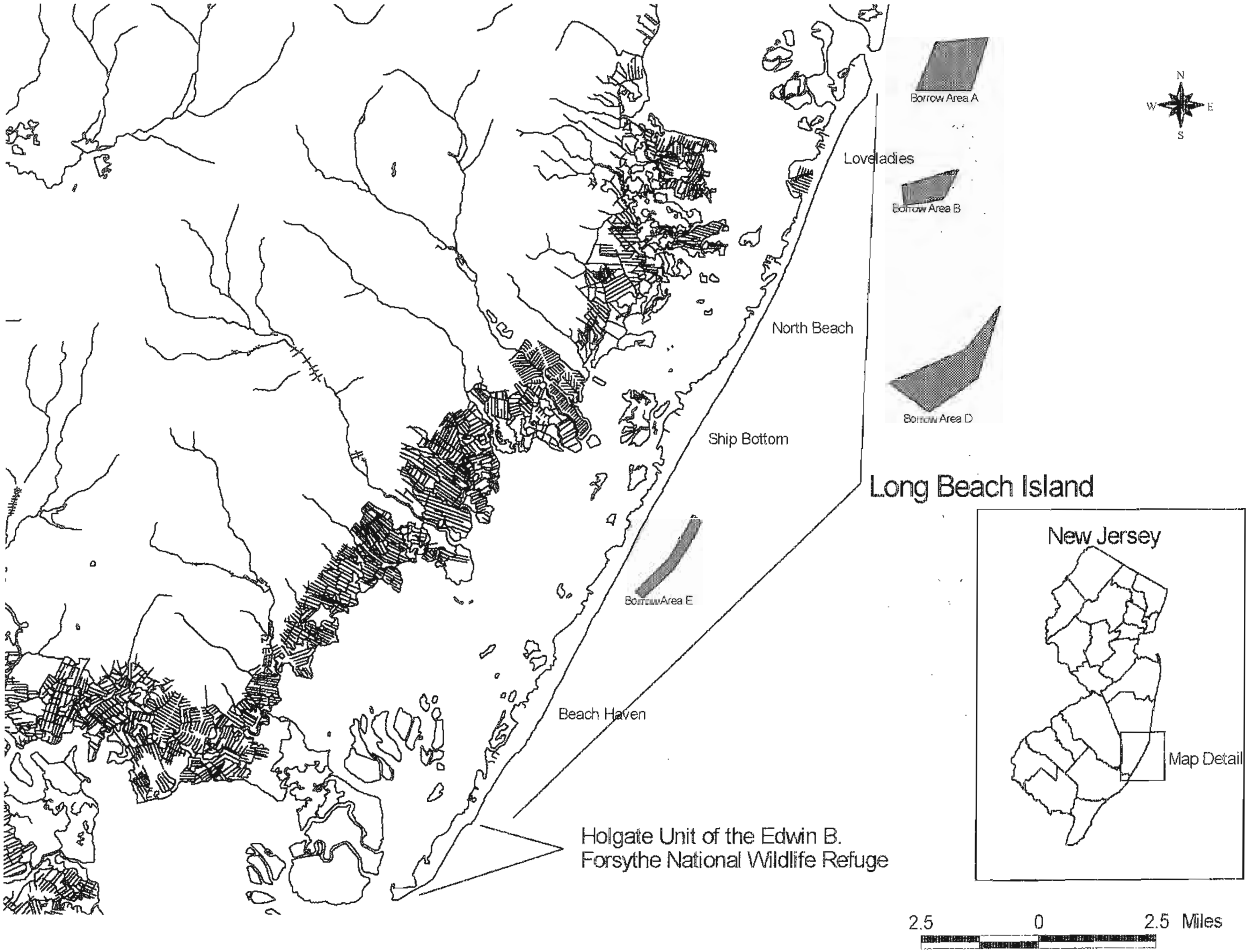


Figure 1. Long Beach Island Project Area.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

II. PROJECT DESCRIPTION

The objectives of the Long Beach Island Project include two components.

1. Reduce the impacts of potential hurricane and storm damages over a 50-year period.

2. Reduce the impacts of shoreline erosion along the ocean beaches of Long Beach Island.

The proposed project would restore berms and dunes through beach nourishment and subsequent renourishment. The Corps proposes to create a 125-foot-wide berm with a top elevation of +8.0 feet based on the North American Vertical Datum (NAVD) for approximately 17 miles along the Atlantic Ocean (U.S. Army Corps of Engineers, 1999). The proposed berm and dune restoration extends from groin 4 (Seaview Drive, Loveladies) to the terminal groin (groin 98) in Long Beach Township - Holgate. The northern end of the study area at Barnegat Light has a wide beach and is not in need of shoreline protection. As a result, this area is not included in the project. The Holgate Unit (southern end of study area) is also not included in the project. Since both ends of the project terminate at a groin, tapers will not be needed. Berm slopes are proposed at 1:10 (vertical:horizontal). A dune with a top elevation of +22 feet NAVD, side slopes of 1:5 (vertical:horizontal), and a top width of 30 feet would also be constructed. Approximately 5.0 million cubic yards of sand are required for the initial berm placement, and 1.3 million cubic yards for dune placement. As part of the berm and dune restoration, approximately 1,031 acres would be covered (approximately 365 acres would be above mean high water (MHW) and 666 acres would be below MHW. Approximately 2.0 million cubic yards of sand would be used every 7 years to renourish the proposed beaches for the project life (i.e., 50 years). In addition, 3.37 acres of American beachgrass (*Ammophila breviligulata*) and 1,019 linear feet of sand fence would be established on the dunes to entrap and maintain sand (Conlin, pers. comm., 1999).

The Corps has identified four offshore borrow areas (Areas A, B, D, and E) as potential sources of sand for this project (Figure 1). Two of these areas may be eliminated as borrow sources due to environmental concerns. Borrow Areas C and F were eliminated earlier in planning due to the presence of trans-Atlantic cables. Use of all four remaining sites will provide all material needed for the initial berm and dune restoration and future renourishment for the project life. However, if only two of the sites are used, a new borrow site would be required during the 50-year project life for beach renourishment (U.S. Army Corps of Engineers, 1999).

III. METHODS AND PROCEDURES

The information and findings presented in this report are based on review of the June 1999 "Barnegat Inlet to Little Egg Inlet Revised Feasibility Report and Integrated Environmental Impact Statement" (U.S. Army Corps of Engineers, 1999) and review of additional information made available to the Service by the Corps. The content of this report is also based on: review of Service files and library material; coordination with the National Marine Fisheries Service (NMFS), New Jersey Division of Fish, Game and Wildlife (NJDFGW), Bureau of Marine

Fisheries, Bureau of Shellfisheries, and Endangered and Nongame Species Program (ENSP); and site visits conducted on May 15, May 29, and June 26, 1996.

IV. PHYSICAL CHARACTERISTICS

Long Beach Island is approximately 20 miles long, and is bounded by Barnegat Inlet to the north, Little Egg Inlet to the south, the Atlantic Ocean to the east, and Barnegat Bay to the west. Six municipalities are located on Long Beach island including: Long Beach Township and the Boroughs of Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven. The land use/cover types for the project area are urban, herbaceous, shrub/scrub, beach/dune, and emergent wetland. Although Long Beach Island is characterized by urban development, many of the inland tidal wetlands remain intact. Seashore and water-oriented summer recreation is the predominant land-use, which includes residential rentals and support services for commercial establishments.

V. FISH AND WILDLIFE RESOURCES

A detailed description of fish and wildlife resources within the vicinity of Long Beach Island is provided in a Service (1996a) Planning Aid Report entitled, "Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey." Resource information is summarized below.

A. BENTHIC ORGANISMS

The Atlantic coast of Long Beach Island supports extensive habitat for benthic organisms. Shoal areas along the coast provide very productive shellfish beds that are inhabited by Atlantic surf clam (*Spisula solidissima*), common razor-shell clam (*Ensis directus*), and hard clam (*Mercenaria mercenaria*) (Normant, pers. comm., 1999). Mysid shrimp of the genera *Parahaustorius* and *Protohaustorius* and the polychaete worm *Magelona rosea* are the most numerous benthic organisms along the Atlantic coast of Long Beach Island (U.S. Corps of Engineers, 1995). A variety of polychaete worms, oligochaete worms, amphipods, isopods, bivalves, and gastropods also occur within the marine environment along Long Beach Island.

B. FINFISH

The Long Beach Island area supports significant recreational and commercial fisheries within adjacent bays (e.g., Barnegat Bay, Manahawkin Bay, and Little Egg Harbor) and along the coast. Commercially valuable fish in the project area include weakfish (*Cynoscion regalis*), Atlantic menhaden (*Brevoortia tyrannus*), bluefish (*Pomatomus saltatrix*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pleuronectes americanus*), American eel (*Anguilla rostrata*), and white perch (*Morone americana*) (Ichthyological Associates, 1979). Species important to recreational fisheries within Barnegat Bay include bluefish, spot (*Leiostomus xanthurus*), and winter flounder. However, American eel, scup (*Stenotomus chrysops*), summer flounder, white perch, and northern puffer (*Sphoeroides maculatus*) are also important recreational fish (Ichthyological Associates, 1978). The semi-anadromous striped bass (*Morone saxatilis*) also occurs within Barnegat Bay and Little Egg Harbor, and supports a productive fishery (McClain, pers. comm., 1999).

Numerous Barnegat Bay and Little Egg Harbor tidal creeks support spawning activities of the anadromous blueback herring (*Alosa aestivalis*) and alewife (*Alosa pseudoharengus*) (Zich, 1977). These tidal creeks and shallow water areas are also important spawning areas for winter flounder, bay anchovy (*Anchoa mitchilli*), and Atlantic silversides (*Menidia menidia*).

C. BIRDS

Migratory shorebirds are a federal trust resource responsibility of the Service. Wetland areas in the vicinity of Long Beach Island, particularly Barnegat Bay and Little Egg Harbor, provide high quality habitats for a variety of migratory shorebirds.

The Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge on the southern end of Long Beach Island provides important resting and feeding areas for migrating shorebirds. In 1995, the Service recorded 3,700 shorebirds on the Holgate Unit during the peak of the spring migration. Black-bellied plover (*Pluvialis squatarola*), semipalmated plover (*Charadrius semipalmatus*), American oystercatcher (*Haematopus palliatus*), sanderling (*Calidris alba*), dunlin (*Calidris alpina*), and short-billed dowitcher (*Limnodromus griseus*) were among the most numerous shorebirds counted during the 1995 survey (U.S. Fish and Wildlife Service, 1995). Colonial nesting waterbirds (e.g., terns, gulls, skimmers, and oystercatchers) also nest on islands and marshes in Barnegat Bay, Manahawkin Bay, and Little Egg Harbor adjacent to Long Beach Island. Coastal marshes provide feeding habitat, while islands in the back bay area provide nesting habitat that is protected from mammalian predators.

Migratory waterfowl are also a federal trust resource responsibility of the Service. Areas adjacent to the project area, including Barnegat Bay, Manahawkin Bay, and Little Egg Harbor, are important resting and feeding areas for migratory waterfowl on the Atlantic flyway. While Barnegat Bay is used by a wide variety of waterfowl, it provides especially important wintering habitat for black duck (*Anas rubripes*) and Atlantic brant (*Branta bernicla*).

Several raptors occur year-round in the project area including the State-listed (endangered) northern harrier (*Circus cyaneus*). The osprey (*Pandion haliaetus*) (State-listed as threatened) also occurs in marshes along Long Beach Island during the spring, summer, and fall.

VI. ENDANGERED AND THREATENED SPECIES

A. PIPING PLOVER

The federally listed (threatened) piping plover (*Charadrius melodus*) nests in two locations within the proposed project area. Piping plovers nest on the beaches of Barnegat Light, and between Harvey Cedars and Loveladies. Piping plovers also nest on the beaches adjacent to the proposed project area within the Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge. Other coastline beaches along Long Beach Island do not currently provide suitable nesting habitat for the piping plover due to beach erosion, which has reduced the beach width such that sufficient nesting habitat is not available above the high tide line. However, if beach conditions change and suitable habitat becomes available through natural accretion or renourishment activities, the piping plover could be expected to nest within suitable habitat along the ocean coastline of Long Beach Island.

Piping plovers nest on sandy beaches above the high tide line on mainland coastal beaches, sand flats, and barrier island coastal beaches. The nesting sites are typically located on gently sloping foredunes, blowout areas behind primary dunes, washover areas cut into or between dunes, ends of sandspits, and on sites with deposits of suitable dredged or pumped sand.

Food for adult plovers and chicks consists of invertebrates such as marine worms, fly larvae, beetles, crustaceans, and mollusks. Feeding areas include intertidal portions of ocean beaches, ocean washover areas, mudflats, sandflats, wrack lines (organic ocean material left by high tide), shorelines of coastal ponds, lagoons, and salt marshes.

Development along the coastal shoreline for residential and commercial uses, and the subsequent stabilization of the once-shifting and dynamic beach ecosystem via seawalls, breakwaters, jetties, and groins have resulted in the deterioration and alteration of natural beaches. The above activities have occurred to such an extent along the Atlantic coast that many beaches no longer provide suitable habitat for the piping plover.

The Service expects that piping plovers will continue to nest on the beaches within the project area. Piping plovers tend to exhibit high site fidelity to nesting areas (U.S. Fish and Wildlife Service, 1996b). In addition, potential and historic nesting areas change over time as a result of coastal storms and littoral drift affecting beach erosion and accretion. Consequently, some current piping plover nesting areas may become unsuitable over time, while new nesting areas may be formed as a result of accretion or the proposed beach nourishment.

The proposed beach nourishment and subsequent renourishment would likely reduce infaunal abundance and species diversity that piping plovers are dependent upon as food resources. The loss of food resources may adversely affect piping plovers until infaunal organisms are capable of recolonizing the project area. Consultation with the Service for each renourishment phase of the project should address this potential impact.

Conversely, dredged spoil deposition has the potential to create additional suitable nesting habitat for piping plovers and other beach nesting birds such as the State-listed (endangered) black skimmer (*Rynchops niger*) and least tern (*Sterna antillarum*), and common terns (*Sterna hirundo*), provided the material is deposited prior to the nesting season (U.S. Fish and Wildlife Service, 1996b). As a result, piping plovers could nest within the project area after nourishment is completed. Recent beach renourishment projects (e.g., Ocean City and Monmouth Beach, New Jersey) have resulted in the creation of piping plover nesting habitat. Unfortunately, high levels of human activity on nourished beaches often prevent nesting success (U.S. Fish and Wildlife Service, 1996b). Therefore, occurrence and nesting of federally listed or State-listed threatened or endangered shorebirds may require restrictions on some recreational (e.g., Off Road Vehicles (ORVs)) and beach management activities (e.g., beach raking) to protect these species from adverse impacts.

If piping plovers expand their current nesting area as a result of the proposed project, the Service would recommend establishing protective zones in accordance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act" (Guidelines) dated April 15, 1994 (Appendix A). Establishment of protective zones would be coordinated with the appropriate municipalities by the ENSP. The Corps would be responsible for providing materials (e.g., fencing, signs) or funds for materials for such protective zones. Additionally, the Corps has agreed to further consultation with the Service pursuant to Section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) for each renourishment phase of the project for the project life (i.e., 50 years) on beaches where piping plovers are documented (U.S. Army Corps of Engineers, 1999). Further consultation may result in seasonal restrictions of construction activities.

In order to prevent future misunderstanding regarding the protection of piping plovers, the Service recommends that the Corps notify each municipality on Long Beach Island individually regarding the potential for recreational activity and beach management (e.g., beach raking) restrictions if piping plovers expand their nesting areas as a result of the proposed project. In addition, each municipality should receive a copy of the above-mentioned Guidelines to become familiar with potential recreational activity and beach management restrictions. The purpose of notifying municipalities in advance is to clarify the responsibilities of the municipalities that are benefitting from the proposed federal project. If municipalities are unwilling to cooperate with the Corps and the Service regarding piping plover management, the Corps should consider eliminating the municipality from the proposed project.

B. SEABEACH AMARANTH

The project may create habitat for the seabeach amaranth (*Amaranthus pumilus*), a federally listed (threatened) plant. The seabeach amaranth is an annual plant, endemic to Atlantic coastal plain beaches, primarily occurring on overwash flats at the accreting ends of barrier beach islands and lower foredunes of non-eroding beaches. The species occasionally establishes small temporary populations in other areas, including bayside beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment or dredge spoil. The seabeach amaranth appears to be intolerant of competition and does not occur on well-vegetated sites (U.S. Fish and Wildlife

Service, 1996c). Although no extant occurrences of the seabeach amaranth are known within the proposed project area, the species has recently naturally recolonized coastal sites within New York and Maryland. Therefore, it is possible that the seabeach amaranth may become naturally reestablished within the project area during the project life. Threats to the seabeach amaranth include construction of beach stabilization structures, beach erosion and tidal inundation, beach grooming, and destruction by off-road vehicles.

C. RECOMMENDATIONS FOR A BIOLOGICAL ASSESSMENT

Project-related activities could adversely affect both the piping plover and seabeach amaranth. Potential adverse effects to the piping plover include: disturbance from renourishment operations and personnel; modification of nesting habitat; loss of food resources; uncontrolled natural and domestic predation; and disturbance from human recreational and municipal activities occurring on the renourished beach. In addition, placement, maintenance, or removal of pipelines above the low tide line, used for the transport of sand from the borrow site to the beach nourishment site, could adversely impact piping plovers during the nesting season. Potential adverse effects to the seabeach amaranth include: trampling or habitat disturbance from renourishment operations and personnel; modification of habitat; trampling or habitat disturbance from human recreational and municipal activities occurring on the renourished beach; and removal or damage to plants by beach raking activities. The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act to prepare a Biological Assessment if the project is a construction project that requires an Environmental Impact Statement (EIS) and the project may affect listed species. Therefore, the Corps must prepare a Biological Assessment to address potential project-related adverse impacts to the piping plover and seabeach amaranth.

In general, the Biological Assessment should contain information concerning listed or proposed species, which may be present in the action area, and an analysis of any potential effects of the proposed action on such species. The following may be considered for inclusion in a Biological Assessment of the proposed project, although actual contents are at the discretion of the federal authorizing agency:

(1) results of field surveys to determine if listed species are present or occur seasonally;

(2) views of recognized experts on the species;

(3) literature review;

(4) analysis of direct, indirect, and cumulative effects of the action on the species; and

(5) analysis of alternative actions.

Specifically, the Biological Assessment should include potential adverse impacts on piping plovers and seabeach amaranth associated with proposed beach nourishment and renourishment activities for the project life (i.e., 50 years). Additionally, the Biological Assessment should address indirect adverse impacts from the proposed beach nourishment on piping plovers specifically relating to increased or continued recreational use of beaches by ORVs and pedestrians. The Service understands that the Corps is currently preparing a Biological Assessment for all of the currently proposed shoreline stabilization projects in New Jersey that may affect piping plovers.

D. RECOMMENDATIONS TO PROTECT PIPING PLOVER AND SEABEACH AMARANTH

To ensure the continued protection of the piping plover over the life of the project, the Service recommends that the Corps reinitiate consultation:

- at least 135 days prior to beginning any beach nourishment associated with the Long Beach Island Project to allow 90 days for formal consultation and 45 days for issuance of a Biological Opinion; and

- at least 135 days prior to any beach maintenance activities (e.g., beach renourishment) for the life of the project (i.e., 50 years).

To reduce impacts associated with proposed beach nourishment and renourishment activities, the Service suggests the following project modifications.

1. If piping plover habitat is documented within the project area or within 300 feet of areas where construction activities would occur (e.g., dredge-transfer pipelines) prior to initiation of project-related activities, avoid all work in the project area between April 1 and August 15 in order to avoid potential adverse impacts on nesting piping plovers. This seasonal restriction would be applicable to maintenance work that may be necessary in subsequent years. Associated work includes, but is not limited to: placement, movement, or maintenance of pipelines; stockpiling of construction materials and equipment; and pumping, placement, or distribution of sand.

2. Ensure that seabeach amaranth will not be adversely affected by construction activities. Conduct surveys for seabeach amaranth prior to initiation of construction activities. Establish a protective zone around any seabeach amaranth sites identified and avoid construction-related pedestrian and vehicular traffic; placement, movement, or maintenance of pipelines; stockpiling of construction materials and equipment; and pumping, placement, or distribution of sand within such zones.

3. Ensure protection of piping plover and seabeach amaranth from indirect, but project-related, impacts from recreational and municipal activities occurring on the renourished beach. The Service recommends that the Corps require municipal or other public or private land managers that will benefit from federally funded beach renourishment projects to agree to protect federally listed species that may be attracted to renourished beaches. To ensure that unauthorized take of federally listed species does not occur following renourishment, the Service recommends that the Corps require each municipality or other public or private entity to prepare a Management Plan that describes the protection that will be afforded to federally listed species. The Management Plan must adhere to the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding

Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act" dated April 15, 1994 (Appendix A). The Service recommends that the Management Plan specifically include the following:

a. establishment of protective zones around piping plover nests and seabeach amaranth sites;

b. off-road vehicle (recreational and essential municipal) restrictions during the piping plover nesting and brood rearing periods (April 1 - August 15);

c. prohibition of kite flying from April 1 - August 15;

d. monitoring of plovers during the nesting and brood rearing period (April 1 - August 15);

e. protection of piping plover nests, chicks, and adults from native and domestic predators;

f. establishment and identification (e.g. fencing and signing) of protective zones; and

g. mechanisms for enforcement of items 1 - 6 above.

Establishment of the protective zones must be coordinated with the Service and the ENSP. If ORVs access the beach on the project site and if piping plovers nest adjacent to the project site, the Guidelines apply to ORV use. The Management Plans must be submitted to the Service for review and comment prior to project initiation to determine if further consultation pursuant to Section 7 of the Endangered Species Act will be required.

Shorebird monitoring within the project area, except within currently known piping plover locations, is not conducted by ENSP. Monitoring of enhanced beach areas that are currently not surveyed by ENSP would be the responsibility of the project proponent (i.e., the Corps).

E. OTHER FEDERALLY LISTED SPECIES, STATE-LISTED SPECIES, AND SPECIES OF SPECIAL CONCERN

The peregrine falcon (*Falco peregrinus*) is known to nest adjacent to the proposed project area, within the Barnegat Division of the Edwin B. Forsythe National Wildlife Refuge in Stafford Township, Ocean County, New Jersey. However, on August 26, 1999, the peregrine falcon was removed from the federal list of threatened and endangered species. Furthermore, no adverse impacts on the peregrine falcon are expected to result from project implementation.

Other than the piping plover, seabeach amaranth, and an occasional transient bald eagle (*Haliaeetus leucocephalus*), no other federally listed or proposed threatened or endangered flora or fauna under Service jurisdiction are known to occur in the vicinity of the project.

The federally listed (endangered) Atlantic Ridley turtle (*Lepidochelys kempii*) and leatherback turtle (*Dermochelys coriacea*), and the federally listed (threatened) loggerhead turtle (*Caretta caretta*), and green turtle (*Chelonia mydas*) may occur in the vicinity of the proposed project. The loggerhead turtle is the most likely sea turtle to use the Long Beach Island area. Except for nesting habitat for sea turtles, principal responsibility for marine turtles and marine mammals is under the jurisdiction of the NMFS. The Service understands that the Corps has contacted the NMFS regarding potential impacts to federally listed species under NMFS jurisdiction that may be affected by the proposed project and that the Corps intends to comply with conditions identified in the NMFS Biological Opinion. A summary of federally listed and State-listed species in New Jersey is included as Appendix C.

A variety of State-listed endangered and threatened species inhabit the beaches and marshes of the Long Beach Island area. Several birds-of-prey occur in the vicinity of the project area including the State-listed (endangered) northern harrier and short-eared owl (*Asio flammeus*), and the State-listed (threatened) osprey and barred owl (*Strix varia*) (New Jersey Division of Fish, Game and Wildlife, 1994). Nesting populations of the State-listed (endangered) sedge wren (*Cistothorus platensis*) occur in high emergent marshes in the vicinity of the Long Beach Island area (New Jersey Division of Fish, Game and Wildlife, 1994). The State-listed (threatened) black rail (*Laterallus jamaicensis*) nests in emergent tidal marshes in the project area (New Jersey Division of Fish, Game and Wildlife, 1994). The State-listed (endangered) black skimmer, roseate tern (*Sterna dougalii*), and least tern also occur along the beaches of the Long Beach Island project area. Several rookeries on islands within the back bays of Long Beach Island provide reproductive habitat for the State-listed (threatened) little blue heron (*Egretta caerulea*) and yellow-crowned night heron (*Nycticorax violacea*) (New Jersey Department of Environmental Protection, 1996). The American bittern (*Botaurus lentiginosus*), a State-listed (threatened) species also occupies the marshes adjacent to the project area. It is unlikely that the proposed Long Beach Island Project would adversely affect the American bittern, little blue heron, yellow-crowned night heron, osprey, northern harrier, short-eared owl, barred owl, sedge wren, and black rail. The least tern, roseate tern, and the black skimmer could be adversely impacted by the proposed project; however, if the recommendations provided above for piping plovers are implemented, adverse impacts on these species would be minimized.

The northern diamondback terrapin (*Malaclemys terrapin terrapin*) inhabits marshes, tidal flats, and beaches associated with the Long Beach Island area. The terrapin is considered a "species of special concern" by the Service. This species has been subject to recent population declines as a result of terrapin entrapment in crab pots and a reduction in nesting habitat. The terrapin breeds in sandy substrate above the levels of normal high tides. Northern diamondback terrapins occur primarily in emergent wetlands and shallow water habitat and feed on crustaceans, mollusks, and other invertebrates (Palmer and Cordes, 1988).

During the winter, terrapins burrow in the mud of tidal creeks and ponds to hibernate either individually or in groups. Terrapins mate in the spring and lay their eggs in sandy substrates above the levels of normal high tides. Predation of eggs and hatchlings represents the major source of natural mortality in most terrapin populations. Eggs and juveniles are preyed upon by raccoons, crows, and gulls (Palmer and Cordes, 1988). However, terrapin entrapment in crab pots can result in significantly higher mortality than natural mortality (e.g., predation and disease) (Roosenberg, 1993).

Although species of special concern and State-listed species receive no substantive or procedural protection under the federal Endangered Species Act, the Service encourages federal agencies and other planners to consider species of special concern and State-listed species in project planning.

VII. IDENTIFICATION OF IMPACTS AND MITIGATIVE MEASURES

A. IMPACTS

Shoreline protection efforts that include extraction of materials from offshore borrow areas and related beach nourishment operations may result in a variety of impacts to benthic organisms, finfish, and wildlife. Beach nourishment and renourishment activities also result in the conversion of shallow water cover types to beach and dune cover types.

1. Extraction from Borrow Areas

Areas offshore of Long Beach Island, particularly the shoals, which contain potential borrow areas, provide productive shellfish habitat (Normant, pers. comm., 1999). Shoal areas also provide structure that finfish use as feeding areas. Fishing grounds are concentrated near the productive shoal areas (McClain, pers. comm., 1999). Dredging sand from shoal areas may adversely affect shellfish and finfish by eliminating the shoal.

Four borrow areas have been identified as potential sources of sand. The Corps proposes to use borrow areas A, D (D and D2), and E. Only half of Borrow Area E will be used for initial beachfill (U.S. Army Corps of Engineers, 1999). However, the NJDFGW identified Borrow

Areas B and E as Prime Fishing Areas, as defined by the Rules on Coastal Zone Management (N.J.A.C. 7:7E, as amended July 18, 1994). Burton and Scott (1998) determined that the community composition of the four borrow areas were similar to the Long Beach Island reference area. The borrow areas were dominated by polychaete worms, followed by mollusks and arthropods (specifically crustaceans). Oligochaete worms also contributed substantially to the faunal composition of the borrow areas (U.S. Army Corps of Engineers, 1999).

The Atlantic surf clam was collected from all borrow areas. Mean abundance of surf clams collected ranged from 183/m^2 at Area D to 568/m^2 at Area A. The total surf clam stock ranged from 12.0 million clams in Area A to 0.05 million clams in Area B. Area A had the greatest average number of bushels collected per tow; approximately 70 percent greater than the regional average. Surf clams of the four borrow areas were of comparable size relative to those of the regional Atlantic Coast (U.S. Army Corps of Engineers, 1999).

Most benthic organisms within the ocean's dynamic ecosystem have adapted to periodic changes in habitat that occur as a result of northeasters, hurricanes, and other storms. As a result, benthic organisms typically recolonize an area quickly, provided the habitat is still suitable. Saloman *et al*. (1982) concluded that benthic organisms recover from dredging events in approximately one year, with minor sedimentological changes, and with a small decline in diversity and abundance within the benthic community. The Corps has also determined that the benthic community of borrow areas would recover within 2 years within the project area (Burton and Scott, 1998). However, disturbances within the borrow areas every 7 years for the life of the project (i.e., 50 years) would likely limit recolonization, thereby maintaining low infaunal abundance and low species diversity.

Dredging may also adversely affect water quality by increasing turbidity, changing temperature and oxygen levels, and releasing or resuspending toxins and bacteria. These factors may cause direct mortality to fish and shellfish, disrupt fish migrations, hamper fish and shellfish spawning, and reduce primary productivity. Additionally, settling of suspended sediment may result in smothering of shellfish and other benthic organisms downcurrent from the borrow area.

The type of equipment used and the time of year extraction occurs may greatly influence the nature and extent of potential adverse impacts related to dredging. For example, dredging with a hydraulic dredge may reduce short-term adverse impacts on water quality, but may impact eggs, young fish, and other slow-moving organisms unable to avoid entrainment. In addition, the entrainment of sea turtles has been documented as an adverse impact of hydraulic hopper dredging (Greene, pers. comm., 1999). The timing of dredging is also important in that if dredging is initiated concurrent with a period of low biological activity (November-January), adverse impacts on fish and wildlife resources may be reduced.

2. Beach Nourishment

The proposed beach nourishment and subsequent renourishment would bury infaunal organisms and result in mortality within the shallow near shore (littoral) zone. Most of the organisms inhabiting the extremely dynamic near shore and intertidal zones are highly mobile and can tolerate significant episodic changes in abiotic factors. However, the proposed project would likely reduce infaunal abundance and species diversity despite the resiliency of the intertidal benthic fauna in recolonizing disturbed areas. Reilly and Bellis (1983) determined that recovery of macrofauna is rapid after beach nourishment activities cease; however, the recolonization community may differ considerably from the original community in terms of species richness and abundance. Based on a review of the literature, the Corps predicts that the benthic community within the littoral zone would recover in 2 years (Burton and Scott, 1998). Differences in grain size from the original beach and sand provided for beach nourishment may also affect the recolonization community. However, the grain size of the Long Beach Island beach (mean = 0.27 mm) does not differ significantly from the grain size at the borrow areas (mean = 0.33 mm) (U.S. Army Corps of Engineers, 1999).

The proposed beach nourishment may adversely affect piping plovers by reducing food resources. Conversely, beach nourishment may create additional suitable nesting habitat that piping plovers and other beach nesting birds, such as black skimmers, least terns, and common terns, may use in future seasons. Recent beach renourishment projects (e.g., Ocean City and Monmouth Beach, New Jersey) resulted in the creation of piping plover nesting habitat that did not exist prior to project construction. As previously noted, high levels of human activity on nourished beaches often prevent nesting success (U.S. Fish and Wildlife Service, 1996b). Therefore, occurrence and nesting of federally listed or State-listed threatened or endangered species may require restrictions on some recreational activities (e.g., ORV use) and beach management activities (e.g., beach raking) to protect these species from adverse impacts.

As previously noted, piping plovers nest in three sections of the project area. Further coordination (e.g., preparation of a Biological Assessment) from the Corps would be necessary prior to beach nourishment to ensure piping plovers or their habitat are not adversely affected by the proposed project.

B. RECOMMENDED MITIGATIVE MEASURES

1. Extraction from Borrow Areas

Based on potential adverse impacts to benthic macroinvertebrates, the NJDFGW strongly discourages the use of Borrow Areas B and E, which are designated as Prime Fishing and Surf Clam Areas (letter dated December 11, 1998, Appendix B). The Service supports the position of the NJDFGW. The NJDFGW also recommends conditional use of Borrow Areas A and D, provided that the sand mining does not alter the existing bathymetry to a significant degree so as to reduce the high fishery productivity of these areas, and to investigate alternative borrow areas, including the Barnegat Inlet. The Service concurs with these recommendations.

In order to minimize repeated impacts on benthic organisms within a borrow area, the Service recommends that the Corps conduct each renourishment dredging phase in a limited portion of the borrow area(s) and alternate locations for each subsequent renourishment cycle. Rotational dredging minimizes frequent, repeated disturbance of a particular area, thereby allowing recolonization of benthic organisms to occur over a longer period of time.

In order to avoid anoxic conditions in the borrow area, which would inhibit recolonization of benthic organisms, the Service recommends avoiding the creation of excessively deep, poorly flushed borrow sites. The Service also recommends dredging not coincide with shellfish or finfish spawning activity. The Corps has agreed to implement these recommendations (U.S. Army Corps of Engineers, 1999). In addition, the Service also recommends that the Corps coordinate with NMFS to ensure protection of Essential Fish Habitats within the project area.

Hydraulic-pipeline dredging generally creates less turbidity than hydraulic-hopper dredging. Additionally, hydraulic-pipeline dredging minimizes the potential entrainment of federally listed sea turtles. However, through formal consultation pursuant to the Endangered Species Act, the NMFS provided a Biological Opinion and an incidental take statement regarding hydraulic-hopper dredge operations (Greene, pers. comm., 1999). Provided that the Corps adheres to the terms and conditions provided in the Biological Opinion, the Service does not oppose the use of hydraulic-hopper dredging.

2. Beach Nourishment

Beach nourishment and subsequent renourishment would create approximately 273 acres of new beach area along Long Beach Island. Much of the created area and the existing beach area would be considered upland. It is assumed that the Corps would obtain an easement for the project area for the project life (i.e., 50 years) in order to complete renourishment activities. However, it is unclear what type of easement would exist after the project is completed. In order to prevent residential or commercial development within the project area or adjacent beach area, the Service recommends that the Corps obtain a perpetual deed restriction or conservation easement for the newly created beach and adjacent beach areas.

As previously discussed, recent beach renourishment projects (e.g., Ocean City and Monmouth Beach, New Jersey) resulted in the creation of piping plover nesting habitat that did not exist prior to project construction. Construction of the proposed project may create suitable nesting habitat for piping plovers, other shorebirds, and colonial nesting waterbirds (e.g., terns, gulls, skimmers, and oystercatchers).

In the event that beach nesting birds do nest or expand their nesting areas on Long Beach Island, in addition to the above recommendations to minimize impacts on the piping plover, the Service recommends that the Corps develop educational materials (e.g., brochures, informational signs) or provide funds for public education and outreach. Development of informational materials would educate beach users about beach nesting birds; thereby reducing disturbance to nesting areas. Public education would also promote public support for protecting beach nesting birds.

Finally, the Service recommends that the Corps develop and implement a shorebird monitoring program, in cooperation with the Service, to monitor the use of the nourished beaches for shorebirds, particularly piping plovers. This shorebird monitoring program should be designed to identify and report use of the project area beaches by shorebirds, particularly the piping plover, for the life of the project (i.e., 50 years).

C. RECOMMENDED HABITAT ENHANCEMENT MEASURES

Beach fill and dune creation offers an opportunity for enhancement of fish and wildlife habitat. Of course, any proposed beach creation activities must be closely reviewed in the context of their effects on other habitats (e.g., shallow open-water habitat) within the Long Beach Island area and any accompanying adverse impacts on fish and wildlife resources must be considered in project planning.

Planning activities for beach fill and dune creation should include an evaluation of potential habitat enhancement for beach nesting birds. Wide beaches with gentle slopes (<7 percent) generally provide high quality habitat for beach nesting birds. Creation of low, wide dunes with washover areas provides adequate foraging and nesting habitat. Dune configurations that are irregular (e.g., staggered and discontinuous) may attract beach nesting birds. The dunes within the Holgate Unit and at Barnegat Light provide excellent examples of irregular dunes. In addition, dune grasses should be planted in sufficient quantity to provide stabilization, but also minimal enough not to prevent nesting opportunities. Fencing systems to trap sand and create dunes should be open to allow passage of juvenile shorebirds between and among the dunes. A broken, zig-zag pattern of fencing parallel to the shore or a Y-type fencing pattern perpendicular to shore are two examples of open fencing systems.

Shorebird and colonial nesting waterbird (e.g., terns, gulls, skimmers, and oystercatchers) habitat in Barnegat Light is currently being reduced by vegetational succession and to a lesser extent, by excessive accretion of sand (Jenkins, pers. comm., 1999). Vegetational succession reduces potential nesting habitat for many colonial nesting waterbirds (e.g., terns, gulls, skimmers, and oystercatchers) and may provide adequate cover for terrestrial predators. Removal or burial of vegetation in the dunes at Barnegat Light, mechanically or chemically, may enhance habitat for colonial nesting waterbirds (Jenkins, pers. comm., 1999). The Service recommends that the Corps coordinate with the Service and the State ENSP to evaluate the feasibility of removing vegetation to restore habitat for colonial nesting waterbirds.

VIII. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

The proposed project area is located in a developed region of New Jersey, which currently supports valuable fish and wildlife resources, including habitat for federally listed species. Implementation of the Long Beach Island project has the potential to enhance fish and wildlife habitat within the project area. Enhancement would be accomplished by creating a wider beach and establishing a dune complex, to include 3.37 acres of planted dune grass. However, by creating a wider beach and a dune complex, the possibility of colonial nesting waterbird, piping plover, and other shorebird use of the project area would increase. Potential use of the project area beaches by humans, ORVs, and the above-mentioned birds may conflict. Monitoring and appropriate management would be required to minimize such conflicts.

At this stage of planning, the Corps (1999) has agreed to implement measures to protect federally listed species and has incorporated most of the Service's recommendations, given in the draft Fish and Wildlife Coordination Act report, to protect fish and wildlife resources into the final project design. Measures that the Corps has committed to implement are indicated below by an asterix.

To comply with the Endangered Species Act, the Corps must:

1. Prepare a Biological Assessment to address potential project-related adverse impacts to the piping plover.*

2. Reinitiate consultation with the Service to ensure protection of the piping plover:*

    - o at least 135 days prior to beginning any beach nourishment associated with the Long Beach Island project to allow 90 days for formal consultation and 45 days for issuance of a Biological Opinion; and

    - o at least 135 days prior to any beach maintenance activities (e.g., beach renourishment) for the life of the project (i.e., 50 years).

Incorporate the following project modifications to minimize adverse impacts on piping plovers and seabeach amaranth.

1. If piping plover habitat is documented within the project area or within 300 feet of areas where construction activities would occur (e.g., dredge-transfer pipelines) <u>prior to</u> initiation of project-related activities, avoid all work in the project area between April 1 and August 15 in order to avoid potential adverse impacts on nesting piping plovers.*

2. To ensure that seabeach amaranth will not be adversely affected by construction activities, conduct surveys and establish protective zones around any identified seabeach amaranth sites.*

3. Ensure protection of piping plover and seabeach amaranth from indirect, but project-related, impacts from recreational and municipal activities occurring on the renourished beach. To ensure that unauthorized take of federally listed species does not occur following renourishment, require each municipality or other public or private entity to prepare a Management Plan that describes the protection that will be afforded to federally listed species.*

To avoid adverse impacts to finfish, shellfish and other benthic organisms at the proposed borrow areas, the Service recommends implementing the following recommendations into the final project design.

1. Avoid the use of Borrow Areas B and E, that are designated as Prime Fishing and Surf Clam Areas.

2. Evaluate alternative borrow areas, such as the Barnegat Inlet.*

3. Conduct each renourishment dredging phase in a limited portion of the borrow area and alternate locations for each subsequent renourishment cycle (rotational dredging).

4. Avoid the creation of excessively deep, poorly flushed borrow sites. Dredge during the period of lowest biological activity for benthic organisms (November to January).*

5. Coordinate with NMFS to ensure the protection of Essential Fish Habitat within the project area.

In addition to the above recommendations to avoid adverse impacts to the federally listed piping plover from beach renourishment, the Service recommends the following measures to protect and enhance habitats for beach nesting birds.

1. Obtain a perpetual deed restriction or conservation easement for the newly created beach and adjacent beach areas.

2. Develop informational materials (e.g., brochures; interpretive signs) to educate beach users about beachnesting birds.

3. Implement a shorebird monitoring program in cooperation with the Service.

4. Coordinate with the Service and ENSP on opportunities to enhance habitats for beachnesting birds (e.g., irregular dune configurations; fencing systems to trap sand; removal or burial of vegetation during beach renourishment).

X. REFERENCES

A. LITERATURE CITED

Burton, W. and L. Scott. 1998. Long Beach Island benthic invertebrate survey. Versar, Incorporated. Columbia, Maryland. Unpublished data.

Ichthyological Associates. 1978. Ecological studies for the Oyster Creek Generating Station: finfish and shellfish. Ichthyological Associates, Incorporated, Forked River, New Jersey.

_____. 1979. Ecological studies for the Oyster Creek Generating Station: finfish, shellfish, and plankton. Ichthyological Associates, Incorporated, Forked River, New Jersey.

New Jersey Department of Environmental Protection. 1996. Biological and conservation database. Division of Parks and Forestry, Natural Heritage Program, Trenton, New Jersey.

New Jersey Division of Fish, Game and Wildlife. 1994. Notable information of New Jersey animals database. New Jersey Department of Environmental Protection, Division of Fish, Game and Wildlife, Trenton, New Jersey.

Palmer, W.M. and C.L. Cordes. 1988. Habitat suitability index models: diamondback terrapin (nesting) - Atlantic coast. U.S. Department of the Interior, Fish and Wildlife Service. Biological Report 82(10.151). 18 pp.

Reilly, F.J. Jr., and V.J. Bellis. 1983. The ecological impact of beach nourishment with dredged materials on the intertidal zone at Bogue Banks, North Carolina. U.S. Army Corps of Engineers Coastal Engineering Research Center, Vicksburg, Mississippi. 74 pp.

Roosenberg, W.M. 1993. Final report: The Chesapeake diamondback terrapin investigations, 1992. Chesapeake Research Consortium. Publication Number 146, Solomons, Maryland. 58 pp.

Saloman, C.H., S.P. Naughton, J.L. Taylor. 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida. U.S. Army Corps of Engineers Coastal Engineering Research Center, Vicksburg, Mississippi.

U.S. Army Corps of Engineers. 1995. Barnegat Inlet to Little Egg Inlet reconnaissance study, New Jersey shore protection study. U.S. Department of the Army, Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania. 138 pp.

_____. 1999. Barnegat Inlet to Little Egg Inlet, Revised Draft Feasibility Report and Intergrated Environmental Impact Statement. U.S. Department of the Army, Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania.

U.S. Fish and Wildlife Service. 1995. Unpublished bird survey data. U.S. Department of the Interior, Fish and Wildlife Service, Region 5, Edwin B. Forsythe National Wildlife Refuge, Oceanville, New Jersey.

_____. 1996a. Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey. Planning Aid Report. U.S. Department of the Interior, Fish and Wildlife Service, New Jersey Field Office, Pleasantville, New Jersey. 23 pp. + appendices.

_____. 1996b. Piping plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

_____. 1996c. Recovery Plan for Seabeach Amaranth (*Amaranthus pumilus*) Rafinesque. Atlanta, Georgia. 70 pp.

Zich, H.E. 1977. The collection of existing information and field investigation of anadromous clupeid spawning in New Jersey. Miscellaneous Report No. 41. New Jersey Division of Fish, Game and Wildlife, Trenton, New Jersey. 38 pp.

B. PERSONAL COMMUNICATIONS

Conlin, B. 1999. Marine Ecologist. U.S. Army Corps of Engineers, Philadelphia District. Philadelphia, Pennsylvania.

Greene, K. 1999. Biologist. National Marine Fisheries Service. U.S. Department of Commerce. Sandy Hook, New Jersey.

Jenkins, D. 1999. Biologist. Endangered and Nongame Species Program. New Jersey Division of Fish, Game and Wildlife, Nacote Creek Research Station, Port Republic, New Jersey.

McClain, J. 1999. Biologist. New Jersey Bureau of Marine Fisheries. New Jersey Department of Environmental Protection. Nacote Creek Research Station, Port Republic, New Jersey.

Normant, J. 1999. Biologist. New Jersey Bureau of Shellfisheries. New Jersey Department of Environmental Protection. Nacote Creek Research Station, Port Republic, New Jersey.

APPENDIX A

Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

United States Department of the Interior

TAKE PRIDE IN AMERICA

FISH AND WILDLIFE SERVICE
300 Westgate Center Drive
Hadley, MA 01035-9589

In Reply Refer To:
FWS/Region 5/ES-TE

APR 21 1994

Mr. John H. Spencer
Bureau of Natural Resources
Department of Environmental Protection
79 Elm Street
Hartford, Connecticut 06106-5127

Dear Mr. Spencer:

Enclosed are the U.S. Fish and Wildlife Service's Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act. This is the final version of the draft guidelines sent to you for review and comment on March 18, 1994.

These guidelines, based on the best available biological information, provide a flexible approach to protecting piping plovers, while minimizing impacts on beach recreation on non-Federal lands. Management techniques recommended in these guidelines will generally facilitate pedestrian access to the shoreline throughout the plover's breeding cycle. Recommended management options that include intensive monitoring will, in most cases, also allow use of motorized vehicles except when flightless chicks are present.

Please contact Anne Hecht at 508-443-4325 or Paul Nickerson at 413-253-8615 if you have questions about these guidelines or other aspects of the piping plover recovery effort.

Sincerely,

Ronald E. Lambertson

Regional Director

Enclosure

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

GUIDELINES FOR MANAGING RECREATIONAL ACTIVITIES IN PIPING PLOVER BREEDING HABITAT ON THE U.S. ATLANTIC COAST TO AVOID TAKE UNDER SECTION 9 OF THE ENDANGERED SPECIES ACT

Northeast Region, U.S. Fish and Wildlife Service
April 15, 1994

The following information is provided as guidance to beach managers and property owners seeking to avoid potential violations of Section 9 of the Endangered Species Act (16 U.S.C. 1538) and its implementing regulations (50 CFR Part 17) that could occur as the result of recreational activities on beaches used by breeding piping plovers along the Atlantic Coast. These guidelines were developed by the Northeast Region, U.S. Fish and Wildlife Service (Service), with assistance from the U.S. Atlantic Coast Piping Plover Recovery Team. The guidelines are advisory, and failure to implement them does not, of itself, constitute a violation of the law. Rather, they represent the Service's best professional advice to beach managers and landowners regarding the management options that will prevent direct mortality, harm, or harassment of piping plovers and their eggs due to recreational activities.

Some land managers have endangered species protection obligations under Section 7 of the Endangered Species Act (see section I below) or under Executive Orders 11644 and 11989[1] that go beyond adherence to these guidelines. Nothing in this document should be construed as lack of endorsement of additional piping plover protection measures implemented by these land managers or those who are voluntarily undertaking stronger plover protection measures.

This document contains four sections: (I) a brief synopsis of the legal requirements that afford protection to nesting piping plovers; (II) a brief summary of the life history of piping plovers and potential threats due to recreational activities during the breeding cycle; (III) guidelines for protecting piping plovers from recreational activities on Atlantic Coast beaches; and (IV) literature cited.

---

[1] Executive Order 11644, Use of Off-Road Vehicles on the Public Lands and Executive Order 11989, Off-Road Vehicles on Public Lands pertain to lands under custody of the Secretaries of Agriculture, Defense, and Interior (except for Indian lands) and certain lands under the custody of the Tennessee Valley Authority.

I. LEGAL CONSIDERATIONS

Section 9 of the Endangered Species Act (ESA) prohibits any person subject to the jurisdiction of the United States from harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, or collecting listed wildlife species. It is also unlawful to attempt such acts, solicit another to commit such acts, or cause such acts to be committed. A "person" is defined in Section 3 to mean "an individual, corporation, partnership, trust, association, or any other private entity; or any officer, employee, agent, department, or instrumentality of the Federal Government, of any State, municipality, or political subdivision of a State, or of any foreign government; any State, municipality, or political subdivision of a State; or any other entity subject to the jurisdiction of the United States." Regulations implementing the ESA (50 CFR 17.3) further define "harm" to include significant habitat modification or degradation that results in the killing or injury of wildlife by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. "Harass" means an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Penalties for violations of Section 9 are provided in Section 11 of the ESA; for threatened species, these penalties include fines of up to $25,000, imprisonment for not more than six months, or both.

Section 10 of the ESA and related regulations provide for permits that may be granted to authorize acts prohibited under Section 9, for scientific purposes or to enhance the propagation or survival of a listed species. States that have Cooperative Agreements under Section 6 of the ESA, may provide written authorization for take that occurs in the course of implementing conservation programs. For example, State agencies have authorized certain biologists to construct predator exclosures for piping plovers. It is also legal for employees or designated agents of certain Federal or State agencies to take listed species without a permit, if the action is necessary to aid sick, injured, or orphaned animals or to salvage or dispose of a dead specimen.

Section 10 also allows permits to be issued for take that is "incidental to, and not the purpose of, carrying out an otherwise lawful activity" if the Service determines that certain conditions have been met. An applicant for an incidental take permit must prepare a conservation plan that specifies the impacts of the take, steps the applicant will take to minimize and mitigate the impacts, funding that will be available to implement these steps, alternative actions to the take that the applicant considered, and the reasons why such alternatives are not being utilized.

Section 7 of the ESA may be pertinent to beach managers and landowners in situations that have a Federal nexus. Section 7 requires Federal agencies to consult with the Service (or National Marine Fisheries Service for marine species) prior to authorizing, funding, or carrying out activities that may affect listed species. Section 7 also requires that these agencies use their authorities to further the conservation of listed species. Section 7 obligations have caused Federal land management agencies to implement piping plover protection measures that go beyond those required to avoid take, for example by conducting research on threats to piping plovers. Other examples of Federal activities that may affect piping plovers along the Atlantic Coast, thereby triggering Section 7 consultation, include permits for beach nourishment or disposal of dredged material (U.S. Army Corps of Engineers) and funding of beach restoration projects (Federal Emergency Management Authority).

Piping plovers, as well as other migratory birds such as least terns, common terns, American oystercatchers, laughing gulls, herring gulls, and great black-backed gulls, their nests, and eggs are also protected under the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712). Prohibited acts include pursuing, hunting, shooting, wounding, killing, trapping, capturing, collecting, or attempting such conduct. Violators may be fined up to $5000 and/or imprisoned for up to six months.

Almost all States within the breeding range of the Atlantic Coast piping plover population list the species as State threatened or endangered (Northeast Nongame Technical Committee 1993). Various laws and regulations may protect State-listed species from take, but the Service has not ascertained the adequacy of the guidelines presented in this document to meet the requirements of any State law.

II. LIFE HISTORY AND THREATS FROM HUMAN DISTURBANCE

Piping plovers are small, sand-colored shorebirds that nest on sandy, coastal beaches from South Carolina to Newfoundland. Since 1986, the Atlantic Coast population has been protected as a threatened species under provisions of the U.S. Endangered Species Act of 1973 (U.S. Fish and Wildlife Service 1985). The U.S. portion of the population was estimated at 875 pairs in 1993 (U.S. Fish and Wildlife Service 1993). Many characteristics of piping plovers contribute to their susceptibility to take due to human beach activities.

LIFE HISTORY

Piping plovers begin returning to their Atlantic Coast nesting beaches in mid-March (Coutu et al. 1990, Cross 1990, Goldin 1990, MacIvor 1990, Hake 1993). Males establish and defend territories and court females (Cairns 1982). Eggs may be present on the beach from mid-April through late July. Clutch size is generally four eggs, and the incubation period[2] usually lasts for 27-28 days. Piping plovers fledge only a single brood per season, but may renest several times if previous nests are lost. Chicks are precocial[3] (Wilcox 1959, Cairns 1982). They may move hundreds of yards from the nest site during their first week of life (see Table 1, Summary of Chick Mobility Data). Chicks remain together with one or both parents until they fledge (are able to fly) at 25 to 35 days of age. Depending on date of hatching, flightless chicks may be present from mid-May until late August, although most fledge by the end of July (Patterson 1988, Goldin 1990, MacIvor 1990, Howard et al. 1993).

Piping plover nests are situated above the high tide line on coastal beaches, sand flats at the ends of sandspits and barrier islands, gently sloping foredunes, blowout areas behind primary dunes, and washover areas cut into or between dunes. They may also nest on areas where suitable dredge material has been deposited. Nest sites are shallow scraped depressions in substrates ranging from fine grained sand to mixtures of sand and pebbles, shells or cobble (Bent 1929, Burger 1987a, Cairns 1982, Patterson 1988, Flemming et al. 1990, MacIvor 1990,

---

[2] "Incubation" refers to adult birds sitting on eggs, to maintain them at a favorable temperature for embryo development.

[3] "Precocial" birds are mobile and capable of foraging for themselves within several hours of hatching.

Strauss 1990). Nests are usually found in areas with little or no vegetation although, on occasion, piping plovers will nest under stands of American beachgrass (Ammophila breviligulata) or other vegetation (Patterson 1988, Flemming et al. 1990, MacIvor 1990). Plover nests may be very difficult to detect, especially during the 6-7 day egg-laying phase when the birds generally do not incubate (Goldin 1994).

Plover foods consist of invertebrates such as marine worms, fly larvae, beetles, crustaceans or mollusks (Bent 1929, Cairns 1977, Nicholls 1989). Feeding areas include intertidal portions of ocean beaches, washover areas, mudflats, sandflats, wrack lines[4], and shorelines of coastal ponds, lagoons or salt marshes (Gibbs 1986, Coutu et al. 1990, Hoopes et al. 1992, Loegering 1992, Goldin 1993). Studies have shown that the relative importance of various feeding habitat types may vary by site (Gibbs 1986, Coutu et al. 1990, McConnaughey et al. 1990, Loegering 1992, Goldin 1993, Hoopes 1993) and by stage in the breeding cycle (Cross 1990). Adults and chicks on a given site may use different feeding habitats in varying proportion (Goldin et al. 1990). Feeding activities of chicks may be particularly important to their survival. Cairns (1977) found that piping plover chicks typically tripled their weight during the first two weeks post-hatching; chicks that failed to achieve at least 60% of this weight gain by day 12 were unlikely to survive. During courtship, nesting, and brood rearing, feeding territories are generally contiguous to nesting territories (Cairns 1977), although instances where brood-rearing areas are widely separated from nesting territories are not uncommon (see Table 1). Feeding activities of both adults and chicks may occur during all hours of the day and night (Burger 1993) and at all stages in the tidal cycle (Goldin 1993, Hoopes 1993).

THREATS FROM NONMOTORIZED BEACH ACTIVITIES

Sandy beaches that provide nesting habitat for piping plovers are also attractive recreational habitats for people and their pets. Nonmotorized recreational activities can be a source of both direct mortality and harassment of piping plovers. Pedestrians on beaches may crush

[4] Wrack is organic material including seaweed, seashells, driftwood and other materials deposited on beaches by tidal action.

eggs (Burger 1987b, Hill 1988, Shaffer and Laporte 1992, Cape Cod National Seashore 1993, Collazo et al. 1994). Unleashed dogs may chase plovers (McConnaughey et al. 1990), destroy nests (Hoopes et al. 1992), and kill chicks (Cairns and McLaren 1980).

Pedestrians may flush incubating plovers from nests (see Table 2, Summary of Data on Distances at Which Plovers React to Disturbance), exposing eggs to avian predators or causing excessive cooling or heating of eggs. Repeated exposure of shorebird eggs on hot days may cause overheating, killing the embryos (Bergstrom 1991). Excessive cooling may kill embryos or retard their development, delaying hatching dates (Welty 1982). Pedestrians can also displace unfledged chicks (Strauss 1990, Burger 1991, Hoopes et al. 1992, Loegering 1992, Goldin 1993). Fireworks are highly disturbing to piping plovers (Howard et al. 1993). Plovers are particularly intolerant of kites, compared with pedestrians, dogs, and vehicles; biologists believe this may be because plovers perceive kites as potential avian predators (Hoopes et al. 1992).

THREATS FROM MOTOR VEHICLES

Unrestricted use of motorized vehicles on beaches is a serious threat to piping plovers and their habitats. Vehicles can crush eggs (Wilcox 1959; Tull 1984; Burger 1987b; Patterson et al. 1991; United States of America v. Breezy Point Cooperative, Inc., U.S. District Court, Eastern District of New York, Civil Action No. CV-90-2542, 1991; Shaffer and Laporte 1992), adults, and chicks. In Massachusetts and New York, biologists documented 14 incidents in which 18 chicks and 2 adults were killed by vehicles between 1989 and 1993 (Melvin et al. 1994). Goldin (1993) compiled records of 34 chick mortalities (30 on the Atlantic Coast and 4 on the Northern Great Plains) due to vehicles. Many biologists that monitor and manage piping plovers believe that many more chicks are killed by vehicles than are found and reported (Melvin et al. 1994). Beaches used by vehicles during nesting and brood-rearing periods generally have fewer breeding plovers than available nesting and feeding habitat can support. In contrast, plover abundance and productivity has increased on beaches where vehicle restrictions during chick-rearing periods have been combined with protection of nests from predators (Goldin 1993; S. Melvin, pers. comm., 1993).

Typical behaviors of piping plover chicks increase their vulnerability to vehicles. Chicks frequently move between the upper berm or foredune and feeding habitats in the wrack line and intertidal zone. These movements place chicks in the paths of vehicles driving along the berm or through the intertidal zone. Chicks stand in, walk, and run along tire ruts, and sometimes have difficulty crossing deep ruts or climbing out of them (Eddings et al. 1990, Strauss 1990, Howard et al. 1993). Chicks sometimes stand motionless or crouch as vehicles pass by, or do not move quickly enough to get out of the way (Tull 1984, Hoopes et al. 1992, Goldin 1993). Wire fencing placed around nests to deter predators (Rimmer and Deblinger 1990, Melvin et al. 1992) is ineffective in protecting chicks from vehicles because chicks typically leave the nest within a day after hatching and move extensively along the beach to feed (see Table 1).

Vehicles may also significantly degrade piping plover habitat or disrupt normal behavior patterns. They may harm or harass plovers by crushing wrack into the sand and making it unavailable as cover or a foraging substrate, by creating ruts that may trap or impede movements of chicks, and by preventing plovers from using habitat that is otherwise suitable (MacIvor 1990, Strauss 1990, Hoopes et al. 1992, Goldin 1993).

III. GUIDELINES FOR PROTECTING PIPING PLOVERS FROM RECREATIONAL DISTURBANCE

The Service recommends the following protection measures to prevent direct mortality or harassment of piping plovers, their eggs, and chicks.

MANAGEMENT OF NONMOTORIZED RECREATIONAL USES

On beaches where pedestrians, joggers, sun-bathers, picnickers, fishermen, boaters, horseback riders, or other recreational users are present in numbers that could harm or disturb incubating plovers, their eggs, or chicks, areas of at least 50 meter-radius around nests above the high tide line should be delineated with warning signs and symbolic fencing[5]. Only persons engaged in rare species monitoring, management, or research activities should enter posted areas. These areas should remain fenced as long as viable eggs or unfledged chicks are present. Fencing is intended to prevent accidental crushing of nests and repeated flushing of

[5] "Symbolic fencing" refers to one or two strands of light-weight string, tied between posts to delineate areas where pedestrians and vehicles should not enter.

incubating adults, and to provide an area where chicks can rest and seek shelter when large numbers of people are on the beach.

Available data indicate that a 50 meter buffer distance around nests will be adequate to prevent harassment of the majority of incubating piping plovers. However, fencing around nests should be expanded in cases where the standard 50 meter-radius is inadequate to protect incubating adults or unfledged chicks from harm or disturbance. Data from various sites distributed across the plover's Atlantic Coast range indicates that larger buffers may be needed in some locations (see Table 2). This may include situations where plovers are especially intolerant of human presence, or where a 50 meter-radius area provides insufficient escape cover or alternative foraging opportunities for plover chicks.[6]

In cases where the nest is located less than 50 meters above the high tide line, fencing should be situated at the high tide line, and a qualified biologist should monitor responses of the birds to passersby, documenting his/her observations in clearly recorded field notes. Providing that birds are not exhibiting signs of disturbance, this smaller buffer may be maintained in such cases.

On portions of beaches that receive heavy human use, areas where territorial plovers are observed should be symbolically fenced to prevent disruption of territorial displays and courtship. Since nests can be difficult to locate, especially during egg-laying, this will also prevent accidental crushing of undetected nests. If nests are discovered outside fenced areas, fencing should be extended to create a sufficient buffer to prevent disturbance to incubating adults, eggs, or unfledged chicks.

For example, on the basis of data from an intensive three year study that showed that lovers on Assateague Island in Maryland flush from nests at greater distances than those lsewhere (Loegering 1992), the Assateague Island National Seashore established 200 meter uffers zones around most nest sites and primary foraging areas (Assateague Island National eashore 1993). Following a precipitous drop in numbers of nesting plover pairs in Delaware the late 1980's, that State adopted a Piping Plover Management Plan that provided 100 ard buffers around nests on State park lands and included intertidal areas (Delaware epartment of Natural Resources and Environmental Control 1990).

Pets should be leashed and under control of their owners at all times from April 1 to August 31 on beaches where piping plovers are present or have traditionally nested. Pets should be prohibited on these beaches from April 1 through August 31 if, based on observations and experience, pet owners fail to keep pets leashed and under control.

Kite flying should be prohibited within 200 meters of nesting or territorial adult or unfledged juvenile piping plovers between April 1 and August 31.

Fireworks should be prohibited on beaches where plovers nest from April 1 until all chicks are fledged.

MOTOR VEHICLE MANAGEMENT

The Service recommends the following minimum protection measures to prevent direct mortality or harassment of piping plovers, their eggs, and chicks on beaches where vehicles are permitted. Since restrictions to protect unfledged chicks often impede vehicle access along a barrier spit, a number of management options affecting the timing and size of vehicle closures are presented here. Some of these options are contingent on implementation of intensive plover monitoring and management plans by qualified biologists. It is recommended that landowners seek concurrence with such monitoring plans from either the Service or the State wildlife agency.

Protection of Nests

All suitable piping plover nesting habitat should be identified by a qualified biologist and delineated with posts and warning signs or symbolic fencing on or before April 1 each year. All vehicular access into or through posted nesting habitat should be prohibited. However, prior to hatching, vehicles may pass by such areas along designated vehicle corridors established along the outside edge of plover nesting habitat. Vehicles may also park outside delineated nesting habitat, if beach width and configuration and tidal conditions allow. Vehicle corridors or parking areas should be moved, constricted, or temporarily closed if territorial, courting, or nesting plovers are disturbed by passing or parked vehicles, or if disturbance is anticipated because of unusual tides or expected increases in vehicle use during weekends, holidays, or special events.

If data from several years of plover monitoring suggests that significantly more habitat is available than the local plover population can occupy, some suitable habitat may be left unposted if the following conditions are met:

1. The Service OR a State wildlife agency that is party to an agreement under Section 6 of the ESA provides written concurrence with a plan that:

   A. Estimates the number of pairs likely to nest on the site based on the past monitoring and regional population trends.

   AND

   B. Delineates the habitat that will be posted or fenced prior to April 1 to assure a high probability that territorial plovers will select protected areas in which to court and nest. Sites where nesting or courting plovers were observed during the last three seasons as well as other habitat deemed most likely to be pioneered by plovers should be included in the posted and/or fenced area.

   AND

   C. Provides for monitoring of piping plovers on the beach by a qualified biologist(s). Generally, the frequency of monitoring should be not less than twice per week prior to May 1 and not less than three times per week thereafter. Monitoring should occur daily whenever moderate to large numbers of vehicles are on the beach. Monitors should document locations of territorial or courting plovers, nest locations, and observations of any reactions of incubating birds to pedestrian or vehicular disturbance.

AND

2. All unposted sites are posted immediately upon detection of territorial plovers.

Protection of Chicks

Sections of beaches where unfledged piping plover chicks are present should be temporarily closed to all vehicles not deemed essential. (See the provisions for essential vehicles below.) Areas where vehicles are prohibited should include all dune, beach, and intertidal habitat within the chicks' foraging range, to be determined by either of the following methods:

1. The vehicle free area should extend 1000 meters on each side of a line drawn through the nest site and perpendicular to the long axis of the beach. The resulting 2000 meter-wide area of protected habitat for plover chicks should extend from the ocean-side low water line to the bay-side low water line or to the farthest extent of dune habitat if no bay-side intertidal habitat exists. However, vehicles may be allowed to pass through portions of the protected area that are considered inaccessible to plover chicks because of steep topography, dense vegetation, or other naturally-occurring obstacles.

OR

2. The Service OR a State wildlife agency that is party to an agreement under Section 6 of the ESA provides written concurrence with a plan that:

A. Provides for monitoring of all broods during the chick-rearing phase of the breeding season and specifies the frequency of monitoring.

AND

B. Specifies the minimum size of vehicle-free areas to be established in the vicinity of unfledged broods based on the mobility of broods observed on the site in past years and on the frequency of monitoring. Unless substantial data from past years show that broods on a site stay very close to their nest locations, vehicle-free areas should extend at least 200 meters on each side of the nest site during the first week following hatching. The size and location of the protected area should be adjusted in response to the observed mobility of the brood, but in no case should it be reduced to less than 100 meters on each side of the brood. In some cases, highly mobile broods may require protected areas up to 1000 meters, even where they are intensively monitored. Protected areas should extend from the ocean-side low water line to the bay-side low water line or to the farthest extent of dune habitat if no bay-side intertidal habitat exists. However, vehicles may be allowed to pass through portions of the protected area that are considered inaccessible to plover chicks because of steep topography, dense vegetation, or other naturally-occurring obstacles. In a few cases, where several years of data documents that piping plovers on a particular site feed in only certain habitat types, the Service or the State wildlife management agency may provide written concurrence that vehicles pose no danger to plovers in other specified habitats on that site.

Timing of Vehicle Restrictions in Chick Habitat

Restrictions on use of vehicles in areas where unfledged plover chicks are present should begin on or before the date that hatching begins and continue until chicks have fledged. For purposes of vehicle management, plover chicks are considered fledged at 35 days of age or when observed in sustained flight for at least 15 meters, whichever occurs first.

When piping plover nests are found before the last egg is laid, restrictions on vehicles should begin on the 26th day after the last egg is laid. This assumes an average incubation period of 27 days, and provides a 1 day margin of error.

When plover nests are found after the last egg has been laid, making it impossible to predict hatch date, restrictions on vehicles should begin on a date determined by one of the following scenarios:

1) With intensive monitoring: If the nest is monitored at least twice per day, at dawn and dusk (before 0600 hrs and after 1900 hrs) by a qualified biologist, vehicle use may continue until hatching begins. Nests should be monitored at dawn and dusk to minimize the time that hatching may go undetected if it occurs after dark. Whenever possible, nests should be monitored from a distance with spotting scope or binoculars to minimize disturbance to incubating plovers.

OR

2) Without intensive monitoring: Restrictions should begin on May 15 (the earliest probable hatch date). If the nest is discovered after May 15, then restrictions should start immediately.

If hatching occurs earlier than expected, or chicks are discovered from an unreported nest, restrictions on vehicles should begin immediately.

If ruts are present that are deep enough to restrict movements of plover chicks, then restrictions on vehicles should begin at least 5 days prior to the anticipated hatching date of plover nests. If a plover nest is found with a complete clutch, precluding estimation of hatching date, and deep ruts have been created that could reasonably be expected to impede chick movements, then restrictions on vehicles should begin immediately.

Essential Vehicles

Because it is impossible to completely eliminate the possibility that a vehicle will accidently crush an unfledged plover chicks, use of vehicles in the vicinity of broods should be avoided whenever possible. However, the Service recognizes that life-threatening situations on the beach may require emergency vehicle response. Furthermore, some "essential vehicles" may be required to provide for safety of pedestrian recreationists, law enforcement, maintenance of public property, or access to private dwellings not otherwise accessible. On large beaches, maintaining the frequency of plover monitoring required to minimize the size and duration of vehicle closures may necessitate the use of vehicles by plover monitors.

Essential vehicles should only travel on sections of beaches where unfledged plover chicks are present if such travel is absolutely necessary and no other reasonable travel routes are available. All steps should be taken to minimize number of trips by essential vehicles through chick habitat areas. Homeowners should consider other means of access, eg. by foot, water, or shuttle services, during periods when chicks are present.

The following procedures should be followed to minimize the probability that chicks will be crushed by essential (non-emergency) vehicles:

1. Essential vehicles should travel through chick habitat areas only during daylight hours, and should be guided by a qualified monitor who has first determined the location of all unfledged plover chicks.

2. Speed of vehicles should not exceed five miles per hour.

3. Use of open 4-wheel motorized all-terrain vehicles (ATVs) or non-motorized all-terrain bicycles is recommended whenever possible for monitoring and law enforcement because of the improved visibility afforded operators.

4. A log should be maintained by the beach manager of the date, time, vehicle number and operator, and purpose of each trip through areas where unfledged chicks are present. Personnel monitoring plovers should maintain and regularly update a log of the numbers and locations of unfledged plover chicks on each beach. Drivers of essential vehicles should review the log each day to determine the most recent number and location of unfledged chicks.

Essential vehicles should avoid driving on the wrack line, and travel should be infrequent enough to avoid creating deep ruts that could impede chick movements. If essential vehicles are creating ruts that could impede chick movements, use of essential vehicles should be further reduced and, if necessary, restricted to emergency vehicles only.

SITE-SPECIFIC MANAGEMENT GUIDANCE

The guidelines provided in this document are based on an extensive review of the scientific literature and are intended to cover the vast majority of situations likely to be encountered on piping plover nesting sites along the U.S. Atlantic Coast. However, the Service recognizes that site-specific conditions may lead to anomalous situations in which departures from this guidance may be safely implemented. The Service recommends that landowners who believe such situations exist on their lands contact either the Service or the State wildlife agency and, if appropriate, arrange for an on-site review. Written documentation of agreements regarding departures from this guidance is recommended.

In some unusual circumstances, Service or State biologists may recognize situations where this guidance provides insufficient protection for piping plovers or their nests. In such a case, the Service or the State wildlife agency may provide written notice to the landowner describing additional measures recommended to prevent take of piping plovers on that site.

IV. LITERATURE CITED

Assateague Island National Seashore. 1993. Piping Plover Management Plan. Assateague Island National Seashore, Berlin, Maryland. 24 pp.

Bent, A.C. 1929. Life histories of North American shorebirds. Part 2. U.S. National Museum Bulletin No. 146. 412 pp.

Bergstrom, P.W. 1991. Incubation temperatures of Wilson's plovers and killdeers. Condor. 91: 634-641.

Burger, J. 1987a. Physical and social determinants of nest site selection in piping plover in New Jersey. Condor. 98: 811-818.

Burger, J. 1987b. New Jersey Endangered Beach-Nesting Bird Project: 1986 Research. Unpublished report. New Jersey Department of Environmental Protection, New Jersey. 37 pp.

Burger, J. 1991. Foraging behavior and the effect of human disturbance on the piping plover (Charadrius melodus). Journal of Coastal Research, 7(1), 39-52.

Burger, J. 1993. Shorebird squeeze. Natural History. May 1993: 8-14.

Cairns, W.E. 1977. Breeding biology of Piping Plovers in southern Nova Scotia. M.S. Thesis. Dalhousie University, Halifax, Nova Scotia. 115 pp.

Cairns, W.E. and I.A. McLaren. 1980. Status of the piping plover on the east coast of North America. American Birds. 34: 206-208.

Cairns, W.E. 1982. Biology and behavior of breeding Piping Plovers. Wilson Bulletin. 94: 531-545.

Cape Cod National Seashore. 1993. Piping plover nest found trampled by pedestrian. News Release. Cape Cod National Seashore, South Wellfleet, Massachusetts. 2 pp.

Collazo, J.A., J.R. Walters, and J.F. Parnell. 1994. Factors Affecting Reproduction and Migration of Waterbirds on North Carolina Barrier Islands. 1993 Annual Progress Report. North Carolina State University, Raleigh, North Carolina. 57 pp.

Coutu, S., J. Fraser, J. McConnaughey and J. Loegering. 1990. Piping Plover distribution and reproductive success on Cape Hatteras National Seashore. Unpublished report. Cape Hatteras National Seashore, Manteo, North Carolina. 67 pp.

Cross, R.R. 1989. Monitoring, management and research of the piping plover at Chincoteague National Wildlife Refuge. Unpublished report. Virginia Department of Game and Inland Fisheries. 80 pp.

Cross, R.R. 1990. Monitoring, management and research of the piping plover at Chincoteague National Wildlife Refuge. Unpublished report. Virginia Department of Game and Inland Fisheries. 68 pp.

Cross, R.R. and K. Terwilliger. 1993. Piping plover flushing distances recorded in annual surveys in Virginia 1986-1991. Virginia Department of Game and Inland Fisheries. 5 pp.

Delaware Department of Natural Resources and Environmental Control. 1990. Delaware Piping Plover Management Plan. Delaware Department of Natural Resources and Environmental Control. 5 pp.

Eddings, K.S., C.R. Griffin, and S.M. Melvin. 1990. Productivity, activity patterns, limiting factors, and management of piping plovers at Sandy Hook, Gateway National Recreation Area, New Jersey. Unpublished report. Department of Forestry and Wildlife Management, University of Massachusetts, Amherst. 79 pp.

Flemming, S.P., R. D. Chiasson, and P.J. Austin-Smith. 1990. Piping Plover nest-site selection in New Brunswick and Nova Scotia. Unpublished document. Dept. of Biology, Queen's University, Kingston, Canada. 31 pp.

Gibbs, J.P. 1986. Feeding ecology of nesting piping plovers in Maine. Unpublished report to Maine Chapter, The Nature Conservancy. Topsham, Maine. 21 pp.

Goldin M., C. Griffin and S. Melvin. 1990. Reproductive and foraging ecology, human disturbance, and management of Piping Plovers at Breezy Point, Gateway National Recreation Area, New York, 1989. Progress report. 58 pp.

Goldin, M.R. 1990. Reproductive ecology and management of piping plovers (Charadrius melodus) at Breezy Point, Gateway National Recreation Area, New York -- 1990. Unpublished report. Gateway National Recreation Area, Long Island, New York. 16 pp.

Goldin, M.R. 1993. Effects of human disturbance and off-road vehicles on piping plover reproductive success and behavior at Breezy Point, Gateway National Recreation Area, New York. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 128 pp.

Goldin, M.R. 1994. Breeding history of, and recommended monitoring & management practices for piping plovers (Charadrius melodus) at Goosewing Beach, Little Compton, Rhode Island (with discussion of Briggs Beach). Report to U.S. Fish and Wildlife Service, Hadley, Massachusetts. 36 pp.

Hake, M. 1993. 1993 summary of piping plover management program at Gateway NWRA Breezy Point district. Unpublished report. Gateway National Recreation Area, Long Island, New York. 29 pp.

Hill, J.O. 1988. Aspects of breeding biology of Piping Plovers Charadrius melodus in Bristol County, Massachusetts, in 1988. Unpublished report. University of Massachusetts, Amherst, Massachusetts. 44 pp.

Hoopes, E.M., C.R. Griffin, and S.M. Melvin. 1992. Relationships between human recreation and Piping Plover foraging ecology and chick survival. Unpublished report. University of Massachusetts, Amherst, Massachusetts. 77 pp.

Hoopes, E.M. 1993. Relationships between human recreation and piping plover foraging ecology and chick survival. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 106 pp.

Howard, J.M., R.J. Safran, and S.M. Melvin. 1993. Biology and conservation of piping plovers at Breezy Point, New York. Unpublished report. Department of Forestry and Wildlife Management, University of Massachusetts, Amherst. 34 pp.

Loegering, J.P. 1992. Piping Plover breeding biology, foraging ecology and behavior on Assateague Island National Seashore, Maryland. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 247 pp.

MacIvor, L.H. 1990. Population dynamics, breeding ecology, and management of Piping Plovers on Outer Cape Cod, Massachusetts. M.S. Thesis. University of Massachusetts, Amherst, Massachusetts. 100 pp.

McConnaughey, J.L., J.D. Fraser, S.D. Coutu, and J.P. Loegering. 1990. Piping plover distribution and reproductive success on Cape Lookout National Seashore. Unpublished report. Cape Lookout National Seashore, Morehead City, North Carolina. 83 pp.

Melvin, S.M., L.H. MacIvor, and C.R. Griffin. 1992. Predator exclosures: a technique to reduce predation of piping plover nests. Wildlife Society Bulletin. 20: 143-148.

Melvin, S.M., C.R. Griffin and A. Hecht. 1994. Mortality of piping plover chicks caused by off-road vehicles on Atlantic coast beaches. Wildlife Society Bulletin, in press.

Nicholls, J.L. 1989. Distribution and other ecological aspects of Piping Plovers (*Charadrius melodus*) wintering along the Atlantic and Gulf Coasts. M.S. Thesis. Auburn University, Auburn, Alabama. 150 pp.

Northeast Nongame Technical Committee. 1993. Legal categories of rare species in the northeastern states. Northeast Nongame Technical Committee, Northeast Association of Fish and Wildlife Agencies. 22 pp.

Patterson, M.E. 1988. Piping plover breeding biology and reproductive success on Assateague Island. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. 131 pp.

Patterson, M.E., J.D. Fraser, and J.W. Roggenbuck. 1991. Factors affecting piping plover productivity on Assateague Island. Journal of Wildlife Management. 55(3): 525-531.

Rimmer, D.W., and R.D. Deblinger. 1990. Use of predator exclosures to protect piping plover nests. Journal of Field Ornithology. 61: 217-223.

Shaffer, F. and P. Laporte. 1992. Rapport synthese des recherches relatives au pluvier siffleur (Charadrius melodus) effectuees aux Iles-de-la-Madeleine de 1987 a 1991. Association quebecoise des groupes d'ornithologues et Service canadien de la faune. 78 pp.

Strauss, E. 1990. Reproductive success, life history patterns, and behavioral variation in a population of Piping Plovers subjected to human disturbance (1982-1989). Ph.D. dissertation. Tufts University, Medford, Massachusetts.

Tull, C.E. 1984. A study of nesting piping plovers of Kouchibouguac National Park 1983. Unpublished report. Parks Canada, Kouchibouguac National Park, Kouchibouguac, New Brunswick. 85 pp.

U.S. Fish and Wildlife Service. 1985. Endangered and Threatened Wildlife and Plants; Determination of Endangered and Threatened Status for the Piping Plover; Final Rule. Federal Register 50 (238): 50726-50734.

U.S. Fish and Wildlife Service. 1993. 1993 Status Update; U.S. Atlantic Coast Piping Plover. Unpublished report. U.S. Fish and Wildlife Service, Sudbury, Massachusetts. 7 pp.

Welty, J.C. 1982. The life of birds. Sauders College Publishing, Philadelphia, Pennsylvania. 754 pp.

Wilcox, L. 1959. A twenty year banding study of the piping plover. Auk. 76:129-152.

Table 1. Summary of Chick Mobility Data

Source	Location	Data
Patterson 1988 (p.40)	Maryland and Virginia	18 of 38 broods moved to feeding areas more than 100 meters from their nests; 5 broods moved more than 600 meters (distance measured parallel to wrackline).
Cross 1989 (p.23)	Virginia	At three sites, observers relocated broods at mean distances from their nests of 153 m +/-97m (44 observations, 14 broods), 32 m +/-7 m (8 observations, 3 broods), and 492 m +/-281 m (12 observations, 4 broods).
Coutu et al. 1990 (p.12)	North Carolina	Observations of 11 broods averaged 212 m from their nests; 3 broods moved 400-725 m from nest sites.
Strauss 1990 (p.33)	Massachusetts	10 chicks moved more than 200 m during first 5 days post-hatch while 19 chicks moved less than 200 meters during same interval.
Loegering 1992 (p.72)	Maryland	Distances broods moved from nests during first 5 days post-hatch averaged 195 m in Bay habitat (n=10), 141 m in Interior habitat (n=36), and 131 m in Ocean habitat (n=41). By 21 days, average movement in each habitat had, respectively, increased to 850 m (n=1), 464 m (n=10), and 187 m (n=69). One brood moved more than 1000 m from its nest.
Melvin et al. 1994	Massachusetts and New York	In 14 incidents in which 18 chicks were killed by vehicles, chicks were run over $\leq$ 10 m to $\leq$ 900 m from their nests. In 7 of these instances, mortality occurred $\geq$ 200 m from the nest.

Table 2. Summary of Data on Distances at which Piping Plovers React to Disturbance

Source	Location	Data
Flushing of Incubating Birds by Pedestrians		
Flemming et al. 1988 (p.326)	Nova Scotia	Adults usually flushed from the nests at distances <40 m; however, great variation existed and reaction distances as great as 210 m were observed.
Cross 1990 (p.47)	Virginia	Mean flushing distances in each of two years were 47 m (n=181, range = 5 m to 300 m) and 25 m (n=214, range = 2 m to 100 m).
Loegering 1992 (p.61)	Maryland	Flushing distances averaged 78 m (n=43); range was 20 m to 174 m. Recommended use of 225 m disturbance buffers on his site.
Cross and Terwilliger 1993	Virginia	Mean flushing distance for all years on all sites (Virginia plover sites, 1986-91) was 63 m (n=201, SD=31, range = 7 m to 200 m). Differences among years were not significant, but differences among sites were.
Hoopes 1993 (p.72)	Massachusetts	Mean flushing distance for incubating plovers was 24 m (n=31).
Disturbance to Non-incubating Birds		
Hoopes 1993 (p.89)	Massachusetts	Mean response distance (all ages, all behaviors) was 23 m for pedestrian disturbances (range = 10 m to 60 m), 40 m for vehicles (range = 30 m to 70 m), 46 m for dogs/pets (range = 20 m to 100 m), and 85 m for kites (range = 60 m to 120 m).
Goldin 1993 (p.74)	New York	Average flushing distance for adult and juvenile plovers was 18.7 m for pedestrian disturbances (n=585), 19.5 m for joggers (n=183), and 20.4 m for vehicles (n=111). Pedestrians caused chicks to flush at an average distance of 20.7 m (n=175), joggers at 32.3 m (n=37), and vehicles at 19.3 m (n=7). Tolerance of individual birds varied; one chick moved 260 m in direct response to 20 disturbances in 1 hour.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX B

Coordination with the
New Jersey Division of Fish, Game and Wildlife

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

State of New Jersey

Christine Todd Whitman
Governor

Department of Environmental Protection
Division of Fish, Game and Wildlife
P.O. Box 400
Trenton, NJ 08625-0400
Robert McDowell, Director

Robert C. Shinn, Jr.
Commissioner

August 5, 1999

Clifford G. Day, Supervisor
New Jersey Field Office
US Fish and Wildlife Service
927 N. Main St., Bldg. D1
Pleasantville, NJ 08232

Dear Mr. Day:

This serves to inform you that the Division of Fish, Game and Wildlife [DFGW] concurs with the Summary Conclusions and Recommendations of the USFWS's Draft 2(b) Coordination Act Report entitled *Barnegat Inlet to Little Egg Inlet Feasibility Study, Ocean County, NJ, March 1999*. The assessment constitutes the Service's report on fish and wildlife impacts that can be expected to result from the US Army Corps of Engineers' proposed Long Beach Island project designed to reduce the threat of storm damage and mitigate the effects of, or prevent, long-term erosion.

We hope this information is of service to you.

Sincerely,

Robert McDowell, Director
Division of Fish, Game and Wildlife

c. A. Didun

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

APPENDIX C

Federally Listed and State-Listed Endangered
and Threatened Species in New Jersey

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

FEDERALLY LISTED ENDANGERED AND THREATENED SPECIES IN NEW JERSEY

An **ENDANGERED** species is any species that is in danger of extinction throughout all or a significant portion of its range.

A **THREATENED** species is any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

	COMMON NAME	SCIENTIFIC NAME	STATUS
FISHES	Shortnose sturgeon*	*Acipenser brevirostrum*	E
REPTILES	Bog turtle	*Clemmys muhlenbergii*	T
	Atlantic Ridley turtle*	*Lepidochelys kempii*	E
	Green turtle*	*Chelonia mydas*	T
	Hawksbill turtle*	*Eretmochelys imbricata*	E
	Leatherback turtle*	*Dermochelys coriacea*	E
	Loggerhead turtle*	*Caretta caretta*	T
BIRDS	Bald eagle	*Haliaeetus leucocephalus*	T
	Piping plover	*Charadrius melodus*	T
	Roseate tern	*Sterna dougallii dougallii*	E
MAMMALS	Eastern cougar	*Felis concolor couguar*	E+
	Indiana bat	*Myotis sodalis*	E
	Gray wolf	*Canis lupus*	E+
	Delmarva fox squirrel	*Sciurus niger cinereus*	E+
	Blue whale*	*Balaenoptera musculus*	E
	Finback whale*	*Balaenoptera physalus*	E
	Humpback whale*	*Megaptera novaeangliae*	E
	Right whale*	*Balaena glacialis*	E
	Sei whale*	*Balaenoptera borealis*	E
	Sperm whale*	*Physeter macrocephalus*	E

	COMMON NAME	SCIENTIFIC NAME	STATUS
INVERTEBRATES	**Dwarf wedgemussel**	*Alasmidonta heterodon*	E
	Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	T
	Mitchell saytr butterfly	*Neonympha m. mitchellii*	E+
	American burying beetle	*Nicrophorus americanus*	E+
PLANTS	**Small whorled pogonia**	*Isotria medeoloides*	T
	Swamp pink	*Helonias bullata*	T
	Eastern prairie fringed orchid	*Platanthera leucophaea*	T+
	Knieskern's beaked-rush	*Rhynchospora knieskernii*	T
	American chaffseed	*Schwalbea americana*	E
	Sensitive joint-vetch	*Aeschynomene virginica*	T
	Sea-beach pigweed	*Amaranthus pumilus*	T+

STATUS:			
E	endangered species	PE	proposed endangered
T	threatened species	PT	proposed threatened
+	presumed extirpated		

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

Note: for a complete listing of Endangered and Threatened Wildlife and Plants, refer to 50 CFR 17.11 and 17.12.

For further information, please contact:

U.S. Fish and Wildlife Service
New Jersey Field Office
927 N. Main Street, Building D
Pleasantville, New Jersey 08232
Phone: (609) 646-9310
Fax: (609) 646-0352

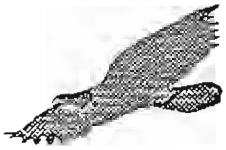
FEDERAL CANDIDATE SPECIES IN NEW JERSEY

CANDIDATE SPECIES are species that appear to warrant consideration for addition to the federal List of Endangered and Threatened Wildlife and Plants. Although these species receive no substantive or procedural protection under the Endangered Species Act, the U.S. Fish and Wildlife Service encourages federal agencies and other planners to give consideration to these species in the environmental planning process.

SPECIES	SCIENTIFIC NAME
Bog asphodel	*Narthecium americanum*

Note: For complete listings of taxa under review as candidate species, refer to Federal Register Vol. 62, No. 182, September 19, 1997 (Endangered and Threatened Wildlife and Plants; Review of Plant and Animal Taxa that are Candidates for Listing as Endangered or Threatened Species).

Revised 10/97



ENDANGERED AND THREATENED WILDLIFE OF NEW JERSEY

Endangered Species are those whose prospects for survival in New Jersey are in immediate danger because of a loss or change in habitat, over-exploitation, predation, competition, disease, disturbance or contamination. Assistance is needed to prevent future extinction in New Jersey.

Threatened Species are those who may become endangered if conditions surrounding them begin to or continue to deteriorate.

BIRDS

Endangered

Pied-billed Grebe,* *Podilymbus podiceps*
Bald Eagle, *Haliaeetus leucocephalus***
Northern Harrier,* *Circus cyaneus*
Cooper's Hawk, *Accipiter cooperii*
Red-shouldered Hawk, *Buteo lineatus* (Breeding)
Peregrine Falcon, *Falco peregrinus***
Piping Plover, *Charadrius melodus***
Upland Sandpiper, *Bartramia longicauda*
Roseate Tern, *Sterna dougallii*
Least Tern, *Sterna antillarum*
Black Skimmer, *Rynchops niger*
Short-eared Owl,* *Asio flammeus*
Sedge Wren, *Cistothorus platensis*
Loggerhead Shrike, *Lanius ludovicianus*
Vesper Sparrow, *Pooecetes gramineus*
Henslow's Sparrow, *Ammodramus henslowii*

Threatened

American Bittern*, *Botaurus lentiginosos*
Great Blue Heron*, *Ardea herodias*
Little Blue Heron, *Egretta caerulea**
Yellow-crowned Night Heron, *Nyctanassa violaceus*
Osprey, *Pandion haliaetus*
Northern Goshawk, *Accipiter gentilis*
Red-shouldered Hawk, *Buteo lineatus* (Non-breeding)
Black Rail, *Laterallus jamaicensis*
Long-eared Owl, *Asio otus*
Barred Owl, *Strix varia*
Red-headed Woodpecker, *Melanerpes erythrocephalus*
Cliff Swallow,* *Hirundo pyrrhonota*
Savannah Sparrow, *Passerculus sandwichensis*
Ipswich Sparrow, *Passerculus sandwichensis princeps*
Grasshopper Sparrow, *Ammodramus savannarum*
Bobolink, *Dolichonyx oryzivorus*
Black-crowned Night Heron, Nycticorax nycticorax

*Only breeding population considered endangered or threatened

**Federally endangered or threatened

REPTILES

Endangered

Bog Turtle, *Clemmys muhlenbergi*
Atlantic Hawksbill, *Eretmochelys imbricata***
Atlantic Loggerhead, *Caretta caretta***
Atlantic Ridley, *Lepidochelys kempi***
Atlantic Leatherback, *Dermochelys coriacea***
Corn Snake, *Elaphe g. guttata*
Timber Rattlesnake, *Crotalus h. horridus*

Threatened

Wood Turtle, *Clemmys insculpta*
Atlantic Green Turtle, *Chelonia mydas***
Northern Pine Snake, *Pituophis m. melanoleucus*

**Federally endangered or threatened

ENDANGERED AND NONGAME SPECIES PROGRAM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION AND ENERGY
DIVISION OF FISH, GAME AND WILDLIFE

AMPHIBIANS

Endangered

Tremblay's Salamander, *Ambystoma tremblayi*
Blue-spotted Salamander, *Ambystoma laterale*
Eastern Tiger Salamander, *Ambystoma t. tigrinum*
Pine Barrens Treefrog, *Hyla andersonii*
Southern Gray Treefrog, *Hyla chrysoscelis*

Threatened

Long-tailed Salamander, *Eurycea longicauda*
Eastern Mud Salamander, *Pseudotriton montanus*

MAMMALS

Endangered

Bobcat, *Lynx rufus*
Eastern Woodrat, *Neotoma floridana*
Sperm Whale *Physeter, macrocephalus***
Fin Whale, *Balaenoptera physalus***
Sei Whale, *Balaenoptera borealis***
Blue Whale, *Balaenoptera musculus***
Humpback Whale, *Megaptera novaeangliae***
Black Right Whale, *Balaena glacialis***

INVERTEBRATES

Endangered

Mitchell's Satyr (butterfly), *Neonympha m. mitchellii***
Northeastern Beach Tiger Beetle, *Cicindela d. dorsalis*
American Burying Beetle, *Nicrophorus americanus***
Dwarf Wedge Mussel, *Alasmidonta heterodon***

**Federally endangered

FISH

Endangered

Shortnose Sturgeon, *Acipenser brevirostrum***

List revisions: March 29, 1979
January 17, 1984
May 6, 1985
July 20, 1987
June 3, 1991

ENDANGERED AND NONGAME SPECIES PROGRAM
GO WILD FOR WILDLIFE
CHECK-OFF N.J. Income Tax Conservation Fund
N.J. Division Fish·Game·Wildlife

The lists of New Jersey's endangered and nongame wildlife species are maintained by the DEP&E's Division of Fish, Game and Wildlife's, Endangered and Nongame Species Program. These lists are used to determine protection and management actions necessary to insure the survival of the State's endangered and nongame wildlife. This work is made possible only through voluntary contributions received through the Wildlife Check-off on the New Jersey State Tax Form. The Wildlife Check-off is the only major funding source for the protection and management of the State's endangered and nongame wildlife resource. For more information about the Endangered and Nongame Species Program or to report a sighting of endangered or threatened wildlife contact: Endangered and Nongame Species Program, Northern District Office, Box 383 R.D. 1, Hampton, N.J. 08827 or call (908) 735-8975.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix E

Cultural Resources

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

PHASE I
SUBMERGED AND SHORELINE CULTURAL RESOURCES INVESTIGATIONS AND HYDROGRAPHIC SURVEY LONG BEACH ISLAND OCEAN COUNTY, NEW JERSEY

CONTRACT DACW61-94-
D-0010 DELIVERY ORDER #47
MODIFICATION #2

DEPARTMENT OF THE ARMY U.S.
ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT

Prepared by: **Hunter Research, Inc. 120 West State Street Trenton, NJ 08608**

Dolan Research, Inc.
4425 Osage Avenue
Philadelphia, PA 19104

Enviroscan, Inc.
1051 Columbia Avenue
Lancaster, PA 17603

Submitted to:

U.S. Army Corps of Engineers
Philadelphia District
The Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Prepared under the supervision of:

____

Richard W. Hunter (Hunter Research, Inc.) Principal Investigator

August 1998 (final submission March 1999)

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

MANAGEMENT SUMMARY

This report describes the results of a Phase I submerged and shoreline cultural resources investigation performed for four segments, totaling 10.5 miles, of the tidal and near-shore zone along New Jersey's Atlantic coast and three proposed offshore sand borrow areas in Ocean County, New Jersey. This study was performed in connection with a program of beach nourishment and shoreline erosion control planned by the Philadelphia District of the U.S. Army Corps of Engineers. Investigative tasks included: background and documentary research; visual inspection and magnetic survey of the shoreline areas at low tide; remote sensing survey of the offshore borrow areas and the near-shore sand placement areas; hydrographic survey of the offshore borrow areas; analysis and evaluation of assembled research and field data; and preparation of this report.

No evidence of prehistoric archaeological resources was noted along the shoreline survey areas, either within the tidal zone or in the adjacent near-shore zone, or at the offshore sand borrow areas. The potential for inundated resources surviving in these areas remains unclear, in part because of the difficulties of reconstructing the paleoenvironment along a fluctuating coastal area. The overall prospect of significant archaeological survival is probably quite limited owing to ongoing coastal erosion. If buried resources do indeed survive within the shoreline survey areas, the beach replenishment process should serve to enhance resource preservation and protection. To address the possibility of prehistoric archaeological resources surviving within the offshore borrow areas and being affected by dredging, a program of controlled, periodic archaeological monitoring of the renewed beach surface is recommended during and immediately following the replenishment operation. No further survey-level investigation for these types of resources is recommended.

In the course of visual inspection of the shoreline, a number of late 20th-century resources were identified (e.g., pilings, timbers, jetties/groins). None of these features were judged to be significant archaeological resources suitable for inclusion in the State or National Registers of Historic Places. A single house was identified in Harvey Cedars (at the edge of Survey Area A) which may retain some archaeological integrity as a historic structure. Further study would be required to provide a full evaluation of the historical significance of this house. However, since the placement of additional sand on the beach is not expected to affect resources to the west of the high water line (such as private residences), no further study is felt to be appropriate in this instance.

Twenty-five magnetic targets were identified within the tidal zone during the pedestrian magnetometer survey of the four shoreline survey areas. Five of these magnetic signatures (four in Area A and one in Area D) may represent potentially significant cultural resources. Remote sensing survey of the four near-shore sand placement areas resulted in the identification of an additional three targets (all adjacent to Area A) which may represent significant submerged cultural resources. As noted above, placement of additional sand on the beach within the tidal and near-shore zone will protect the source of these magnetic anomalies, and no further study is considered necessary for these targets. The targets should be clearly recorded for future reference and sand placement should be undertaken with particular care in these locations.

One magnetic target, possibly deriving from a shipwreck, was identified in proposed offshore Borrow Area D. Additional Phase I-level underwater archaeological investigation is recommended for this target. If further study shows this target to be a potentially significant underwater resource, such as a shipwreck, consideration should be given to avoiding this location during sand borrowing. If this is not feasible, further Phase II-level investigation is recommended to clarify the character of this potentially significant resource and to evaluate its eligibility for inclusion in the National Register of Historic Places.

TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF PLATES AND TABLES

ACKNOWLEDGEMENTS

Various individuals contributed to the completion of this project. Special thanks are extended to the staff of the Philadelphia District of the U.S. Army Corps of Engineers, and in particular Michael Swanda, Archaeologist, Environmental Resources Branch, for providing project-related materials, information and advice.

Thanks are due to the staff of the New Jersey State Historic Preservation Office and the New Jersey State Museum, who assisted us in using these agency's site maps and files. Thanks are also extended to the staffs of the the New Jersey State Library and the Long Beach Island Historical Society Museum for their assistance in identifying relevant archival materials and historic maps.

Background research for this survey was performed by Damon Tvaryanas and Sarah Waters of Hunter Research. The shoreline pedestrian visual survey was conducted by Damon Tvaryanas, Sarah Waters, Diane Kimbrell-Howell and Jennifer Estabrooke of Hunter Research. The pedestrian magnetometer survey was conducted by Timothy Bechtel of Enviroscan. The near-shore and offshore remote sensing survey was performed by Lee Cox, Wess Hall and Ralph Wilbanks of Dolan Research. The report graphics were produced by Paul Jung and Dawn Turner of Hunter Research, Timothy Bechtel of Enviroscan and Jason Fantom of Dolan Research. The prehistoric, terrestrial and general sections of the project report were prepared by Damon Tvaryanas, Sarah Waters and Richard Hunter of Hunter Research. The pedestrian magnetometer survey portion of the project report was prepared by Timothy Bechtel of Enviroscan. The near-shore and offshore remote sensing portions of the project report were prepared by Lee Cox of Dolan Research. Final editing and final report assembly were carried out by Michael Tomkins.

Richard Hunter, M.A., S.O.P.A, Hunter Research, Inc.
Principal Investigator

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

CHAPTER 1

INTRODUCTION

A. Project Background and Scope-of-Work

The following technical report describes a Phase I submerged and shoreline cultural resources investigation conducted along an 18-mile stretch of Atlantic coastline extending between Barnegat Inlet and Little Egg Inlet, Ocean County, New Jersey (Figure 1.1). This work was performed in connection with U.S. Army Corps of Engineers (USACOE) studies of shoreline erosion problems along New Jersey's Atlantic shoreline and the agency's development of plans for remedial beach nourishment. The survey specifically addressed four segments of shoreline along the southeastern margin of Long Beach Island (totaling approximately 10.5 miles) where beach nourishment is envisioned and the locations of three proposed offshore sand borrow areas (totaling approximately 1,055 acres) and four proposed near-shore sand borrow areas (totaling approximately 320 acres).

The cultural resources investigations reported here represent part of a program of ongoing environmental studies that the USACOE is carrying out in cooperation with the New Jersey Department of Environmental Protection. The work was carried out as Delivery Order No. 47 and Modification No. 2 under Contract DACW61-94-D-0010 between Hunter Research, Inc. and the U.S. Army Corps of Engineers (Philadelphia District). Dolan Research, Inc. and Enviroscan, Inc. operated as subconsultants to Hunter Research for these studies, supplying, respectively, offshore and onshore remote sensing expertise. Hydrographic survey services were provided by *Hydrographic Surveys* working as a subconsultant to Dolan Research.

The cultural resources investigations involved two principal work elements:

1). a Phase I-level terrestrial cultural resources survey designed to locate and identify any remains of prehistoric and historical archaeological resources along four non-contiguous segments of shoreline located between Barnegat Inlet and Little Egg Inlet:

Area A - located between Dolphin Street and North 17th Street, within the municipalities of Loveladies, Long Beach Township; Harvey Cedars Borough; Frazier Park, Long Beach Township and Surf City Borough.

Area B - located between South 22nd Street and Stockton Street, within the municipalities of Ship Bottom Borough; Brant Beach and Beach Haven Crest, Long Beach Township.

Area C - located between Nebraska Boulevard and 27th Street, within the municipality of Long Beach Township and containing the communities of Beach Haven Park, Haven Beach, Beach Haven Terrace, Beach Haven Gardens, and Spray Beach.

Area D - located between 6th Street and Webster Avenue, within the municipalities of Beach Haven Borough and Holgate, Long Beach Township.

2). a Phase I-level underwater archaeological remote sensing and hydrographic survey designed to locate targets associated with

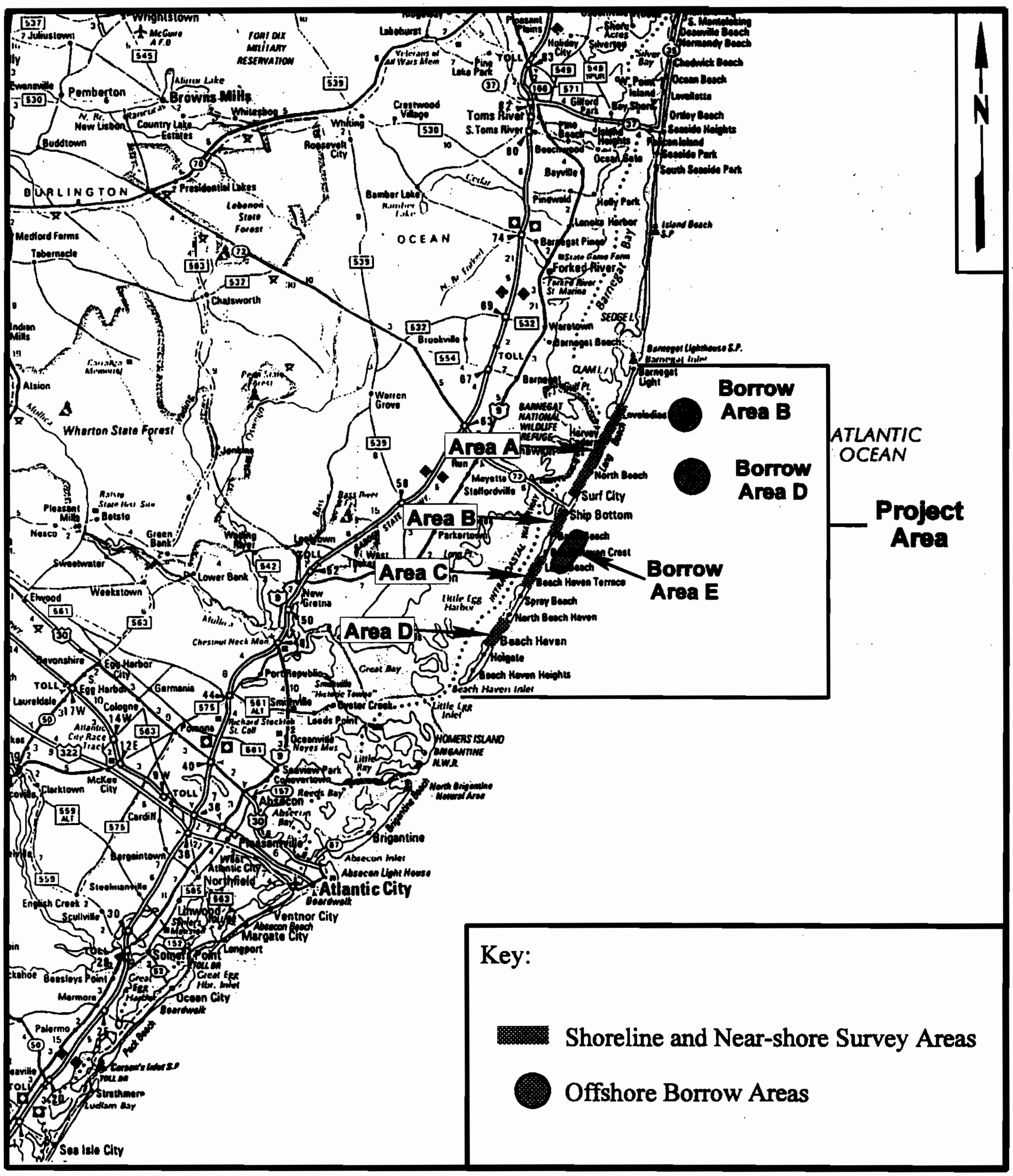


Figure 1.1. General Location of Shoreline and Near-shore Survey Areas and Offshore Borrow Areas. Source: U.S. Geological Survey 1978. Scale 1 inch: 8 miles (approximately).

submerged archaeological resources within the four near-shore sand placement areas (immediately offshore from Areas A-D as shown above) and three proposed offshore sand borrow areas situated offshore from the communities of Loveladies (Borrow Area B), Harvey Cedars (Borrow Area D) and Beach Haven Crest/Brant Beach (Borrow Area E).

Tasks performed included: background and documentary research (for both the underwater and terrestrial surveys); a visual inspection and pedestrian magnetometer survey of the four shoreline segments (carried out at low tide); acoustic and magnetic remote sensing with follow-up target analysis (underwater survey only); bathymetric and hydrographic survey (underwater survey only); analysis of assembled research and field data; and preparation of this report. The purpose of these investigations was twofold: 1). to determine the presence or absence of submerged or shoreline cultural resources that are potentially eligible for inclusion in the National Register of Historic Places in areas which might be affected by proposed beach nourishment and sand borrow activities; and 2). to assess likely project impacts and make recommendations as to the need for further cultural resources studies, if potentially significant resources are identified which may be adversely affected by the proposed project actions.

These investigations were conducted in accordance with the instructions and intents of various applicable Federal and State legislation and guidelines governing the evaluation of project impacts on archaeological resources, notably: Section 101(b)(4) of the National Environmental Policy Act of 1969; Section 1(3) and 2(b) of Executive Order 11593; Section 106 of the National Historic Preservation Act; 23 CFR 771, as amended October 30, 1980; the guidelines developed by the Advisory Council on Historic Preservation published November 26, 1980; the amended Procedures for the Protection of Historic and Cultural Properties as set forth in 36 CFR Part 800 (October 1, 1986); and New Jersey Executive Order 215.

B. Criteria of Evaluation

The information generated by these investigations was considered in terms of the criteria for evaluation outlined by the U.S. Department of the Interior, National Register Program:

The quality of significance in American history, architecture, archaeology and culture is present in districts, sites, buildings, structures and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:

A. that are associated with events that have made a significant contribution to the broad patterns of our history; or

B. that are associated with the lives of persons significant in our past; or

C. that embody the distinctive characteristics of a type, period or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

D. that have yielded, or may be likely to yield information important in prehistory or history.

National Register of Historic Places Bulletin 20 clarifies the National Register review process with regard to shipwrecks and other submerged cultural resources. Shipwrecks must meet at least one of the above criteria and retain integrity of location, design, settings, materials, workmanship, feelings and association. Determining the significance of a historic vessel depends on establishing whether the vessel is:

1. the sole, best, or a good representative of a specific vessel type; or

2. is associated with a significant designer or builder; or

3. was involved in important maritime trade, naval recreational, government, or commercial activities.

Properties which qualify for the National Register, must have significance in one or more "Areas of Significance" that are listed in National Register Bulletin 16A. Although 29 specific categories are listed, only some are relevant to the submerged cultural resources. Architecture, commerce, engineering, industry, invention, maritime history and transportation are potentially applicable data categories for the type of submerged cultural resources which may be expected in the study areas.

Ordinarily, cemeteries, birthplaces or graves of historical figures, properties owned by religious institutions or used for religious purposes, structures that have been moved from their original locations, reconstructed historic buildings, properties primarily commemorative in nature, and properties that have achieved significance within the past 50 years shall not be considered eligible for the National Register. However, such properties will qualify if they are integral parts of districts that do meet the criteria or if they fall within the following categories:

A. a religious property deriving primary significance from architectural or artistic distinction or historical importance; or

B. a building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

C. a birthplace or grave of a historical figure of outstanding importance if there is no other appropriate site or building directly associated with his productive life; or

D. a cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

E. a reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

F. a property primarily commemorative in intent of design, age, tradition, or symbolic value has invested it with its own historic significance; or

G. a property achieving significance within the past 50 years if it is of exceptional importance.

C. Definition of Terms

The following definitions are from the Department of the Interior, National Register of Historic Places 36 CFR 63 (Federal Register, Vol. 42, No. 183, Wed. Sept. 21, 1977, pp. 47666-67):

1. A "site" is the location of a significant event, or prehistoric or historic occupation or activity or a building or structure whether standing, ruined, or vanished where the location itself maintains historical or archaeological value regardless of the value of any existing structures.

2. A "building" is a structure created to shelter and form of human activity such as a house, barn, church, hotel or similar structure. "Buildings" may refer to a historically related complex, such as a courthouse and jail or a house and barn.

3. A "structure" is a work make up of interdependent and interrelated parts in a definite pattern or organization. Constructed by man, it is often an engineering project large in scale.

4. An "object" is a material thing of functional, aesthetic, cultural, historical, or scientific value that may be, by nature or design, movable yet related to a specific setting or environment.

D. Previous Research and Principal Information Sources

Several cultural resource surveys have been completed in and close to the project area.

In 1977 an archaeological survey was conducted in conjunction with a proposed waste water collection facility for the town of Manahawkin and its environs in Stafford Township. As part of this investigation, Bonnet Island, a small body of land located in Manahawkin Bay, a few hundred feet to the west of Surf City, was subjected to a program of background research, field inspection and limited subsurface testing. Although this investigation identified several historic cultural resources on the mainland in the vicinity of Manahawkin, none were identified on Bonnet Island or within the general vicinity of the project area (Mounier 1977).

In 1990, Archaeologist R. Alan Mounier completed a second cultural resources survey in the vicinity of the project area. This investigation was undertaken for a proposed transatlantic telecommunications cable alignment which was to cut across Manahawkin Bay and traverse Long Beach Island along Bergen Avenue in North Beach. This work also included field inspection and selective subsurface testing. No prehistoric or historic resources of interest were found within the project corridor. Mounier noted severely disturbed landscapes on Long Beach Island from the ocean to the bay (Mounier 1990).

Despite a statewide survey of archaeological resources conducted in the early part of this century (Skinner and Schrabisch 1913) and more recent cultural resource investigations, no confirmed prehistoric sites have been identified either within the tidal zone of the current project area or on Long Beach Island itself. New Jersey State Museum site maps show four sites (sites 28Oc35, 28Oc37, 28Oc38 and 28Oc39) on the bay side of the island, but these sites have been incorrectly mapped. These site numbers in fact relate to a series of small shell heaps located in the area of Barnegat (Skinner and Schrabisch 1913; New Jersey State Museum site maps and files).

The apparent absence of documented prehistoric resources may not be a true reflection of prehistoric activity along the shoreline between the Barnegat and Little Egg Harbor Inlets. This area was highly developed in the late 19th century and first half of the 20th century, and the systematic identification of archaeological sites has only taken place in recent decades. The resource maps of the New Jersey Historic Preservation Office do, in fact, record that prehistoric artifacts have occasionally been recovered from the floor of Manahawkin Bay and many prehistoric sites are known to exist nearby on the mainland.

No potentially significant historical archaeological resources have been previously documented along the tidal shoreline and tidal zone of the current project area. Numerous shipwrecks, however, are known to have occurred along the beaches of Long Beach Island. A list of documented shipwrecks in the Long Beach Island vicinity is provided in Appendix A.

While the prehistoric and historic archaeology of this stretch of the Ocean County shoreline has been little studied and scant information is available concerning Native American or early European activity in the area, extensive paleoenvironmental research has been conducted along the Atlantic coastline and in nearby Delaware Bay (e.g., Belknap and Kraft 1977; Kraft 1977a; Kraft et al. 1979; Belknap and Kraft 1981; Kraft et al. 1983). This research has some bearing on the potential for prehistoric resources in the tidal zone and is summarized below in Chapter 3.

Although historic architectural survey was not a primary work component in the current investigation, examination of the maps and files of the New Jersey Historic Preservation Office indicate that there are several historic resources in the project vicinity currently listed in the State and National Registers of Historic Places. These are the Barnegat City Public School (now the Barnegat Light Museum, SR 12/08/75, NR 06/07/76), Barnegat Lighthouse (SR 9/11/70, NR 06/07/76), the Beach Haven Historic District (including the Dock Road Historic District, SR 4/20/83, NR 7/14/83), Converse Cottage (SR 04/20/83, NR 07/14/83), Sherbourne Farm (SR 04/20/83, NR 07/14/83) and the Dr. Edward H. Williams House (04/20/83, NR 07/14/83). The last four resources are all included within the Beach Haven Multiple Resource Area. In 1981, the New Jersey Historic Sites Survey inventoried the historic resources of Long Beach Island and generated an additional list of potentially eligible resources (Table 1.1) (New Jersey Historic Sites Inventory 1981).

Of these previously identified resources, the only ones located in close proximity to the present study area are the Barnegat Lighthouse at 7 East 5th Street in Barnegat, the Ship Bottom Historic District and Aunt Hill. The Barnegat Lighthouse is a mid-19th century 150-foot tall lighthouse located at the extreme northern tip of the island. The light keeper's house at 7 East 5th Street in Barnegat is a typical example of a late 19th century Long Beach Island cottage. The Ship Bottom Historic District is a district composed primarily of late 19th-century and early 20th-century summer cottages which on its east abuts the beach front. Aunt Hill is another late 19th-century cottage and is notable for being one of the oldest buildings in Spray Beach. Of these resources only the Barnegat Lighthouse is actually listed in either the State or National Registers, and none are located directly on the beach or in the tidal zone.

A wide variety of information sources have been consulted during the course of this study. Basic information sources routinely examined for all aspects of USACOE cultural resources work in New Jersey include: the site maps, files, technical reports and planning documents held by the New Jersey Historic Preservation Office and the New Jersey State Museum; archival data and published historical materials held by the New Jersey State Archives and the New Jersey State Library; and materials held by the Philadelphia District offices of the USACOE.

E. Research Methodology and Research Design

From a methodological standpoint, since this cultural resources investigation focused chiefly on the potential for submerged resources in the offshore borrow area and shoreline resources within the tidal zone, a strongly cartographic and geographic approach was adopted for the

TABLE 1.1 LIST OF LONG BEACH ISLAND HISTORIC RESOURCES RECOMMENDED FOR THE STATE AND NATIONAL REGISTERS [New Jersey Historic Sites Inventory, 1981]

Resource Name	Location
Beach Haven	
Historic Resources of Beach Haven (District Nomination)	Pearl to 2nd Street between Atlantic & Bay Avenues
“The Shore”	319 Liberty Avenue
Old Dock Road Historic District	West Avenue & Dock Road; east to Bay Avenue
Beach Haven Heights	
Life Saving Station	West & Pershing Avenues
Spray Beach	
Aunt Hill	Atlantic Avenue & 25th Street
Beach Haven Terrace	
Life Saving Station	Ocean & Beach Avenues
Brant Beach	
Brant Beach Railroad Station	Stanton Avenue & Long Beach Boulevard
Loveladies	
Loveladies Life Saving Station	Long Beach Boulevard & Station Avenue
Ship Bottom	
Ship Bottom Historic District	25th to 27th Street; east from Central Avenue
Life Saving Station #20	117 East Ship Bottom Avenue
Harvey Cedars	
Harvey Cedars Hotel	Atlantic & Cedars Avenues
Life Saving Station	East Cape May Avenue & Long Beach Boulevard
Barnegat Light	
Benjamin Archer House	Central & 12th Streets
Zieber House	7 East 12th Street
12 East 12th Street	12 East 12th Street
Larsen House	16 East 12th Street
Old Archer House	18 East 12th Street
Railroad Station	West 11th Street
11th and Central Avenue	11th and Central Avenue
Haddock House	Central Avenue between 6th & 7th Streets
7 East 5th Street	7 East 5th Street
Peckworth House	4 West 5th Street

Bailey House	West 4th Street
Independent Fishery Historic District	Along Barnegat Bay near 18th Street

background research. Emphasis was placed initially on mapping known and suspected resources, and analyzing these locations in relation to changes in sea level, shoreline configuration and land use. Cartographic research was supplemented with oral historical research, a review of secondary sources and consideration of paleogeographic issues. Fieldwork focused chiefly on gathering remote sensing and hydrographic information (for the underwater survey) and on performing a pedestrian magnetometer survey and visual inspection (for the terrestrial survey). At this level of investigation, a non-intrusive landscape and literature-based approach to the study of cultural resources provides the most effective means of assessing archaeological potential without engaging in a complex and expensive program of subsurface investigation and diving.

The potential for prehistoric resources was assessed with reference to standard texts on New Jersey prehistory (e.g., Kraft 1986) and available preservation planning documents, including the overall framework and specific historic contexts for the New Jersey Comprehensive Historic Preservation Plan (e.g., Grumet 1990) and the earlier definition of key archaeological research issues (e.g., Chesler 1982). In framing research questions concerning historic resources, the project area was considered to possess a low potential for all types of historic resources, except shipwrecks, since most of it presently lies underwater and has been (or has become) inundated during the historic period.

The offshore borrow areas were considered to have a moderate potential for shipwrecks, a condition that could be most effectively examined through systematic documentary research, remote sensing and hydrographic survey (for detail on the remote sensing and hydrographic methodologies, see below, Chapter 5). Documentary research aimed to provide a framework for identifying submerged historic archaeological resources which may have been deposited within the three offshore borrow areas or within the four tidal zones, and to determine the extent of subsequent activities that may have removed or disturbed such resources. While the emphasis of this research focused chiefly on maritime activity in the project vicinity, a broad-based historic overview is also presented (see below, Chapter 4) in order to supply an appropriate framework for assessing the potential significance of submerged and shoreline cultural resources of the historic period. Historic maps, primary and secondary shipwreck lists, primary historical accounts, newspapers, and county and thematic histories were all used to develop a set of expected resources within the project area. Knowledgeable local residents and other experts on New Jersey history and archaeology were also contacted. Data from the background research was also used to generate a list of shipwrecks and ship losses along this section of the Atlantic shore (see below, Appendix A).

CHAPTER 2 GEOGRAPHICAL SETTING

The study areas examined during this investigation are located along an 18-mile stretch of the Atlantic coastline between Barnegat Inlet and Little Egg Inlet (Figure 1.1). In total, they comprise approximately 10.5 miles of shoreline and tidal zone, 320 acres of near-shore area and 1,055 acres of offshore area.

The terrestrial portions of the study area lie within the Outer Lowland subprovince of the Atlantic Coastal Plain physiographic zone, which begins roughly at the entrance to New York Harbor and terminates approximately at the entrance to Delaware Bay. Overall, the topography of the Coastal Plain is characterized by level to gently rolling terrain, with more than one-half of the surface area lying below 100 feet above sea level. Much of the area examined during this study lies at or below sea level and is subject to tidal fluctuation. The underlying geology consists of the Pleistocene sands and gravels of the Cape May Formation which were originally laid down in the Sangamon interglacial stage. These deposits mask earlier sediments of Cretaceous age (Wolfe 1977:138-139,

288-290).

The northernmost of the three sand borrow areas, Borrow Area B, is located approximately 15,000 feet south of Barnegat Inlet and approximately 8,700 feet east of Loveladies. Borrow Area D is located 33,000 feet south of Barnegat Inlet and approximately 18,000 feet east of Surf City. Borrow Area E is approximately 60,000 feet south of Barnegat Inlet and approximately 6,000 feet east of Beach Haven Crest and is the closest borrow area to the shoreline.

A. Shoreline Survey Areas

The terrestrial survey areas consist of four separate segments of shoreline (Areas A-D) covering a total of 10.5-miles of Long Beach Island ocean front and including approximately 320 acres of the adjacent near-shore zone extending seaward (see below). Area A is located between Dolphin Street and North 17th Street, within the municipalities of Loveladies, Long Beach Township; Harvey Cedars Borough; Frazier Park, Long Beach Township and Surf City Borough. Area B is located between South 22nd Street and Stockton Street, within the municipalities of Ship Bottom Borough; Brant Beach and Beach Haven Crest, Long Beach Township. Area C is located between Nebraska Boulevard and 27th Street, within the municipality of Long Beach Township and contains the communities of Beach Haven Park, Haven Beach, Beach Haven Terrace, Beach Haven Gardens, and Spray Beach. Area D is located between 6th Street and Webster Avenue, within the municipalities of Beach Haven Borough and Holgate, Long Beach Township.

Long Beach Island is a coastal barrier island located between Barnegat Inlet to the north and Little Egg Inlet to the south. It is separated from the mainland by Little Egg Harbor (between Beach Haven Heights and Ship Bottom), Manahawkin Bay (between Surf City and Barnegat Light) and other less defined bay areas dominated by large patches of marshland and numerous small islands. The harbor and the bay are part of the New Jersey portion of the Intracoastal Waterway, which extends from Point Pleasant, Monmouth County to Cape May, Cape May County.

The soils in the Long Beach Island study areas have been classified as belonging to the Fripp series (FtB). This soil group consists of deep, excessively drained soils formed in sandy coastal dune sediments. The land formation is composed of nearly level and gently sloping sand dunes with areas developed for residential and commercial use. The foredunes have a sparse grass and shrub cover and their shape is continually changed by the wind, while the backdunes remain more stable. As the dunes are at a low elevation, they are subject to tidal and storm flooding and a constant spraying of salty water, which typically leads to severe erosion in unvegetated areas. The shape of the shoreline dunes are continually being changed by these forces and thus retain no soil profile development (Hole and Smith 1980). The northern end of Long Beach Island is less developed in the area of Barnegat National Wildlife Refuge, but the rest of the island, especially to the south, is dominated by intense suburban/resort-related development.

B. Near-shore Survey Areas

The near-shore sand placement areas are situated immediately adjacent to the shoreline of the four terrestrial survey areas defined above. Water depths across the area range from mean low water (MLW) datum to 12 feet (MLW). Coordinates for the corners of the near-shore areas are expressed in the New Jersey State Plane Coordinate System (NAD 83) as follows:

Area A - Loveladies to Surf City (between Dolphin Street & North 17th Street)

Point #	Northing	Easting
1	329,927	601,188
2	302,723	588,552

Area B - Ship Bottom to Brant Beach (between South 22nd Street & Stockton Street)

Point #	Northing	Easting
1	295,518	583,905
2	285,324	578,358

Area C - Long Beach Township (between Nebraska Boulevard & 27th Street)

Point #	Northing	Easting
1	279,427	575,139
2	271,488	570,795

Area D - Beach Haven (between 6th Street & Webster Avenue)

Point #	Northing	Easting
1	266,933	568,437
2	258,721	562,470

C. Offshore Borrow Areas

Borrow Area B is irregular in shape with its longest axis oriented northeast-southwest direction. Water depths across the borrow area range from 28 feet (MLW) to 33 feet (MLW). Coordinates for the corners of Borrow Area B are expressed in the New Jersey State Plane Coordinate System (NAD 83) as follows:

Site Name		Northings	Eastings
Borrow	(1)	325,827.281	610,362.000
Area B	(2)	325,352.031	609,280.312
	(3)	324,204.875	609,540.500
	(4)	324,145.312	606,533.750
	(5)	323,471.188	604,999.438
	(6)	322,249.312	608,550.250
	(7)	322,147.281	604,975.562
	(8)	321,983.156	607,787.312
	(9)	320,994.969	604,954.750

Borrow Area D is irregular in shape with its longest axis generally oriented in a northeast-southwest direction. Water depths range from between 39 feet (MLW) and 49 feet (MLW). Coordinates for the corners of Borrow Area D are expressed in the New Jersey State Plane Coordinate System (NAD 83) as follows:

Site Name		Northings	Eastings
Borrow	(1)	308,319.688	611,359.375
Area D	(2)	306,346.094	609,237.750
	(3)	306,298.406	609,186.500
	(4)	305,578.250	610,141.000
	(5)	305,230.938	606,457.875
	(6)	304,341.500	609,591.312
	(7)	304,137.938	603,664.062
	(8)	303,461.938	601,936.125
	(9)	303,349.719	608,971.438
	(10)	302,781.875	602,856.688
	(11)	301,741.625	606,438.812
	(12)	300,999.250	605,269.625

Borrow Area E is irregular in shape with its longest axis oriented in a northeast-southwest direction, generally paralleling the Long Beach Island shoreline. Water depths across the borrow area range from 15 feet (MLW) to 30 feet (MLW). Coordinates for Borrow Area E are expressed in the New Jersey State Plane Coordinate System (NAD 83) as follows:

Site Name		Northings	Eastings
Borrow	(1)	287,584.781	584,570.062
Area E	(2)	287,294.938	585,106.188
	(3)	287,163.094	584,207.188
	(4)	285,719.031	584,167.625
	(5)	284,889.094	582,250.438
	(6)	284,192.562	583,258.438
	(7)	283,346.438	580,923.000
	(8)	283,317.781	582,403.312
	(9)	282,730.531	580,180.312
	(10)	281,780.469	580,900.562
	(11)	281,257.188	580,230.500
	(12)	280,815.531	577,871.062
	(13)	279,688.281	576,511.750
	(14)	279,410.781	577,866.000
	(15)	279,255.875	577,667.625

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

CHAPTER 3

PALEOENVIRONMENT AND PREHISTORIC BACKGROUND

A. Mid-Atlantic Coastal Plain Prehistory

Atlantic coastal regions are among the most dynamic environments currently found on earth, and dynamic change was no less of a hallmark in the prehistoric past. As a consequence, paleoenvironmental reconstruction for any given coastal geographical location, such as the Middle Atlantic coastal zone, is an extraordinarily complex task fraught with uncertainty and a sparsity of scientific data.

The Pleistocene Epoch witnessed a series of cold periods and associated "ice ages," the most recent of which terminated approximately 14,000 to 12,000 years ago. One of the most dramatic effects of these "ice ages" was the lowering of ocean levels worldwide as sea water was frozen and trapped in glaciers and continental ice sheets. Milliman and Emery (1968) argue on the basis of 80 radiocarbon samples taken along the Atlantic continental shelf that sea levels 30,000 to 35,000 years ago were close to those at present. Sea levels dropped subsequently as much as 130 meters during the final Wisconsinan glacial advance around 16,000 years ago. Along the Atlantic coast, ocean beaches during this period lay at the edge of the modern continental shelf, perhaps 100 kilometers east of the modern New Jersey coastline (Figure 3.1). Belknap and Kraft (1977) question the maximum depth of sea level drop, but agree with the overall pattern.

Overall climatic patterns have changed on a regional and continental basis during the Holocene Epoch, which began at the end of the Pleistocene. Sea levels have continued to rise as a result of the release of water from melting ice sheets. As the sea level rose, it began to transgress, or cover, the land mass of the Coastal Plain (the modern Atlantic continental shelf) to the west. The Holocene marine transgression, or sea level rise, began around 14,000 years ago and proceeded rapidly until around 7,000 years ago (Milliman and Emery 1968; Kraft et al. 1983). The temporal progress of this westward movement of the coastline, which continues at present, is illustrated in Figure 3.1.

The implications of such dynamic changes for any paleoenvironmental reconstruction of the physical locations currently occupied by the coastal tidal zones of Ocean County and its near shore areas are profound. Climatic changes resulted in a succession of vegetation types moving northward, while the coastline and associated marine and eustatic environments were approaching from the east. As temperatures warmed and the climate alternated between dry and moister periods during the Holocene, open grassy environments were replaced by boreal evergreen forests and then by deciduous forests. As the coastline steadily approached, the local environment shifted from inland forest to salt tidal marsh to lagoon to coastal sand barrier or nearshore underwater marine deposits. A paleoenvironmental reconstruction must therefore consider both the generally northward-moving vegetational patterns arising from the regional climatic shifts and the westward-moving coastal geomorphological changes associated with coastal environments.

The occupancy of prehistoric man within these dynamic and mobile environments is a primary focus of this study. Human occupation of the Upper Delaware River valley had begun by 11,000-10,500 year B.P. within a boreal forest composed primarily of pine and birch which shifted, as temperatures warmed, to pine and oak (Dent 1979, 1991; Stewart 1990, 1991). Similar vegetation cover extended throughout much of the region, although the presence of favorable

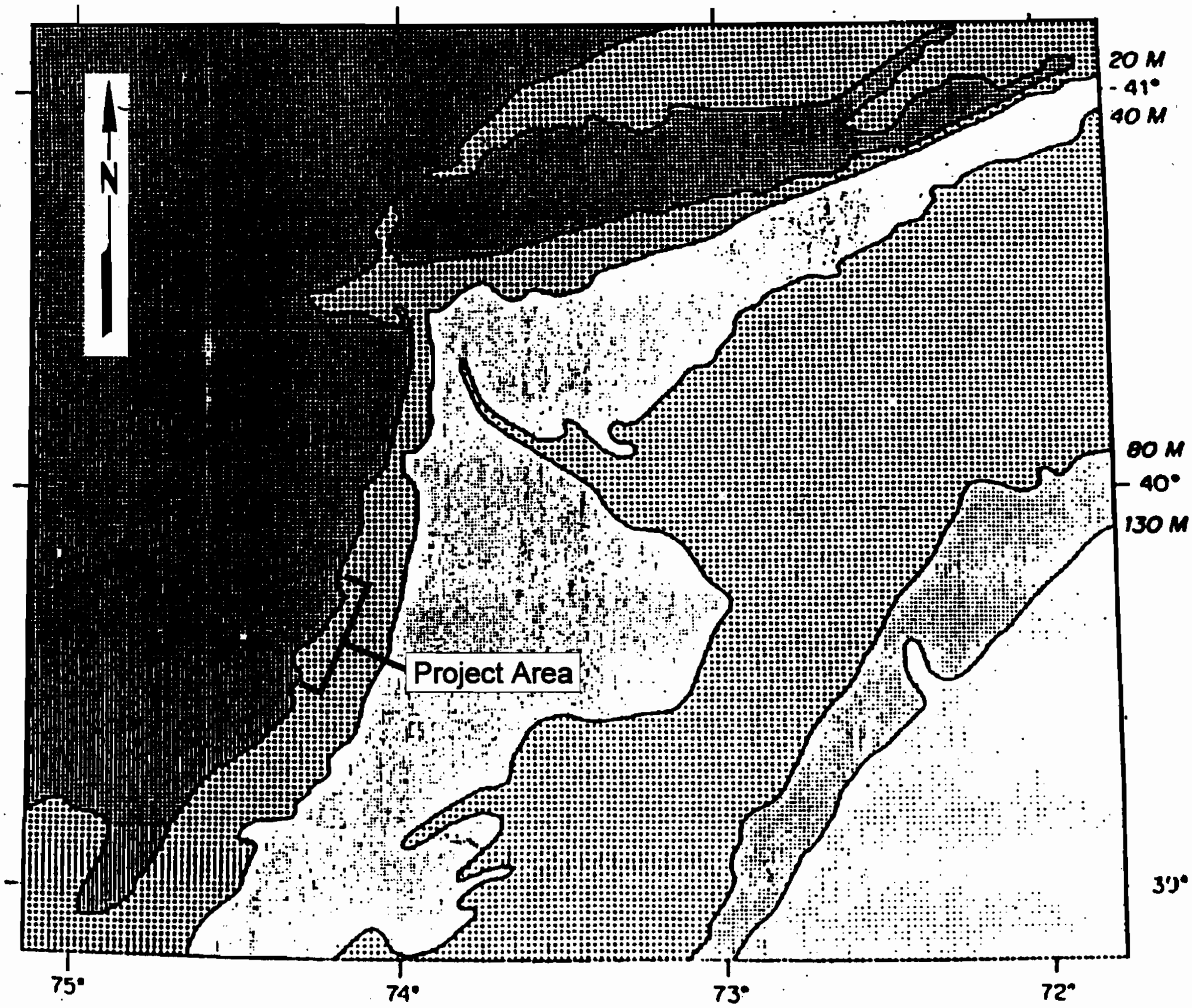


Figure 3.1. Progressive Shifts in Shoreline Positions Along the New Jersey and New York Coasts (Source - Edwards and Emery 1977: Figure 3). General Location of Project Area is Bracketed.

microenvironments arising due to topography, solar exposure and surface water (ponds, lakes and rivers) exerted a considerable influence on prehistoric subsistence and adaptations.

Evidence of Paleo-Indian occupation on the Coastal Plain of New Jersey, generally in the form of isolated fluted point sites (Kraft 1977b; Cavallo 1981; Custer et al. 1983; Bello and Cresson 1995) reflect the presence of early human groups in the region. The point distribution is biased by non-systematic surface collection, but nevertheless provides some indication of the nature of Paleo-Indian adaptations. It is argued that these points and associated finds are indicative of hunting and game processing activities (Bonfiglio and Cresson 1978). Similar tool assemblages from the late Paleo-Indian site of Turkey Swamp (Cavallo 1981) near the boundary between the Inner and Outer Coastal Plains are interpreted as reflecting similar activities.

The distribution of surface finds within the Inner Coastal Plain suggests an association with poorly drained bay/basin features (Bonfiglio and Cresson 1978). Custer et al. (1983) note a difference between the continuous size distribution of fluted points from the Outer Coastal Plain as opposed to the lack of the extremes of unresharpened (longer) and heavily resharpened (short) points on the Inner Coastal Plain, and infer an adaptational difference. A settlement model proposed by Gardner (1977) for the Flint Run Paleo-Indian Complex in Virginia has been introduced to suggest that Paleo-Indian groups on the Outer Coastal Plain pursued a "cyclical" mobility pattern with groups returning to the secondary cobble sources of the Inner Coastal Plain. Those groups which occupied the Inner Plain, on the other hand, enjoyed more ready access to these cobble sources. Lithic procurement was thus "embedded" in other subsistence pursuits (Binford 1979; Goodyear 1979), and groups had less need to curate points and other retouched pieces (Custer et al. 1983).

As indicated in the earlier discussion of transgressing sea levels, the shoreline of Ocean County was not a coastal location at the time of Paleo-Indian occupancy. Edwards and Emery (1977) provide a hypothetical reconstruction of the land area of the Middle Atlantic coast around 10,000 to 12,000 years ago, which serves to illustrate potentially attractive locations for human habitation currently offshore and the eastern positions of environments currently along the Jersey coast (Figure 3.2). The current site of the South Jersey coastline was covered by inland forest, probably with surface water locations. Thus, any evidence of Paleo-Indian occupation in the vicinity of the project area would not relate directly to coastal environments but to exploitation of inland forest/riverine habitats.

Paleo-Indian hunting and gathering groups would, of course, have also occupied coastal areas, but these geographic locations currently lie on the continental shelf and are submerged. Fossil animal remains have been dredged from locations on the shelf (Merrill et al. 1965; Whitmore et al. 1967; Edwards and Emery 1977) which correlate with former estuarine locations and former shorelines, particularly the mid-shelf position of the shoreline around 10,000-9,000 years B.P. (Figure 3.3). The mammoth, oriented to more open habitats, may have occupied the region prior to the arrival of humans, but the forest mastodon was a contemporary of early Paleo-Indians. Deer and possibly caribou would also have been common inhabitants in the early Holocene forests. Fossil remains of walrus indicate the extent to which water temperatures were lower at the end of the Pleistocene and earlier in the Holocene (Edwards and Merrill 1977). The fossil shells of oysters, a shallow estuarine species, have been recovered from the shelf, and are other indicators of the successive relocation of tidal estuaries (Merrill et al. 1965). Artifacts possibly associated with Paleo-Indian/Early Archaic groups are occasionally found

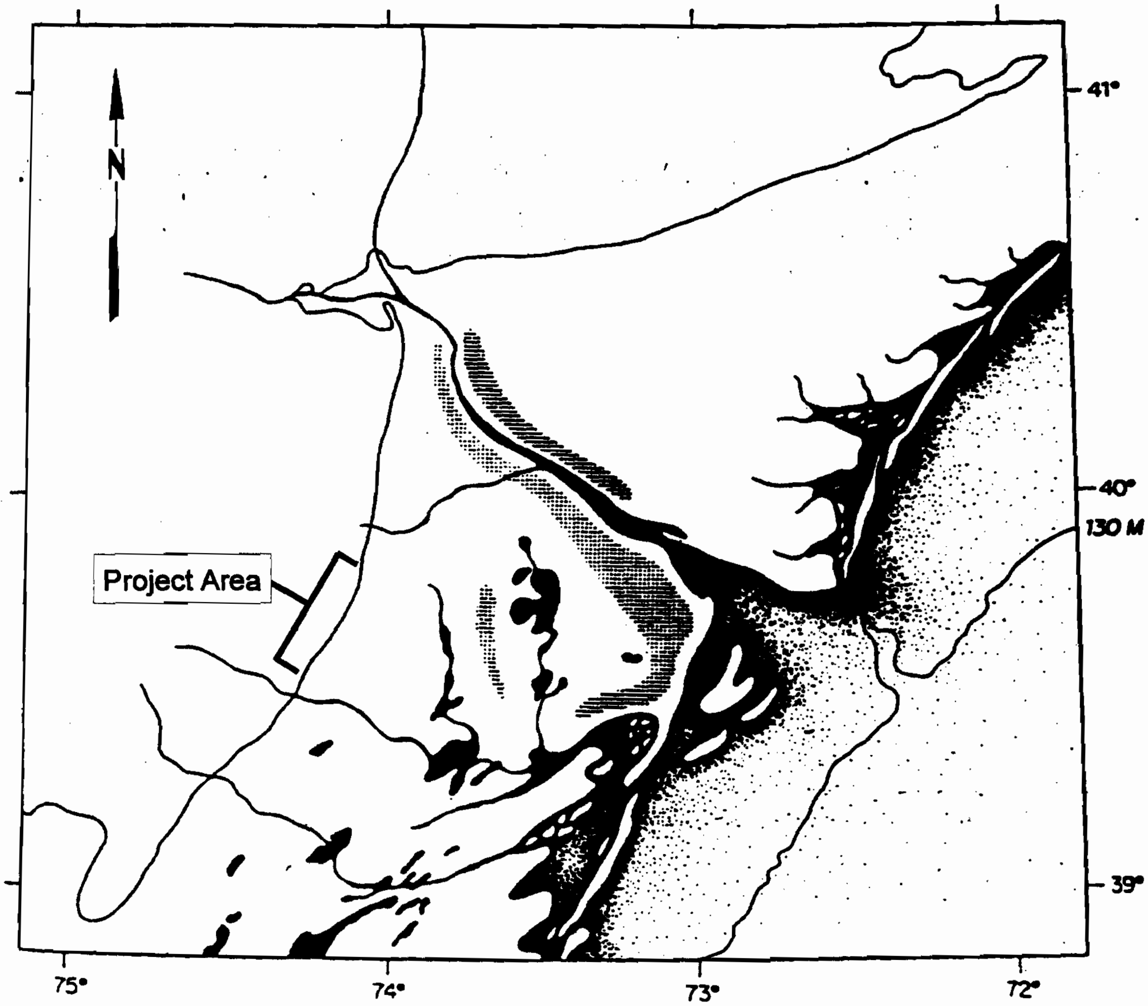


Figure 3.2. A Reconstruction of the Middle Atlantic Coastal Area 10,000 to 12,000 Years Ago (Source - Edwards and Emery 1977: Figure 6). General Location of Project Area is Bracketed.

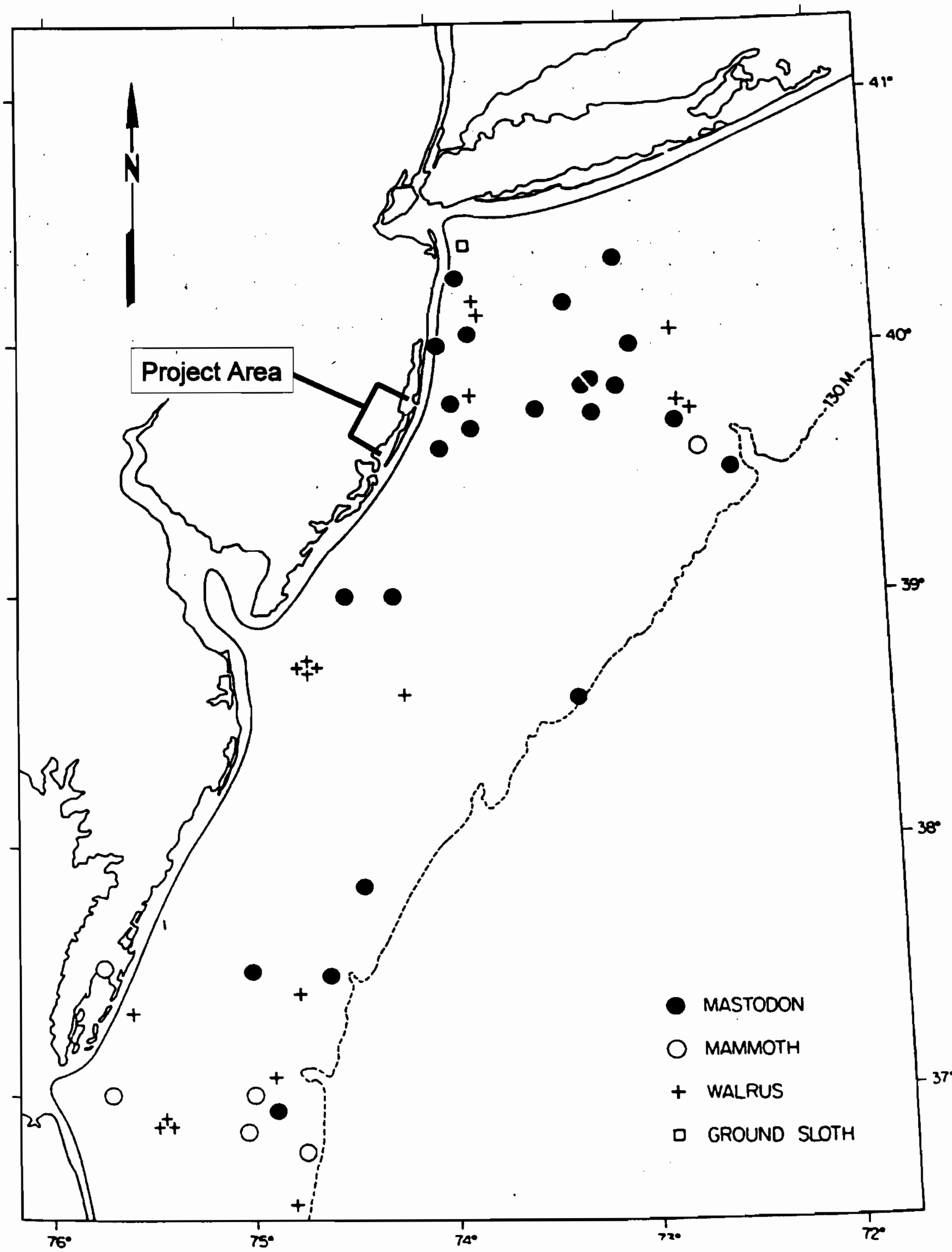


Figure 3.3. Fossil Finds on the Middle Atlantic Continental Shelf (Source - Edwards and Merrill 1977: Figure 11). General Location of Project Area is Bracketed.

in underwater contexts, such as the bifacially-flaked point recovered recently from Blue Hill Bay on the coast of Maine (Crock et al. 1993).

Hypothetical reconstructions of the Middle Atlantic coast between 6,000 and 8,000 years ago (Figure 3.4) suggest estuarine areas were approaching the current coastline location, but that location remained an inland one (Edwards and Emery 1977:Figure 7; see also Kraft 1977a:Figure 24). Tidal salt marshes may have emerged in advance of the transgressing shoreline in South Jersey by 5,000 years ago, and the shoreline achieved its current location approximately 3,000 years B.P. (Kraft 1977a:Figure 27). Climatic conditions were warm and somewhat moister than in the preceding Boreal phase, with oak and hemlock as dominant vegetation species (Deevey 1952; Dent 1979), but perhaps with pine persisting in coastal areas.

This time period coincides with the emergence of another archaeologically-defined human adaptational phase, the Archaic. Material culture changes during the Archaic include the appearance of ground stone tools in addition to flaked stone artifacts. The raw materials utilized for tools also shifts from cryptocrystalline rocks to igneous rhyolite, suggestive of shifts in mobility and possibly in social organization (Custer 1986, 1989). Archaic sites have been attributed to macro-band and micro-band base camps in areas of "maximum habitat overlap" as defined by Custer (1989), such as interior freshwater swamps and bay/basin loci. Coastal tidal salt marshes and estuarine environments would have been food resource-rich habitats available for exploitation.

Climatic changes commencing about 4,600 years B.P. produced the warmest and driest conditions of the current post-glacial period, with oak and hickory becoming dominant tree species. These climatic changes appear to roughly coincide with the emergence of the archaeologically-defined Woodland I phase (Custer 1989). The Woodland I phase is typified by diagnostic lithic forms, an increase in base camps and the appearance of cache pits and ceramic storage vessels, indicative of a greater degree of sedentism. Evidence for long-distance trade/exchange is manifested in the presence of Adena material culture from the Ohio River valley at habitation and mortuary sites dating from around 2,500 to 2,000 years B.P. Increasing exploitation of estuarine resources is noted during the period of Adena influence.

The warm and dry climatic conditions began to yield to a cooler, moister modern climate with oak and chestnut vegetation about 2,000 years B.P., roughly coincident with the waning of Adena influence. By 1,000 years B.P. the trade and exchange network influence had disappeared, and the archaeologically-defined Woodland II phase emerges. Increasing evidence of sedentism is manifested in the expanded use of storage facilities and more permanent house structures. Increased gathering of shellfish and harvesting of plants reflect an intensification of food procurement evidently related to population growth. The emergence of agricultural production is also related to this sedentary settlement pattern which was maintained until European contact. Material culture is typified by distinctive ceramic forms and small triangular projectile points, the latter evidently indicative of bow-and-arrow technology (Custer 1989).

B. Project Area Prehistory

There are no confirmed prehistoric sites within the limits of the shoreline survey areas. The nearest recorded sites comprise a cluster of half a dozen resources lying approximately six miles to the northwest on the mainland. The closest of these sites is 28Oc40, a shell heap located on the point between Waretown and Barnegat Light. The Waretown Creek Site (28Oc43), another shell midden, is located a few miles to the north of 28Oc40 near the mouth of Waretown Creek. Site 28Oc42, less than a mile to the north of the

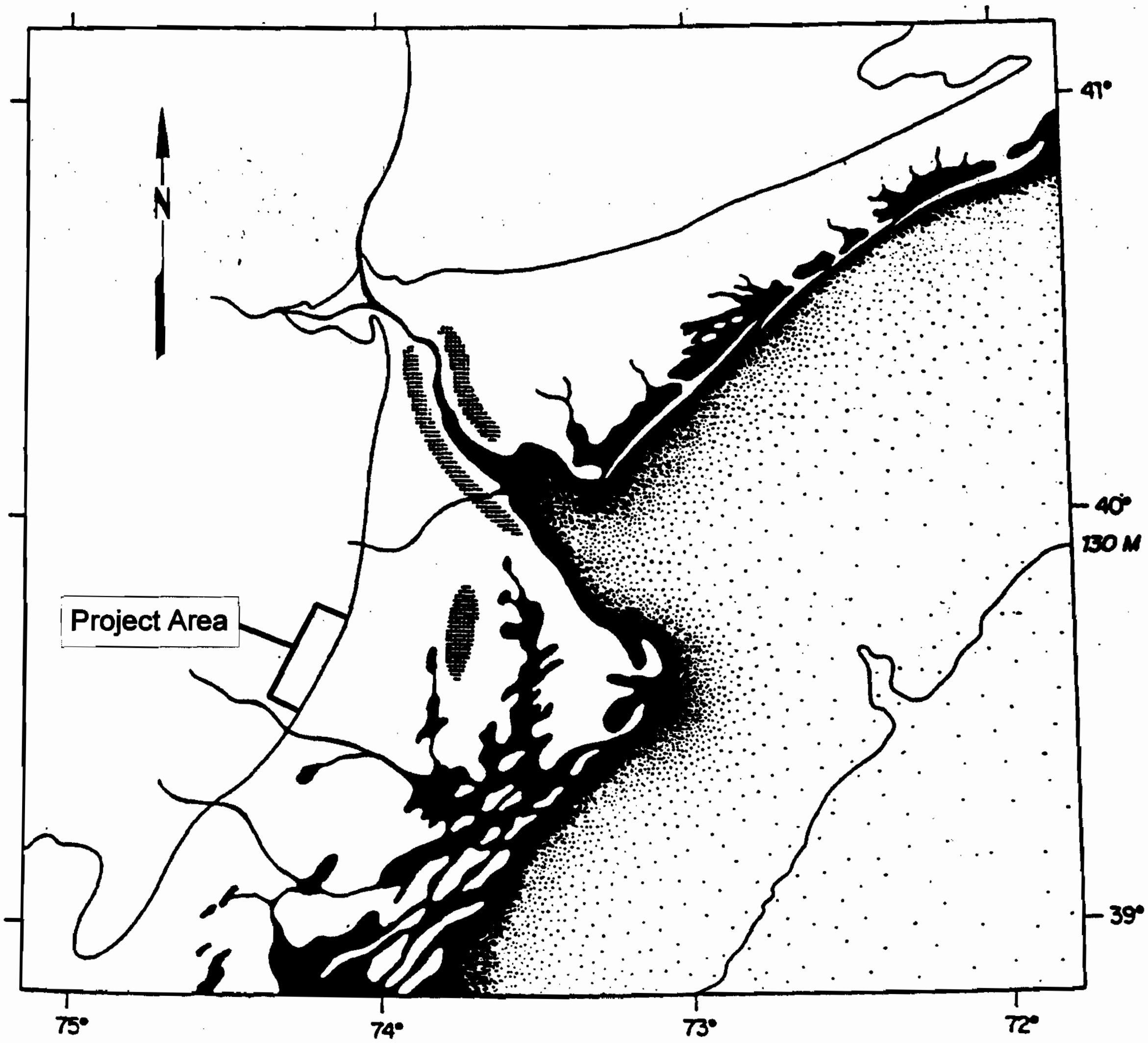


Figure 3.4. A Reconstruction of the Middle Atlantic Coastal Area 6,000 to 8,000 Years Ago (Source - Edwards and Emery 1977: Figure 7). General Location of Project Area is Bracketed.

Waretown Creek Site, was recorded in 1913 as "a camp site" in the woods northeast of Waretown (Skinner and Schrabisch 1913; New Jersey State Museum site maps and files).

About one mile further north of this site and about six and a half miles distant from the most northern point of the project area are two more significant sites (28Oc2 and 28Oc55) excavated by Dorothy Cross in 1940. Collectively, these sites are known as the Oyster Creek site and consist of two knolls rising above the meadows along Barnegat Bay just south of Oyster Creek. Cross noted that she encountered a single burial with nine stone artifacts and approximately 90 potsherds. Two of the stone artifacts were sandstone celts found lying close to the cranium. The other artifacts were jasper and chert scrapers and five projectile points, four being described as being of "flinty material," two as "triangular" and one as "shale stemmed" (Cross 1941). Another site (28Oc8) was recorded approximately one quarter mile to the north on the opposite side of Oyster Creek. No information is on record about this site. The final previously recorded site is located about seven and a half miles from the project area just north of Staffordville. This site consisted of a small shell midden exposed by a railway cut (Skinner and Schrabisch 1913).

CHAPTER 4

HISTORICAL BACKGROUND

A. Historic Overview

Long Beach Island, like southern New Jersey's other barrier islands, remained largely unsettled throughout the 17th and 18th centuries (Figure 4.1). The islands were inhospitable places, separated from the mainland by large expanses of salt marsh and cedar swamp. The earliest of South Jersey's European settlers utilized these sandy strips of land principally as wild pasture. As winter moved into spring, mainland settlers would ferry their cattle to the island. There, the animals were left to forage freely during the warmer months of the year, not to be returned to the mainland before the turning of the leaves and onset of colder weather (Brinckmann 1992:8).

The coming of winter signaled the start of another island activity. In December, January and February of each year, migrating Right whales trace the outline of New Jersey's coast as they wind their way southward to warmer winter waters. Right whales were being hunted off New Jersey's coast as early as 1633. In that year, the Dutch explorer, De Vries reported that he and his crew had taken seven of the great mammals while transiting the coast between the Delaware Bay and New Amsterdam (Wilson 1953:158). More structured whaling operations were established well before the end of the 17th century. Thomas Budd, in his 1685 promotional pamphlet entitled "Good Order Established in Pennsylvania & New Jersey," noted that "on the Sea-Coaſts of New Jersey there being Whale Fiſheries already begun." These "Fiſheries" were centered on island base camps.

The first patent for Long Beach Island was received in 1690 by a former New England whaler, Aaron Inman, although there is some mention of an earlier New England whaler by the name of Soper being resident on the island before Inman's arrival (Woolman, Price and Rose 1878:46; Wilson 1953:159; Lloyd 1994:11). Inman and three sons established themselves at the southern end of the "Great Swamp" within the bounds of present day Surf City. The Great Swamp covered a 200-acre tract covering what is today the northern half of Surf City and parts of North Beach. Its fresh water spring watered a massive stand of Atlantic white cedar trees (Lloyd 1994:11). The Inmans were soon joined by other New England and Long Island whale men seeking new opportunities. According to later accounts, Inman erected a house on the bay side of the island and a 30-foot tower with a crow's nest on the beach (Wilson 1953:158; Lloyd 1994:13-14). From the tower, lookouts could spot surfacing whales and dispatch small boats to pursue them. Slaughtered whales were towed as far back to shore as possible and butchered in the surf. After the blubber was cut from the carcasses, it was rendered in large iron kettles on the beach. Other less well documented Long Beach Island whaling stations were established at "Harvey's Whaling Quarters" (in present day Harvey Cedars) and on Brant Beach at Hick's Point (Woolman, Price and Rose 1878:46; Wilson 1953; Oxenford 1992:33; Lloyd 1994:11-13). Whaling continued after a fashion well into the 19th century. John Fanning Watson, the well known Philadelphia historian visited the island and recorded that he was "surprised to learn from old Stephen Inman, one of the 12 islanders of Long Beach, that he and his family have never ceased to be whale catchers along this coast. They devote themselves to it in February and March. Generally catch two or three of a season, so as to average 40 or 50 barrels of oil apiece. Sometimes whales are taken making 90 barrels of oil. Whale bones of a large size are seen bleaching about the sand" (Barber and Howe 1845:369).

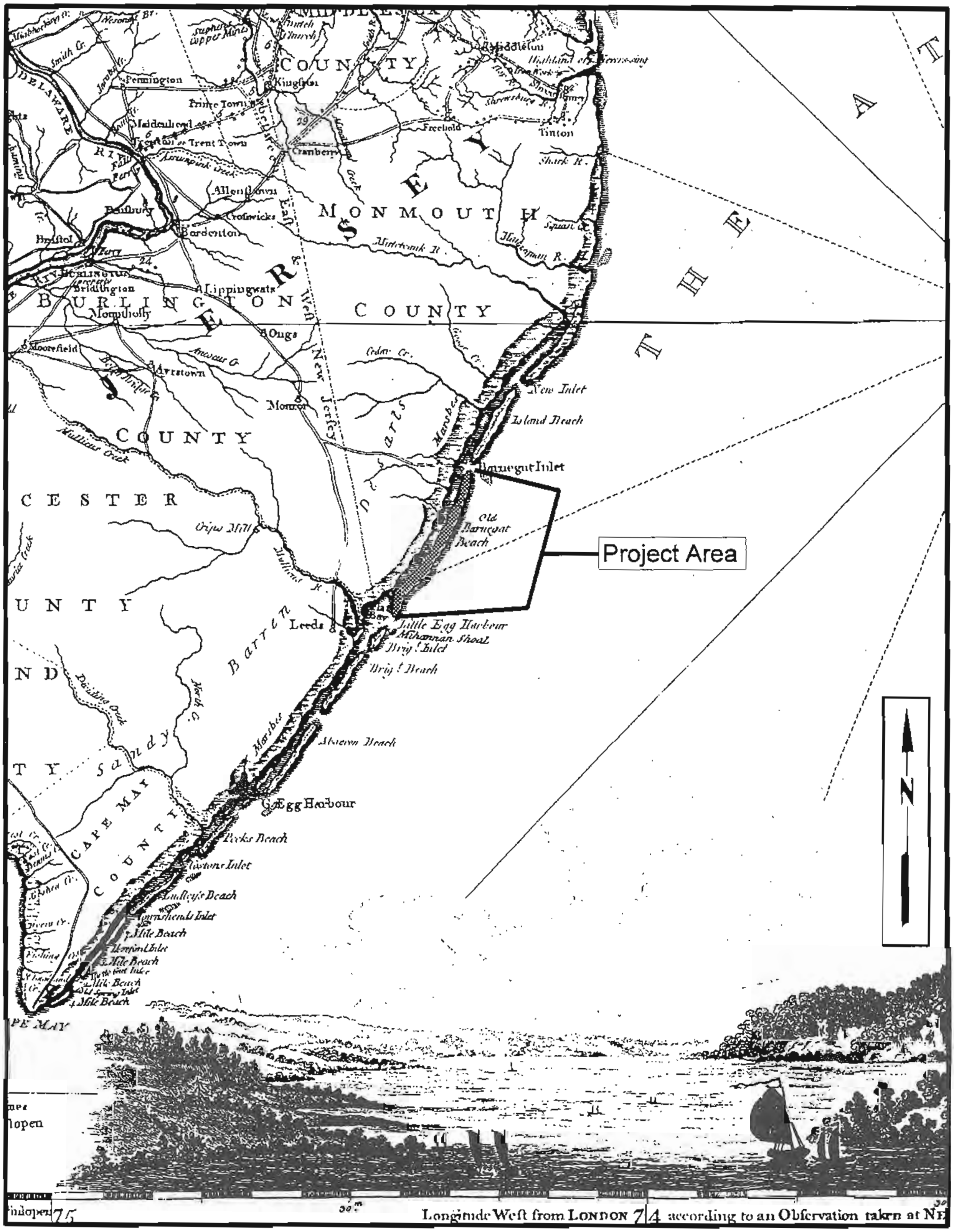


Figure 4.1. Holland, Major. Map of "the Provinces of New York and New Jersey with Part of Pennsylvania, and the Province of Quebec." 1776. Scale 1 inch: 18 miles (approximately). General Location of Project Area Shaded.

1. Tucker's Beach

Other than whale men, Long Beach saw few early settlers. The island's only 18th-century claim to fame was as the site of a revolutionary "massacre." In 1782, a Tory party led by John Bacon surprised the sleeping crew of the American armed galley the Alligator and killed about 25 of them. The encounter took place about one mile south of present day Barnegat Light (Nash 1936:21). Otherwise, the island remained relatively quiet. Both the inland island thickets and the ocean front dunes were obviously unsuitable for agriculture and the island's exposed location left buildings vulnerable to the violence of Atlantic winter storms. In fact, the family of Ephraim Morse, one of the area's first settlers, is said to have been swept from their island home by a rising storm tide. Morse and his wife escaped to the mainland but their five children died from exposure to the cold winter waters. This event occurred during the 1740s when Morse was the sole permanent resident of a seven-mile-long island which was known as Short Beach and was located in what is today the mouth of Little Egg Inlet, to the southwest of the project area (Woolman, Price and Rose 1878:46; Lloyd 1994:15). The island, now entirely eroded into the sea, was perhaps the very first of New Jersey's ocean front resorts. Morse had eked out an existence on the island raising cattle on salt hay and supplying the ships which visited Little Egg Harbor on their way between the ports of New York and Philadelphia. After his wintery brush with death, Morse moved to the mainland and, in 1765, sold his island holdings to Reuben Tucker, a Quaker from Orange County, New York (Woolman, Price and Rose 1878:46; Lloyd 1994:15).

Learning from Morse's experience, Tucker constructed his house on the dunes at the northern end of the island, this containing the highest elevation on the small land mass. The building served Tucker both as his personal residence and as his primary source of income. "Tucker's Island" became well known as the location of the most popular inn on the Jersey coast, catering both to Little Egg Harbor's burgeoning maritime traffic and to visiting sportsmen and market gunners (Woolman, Price and Rose 1878:46; Lloyd 1994:15-17). After the Revolution, Tucker's house also began to attract more genteel clientele. Previously, it was not totally unknown for families to make the long trek across New Jersey's Pinelands to visit the beach, but the accommodations they could expect upon their arrival were makeshift at best. Beach visitors usually stayed in small tents pitched in the shelter of the tall island dunes. With the opening of Tucker's Boarding House, vacationers were given the option to pass their time on the ocean front in the relative comfort of home. The number of individuals who visited Tucker's Island grew each year. Perhaps most notably, Tucker's became the annual location of a five-day religious retreat held by some of Philadelphia's more influential Quakers.

At some unknown date in the years surrounding 1800, a strong storm passed over Tucker's Island. The churning waves and crashing surf opened up a new inlet, splitting Tucker's Island in two. The shorter uninhabited southern section was named "Little Island" while the northern section continued to be known as Tucker's Island or Short Beach. The original northern inlet which separated Tucker's Island from Long Beach island was afterwards called the "Old Inlet" and the new southern inlet was named, simply, "New Inlet" (Figure 4.2). It was not until the 20th century that the new inlet was given its present name, Little Egg Harbor Inlet (Lloyd 1994:17).

After Reuben Tucker's death, his wife, "Mammy Tucker" took over management of the Boarding House. After Mrs. Tucker's death, around 1815, the property was managed by Thomas Cowperthwaite, then John Horner and later the Rogers and Willits families. The Tucker Boarding House burned down in 1845 and in 1848 a lighthouse was built on the approximate site of the old boarding house. This light flashed over the dark ocean waters until 1859 when the light was allowed to go black. With the close of the Civil

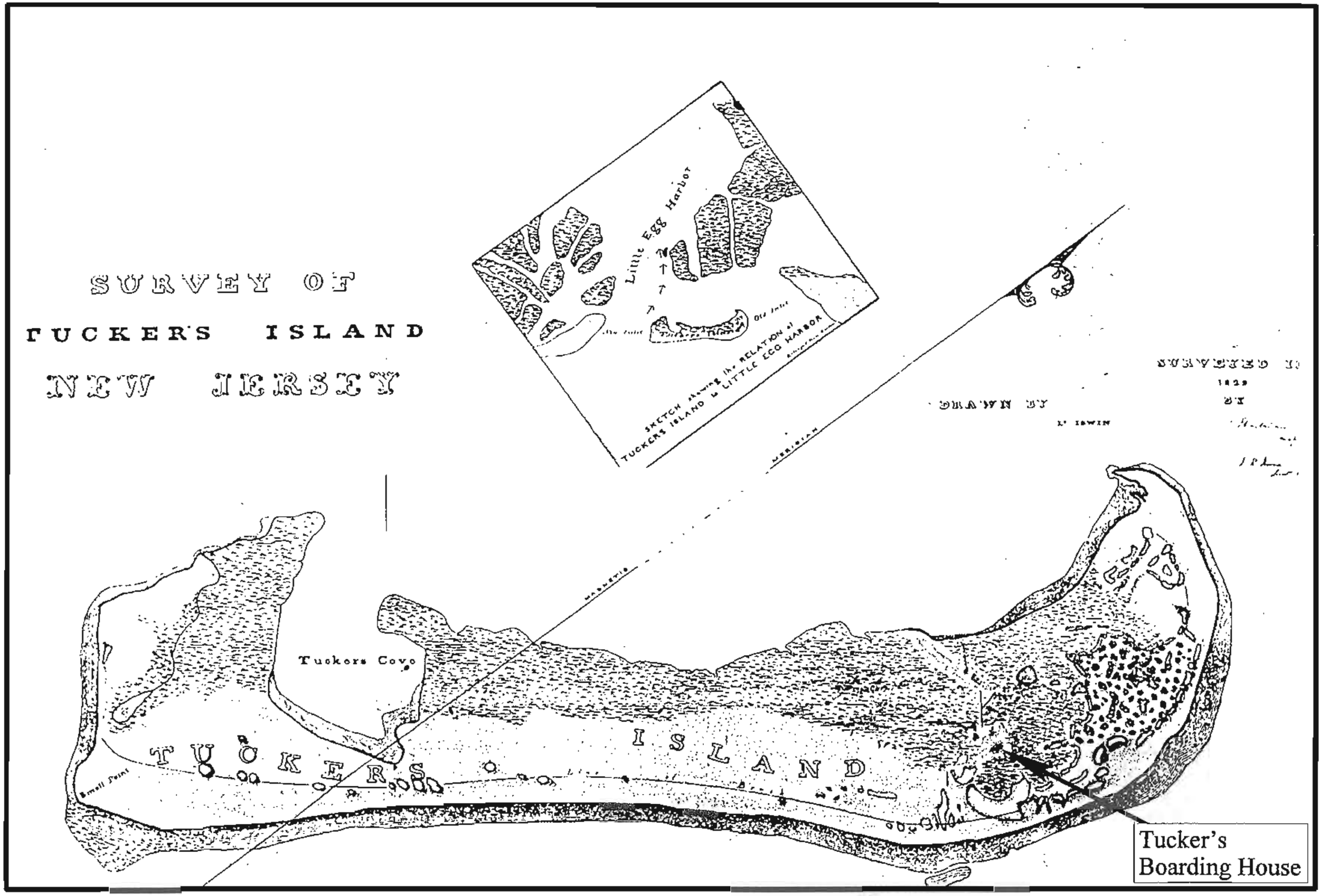


Figure 4.2. Survey Map of Tucker's Island, New Jersey, Located Off the Southern Tip of Long Beach Island. 1829. Tucker's Boarding House Visible as the Black Dot at the Center of the Northern End of the Island. Inset Shows Position of Old and New Inlets. Scale 1 inch: 2,600 feet (approximately). Source -Lloyd 1994. Island is Located South of the Project Area.

War in 1865, Congress allotted funds for the construction of "Tucker's or Little Egg Harbor Light" and a new lighthouse was constructed by 1867. This light consisted of a frame, keeper's house surmounted by a 44-foot-high red tower (Figure 4.3a) (Woolman, Price and Rose 1878:54; Lloyd 1994:17-19).

No additional improvements were made to the island until the coming of the railroad to Tuckerton in 1871. Motivated by the potential for growth, two large hotels were erected on the small island. The first was the Columbia, a four story hotel which opened in 1875, and the second was the St. Albans (Plate 4.1). The small resort soon acquired the name "Sea Haven." Connection was provided between the terminus of the rail line and the island by the small paddle wheel steamship Mary. In a fairly short period of time a handful of small cottages were constructed to complement the large hotels (Lloyd 1994:20-21).

One event that somewhat curtailed the development of the island was the opening of a "slough" between the island and its beach. In 1874, the Old Inlet had been completely filled by ocean deposited sand, attaching Tucker's to Long Beach Island. But, before long, the bay waters cut a wide canal between the island and its beach front, leaving the beach attached to Long Beach Island and buffering Tucker's Island, once again a true island but now located within Little Egg Harbor Bay and no longer fronting the ocean (Figure 4.3a). This meant that hotel patrons had to be ferried across the slough whenever they wished to visit the beach that had been the island's main attraction in the first place (Lloyd 1994:17-22).

By the late 1880s, Sea Haven had been eclipsed by the larger more popular resorts of Long Beach Island and a long period of gradual decline began. By 1900, both the Columbia and St. Albans had been abandoned (Lloyd 1994:24). The only remaining residents were the families of the men of the Little Egg Harbor Life Saving Station. On February 4, 1920, a large storm reopened the Old Inlet making Tucker's Beach its own island. The inlet continued to enlarge over the following weeks (Figure 4.3b). Tucker's Beach remained relatively unaffected but the southern end of Long Beach Island was rapidly disappearing into the sea. In order to slow the erosive process two long jetties were constructed at Cleveland Avenue and at McKinley Avenue. The jetties were successful in protecting the southern tip of Long Beach Island but changed the coastal currents so much that Tucker's Beach began to slip into the sea (Lloyd 1994:26-27).

By 1927, all of Tucker's Beach had eroded leaving Tucker's Island exposed to the direct actions of the surf. On October 12, 1927, the Tucker's Island Lighthouse collapsed into the sea. The erosion continued and in 1932 the island was removed from Long Beach Township's tax rolls. Sea Haven was completely gone, only the southernmost tip of the island survived. In 1934, the Little Egg Harbor Coast Guard Station, abandoned in 1933, met the same fate as the light house. Through the 1940s the island continued to survive, although reduced to little more than a sand bar. By the early 1950s, Tucker's Island had disappeared completely beneath the waves (Lloyd 1994:30).

2. Long Beach Island

The success of Tucker's early resort brought neighboring Long Beach Island to the attention of investors and developers. In 1815, stage service became available between Philadelphia and Tuckerton. At first this trip took two days to complete but later, after 1828, the journey was cut to a single day by better roads and a faster coach (Brinckmann 1992:8). With transportation readily available, if somewhat slow and uncomfortable, Long Beach Island became much more attractive to summer visitors. The island's first boarding house was opened in 1815 by Joseph Horner. It was situated on a large tract of land near the southern end of the island. Guests were shuttled by sailboat from the Green Street wharf at Tuckerton to the

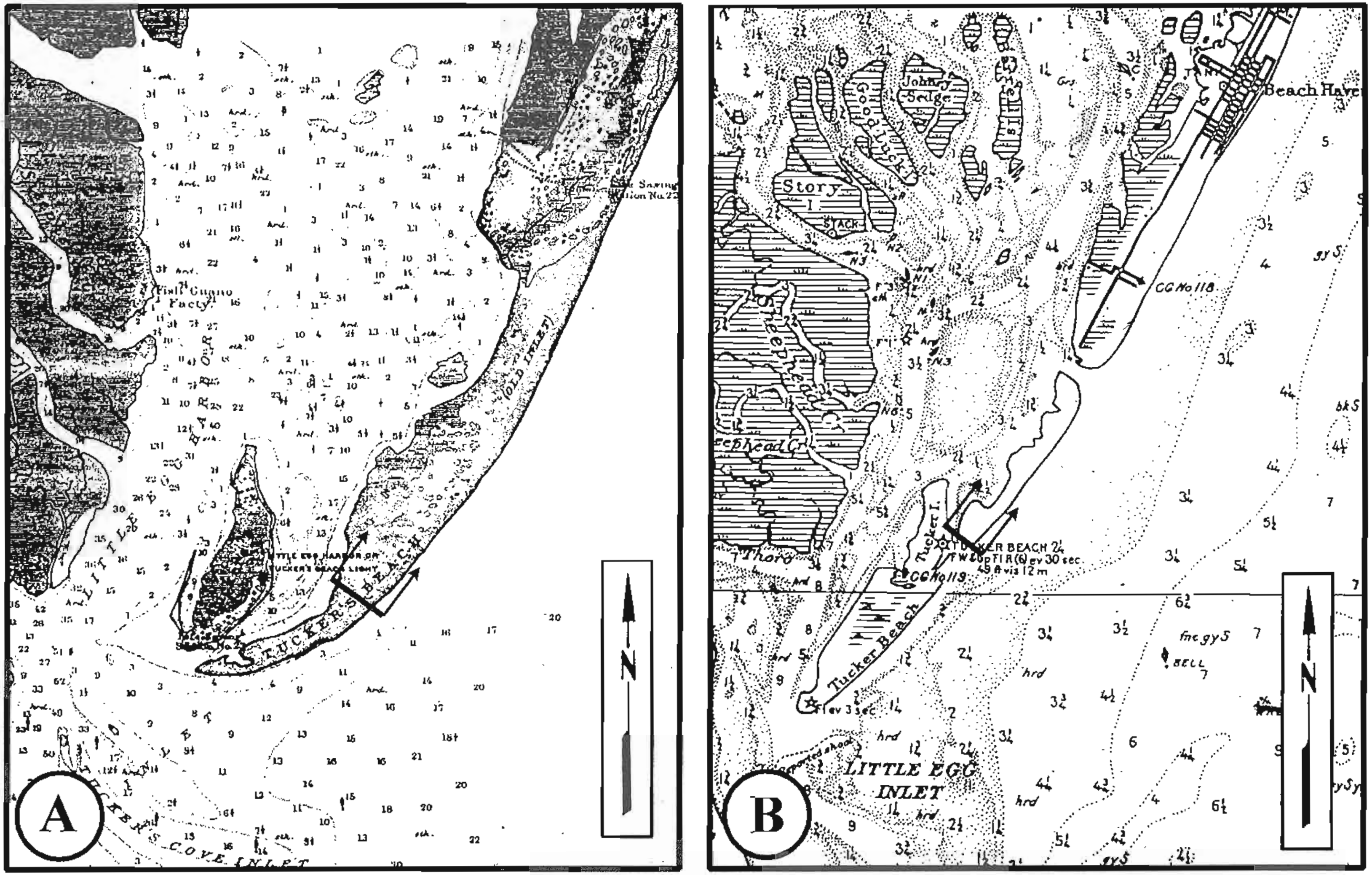


Figure 4.3. A. U.S. Coast Survey Chart. 1874. Scale 1 inch: 3,700 feet (approximately). B. U.S. Coast Survey Chart. 1921. Scale 1 inch: 5,800 feet (approximately). Source -Lloyd 1994. Southwestern Limits of Project Area Shown with Arrows.

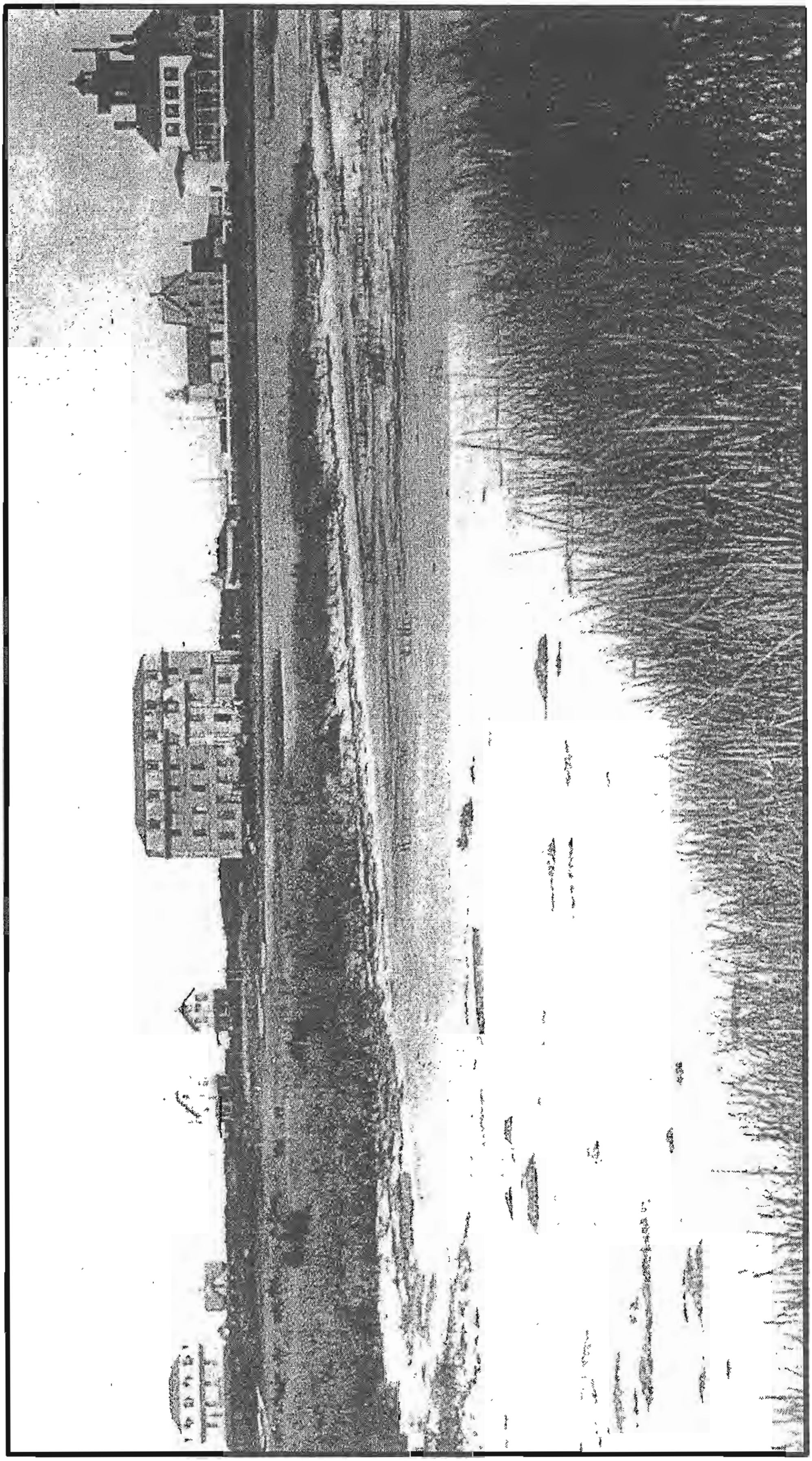


Plate 4.1. Historic Photograph of Sea Haven on Tucker's Island. Circa 1900. Little Egg Harbor Light House is Visible at Right, Columbia Hotel at Center and St. Albans Hotel at Left of the View (Source -Lloyd 1994).

island's bay side. In 1822, Horner sold his interest in the hotel and its lands to "The Philadelphia Company." Horner was retained to manage the much renovated and enlarged boarding house. In 1847, the "Company House" was sold to Lloyd Jones of Tuckerton who again enlarged the premises. Thomas Bond purchased the property in 1851 and under his ownership "Bond's Long Beach Island House" grew in popularity to become the most famous hotel on the New Jersey Coast (Woolman, Price and Rose 1878:46; Brinckmann 1992:9; Lloyd 1994:79-83). The resort's popularity continued throughout much of the third quarter of the 19th century. Bond's Hotel would stand until 1909 when its abandoned hulk was finally demolished (Lloyd 1994:83).

The island's second hotel was a boarding house opened by Jacob Herring on the northernmost tip of the island. Herring's clientele was primarily from New York and they catered specifically to sportsmen. In 1834, the United States Government constructed the first Barnegat Lighthouse (see below) a few hundred feet to the north of the Herring place. The lighthouse and its keeper's house helped to spur the growth of a small community on the northernmost tip of the island (Plate 4.2). In 1855, the Herring property was purchased by Captain John M. Brown, a former wreck master from the Squan area. In addition to the Herring property, Brown also purchased additional lands on the north end of the island including almost two miles of beach front. Under Brown's ownership, the northern end of the island was popularly known as Brownsville (Figure 4.4). Brown renamed the Herring boarding house the Ashley Hotel after his wife's maiden name. After Brown's ownership the property passed to Charles Martin who renamed the old building the Kinsey Hotel (Lloyd 1994:45-46). The hotel remained in operation until 1884. Three years later, it was demolished so the property could be redeveloped as part of the rapidly growing Barnegat City (see below, Section 4).

Another important early Long Beach Island hostelry was the "The Mansion of Health." This hotel was constructed on the southernmost edge of the "Great Swamp" on the north side of present day West 7th Street between Barnegat and Central Avenues. Its proprietors were the "Great Swamp Long Beach Company." The Great Swamp was destroyed in 1821, the same year the Mansion of Health was constructed. The Norfolk and Long Island Hurricane of 1821 blew directly over Long Beach Island sending breakers crashing over the tall dunes which ringed the swamp, uprooting many of trees and permanently altering delicately balanced ecological conditions. The Mansion of Health survived the storm and soon became the most renowned hotel on the New Jersey coast (Woolman, Price and Rose 1878:46; Brinckmann 1992:8; Lloyd 1994:38-39).

Small boats carried guests to a landing on a small bay located at the bay end of South First Street. The bay is still known as Mansion Cove. Under the ownership of Hudson Busby, the Mansion and its property acquired the popular name "Buzby's Place." The popularity of the Mansion of Health began to wane during the early 1850s and by the late 1850s it had been abandoned (Woolman, Price and Rose 1878:46; Brinckmann 1992:8; Lloyd 1994:38-39).

The fourth of Long Beach Island's earliest hotels was the Harvey Cedars. This hotel was not actually located on Long Beach Island itself but rather on a small six-acre island located just north of the Great Swamp. At the heart of the hotel was a small house constructed in the first quarter of the 19th century by Sylvanus Cox. Cox also erected a wooden bridge across the narrow strait which separated his small island from Long Beach. Cox sold his island to Samuel Perrine of Barnegat in 1841. Perrine enlarged the house and fitted it up as a boarding house catering specifically to sportsmen. The hotel burned to the ground in 1880 but was immediately rebuilt (Woolman, Price and Rose 1878:46;

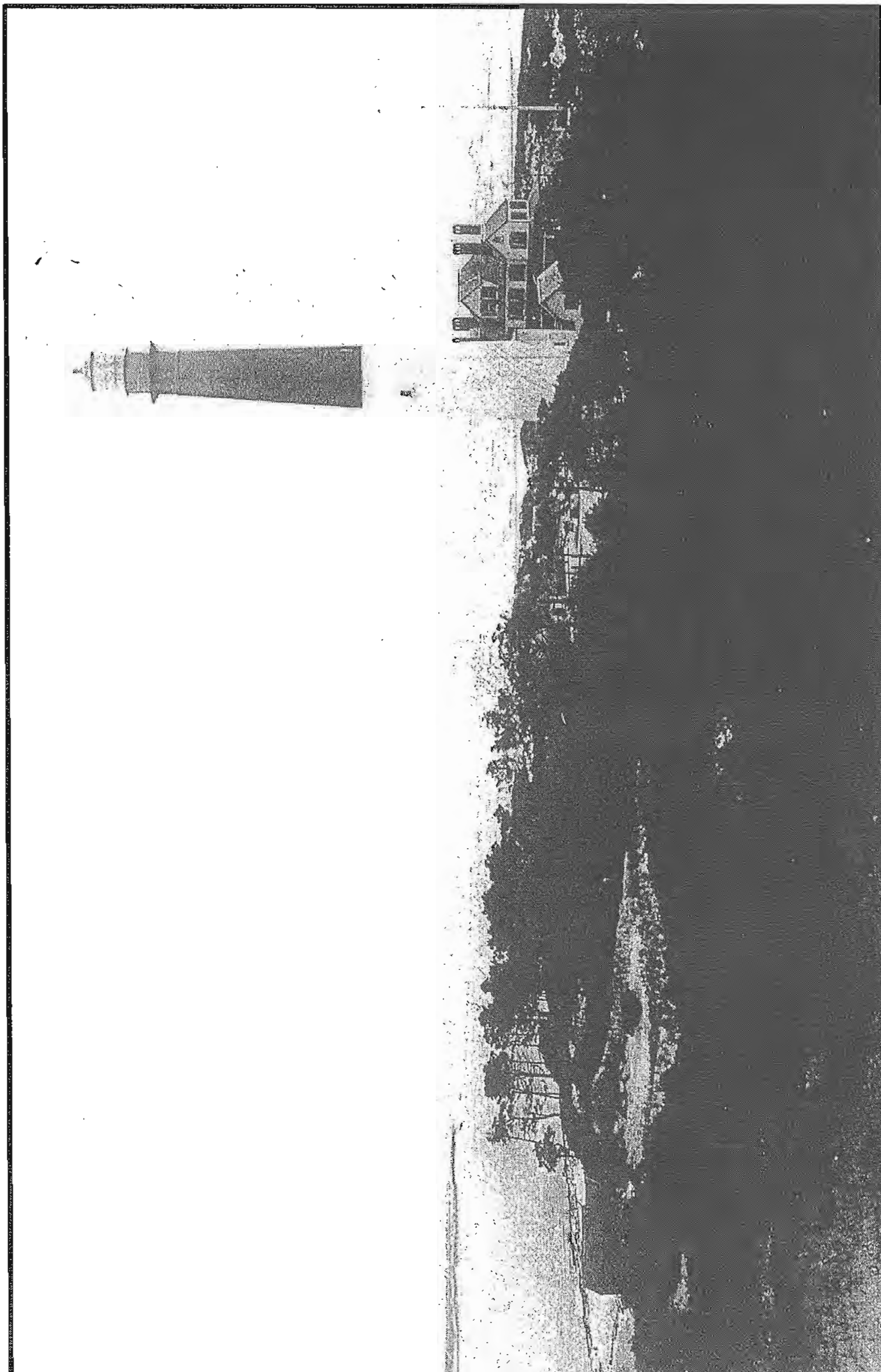


Plate 4.2. Historic Photograph of Barnegat Light House and Keeper's House Looking Northeast Across Barnegat Inlet. Circa 1900 (Source - Lloyd 1994).

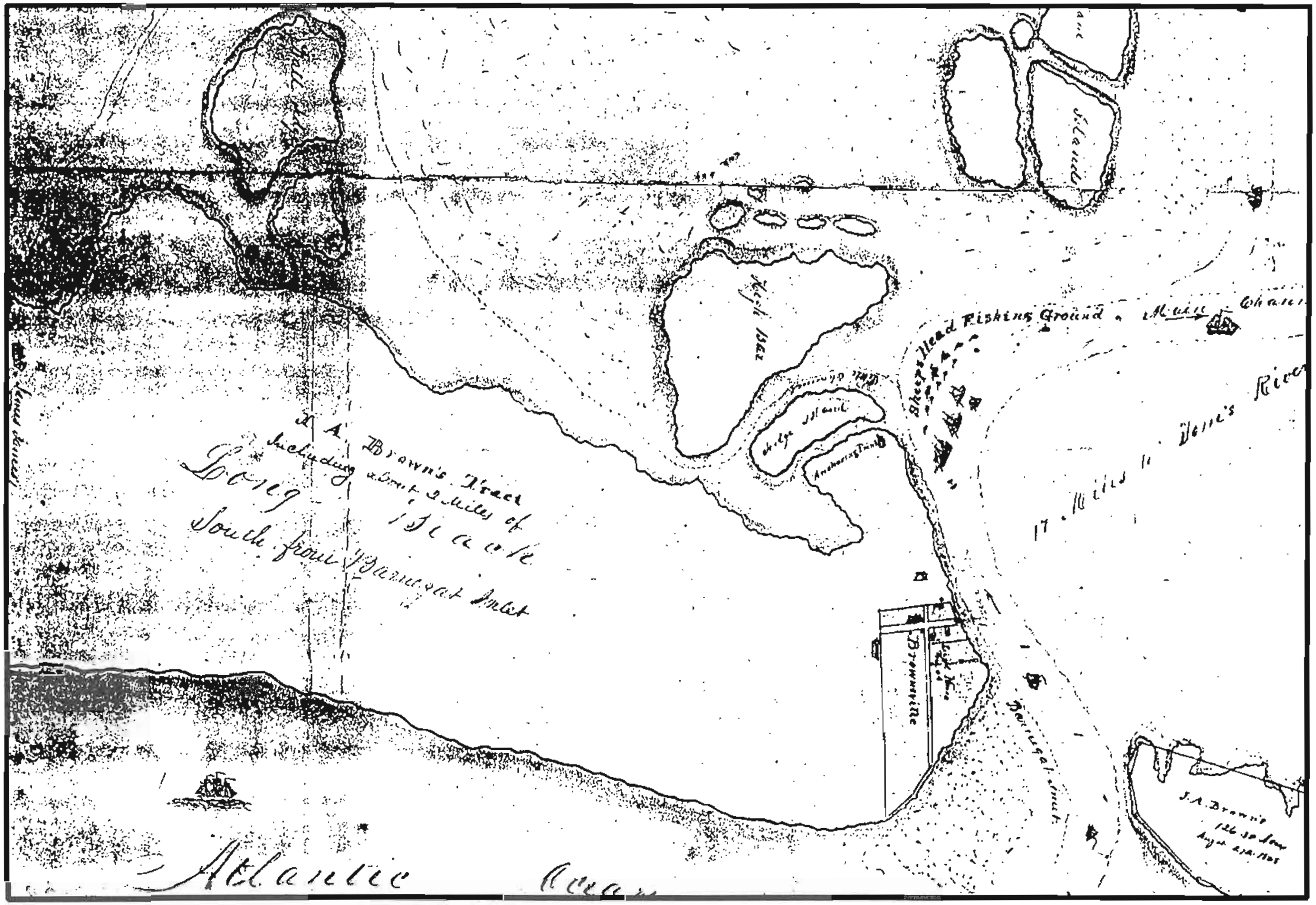


Figure 4.4. Survey of J.A. Brown Tract. 1869. No Scale Given.. Barnegat Lighthouse and Brownsville at Right and James James' Club House is Shown at Far Left. Source - Lloyd 1994. Area is Located at the Northern End of Long Beach Island at Barnegat Inlet, North of the Project Areas.

Brinckmann 1992:8; Lloyd 1994:38-39; Allaback 1995:6). The rebuilt Harvey Cedars, now the Harvey Cedars Bible Conference, is the oldest surviving hotel on Long Beach Island.

During the mid-19th century, the landscape of Long Beach Island remained much as it had been since the construction of the first boarding houses. Practically the only addition was the construction of another small sportsman's hotel, James James' Club House, at the southern end of the Brown tract (Lloyd 1994:43). The Civil War came and went, and each year as the weather grew warm, guests returned to the rooms in Harvey's and Bond's Hotels. Wives picnicked on the dunes while their husbands fished in the surf and hunted wild fowl in the bay marshes and island thickets. Besides renovations and improvements to the hotels themselves, no notable new development occurred on the island. The island did have a few permanent residents, to quote the "History of The New Jersey Coast" provided in the Woolman, Price and Rose *Historical and Biographical Atlas* of 1878, "every two or three miles a small house may be found sheltered behind sand-hills, the homes of recluse families, who reside there, and gather a livelihood from the natural productions of the neighboring bay, or from the precarious spoils which the ocean throws upon the strand .... it is probable that many of these places will, before long, be superseded by the summer homes of city families." This change had already begun by the time the atlas was published and its catalyst was the railroad.

Regular train service to Tuckerton began on Wednesday, November 1, 1871. The tracks of the Tuckerton Railroad had been laid through the Pine Barrens of southern Ocean County in just about one year, connecting the small New Jersey port, by way of the small crossroads village of Whiting, with other larger rail lines leading both to Philadelphia and New York City. The former one-day stage coach trip between Philadelphia and the shore was cut to less than 16 hours. Trains arrived in Tuckerton at 2:45 and 9:00 P.M. and departed at 4:35 and 11:00 A.M. each day (Brinckmann 1992).

3. Beach Haven

One of the prime investors in the Railroad was Archelous Pharo, one of Tuckerton's wealthiest and most prominent residents. Pharo was also one of the most dedicated of Long Beach Island's proponents. In 1867, he had purchased a 670-acre tract on the island and in 1871, the opening year of the railroad, he erected a summer home there. Pharo saw to it that a spur line was constructed linking the main trunk of the Tuckerton Railroad with a steamboat dock constructed at Edge Cove. The railroad company purchased the Steamboat "Barclay" from the Rancocas Steamboat Company and instituted regular summer service to the island. The principal railroad investors immediately incorporated a new company, "The Tuckerton & Long Beach Building & Land Association" which purchased Pharo's property. Streets and lots were laid out on a 1,000-acre site located approximately two miles to the north of Bond's House. The new development was given the name "Beach Haven." Building commenced in 1874 with a new four story hotel, the Parry House, anchoring the new resort. The Parry House was followed not long after by the towered Engleside Hotel (Plate 4.3) and later the Ocean House, the Magnolia and St. Rita's. In addition to the hotels, a multitude of private summer cottages, the Beach Haven Yacht Club and the Holy Innocents Episcopal Church were erected (Brinckmann 1992; Lloyd 1994:63, 85-115).

On August 12 of 1881, the Parry House burnt to the ground. Not easily discouraged, Charles T. Parry, the hotel's principal stockholder, decided to rebuild nearly immediately. The site chosen, however, was a quarter mile south of the original site. A narrow gauge horse railway had to be constructed across

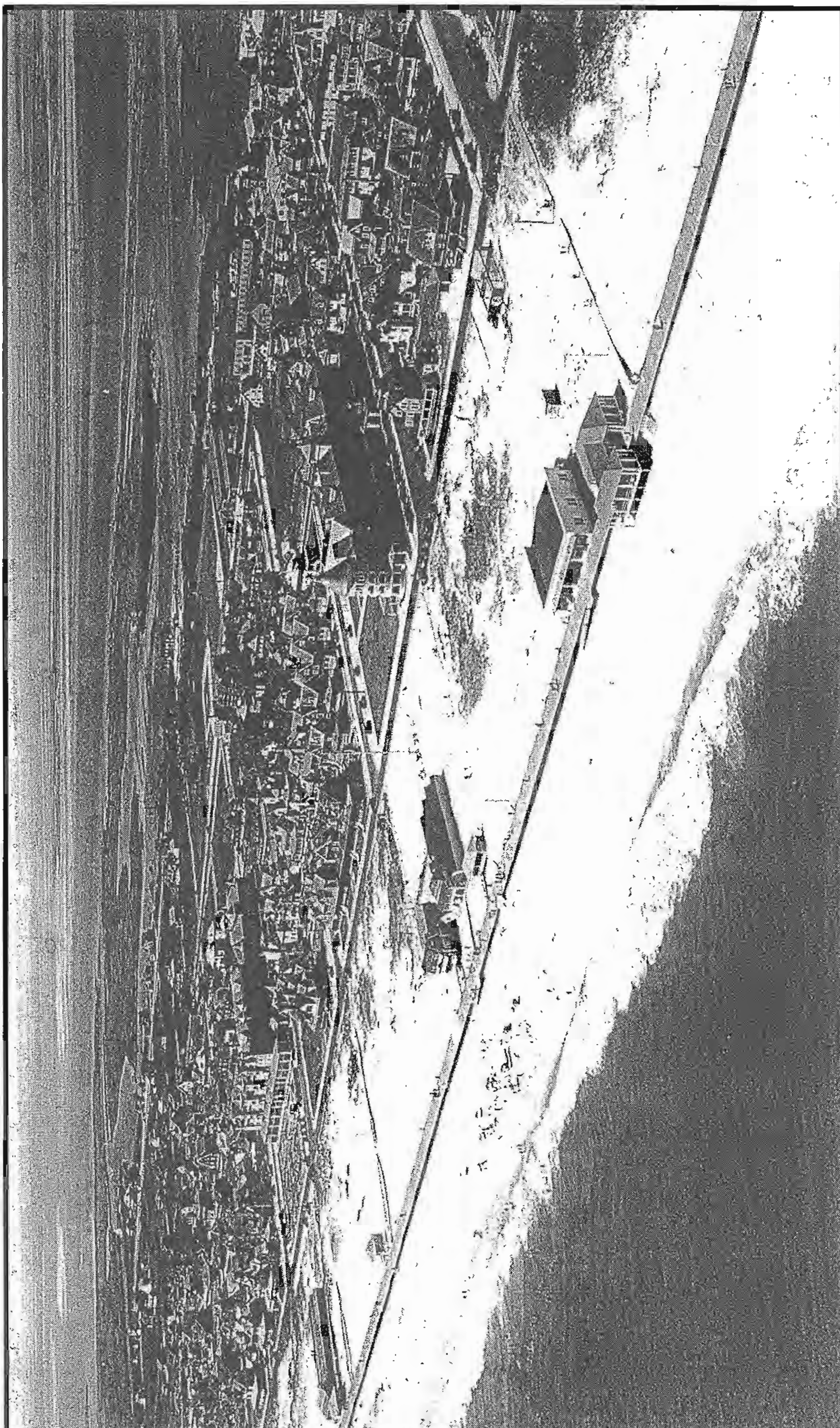


Plate 4.3. Oblique Aerial View of Beach Haven Looking Southwest. Circa 1930. The Beach Haven Boardwalk and Bath Houses in Foreground, the Engleside Hotel to Right and the Baldwin Hotel at Left of the View (Source - Lloyd 1994).

the meadows to move materials to the building site on a lot between Marine and Pearl Streets. The massive new hotel was designed by the Philadelphia architectural firm, Wilson Brothers, and was at first known as The Arlington. The name was later changed to the Hotel Baldwin after the Baldwin Locomotive Works which Parry owned in part and which separately served as one of the hotel's chief backers (Lloyd 1994:85-87).

Since the date of its initial construction, Beach Haven has effectively been Long Beach Island's "Capital City." Beach Haven Borough was formed in 1890 from Eagleswood Township. Previously each area of the island had fallen under the jurisdiction of the mainland township to which it would belong if the township's northern and southern boundary lines were extended eastward across the bay (Snyder 1969). Partially in response to this, Long Beach Township was formed from parts of Little Egg Harbor, Eagleswood, Stafford, Ocean and Union Townships in 1899 in order to create a single island governing body, Long Beach Township (Snyder 1969). This effort was thwarted by the several island communities which had, like Beach Haven, already established themselves as independent boroughs.

Perhaps Beach Haven's most intensive periods of growth occurred after 1886 when a series of causeways and trestle bridges were constructed to carry the railroad across the bay. The railroad connection was made at the bay's smallest width. The rail line came ashore at Surf City (see below, Section 8) and met another line, the Manahawkin and Long Beach Railroad, which was constructed down the center of the island length ways, connecting Beach Haven at the south to Barnegat City (see below, section 4) at the north. This not only increased the number of visitors, but also opened up practically all of the island to development (Brinckmann 1992; Lloyd 1994:115-126).

In 1898, Long Beach Island's first boardwalk (Plate 4.4) was erected at Beach Haven. This fairly small boardwalk was widened and lengthened in 1916. In total, it was a 22-block-long pine structure which ran from 7th Street to Holyoake Avenue. Unlike many of its counter parts in other New Jersey ocean front towns, Beach Haven's boardwalk was isolated from the town and had few buildings along its length, initially only the bath houses of the large hotels, a first aid station at Coral Street and two pavilions. A few more buildings were added later. Within ten years of the walk's original construction, a T-shaped fishing pier was added at Berkley Avenue. Like other walks, Beach Haven's was very susceptible to the effects of storms. In 1928, the southernmost seven blocks of the boards were washed away in an autumn gale. Thereafter, the structure terminated at Belvoir Avenue. The massive hurricane of 1944 destroyed the remaining section of the walk. The pilings were removed and the boardwalk was never rebuilt. A smaller boardwalk was also constructed at Beach Haven Terrace (see below, section 14). This structure has also been removed (Lloyd 1994, 141-149).

Beach Haven's second big period of growth occurred after 1914. In 1912, the Long Beach Island Turnpike company was formed with the express purpose of connecting the island to the mainland by means of an automobile causeway. At this time, Beach Haven (Figure 4.5) had been heavily subdivided but not yet thoroughly built up. By 1914, a narrow two-lane highway was constructed connecting Ship Bottom to the mainland counterparts. The completion of the causeway spurred a period of large scale development and drastically increased the number of year round residents. Another result was that the causeway drastically diminished the need for rail service. All passenger service to Long Beach Island was halted after 1930 and in 1935, a northeaster washed out one mile of trestle, permanently ending the days of railroad service to the island. Long Beach Island's

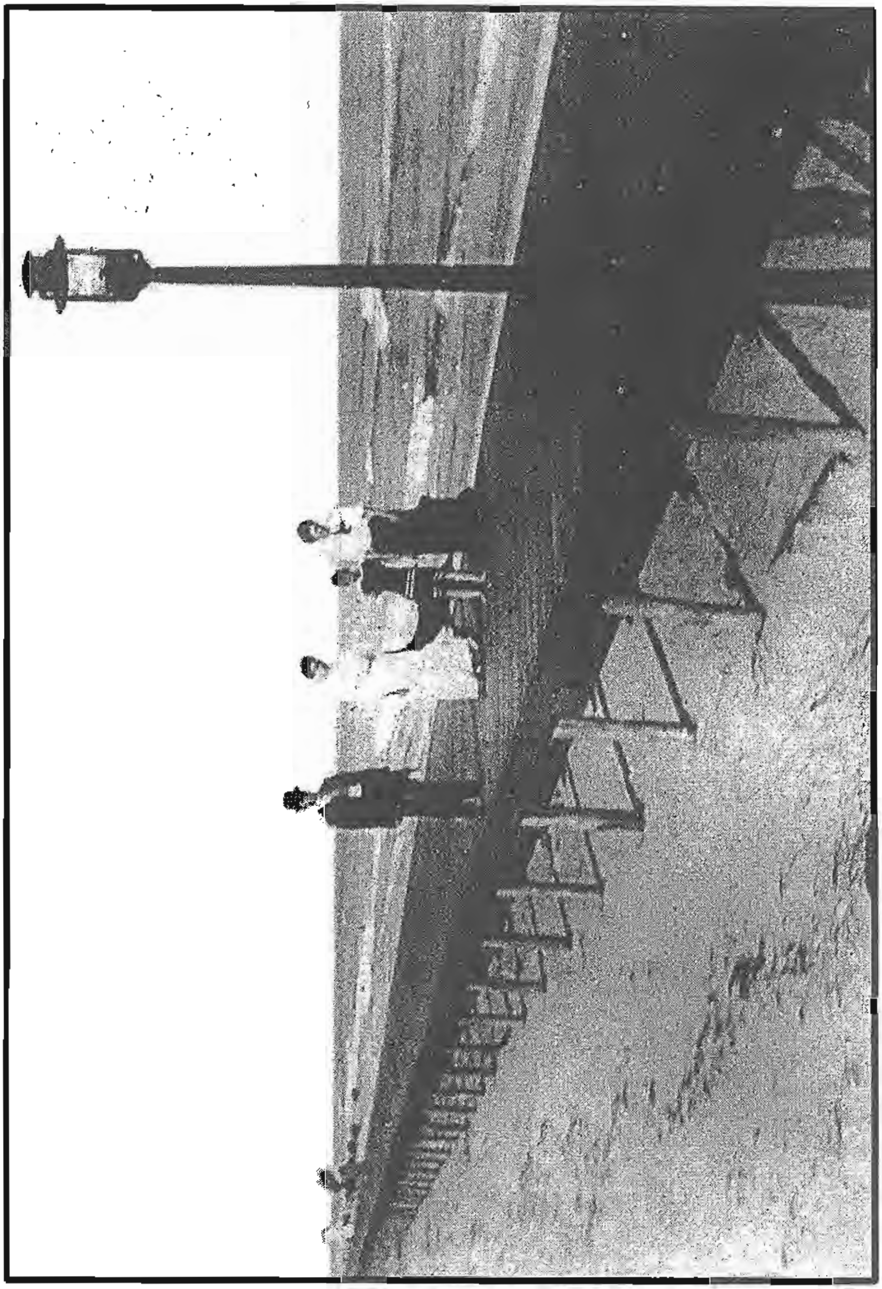


Plate 4.4. Historic Photograph of the First Beach Haven Boardwalk. Circa 1900 (Source -Lloyd 1994).

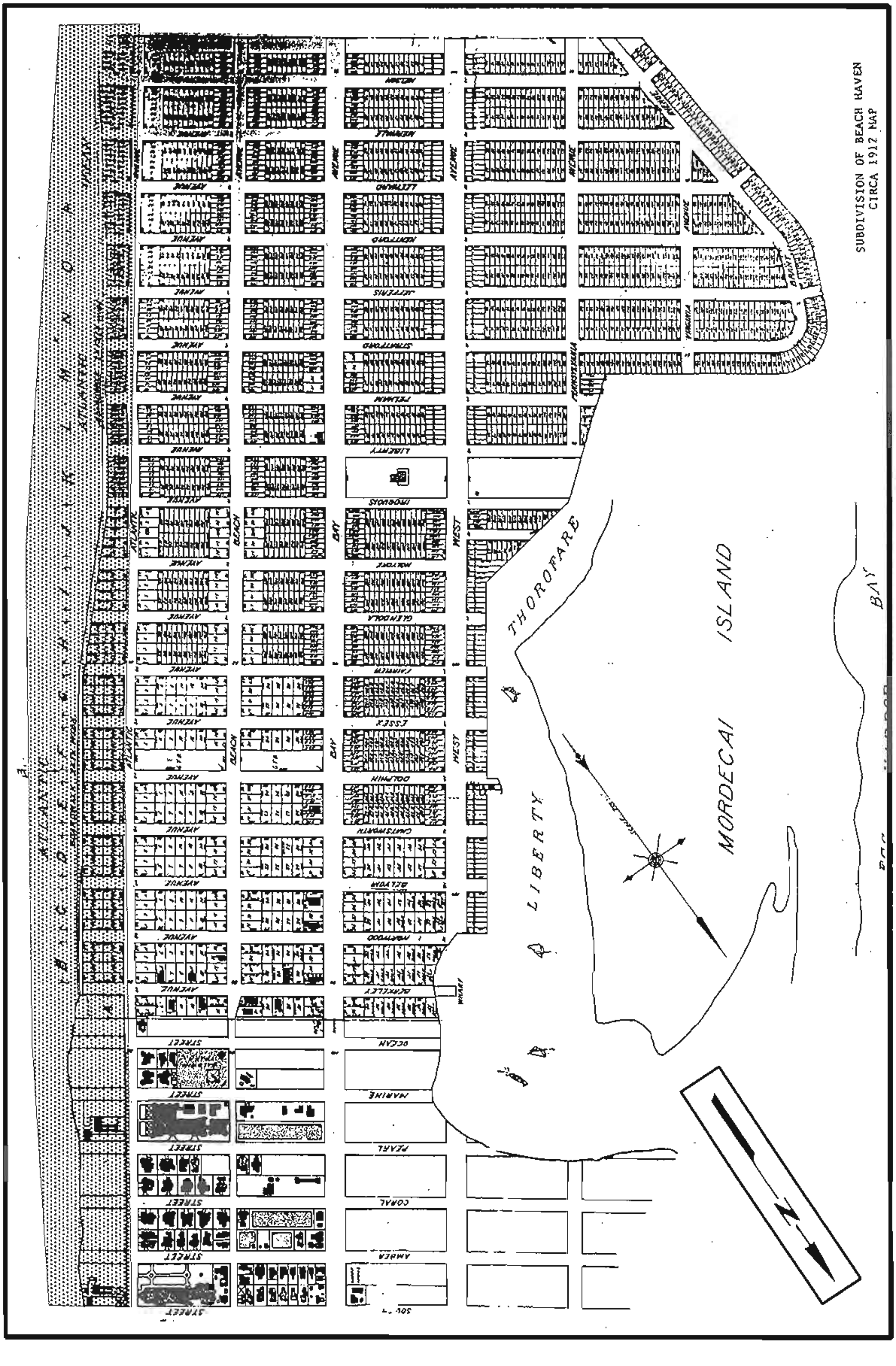


Figure 4.5. Subdivision Map of Beach Haven. Circa 1912. Scale 1 inch: 800 feet (approximately). Source-New Jersey Historic Sites Inventory 1981. Survey Area D Shaded.

biggest growth spurt occurred with the construction of the Garden State Parkway in 1954. Never before had the area been so accessible to tourists and never before had it been so easy to live on the island all year long. In order to accommodate the increased traffic, the original two-lane causeway was replaced in 1956 by a large new highway. Three years later the old causeway was removed (Lloyd 1994:131-137).

4. Barnegat City

The immediate success of Beach Haven demonstrated the possibilities which Long Beach Island held for developers. One of Beach Haven's earliest sister communities on Long Beach Island was Barnegat City. Barnegat City was located at the very northern end of the island on the land which surrounding the Barnegat Lighthouse. The Barnegat City Beach Association fostered development plans for a large resort at the northern tip of the island. Ground was broken on the new resort in 1881 and soon the small resort boasted three hotels -- the Oceanic, the San Souci (later known as the Sunset) and the Social. The Sunset was located on the edge of the bay and stayed open all winter to accommodate sportsmen. Barnegat City was linked to the mainland by a steamship line which brought passengers from the railroad stop at Barnegat to the Barnegat City landing on the Bayside of Long Beach Island. Vacationers were then conveyed by horse railway to the ocean front development (Lloyd 1994:44-49).

The year 1886 saw the opening of the trestle bridge which brought rail service directly to the island. Barnegat City was at the northern end of the rail line. While the new railroad spurred growth at Beach Haven to an unprecedented degree, Barnegat City on the other hand was already on the down slope of its period of popularity. The initial plans for the railroad bridge were made specifically with the idea of promoting Barnegat City, but by the time it was actually constructed, erosion had become such a problem that little new growth occurred. Erosion forced the owners of the Oceanic Hotel to move the building back from its beach front location. Several private cottages were entirely lost to the sea (Lloyd 1994:44-49). Although Barnegat City's residents were optimistic enough to have the village established as a borough separate from Long Beach Township in 1904, Barnegat City's decline was further speeded by a typhoid epidemic in 1905 (Snyder 1969:205). The Oceanic stayed in operation until 1920 when half of the building washed into the sea. The Sunset burned to the ground in 1932. Barnegat City's decline was so precipitous that, although the automobile causeway was constructed across the bay in 1914, no road was extended to the north end of the island until 1920. Three years later, rail service was discontinued for lack of riders. A small community remained at Barnegat City throughout the second quarter of the 20th century and with development pressures growing around mid-century, the surviving ground at the northern end of the island was once again developed. In 1948, Barnegat City's name was changed to Barnegat Light and as such it survives today extending from 30th Street north (Lloyd 1994:49).

5. Loveladies

The name Loveladies is derived from Lovelady Island, a bay islet named after its former owner, Thomas Lovelady. The name became applied to this section of Long Beach Island when a name was needed for U.S. Life Saving Station #114. Loveladies Island was the closest named geographical feature of note. Until the 1930s, when the railroad stopped running on Long Beach Island, the area was known as Club House, named after the James' Long Beach Island Club House (see above). This name had been given to the area by the Manahawkin and Long Beach Island Railroad, which operated a stop for the life saving station. The railroad, for reasons of modesty, did not want to use the name "Lovelady's." Lovelady's did not come into general usage as an area name until after the demise of the railroad. The name was again changed after the decommissioning of the station at the close of World War II. This time Long Beach Township's mayor, Howard Schiffer, decided that Long Beach Park was a better name for the still undeveloped area. By mid-century only a few homes had been constructed in the area. Long Beach Park was most notable for the 30-acre Long Beach Island Center for the Arts and Sciences constructed in 1949. In 1952, the area was officially renamed Loveladies. Building on the tract did not truly begin until 1954 when the construction of the Garden State Parkway increased development pressures on Long Beach Island (Lloyd 1994:169). Present-day Loveladies consists of the northernmost segment of Long Beach Township and extends from Barnegat Light at approximately Holly Drive south to 87th Street and the start of Harvey Cedars.

6. Harvey Cedars

The origin of the name Harvey Cedars is the source of much debate. Vivian Zinkin in her book *Place Names of Ocean County* attributes the first half of the name to a Harvey family of whalers (Zinkin 1976:85-86). John Bailey Lloyd in his book *Eighteen Miles of History on Long Beach Island* says that Harvey is a corruption of the word harvest and that the region acquired its name from a large hummock of cedar trees near which early salt hay harvesters frequently took shelter (Lloyd 1994:71). In either case, this town formed around the Harvey Cedars Life Saving Station and the Harvey Cedars Hotel (now the Harvey Cedars Bible Conference). Although Harvey Cedars incorporated as its own borough in 1894, and attempts were made to attract development (for example, an impressive pavilion was constructed on the beach in 1898), the community remained sparsely built until the construction of the Garden State Parkway in 1954 (Snyder 1969:202; Lloyd 1994:72-77). Today, the borough of Harvey Cedars is located between Loveladies and North Beach, extending between 86th and William Streets.

7. North Beach

The section of Long Beach Island located immediately to the north of Surf City and south of Harvey Cedars, today known as North Beach, was formerly known as "The Frazier Tract." Daniel B. Frazier, the owner of the Harvey Cedars Hotel, bought this undeveloped tract of land in 1911 from the estate of U.S. Senator William Sewell. Frazier was anticipating a rise in land values after the opening of the automobile causeway in 1914. In 1936, the land was seized by the Township of Long Beach for failure to pay back taxes. The township broke up the tract and began selling lots in 1937. This measure was taken in order to circumvent a plan by the State of New Jersey to purchase the tract for parkland, a move which would have removed it from the tax rolls and limited the long term growth potential of the area. The Frazier Tract was subdivided into fifteen 200-foot-wide lots which ran from ocean to bay. The name "North Beach" was acquired in 1949 when a group of builders erected a bay side development of 20 houses which they called the "North Beach Homes" (Lloyd 1994:167-168).

8. Surf City

Present-day Surf City is located on a parcel of land which was formerly associated with the Mansion of Health. In 1873, this section of the island was given the name Long Beach City in anticipation of its development. In 1894, Long Beach City was incorporated as its own borough. The name was changed to Surf City in 1899 because of confusion between it and Long Branch (Snyder 1969:205). The present-day community grew up around two hotels, the "Mansion," or Surf City Hotel as it was later known, and the Surf House. The Mansion was not the Mansion of Health. That hotel burned down in 1874 after a long period of vacancy. This Mansion was a second hotel constructed on the foundations of the first in 1884. It was originally located on the north side of West 7th Street but was later moved to a location opposite the rail stop at 8th Street (Lloyd 1990:119-120). In the 1890s the hotel's name was changed to the Long Beach Inn. It retained this name until 1900 when the building was renamed the Marquette (Lloyd 1994:31-33).

The Surf House was located on East 6th Street. This establishment derived much of its popularity from the fact that it held the village's only pre-Prohibition liquor license. This establishment burned down in 1914. After the demise of the Surf House, the Marquette's name was changed once again to the Surf City Hotel. The hotel remained without competition until 1927 when the Surf Villa was opened at 16th Street. The Surf City Hotel survived at least until 1994.

The little town consistently made efforts to spur its development. One such effort was the pavilion constructed on its beach front at 11th Street in 1898. Despite these efforts there were less than a dozen residences in the town at the start of the 1920s and no houses had been built north of 12th Street. This was the area formerly occupied by the "Great Swamp." The town leveled its dunes in 1919 to give the small community room in which to grow, but the area remained almost totally undeveloped until after 1935. Surf City, like nearly all of Long Beach Island, has since been thoroughly developed (Lloyd 1994:31-33). Today it encompasses the area between North 25th Street and South 3rd Street.

9. Ship Bottom

Although the name "Ship Bottom" has been used to describe a section of Long Beach Island since 1817, the area did not develop into an actual community until after 1898 when a small settlement suddenly sprung up around Life Saving Station #20 and its keeper's house. Ship Bottom began as a small group of one-story summer bungalows on the island's ocean front. Initially, it was comprised of a five-block area around the life saving station. At the time of its development, the owner of the Ship Bottom real estate was Henry McLaughlin, the developer of Brant Beach (see below, Section 10). McLaughlin had retained these more northern lands for sale after Brant Beach had become fully developed. One of the prime motivators in Ship Bottom's development was the Island's rail connection at Ship Bottom in 1886. It also became the terminus of the automobile causeway which opened in 1914. After the arrival of automobiles, Ship Bottom quickly became heavily developed with a series of large houses constructed between South 26th and 27th Streets (Lloyd 1990:92-96).

To the north of Ship Bottom was Beach Arlington, established in 1892. Above Beach Arlington, beginning at present day 14th Street, was the small community known as Bonnet Beach. Only six blocks in length, Bonnet Beach was also founded by Henry McLaughlin (in 1922). To the north of Bonnet Beach was Edgewater Beach. Edgewater encompassed the area between North 3rd Street and 7th Street. This tract had previously been known as Bonnet City. Under that name the area had been marketed for development by Kate B. Crane in the 1890s. This development scheme never reached fruition and the tract was resold in 1908 to Lester Osborne of Philadelphia who renamed the parcel Edgewater Beach and began constructing and selling bungalows (Lloyd 1990:92-96). In 1925, Ship Bottom and the rest of these small communities incorporated as Ship Bottom-Beach Arlington Borough separating themselves from Long Beach Township. The name of this borough was officially shortened to Ship Bottom in 1948 (Snyder 1969).

10. Brant Beach

Brant Beach, located in Long Beach Township, was founded by Henry B. McLaughlin, a Philadelphia lawyer, banker and real estate investor. In the years immediately following 1900, McLaughlin purchased portions of the holdings of the failed Barnegat and Long Beach Island Development Corporation, an organization set up in the 1890s to develop various sections of Long Beach Island.

McLaughlin's purchases included the stretch of island between present-day 55th Street and 62nd Streets. This tract was completely undeveloped at the time of McLauglin's purchases but it did not remain so for very long. By 1909, McLaughlin had established the Beach Haven North Development Company. By 1910, the name of Beach Haven North had been changed to Brant Beach. This community was not initially focused on the ocean, as most of Long Beach Island's other communities were, but rather on a small beach which edged a sheltered cove on the bay side of the island. A small boardwalk and dock were constructed on the cove. Although the cove was to be the focus of the community, the ocean lots still remained in highest demand and it was on the ocean side of the island that the local contractor William Shinn, hired by McLaughlin, began to construct Brant Beach's first houses (Lloyd 1990:92-96) .

With the opening of the automobile causeway in 1914, development of Brant Beach really took off. Brant Beach expanded greatly during the 1920s when the Brant Beach Realty Company developed the area between South 31st and 55th Streets. The Company's initial grandiose plans were scaled back with the onset of the Depression. The Company instead built one and one half story Cape Cod homes on large tracts. Today Brant Beach spans the entire area between South 31st and 74th Streets (Lloyd 1990:92-96).

11. Beach Haven Crest

Beach Haven Crest, located between Brant Beach and Brighton Beach, was developed in the 1930s by James McMurray. McMurray obviously hoped to capitalize on the reputation of Beach Haven with his choice of name. The ocean front development was centered around the operations of the Crest Fishery, hence the second part of its name. The Crest Fishery was one of Long Beach Island's pound fisheries. Pound fisheries trapped large schools of fish in net traps set up two to three miles off the beach in about 36 feet of water. The pound fisheries came to Long Beach Island after the introduction of the railroad. The railroad made it possible to ship large quantities of fish quickly to distant markets. In the 1920s and 1930s at the height of the industry, there were approximately five fisheries working off the island (Lloyd 1994:151).

12. Brighton Beach

Development of Brighton Beach began in 1920. The man behind the development was William C. Smith. Brighton Beach is bounded to the north by Beach Haven Crest and to the south by Peahala Park (Lloyd 1994:167).

13. Peahala Park

The area between 88th Street and 96th Street in Long Beach Township is known as Peahala Park. The area derives its name from the Peahala Hunting Club. At its peak, Long Beach Island had about a dozen hunting clubs with the most famous being the Peahala and the Corinthian. The Peahala club was formed in 1882, when an old boarding house, tract of land and two small bay islands were purchased from Captain Thomas Jones by a group of Burlington County sportsmen. The area was then known as "Tommie Jones" after the hotel's proprietor. The old boarding house, located at the intersection of 89th Street and Beach Avenue served as the club headquarters until 1892 when a new club house was constructed a short distance to the south at what is today the intersection of 90th Street and Beach Avenue. The club remained the island's most exclusive and most popular through the first quarter of the 19th century before falling into disuse during the 1930s (Lloyd 1994:125-126). In 1940, the property was leveled, streets were laid out and, like the rest of the island, the area began to be developed (Lloyd 1994:166-167).

14. Beach Haven Park, Haven Beach, The Dunes, Beach Haven Terrace and Beach Haven Gardens

Beach Haven Park was developed in the mid-1930s by Herbert and Jerome Shapiro. Haven Beach was one of the many early 20th-century developments named after Beach Haven. The Dunes, located between Haven Beach and Beach Haven Terrace, was notable for the fact that each of its large Cape Cod houses had a roof of a different color. The builder of The Dunes' houses were James O'Brogden and his wife, Elizabeth. Beach Haven Terrace was founded in 1907 by the Fidelity Land Company of Philadelphia and was focused around U.S. Life Saving Station #114. It is bounded to the south by Beach Haven Gardens, a small subdivision established in 1926, and by Spray Beach on the south (Lloyd 1994:166).

15. Spray Beach

During the 19th century the area of Long Beach Island today known as Spray Beach was known as Cranberry Hill. It was an especially wild portion of the island with high sand dunes and numerous swampy areas. In the 1890s, the area was purchased by William Ringgold and John Luther Long. Ringgold had been one of the initial investors and principal owners of the Dolphin Inn in North Beach Haven (see below, Section 16) and therefore had great familiarity with the area. Four large cottages were erected on the tract. One, located on what is today 24th Street, was quickly fitted out as a hotel and was called the "Spray Beach House." The hotel served as the center of the small community which quickly grew up around it. The hotel was demolished in 1968 (Lloyd 1994:165).

16. North Beach Haven

The first development in the area today known as North Beach Haven began in 1884 by William Hewitt. Hewitt, hoping to capitalize on Beach Haven's success, built a hotel called the Waverly House on the tract of land immediately to the north of Beach Haven within the bounds of Long Beach Township. Hewitt began selling lots on the small creek which formed the northern boundary of Beach Haven and convinced a group of investors led by William Ringgold to construct a second hotel to be named the Dolphin Inn on the tract. The hotel, located on what is today 13th Street, opened in 1887 and served as the centerpiece of an eight-block-long development extending from 12th Street to 20th Street, laid out by Hewitt and known as Waverly Beach. Waverly Beach is presently known as North Beach Haven. The Dolphin Inn, later renamed "The Breakers," was destroyed by the Hurricane of 1944 (Lloyd 1994:165).

17. Holgate and Beach Haven Heights

Holgate is located on the tract of land on which Joseph Horner opened Long Beach Island's first boarding house (see above, Section 2). As a community, Holgate had its start in 1876, when portions of the boarding house property were purchased by Lafayette Horter and James Holgate. Two years later the two men began to erect cottages for themselves on the properties. Holgate continued to buy property in the area, becoming, by 1907, one of the largest landowners on the island. Besides the two early cottages there was little development on the island during the 19th century. It was not until the 1920s that Holgate began to be developed. As mentioned above, on February 4, 1920, a large storm re-opened the Old Inlet which had formerly separated Long Beach Island from Tucker's Beach. With the rebirth of the inlet, sportsmen began to be attracted to the area, taking advantage of the good fishing caused by the intermingling of the bay and ocean currents. This increase in attention also attracted developers (Lloyd 1990:47-52). First to be developed was the southernmost tip of Long Beach Island. In 1922, developer Robert Osborne formed the Beach Haven Heights Land Company and set about laying out streets. The northern section of Holgate developed more slowly around mid-century. The land at the southernmost tip of this area was not developed and later became part of New Jersey's Great Bay Wildlife Management Area.

B. Maritime History

Although historically lacking major ports, New Jersey's Atlantic Coast lies along a number of the most active shipping routes of the 18th, 19th and 20th centuries. Over the centuries numerous ships have been wrecked along New Jersey's 127-mile-long coast line and a great number occurred specifically off Long Beach Island. Although most of these wrecks occurred some distance offshore, several ships are known to have met their final end on Tucker's Beach and Long Beach Island. The most famous of these was the steel bark Fortuna which ran aground at the foot of 16th Street in Beach Arlington on January 10, 1910. This ship was heavily salvaged making it unlikely that any remains survive beneath the sands of the beach. Several other ships are known to have ended their ocean-going careers on the island's beaches. The schooner Cecil B. Stewart, for instance, ran aground at Harvey Cedars in 1927 and broke apart on the beach (Nash 1936:64). The Helen J. Seitz, a five-masted schooner, grounded at Long Beach on February 9, 1907. The wreck was deliberately burned by her master to avoid heavy salvage fees (Nash 1936:51-55). A more complete list of ships known to have been lost near the project area is included in Appendix A.

By the first quarter of the 19th century, volunteer life saving stations had been established in many locations along New Jersey's coast. The first federal assistance came in 1823, when an appropriation was made for the construction of a lighthouse at Cape May. A lighthouse had been previously constructed on Sandy Hook in 1761, but this was financed by New York merchants, and only later was acquired by the federal government. Following the construction of the Cape May Lighthouse, a series of lighthouses were constructed along the New Jersey shoreline. The present project area contained two of these lighthouses. The larger of these is the Barnegat Lighthouse Tower (Figure 4.6a). The first Barnegat Lighthouse, the fourth on the Jersey coast, stood at the very northern tip of Long Beach Island and was erected in 1834. As this light proved to be of insufficient magnitude and was threatened by erosion, a new 150-foot-tall tower was constructed 900 feet south of the old one in 1858. It was first lit in 1860. In 1889 a two and a half story keeper's house was constructed for the families of the three men who manned the tower (Plate 4.2). The keeper's house stood until 1920 when the government, anticipating the destruction of the tower by erosion, auctioned the large building off for scrap. Although the sea finally approached as close as 50 feet, the residents of Barnegat Light managed to raise enough money to build the jetties required to save the light. The government replaced the light with an offshore light ship and extinguished the beam on August 15, 1927. It still stands today as Long Beach Island's best known landmark (Lloyd 1990:10-17; 1994:46).

The second of the project area's lighthouses was the Little Egg Harbor Light (Figure 4.6b). This lighthouse formerly stood on Tucker's Island. The first lighthouse in this location was erected in 1848. Its use was discontinued in 1859, but it was rebuilt and relit in 1867. This light consisted of a 44-foot-high tower built above a keeper's house (Plate 4.1). The house fell into the sea on October 12, 1927 (Woolman, Price and Rose 1878:54; Lloyd 1990:19-20).

Life saving stations were also financed by the federal government. In the first quarter of the 19th century, volunteer life saving stations were scattered along the New Jersey shore. Typically, these were manned by local fishermen. The first federal appropriation for life saving stations in any state occurred in 1848 when $10,000 was set aside to provide for life boats, rockets and the construction of eight life saving stations on the New Jersey coast between Sandy Hook and Little Egg Harbor. In

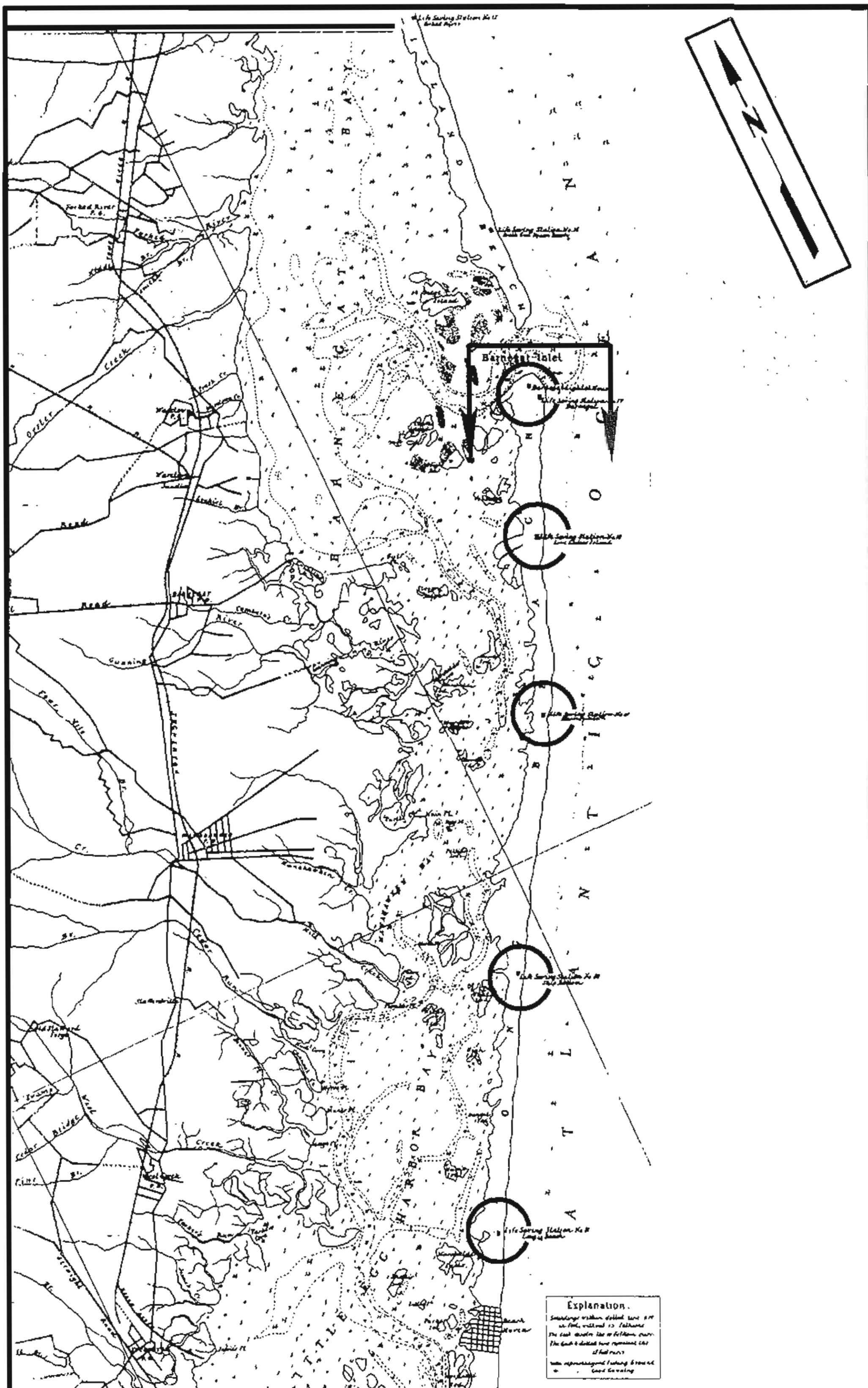


Figure 4.6a. Woolman, H.C., Price, T.T. and T.F. Rose. *Historical and Biographical Atlas of the New Jersey Coast*. 1878. Scale 1 inch: 6,400 feet (approximately). Life Saving Stations Circled and Northeastern Limit of Project Area Shown with Arrows.

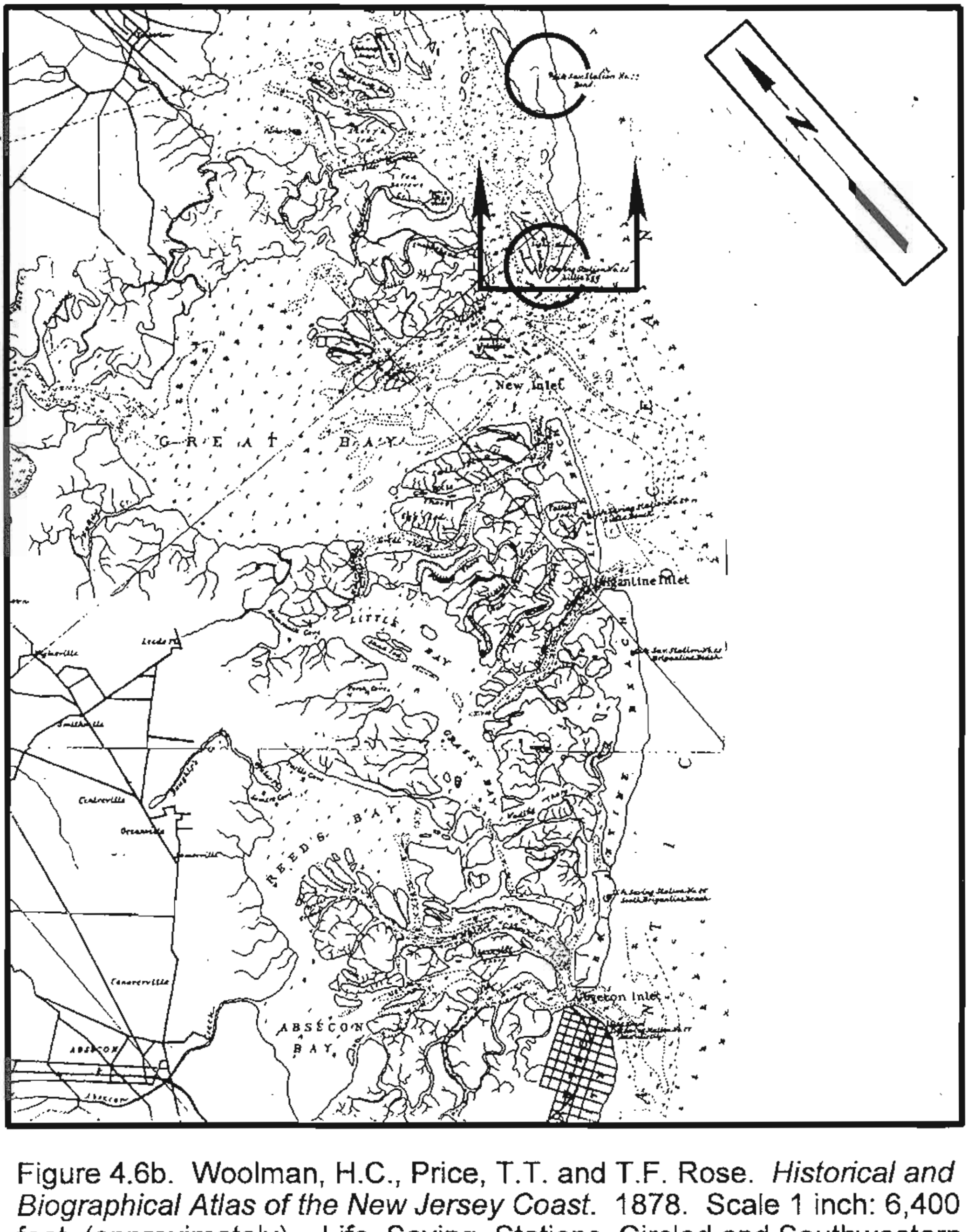


Figure 4.6b. Woolman, H.C., Price, T.T. and T.F. Rose. *Historical and Biographical Atlas of the New Jersey Coast*. 1878. Scale 1 inch: 6,400 feet (approximately). Life Saving Stations Circled and Southwestern Limit of Project Area Shown with Arrows.

Table 4.1. Lifesaving Stations Within the Vicinity of the Project Area

Early #	Later #	Name of Life Saving Station	Latitude North	Longitude West
172	113	Barnegat City	39° 45' 34"	74° 06' 13"
18	114	Lovelady's Island	39° 43' 37"	74° 07' 01"
19	115	Harvey's Cedars	39° 41' 23"	74° 08'13"
20	116	Ship Bottom	39° 38' 13"	74° 10' 42"
21	117	Long Beach	39° 35' 03"	74° 13' 03"
22	118	Bond's	39° 31' 59"	74° 15' 16"
23	119	Little Egg Harbor	39° 30' 05"	74° 17'2 8"

Source: Woolman, Price and Rose 1878

Plate 4.5. Present-day view of Harvey Cedars Life Saving Station which is located on East Cape May Avenue, outside of project area (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:32].

1849, another appropriation was made for six additional life saving stations between Little Egg Harbor and Cape May. The observation towers, small wooden buildings and tiny boats associated with these posts were the only means of defense against the loss of human lives.

Initially, there were two life saving stations on Long Beach Island. The first was located at Harvey Cedars and the second near Bond's Hotel. In 1870, congress provided the first funds for a professional United States Life Saving Service and in 1886, the federal government inaugurated the policy of manning all stations with paid crews (Wilson 1964). Each station was manned by a crew ranging from one to six men during storm season, between September and April.

By 1900, New Jersey had 42 life saving stations each set approximately three miles apart. There were six stations on Long Beach Island between 1871 and 1915 (Table 4.1). Another life saving station, called the Little Egg Harbor Station was located on Tucker's Island. The locations of these stations can be seen on the Woolman, Price and Rose map of 1878 (Figures 4.6a and 4.6b).

Lovelady's Island, Harvey Cedars and Long Beach Life Saving Stations still stand today in their original locations (Plate 4.5). Bond's Life Saving Station was moved a quarter mile to the south to Janet Avenue in the 1920s, and is now a private dwelling. The other life saving stations have been demolished or otherwise destroyed (Woolman, Price and Rose 1878:57; Nash 1936:123; Wilson 1964; Lloyd 1994:57-58).

CHAPTER 5

CULTURAL RESOURCES POTENTIAL

This chapter addresses in broad terms the potential for cultural resources along the specified segments of shoreline and tidal zone and in the proposed near-shore sand placement areas between Little Egg Inlet and Barnegat Inlet and also within the proposed offshore sand borrow areas. First, the potential survival of prehistoric and historic terrestrial resources, i.e., resources that were formed on land and have since been inundated by water or sediment as a result of rising sea level and other offshore depositional activity, si discussed. Second, the potential for underwater resources is examined, i.e., resources such as shipwrecks, downed airplanes, or jetties, whose original formation occurred in a marine environment.

A. Submerged and Shoreline Terrestrial Resources

Much research has focused upon the geomorphology of Atlantic coastal regions (Emery and Milliman 1970; Kraft 1971; Sheridan et al. 1974; Belknap and Kraft 1977; Weil 1977; Kraft et al. 1979) and of the implications fo geomorphological change for archaeological site preservation (Kraft 1977a; Belknap and Kraft 1981; Kraft et al. 1983).

Since the earliest date of its occupation by mankind, the Atlantic coast of New Jersey has been in a constant state of change, continually subject not only to radical erosion by wave action and redeposition of sand, but also to a gradual rising sea level and compression of underlying geologic strata. Figures 3.1, 3.2 and 3.4 show the considerable degree to which the coastline has changed over the period of human occupation. Even when considering the likelihood of the survival of on-shore and near-shore marine-related historic resources one must take into account the effects of coastal change. A dramatic representation of coastal fluctuation may be seen in Figure 4.3, which shows the extent to which a small portion of the Long Beach Island coastline changed over only a 50-year period. An understanding of the processes of geomorphic change affecting the New Jersey coastal zone is essential in order to make any basic predictions about the potential for both prehistoric and historic site preservation.

Stuiver and Daddario (1963:951) published five radiocarbon dates on peat deposits above basement surfaces at increasing depths from the lagoon between the Brigantine City Barrier (just south of the project area) and the New Jersey mainland. These data indicated a submergent rate of three meters per millennium from 6,000 years ago until 2,000 to 3,000 years ago, when the rate slowed to 1.2-1.4 meters per millennium. Additional evidence exists to indicate that sea-level rise along the New Jersey coastline was not a completely linear trend, but was to some degree cyclical with fluctuating transgressive rises and regressive falls (Kraft et al. 1983:105).

Coastal mainland environments respond ot variations in sea level by changing into coastal marshes, barrier beaches, or even succumbing entirely to the ocean/ bay waters. Tectonic activity, related in the Middle Atlantic to the offshore Baltimore Canyon Trough geosyncline, and the potential "water loading" effect have also caused a downward dip of stratigraphy below the sea bottom (Kraft and John 1978:106). Analysis of marine cores provides evidence of a transgressive stratigraphic sequence of sedimentary facies occurring at increasing depths as one moves offshore with a Pleistocene land surface at the base overlaid by tidal salt marsh mud and peat, which is in turn covered by coarser barrier sands and shallow fine marine sands. Radiocarbon data reflect a parallelism of sea level dates as depth increases relative to the modern Coastal Plain (Belknap and Kraft 1977; Kraft and John 1978:106). Kraft and John cite these coastal data as classic examples of Walther's Law of Correlation of Sedimentary Facies, wherein the horizontal distribution of sediments in present geographic environments is expected to be reflected in a similar vertical distribution of sediments from environments moving through geologic time (1978:106-108).

Despite the horizontal movement of coastal environments, the sedimentary sequences discussed above indicate that the environmental structure and relative positions of environmental types have remained stable, i.e. as lagoon/barrier shorelines with fringing coastal marshes which often were cut by large estuaries of (presently drowned) rivers (Kraft et al. 1983:59). Kraft et al. (1983:111) emphasize that the preservation potential for a submerged archaeological site is a function of two principal variables: the pre-Holocene topography on which the site was deposited; and the rate of sea-level rise.

Locations with the highest potential fo archaeological site preservation are found beneath marine sediments which occur along the flanks of former interfluves which lie below the marine eroded zone, yet are still shallow enough to be accessible (Kraft et al. 1983:112). The following are three archaeological site preservation scenarios: 1). a headland site near a freshwater source (based upon the Woodland mortuary site of Island Field in Delaware) where continued landward migration of the coastal barrier and sea would most likely consume any traces of cultural materials; 2). a shell midden at the edge of a marsh and lagoon where the material may conceivably be preserved in the marsh/ lagoon mud facies below a rising sea level; and 3). a site which originated adjacent to an estuary or tidal river, due to the delay between burial and the arrival of the eroding shoreline, would become more deeply buried and stand a greater chance of survival, although its accessibility is reduced (Kraft et al. 1983:110-111).

Examples of submerged terrestrial resources which have survived inundation processes include karst formations in Sarasota County, Florida, and in the Gulf of Mexico off Fort Myers. Both sites have produced evidence of prehistoric human occupation (Ruppe 1979). These examples reflect geomorphological processes within the Gulf of Mexico, the effects of which are somewhat less dramatic than those encountered along the Atlantic coast. Clearly, the research of Kraft and others along the Delaware coast demonstrates that the study of coastal geomorphology and environments is capable of providing useful insights into the nature and condition of submerged cultural resources that may exist. It is also clear that the inundation of prehistoric and early historic archaeological sites may result in extensive resorting or removal of the archaeological record. Furthermore, while isolated artifacts preserved in the bottom sediments could survive in an excellent state of preservation, the associated context of human activity may have been destroyed. The high energy environments that are often present along ocean coastlines will lessen the likelihood that fragile evidence of prehistoric occupations would survive.

In addition to the relatively few documented occurrences of inundated terrestrial resources, considerable effort has been expended over the past quarter century in attempting to develop effective predictive models that can guide researchers intent on locating submerged prehistoric resources and assessing site preservation potential. Much of this work has taken place in the Gulf of Mexico and along the Atlantic Continental Shelf in connection with offshore gas and oil leasing activities (e.g., Coastal Environments, Inc. 1977; Bourque 1979). For the most part, these studies conclude that paleogeographic analysis (with particular reference to sea level change and coastal geomorphic processes), coupled with remote sensing and selective core sampling, can assist in narrowing down offshore areas where site preservation potential is high. As just one example, although the location and identification of submerged Archaic sites would be difficult, their association with shell middens should increase the chances of their being detected. Indeed, investigations in the Gulf o f Mexico off the west coast of Florida have confirmed both the association of prehistoric material with submerged middens and the detectability of these sites using side scan sonar remote sensing (Ruppe 1979).

The macro-scale model-building studies noted above are valuable as an overall guide to preservation potential of terrestrial resources within large expanses of ocean, but they tend to be too broad and generalized for effective application in the study of small offshore tracts such as those proposed for sand borrowing off the New Jersey coast. The need for detailed, local paleogeographic data will always be paramount for site-specific offshore studies, and in most instances, such data are not readily available, being both expensive and logistically awkward to derive and interpret.

B. Underwater Resources

As with inundated terrestrial resources, the effect of coastal geomorphic processes may either erode or bury underwater resources, and the processes may occur rapidly or slowly over time. However, because of the "accidental" and rapid manner in which many underwater resources (notably shipwrecks) are formed, and the shorter elapsed time involved before their remains are sought, they are frequently better preserved and generally more easily discovered. Underwater resources, such as shipwrecks, because they usually constitute a stronger physical (topographic, magnetic) anomaly than most inundated terrestrial resources are also far more easily identified by remote sensing techniques involving the use of magnetic, acoustic or sonar detection equipment.

1. Potential for Shipwreck Preservation, Identification, and Evaluation

In many cases, the remains of shipwrecks may be submerged, but not buried beneath sediment. Shipwreck material deposited in even the shallowest environment can settle rapidly into the bottom with its associated archaeological record intact. The wreck of the De Braak (1798), discovered near the Delaware Breakwater close to the study area, provides a classic example. A good portion of the lower hull survived intact, along with an extensive associated artifact assemblage (Shomette 1993). Even in extremely high-energy environments, evidence of the ship structure frequently survives. A recent discovery of a wooden hull sailing vessel adjacent to the Showboat Casino in Atlantic City also confirms that vessels have survived the inundation process in the project vicinity (correspondence files of the New Jersey Historic Preservation Office). Numerous other archaeological investigations off the coasts of the states of Massachusetts, North Carolina, Florida, and Texas, and of England, Israel and Turkey, also offer examples of ship remains surviving inundation by sediment and the preservation of valuable archaeological data.

At many shipwreck sites, sand and light mud similar to the bottom sediments in portions of the project area have provided an excellent environment for preservation. Given the extent of vessel losses in the vicinity of the project area, and the level of preservation at shipwreck sites in other similar environments, it was considered very likely that well-preserved shipwreck sites would survive within the designated survey areas. However, it was felt that potential shipwreck sites would almost certainly be buried beneath an extensive amount of sand. Wrecked vessels typically act to trap sand, particularly in an environment where strong long-shore currents transport high volumes of suspended sand up and down the coastal margins. On the other hand, buried wreck sites may sometimes become exposed again as severe coastal storms can also erode the sand which encapsulates wreck sites.

As a major conduit for exploration, colonization and expanding coastal commerce, the Long Beach Island littoral is an obvious and natural repository for underwater resources. Strong coastal storms, often with a lethal combination of treacherous northeast winds and swift tidal currents, coupled with the presence of shallow water and historically heavy coastal traffic, have conspired over the last three centuries to make the Long Beach Island shoreline the final resting place for dozens of documented sailing vessels, steamships, barges, tugs and large modern ships.

A recent Bureau of Land Management study of the Continental Shelf from the Bay of Fundy to Cape Hatteras has characterized the New Jersey Coastal Zone as an area of "moderately heavy" predicted shipwreck density (Bourque 1979). An inventory of shipwrecks and all types of ship losses near Long Beach Island was compiled during the background research phase of this study and confirms this predicted density (Appendix A). Drawn from a range of primary and secondary sources, this extensive shipwreck list, while far from comprehensive, nonetheless gives an indication of the variety of shipwrecks that have occurred in the project vicinity. Although there are no documented underwater resources within the limits of the three proposed off-shore sand borrow areas, Appendix A and secondary and primary historical sources show that numerous vessels have been deposited in their general vicinity throughout the historic period. The project area is therefore considered on the basis of background research to hold a high potential for yielding underwater resources of a caliber suitable for inclusion in the National Register of Historic Places.

Based on the information in Appendix A, the types of underwater resources that may be present in the Cape May vicinity include a variety of materials dating from the 18th century through World War II. Appendix A also lists several recent shipping disasters which have occurred within the last 40 years. Potential vessel types include wrecks representative of all phases of commercial and naval activity taking place in the Delaware Bay and along the New Jersey portion of the Atlantic Coast. Wood-hulled ships, ranging from small fishing sloops, shallops, recreational sailing and motor craft and coastal schooners, to sail-rigged warships, have been lost in the vicinity of Long Beach Island. Iron-hulled vessels, including paddle-wheel steamboats and World War II-era merchant ships sunk by German submarines, have also been lost in the project vicinity. Large 20th-century steamships and freighters are also among the listed losses in the region. Many of these types of vessels would potentially lend historic insights into a wide range of maritime topics, including the contexts of naval activity, shipbuilding and regional shipping, and patterns of trade and industry.

CHAPTER 6

FIELD INVESTIGATIONS

The fieldwork component of this survey involved chiefly visual inspection and remote sensing to identify potentially significant cultural resources within the shoreline, near-shore and offshore survey areas. Visual inspection and magnetic survey of the shoreline were conducted along four segments of the tidal zone totaling 10.5 miles of Long Beach Island's Atlantic coastline (Areas A-D). Comprehensive magnetic, acoustic and bathymetric remote sensing and hydrographic survey were conducted within the near-shore sand placement areas (located directly offshore from Areas A-D), as well as within the three proposed offshore sand borrow areas, in order to locate, identify and preliminarily evaluate submerged cultural resources that might be affected by the proposed depositional or dredging activity. Analysis of remote sensing data aimed primarily at isolating potentially significant targets that might require further investigation or avoidance. No visual inspection of underwater targets (i.e., diving) was conducted.

A. Shoreline Survey

1. Visual Inspection

The shoreline survey limits were defined as four segments of the Long Beach Island shoreline: Area A - Loveladies to Surf City, between Dolphin and North 17th Streets; Area B - Ship Bottom to Brant Beach, between South 22nd and Stockton Street; Area C - Long Beach Township, between Nebraska and 27th Streets; and Area D - Beach Haven, between 6th Street and Webster Avenue. Four archaeologists and one architectural historian inspected the four areas on foot between April 27 and 29, 1998. During periods of low tide, the surveyors walked along a series of north-south oriented transects spaced 50 feet apart (or closer, depending on the width of available beach front). The transects extended from the mean low water line to 50 feet west of the mean high water line. In addition to inspecting, recording and photographing cultural features encountered along the waterfront, the project staff asked local residents and the staff of the Long Beach Island Historical Society Museum if they had any knowledge of buried or submerged cultural resources along the section of ocean front under study.

Area A (Figure 6.1)

This section of shoreline is separated from the nearby beachfront homes and other properties by a line of eroding sand dunes with sparse and patchy vegetation (Plate 6.1). The foredunes are mostly protected from human activity by sections of fencing and accompanying warning signs. Despite such protective measures, natural erosion of the dunes has caused a steep slope down towards the waters edge. Stone and composite wood and stone jetties and groins, constructed mostly of basalt or diabase boulders set between wood pilings, were noted at regular intervals throughout Area A, beginning at Dolphin Street (Plate 6.2). Approximately 20 composite wood and stone and 11 stone structures of this sort were recorded.

One historic resource of possible interest, a residence at 14 South 73rd Street in Harvey Cedars, was noted within Area A [A-5] (Plate 6.3). This building, located adjacent to the dune ridge, appears to date from the late 19th century, but also displays some 20th-century alterations. Like other buildings on the same side of the block, it faces north towards 73rd Street rather than towards the ocean. The foundation of the two story structure was not visible. The front gabled roof is wood shingled and the main body of the house is sheathed in heavily

Plate 6.1. Shoreline Survey Area A: general view looking southwest from Dolphin Street showing the northeastern limit of Shoreline Survey Area A (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/6:11].

weathered clapboards. A single narrow brick chimney rises above the roof's ridge line near the building's center. A projecting second story bay overhangs the porch along the street front. The porch roof and the front of the bay are covered in asphalt shingles. The porch and a one bay deep addition at the rear of the house seem to be later alterations to the earlier central core of the building. The similarity of the wide window surrounds observed on both the front and rear additions suggests that both additions were the result of a single episode of building enlargement. Multiple projecting window bays were noted along the west side of the house, which also has a late 20th-century deck addition. Although the building's windows are double hung 20th-century replacements, the front door is wooden paneled and appears to date to the early phases of the building's life, if not to the period of original construction. A small one story outbuilding with a wood shingled roof and clapboard sheathing extending to the ground surface stands 15 feet to the south of the main house. The smaller structure has a small porch facing the beach. The window surrounds match detailing on the porch and rear additions to the main house.

All other cultural features identified in Area A were composed of 20th-century materials, including a group of 35 weathered wood pilings and boards located midway between the low tide line and the base of the dune at East 84th Street [A-1]. A conglomeration of concrete, wood pilings and boards was located near the base of the dune at 73rd Street in Harvey Cedars [A-2]. A few hundred feet to the south at the end of 72nd Street in Harvey Cedars an outcrop of large stones was noted in the surf [A-3], most likely representing the remains of a partially buried jetty/ groin. Feature A-4, composed of two series of parallel wood pilings along the edge of the foredune, was located north of Bergen Street in Harvey Cedars. The orientation of the pilings with the sand dune formation indicate that it was probably a former walkway to the beach.

Plate 6.2. Shoreline Survey Area A: general view looking east southeast showing wood piling jetty/groin ending in a stone barrier, partially covered by sand. This jetty/groin is located at Loveladies Public Beach Access (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/6:17].

Area B (Figure 6.2)

This section of shoreline is slightly more populated than Area A to the north, yet the appearance of the beachfront is generally consistent with Area A described above (Plate 6.4). Eleven composite and two stone jetties/ groins were observed spaced at regular intervals along this section of the shoreline. A series of wood pilings [B-1], was located between two jetties/groins just north of Stockton Street. The pilings, partially obscured by the dune slump, were probably part of a modern sand retaining structure to protect the dune from erosion.

Area C (Figure 6.3)

The shoreline in Area C is again visually similar to that in Areas A and B (Plate 6.5). Nine jetties/groins were observed, eight of which were

Plate 6.3. Shoreline Survey Area A: view looking southwest showing Historic Resource A-5, House #14 at the end of East 78th Street (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/6:3].

Plate 6.4. Shoreline Survey Area B: general view looking southwest from Brownson Street (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:24].

Plate 6.5. Shoreline Survey Area C: general view looking southwest from Nebraska Boulevard (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:19].

composite wood and stone, and one entirely of stone. No other cultural materials were observed in this survey area.

Area D (Figure 6.4)

This portion of the Long Beach Island shoreline appears less eroded. Visually, the shoreline resembles that observed in Areas A, B and C, although the beach is more expansive between the waterline and the dune structure (Plates 6.6 and 6.7). Nine jetties/groins are spaced at regular intervals along this section of beach; seven are composite wood and stone, one is entirely stone, and one is constructed entirely of wood.

Several 20th-century features were observed along this stretch of shoreline. Three wood pilings [D-1] were located approximately 40 feet into the surf near Berkeley Avenue (Plate 6.8). Feature D-2, a double and in some areas triple row of pilings, began at the low tide line at Chatsworth Avenue and gently curved into the surf, appearing sporadically for approximately 100 feet. Feature D-3 was located at the end of Holyoke Avenue (Plate 6.9). This feature was composed of two rows of pilings which emerge from the surf for a short distance before being covered by sand. Four other modern wooden piling configurations were located between Jefferies Avenue and Marshall Avenue [D-4, D-5, D-6, D-7]. At the south end of survey Area D, between Marshall Avenue and Webster Avenue, the beach showed signs of disturbance from recent heavy machinery activity.

2. Pedestrian Magnetometer Survey

The purpose of the pedestrian magnetometer survey along the shoreline was to detect and delineate anomalies that might be related to potential historic cultural materials, with a particular emphasis on shipwrecks. The field survey was completed between April 29 and May 5, 1998 by Enviroscan, Inc. The areas surveyed were the same four

Plate 6.6. Shoreline Survey Area D: general view looking southwest from 6th Street (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:17].

Plate 6.7. Shoreline Survey Area D: general view looking northeast from Webster Avenue (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:2].

Plate 6.8. Shoreline Survey Area D: view looking east showing Historic Resource D-1, composed of wood pilings in surf near Ocean Street (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:14].

Plate 6.9. Shoreline Survey Area D: view looking southeast showing Historic Resource D-3, composed of wood Pilings Partially Submerged in the surf at the end of Holyoke Street (Photographer: Sarah Waters, April 1998) [HRI Neg. # 98007/5:15].

shoreline parcels of Long Beach Island subjected to the visual ground surface inspection described above (Areas A-D). The original proposed magnetometer survey specified east-west magnetic profiles at 50-foot spacing intervals, but the survey strategy was altered to study north-south profiles at a less than 50-foot spacing, with a station spacing of less than five feet. This adjustment was necessary to compensate for the mean high water line erosion of the beach back to dune fences, bulkheads and private residences in order to most accurately represent any magnetic signatures (see below, Appendix B).

The high-sensitivity total field intensity magnetic survey was conducted using a Geometrics G-858 cesium vapor magnetometer. The magnetometer was equipped with two sensors to simultaneously record total field data along parallel profiles ten feet apart. Readings were automatically triggered at one-second intervals as the sensor array was carried at normal walking speed and were time-stamped and stored in the memory of the magmapper. The dual-sensor array was carried along each of four profiles: 1). a line west northwest of the mean high water line; 2). the mean high water line itself; 3). a line between the mean high and low water lines; and 4). the mean low water line. In each survey area, the profile along the mean low water line was walked at times corresponding to the local ebb tide plus or minus 90 minutes, providing a profile somewhat seaward of the mean low water line. A total of eight magnetic profiles were recorded for each survey area (Appendix B). Magnetic field variations unrelated to subsurface targets were recorded using a Geometric G-856 magnetometer with a single proton precession sensor at a separate fixed location for each survey area. The survey data was adjusted accordingly to yield a data set representing primarily local, time-invariant anomalies related to subsurface targets.

Magnetic survey station coordinates were recorded using a Trimble Pathfinder global positioning system (GPS). The GPS data was corrected in real time using radio beacon corrections supplied by the United States Coast Guard GPS base station in Barnegat Light, New Jersey. The resulting differential GPS (DGPS) positioning has a nominal accuracy of less than two feet.

The composite stone and/or wood jetties/groins along the survey areas caused magnetic anomalies to appear regularly spaced in every data profile. Thus, the east-west trending of linear anomalies likely represent jetty/groins rather than shipwrecks. Anomalies between the jetties along the dune bases may be due to the presence of steel wire and bolts in the bulkheads and fences constructed to prevent dune erosion, and are also not likely representative of significant historic cultural resources.

In total, five magnetic targets may represent historic resources, such as shipwreck remains. Potentially significant magnetic anomalies identified during this shoreline magnetometer survey (and including near-shore and offshore remote sensing survey targets [see below section B]) are summarized in Table 6.1. This table lists the character, amplitude range and New Jersey state plane grid coordinates for each of the potentially significant magnetic targets.

Area A (Figures 6.1 and 6.5a-b)

A very large point target with a highly coherent character [MA-4] may be interpreted as the potential remains of a shipwreck, although an underwater magnetic target, possibly related, was located offshore and slightly north of MA-4 [4:816](see below, Section B). Together, these targets are perhaps more likely to represent an outflow pipe or other such linear east-west structure. Three other possible shipwreck targets were encountered in Area A with slightly less coherent signatures [MA- 1, MA-3 and MA-7]. Aside from these magnetic anomalies which might represent shipwrecks, a possible debris field [MA-5], located near Essex Avenue, was also identified. This target is suspect as a historic resource, however, due to its proximity to fences and other potential signature-altering materials. The remaining magnetic anomalies identified in Area A [MA-2, MA-6, MA-8 thru MA-13] are associated with jetties/groins and other 20th-century features that are visible above ground.

Area B (Figures 6.2 and 6.6)

No significant magnetic anomalies were identified in Area B. The five magnetic targets that were located [MB-1 thru MB-5] are all associated with identified in Area A [MA-2, MA-6, MA-8 thru MA-13] are associated with jetties/groins and other 20th-century features that are visible above ground.

Area B (Figures 6.2 and 6.6)

No significant magnetic anomalies were identified in Area B. The five magnetic targets that were located [MB-1 thru MB-5] are all associated with jetties/groins.

Area C (Figures 6.3 and 6.7)

Only one magnetic anomaly [MC-1] was encountered along the shoreline in Area C. The target may be a debris field located near Colorado Boulevard. The character of the magnetic signature was incoherent, which may have been caused by its proximity to a jetty/groin.

Area D (Figure 6.4 and 6.8)

Two potentially significant magnetic anomalies were identified along the shoreline in Area D. A signature suggestive of a possible shipwreck [MD-4] was discovered between Jefferies Avenue and Holyoke Avenue. Magnetic Target MD-6, between Holyoke Avenue and Essex Avenue, produced numerous small coherent signature peaks, potentially indicating an extensive debris field. The remaining magnetic anomalies identified in Area D [MD-1 thru MD-3 and MD-5] are associated with jetties/groins and other visible 20th-century features.

B. Near-shore and Offshore Remote Sensing

1. Field Techniques and Procedures

The remote sensing survey conducted by Dolan Research, Inc. consisted of magnetometer and side-scan sonar investigations of near-shore sand placement areas offshore from the four shoreline survey areas (Areas A thru D) discussed above (Figures 6.1-6.4) and three potential offshore sand borrow areas (Borrow Areas B, D, and E) (see below Figures 6.9-6.16). This fieldwork was completed between April 27 and May 2, 1998. The survey was conducted to locate, identify and preliminarily assess the significance of submerged prehistoric and historic resources that might be affected by future dredging and disposal activities. The underwater survey was designed to generate sufficient magnetic, acoustic, and bathymetric remote sensing data to identify anomalies caused by submerged cultural resources, such as shipwrecks. Analysis of the remote sensing data aimed to isolate targets of potential prehistoric and historical significance that might require further investigation or avoidance. No diving was undertaken on these targets.

All remote sensing fieldwork was carried out from a 25-foot survey vessel suitable for shoal and open water operations. A Geometrics, G-866, proton precession magnetometer, capable of +/- one gamma resolution, was employed to collect magnetic remote sensing data. A two-second sampling rate by the magnetometer's towed sensor, coupled with a four knot vessel speed, assured a magnetic sample every ten feet. A precision echo depth sounder with a 208 kHz narrow beam transducer was used to collect bathymetric data. Survey vessel trackline control and position fixing were obtained by using a laptop PC-based software (Hypack) package in conjunction with a Navstar DGPS onboard the survey vessel. Differential corrections were provided by a U.S. Coast Guard beacon transmitting from Sandy Hook, New Jersey. The onboard computer and black/white monitor were interfaced with the DGPS satellite positioning system. Positioning data from the DGPS was converted by the computer to New Jersey NAD 83 X, Y coordinates in real time. These X, Y coordinated were used to guide the survey vessel precisely along predetermined tracklines. While surveying, vessel positions were continually updated on the computer monitor to assist the vessel

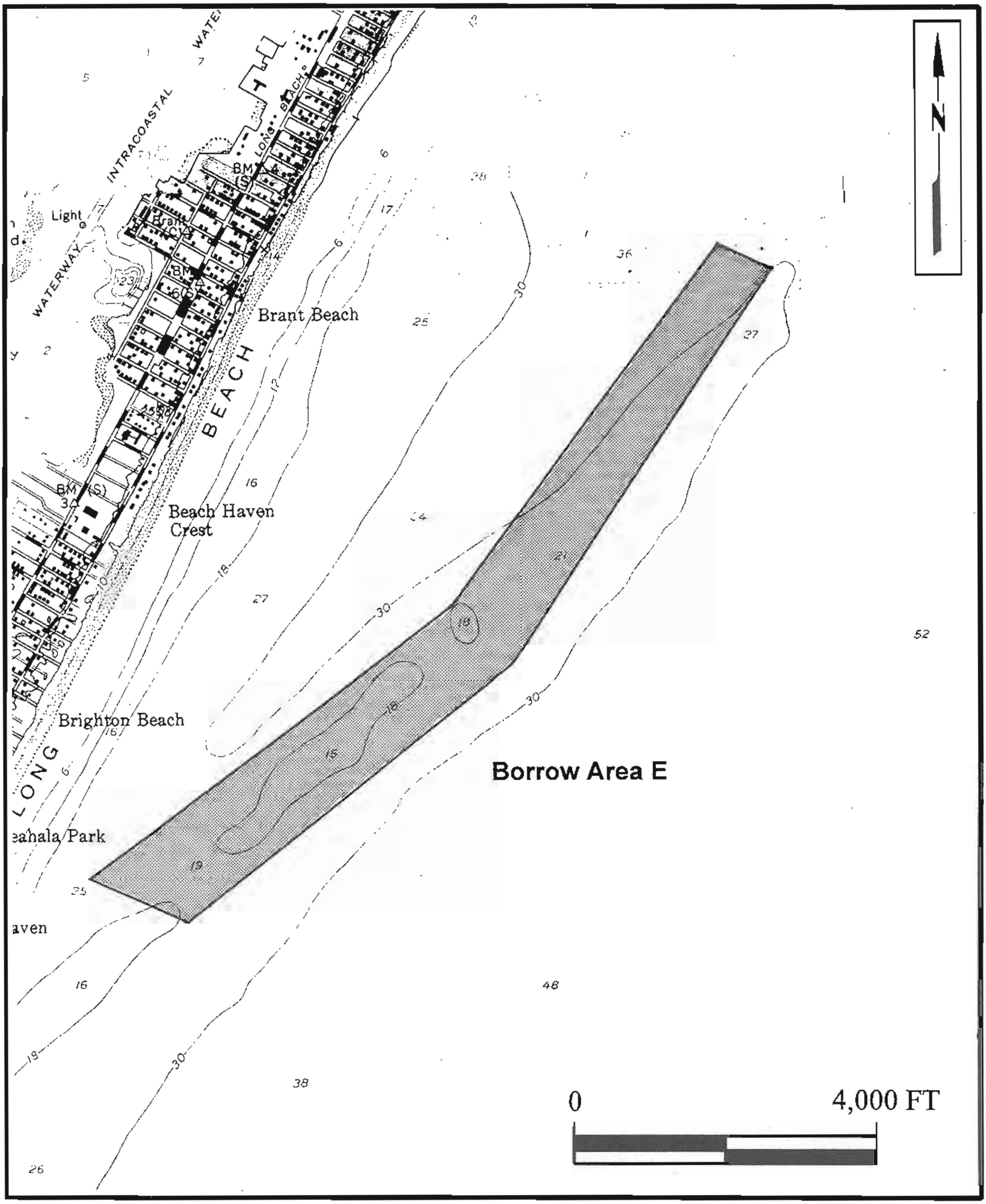


Figure 6.10. Map Showing Location of Borrow Area E.

operator, and the processed X, Y data were continually logged on computer disk for post-processing and plotting.

Position coordinates were logged into the onboard computer. To allow for the detection of subtle magnetic anomalies typically associated with smaller wooden vessels, survey lane spacing for the survey was established at 75 feet offsets. DGPS position fixes were recorded every 50 feet along each survey lane. Magnetic records were event marked at 100-foot intervals along each lane. This allowed researchers to rapidly integrate magnetic and acoustic records into a survey map and to pinpoint the location of each identified target.

Magnetic data collected in the three offshore borrow areas were contour plotted at 10 gamma intervals. All sonagram records were inspected for potential man-made features present on the bottom surface. After fieldwork data was collected, magnetic data was correlated with sonar records to identify targets of potential significance (see Table 6.1). Additional investigation or avoidance was recommended for target signatures with the potential to yield submerged cultural resources (discussed in Chapter 7).

2. Results

Analysis of the magnetic signatures identified during the survey was based on several criteria. After the magnetic data was contour plotted, each anomaly was analyzed according to: 1). magnetic intensity (total distortion of the magnetic background measured in gammas); 2). pulse duration (detectable signature duration); 3). signature characteristics (negative monopolar, positive monopolar, dipolar, or multi-component); and 4). spatial extent (total area of disturbance). Acoustic (side scan sonar) targets were analyzed according to their spatial extent, configuration, location and environmental context. Magnetic records were correlated with the acoustic targets to provide any further information on the identity of the material generating the remote sensing signatures.

Inspection of the remote sensing records confirmed the presence of four potentially significant targets: three along Near-shore Survey Area A (Figure 6.1); and one in Offshore Borrow Area D (Figure 6.14).

Following is a brief summary of the four potentially significant targets.

Near-shore Area A

Target #: 4: 735
Coordinates (NAD 83): [redacted]

This dipolar magnetic signature produced a maximum distortion of 389 gammas and extended over six sample intervals (Figure 6.17). Acoustic imagery confirms the presence of a wreck-like object (Figure 6.18), approximately 120 feet by 20 feet, that remains partially buried perpendicular to the shoreline. Water depth was 12 feet. The offshore end of the target site has at least three to four feet of relief above the ocean bottom. The signature characteristics are consistent with those derived from shipwreck sites.

Target #: 4: 816
Coordinates (NAD 83): [redacted]

This target produced a magnetic signature only. It consisted of a multi-component magnetic signature with a maximum distortion of 1,496 gammas which extended over 13 sample intervals (Figure 6.19). The lack of an associated acoustic image confirms that the material responsible for generating the anomaly is buried. Magnetic influence from the target covered an area approximately 175 feet along the shoreline. Water depth was 12 feet. The possibility exists that the target may be associated with a buried shoreline feature (i.e. outflow pipe, jetty/groin). However, this magnetic signature was

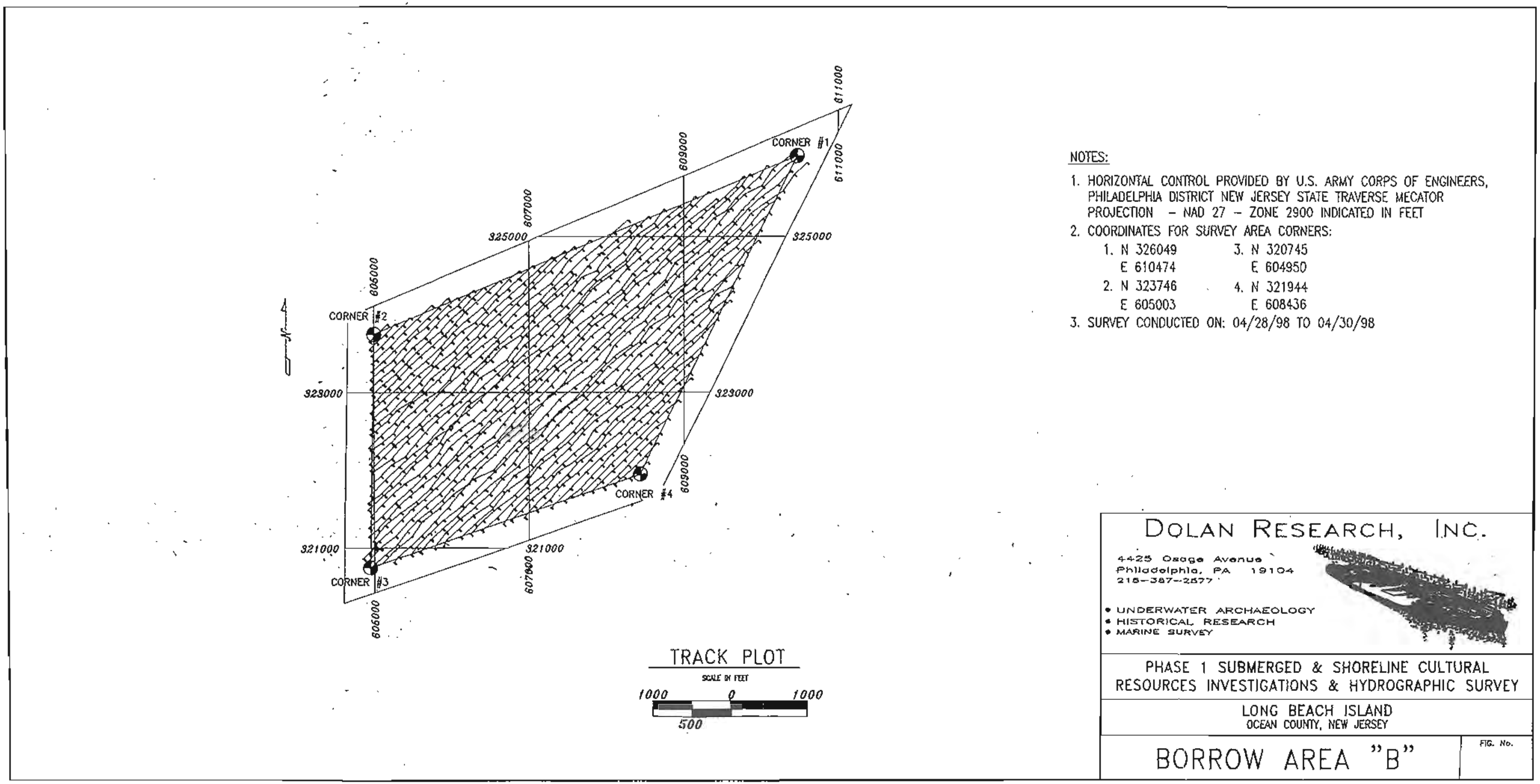
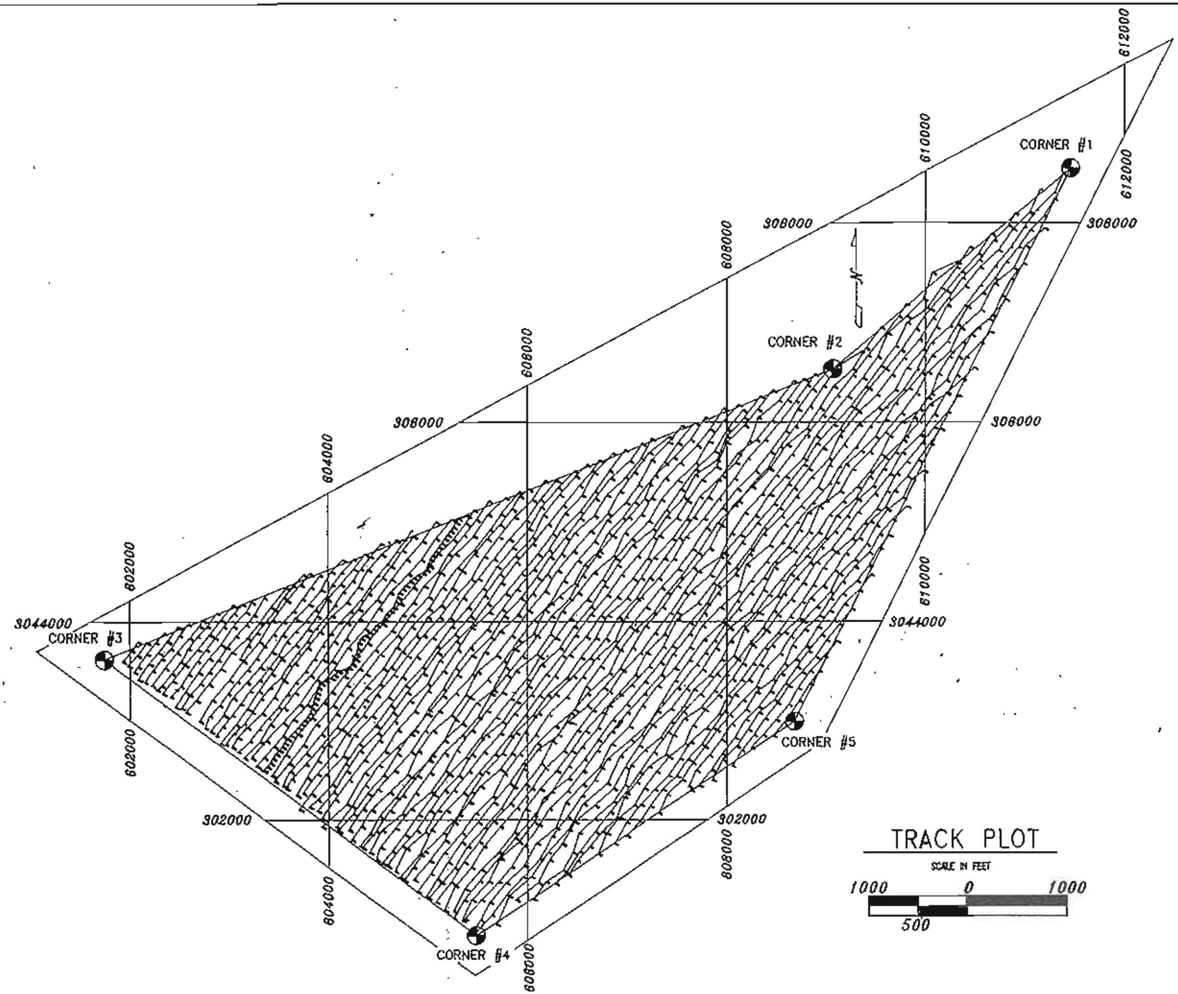


Figure 6.11. Borrow Area B, Tract Plots.



NOTES:

1. HORIZONTAL CONTROL PROVIDED BY U.S. ARMY CORPS OF ENGINEERS, PHILADELPHIA DISTRICT NEW JERSEY STATE TRAVERSE MECATOR PROJECTION – NAD 27 – ZONE 2900 INDICATED IN FEET
2. COORDINATES FOR SURVEY AREA CORNERS:

1. N 308547 E 611460	4. N 300837 E 605481
2. N 306527 E 609065	5. N 302994 E 608686
3. N 303618 E 601741	

3. SURVEY CONDUCTED ON: 04/30/98 TO 05/01/98

DOLAN RESEARCH, INC.

4425 Osage Avenue
Philadelphia, PA 19104
215-387-2577

- UNDERWATER ARCHAEOLOGY
- HISTORICAL RESEARCH
- MARINE SURVEY

PHASE 1 SUBMERGED & SHORELINE CULTURAL RESOURCES INVESTIGATIONS & HYDROGRAPHIC SURVEY

LONG BEACH ISLAND
OCEAN COUNTY, NEW JERSEY

BORROW AREA "D"

FIG. No.

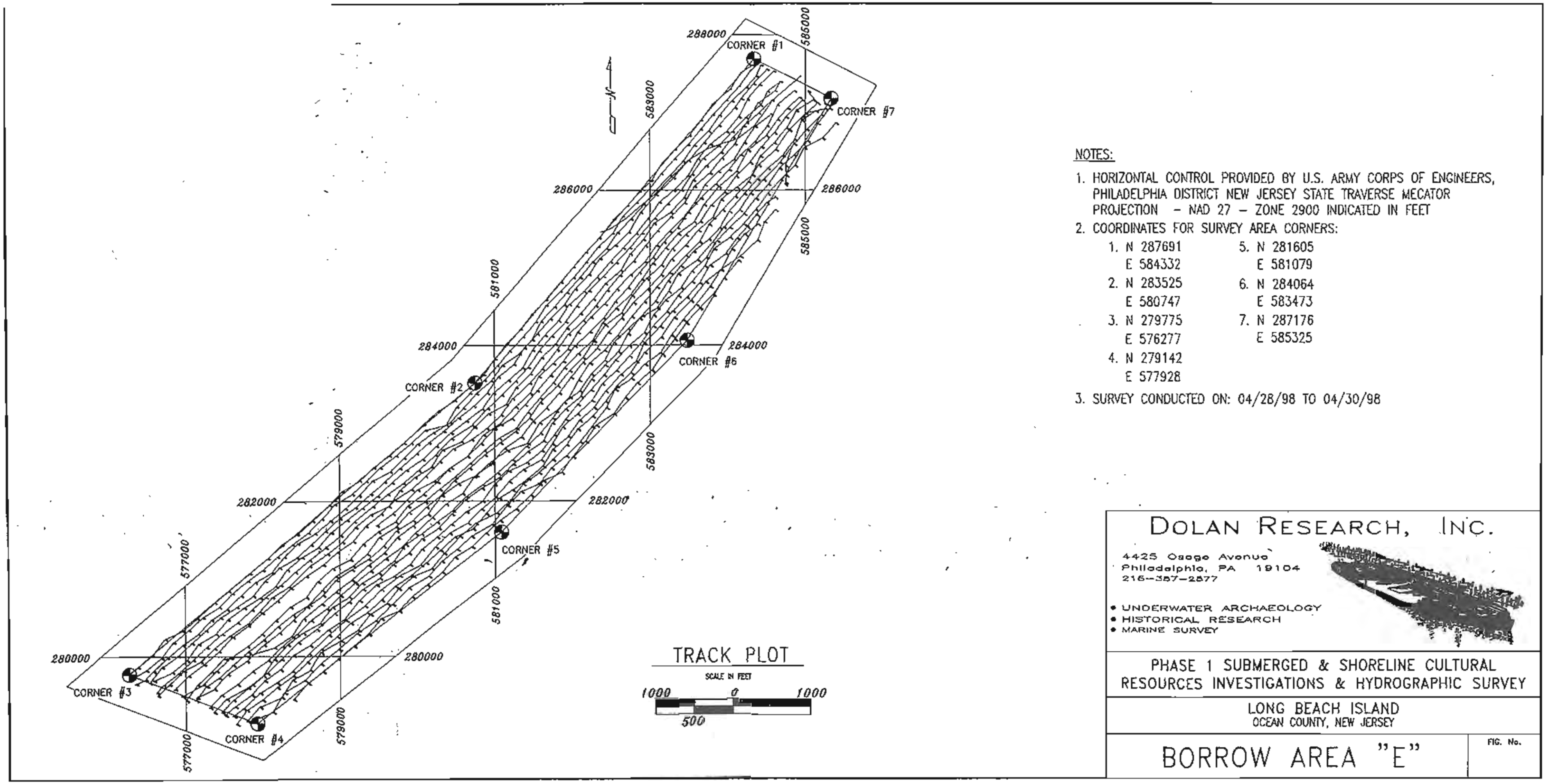


Figure 6.15. Borrow Area E, Tract Plots.

The survey lines within each area were performed at 500-foot intervals with soundings plotted every 50 feet along each line. Depth information was collected every two to three feet. Borrow Area B was 41,215 linear feet and the check run was 7,800 linear feet. Borrow Area D was 67,700 linear feet and the check run was 10,300 linear feet. Borrow Area E was 54,000 linear feet and the check run was 11,500 linear feet. Total linear feet equaled 192,515. As per instructions given to Hydrographic Surveys, cross section sounding lines were run perpendicular to the longest axis of the borrow areas and spaced 500 feet apart. One check line run was performed in each borrow area.

2. Field Techniques and Procedures

An enclosed 24-foot Monark aluminum hull survey vessel was used to perform soundings. The survey vessel was powered by a 220 HP 653 Detroit Diesel in-board power plant. The vessel was equipped with a custom rudder for maximum maneuverability. The on-board survey systems include full navigational electronics, 2 VHF radios, GPS navigation system, U.S. Coast Guard approved running gear and safety equipment, and an onboard power inverter as well as a 1,000 watt generator. The weather tight instrumentation console contained the survey recording equipment, fathometer, computer, GPS receiver and VHF radio. The platform was equipped with a center hull mounted eight degree transducer.

Survey equipment included the Starlink 212G/MBA-2DGPS sub-meter positioning system, which was used for determining horizontal location. To collect the sounding data an Innerspace Model 448 Thermal Depth Sounder recorder 208 kHz was used. Actual measured depths were recorded on thermal paper and digitized readings were output to the onboard computer via software (Hypack) for storage. An internal clock with battery backup was used when recording the depths. The depth recorder utilized an eight degree beam width transducer which exhibits +/- 0.1 foot printer resolution. The pulse length ranges between 0.15 and 0.6 ms, depending upon frequency and operating depth. The Hypack software was used for navigation, data collection and post processing.

Hydrographic Surveys also employed the TSS Dynamic Motion Sensor (DMS) - 05. The DMS-05 has a heave accuracy of five centimeters or five percent, whichever is greater. The roll and pitch accuracy is .03 degrees at +/- five degrees. The heave range is +/- 10 meters with resolution of one centimeter. David Clarke (David Clarke and Associates, LLC of Mahwah, New Jersey) was the DMS technician and provided the following descriptive report of vertical and horizontal control and calibration:

Vertical Control

Vertical control was maintained with the use of a United States Coast and Geodetic Survey (USC&GS) bench mark located at the entrance to the Barnegat Light in Barnegat Light, New Jersey. The bench mark is located south of the center divider to the dual roadway leading to Barnegat lighthouse. The elevation of Barnegat Light 3 1962, 1980 is 5.76 feet Mean Lower Low Water. An on site tide board was set prior to the surveys beginning on a wooden pile located inside Barnegat Inlet. A level run was performed using the project bench mark and tying into the tide board and closing within .01 feet. The tide board was manually observed at 10 minute intervals during the course of the survey. Knowing the unusual dynamics of the Barnegat Inlet, the tide board was used only as a verification of the Atlantic City National Oceanic and Atmospheric Administration (NOAA) Automatic Tide Station. The Atlantic City Tide Station was also confirmed by the Sandy Hook Tide Station. The Atlantic City Tide Station was held as the official tide reading for the project. The Atlantic City Tide Station was the best location for tide readings as the sea conditions were the most similar to those in the survey areas. The Barnegat Tide Station inside the inlet did not reflect the same height or time values as the outer sea conditions.

The NOAA 1998 tide tables for the east coast of North and South America were the source for the tidal corrections. The conclusion was that the Atlantic City tide readings were accurate, as confirmed by the Sandy Hook Tide Station adjustment to actual readings and also confirmed by the project tide board corrected for Atlantic City readings.

All soundings are in feet and tenths and refer to North America Vertical Datum (NAVD). The tidal datum correlation's at Atlantic City are detailed on each page of the drawings shown in Appendix C. Note that NAVD soundings are 2.972 feet deeper than Mean Lower Low Water sounding.

Horizontal Control

Borrow area coordinates were provided to Hydrographic Surveys by Dolan Research, Inc. The project coordinates refer to New Jersey Mercator NAD 1983 (code 2900) (see Appendix C).

Calibration

Unlike microwave or R/A systems, DGPS operation has no prescribed calibration requirements (USACOE Manual EM 1110-2-1003, 1994). A calibration check was performed at a known day marker to assure the proper geodetic reference datum. The Sandy Hook reference station (identification #008) was used as the differential (286 kHz frequency; N 402830, E 740070; range 100 nautical miles). Careful attention was placed on the delusion of the precision value to assure the geometric strength of the configuration of satellites during the course of the survey. A calibration of the TSS DMS 05 heave motion sensor was conducted prior to the commencement of the project. The Innerspace 448 Depth sounder was calibrated by means of the bar check calibration method. A suspended bar with graduated marks on the cables was used to perform the calibration. The calibration increments were taken at five foot intervals throughout the project range. Two bar checks were performed daily, one prior to survey and one at the completion of the days survey. The bar check calibration was performed directly at the corresponding borrow area.

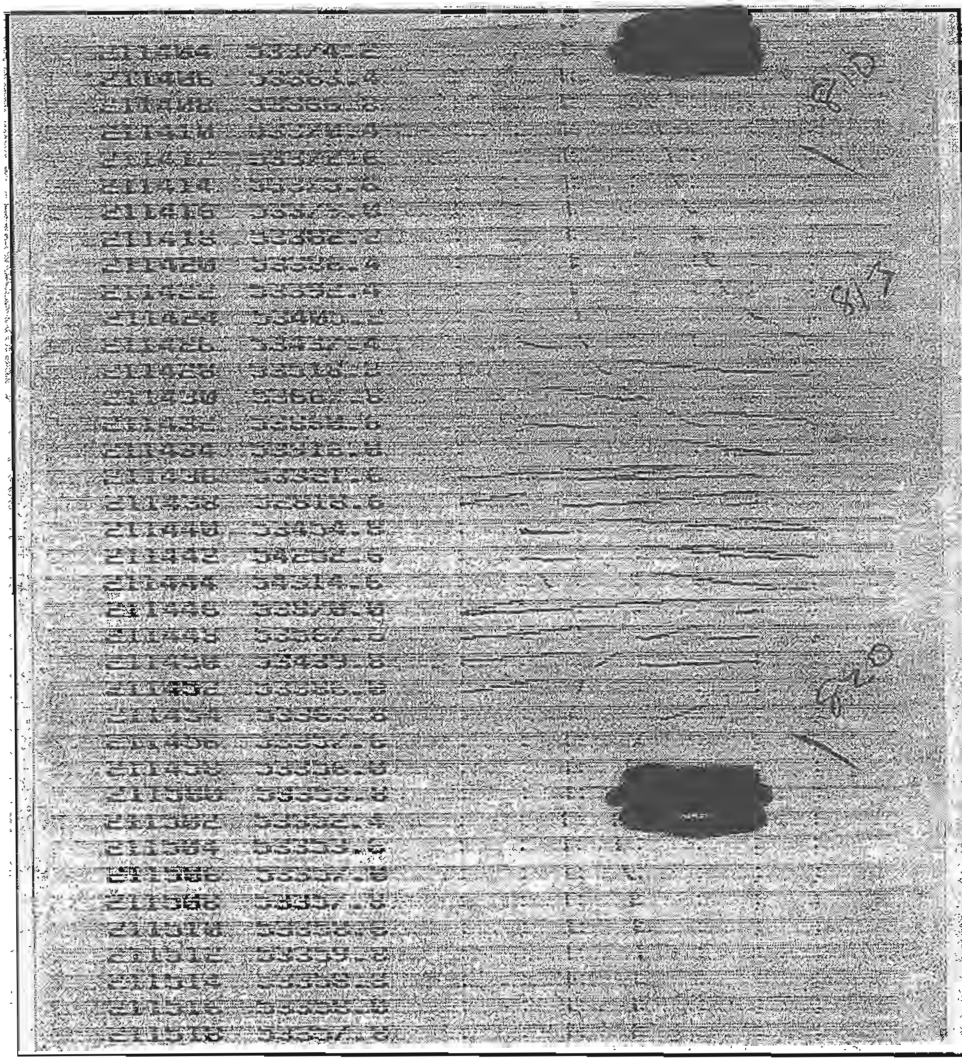


Figure 6.19 Near-shore Survey Area A, Magnetic Signature, Target # 4:816.

likely generated by a much larger object. The signature characteristics are consistent with those derived from shipwreck sites.

Target #: 4: 1009
Coordinates (NAD 83): [redacted]

This target produced a magnetic signature only. It consisted of a dipolar, magnetic signature with a maximum distortion of 650 gammas which extended over eight sample intervals (Figure 6.20). The lack of an associated acoustic image confirms that the material responsible for generating the anomaly is buried. Magnetic influence from the target covered an area approximately 100 feet along the shoreline. Water depth was 11 feet. The possibility exists that the target may be associated with a buried shoreline feature (i.e. outflow pipe, groin). However, this magnetic signature was likely generated by a larger object. The signature characteristics are consistent with those derived from shipwreck sites.

Offshore Borrow Area D

Target #: 7: 614
Coordinates (NAD 83): [redacted]

This dipolar magnetic signature produced a maximum distortion of 390 gammas that extended over eight sample intervals (Figure 6.21). The target is located in lane eight. Water depth was 36 feet. Magnetic influence from this target covered an area approximately 100 feet by 40 feet. Acoustic image confirms the presence of a hard, elongated object approximately ten feet by 30 feet, with three feet to five feet of relief off the bottom (Figure 6.22). The signature characteristics are consistent with those derived from shipwreck sites.

C. Hydrographic Survey

Between the May 7 and 15, 1998, Hydrographic Surveys performed a condition survey of the three offshore sand borrow areas as subconsultants to Dolan Research, Inc. The survey was conducted in accordance with the United States Army Corps of Engineers (USACOE) Manual, *Engineering and Design - Hydrographic Surveying, EM 1110-2-1003, USACOE October 31, 1994*. The accuracy criteria for this fathometric survey was Class I: Contract Payment Survey classification. Class I surveys are intended to encompass all work associated with contracted construction activities, particularly those surveys performed to measure the amount of excavated, deposited, and/or placed material in subsurface areas (USACOE Manual EM 1110-2-1003, 1994). The purpose of the survey was to obtain accurate depth readings of the three designated potential sand borrow areas. A five-page plan view drawing detailing the results of the surveys was submitted to the Philadelphia District offices of the U.S. Army Corps of Engineers as part of Hydrographic Surveys report. A textual description of the survey follows.

1. Survey Area

The area surveyed encompassed the following proposed Sand Borrow Areas: B). approximately 15,000 feet south of Barnegat Inlet and approximately 8,700 feet east of Loveladies, encompassing approximately 272 acres; D). approximately 33,000 feet south of Barnegat Inlet and approximately 18,000 feet east of Surf City, encompassing approximately 510 acres; E). approximately 60,000 feet south of the Barnegat Inlet and approximately 6,000 feet east of Beach Haven Crest, encompassing approximately 273 acres.

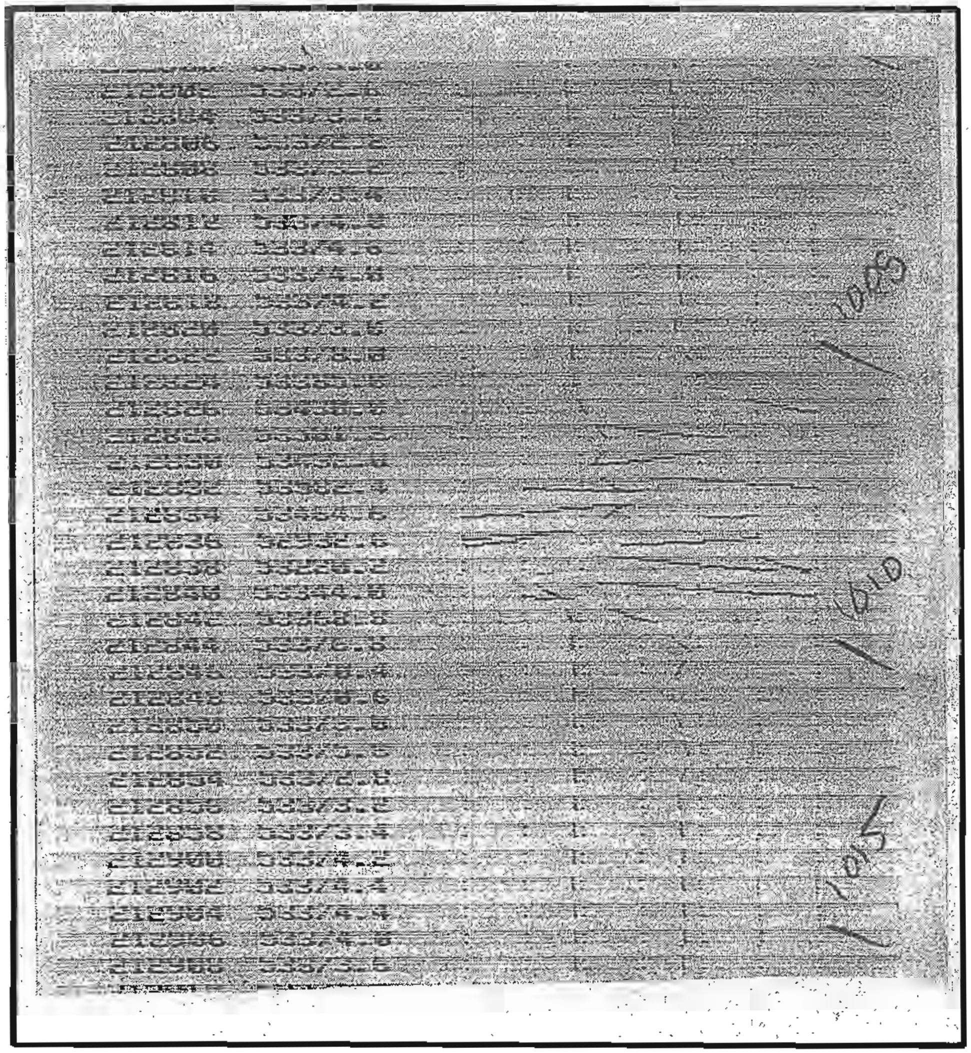


Figure 6.20. Near-shore Survey Area A, Magnetic Signature, Target # 4:1009.

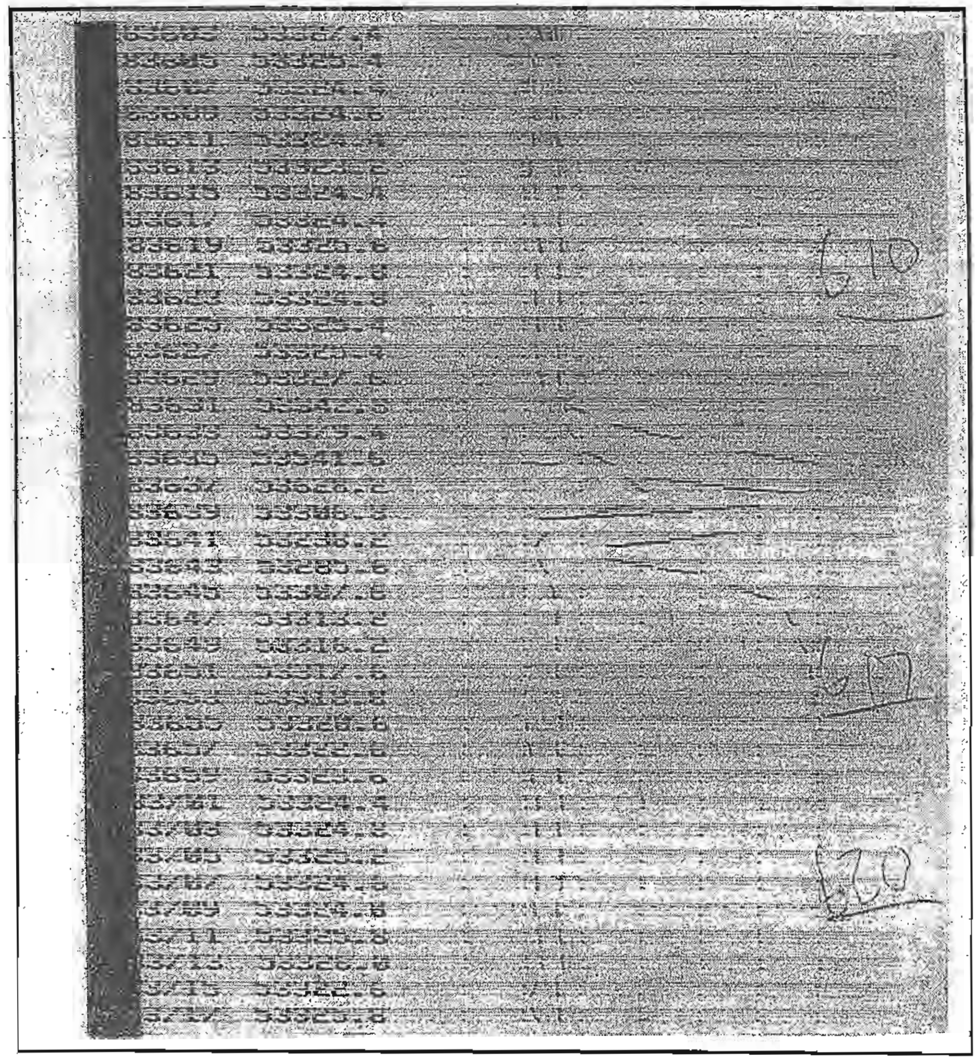


Figure 6.21. Borrow Area D, Magnetic Signature, Target # 7:614

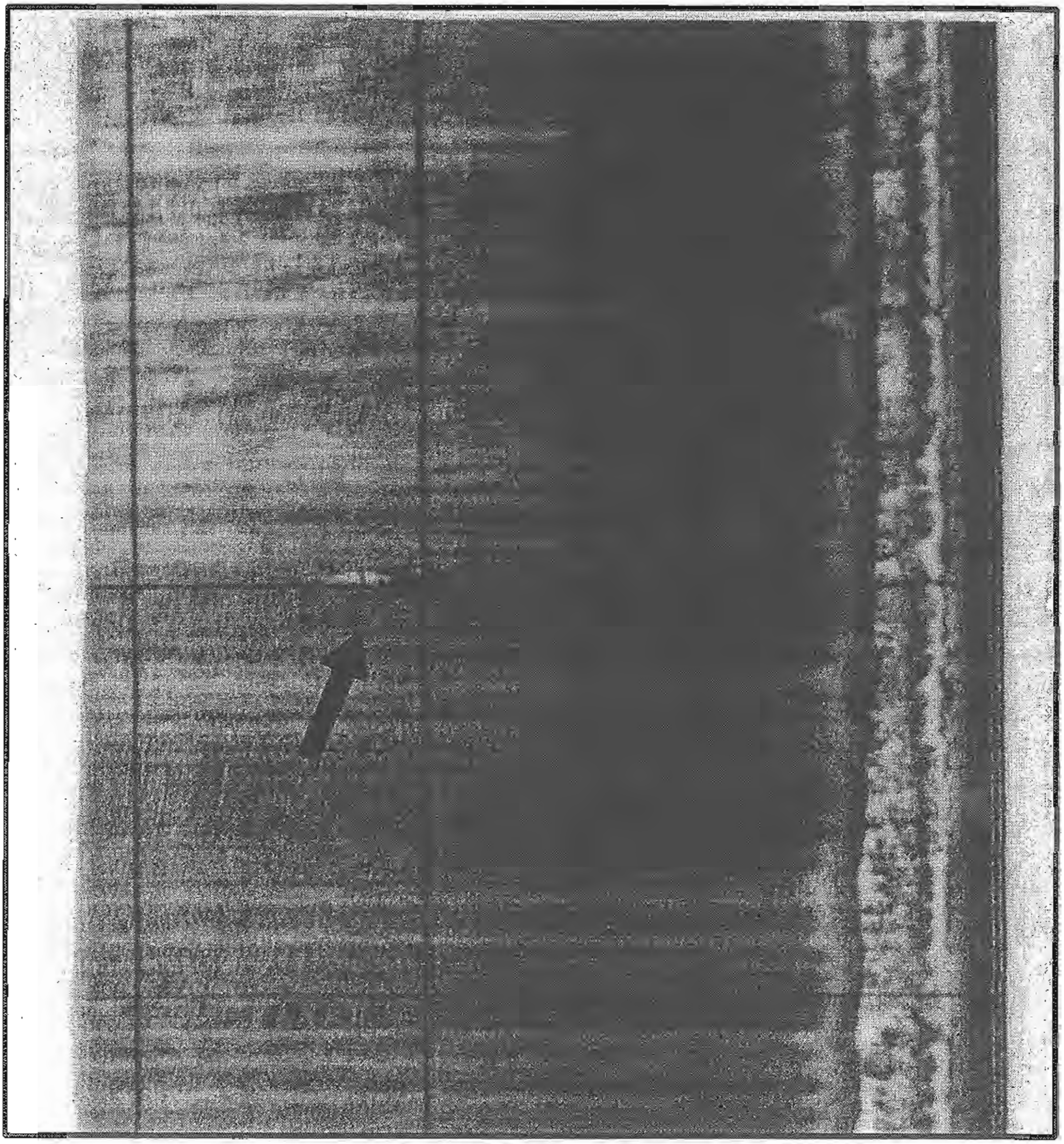


Figure 6.22. Borrow Area D, Acoustic Signature, Target # 7:614.

CHAPTER 7

EVALUATION, ASSESSMENT OF IMPACT AND RECOMMENDATIONS

As throughout the main body of this report, this chapter maintains a distinction between submerged and shoreline terrestrial resources (i.e., prehistoric and historic resources that were formed on land and have since, in some cases, been inundated by water or sediment as a result of rising sea level and other offshore erosive and depositional activity) and underwater resources (i.e., resources such as shipwrecks or downed airplanes, whose original formation occurred in a marine environment). Both types of resources are a potential issue in the proposed shoreline and near-shore survey areas; underwater resources are the principal concern within the borrow areas, although there also exists some potential for inundated prehistoric resources in these zones.

A. Submerged and Shoreline Terrestrial Resources

During the period of prehistoric and historic human activity in the Mid-Atlantic region, which extends over the past 15,000 years or so, the areas investigated during this study have experienced ongoing and increasing inundation as a result of rising sea level. For the most part, inundation has been accompanied by accumulation of sediments on the ocean floor, although offshore scouring and shifts in littoral drainage may also have produced local erosional effects. Cultural resources that were originally formed on land may now therefore lie submerged beneath the waters and variable depths of sediment in the Atlantic Shore Zone. Alternatively, they may also have been eroded through natural forces, such as water or wind action, or through human agency such as dredging.

Prehistoric Resources - It is extremely difficult to reconstruct in detail the natural environment (topography, drainage, soils, flora and fauna) and land use history of areas that are now submerged beneath the Atlantic Ocean and thereby derive an accurate assessment of prehistoric archaeological potential. The work of Kraft and others studying the geomorphology of the Delaware coastline is a valuable aid in understanding the processes that are at work and providing a hypothetical model for predicting cultural resource occurrence (see above, Chapter 3). However, testing such a model and reconstructing the geomorphology and geoarchaeology of any given section of inundated terrain within the Atlantic Shore Zone would require extensive and systematic bathymetrically-referenced sampling of the bay floor sediments, a task that is well beyond the scope of the current investigation. For this reason, it is not possible to offer a definitive evaluation of prehistoric archaeological potential for either the proposed sand borrow areas or the tidal zone on the basis of the research conducted to date.

At some future date, in the context of larger-scale engineering offshore projects, a better sense of the paleoenvironment and prehistoric archaeological potential of the study area could perhaps be obtained from a carefully designed program of sediment sampling conducted jointly by coastal geomorphologists and archaeologists. Specifically, sampling of this type within the proposed sand borrow areas could establish the depth below the bay floor of prehistoric land surfaces and the thickness of overlying (i.e., post-depositional in a cultural sense) sands and muds. This would enable the depth to which sand borrowing and other ocean floor disturbance could take place without affecting possible cultural strata. Such core samples would also constitute the beginnings of a geoarchaeological data bank for the ocean floor on the Continental Shelf and would serve as a valuable reference for other dredging and sand borrowing actions along the New Jersey Atlantic Coast.

With regard to research issues attendant on the historic contexts defined in New Jersey's Comprehensive Historic Preservation Plan, paleoenvironmental (or, indeed, archaeological) data from the Atlantic Shore Zone would add considerably to the geographic and settlement-subsistence context within which the few known terrestrial Paleo-Indian and Archaic archaeological resources in New Jersey's Coastal Plain are currently analyzed. The contribution of offshore paleoenvironmental and archaeological research to studies of Woodland period cultures is likely to be less significant, but there remains some potential for inundated procurement sites around the peripheries of former tidal marsh environments.

In the context of the three proposed offshore sand borrow areas, further "field" investigation -- either in the form of remote sensing (such as sub-bottom profiling) or coring -- is not, in the opinion of this consultant, a necessary, appropriate or cost-effective approach to clarifying the potential for prehistoric archaeological resources within specific borrow area limits. Reconstruction of the ocean floor topography would be of some assistance in refining areas of potential, but would still leave archaeologists largely ignorant on matters of site location, site boundaries and site stratigraphy, not to mention issues such as site function and inter-site and intra-site patterning.

Yet, recognizing that prehistoric cultural materials may on occasion be dredged up and redeposited along the shore during the course of beach replenishment (as occurred recently along a nourished stretch of the northern New Jersey shoreline), some basic information on offshore prehistoric site locations may be recovered by making provision for controlled, periodic monitoring of the beach surface during and immediately following the replenishment process. This can be undertaken by one or two trained archaeologists systematically walking and inspecting the sands for evidence of redeposited prehistoric (and historic) cultural materials and coordinating with the dredge crews to pin down as precisely as possible the source of the borrowed sand. In this manner, over time, a partial and some what gross record of offshore prehistoric site locations may be assembled and correlated with available bathymetry to produce some semblance of a paleoenvironmental reconstruction.

Since the tidal zone and shoreline of the four shoreline (and immediately adjacent near-shore) survey areas involved in the current study are to be "nourished" through the deposition of additional sand, buried prehistoric land surfaces and associated cultural resources, if these exist, should receive additional protection as a result of the proposed project action. There would not appear, therefore, to be any need to sample sediments within the tidal or near-shore zone in conjunction with the present project. No further prehistoric archaeological study is therefore recommended along the shoreline within the tidal and near-shore study area segments.

Historic Resources - Transient activities, such as hunting and fishing and the occasional loading and unloading of vessels, were sporadically pursued along the Long Beach Island section of New Jersey's Atlantic coast prior to the mid-19th century. There is also limited documentary evidence for extremely low density settlement and economic activity along this stretch of shoreline from the late 17th through late 19th centuries. However, no field evidence has been found during the current investigations for either short-lived or more substantive "permanent" early historic cultural features along the Long Beach Island littoral. It should be noted that despite the absence of above-ground and surface cultural features in this zone that pre-date the late 19th century, the finding of subsurface remains of an early 18th-century British vessel beneath a parking lot adjacent to the Showboat Casino in Atlantic City demonstrates that there is some potential for early historic archaeological resources along the shoreline. Overall, however, the potential for early historic resources being encountered along the beach during beach nourishment activities is still considered to be slight and highly localized. In the opinion of the consultant, no additional field investigation into early historic resources is warranted. In the unlikely event that early historic remains are unexpectedly encountered during the placement of sand on the beach, it is suggested that provision be made for such resources to be inspected, recorded and evaluated by a qualified archaeologist.

Since the time of their initial development, the shore communities on southern New Jersey's barrier islands have become progressively more built-up, to the extent that human land use has arrested slightly (and even reversed in some places) the steady post-glacial westward movement of the coastline. Numerous erosion abatement structures, notably groins and bulkheads, have been constructed to aid in these efforts and several of these are present along the Long Beach Island shoreline (Table 7.1). Other structures, including both boardwalks and piers have also been constructed in conjunction with the shore's resort functions, but Long Beach Island is devoid of these particular types of shoreline feature. While the groins and bulkheads are often difficult to date and in varying states of repair, most are probably less than 50 years old and therefore do not meet the age criterion for inclusion in the National Register of Historic Places. The older examples tend to be the least well preserved. No groins or bulkheads meriting National Register listing were observed along the Long Beach island shoreline. In any event, it is regarded that preservation of shoreline structures, even if they are presently ruinous, is entirely consistent with the goals of shoreline protection, since piers, groins and other features projecting into the ocean, perpendicular from the shore, can assist in stabilizing the strand.

Aside from the groins, bulkheading and various pilings noted along the shoreline, only one other structure was identified as being of potential historic interest. This is a late 19th-century residence at 14 South 73rd Street in Harvey Cedars (Table 7.1). More detailed examination of the exterior and interior of this building would be necessary before a full evaluation of its National Register eligibility could be given. However, the house is situated above the high tide line and will not be directly affected by the proposed project actions. Indeed, beach nourishment should serve to protect this building. No further assessment of this structure is considered necessary in the context of the current project.

The potential for historic period terrestrial (as opposed to underwater) resources within the three proposed offshore sand borrow areas is negligible. These areas are likely to have been inundated throughout the historic period.

B. Underwater Resources

Background research confirms European maritime activity along the New Jersey Atlantic coast from at least as early as the first quarter of the 17th century. English, Dutch (and to a lesser extent Scandinavian) sailors were the first Europeans to explore the region during this period and were also the first to extensively traverse the waterways of the interior while establishing settlements in the present-day states of Pennsylvania, New Jersey and New York. Although extensive permanent settlement and development of the barrier islands did not, for the most part, start to occur until the mid-19th century, the inlets separating the islands, such as those at either end of Long Beach Island, were used as transportation arteries by settlers inland at least as early as the 18th century. This local maritime activity was very limited in scope, however, and the vast majority of shipping activity within the offshore study areas was almost exclusively transient (i.e., coastal). Vessels crossing the study areas were participating in the network of coastal trade that linked the Delaware Bay ports and New York with other ports from Maine to Texas. International maritime traffic was also present in the project vicinity and involved shipping passing from the eastern seaboard to ports in the Caribbean and Central and South America. Much of this coastal traffic, when caught in heavy seas and bad weather

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
SHORELINE AND NEAR-SHORE AREA A (Figure 6.1) Dolphin Street to North 17th Street			
1. Feature A-1	Area A, Harvey Cedars, mid-beach, near terminus of 84th Street	Aligned with Magnetic Target MA-6; modern conglomeration of wood pilings and planks	No further study recommended
2. Feature A-2	Area A, Harvey Cedars, near terminus of 73rd Street	Modern concrete and wood formation of pilings and boards, possible former bulkhead	No further study recommended
3. Feature A-3	Area A, Harvey Cedars, near terminus of Sussex Avenue	Rock outcrop in surf; former portion of jetty/groin	No further study recommended
4. Feature A-4	Area A, Harvey Cedars, near terminus of Salem Avenue	Modern set of pilings at edge of dune slope with wood planking attached, possible former walkway	No further study recommended
5. Feature A-5	Area A, #14 South 73rd Street in Harvey Cedars	Historic structure	Further study required for full evaluation, however, current project is not likely to have an adverse effect on the resource; no further study recommended
6. Features (Area A)	Occurring at similar spatial intervals from North 17th Street to Dolphin Street; emerge from shoreline and continue in an east-west line into the surf	Visible wood/stone composite jetties/groins; some composed only of stone	No further study recommended
7. Magnetic Target MA-1	Area A, North Beach shoreline (N 308700 to N 308730)	Semi-coherent point target; possible shipwreck remains; suspect due to proximity of fences, groins, etc.	Current project plans will protect resource; no further study recommended
8. Magnetic Target MA-2	Area A, North Beach shoreline (N 309380 to N 309420)	Semi-coherent point target, linear east-west; signature attributed to jetty/groin	No further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
9. Magnetic Target MA-3	Area A, North Beach shoreline (N 310060 to N 310100)	Incoherent point target; possible shipwreck remains	Current project plans will protect resource; no further study recommended
10. Magnetic Target MA-4	Area A, Harvey Cedars shoreline (N 310920 to N 311080)	Highly coherent, very large point target; possible shipwreck remains	Current project plans will protect resource; no further study recommended
11. Magnetic Target MA-5	Area A, Harvey Cedars shoreline (N 316200 to N 316320)	Incoherent point target; possible debris field, but suspect due to proximity of fences, etc.	Current project plans will protect resource; no further study recommended
12. Magnetic Target MA-6	Area A, Harvey Cedars shoreline (N 321100 to N 321160)	Coherent, linear east-west target; aligned with Feature A-1	No further study recommended
13. Magnetic Target MA-7	Area A, approximately 800 feet north of Loveladies/ Harvey Cedars shoreline border (N 322520 to N 322640)	Semi-coherent, double peak point target; possible shipwreck remains	Current project plans will protect resource; no further study recommended
14. Magnetic Target MA-8	Area A, Loveladies shoreline (N 323580 to N 323660)	Semi-coherent, linear east-west target; signature attributed to groin/jetty	No further study recommended
15. Magnetic Target MA-9	Area A, Loveladies shoreline (N 325520 to N 325560)	Negative spike on single profile; sensor malfunction	No further study recommended
16. Magnetic Target MA-10	Area A, Loveladies shoreline (N 326000 to N 326040)	Semi-coherent linear east-west target; signature attributed to groin/jetty	No further study recommended
17. Magnetic Target MA-11	Area A, Loveladies shoreline (N 326540 to N 326560)	Negative spike on single profile; sensor malfunction	No further study recommended
18. Magnetic Target MA-12	Area A, Loveladies shoreline (N 326620 to N 326700)	Semi-coherent linear east-west target; signature attributed to groin/jetty	No further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
19. Magnetic Target MA-13	Area A, Loveladies shoreline (N 328240 to N 328300)	Negative spike on single profile; sensor malfunction	No further study recommended
20. Magnetic Target 4:735	Area A, Near-shore off North Beach (N 307327, E 607019)	Acoustic image confirms presence of partially buried object perpendicular to shoreline; potential shipwreck remains	Current project plans will protect resource; no further study recommended
21. Magnetic Target 4:816	Area A, Near-shore off Harvey Cedars (N 310905, E 592753)	Magnetic signature only; lack of acoustic image confirms material is buried; signature occurs due east of Magnetic Target MA-4; possible outflow pipe, groin, or shipwreck remains	Current project plans will protect resource; no further study recommended
22. Magnetic Target 4:1009	Area A, Near-shore off Harvey Cedars (N 319658, E 596864)	Magnetic signature only; lack of acoustic image confirms material is buried; signature occurs just northeast of groin; possible outflow pipe, groin, or shipwreck remains	Current project plans will protect resource; no further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
SHORELINE AND NEAR-SHORE AREA B (Figure 6.2) South 22nd Street to Stockton Street			
23. Feature B-1	Area B, between Brant Beach and Beach Haven Crest, near terminus of Brownson Street	Modern series of wood pilings in dune structure, possible former retaining wall or walkway	No further study recommended
24.Features (Area B)	Occurring at similar spatial intervals from Stockton Street to 22nd Street; emerge from shoreline and continue in a n east-west line into the surf	Visible wood/stone composite jetties/groins; some composed only of stone	No further study recommended
25. Magnetic Target MB-1	Area B, Brant Beach shoreline (N 284780 to N 284840)	Semi-coherent linear east-west target; signature attributed to jetty/groin	No further study recommended
26. Magnetic Target MB-2	Area B, Brant Beach shoreline (N 285500 to N 285540)	Semi-coherent linear east-west target; signature attributed to jetty/groin	No further study recommended
27. Magnetic Target MB-3	Area B, Brant Beach shoreline (N 286160 to N 286200)	Semi-coherent linear east-west target; signature attributed to jetty/groin	No further study recommended
28. Magnetic Target MB-4	Area B, Brant Beach shoreline (N 288160 to N 288220)	Semi-coherent linear east-west target; signature attributed to jetty/groin	No further study recommended
29. Magnetic Target MB-5	Area B, Brant Beach shoreline (N 290220 to N 290280)	Semi-coherent linear east-west target; signature attributed to jetty/groin	No further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
SHORELINE AND NEAR-SHORE AREA C (Figure 6.3) Nebraska Boulevard to 27th Street			
30. Features (Area C)	Occurring at similar spatial intervals from 27th Street to Nebraska Boulevard; emerge from shoreline and continue in an east-west line into the surf	Visible wood/stone composite jetties/groins; some composed only of stone.	No further study recommended
31. Magnetic Target MC-1	Area C, Haven Beach shoreline (N 276360 to N 276420)	Incoherent target extending northward from jetty/ groin; possible debris field, however, proximity of jetty/groin suspect	No further study recommended
SHORELINE AND NEAR-SHORE AREA D (Figure 6.4) 6th Street to Webster Avenue			
32. Feature D-1	Area D, Beach Haven, near terminus of Berkeley Avenue, approximately 40 feet offshore	Three wood pilings in the surf, possible pier remnants; appear modern	No further study recommended
33. Feature D-2	Area D, Beach Haven, near terminus of Chadsworth Avenue	Three rows of wood pilings, curving into surf; appear modern; proximity of Magnetic Target MD-6	No further study recommended
34. Feature D-3	Area D, Beach Haven, near the terminus of Holyoak Avenue	Two rows of modern wood pilings, covered by sand near surf line; appear modern; proximity of Magnetic Target MD-6	No further study recommended
35. Feature D-4	Area D, Beach Haven, near the terminus of Jefferies Avenue	18 wood pilings, no apparent configuration; appear modern; proximity of Magnetic Target MD-3	No further study recommended
36. Feature D-5	Area D, Beach Haven, near terminus of Leeward Avenue	Rows of wood pilings, covered by sand nearing surf line; appear modern; proximity of Magnetic Target MD-2	No further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
37. Feature D-6	Area D, Beach Haven, near terminus of Nelson Avenue	Wood pilings adjacent to wood jetty/groin; appears modern	No further study recommended
38. Feature D-7	Area D, Beach Haven, near terminus of Marshall Avenue	33 wood pilings extending toward nearby jetty/ groin; appears modern	No further study recommended
39. Features (Area D)	Occurring at similar spatial intervals from Webster Avenue to 6th Street in Area D; emerge from shoreline and continue in an east-west line into the surf	Visible wood/stone composite jetties/groins; some composed only of stone.	No further study recommended
40. Magnetic Target MD-1	Area D, Beach Haven shoreline (N 260060 to N 260300)	Semi-coherent linear east-west target; signature attributed to jetty/groin; proximity of Feature D-6	No further study recommended
41. Magnetic Target MD-2	Area D, Beach Haven shoreline (N 260560 to N 260720)	Coherent target with multiple peaks; semi-linear east to west; signature attributed to steel jetty/groin; proximity of Feature D-5	No further study recommended
42. Magnetic Target MD-3	Area D, Beach Haven shoreline (N 261020 to N 261100)	Semi-coherent linear east west target with double peak; signature attributed to jetty/groin; proximity of Feature D-4	No further study recommended
43. Magnetic Target MD-4	Area D, Beach Haven shoreline (N 261680 to N 261720)	Semi-coherent point target; possible shipwreck remains	Current project plans will protect resource; no further study recommended
44. Magnetic Target MD-5	Area D, Beach Haven shoreline (N 261960 to N 262080)	Incoherent linear east-west target; signature attributed to jetty/groin	No further study recommended
45. Magnetic Target MD-6	Area D, Beach Haven shoreline (N 262620 to N 263040)	Incoherent or numerous small coherent peaks noted in target signature; possible extensive debris field; proximity of both Features D-2 and D-3 probable source of signature	No further study recommended

TABLE 7.1. SUMMARY OF CULTURAL RESOURCES IDENTIFIED DURING STUDY			
CULTURAL RESOURCE TYPE	**LOCATION**	**FIELD EVIDENCE/ INTERPRETATION**	**EVALUATION/ RECOMMENDATION**
OFFSHORE BORROW AREA D (Figures 6.9 and 6.14)			
45. Magnetic Target 7:614	Offshore Borrow Area D (N 303572, E 607019)	An acoustic image confirms the magnetic target; possible shipwreck remains	Current project plans may effect resource; further study recommended

between Sandy Hook to the north and Cape May to the south, deliberately sought shelter in New Jersey's Harbors, bays and inlets.

As a result of the extensive historic maritime activity offshore of New Jersey's Atlantic coast, a wide variety of underwater resources may be anticipated in the vicinity of the study areas as is evidenced in the list of documented shipwrecks presented in Appendix A. Remote sensing, both onshore on the beach within the tidal zone, and offshore in the near-shore zone and in the three proposed offshore sand borrow areas, has also encountered a number of anomalies that may prove to be shipwrecks or other submerged features of historic interest (Table 7.1).

Within Area A, between North 17th Street and Dolphin Street, four anomalies of potential interest were noted onshore (Magnetic Targets MA-1, MA- 3, MA-4 and MA-7) and another three were pinpointed immediately offshore in the near-shore zone (Targets 4:735, 4:816 and 4:1009). One other onshore anomaly was noted in Area D, between 6th Street and Webster Avenue (Magnetic Target MD- 4). No potential shipwrecks were noted onshore in Areas B and C or in the near-shore zone in Areas B, C and D.

Without further study (chiefly, diving and probing), it is not possible to definitively identify the onshore anomalies in the Areas A and D and the near-shore anomalies in Area A as shipwrecks and some may, in fact, be related to groins or outfall pipes. However, since the proposed beach nourishment will entail deposition of sand in these locations, the source of these anomalies will be protected. No further study of these targets is considered necessary within the context of the current project. Care should be taken not to traverse these locations with heavy machinery so as to prevent damage to possible subsurface cultural deposits. The locations should be clearly marked in the field so they can be avoided by the contractor.

Remote sensing of the three proposed offshore sand borrow areas resulted in the identification of a single target within Borrow Area D (Magnetic Target 7:614) that produced a signature resembling those typically found at shipwreck sites. With regard to this target, it is not possible without some form of rudimentary ground truthing to establish whether it represents the site of a shipwreck or other submerged resource of true historic interest. For this reason, it is recommended that supplementary Phase I-level study -- typically involving a more focused program of remote sensing, diving, visual inspection, probing and recording -- be undertaken at this target to obtain a clearer "read" on whether the anomaly in question derives from a potentially important submerged resource.

If supplementary investigation of this type reveals the definite or suspected existence of a potentially significant resource, such as a shipwreck, consideration should be given to avoiding this location during sand borrow dredging activities by designating a suitably protective "no dredge" buffer zone around the target. If avoidance is not a viable option, additional Phase II-level archaeological investigation -- conceivably involving further diving, visual inspection, probing, recording and, if appropriate, overburden removal and still more recording -- is recommended at this target to fully characterize and evaluate the object(s) responsible for generating the remote sensing signature. Ground truthing of this target at both the supplementary Phase I and Phase II level of investigation should ultimately aim to evaluate whether this potential underwater cultural resource is of sufficient caliber to merit inclusion in the National Register of Historic Places. As part of the resource identification and evaluation process, field data should also be correlated, wherever possible, with background historical information.

C. Summary

In summary, the conclusions and recommendations from this Phase I submerged and shoreline cultural resources investigation is as follows:

1. The potential for significant submerged prehistoric terrestrial resources within the four shoreline survey areas (within both the tidal and near-shore zones) and at the three proposed offshore sand borrow locations is unclear, in large part because detailed reconstruction of the paleoenvironment is not possible at this level of study. There is a negligible potential for submerged historic terrestrial resources within the borrow areas because they were most likely inundated throughout the historic period.

2. A program of controlled, periodic archaeological monitoring of the renewed beach surface is recommended during and immediately following the replenishment operation to check for archaeological materials originating in the offshore sand borrow material.

3. No evidence of prehistoric or early historic terrestrial archaeological resources was noted within the designated project areas during these studies. No further pre-project investigation of prehistoric and historic terrestrial resources in the near-shore zone, the tidal zone or along the shoreline is considered necessary within the four shoreline survey areas, since deposition of sand will enhance preservation of buried resources (if indeed these exist below ground).

4. A few above-ground structures and structural remains (notably, one residence in Harvey Cedars, and several groins, bulkheads and pilings) dating from the late 19th century through the late 20th century have been identified within the four shoreline survey areas. Most of these cultural features are not considered historically significant, although a full evaluation of the home in Harvey Cedars would require more detailed historical and architectural study at the Phase II level. In the opinion of the consultant, the significance of this particular structure and other features along the shoreline is a moot point, since the proposed beach nourishment should aid in their preservation, and their being left intact should also help stabilize the shoreline.

5. Five magnetic targets were noted onshore within the tidal zone (four in Area A and one in Area D) and an additional three magnetic targets were identified in the near-shore zone adjacent to Area A. It is unclear how many of these targets derive from shipwrecks or other features of historic interest. Since the proposed beach nourishment should aid in their preservation, no further study is recommended. Care should be taken to avoid damaging the onshore target locations through use of heavy machinery on the beach.

6. One magnetic underwater target has been identified in offshore Borrow Area D and may represent a significant underwater resource such as a historic shipwreck. Ground truthing of this target at the Phase I level is recommended. This should involve reacquisition and more focused analysis of the target remote sensing signature, diving, visual inspection, probing and recording. If further study shows this target to be a potentially significant underwater resource, such as a shipwreck, consideration should be given to avoiding this location during sand borrowing. If this is not feasible, further Phase II-level investigation is recommended to clarify the character of this potentially significant resource and to evaluate its eligibility for inclusion in the National Register of Historic Places.

REFERENCES

Allaback, S. (editor)

1995 *Resorts & Recreation: An Historic Theme Study of the New Jersey Coastal Heritage Trail Route. The Atlantic Shore: Middlesex, Monmouth, Ocean, Burlington, Atlantic and Cape May Counties*. The Sandy Hook Foundation, Inc. and National Park Service, Mauricetown, New Jersey.

Barber, J., and H. Howe

1868 *Historical Collections of New Jersey: Past and Present*. New Haven, Connecticut.

Belknap, D. F., and J. C. Kraft

1977 Holocene Relative Sea-Level Changes and Coastal Stratigraphic Units on the Northwest Flank of the Baltimore Canyon Trough Geosyncline. *Journal of Sedimentary Petrology* 47:610-629.

1981 Preservation Potential of Transgressive Coastal Lithosomes on the U.S. Atlantic Shelf. *Marine Geology* 42:429-442.

Bello, C. A., and J. H. Cresson

1995 A Fluted Point from Island Beach State Park. *Bulletin of the Archaeological Society of New Jersey* 50.

Binford, L.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-173.

Bonfiglio, A., and J. H. Cresson

1978 Aboriginal Cultural Adaptation and Exploitation of Periglacial Features in Southern New Jersey. Paper presented at the 1978 Middle Atlantic Archaeological Conference, Rehobeth Beach, Delaware.

Bourque, B.

1979 *A Summary and Analysis of Cultural Resource Information Concerning the Continental Shelf from the Bay of Fundy to Cape Hatteras: Shipping*. Peabody Museum of Archaeology and Ethnology, Cambridge, Massachusetts.

Brinckmann, J.

1992 *The Tuckerton Railroad*. John Brinckmann, Privately Printed, Edison, New Jersey.

Cavallo, J. A.

1981 Turkey Swamp: A Late Paleo-Indian Site in New Jersey's Coastal Plain. *Archaeology of Eastern North America* 9:1-17.

Chesler, O. (editor)
1982 New Jersey's Archaeological Resources from the Paleo-Indian Period to the Present: A Review of Research Problems and Survey Priorities. On file, New Jersey State Historic Preservation Office (NJDEPE), Trenton, New Jersey.

Coastal Environments Inc.
1977 *Cultural Resources Evaluation of the Northern Gulf of Mexico Continental Shelf*. National Park Service, U.S. Department of the Interior, Washington D.C. 3 vols.

Crock, J., J. Petersen, and R. Anderson
1993 Scalloping for Artifacts: A Biface and Plummet from Eastern Blue Hill Bay, Maine. *Archaeology of Eastern North America* 21:179-192.

Cross, D.
1941 *Archaeology of New Jersey*. Archaeological Society of New Jersey and the New Jersey State Museum, Trenton, New Jersey.

Custer, J. F.
1986 Periglacial Features of the New Jersey Coastal Plain: A Demurrer. *Bulletin of the Archaeological Society of New Jersey* 40:21-25.

1989 *Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study*. University of Delaware Press, Newark, Delaware.

Custer, J. F., J. A. Cavallo, and R. M. Stewart
1983 Paleo-Indian Adaptations on the Coastal Plain of Delaware and New Jersey. *North American Archaeologist* 4:263-276.

Deevey, E. S., Jr.
1952 Radiocarbon Dating. *Scientific American* 52:24-28.

Dent, R. J.
1979 Ecological and Sociocultural Reconstruction in the Upper Delaware Valley. Unpublished Ph.D. dissertation, Ann Arbor, Michigan.

1991 Archaeology in the Upper Delaware Valley: The Earliest Populations. In *The People of Minisink: Papers from the 1989 Delaware Water Gap Symposium*, edited by David G. Orr, and Douglas V. Campana. pp. 117-140. Mid-Atlantic Region of the National

Park Service, United States Department of the Interior, Philadelphia, Pennsylvania.

Edwards, R. L., and K. O. Emery
1977 Man on the Continental Shelf. In *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by W. S. Newman, and B. Salwen. pp. 353-359. Annals of the New York Academy of Sciences, New York, New York.

Edwards, R. L., and A. S. Merrill
1977 A Reconstruction of the Continental Shelf Areas of Eastern North America for the Times 9,500 B.P. and 12,500 B.P. *Archaeology of Eastern North America* 5 (Fall):1-43.

Emery, K. O., and J. Milliman
1970 Quaternary Sediments of the Atlantic Coastal Shelf of the United States. *Quaternaria* 12:3-18.

Gardner, W. M.
1977 The Flint Run Paleo-Indian Complex and Its Implications for Eastern North American Prehistory. In *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by W. Newman, and B. Salwen. pp. 257-263. Annals of the New York Academy of Science, New York, New York.

Gentile, G.
1988 *Shipwrecks of New Jersey, a Popular Dive Guide*. Sea Sports Publications, Norfolk, Virginia.

Goodyear, A.
1979 A Hypothesis for the Use of Cryptocrystalline Raw Materials Among Paleo-Indian Groups of North America. *University of South Carolina Institute of Archaeology and Anthropology Research Manuscript Series 156*.

Grumet, R. S.
1990 *New Jersey Paleo-Indian Historic Context*. Technical report. Preservation Planning Branch, Resource Planning and Preservation Division, Cultural Resource Management, Mid-Atlantic Region, National Park Service, Washington, D.C.

Hole, T. J., F. , and H. C. Smith
1980 *Soil Survey of Ocean County, New Jersey*. United States Department of Agriculture in cooperation with New Jersey Agricultural Experiment Station, Cook College, Rutgers, the State University; and The New Jersey Department of Agriculture, State Soil Conservation Committee.

Holland, M.
1776 The Provinces of New York and New Jersey with Part of Pennsylvania and the Province

of Quebec. Map. Harry Margary, Lympne Castle, Kent, England.

Kraft, H. C.
1977a Paleoindians in New Jersey. In *Amerinds and Their Paleo-Environments in Northeastern North America*, edited by W. S. Newman, and B. Salwen. pp. 264-281. Annals of the New York Academy of Sciences, New York, New York.

1986 *The Lenape: Archaeology, History and Ethnography*. New Jersey Historical Society, Newark, New Jersey.

Kraft, J. C.
1971 Sedimentary Facies Patterns and Geologic History of a Holocene Marine Transgression. *Geological Society of America Bulletin* 82:2131-2158.

1977b Late Quaternary Paleogeographic Changes in the Coastal Environments of Delaware, Middle Atlantic Bight, Related to Archaeological Settings. In *Amerinds and Their Paleoenvironments in Northeastern North America*, edited by W. Newman, and B. Salwen. pp. 35-69. Annals of the New York Academy of Sciences, New York, New York.

Kraft, J. C., E. A. Allen, D. Belknap, C. J. John, and E. M. Maurmeyer
1979 Processes and Morphologic Evolution of an Estuarine and Coastal Barrier System. In *Barrier Islands, from the Gulf St. Lawrence to the Gulf of Mexico,* edited by S. P. Leatherman. pp. 149-183. Academic Press, New York, New York.

Kraft, J. C., D. Belknap, and I. Kayan
1983 Potentials of Discovery of Human Occupation Sites on the Continental Shelves and Nearshore Coastal Zone. In *Quaternary Coastlines and Marine Archaeology: Towards the Prehistory of Land Bridges and Continental Shelves,* edited by P. Masters, and N. Flemming. pp. 87-120. Academic Press, London, England.

Kraft, J. C., and C. J. John
1978 Paleogeographic Analysis of Coastal Archaeology Settings in Delaware. *Archaeology of Eastern North America* 6:41-60.

Krotee, W., and R. Krotee
1965 *Shipwrecks Off the New Jersey Coast.* Society of America Middle Atlantic Underwater Council, Philadelphia, Pennsylvania.

Lloyd, J. B.
1990 *History on Long Beach Island*. Down the Shore Publishing and The SandPaper, Inc., co-publishers, Harvey Cedars, New Jersey.

1994 *Eighteen Miles of History on Long Beach Island*. Down the Shore Publishing and The SandPaper, Inc., co-publishers, Harvey Cedars, New Jersey.

Merrill, A., K. O. Emery, and R. Meyer
1965 Ancient Oyster Shells on the Atlantic Continental Shelf. *Science* 147:398-400.

Milliman, J. D., and K. O. Emery
1968 Sea Levels During the Past 35,000 Years. *Science* 162:1121-1123.

Mounier, A. K.
1990 Stage I Archaeological Survey of Transatlantic Telecommunications Cable Alignment, Manahawkin Bay to Long Beach Island, Ocean County, New Jersey. On file, New Jersey State Historic Preservation Office, Trenton, New Jersey.

Mounier, R. A.
1977 A Preliminary Archaeological Survey of Greenbriar North, Brick Township, Ocean County, New Jersey. Technical report. On file, New Jersey State Historic Preservation Office (NJDEPE), Trenton, New Jersey.

Nash, C. E.
1936 *The Lure of Long Beach*. Long Beach Board of Trade, Long Beach Island, New Jersey.

New Jersey Historic Sites Inventory
1981 Subdivision Map of Beach Haven, Circa 1912. Map. On file, New Jersey State Historic Preservation Office, Trenton, New Jersey.

New Jersey State Museum
n.d. New Jersey State Museum Site Maps and Files. New Jersey State Museum (NJDS), Trenton, New Jersey.

North, W.
1963 *Shipwrecks of New Jersey*. Newark, New Jersey.

Oxenford, D. D.
1992 *The People of Ocean County*. Edited by V. B. Oxenford. The Balente Publishing House, Inc., Point Pleasant Beach, New Jersey.

Ruppe, R. J.
1979 The Archaeology of Drowned Terrestrial Sites: A Preliminary Report. Bureau of Historic Sites and Properties, Bulletin No. 6, Tallahassee, Florida.

Sheridan, R., C. E. Dill, Jr., and J. Kraft
1974 Holocene Sedimentary Environment of the Atlantic Inner Shelf Off Delaware. *Geological Society of America Bulletin* 85:1319-1328.

Shomette, D.
1993 *The Hunt for HMS De Braak*. Carolina Academic Press, Durham, North Carolina.

Skinner, A. B., and M. Schrabisch
1913 A Preliminary Report of the Archaeological Survey of the State of New Jersey. *Geological Survey of New Jersey Bulletin 9*.

Snyder, J. P.
1969 *The Story of New Jersey's Civil Boundaries, 1606-1968*. Bureau of Geology and Topography, Trenton, New Jersey.

Stewart, R. M.
1990 Archaeology, Sedimentary Sequences, and Environmental Change in the Delaware River Basin. On file, Bureau for Historic Preservation, Pennsylvania Historical and Museum Commission, Harrisburg, Pennsylvania.

1991 Archaeology and Environment in the Upper Delaware Valley. In *The People of Minisink: Papers from the 1989 Delaware Water Gap Symposium*, edited by D. G. Orr, and D. V. Campana. pp. 79-107. Mid-Atlantic Region of the National Park Service, United States Department of the Interior, Philadelphia, Pennsylvania.

Weil, C. B.
1977 *Sediments, Structural Framework, and Evolution of the Delaware Bay, a Transgressive Estuarine Delta*. College of Marine Studies, University of Delaware, Newark, Delaware.

Whitmore, F. C., Jr., K. O. Emery, H. G. Cooke, S., and D. J. Swift, P.
1967 Elephant Teeth on the Atlantic Continental Shelf. *Science* 156:1477-1481.

Wilson, H. F.
1953 *The Jersey Shore: A Social and Economic History of the Counties of Atlantic, Cape May, Monmouth and Ocean*. Lewis Publishing Company, New York, New York.

1964 *The Story of the Jersey Shore*. The New Jersey Historical Series D. Van Nostrand Company, Princeton, New Jersey.

Wolfe, P. E.
1977 *The Geology and Landscapes of New Jersey*. Crane Russak, New York, New York.

Woolman, H., T. Price, and T. Rose
1878 *Historical and Biographical Atlas of the New Jersey Coast*. Woolman and Rose, Philadelphia, Pennsylvania.

Zinkin, V.
1976 *Place Names of Ocean County*. Ocean County Historical Society, Toms River, New Jersey.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix F

Real Estate Plan

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Feasibility Study
Barnegat Inlet to Little Egg Inlet
Real Estate Plan

1. PURPOSE: This Real Estate Plan is for the Barnegat Inlet to Little Egg Inlet Feasibility Study. This is a part of the ongoing New Jersey Shore Protection Study. This study was completed under authority of resolutions adopted by the Committee on Public Works and Transportation, U.S. House of Representatives, and the Committee on Environment and Public Works, U.S. Senate, dated December 1987. The Reconnaissance Report was completed in March of 1995. The non-Federal sponsor is the New Jersey Department of Environmental Protection (NJDEP).

2a. PROJECT AREA DESCRIPTION: The study area, also known as Long Beach Island (LBI), is a sandy barrier island located in Ocean County, New Jersey, along the Atlantic coastline. It is bounded on the north by Barnegat Inlet and on the south by Little Egg/Beach Haven Inlet complex. LBI consists predominantly of separate residential dwellings, except for its 2.5 mile southern extremity which constitutes the Holgate Unit of the Forsythe National Wildlife Refuge. The developed areas of the island are divided into six political jurisdictions, the largest of which, the municipality of Long Beach Township, is comprised of four discontinuous units. The other five incorporated areas are the boroughs of Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven.

2b. RECOMMENDED PLAN: The purpose of this project is shoreline protection and erosion control. The selected plan consists of berm and dune restoration utilizing sand obtained from offshore borrow sources. This plan would require 4.95 million cubic yards of sand for initial berm placement, and 2.45 million cubic yards for dune placement. Sand will be hydraulically pumped onto the existing beach and then shaped. Approximately 1.9 million cubic yards would be needed for periodic nourishment every 7 years over a 50-year period of analysis. The berm and dune restoration extends from groin 4 (Seaview Drive, Loveladies) to the terminal groin (98) in Long Beach Township-Holgate, approximately 17 miles. The Barnegat Light area (northern end of the study area) is not included in the project due to low erosion and ample shore protection. Similarly, the Holgate Unit (southern end of the study area) was also not included based on the report of the US Fish and Wildlife Service (USFWS, 1996) that they do not consider beach nourishment on the Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge necessary. Because both ends of the project terminate at a groin, no tapers are needed. The template for the plan is a dune at an elevation of 22-ft NAVD, with a 30-ft dune crest width; 1V: 5H slopes from dune crest down to a berm at elevation +8 ft NAVD, a berm width of 125 ft from centerline of dune. Often the public's perception of Berm width is considered from the toe of dune to mean high water (MHW) or the useable portion of the beach. The average usable beach from the seaward toe of dune to MHW water is 105 feet. The beachfill continues from MHW with the profile at 1V: 10H slopes from the berm to mean low water (MLW). The fill is expected to maintain the existing profile shape from MLW to depth of closure (occurring at approximately -29 ft NAVD). Average dune widths for LBI are already at 29 feet. Existing dune elevations are at 19 ft on average while berm width averages are at 111 feet, as defined from the dune centerline. Construction access points to the beach will be from the public streets as indicated in Exhibit D. Lands below the MHWL extending 3 miles seaward (to include the borrow area) are owned and controlled by the

NJDEP. The borrow areas are located off LBI below the Mean High Water Line (MHWL) and are owned and controlled by the non-Federal sponsor with the exception of Borrow Area D2. Use of borrow area D2 extends beyond the three mile limit, necessitating a Memorandum of Agreement between the U. S. Department of Interior, Minerals Management Service, and the non-Federal sponsor be developed. The duration of Temporary Work Area Easements (TWAE) for access and staging is estimated to be two years. This will allow sufficient time for construction, contractor mobilization/demobilization, weather delays, etc. Acreage requirements are indicated in Exhibit D.

2c. OWNERSHIPS: The dune and berm will be constructed on existing beachfront owned by private and commercial owners, Long Beach Township, and the boroughs of Harvey Cedars, Surf City, Ship Bottom, and Beach Haven. Construction areas would exclude any existing structures. A total of approximately 845 privately owned parcels with 825 ownerships, 5 commercial parcels with 5 ownerships, and 116 public parcels with 6 ownerships are indicated to be impacted by the proposed project. The required staging/access areas are publicly owned, as are perpetual access areas. The TWAE will not require access from the adjacent properties during construction since the work will be primarily confined to the seaward side of the dune and equipment will be such as to work over the dune. Ownership information is indicated in Exhibit A.

2d. ESTIMATED VALUE: The detailed Real Estate Cost Estimate in MCACES format is included in Exhibit B. The required TWAE (approximately 19.72 ac.), perpetual restrictive dune/beach nourishment easements (approximately 330 ac. including the area from the landward toe of dune to the MHWL), are considered to have nominal value because of special benefits. The proposed project will create a betterment to the properties that otherwise would not exist.

3. DESCRIPTION OF NFS' EXISTING OWNERSHIP: Submerged lands below the MHWL of the Atlantic Ocean are owned by the State of New Jersey and managed by the NJDEP Bureau of Tidelands Management.

4. RECOMMENDED ESTATES: The construction, operation and maintenance of the dune and berm will require a standard restrictive dune easement and perpetual beach nourishment easement.   A standard TWAE with a duration of two years will be required for access/staging during construction.

Dune/Berm:

<u>RESTRICTIVE DUNE EASEMENT</u>

A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. ____), to construct, operate, maintain, patrol, repair, rehabilitate, and replace a dune system and appurtenances thereto, together with the right to post signs, plant vegetation and prohibit the grantor(s), (his) (her) (its) (their) heirs, successors, assigns and all others from entering upon or crossing over said dune easement; reserving, however, to the grantor(s), (his) (her) (its) (their) heirs, successors, assigns, the right to construct dune walkover structures in accordance with any applicable Federal, State, or local laws or regulations, provided that such structures shall not violate the integrity of the dune in shape or dimension and prior approval of the plans and specifications for such structures shall have been obtained from the District Engineer, U.S. Army Engineer District, Philadelphia, and all other rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

PERPETUAL BEACH NOURISHMENT EASEMENT

A perpetual and assignable easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. ____), to construct, operate, maintain, patrol, repair, renourish, and replace the beach berm and appurtenances thereto, including the right to borrow and/or deposit fill, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the easement; reserving, however, to the grantor(s), (his) (her) (its) (their) heirs, successors and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however to existing easements for public roads and highways, public utilities, railroads and pipelines.

Additionally, the following standard estate would be required for staging and access during construction:

TEMPORARY WORK AREA EASEMENT (Estate No. 15)

A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tract Nos. ____), for a period not to exceed two years, beginning with date possession of the land is granted to the United States, for use by the United States, its representatives, agents, and contractors as a work area, including the right to borrow and/or deposit fill, spoil, and waste material thereon and to move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the Barnegat Inlet to Little Egg Inlet Shore Protection Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however to existing easements for public roads and highways, public utilities, railroads and pipelines.

5. EXISTING FEDERAL PROJECTS: There are no federal projects in the proposed project area.

6. EXISTING FEDERAL OWNERSHIP: There is no Federally-owned land within the project area.

7. NAVIGATIONAL SERVITUDE: Navigational Servitude will apply to this shoreline

protection/erosion control project. No Federal Government interest in real property is required with respect to lands subject to navigational servitude. The non-Federal sponsor owns all the lands below the MHWL, but due to navigational servitude no right-of-entry will be necessary.

8. REAL ESTATE MAPPING: Plates R-1 through R-13, dated 11 February 1999, are attached as Exhibit D. The maps include delineation of the land, estates, and acreages to be acquired and indicate parcels impacted by the project.

9. INDUCED FLOODING: No induced flooding is anticipated due to this proposed project.

10. BASELINE COST ESTIMATE FOR REAL ESTATE: The detailed real estate cost estimate in MCACES format is included in Exhibit B. Since the number of parcels impacted for this project is unusually large, costs to the non-Federal sponsor in the acquisition of the real estate are being kept in check. As the result of this project each property owner will accrue special benefits, therefore compensation is nominal. Informal value estimates will be completed in lieu of formal appraisals, since values will be less than $2,500 per tract, at an estimated cost of $25,000. Rather than obtaining Title Evidence for each individual parcel, Verification of Ownerships will be completed at an estimated cost of $10,000 for this job action. No individual survey and title description will be done on each parcel in the acquisition of the easements. Each municipality has affixed on their mapping a building line limit that has been surveyed, and is or will be required to be recorded at the Ocean County Courthouse. The easements for each parcel of this project will reference the building limit line. The cost for the preparation and recordation of these plats by the municipalities has been estimated at $3,000. These costs have been discussed with and agreed to by the non-Federal sponsor.

11. PUBLIC LAW 91-646 RELOCATIONS: There are no Public Law 91-646 relocations required in connection with the project.

12. MINERAL ACTIVITY: There is no present or anticipated mineral activity in the vicinity of the project, which may affect the operation thereof.

13. ASSESSMENT OF THE NFS'REAL ESTATE ACQUISITION CAPABILITIES: The NFS, the New Jersey Department of Environmental Protection, has indicated that the required real estate acquisitions would be accomplished with the assistance of the municipalities of Long Beach Township, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven. The NFS has real estate acquisition, eminent domain, and "quick-take" authorities in the project area and has indicated that each of the municipalities has condemnation authority. It is anticipated that the State of New Jersey would enter into a State Aid Agreement with these municipalities whereby the municipalities provide the real estate in order to receive state funding for the project's construction. The Assessment of the Non-Federal sponsor's Real Estate Acquisition Capability is included in Exhibit C.

14. ZONING CHANGES: No zoning changes are proposed in lieu of, or to facilitate real estate acquisition.

15. ACQUISITION SCHEDULE: The non-Federal sponsor, the New Jersey Department of Environmental Protection, has indicated that the required real estate acquisitions would be accomplished with the assistance of the municipalities of Long Beach Township, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven. Following is the estimated acquisition schedule based on an estimated PCA execution date of 1 Sep 2001:

1. PCA execution	01 Sep2001
2. Forward maps to sponsor	02 Sep 2001-09 Sep 2001
3. Recordation of Building Limit Line	10 Sep 2001-10 Dec 2001
4. Ownership Verification	10 Sep 2001-10 Dec 2001
5. Informal Value Estimates	11 Dec 2001-11 Mar 2002
6. Negotiations	12 Mar 2002-12 Nov 2002
7. Closings	13 Nov 2002-31 Jan 2003
8. Condemnations (if necessary)	01 Feb 2003-01 Oct 2003
9. Possession	02 Oct 2003-02 Nov 2003

16. RELOCATION OF UTILITIES AND FACILITIES: There are no relocations of utilities or facilities required for this project.

17. HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE: The Preliminary Hazardous, Toxic, and Radioactive Waste Assessment indicated there are twelve (12) potentially contaminated sites within approximately a 2 mile radius of the project. Since none of these sites, however, are located on the beach or close enough to have any impact on the project, there is considered to be no HTRW contamination potential in the project area. Therefore, the real estate cost estimates contained in this Real Estate Plan do not reflect the presence of contamination.

18. LANDOWNER SENTIMENT: The majority of the landowners are concerned about the need for shoreline protection and continued erosion and would likely support this project for that purpose. However, in one segment of Long Beach Township, known as Loveladies, some of the property owners oppose the project unless they receive financial compensation for the easement on their property.

19. NOTIFICATION TO NFS OF RISKS PRIOR TO PCA EXECUTION: The non-Federal sponsor, New Jersey Department of Environmental Protection, will be notified in writing regarding the risks associated with acquisition of land prior to the execution of the PCA.

20. PUBLIC ACCESS: ER 1165-2-130, Para. 6.(h) requires public use by all (including non-residents) on equal terms. This means that the project beaches will not be limited to a segment of the public. Public use is construed to be effectively limited as follows: a) when available public access points to any particular shore are spaced more than one-quarter (1/4) mile apart; b) when there is a lack of sufficient parking facilities for the general public (non-resident-users) located reasonably nearby and with reasonable public access. Generally, parking should be available within a reasonable walking distance of the beach.

Public access and sufficient parking for the general public is available in the boroughs of Beach

Haven, Ship Bottom, Surf City, and Harvey Cedars as prescribed in the regulations. The same holds true for Long Beach Township except in the areas known as Loveladies and North Beach. In an approximately 2.1 mile stretch, Loveladies has three (3) points of public access, while North Beach has one (1) in a 1.3 mile stretch. According to information provided by Long Beach Township, Loveladies has approximately 811 parking spaces, and North Beach 120, primarily located on the bayside of Long Beach Boulevard in each of those areas, that are available for general public use.

In order to bring these two areas of Long Beach Township into compliance with ER 1165-2-130, Para. 6.(h) as cited above so as to be eligible for Federal assistance through this project, the following is required:

> 1. In addition to the existing public access points, establish new ones to meet the ¼ mile distance between each. This would require the non-Federal sponsor to obtain permanent easements for these access points if they have not already done so. Recommended sites to establish these access points in Loveladies are Tracts 20.07, 20.33, 20.82, 20.107, 20.133 Lot 6; in North Beach, Tracts 18.13, 18.41, 18.93, 18.119.
>
> 2. Remove current restrictions prohibiting parking on one side of streets from 9:00am Wed through 9:00pm Sun.
>
> 3. Provide at a minimum an additional 100 parking spaces in the North Beach area. The 120 spaces identified by the Township for this 1.3 mile area are essentially located within a .3 mile stretch of the south end. Recommend that parking be made available in the vicinity of the recommended access points 18.41, 18.119, and the existing access point 18.65. Toward this end, it is recommended that the non-Federal sponsor purchase in fee property to satisfy the required parking spaces needed. Possible sites for this purpose, presently listed as vacant land, are Tracts 18.35, 18.67 and 18.111. If this option proves untenable, the non-Federal sponsor should provide parking on Long Beach Boulevard in this North Beach area. This option may require removal of the bike paths and median.
>
> 4. As long as no restrictions are placed on the parking spaces as identified by the Township in the Loveladies' area, the availability appears satisfactory. However, since this parking is on the bayside, it is recommended that this 2.1 mile stretch have sufficient lights for the pedestrian public to cross Long Beach Boulevard to access the beach area.

21. The local sponsor as well as the non-Federal sponsor have confirmed that public access will be provided every (1/4) mile and that parking area will be created where possible. The final details regarding public access point will be completed in the PED phase of the study.

EXHIBIT A

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

R-2

	ADDRESS	OWNER	Assessor Parcel Number
87	Long Beach Blvd	Andrew N & Lore N Yao	18-00020-0097-00005
89-d	Long Beach Blvd	Eugene F & Jeannine T Mccabe	18-00020-0102-00001
91-d	Long Beach Blvd	Princeton Econ Institute	18-00020-0103-00001-0004
93-b	Long Beach Blvd	Irvin & Lois Cohen	18-00020-0104-00002
95-d	Long Beach Blvd		18-00020-0107-00004
97-d	Long Beach Blvd	Robert S Hekemian	18-00020-0109-00001-0004
			18-00020-0110-00002
101	Long Beach Blvd	Thomas & Susan Shenk	18-00020-0111-00005
103-b	Long Beach Blvd	Vincent J & Janis M O'brien	18-00020-0113-00001-0002
105-d	Long Beach Blvd	Smith James M & Marie David	18-00020-0114-00004
105	Long Beach Blvd	Moore Properties Llc	18-00020-0114-00005
107-d	Long Beach Blvd	Julius W & Helen Sostazko	18-00020-0115-00004
107	Long Beach Blvd	J R Cantor	18-00020-0115-00005
109-f	Long Beach Blvd	Stanley M & Janice M Berenstain	18-00020-0116-00006
7	Coast Ave	Joel H & Judith Golden	18-00020-0117-00007
6	E Arts Ln	John C & Dorothy G Heymann	18-00020-0119-00006
7	E Arts Ln	Vincent Perllio	18-00020-0119-00007
8	E Arts Ln	Donald M Weill	18-00020-0119-00008
123	Long Beach Blvd	Juanita B Siegel	18-00020-0119-00009
129-d	Long Beach Blvd	K Mccormick	18-00020-0125-00004
131-d	Long Beach Blvd	William & Carolyn Mascharka	18-00020-0127-00001-0003
133	Long Beach Blvd	George E & Sandra T Norcross Iii	18-00020-0129-00001-0005
135	Long Beach Blvd	Nautical Leisure Inc	18-00020-0129-00001-0010
10	S Seaview Dr	Mariana A Fitzpatrick	18-00020-0133-00005
12	S Seaview Dr	Anthony J & Eileen A Cuti	18-00020-0133-00006
14	S Seaview Dr	Walter Spiro	18-00020-0133-00007
9	N Sea View Dr	Elmo J & Adeline M Diianni	18-00020-0137-00005
11	N Sea View Dr	Lionel A & Gail B Kaplan	18-00020-0137-00006
13	N Sea View Dr	Marc & Ruthellen Rubin	18-00020-0137-00007
145	Long Beach Blvd	Ja Dr & Tm Fabiani	18-00020-0139-00005

	Address	Property Owner	Assessor Parcel Number
		Borough Of Harvey Cedars	10-00057-0000-00008
7	E 79th St	John A Cadmus	10-00079-0000-00004
22	E 80th St	Dorothy E Maketa	10-00079-0000-00005
		Borough Of Harvey Cedars	10-00079-0000-00006
11	E 80th St	William B & Doris J Kuen	10-00080-0000-00005
9	E 80th St	Thomas & Karyn Hierl	10-00080-0000-00006
14	E 81st St	Pauline K Herman	10-00080-0000-00009
12	E 81st St	Harry A & Ellen S Yospin	10-00080-0000-00010
13	E 81st St	Michael & Maryanne Pontoriero	10-00081-0000-00005
		Borough Of Harvey Cedars	10-00081-0000-00006
14	E 82nd St	George K & Huguett E Pagoumian	10-00081-0000-00007
12	E 82nd St	Kenneth R Sandler	10-00081-0000-00008
	Beach	Borough Of Harvey Cedars	10-00082-0000-00006
13	E 82nd St	Robert J & Michele K O'shea	10-00082-0000-00006-0001
16	E 83rd St	Lawrence S Teacher	10-00082-0000-00007
13	E 83rd St	Three E's Properties	10-00083-0000-00006
20	E 84th St	Borough Of Harvey Cedars	10-00083-0000-00007
18	E 84th St	Jet Set Partnership	10-00083-0000-00008
15	E 84th St	Borough Of Harvey Cedars	10-00084-0000-00006
13	E 84th St	Henrietta Obert	10-00084-0000-00007
16	E 85th St	Richard & Elizabeth Kowalski	10-00084-0000-00008-0001
12	E 86th St	Edmund & Harriet Mancini	10-00085-0000-00001
13	E 85th St	Herbert M & Barbara E Frank	10-00085-0000-00002
13	E 86th St	Laura Wechsler	10-00086-0000-00003
11	E 86th St	Francis Charles Nichols	10-00086-0000-00004
5	E Seashell Ln	Cohen M & P G Richard	18-00020-0003-00003
7	E Seashell Ln	Sheldon M & Jill F Bonovitz	18-00020-0003-00004
5-c	Long Beach Blvd	Vincent & Aurea Laracca	18-00020-0005-00001-0003
7-a	Long Beach Blvd	Frank Bodenchak	18-00020-0007-00001
9-c	Long Beach Blvd	Ben & Karen Addiego	18-00020-0009-00001-0003
	N East Ln	B & K Addiego	18-00020-0011-00004
13-c	Long Beach Blvd	David R Peasback	18-00020-0013-00003
15-c	Long Beach Blvd	Residence Miller	18-00020-0015-00001-0003
17-c	Long Beach Blvd	Edward Schumann	18-00020-0017-00003
19-b	Long Beach Blvd	Leslie & Barbara Kaplan	18-00020-0019-00001-0002
21	Long Beach Blvd	Eric & Donna M Brooks	18-00020-0021-00001
23-b	Long Beach Blvd	Elizabeth W Sahlman	18-00020-0023-00001-0002
25-b	Long Beach Blvd	Kenneth J & Joanne Burkhardt Jr	18-00020-0025-00001-0001
27-b	Long Beach Blvd	Ellen B Seltzer	18-00020-0027-00001-0002
29	Long Beach Blvd	Glenn P Pitcairn	18-00020-0029-00001
31	Long Beach Blvd	Glenn P Pitcairn	18-00020-0031-00001
33-a	Long Beach Blvd	George Uslar	18-00020-0033-00001
35-d	Long Beach Blvd	Treatment & Recover Scientific	18-00020-0035-00001-0004
37	Long Beach Blvd	Thomas R & Paula W Kline	18-00020-0037-00001-0005
39-d	Long Beach Blvd	Hs Feinberg	18-00020-0039-00001-0004
41	Long Beach Blvd	Charles & Margaret Profito	18-00020-0041-00001
43-d	Long Beach Blvd	Robert N Herdelin	18-00020-0043-00004
45-d	Long Beach Blvd	Robert Herdelin	18-00020-0045-00004
47-d	Long Beach Blvd	Levinson Family Associates	18-00020-0047-00004
49-d	Long Beach Blvd	Sheila T Schlussel	18-00020-0049-00004
51-d	Long Beach Blvd	Maxine Eisenberg	18-00020-0051-00004
6805	Long Beach Blvd	Township Of Long Beach	18-00020-0053-00002
55-d	Long Beach Blvd	Robert & Ruth Kramer	18-00020-0055-00005
55-f	Long Beach Blvd	Township Of Long Beach	18-00020-0055-00006
57-b	Long Beach Blvd	Carmelo J Viscuso	18-00020-0065-00002
59-d	Long Beach Blvd	Carol B Lackland	18-00020-0066-00004
61-d	Long Beach Blvd	Nancy A Roncati	18-00020-0067-00004
63	Long Beach Blvd	Richard V & Tina Carolan	18-00020-0068-00001
65	Long Beach Blvd	Samuel A & Susan C Liebman	18-00020-0069-00005
69	Long Beach Blvd	Masoud G & Rosa Kian	18-00020-0076-00005
71	Long Beach Blvd	Newell & Ruth S Fischer	18-00020-0077-00005
		Unknown	18-00020-0082-00001

75	Long Beach Blvd	Clyde V & Gail Rockoff	18-00020-0083-00001
77	Long Beach Blvd	Donald J & B Goldberg	18-00020-0087-00004
79	Long Beach Blvd	Shanin & Tracey Specter	18-00020-0089-00005
81	Long Beach Blvd	Allen K & Susan Y Fox	18-00020-0093-00001-0005
83	Long Beach Blvd	Leo & Doreen Steg	18-00020-0095-00001-0005
85	Long Beach Blvd	Janet B Messersmith	18-00020-0096-00005

	Address	Property Owner	Assessor Parcel Number
		Unknown	10-00019-0000-00003-0001
		Unknown	10-00019-0000-00003-0002
		Unknown	10-00019-0000-00006
		Unknown	10-00019-0000-00005
		Unknown	10-00019-0000-00004
		Unknown	10-00020-0000-00007-0002
		Unknown	10-00020-0000-00007-0001
		Unknown	10-00020-0000-00009
		Unknown	10-00020-0000-00008
		Unknown	10-00020-0000-000010
15	E Gloucester Ave	Andrew & Barbara Hosie	10-00021-0000-00007-0000-C-0001
15	E Gloucester Ave	Robert & Pamela Epifano Jr	10-00021-0000-00007-0000-C-0002
	Beach	Borough Of Harvey Cedars	10-00021-0000-00008
14	E Salem Ave	Metz W & Ruth M Peter	10-00021-0000-00009
11	E Salem Ave	Keller J & Dorothy Ann Geo	10-00022-0000-00006
	Beach	Borough Of Harvey Cedars	10-00022-0000-00007
10	Hudson Ave	Salvatore & Patricia De Lorenzo	10-00022-0000-00008
9	E Hudson Ave	Martin Dimmerman	10-00023-0000-00001
	Beach	Borough Of Harvey Cedars	10-00023-0000-00002
14	E Passaic Ave	Willis T & Nancy J King Jr	10-00023-0000-00003-0001
12	E Passaic Ave	John J Rodriguez	10-00023-0000-00003-0002
11	Hudson Ave	Daniel A & Joanne C Cuoco	10-00023-0000-00013
13	E Passaic Ave	New Imper Realty Corp	10-00024-0000-00006
	Beach	Borough Of Harvey Cedars	10-00024-0000-00007
14	E Burlington Ave	Barney & Sylvia R Naden	10-00024-0000-00008
14	E Burlington Ave	Henry C Schwartz	10-00024-0000-00009
15	E Burlington Ave	Arlene H Pollack	10-00025-0000-00006
13	E Burlington Ave	Robert K Brookland	10-00025-0000-00007
	Beach	Borough Of Harvey Cedars	10-00025-0000-00008
	Beach	Borough Of Harvey Cedars	10-00025-0000-00009
16	E Atlantic Ave	Borough Of Harvey Cedars	10-00025-0000-00010
14	E Atlantic Ave	Russell G Romond	10-00025-0000-00011
11	E Atlantic Ave	Robert J & Joan Axelrod	10-00037-0000-00006
6305-d	Long Beach Blvd	Denise M Hughes	10-00037-0000-00008
6307	Long Beach Blvd	Page James H Box Jr	10-00038-0000-00005
6309-f	Long Beach Blvd	Gardner P & Shirley Dunnan	10-00038-0000-00006
6309-g	Long Beach Blvd	William E & Nancy R Boye	10-00038-0000-00007
6311-f	Long Beach Blvd	Walter M Strine Jr	10-00038-0000-00018
6311	Long Beach Blvd	Mary A Feeley	10-00038-0000-00019
14-b	Mercer Ave	Robert & Pamela Friedman	10-00038-0000-00020
14-a	Mercer Ave	Allen K & Suzan Fox	10-00038-0000-00021
13-a	Mercer Ave	Lawrence R Bardfeld	10-00039-0000-00007
	Beach	Borough Of Harvey Cedars	10-00039-0000-00008
6403-g	Long Beach Blvd	Walter J & Muriel Polett Jr	10-00039-0000-00009
6405-d	Long Beach Blvd	Terry K Riegel	10-00039-0000-00018
12	E Middlesex Ave	M J H Da Puzzo	10-00039-0000-00019
11	E Middlesex Ave	Terrence & Marilyn Larsen	10-00040-0000-00006-0001
13	E Middlesex Ave	John M & Ellen C Galat	10-00040-0000-00007-0001
	Beach	Borough Of Harvey Cedars	10-00040-0000-00008
12-b	E Essex Ave	Goodman Family Partnership Lp	10-00040-0000-00009
12-a	E Essex Ave	Gloria M Winchell	10-00040-0000-00010
13	E Essex Ave		10-00042-0000-00008
	Beach	Borough Of Harvey Cedars	10-00042-0000-00009
12	E 68th St	Patricia C Hogan	10-00042-0000-00010
10	E 68th St	Kevin L & Margaret A Leen	10-00042-0000-00011
9	68th St	Harvey & Phyllis Karan	10-00042-0001-00005
8	E 69th St	Virginia W Paske	10-00042-0001-00006
8	E 69th St	Jerome P & Deborah R Epstein	10-00042-0001-00007
7	E 69th St	Bruce L & Joan S Kirchenheiter	10-00042-0002-00004
7	E 69th St	Susan M Hughes	10-00042-0002-00005
8	70th St	William T & Barbara Kretzer	10-00042-0002-00006
7-a	70th St	Mutya S Shaw	10-00042-0003-00004

7-b	70th St	Victor W & Carolyn S Groisser	10-00042-0003-00005
8	E Sussex Ave	Ronald & Roberta L Berg	10-00042-0003-00006
15	E Sussex Ave	George J & Janet M Sella Jr	10-00043-0000-00005
7101	Long Beach Blvd	Laurence A Liss	10-00043-0000-00006
		Borough Of Harvey Cedars	10-00043-0000-00008
		Borough Of Harvey Cedars	10-00043-0000-00009-0001
7201	Long Beach Blvd	Sisters Of Charity Of St Elizabeth	10-00044-0000-00004
		Sisters of Charity of St. Elizabeth	10-00044-0000-00005
13	E 73rd St	Donald E & Gail J Mcgovern	10-00052-0000-00007
		Borough Of Harvey Cedars	10-00052-0000-00009
		Borough Of Harvey Cedars	10-00052-0000-00010
12	E 74th St	Thomas M & Margaret R Gorrie	10-00052-0000-00011
14	E 74th St	Margaret Armstrong	10-00052-0000-00011-0001
15	E 74th St	Ilan & Therese Plawker	10-00053-0000-00007
	N/se 74th St	Borough Of Harvey Cedars	10-00053-0000-00008
		Emily Smith	10-00053-0000-00009
		Borough Of Harvey Cedars	10-00053-0000-00010
14	E 75th St	Stephen T & Sifton D Hoagland	10-00053-0000-00011
		Borough Of Harvey Cedars	10-00054-0000-00008
	Beach	Borough Of Harvey Cedars	10-00054-0000-00009
		Borough Of Harvey Cedars	10-00054-0000-00010
14	E 76th St	Daniel P O'connell	10-00054-0000-00011
17	E 76th St		10-00055-0000-00008
		Borough Of Harvey Cedars	10-00055-0000-00009
18	E 77th St	Borough Of Harvey Cedars	10-00055-0000-00010
		Borough Of Harvey Cedars	10-00055-0000-00011
14	E 77th St	Rona Stein	10-00055-0000-00012
	Beach	Borough Of Harvey Cedars	10-00056-0000-00008
		Borough Of Harvey Cedars	10-00056-0000-00009
	Beach	Borough Of Harvey Cedars	10-00056-0000-00010
		Borough Of Harvey Cedars	10-00056-0000-00011

5409-f	Long Beach Blvd	Irene G Bush	10-00006-0000-00017
5409	Long Beach Blvd	Edward & Marilyn G Bennett	10-00006-0000-00017-0001
	Beach	Borough Of Harvey Cedars	10-00006-0000-00017-0002
5411-c	Long Beach Blvd	Barberia A Laura	10-00006-0000-00018-0001
5411-f	Long Beach Blvd	Maryellen Barberia	10-00006-0000-00018-0002
5411-a	Long Beach Blvd	Maria C Grostein	10-00006-0000-00019
5411-b	Long Beach Blvd	Irwin & Brenda Goldman	10-00006-0000-00020
5411	Long Beach Blvd	Howard Panster	10-00006-0000-00021
5411-d	Long Beach Blvd	Jeffrey & Mara Van Etten	10-00006-0000-00022
5413-a	Long Beach Blvd	Maureen E Gelnaw	10-00006-0000-00023-0001
5413-b	Long Beach Blvd	Atlantic City Electric Co	10-00006-0000-00023-0002
5413-c	Long Beach Blvd	Gibbs A & Margaret R Todd	10-00006-0000-00023-0003
5415-a	Long Beach Blvd	Barry & Maxine Montague	10-00006-0000-00024-0001
5415-b	Long Beach Blvd	Francis C & Annamarie L Hand	10-00006-0000-00024-0002
5415-c	Long Beach Blvd	Atlantic City Electric Co	10-00006-0000-00024-0003
5417-a	Long Beach Blvd	Seymour & Susan Koslowsky	10-00006-0000-00025
5417-b	Long Beach Blvd	Andrew D & Nancy Freeman	10-00006-0000-00026
5417-c	Long Beach Blvd	Irene G Schragger	10-00006-0000-00027
5417	Long Beach Blvd	Michael Decristofaro	10-00006-0000-00028
5417-d	Long Beach Blvd	Frank W & Mary Lou Hogan Jr	10-00006-0000-00029
5419	Long Beach Blvd	Atlantic City Electric Co	10-00006-0000-00030
5419-d	Long Beach Blvd	Antoinette M Gardner	10-00006-0000-00031
5419-c	Long Beach Blvd	Edwin A & Alma Lakin	10-00006-0000-00032
5419-b	Long Beach Blvd	Linda D Martinelli	10-00006-0000-00033
5419-a	Long Beach Blvd	Howard E & Mary Louise Cook	10-00006-0000-00034
5421	Long Beach Blvd	Teresa J Pataffi	10-00006-0000-00035
5423-2	Long Beach Blvd	John H & Sophia Steber	10-00006-0000-00036
5423-1	Long Beach Blvd	David & Joyce C Kurz	10-00006-0000-00036-0001
5423-3	Long Beach Blvd	Frank L & Linda L Coulson	10-00006-0000-00036-0002
5423-b	Long Beach Blvd	Frank L & Linda Coulson Jr	10-00006-0000-00037
5423-d	Long Beach Blvd	Bruno W & Rita Linsker	10-00006-0000-00038
5423-c	Long Beach Blvd	Leonard B & Miriam Orner Famil	10-00006-0000-00039
12	E Cumberland Ave	Edward S Meline	10-00006-0000-00040

14	E Cumberland Ave	Lester B & Dorothy Bloch	10-00006-0000-00041

5303-d	Long Beach Blvd	Thil & Chandra Yoganathan	10-00005-0000-00001-0004
5303	Long Beach Blvd	Vannerson Partners, The	10-00005-0000-00001-0005
5305-d	Long Beach Blvd	Carmel D'amello	10-00005-0000-00003-0004
5305	Long Beach Blvd	John W & Susan Vanpoznak	10-00005-0000-00003-0005
5307-d	Long Beach Blvd	H J Gilbert	10-00005-0000-00004-0004
5307	Long Beach Blvd	Daniel & Harriet Mironov	10-00005-0000-00004-0005
5309-d	Long Beach Blvd	Eileen M Troast	10-00005-0000-00005
5311-a	Long Beach Blvd	Rose Marie Tarangelo	10-00005-0000-00006
10	E Bergen Ave	Edward B & Karen Mullaney	10-00005-0000-00013
12	E Bergen Ave	Richard T Dewling	10-00005-0000-00014
13	E Bergen Ave	Frank E & Ellen A Mignoni	10-00006-0000-00005
	Bergen Ave	Borough Of Harvey Cedars	10-00006-0000-00006
11	E Bergen Ave	Edward S & Eileen Meline	10-00006-0000-00007
9-a	E Bergen Ave	John & Janice D Zennario	10-00006-0000-00008
1001	Long Beach Blvd	Salvatore & Mgt Girardo	18-00018-0001-00004
1003-d	Long Beach Blvd	Araxy Tatarian	18-00018-0003-00004
1007-c	Long Beach Blvd	Joanne Mainardi	18-00018-0007-00003
1009-d	Long Beach Blvd	Weichert Co Realtors	18-00018-0009-00004
1011-d	Long Beach Blvd	Robt F Calman	18-00018-0011-00004
1013-c	Long Beach Blvd	Rosemarie B Greco	18-00018-0013-00003
1015-c	Long Beach Blvd	Atlantic City Electric Co	18-00018-0015-00001-0003
1017	Long Beach Blvd	Joseph J & Alice P Steinke	18-00018-0017-00003
1019-c	Long Beach Blvd	Atlantic City Electric Co	18-00018-0019-00003
1021-c	Long Beach Blvd	Charles E Mortimer	18-00018-0021-00003
1023	Long Beach Blvd	North Beach Estates Assoc	18-00018-0023-00005
1025	Long Beach Blvd	Chas D Ficke	18-00018-0025-00001
1027-c	Long Beach Blvd	Joseph & Judith Abrams	18-00018-0027-00003
1029-c	Long Beach Blvd	John Aldrich	18-00018-0029-00003
1031-c	Long Beach Blvd	Ronald & Karen Petrosky	18-00018-0031-00003
1033-b	Long Beach Blvd	Mary L Raab	18-00018-0033-00001
1035-c	Long Beach Blvd	William B Van Buren Iii	18-00018-0035-00003
1037-c	Long Beach Blvd	John J & Linda C Flood	18-00018-0037-00003
1039-c	Long Beach Blvd	Jeffrey M Melin	18-00018-0039-00001-0003
1041-a	Long Beach Blvd	Russell Weller	18-00018-0041-00001
1043-c	Long Beach Blvd	Frank & Irene Bodenchak	18-00018-0043-00002
1045-c	Long Beach Blvd	R Williams	18-00018-0045-00003
1047-c	Long Beach Blvd	Franklin E & Betty Barr	18-00018-0047-00003
1049-c	Long Beach Blvd	Joan Beverly King O'reilly	18-00018-0049-00003
1051-c	Long Beach Blvd	Rose Mainardi	18-00018-0051-00003
1051-d	Long Beach Blvd	J M Encke Sr	18-00018-0051-00004
1057-c	Long Beach Blvd	Calvin E & Dolores M Jacobs	18-00018-0057-00002
1059-c	Long Beach Blvd	Sandra S & Kenneth S Stein	18-00018-0059-00003
			18-00018-0059-00004
1061-c	Long Beach Blvd	Bertha S Graham	18-00018-0061-00001-0003
1063-c	Long Beach Blvd	Gale W & Patricia M Moser	18-00018-0063-00003
1065-a	Long Beach Blvd	Township Of Long Beach	18-00018-0065-00001
1067-c	Long Beach Blvd	Perry & Barbara Kaplan	18-00018-0067-00003
1069-c	Long Beach Blvd	Carolyn Dorfman	18-00018-0069-00003
1071-c	Long Beach Blvd	Vincent E & Doris Hoyer	18-00018-0071-00003
1073-c	Long Beach Blvd	Annamarie Greek	18-00018-0073-00003
1075	Long Beach Blvd	Mary Grace Sobel	18-00018-0075-00001
1077-c	Long Beach Blvd	Helen P Kambin	18-00018-0077-00001-0001
1079-c	Long Beach Blvd	David A & Adrienne A Ackerman	18-00018-0079-00003
1081-c	Long Beach Blvd	Eva Koerner	18-00018-0081-00003
1083	Long Beach Blvd	Ignacy Stark	18-00018-0083-00001
1085	Long Beach Blvd	Dorothy B Decarlo	18-00018-0085-00001
1087-c	Long Beach Blvd	Clarence J & Anne C Venne	18-00018-0087-00001-0003
1089-c	Long Beach Blvd	Stanley R Kranjc	18-00018-0089-00001
1091-c	Long Beach Blvd	Mccollister H & Carol J Daniel	18-00018-0091-00003
1093-c	Long Beach Blvd	Constance Stockwell	18-00018-0093-00003
1095-c	Long Beach Blvd	Arthur H Schwerzel	18-00018-0095-00001-0003
1097-c	Long Beach Blvd	Herbert G Case	18-00018-0097-00003
1099-b	Long Beach Blvd	Jerome G & Susan Peach	18-00018-0099-00002

1101	Long Beach Blvd	1101 North Beach Llc	18-00018-0101-00001
1103	Long Beach Blvd	Dm & Jl Crann	18-00018-0103-00001
1105-b	Long Beach Blvd	John W Pegg	18-00018-0105-00001-0002
1105-c	Long Beach Blvd	John W Pegg	18-00018-0105-00001-0003
1107-b	Long Beach Blvd	Geo D & Susan M Edwards	18-00018-0107-00002
1109	Long Beach Blvd	Galluzzi Family Llc	18-00018-0109-00001
1111	Long Beach Blvd	Allan R & Evelyn S Anderson	18-00018-0111-00002
1113-a	Long Beach Blvd	David H & Sandra L Martin	18-00018-0113-00001
1113-b	Long Beach Blvd	George E & Clare M Anderson Jr	18-00018-0113-00002
1115-b	Long Beach Blvd	Gerard J & L L Hansen	18-00018-0115-00002
1115-c	Long Beach Blvd	Mary A Ramsey	18-00018-0115-00003
1117	Long Beach Blvd	Charles A Dreyling	18-00018-0117-00001
1119	Long Beach Blvd	Peter & Norma Donovan	18-00018-0119-00002
1119	Long Beach Blvd	Troiano Maria	18-00018-0119-00003

R-6

	Address	Property Owner	Assessor Parcel Number
1	S 3rd St	Mary E Nevins	32-00008-0000-00001
			32-00008-0000-00002
207	S Ocean Ave	Alan I & Lydia Rosenfeld	32-00008-0000-00003
203	S Ocean Ave	Michael & Doris La Placa	32-00008-0000-00004
		Unknown	32-00009-0000-00001
		Unknown	32-00009-0000-00002
		Unknown	32-00009-0000-00003
		Unknown	32-00011-0000-00001
		Unknown	32-00011-0000-00002
		Unknown	32-00011-0000-00003
		Unknown	32-00011-0000-00004
		Unknown	32-00012-0000-00001
		Unknown	32-00012-0000-00003
		Unknown	32-00049-0000-00003
		Unknown	32-00049-0000-00004
1801	Ocean Ave	Charles J & Elizabeth Brinamen Jr	32-00050-0000-00001
1807	Ocean Ave	Arthur T Dinager	32-00050-0000-00002
1811	Ocean Ave	Minna J Finberg	32-00050-0000-00003
1817	Ocean Ave	Willian H & Joann M Mulcahy	32-00050-0000-00004
1901	Ocean Ave	Lance & Stephanie Lichtensteiger	32-00051-0000-00001
1907	Ocean Ave	Jeffrey H & Jane Dorval	32-00051-0000-00002
14	20th St	Gloria A Viola	32-00051-0000-00003
6	21st St	Lynn S Scarbo	32-00052-0000-00003
			32-00052-0000-00004
37	20th St	Joseph & Norma Yurcisin	32-00052-0000-00015
47	20th St	George Nestoros	32-00052-0000-00019
2101	Ocean Ave	Ross H & Jane Dudley	32-00053-0000-00001
2107	Ocean Ave	Jon M Conahan	32-00053-0000-00002
2111	Ocean Ave	Stanley P & Sharon K Knight	32-00053-0000-00003
10	22nd St	Claire P Qual Res Steinberg	32-00053-0000-00004
2201	Ocean Ave	Vincent Dr & Maria Mastrota	32-00057-0000-00001-0001
2207	Ocean Ave	Debra Wright	32-00057-0000-00002-0001
2215	Ocean Ave	Alvin A & Anne T Clay	32-00057-0000-00003
6	23rd St	Crowell Family Trust	32-00057-0000-00004
7	23rd St	Hannah T Hollister	32-00058-0000-00001
2307	Ocean Ave	Frederick Goldman	32-00058-0000-00002
2313	Ocean Ave	Martin W & Margaret C Caulfield	32-00058-0000-00003
6	24th St	Carole J Mccann	32-00058-0000-00004
2401	Ocean Ave		32-00059-0000-00001
2411	Ocean Ave	Marshall D Strode	32-00059-0000-00002
2419	Ocean Ave	Lehrer Family Real Est Prtnshp	32-00059-0000-00003

	Address	Property Owner	Assessor Parcel Number
3109	Ocean Blvd	Stephen T & E M Whelan	18-00015-0150-00001
3107	Ocean Blvd	Samuel & Frances Mantone	18-00015-0150-00002
3101	Ocean Blvd	Walter & Elizabeth Bereza	18-00015-0150-00003
	Beachfront	Township Of Long Beach	18-00025-0031-00001
137	E 31st St	Borough Of Ship Bottom	29-00017-0000-00001
138	E 30th St 1	Ship Bottom Assoc	29-00017-0000-00002-0000-C-2.01
138	E 30th St 2	Ship Bottom Assoc	29-00017-0000-00002-0000-C-2.02
132	E 29th St	E Hanover	29-00018-0000-00002
130	E 29th St	Forsythe Family Trust	29-00018-0000-00003
135	E 29th St	Shawn & Lorraine Mahoney	29-00019-0000-00001-0001
136	E 28th St	Dennis M & Estelle S Forcelle	29-00019-0000-00001-0002
137	E 28th St	Ellen Tesler	29-00020-0000-00001
140	E 27th St	Rodney & Anne Odell	29-00020-0000-00002
135	E 27th St	Helen Dinnocenti	29-00023-0000-00001
136	E Ship Bottom Ave	Margaret A Carson	29-00023-0000-00002
2601	Ocean Ave	Carl Menk Jr	29-00024-0000-00001
2515	Ocean Ave	Helen A Keller	29-00025-0000-00001
2511	Ocean Ave A	Dorothy E Jedziniak	29-00025-0000-00002-0002-C-000A
2511	Ocean Ave B	Dorothy E Jedziniak	29-00025-0000-00002-0002-C-000B
2501	Ocean Ave	Thomas & Jacquelyn Valerio	29-00025-0000-00002-0003
2401	Ocean Ave	Borough Of Ship Bottom	29-00029-0000-00001
2301	Ocean Ave	Borough Of Ship Bottom	29-00030-0000-00001
2201	Ocean Ave	Borough Of Ship Bottom	29-00037-0000-00001
2117	Ocean Ave	Frank Holtham Jr	29-00038-0000-00001
2113	Ocean Ave	Joseph De Mesquita	29-00038-0000-00001-0001
2109	Ocean Ave	Francis R Rinaudo	29-00038-0000-00002
2101	Ocean Ave	John Quintana	29-00038-0000-00003
2001-2017	Ocean Ave	Borough Of Ship Bottom	29-00045-0000-00001
		Borough of Ship Bottom	29-00045-0000-00002
131	E 19th St	Joseph H & Pauline M Jt Lock	29-00056-0000-00001
1817	Ocean Ave	Jos & Regina Guarneri	29-00056-0000-00001-0001
1801	Ocean Ave	Borough Of Ship Bottom	29-00056-0000-00002
1719	Ocean Ave	Francis A & Joan F Mcteigue	29-00057-0000-00001
1717	Ocean Ave	Borough Of Ship Bottom	29-00057-0000-00002
		Unknown	29-00057-0000-00003
1619	Ocean Ave	John V & Bernadette Truglio	29-00066-0000-00001
1611	Ocean Ave	David & Audrey A Egger	29-00066-0000-00001-0001
136	E 16th St	Joseph Mistrano	29-00066-0000-00002
1501	Ocean Ave	Borough Of Ship Bottom	29-00067-0000-00001
1401	Ocean Ave	Borough Of Ship Bottom	29-00076-0000-00001
1319	Ocean Ave	Borough Of Ship Bottom	29-00077-0000-00001
		Unknown	29-00077-0000-00002
1307	Ocean Ave	Stephen E & Ellen T Voda	29-00077-0000-00003
1301	Ocean Ave	Floyd M Bishop	29-00077-0000-00004
1201-1219	Ocean Ave	Borough Of Ship Bottom	29-00086-0000-00001
		Borough of ship bottom	29-00086-0000-00004
1113-1119	Ocean Ave	Borough Of Ship Bottom	29-00087-0000-00001-0001
1101-1109	Ocean Ave	Marijan Stipicevic	29-00087-0000-00003-0001
901	Ocean Ave C918	Lawrence & Tamar T Skolnick	29-00096-0000-00001-0001
113-141	E 9th St	George & Eleanor Bevis	29-00106-0000-00001
719	Ocean Ter	Richard & Louise C Morrison	29-00107-0000-00001
711	Ocean Ter	Edward W & Josephine Schaefer	29-00107-0000-00002
705	Ocean Ter	Dorothy Christ Georgiou	29-00107-0000-00003
701	Ocean Ave	Varava Alexander Jr Trust	29-00107-0000-00004
619	Ocean Ave	Borough Of Ship Bottom	29-00116-0000-00002
611	Ocean Ter	Johanna Cappelletti	29-00116-0000-00003
607	Ocean Ter	Arnold & Joan Rose	29-00116-0000-00004
601	Ocean Ave	Nichole Barrett	29-00116-0000-00005
519	Ocean Ave C	Joseph & Georgeann C Esmerado	29-00117-0000-00001-0000-C-0001
507	Ocean Ave	Michael & Cowan Margaret Kvidera	29-00117-0000-00002
503	Ocean Ave	William J Carew	29-00117-0000-00003
419	Ocean Ave	Vernon & Joyce Miller Jr	29-00130-0000-00001

411	Ocean Ave	Pamela M Ferguson	29-00130-0000-00002-0001
134	E 4th St	Kevin & Stella Coogan	29-00130-0000-00004-0001
136	E 4th St	G A Edlin	29-00130-0000-00004-0002
315	Ocean Ave 1st	Irene De Lorenzo	29-00131-0000-00001-0000-C-1.01
		Unknown	29-00131-0000-00002
305	Ocean Ave	Jean L Page	29-00131-0000-00003
136	E 3rd St	Randolph E & Elizabeth H Mershon	29-00131-0000-00004

R-8

	Address	Property Owner	Assessor Parcel Number
6513	Ocean Blvd	Santo G & Laura A Fiasconaro	18-00015-0027-00001
6507	Ocean Blvd	Mackinney Family Partnership Lp	18-00015-0027-00002
6505	Ocean Blvd	Mackinney Family Partnership L P	18-00015-0027-00003
6503	Ocean Blvd	Jos & Elizabeth R Steinert	18-00015-0027-00004
6415	Ocean Blvd	Richard A Bergman	18-00015-0031-00001
6409	Ocean Blvd	Michael & Louise Migliore	18-00015-0031-00002
6401	Ocean Blvd	Joseph A & Ellen C Hunoval	18-00015-0031-00003
	E Dupont Ave	Joseph A & Ellen C Hunoval	18-00015-0031-00004
6315	Ocean Blvd	David N & Susan T Shaffer	18-00015-0034-00001
6307	Ocean Blvd	David N & Susan T Shaffer	18-00015-0034-00002
			18-00015-0034-00003
6301	Ocean Blvd	Johnette Venne	18-00015-0034-00004
		Unknown	18-00015-0034-00005
		Unknown	18-00015-0034-00006
		Unknown	18-00015-0034-00007
6215	Ocean Blvd	M Griffin	18-00015-0037-00001
6209-rear	Ocean Blvd	Township Of Long Beach	18-00015-0037-00002
6201	Ocean Blvd	Mechanical Contr Retire Pmc	18-00015-0037-00003
6209	Ocean Blvd	Pamela Foote	18-00015-0037-00004
6109	Ocean Blvd	Rheta Santangelo	18-00015-0040-00001
	Ocean Blvd	Township Of Long Beach	18-00015-0040-00002
6107	Ocean Blvd	Rheta Santangelo	18-00015-0040-00003
6105	Ocean Blvd	Avinash C & Ansuya Nigam	18-00015-0040-00004
6103	Ocean Blvd	William & Brian Ingram	18-00015-0040-00005
6013	Ocean Blvd	Walter G Scheuerman Iii	18-00015-0043-00001
6009	Ocean Blvd	John T Ligreci	18-00015-0043-00002
6001	Ocean Blvd	L H Rosch	18-00015-0043-00003
101	E Stanton Ave	Vincent E & Aurea E Laracca	18-00015-0046-00002
5905	Ocean Blvd	Robert Heal	18-00015-0046-00003
5901	Ocean Blvd	Louise Panczner	18-00015-0046-00004
5815	Ocean Blvd	Elias Tsoukas	18-00015-0051-00001
5809	Ocean Blvd	John F & Kathleen M Norris	18-00015-0051-00002
5803	Ocean Blvd	Richard F & Mary Elizabeth Cuba	18-00015-0051-00003
	Ocean Ave	Township Of Long Beach	18-00015-0051-00004
5713	Ocean Blvd	Phyllis A Burlington	18-00015-0056-00001
5707	Ocean Blvd	Rodney H & Brenda Watson	18-00015-0056-00002
5701	Ocean Blvd	Lbi Associates	18-00015-0056-00003
		Unknown	18-0001500056-00004
5615	Ocean Blvd	N Aynilian	18-00015-0061-00001
5609	Ocean Blvd	Roman & Joan Fyk	18-00015-0061-00002
5605	Ocean Blvd	Vincent E Puma	18-00015-0061-00003
		Unknown	18-00015-0061-00004
5601	Ocean Blvd	James A & Mary E Conway	18-00015-0061-00005
5301	Ocean Blvd	Herbert & Janet Dardik	18-00015-0072-00001-0001
5305	Ocean Blvd	Richard Olchaskey	18-00015-0072-00001-0002
5211	Ocean Blvd	Robert O & Cheryl E Baldi	18-00015-0075-00001
5203	Ocean Blvd	Kay R John	18-00015-0075-00002
5107	Ocean Blvd	Robert G Previdi	18-00015-0079-00001
5101	Ocean Blvd	S & A Barberides	18-00015-0079-00002
5105	Ocean Blvd	Harry & Beverly Bennett	18-00015-0079-00003
5109	Ocean Blvd	Christina G Eichbaum	18-00015-0082-00001
		Unknown	18-00015-0082-00002
	Ocean Blvd	Frederick N & Retha B Alyea	18-00015-0082-00003
5001	Ocean Blvd	Thos & Cathie Minehart	18-00015-0082-00004
4911	Ocean Blvd	Robert E & Ann F Personette	18-00015-0086-00001
4907	Ocean Blvd	Jos R & Joanne M Monaco	18-00015-0086-00002
4901	Ocean Blvd	Wheeler Real Estate Partners L P	18-00015-0086-00003
4805	Ocean Blvd	Edwin & Gloria Mittleman	18-00015-0091-00001-0001
4803	Ocean Blvd	James G Clarke	18-00015-0091-00001-0002
4801	Ocean Blvd	Said Abou Samra	18-00015-0091-00002
4709	Ocean Blvd	Phillip H Caramico	18-00015-0094-00001
4707	Ocean Blvd	R & H Amendolara Macdonald	18-00015-0094-00002

4701	Ocean Blvd	Mj & R Hinman W Matto	18-00015-0094-00003
4609	Ocean Blvd	Harry A & Joan K Widmeier	18-00015-0096-00001
4601	Ocean Blvd	Daub L & Carolyn Anderson	18-00015-0096-00002
4509	Ocean Blvd	James G & Jane R Clarke	18-00015-0100-00001
4505-7	Ocean Blvd	John J & Christine L Fote	18-00015-0100-00002
4411	Ocean Blvd	Louis S & Debraa Campisano	18-00015-0103-00001
4403	Ocean Blvd	Milton E & Andrea B Coll	18-00015-0103-00002
4407	Ocean Blvd	Gregory Bradshaw	18-00015-0103-00003
4307-9	Ocean Blvd	Joan S Gesemyer	18-00015-0107-00001
4303	Ocean Blvd	Richard I & Geri M Samuel	18-00015-0107-00002
4209	Ocean Blvd	Caroline A Shaw	18-00015-0110-00001
4205	Ocean Blvd	Joseph A & Mary Gregg	18-00015-0110-00002
4201	Ocean Blvd	Edith M Marshall	18-00015-0110-00003
4109	Ocean Blvd	Lois Fleischmann Joyce Haas	18-00015-0114-00001
4101	Ocean Blvd	David P & Lois Y Tulin	18-00015-0114-00002
4009	Ocean Blvd	Robert L Toner	18-00015-0117-00001
4007	Ocean Blvd	Brian & Deborah Daly	18-00015-0117-00002
4001	Ocean Blvd	Atlantic City Electric Co	18-00015-0117-00003
3911	Ocean Blvd	Richard I & Geri M Samuel	18-00015-0121-00001
3905	Ocean Blvd	Daniel & Lucille Cerami	18-00015-0121-00002
3901	Ocean Blvd	Thomas R Woolley	18-00015-0121-00003
3809	Ocean Blvd	George F & Elizabeth Peper	18-00015-0124-00001
3803	Ocean Blvd	R L Midouhas	18-00015-0124-00002
3709	Ocean Blvd	Clark R Gesemyer	18-00015-0127-00001
3707	Ocean Blvd	James Anderson	18-00015-0127-00002
3701	Ocean Blvd.	Thomas & Olga Mcbride	18-00015-0127-00003
3611	Ocean Blvd	Paul F Petrone	18-00015-0131-00001
3601	Ocean Blvd	Rachel C Tennis	18-00015-0131-00002
3509	Ocean Blvd	John Z Delp	18-00015-0134-00001
3507	Ocean Blvd	Denis G Mcgarry	18-00015-0134-00002
3501	Ocean Blvd	Patricia Alfred & Catherine Meyer	18-00015-0134-00003
3409	Ocean Blvd	Marvin & Sandra Strauss	18-00015-0138-00001
3401	Ocean Blvd	Andrew T Ezzell	18-00015-0138-00002
3307	Ocean Blvd	Neal J & Ellen M Brower	18-00015-0142-00001
	Ocean Blvd	Jos E & Mary D Colen	18-00015-0142-00002
3207	Ocean Blvd	Jos E Colen Jr	18-00015-0146-00001
3205	Ocean Blvd	Rose M Connolly	18-00015-0146-00002
3203	Ocean Blvd	Jas A Carroll Jr	18-00015-0146-00003
		Township of Long Beach	18-00025-0031-00001
	Beachfront	Township Of Long Beach	18-00025-0033-00001
	Beachfront	Township Of Long Beach	18-00025-0035-00001

	Address	Property Owner	Assessor Parcel Number
123	E Texas Ave	Franklin B & Ruth D Mclaughlin	18-00011-0018-00007
119	E Texas Ave	Thomas P & Donna A Cullen	18-00011-0018-00008
122	E Florida Ave	James & Donna E Grimes	18-00011-0018-00009
123	E Florida Ave	Eileen M Daly	18-00011-0022-00006
121	E Florida Ave	Lewis G & Anne B Lynch Jr	18-00011-0022-00007
120	E California Ave	Thomas J & Patricia A Lynch	18-00011-0022-00008
122	E California Ave	Martin P Casey	18-00011-0022-00009
121	E California Ave	Mary F & Dwight Degener	18-00011-0025-00006
122	E Alabama Ave	Robert L Tennis	18-00011-0025-00014
121	E Alabama Ave	R & M Knowles	18-00011-0027-00005-0001
123	E Alabama Ave	Szymanski J & K Pessel P&a	18-00011-0027-00005-0002
122	E Muriel Ave	Mark A & Susan L Decaro	18-00011-0027-00006-0002
116	E Jerome Ave	Doris E Schneider	18-00011-0030-00006
120	E Jerome Ave	Joanne Gardner	18-00011-0030-00007
123	E Muriel Ave	John C Chigounis	18-00011-0030-00016
115	E Jerome Ave	Isabella S Schulze	18-00011-0032-00008-0001
120	E Herbert Ave	Gerald A White	18-00011-0032-00009-0002
123	E Herbert Ave	Thomas A & Shari A Ruchalski	18-00011-0037-00008
125	E Herbert Ave	Marion A Marson	18-00011-0037-00009
119	E Seabreeze Ave	David W & Elaine Griffin	18-00012-0007-00007
	E Mariners Ln	Julia H Lewis	18-00012-0007-00016
	E Mariners Ln	Julia H Lewis	18-00012-0007-00017
	E Bay Berry Dr	Eliz Susan Ripps Ripps	18-00012-0009-00015
		Unknown	18-00012-0009-00016
		Unknown	18-00012-0009-00017
128	E Cape Cod Ln	Michael & Ann Marie Gulban	18-00012-0012-00012
121	E Bayberry Dr	Patrick & Lynn M Mcshane	18-00012-0012-00013
121	E Cape Cod Ln	E J Musselman	18-00012-0015-00007
122	E Oceanview Dr	Thomas C & Mary L Readinger	18-00012-0015-00008-0002
124	E Oceanview Dr	John Nelson	18-00012-0015-00008-0003
121	E Oceanview Dr	Danyo J & Sara L Joseph	18-00012-0018-00007
118	E Sand Dune Ln	Barnett E & Diane Hoffman	18-00012-0018-00008
128	E Sand Dune Ln	May Capio	18-00012-0018-00015
123	E Sand Dune Ln	Larry & Linda Madres	18-00012-0021-00007-0002
122	E Sailboat Ln	Boyer J & Carol A Thomas	18-00012-0021-00008
120	E Sailboat Ln	Lucienne N Aynilian	18-00012-0021-00009
123	E Sailboat Ln	Gerald A & Joan Mcminn	18-00012-0024-00007
121	E Sailboat Ln	Daniel F & J M Lundy	18-00012-0024-00008
120	E Mermaid Ln	Edw & Joan Weinman	18-00012-0024-00009
123	E Mermaid Ln	Leonard & Phyllis Silidker	18-00013-0003-00007
123	E 87th St	Wellmann Family Partnership Lp	18-00013-0006-00008
118	E 86th St	Edw R & M M Dowling	18-00013-0006-00009
120	E 86th St	Joseph E Saccomanno	18-00013-0006-00010
115	E 86th St	Dorothy K Stults	18-00013-0009-00005
118	E 85th St	Lois S Davidson	18-00013-0009-00006
117	E 85th St	Barbara K Cristoforo	18-00013-0012-00006
116	E New York Ave	Beatrice Rogin	18-00013-0012-00007
119	E New York Ave	Blanche P Roberts	18-00013-0015-00006
120	E Connecticut Ave	Daub L & Carolyn A Anderson	18-00013-0015-00007
117	E Connecticut Ave	Henry V Cardoni	18-00013-0018-00005-0002
116	E Rhode Island Ave	George A Dunn	18-00013-0018-00010
117	E Rhode Island Ave	Elizabeth V Martin	18-00013-0021-00005
120	E Massachusetts Ave	Howard E Klein	18-00013-0021-00006
121	E Massachusetts Ave	Nj & Cv Demos	18-00014-0004-00003
110	E Surf Ave	Byron Leeds	18-00014-0004-00004
	E Massachusetts Ave	Byron Leeds	18-00014-0004-00005
114	E Surf Ave	Thos J & Irene M Kennedy	18-00014-0004-00006
118	E Surf Ave	Long S & Carolyn M Hansen	18-00014-0004-00007
109	E Surf Ave	N & C Wilson J Kurilko	18-00014-0006-00005
117	E Surf Ave	Paul J Contillo	18-00014-0006-00010
110	E Jeanette Ave	Craig W Yates	18-00014-0010-00002-0003
	E Winifred Ave	Frank Joseph Brogan	18-00014-0010-00002-0004

103	E Winifred Ave	Glenn Alan & D A Burkland	18-00014-0010-00002-0005
109	E Jeanette Ave	Joseph R & M S Flynn	18-00014-0014-00002-0002
107	E Jeanette Ave	John & Sharon Pushko	18-00014-0014-00003
110	E Hobart Ave	Robert G Previdi	18-00014-0014-00004
109	E Hobart Ave	Vincent & Aurea Laracca	18-00014-0018-00002
112	E Culver Ave	Vincent & Aurea Laracca	18-00014-0018-00003
110	E Culver Ave	Vincent & Aurea Laracca	18-00014-0018-00004
108	E Lavenia Ave	Jos A & E C Hunoval Jr	18-00014-0022-00003
107	E Culver Ave	Constance Kiewra	18-00014-0022-00007
105	E Lavenia Ave	Et & Hc Mclaughlin	18-00014-0027-00002
7405	Ocean Blvd	Harvey L Bennett	18-00014-0029-00002
7401	Ocean Blvd	Bert C & Anne M Del Villano Jr	18-00014-0029-00003
7311	Ocean Blvd	Donald B Crawford	18-00014-0029-00004
7307	Ocean Blvd	Tiska S & Cecelia Fred	18-00015-0006-00001
	Ocean Blvd	Brant Beach Land Co	18-00015-0006-00002
		Unknown	18-00015-0006-00003
7211	Ocean Blvd	Harry A & Joan K Widmeier	18-00015-0006-00005
7219	Ocean Blvd	Jerry L & Anna May Case	18-00015-0006-00006
7303	Ocean Blvd	Edward C Evans	18-00015-0006-00007
7207	Ocean Blvd	John & Sharon Pushko	18-00015-0006-00008
7213	Ocean Blvd	James D & Edda M Palmer	18-00015-0006-00009
106	E Coghlan Ave	Rebl Llc	18-00015-0006-00010
7115	Ocean Blvd	Douglas R & Gina T Zegel	18-00015-0010-00001
7101	Ocean Blvd	Robt R & Barbara Bachman	18-00015-0010-00002
7011	Ocean Blvd	Patrick & Joanna Filosa	18-00015-0013-00001
7003	Ocean Blvd	Harry F & Esther E Pearson	18-00015-0013-00002
6911	Ocean Blvd	Dennis N & Linda D Longstreet	18-00015-0015-00001
6903	Ocean Blvd	Daub L & Carolyn Anderson	18-00015-0015-00002
	Ocean Blvd	Township Of Long Beach	18-00015-0018-00001
6607	Ocean Blvd	John F & J A Derham	18-00015-0024-00001-0001
6605	Ocean Blvd	Joseph & Mary Malvasio	18-00015-0024-00001-0002
6601	Ocean Blvd	Virginia Estabrook	18-00015-0024-00002

	Address	Property Owner	Assessor Parcel Number
	E South 31st St	John Kuiper Inc	18-00006-0029-00006
		Unknown	18-00006-0029-00007
		Unknown	18-00006-0029-00008
	E South 32nd St	Township Of Long Beach	18-00006-0035-00004
206	E 33rd St E	John & Karin Belisle	18-00006-0035-00007
	E 33rd St E	Unknown	18-00006-0035-00008
		Unknown	18-00006-0035-00014
		Unknown	18-00006-0043-00003
210	E 34th St E	George P & Anita Cain Jr	18-00006-0043-00004-0001
208	E 34th St E	Anthony C & Joanne Quartell	18-00006-0043-00005-0001
202	E Marine Ln	Township Of Long Beach	18-00008-0009-00004
202	E Ryerson Ln	Township Of Long Beach	18-00008-0013-00004
		Unknown	18-00008-0016-00003
	E Ramapo Ln	Township Of Long Beach	18-00008-0020-00004
12213	Ocean Ave	Michael R & Barbara Loreti	18-00008-0023-00001
	E Holly Banks Ln	Township Of Long Beach	18-00008-0023-00002
		Township Of Long Beach	18-00008-0023-00003
12201	Ocean Ave	Richard J & C M Ruban	18-00008-0023-00004
		Unknown	18-00008-0023-00005
12211	Ocean Ave	Harvey & Josephine Schlage	18-00008-0023-00006
12103	Ocean Ave	Vivian M Steinberg	18-00008-0026-00001
	E Holly Banks Ln	Township Of Long Beach	18-00008-0026-00002
		Unknown	18-00008-0026-00003
135	E Mac Evoy Ln	Philip & Mgt Damato	18-00010-0004-00007
	E Mac Evoy Ln	Township Of Long Beach	18-00010-0004-00009
112	E Weldon Pl	Lorraine Gahles-kildow	18-00010-0004-00010-0006
114	E Weldon Pl	Robert & Roberta Meyers	18-00010-0004-00010-0007
111	E Nevada Ave	Atlantic City Electric Co	18-00010-0011-00005
124	E Colorado Ave	Marie Allen Hand	18-00010-0011-00007
123	E Colorado Ave	Jj & Aw Oros	18-00010-0015-00006
122	E Wyoming Ave	Betty L Brown	18-00010-0015-00008
123	E Wyoming Ave	P L & Lawrence D'onofrio	18-00010-0018-00005
	E Mississippi Ave	Wm B & K A Thompson Jr	18-00010-0018-00007
123	E Mississippi Ave	William F Crawford	18-00010-0022-00004
122	E Idaho Ave	Bruce E & Joan A Hagen	18-00010-0022-00005
123	E Idaho Ave	John F & Bonnie C Zanger	18-00010-0026-00005
126	Tennessee Ave	Richard J & Linda J Sclarow	18-00010-0026-00008
123	Tennessee Ave	Vincent B & Joan M Pica	18-00010-0028-00006
124	E Kentucky Ave	Jeannette Alach	18-00010-0028-00008
127	E Kentucky Ave	King&swoyer Realty Inc	18-00010-0031-00007
124	E South Carolina Ave	Lawrence R & Laura Inserra Jr	18-00010-0031-00008
123	E South Carolina Ave	Carmine & P A Ferragamo	18-00010-0035-00006
119	E South Carolina Ave	Rene Desfor	18-00010-0035-00007
126	E North Carolina Ave	Jill Richards	18-00010-0035-00008
125	E North Carolina Ave	Lawrence Lippincott Mears	18-00010-0038-00005-0001
118	E Virginia Ave	Robert J & Denise Davieau	18-00010-0038-00007-0001
116	E Virginia Ave	Dean P & Eileen G Thomas	18-00010-0038-00007-0002
121	E Virginia Ave	Francis A Bishop	18-00010-0042-00007
106	Rose Ct	Anthony R & Patricia Mack	18-00010-0045-00001-0003
108	Rose Ct	Joseph P Mack	18-00010-0045-00001-0004
107	Rose Ct	Joseph P Mack	18-00010-0045-00001-0005
105	Rose Ct	Wm N & P I Macfarlane	18-00010-0045-00001-0006
120	Nebraska Ave	James E & Lois M Pinkin	18-00011-0003-00003
125	Nebraska Ave	Nina Messer	18-00011-0006-00007
		Unknown	18-00011-0006-00009
124	E Louisiana Ave	Chas E Friedmann	18-00011-0006-00010
125	E Louisiana Ave	Aralene B J Doan	18-00011-0009-00006
127	E Louisiana Ave	Patricia E Pendergast	18-00011-0009-00007
124	E Kansas Ave	William & Janet Housenick	18-00011-0009-00008
123	E Kansas Ave	Michael & Anne V Ambrosio	18-00011-0012-00006
		Unknown	18-00011-0012-00008
	E Lillie Ave	Twp Of Long Beach	18-00011-0012-00009

	E Lillie Ave	Township Of Long Beach	18-00011-0012-00010
	E Lillie Ave	Township Of Long Beach	18-00011-0014-00008
	E Lillie Ave	Herbert L Shapiro	18-00011-0014-00009
	Oceanfront	Geo J & Barbara A Kelly	18-00011-0014-00010
128	E Texas Ave	L B I Partners	18-00011-0014-00011
	Beachfront	Township Of Long Beach	18-00025-0032-00001

R-11

	Address	Property Owner	Assessor Parcel Number
1	3rd St	Joseph V & Olga Caponegro	04-00177-0000-00012-0001
8	5th St	Theodore R Schoenberg	04-00178-0000-00007
		Unknown	04-00178-0000-00008
		Unknown	04-00178-0000-00009
10	6th St	John A & Christine P Kline	04-00179-0000-00009
		Unknown	04-00179-0000-00010
	5th St	Borough Of Beach Haven	04-00179-0000-00011
		Unknown	04-00179-0000-00012
2	7th St	Diane Sullivan	04-00180-0000-00008
5	6th St	William R & J M Cunningham	04-00180-0000-00010
7	6th St	Joseph T & Mariela V Mc Carrie	04-00180-0000-00011
		Unknown	04-00181-0000-00001
		Unknown	04-00182-0000-00001
		Unknown	04-00183-0000-00001
		Unknown	04-00184-0000-00001
		Unknown	04-00195-0000-00010
		Unknown	04-00195-0000-00011
		Unknown	04-00195-0000-00012
2	Taylor Ave	James & June Thompson	04-00196-0000-00008-0001
4	Taylor Ave	Laura J Weber	04-00196-0000-00008-0002
1	8th St	Joseph F & Eileen Lane Jr	04-00196-0000-00009
2	9th St	Mortimer & Marcia Nelson	04-00197-0000-00007
1	Taylor Ave	Michael D Zisman	04-00197-0000-00008
		Unknown	04-00198-0000-00001
		Unknown	04-00199-0000-00001
		Unknown	04-00200-0000-00001
2	10th St	Cosimo J & Maria J Colandrea	04-00214-0000-00008
4	10th St	Cosimo J & Maria Colandrea	04-00214-0000-00009
5	9th St	Patricia M Riker	04-00214-0000-00010
2	11th St	James V & Carol B Bastek	04-00215-0000-00005-0002
1	10th St	Shirlee No Gross	04-00215-0000-00006-0001
6	12th St	John J & Eileen P Flynn	04-00216-0000-00007
3	11th St	John & Dolores Borakos	04-00216-0000-00008
5	11th St	Marietta K Hill	04-00216-0000-00009
3	12th St	Patty Jo Beyer	04-00217-0000-00005
1	12th St	Emil Beyer	04-00217-0000-00006
		Unknown	04-00218-0000-00001
		Unknown	04-00218-0000-00001
212	E 13th St	Elaine B Hansen	18-00004-0004-00003-0002
214	E 13th St	Bernard & Rosaline Peach	18-00004-0004-00003-0003
213	E 13th St	Richard & Annette Kaplan	18-00004-0009-00005
214	E 14th St	Thomas A & M S Ehrhart	18-00004-0009-00007
215	E 14th St	M J & J E Gouveia	18-00004-0015-00005
224	E 15th St	Thomas E Calkins	18-00004-0015-00006-0001
228	E 15th St	Desiree & Forrar Louise Branca	18-00004-0015-00006-0002
		Unknown	18-00004-0021-00007
	E 16th St	Township Of Long Beach	18-00004-0021-00008
		Unknown	18-00004-0021-00009
213	E 16th St	Murray & Mary Sobel	18-00004-0026-00004
215	E 16th St	Louis & E A Maier	18-00004-0026-00005
218	E 17th St	Michael D & Stace Chillemi Jr	18-00004-0026-00006
216	E 17th St	Mary T Holland	18-00004-0026-00007
213	E 17th St	P Fowler	18-00004-0032-00005
211	E 17th St	Bacon Family Partners	18-00004-0032-00007
216	E 18th St	Bacon Family Partners	18-00004-0032-00008
208	E 18th St	Eleftnerios Karnavas	18-00004-0032-00009
209	E 18th St	Audry S Weintrob	18-00004-0038-00005
207	E 18th St	Mary Ann Lenehan	18-00004-0038-00006
		Unknown	18-00004-0038-00007
214	E 19th St	John A & P B Woolley	18-00004-0038-00008
		Unknown	18-00004-0038-00009
209	E 19th St	George W & Janice O'connell	18-00004-0044-00001

208	E 20th St	David H & Constance K Weaver	18-00004-0044-00002
	E 20th St	Edith Cole	18-00004-0044-00003
205	E 19th St	David Dickstein	18-00004-0044-00010
	14th St	Township Of Long Beach	18-00004-0049-00005
	E 21st St	Township Of Long Beach	18-00004-0049-00006
	E 21st St	Township Of Long Beach	18-00004-0049-00007
208	E 21st St	Rebecca S Jezierski	18-00004-0049-00008
	E 14th St	Township Of Long Beach	18-00004-0049-00013
	E 14th St	Township Of Long Beach	18-00004-0049-00014
210	E 27th St	June K Hudson	18-00006-0005-00004
		Unknown	18-00006-0005-00007
207	E 27th St	M L & Cook A S Anton	18-00006-0008-00002
2705	N Atlantic Ave	Ac & Se Cook Iii	18-00006-0008-00004
		Unknown	18-00006-0008-00007
210	E 28th St	Robert & Susan Spass	18-00006-0008-00008
		Unknown	18-00006-0013-00004
		Unknown	18-00006-0013-00006
214	E 29th St	Rheta Santangelo	18-00006-0013-00007-0001
212	E 29th St	Carl M Valenti	18-00006-0013-00007-0002
209	E 29th St	Donald C & Patricia M Kouba	18-00006-0018-00002
2909	N Atlantic Ave	Herbert V Young	18-00006-0018-00005
207	E 30th St	Jc Chidester Jh David Fioravanti Iv	18-00006-0024-00002
		Unknown	18-00006-0024-00008
		Unknown	18-00006-0024-00013
	Beachfront	Township Of Long Beach	18-00025-0034-00001

	Address	Property Owner	Assessor Parcel Number
		Unknown	04-00018-0000-0002
		Unknown	04-00018-0000-0003
		Unknown	04-00018-0000-0004
	Bay Ave	Borough Of Beach Haven	04-00018-0000-00021
221	Nelson Ave	Gerald E & Cynthia Fastman	04-00019-0000-00011-0001
219	Nelson Ave	Thomas B & Fabiola Cherubini	04-00019-0000-00012-0001
		Unknown	04-00020-0000-00010-0001
		Unknown	04-00020-0000-00010-0002
		Unknown	04-00020-0000-00011-0001
		Unknown	04-00020-0000-00011-0002
		Unknown	04-00020-0000-00012-0001
		Unknown	04-00020-0000-00012-0002
		Unknown	04-00020-0000-00013
	Merivale Ave	Borough Of Beach Haven	04-00020-0000-00014
		Unknown	04-00021-0000-0008-0001
200	Jefferies Ave	Edward Suski Jr	04-00042-0000-00010
	Kentford Ave	Borough Of Beach Haven	04-00042-0000-00013
		Unknown	04-00046-0000-00001
		Unknown	04-00047-0000-00001
100	Liberty Ave	John & Sharon Pushko	04-00064-0000-00001
1701	S Beach Ave	Vincent P & Suzanne L Maltese	04-00064-0000-00001-0001
133	Pelham Ave	Ruth J Palmer	04-00064-0000-00001-0002
	Beachfront	Borough Of Beach Haven	04-00064-0000-00002
		Unknown	04-00064-0000-00003
		Unknown	04-00065-0000-00007
		Unknown	04-00065-0000-00008
114	Holyoke Ave	Westlock Controls Corp	04-00066-0000-00007
		Unknown	04-00066-0000-00008
		Unknown	04-00066-0000-00009
		Unknown	04-00066-0000-00010
		Unknown	04-00066-0000-00011
100	Glendola Ave	Robert A & Theresa C Grosso	04-00067-0000-00008
	Atlantic Ave	E J & H D Lyons	04-00067-0000-00009
	Atlantic Ave	Borough Of Beach Haven	04-00067-0000-00010
101	Glendola Ave	Howard & Jacqueline Guttman	04-00084-0000-00007
		Unknown	04-00089-0000-00001
		Unknown	04-00089-0000-00002
	Essex Ave	Robert E Ward	04-00090-0000-00001
	Atlantic Ave	Robert E Ward	04-00090-0000-00002
	Atlantic Ave	Borough Of Beach Haven	04-00090-0000-00003
		Unknown	04-00091-0000-00004
1009	S Atlantic Ave	Robert Sullivan	04-00091-0000-00001-0001
1015	S Atlantic Ave	James & Anne Crouse	04-00091-0000-00001-0002
1001	S Atlantic Ave	Beth Hallam	04-00091-0000-00003
	Atlantic Ave	Unknown	04-00091-0000-00004
		Unknown	04-00091-0000-00006
		Unknown	04-00091-0000-00007
917	S Atlantic Ave	Anthony & Barbara Reale	04-00107-0000-00001-0002
		Unknown	04-00107-0000-00004
		Unknown	04-00107-0000-00005
		Unknown	04-00107-0000-00006
		Unknown	04-00107-0000-00008
		Unknown	04-00108-0000-00005
		Unknown	04-00108-0000-00006
		Unknown	04-00108-0000-00007
1	Belvoir Ave	Albert R Zelin	04-00108-0000-00008
		Unknown	04-00108-0000-00009
2	Berkeley Ave	Robert J & Theresa A Getzewich	04-00109-0000-00005
1	Berkeley Ave	Sally J Haley	04-00110-0000-00001-0003
3	Berkeley Ave	James D & Susan M Lynch	04-00110-0000-00001-0004
2	Ocean St	John P & Joyce O'brien	04-00110-0000-00003
		Unknown	04-00110-0000-00004

		Unknown	04-00123-0000-00007
	5th St Centre St	Borough Of Beach Haven	04-00124-0000-00001-0001
	Marine St	Paris F & Maxine Donald	04-00124-0000-00002-0001
9	Pearl St 1	Philip & Margaret Damato	04-00125-0000-00002-0000-C-01.A
	Beach	Condo Asso Oceanus	04-00125-0000-00004
		Unknown	04-00125-0000-00004-0001
		Unknown	04-00125-0000-00005-0001
7	Pearl St	Jean Pinotti	04-00125-0000-00005
21	Coral St	Jamarmeg Realty Llc	04-00138-0000-00001
20	Amber St E1	Richard W & Eva A Pfuhler	04-00138-0000-00002-0001
30	Engleside Ave	Motel Engleside	04-00139-0000-00001
15	S Atlantic Ave	Club & Hughes Seashell	04-00159-0000-00001
		Unknown	04-00159-0000-00002
	Centre St	Julius & Clara A Robinson	04-00160-0000-00003-0000-C-00A1
2	3rd St	Nicholas J & Margaret Cerbo	04-00161-0000-00011
4	3rd St	Anne M Martinelli	04-00161-0000-00012
5	2nd St	Haven Borough Beach	04-00161-0000-00013
1	2nd St	Victor & Helen Fadini	04-00161-0000-00014

R-13

	Address	Property Owner	Assessor Parcel Number
6805	Long Beach Blvd	Township Of Long Beach	18-00001-0005-00001
	E Cleveland Ave	Township Of Long Beach	18-00001-0008-00001
5403	S Bay Ave	Stephen Tucker	18-00001-0011-00001-0001
5405	S Bay Ave	Peter & Carmela Frasca	18-00001-0011-00001-0002
	E Mckinley Ave	Township Of Long Beach	18-00001-0011-00002
	W Washington Ave	Township Of Long Beach	18-00001-0011-00003
	E Washington Ave	Township Of Long Beach	18-00001-0014-00003
		Unknown	18-00001-0014-00004
		Unknown	18-00001-0014-00005
		Unknown	18-00001-0014-00009
3	Harding Ave	Pasquale Storino	18-00001-0017-00002
5	Harding Ave	Township Of Long Beach	18-00001-0017-00003
		Unknown	18-00001-0017-00004
		Unknown	18-00001-0017-00005
	W Roosevelt Ave	Township Of Long Beach	18-00001-0017-00006
	W Roosevelt Ave	Laura H Campbell	18-00001-0017-00007
	W Roosevelt Ave	R A Wright	18-00001-0020-00002
	E Roosevelt Ave	Township Of Long Beach	18-00001-0020-00003
	E Roosevelt Ave	Township Of Long Beach	18-00001-0020-00004
	E Roosevelt Ave	Township Of Long Beach	18-00001-0020-00005
		Unknown	18-00001-0020-00006
		Unknown	18-00001-0020-00007
	E Pershing Ave	Township Of Long Beach	18-00001-0020-00008
	E Pershing Ave	Julia H Osborn	18-00001-0023-00003
	E Pershing Ave	Township Of Long Beach	18-00001-0023-00004
		Unknown	18-00001-0023-00005
4903	S Bay Ave	Emil & June Stevens	18-00001-0025-00001
4905	S Bay Ave	Peter & Rhoda Kunzler	18-00001-0025-00002
4907	S Bay Ave	Donna Posa	18-00001-0025-00003
4909	S Bay Ave	Robt L & J R Delaney	18-00001-0025-00004
4911	S Bay Ave	Alan S & Mary Meszaros	18-00001-0025-00005
4913	S Bay Ave	William P & Judith Deni	18-00001-0025-00006
5001	S Bay Ave	Lotz Family Limited Partnership	18-00001-0025-00007
4901	S Bay Ave	Thos & Gloria Kirwan	18-00001-0029-00001
		Unknown	18-00001-0032-00002
	E Jacqueline Ave	Township Of Long Beach	18-00001-0032-00003
	E Jacqueline Ave	Twp Of Long Beach	18-00001-0032-00004
4801	S Bay Ave	R & C Libauer	18-00001-0032-00006
		Unknown	18-00001-0032-00007
4703	S Bay Ave	Gilbert A Wetzel	18-00001-0035-00001
4701	S Bay Ave	& Millicent	18-00001-0035-00002
	E Carolina Ave	Township Of Long Beach	18-00001-0035-00003
	E Carolina Ave	Township Of Long Beach	18-00001-0035-00004
4603	S Bay Ave	Mae C Andre	18-00001-0036-00001
4601	S Bay Ave A	Shirley R & P Groshardt	18-00001-0036-00002-0000-C-0001
4505	S Bay Ave	Wm Heaviside	18-00001-0037-00001
4501	S Bay Ave	Gerald E & Sheila J Fields	18-00001-0039-00001
4407	S Bay Ave	Alvin A & Joan Margulies	18-00001-0039-00002
4405	S Bay Ave	Robt J & Marianne Vanvolkenburgh	18-00001-0039-00003
4403	S Bay Ave	Salvatore & Marie A Tuccelli	18-00001-0039-00004
4401	S Bay Ave	Gary & Jayne Clemente	18-00001-0039-00005
4301	S Long Beach Blvd	Robert & Claire A Neuner	18-00001-0045-00001
4303	S Long Beach Blvd	John C Giacopelli Lbi Trust	18-00001-0045-00002
4305	S Long Beach Blvd	Thos Caprio	18-00001-0045-00003
4307	S Long Beach Blvd	William J & Susan M Feil	18-00001-0045-00004
4311	S Long Beach Blvd	David & Dianne Elderkin	18-00001-0045-00005
4209	S Long Beach Blvd	Anthony T & Muriel L Piperata	18-00001-0047-00001
4205	S Long Beach Blvd	Jyoti P & Rajkumari Keswani	18-00001-0047-00001-0001-C-0001
4201	S Long Beach Blvd	Mark L Shapiro	18-00001-0047-00001-0002-C-0001
4101	S Long Beach Blvd	Robert E & Ann L Madden	18-00001-0049-00001
4103	S Long Beach Blvd	Thomas M & Corinne K Marsich	18-00001-0049-00002
4005	S Long Beach Blvd	Patrick & Leora Cozza	18-00001-0049-00003

4003	S Long Beach Blvd	Kushner Charlotte	18-00001-0049-00004
4001	S Long Beach Blvd	Elsa M Bender	18-00001-0049-00005
3903	S Long Beach Blvd	Kontos Evris & Evangelia	18-00001-0054-00001
3901	S Long Beach Blvd	J Shapiro	18-00001-0054-00002
3805	S Long Beach Blvd	J Shapiro	18-00001-0054-00003
3803	S Long Beach Blvd	Gary R Brickner	18-00001-0054-00004
3801	S Long Beach Blvd	James A Dicso	18-00001-0054-00005
3703	S Bay Ave	Priscilla M Teleky	18-00001-0056-00001
3707	S Bay Ave	Mark L & Diane M Shapiro	18-00001-0056-00002
3701	S Bay Ave	Sandra Rizzo	18-00001-0056-00003
3705	S Bay Ave	Mark L Shapiro	18-00001-0056-00004
	E Rosemma Ave	Shapiro Ripps Assoc	18-00001-0062-00002
3505	S Bay Ave	Nancy Joan Wyatt	18-00001-0065-00001
3501	S Bay Ave	Stanley M & Stass Krebushevski	18-00001-0065-00002
3405	S Bay Ave	Alan G & Darlene G Wheeler	18-00001-0067-00001
3401	S Bay Ave	Peter & Carmela Frasca	18-00001-0067-00002
3305	S Bay Ave	Jo Ann Graye	18-00001-0069-00001
3301	S Bay Ave	Neil & Lisa A Doherty	18-00001-0069-00002
3205	S Bay Ave	Edmond Thos R C Helen	18-00001-0072-00001
	Beck Ave	Thos R & H C H Edmond	18-00001-0072-00002
		Unknown	18-00001-0072-00003
	Webster Ave	Wm H Jones	18-00001-0072-00004
	E Osborn Ave	Township Of Long Beach	18-00001-0072-00005
	Webster Ave	Andrew Sabo	18-00001-0072-00006
3203	S Bay Ave	Vecchio Lori T Lo	18-00001-0072-00007
		Unknown	18-00001-0072-00008
3105	S Bay Ave	Harold L & Adelaide E Willis	18-00001-0075-00001
	W Webster Ave	Willis W Moore	18-00001-0075-00002
	W Webster Ave	Elizabeth Moore Wentz	18-00001-0075-00003
	E Webster Ave	Township Of Long Beach	18-00001-0075-00004
3101	S Bay Ave 1	O & E Wysocki J Kotsopey	18-00001-0078-00001-0000-C-0001
		Unknown	18-00001-0078-00002
3003	S Bay Ave	James F & Nancy Gleber	18-00001-0078-00003
3001	S Bay Ave	Peter & Tulla Milone	18-00001-0078-00004
2905	S Bay Ave	Mark A & Sandra Rosenbloom	18-00001-0078-00005
2903	S Bay Ave	Morton G & Vivian Kramer	18-00001-0078-00006
2901	S Bay Ave	Martin & Kathleen Knutson	18-00001-0078-00007
2805	S Bay Ave	Peter & Carmela Frasca	18-00001-0078-00008
2803	S Bay Ave	Kevin T & Mindy A Martin	18-00001-0078-00009
2801	S Long Beach Blvd C1	Peter & Angela Lisciotto	18-00001-0083-00001-0000-C-0001
	E Marshall Ave	Township Of Long Beach	18-00001-0083-00002
	E Marshall Ave	Township Of Long Beach	18-00001-0083-00005
2711	S Bay Ave	Robert Wink	18-00001-0087-00001
	E Marshall Ave	Alexander Leonard & Stella Bundz	18-00001-0087-00002
	E Marshall Ave	Ida London	18-00001-0087-00003
	E Marshall Ave	Township Of Long Beach	18-00001-0087-00004
	E Osborn Ave	Township Of Long Beach	18-00001-0087-00005
	E Osborn Ave	Township Of Long Beach	18-00001-0087-00006
	E Osborn Ave	Township Of Long Beach	18-00001-0087-00007
	E Osborn Ave	Nicholas & Donna Kuiken	18-00001-0087-00008
2605	S Bay Ave	Joseph Altier	18-00001-0090-00001
2503	S Bay Ave	Priscilla M Teleky	18-00001-0090-00002
2501	S Bay Ave	Helene A Kuiken	18-00001-0090-00003
2603	S Bay Ave	Robert & Ann L Madden	18-00001-0090-00004
2601	S Bay Ave	Lori Ann Personnel Wisneski	18-00001-0090-00005

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXHIBIT B

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Feasibility Study Cost Estimate-MCACES Format
Real Estate Acquisition Requirements
Barnegat Inlet to Little Egg Inlet
New Jersey Shore Protection

		Private			Commercial			Public			Requirement		
		#	$ each	req	#	$ each	req	#	$ each	req	Base	Contingency	Total
0102-------	ACQUISITIONS												
010201---	By Government												
010202---	By Non-Federal Sponsor (NFS)												
01020201	Recordation of Building Line Lim	6	500	3,000	5	0	0	116	0	0	3,000	450	3,450
01020102	Verification of Ownerships	845		10,000	5	0	0	116	0	0	10,000	1,500	11,500
01020203	Negotiations	825	300	247,500	5	600	3,000	6	300	1,800	252,300	37,845	290,145
010203---	By Government on Behalf of NFS												
010204---	Review of NFS												
01020401	Permanent Easement	job									2,000	300	2,300
01020402	Verification of Ownerships	job									2,000	300	2,300
01020403	Negotiations	825	38	31,350	5	38	190	6		0	31,540	4,731	36,271
	SUBTOTAL										300,840	45,126	345,966
0103-------	CONDEMNATIONS												
010301---	By Government												
010302---	By Non-Federal Sponsor (NFS)	80	3,000	240,000							240,000	36,000	276,000
010303---	By Government on Behalf of NFS												
010304---	Review of NFS	80	100	8,000							8,000	1,200	9,200
	SUBTOTAL										248,000	37,200	285,200
0105-------	APPRAISALS												
010501---	By Government												
010502---	By Non-Federal Sponsor (NFS)	job									25,000	3,750	28,750
010503---	By Government on Behalf of NFS												
010504---	Review of NFS	job									1,000	150	1,150
	SUBTOTAL										26,000	3,900	29,900
0106-------	PL 91-646 ASSISTANCE												
010601---	By Government												
010602---	By Non-Federal Sponsor (NFS)										0	0	0
010603---	By Government on Behalf of NFS												
010604---	Review of NFS										0	0	0
	SUBTOTAL										0	0	0
0107-------	TEMPORARY PERMITS/LICENSES/RIGHTS-OF-WAY												
010701---	By Government												
010702---	By Non-Federal Sponsor (NFS)	6	500	3,000							3,000	450	3,450
010703---	By Government on Behalf of NFS			0									
010704---	Review of NFS	job	500	500							500	75	575
010705---	Other												
010706---	Damage Claims												
	SUBTOTAL										3,500	525	4,025
0115-------	**REAL ESTATE PAYMENTS**												
011501---	Land Payments												
01150101	By Government										0	0	0
01150102	By Non-Federal Sponsor (NFS)										0	0	0
01150103	By Government on Behalf of NFS										0	0	0
01150104	Review of NFS										0	0	0
011502---	PL 91-646 Assistance Payments										0	0	0
01150201	By Government										0	0	0
01150202	By Non-Federal Sponsor (NFS)										0	0	0
01150203	By Government on Behalf of NFS										0	0	0
01150204	Review of NFS										0	0	0
011503---	Damage Payments										0	0	0
01150301	By Government										0	0	0
01150302	By Non-Federal Sponsor (NFS)										0	0	0
01150303	By Government on Behalf of NFS										0	0	0
01150304	Review of NFS										0	0	0
	SUBTOTAL										0	0	0
Account 02 Facility/Utility Relocations (Construction cost only)												0	0
	REAL ESTATE ACQUISITION TOTAL										**$578,340**	**$86,751**	**$665,091**

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXHIBIT C

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
BARNEGAT INLET TO LITTLE EGG INLET
OCEAN COUNTY, NEW JERSEY

1. Legal Authority

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?

Yes. The non-Federal sponsor (NFS), the New Jersey Department of Environmental Protection (NJDEP) has acquisition authority in the project area.

b. Does the sponsor have the power of eminent domain for this project?

Yes. The NFS has the power of eminent domain for this project.

c. Does the sponsor have "quick-take" authority for this project?

Yes. The NFS has "quick-take" authority for this project.

d. Are there any lands/interests in land required for the project located outside the sponsor's political boundary?

No.

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn?

N/A

2. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including P.L. 91-646, as amended?

No. The NFS is familiar with the requirements of P.L. 91-646.

b. If the answer to 2a is yes, has a reasonable plan been developed to provide such training?

N/A

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?

Yes.

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?

Yes. The NFS has indicated that assistance would be requested from the local municipalities to acquire the necessary real estate interests.

e. Can the sponsor obtain contractor support, if required, in a timely fashion?

Yes

f. Will the sponsor likely request USACE assistance in acquiring real estate?

No.

3. <u>Other Project Variables:</u>

a. Will the sponsor's staff be located within reasonable proximity to the project site?

Yes.

b. Has the sponsor approved the project/real estate schedule/milcstones?

Yes.

4. <u>Overall Assessment:</u>

a. Has the sponsor performed satisfactorily on other USACE projects?

Yes

b. With regard to this project, the sponsor is anticipated to be: highly capable/fully capable/moderately capable/marginally capable/insufficiently capable?

Fully capable.

5. Coordination

a. Has this assessment been coordinated with the sponsor?

Yes.

b. Does the sponsor concur with this assessment?

Yes.

Prepared by:

Mary Daly 2/10/99

Mary Daly
Realty Specialist

Reviewed and approved by:

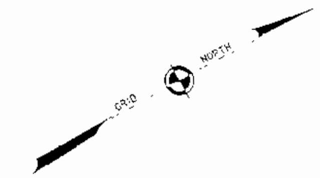
Susan K Lewis 2/11/99

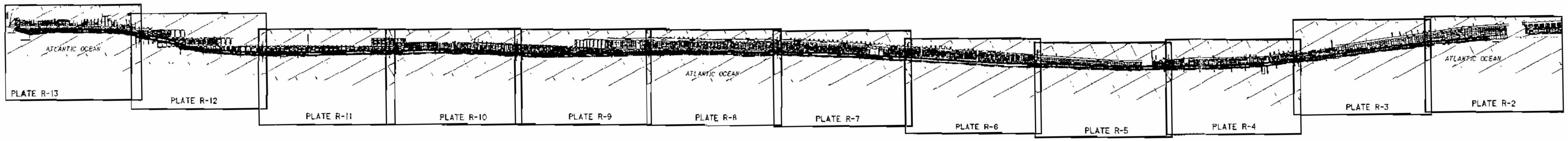
Susan K. Lewis
Chief, Civil Projects Support Branch
Real Estate Division

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

EXHIBIT D

BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT





LEGEND FOR PLATES

PROJECT LIMITS

CENTERLINE AND TOP OF BERM

SEAWARD TOE OF BERM

TAX MAP MEAN HIGH WATER LINE

MHW DESIGN MEAN HIGH WATER LINE

PARCEL LINE

STAGING AREA

(20) TRACT NUMBER

REAL ESTATE INTERESTS REQUIRED FOR PROJECT

PLATE NUMBER	APPROX. ACREAGE		REMARKS
	PERP. EASMNT.	WORK AREA ESMT.	
R-2	13.12		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-2		0.83	INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-3	27.42		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-3		1.75	INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-4	29.62		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-4		1.75	INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-5	29.93		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-5		1.74	INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-6	29.00		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-6		1.73	INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-7	28.09		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-7		1.71	INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-8	29.64		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-8		1.74	INCLUDES 0.03 OF AN ACRE FOR 3 STAGING AREAS
R-9	23.83		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-9		1.75	INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-10	28.74		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-10		1.73	INCLUDES 0.03 OF AN ACRE FOR 3 STAGING AREAS
R-11	28.39		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-11		.67	INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-12	30.02		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-12		1.72	INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-13	26.70		PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-13		1.60	INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
TOTALS	330.00	19.72	

NOTES:

THESE PLATES ARE FOR PLANNING PURPOSES ONLY.

THESE PLATES ARE BASED ON INFORMATION PROVIDED BY THE PHILADELPHIA DISTRICT U.S. ARMY CORPS OF ENGINEERS FOR BASE MAPPING AND PROJECT DESIGN AS OF 28 OCT 1998.

TAX MAP INFORMATION IS DERIVED FROM DIGITALLY REPRODUCED (SCANNED) TAX MAPS AS PROVIDED BY THE PHILADELPHIA DISTRICT U.S. ARMY CORPS OF ENGINEERS.

THE TRUE POSITION OF ALL PARCEL LINES CAN ONLY BE DETERMINED BY AN ACCURATE LAND SURVEY PERFORMED BY A NEW JERSEY REGISTERED LAND SURVEYOR.

BASE MAPPING PREDICATED ON THE NEW JERSEY STATE PLANE COORDINATE SYSTEM.

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: CHB
SUBMITTED BY:
CADASTRAL
RECOMMENDED BY:
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

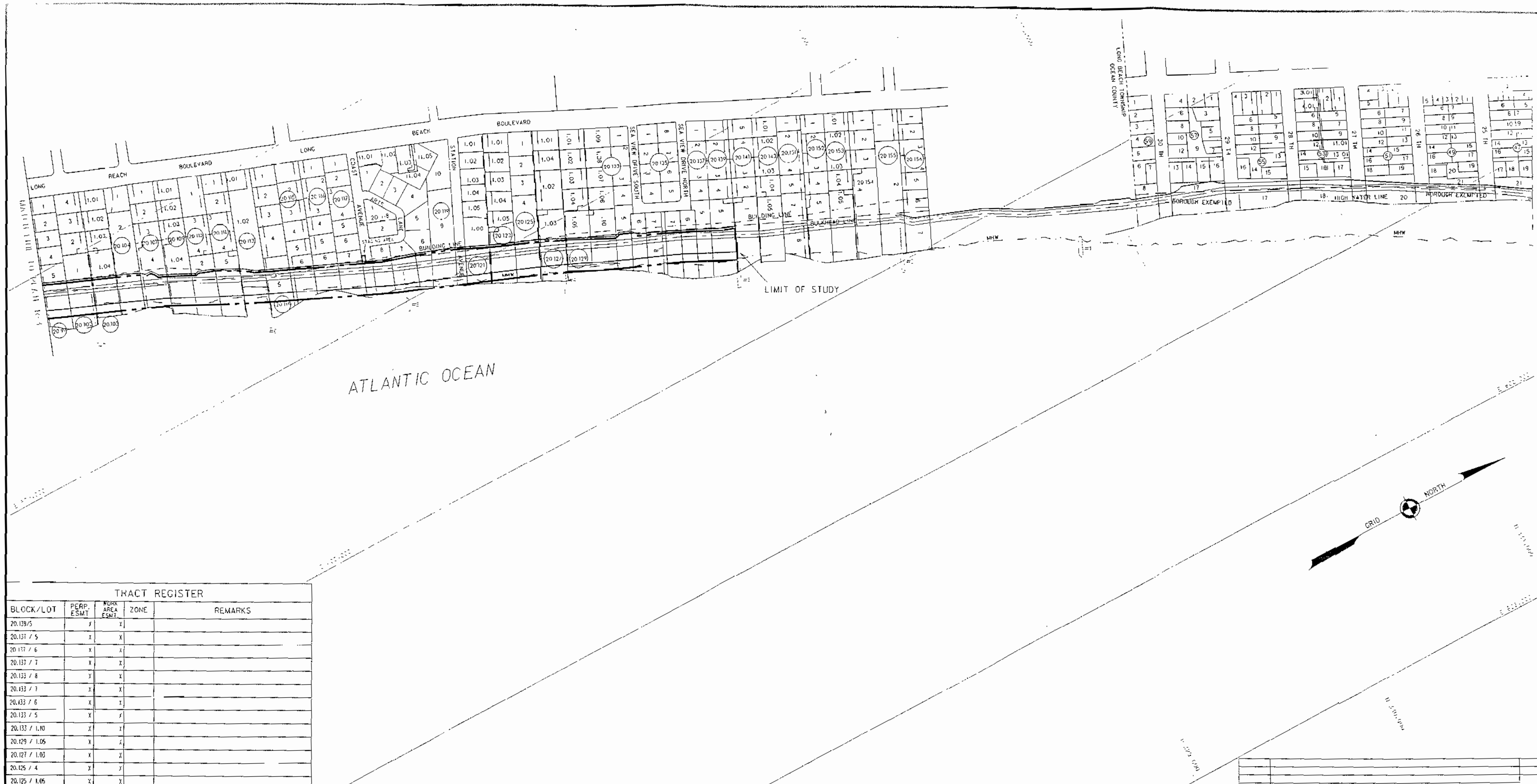
APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-1

SCALE IN FEET 2500 1250 0 2500 5000

SHEET 1 OF 13 DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.139/5	X	X		
20.137 / 5	X	X		
20.137 / 6	X	X		
20.137 / 7	X	X		
20.133 / 8	X	X		
20.133 / 7	X	X		
20.133 / 6	X	X		
20.133 / 5	X	X		
20.133 / 1.10	X	X		
20.129 / 1.05	X	X		
20.127 / 1.03	X	X		
20.125 / 4	X	X		
20.125 / 1.05	X	X		
20.119 / 9	X	X		
20.119 / 6	X	X		
20.119 / 7	X	X		
20.119 / 8	X	X		
20.117 / 7	X	X		
20.116 / 6	X	X		
20.115 / 5	X	X		
20.115 / 6	X	X		
20.114 / 5	X	X		
20.113 / 1.02	X	X		
20.111 / 5	X	X		
20.110 / 5	X	X		
20.109 / 1.04	X	X		
20.107 / 4	X	X		
20.104 / 2	X	X		
20.103 / 1.04	X	X		
20.102 / 1	X	X		
20.97 / 5	X	X		
20.121/1.06	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L. Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO
LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

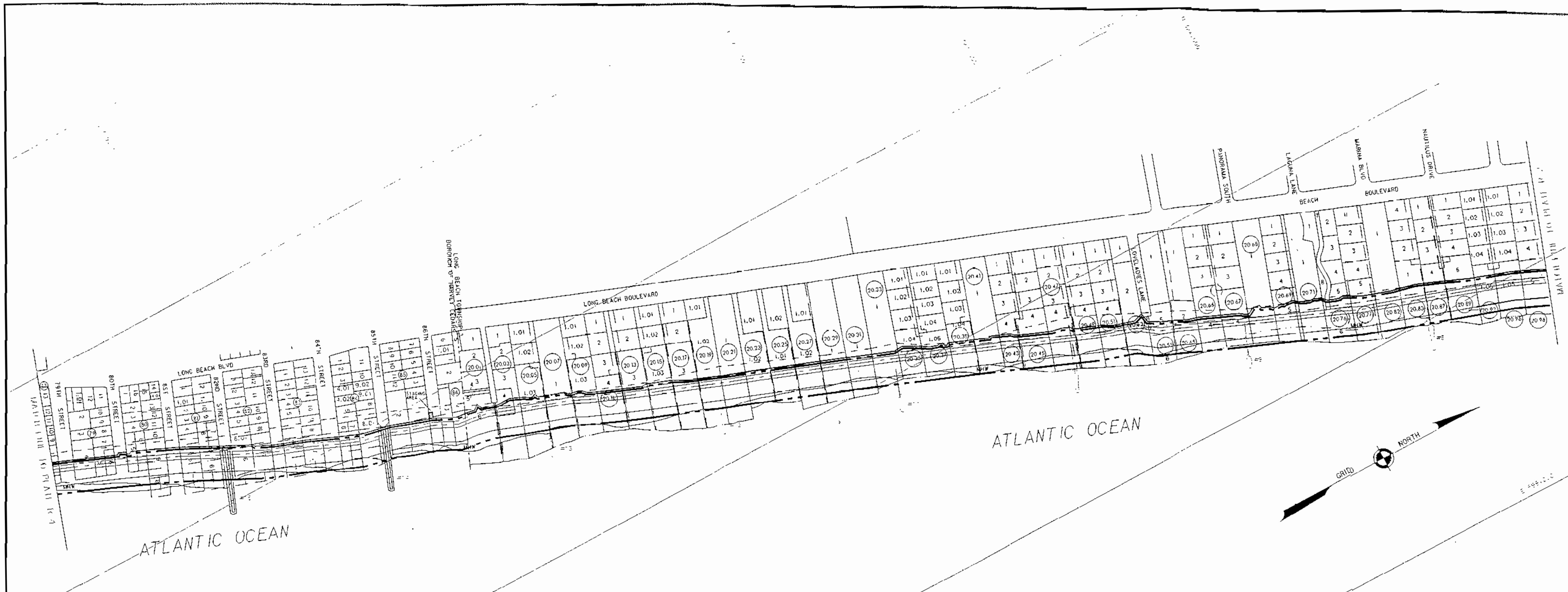
US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-2

SCALE IN FEET
200 100 0 200 400

SHEET 2 OF 13
DRAWING NO

FILE NAME: 2d.1802re.dgn



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.96 / 5	X	X		
20.95 / 1.05	X	X		
20.93 / 1.05	X	X		
20.89 / 5	X	X		
20.87 / 4	X	X		
20.83 / 1	X	X		
20.77 / 5	X	X		
20.76 / 6	X			
20.76 / 5	X	X		
20.76 / 7	X	X		
20.76 / 8	X	X		
20.71 / 1	X	X		
20.69 / 5	X	X		
20.68 / 1	X	X		
20.67 / 4	X	X		
20.66 / 4	X	X		
20.65 / 2	X	X		
20.55 / 5	X	X		
20.53 / 2	X	X		
20.51 / 4	X	X		
20.49 / 4	X	X		
20.47 / 4	X	X		
20.45 / 4	X	X		
20.43 / 4	X	X		
20.41 / 1	X	X		
20.39 / 1.04	X	X		
20.37 / 1.05	X	X		
20.35 / 1.04	X	X		
20.33 / 1	X	X		
20.31 / 1	X	X		
20.29 / 1	X	X		
20.27 / 1.02	X	X		
20.25 / 1.01	X	X		
20.23 / 1.02	X	X		
20.21 / 1	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.19 / 1.02	X	X		
20.17 / 3	X	X		
20.15 / 1.03	X	X		
20.13 / 3	X	X		
20.11 / 4	X	X		
20.09 / 1.03	X	X		
20.07 / 1	X	X		
20.05 / 1.03	X	X		
20.03 / 3	X	X		
20.02 / 4	X	X		
20.01 / 6	X	X		
86 / 4	X	X		
86 / 3	X	X		
85 / 1	X	X		
85 / 2	X	X		
84 / 8.01	X	X		
84 / 7	X	X		
84 / 6	X	X		
83 / 7	X	X		
83 / 6	X	X		
82 / 7	X	X		
82 / 6	X	X		
81 / 6	X	X		
81 / 5	X	X		
80 / 9	X	X		
80 / 8	X			
80 / 6	X	X		
80 / 5	X	X		
79 / 6	X	X		
79 / 5	X	X		
79 / 4	X	X		
57 / 8	X	X		
82/6.01		X		
20.82/1	X	X		
20.55/6	X			

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S.. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB

SUBMITTED BY: G H Barnes
CADASTRAL

RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314

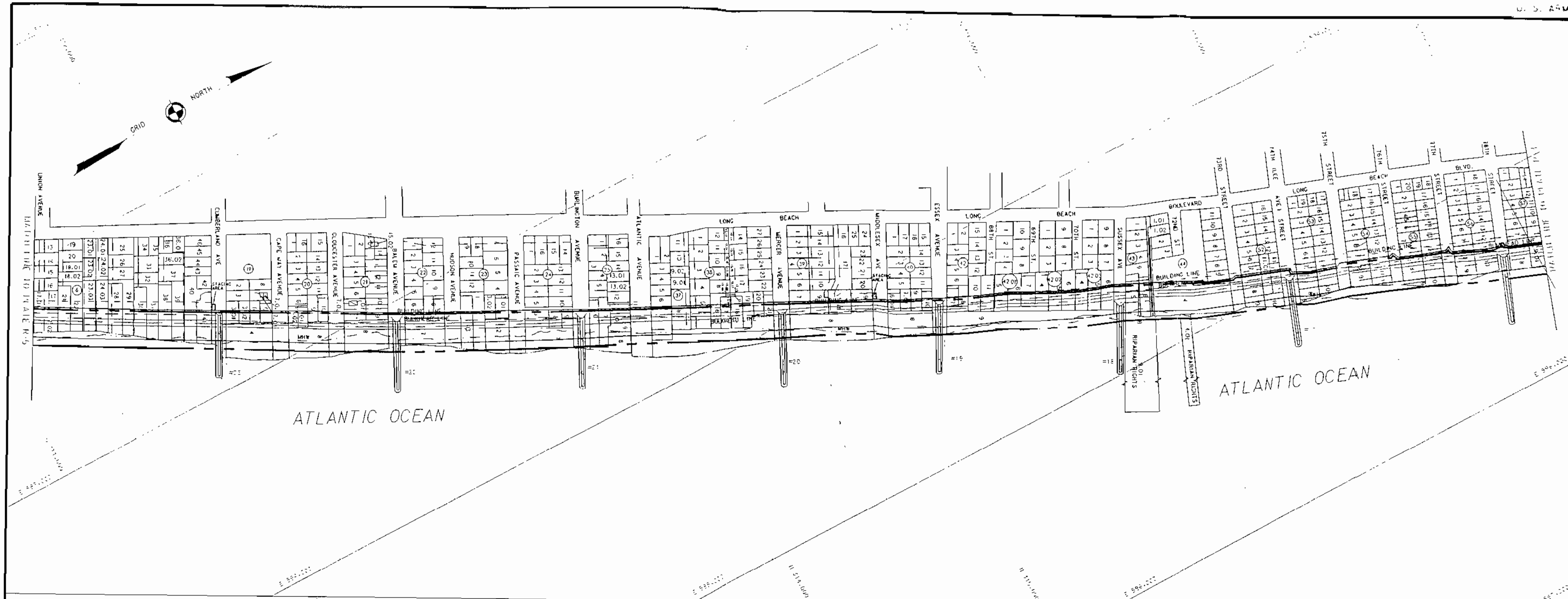
INSTALLATION OR PROJECT NO.

PLATE
R-3

SCALE IN FEET
200 100 0 200 400

SHEET 3 OF 13

DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS REMARKS
57 / 8	X	X		
57 / 9.01	X	X		
56 / 11	X	X		
56 / 10	X			
56 / 9	X			
56 / 8	X	X		
55 / 12	X	X		
55 / 11	X			
55 / 10	X			
55 / 9	X			
55 / 8	X	X		
54 / 11	X	X		
54 / 10	X			
54 / 9	X			
54 / 8	X	X		
53 / 11	X	X		
53 / 10	X			
53 / 9	X			
53 / 8	X			
53 / 7	X	X		
52 / 11	X	X		
52 / 11.01	X	X		
52 / 10	X			
52 / 9	X			
52 / 8	X			
52 / 7	X	X		
44 / 4	X	X		
44 / 4.01	X			
44 / 2	X	X		
44 / 1.02	X	X		
44 / 1.01	X	X		
43 / 6	X	X		
43 / 8	X	X		
43 / 9.01	X			
[illegible]	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
43 / 5	X	X		
42.03 / 6	X	X		
42.03 / 5	X	X		
42.03 / 4	X	X		
42.02 / 6	X	X		
42.02 / 5	X	X		
42.02 / 4	X	X		
42.01 / 7	X	X		
42.01 / 6	X	X		
42.01 / 5	X	X		
42 / 11	X	X		
42 / 10	X	X		
42 / 9	X			
42 / 8	X	X		
42 / 7	X	X		
40 / 10	X	X		
40 / 9	X	X		
40 / 8	X			
40 / 7.01	X	X		
40 / 6.01	X	X		
39 / 19	X	X		
39 / 18	X	X		
39 / 9	X	X		
39 / 8	X			
39 / 7	X	X		
38 / 21	X	X		
38 / 20	X	X		
38 / 19	X	X		
38 / 18	X	X		
38 / 7	X	X		
38 / 6	X	X		
38 / 5	X	X		
37 / 8	X	X		
37 / 7	X	X		
37 / 5		X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
25 / 11	X	X		
25 / 10	X			
25 / 9	X			
25 / 8	X			
25 / 7	X	X		
25 / 6	X	X		
24 / 9	X	X		
24 / 8	X	X		
24 / 7	X			
24 / 6	X	X		
23 / 3.01	X	X		
23 / 3.02	X	X		
23 / 1	X	X		
23 / 13	X	X		
22 / 8	X	X		
22 / 7	X			
22 / 6	X	X		
21 / 9	X	X		
21 / 8	X			
21 / 7	X	X		
44/5		X		
23/2	X			
20/8	X			
20/10	X	X		
20/9	X	X		
20/7.01	X	X		
20/7.02	X	X		
19/4	X			
19/5	X	X		
19/6	X	X		
19/3.02	X	X		
19/3.01	X	X		
6/41	X	X		
6/40	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
6/39	X	X		
6/38	X	X		
6/31	X	X		
6/30	X	X		
6/29	X	X		
6/28	X	X		
6/24.03	X	X		
6/23.03	X	X		
6/22	X	X		
6/21	X	X		
6/17	X	X		
6/17.01	X	X		
6/17.02	X			

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: CHB

SUBMITTED BY:
G H Barnes
CADASTRAL

RECOMMENDED BY:
Nancy L. Roberts
CHIEF, PNC BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314

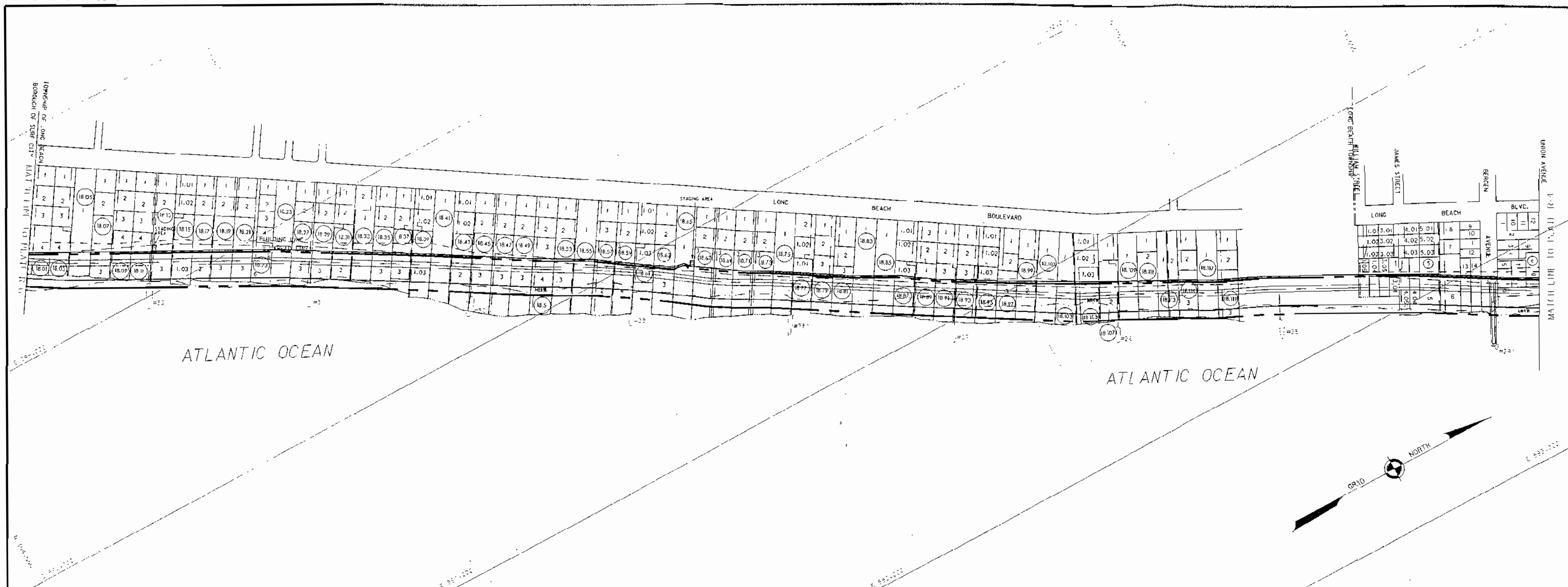
INSTALLATION OR PROJECT NO.

PLATE R-4

SCALE IN FEET
200 100 0 200 400

SHEET 4 OF 13

DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
6 / 8	X	X		
6 / 7	X	X		
6 / 6	X			
6 / 5	X	X		
5 / 14	X	X		
5 / 13	X	X		
5 / 6	X	X		
5 / 5	X	X		
5 / 4.04	X	X		
5 / 4.05	X	X		
5 / 3.04	X	X		
5 / 3.05	X	X		
5 / 1.04	X	X		
5 / 1.05	X	X		
18.119 / 3	X	X		
18.117 / 1	X	X		
18.115 / 3	X	X		
18.113 / 2	X	X		
18.113 / 1	X	X		
18.111 / 2	X	X		
18.109 / 1	X	X		
18.107 / 2	X	X		
18.105 / 1.03	X	X		
18.105 / 1.02	X	X		
18.103 / 1	X	X		
18.101 / 1	X	X		
18.99 / 2	X	X		
18.97 / 3	X	X		
18.95 / 1.03	X	X		
18.93 / 3	X	X		
18.91 / 3	X	X		
18.89 / 1	X	X		
18.87 / 1.03	X	X		
18.85 / 1	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
18.83 / 1	X	X		
18.81 / 3	X	X		
18.79 / 3	X	X		
18.77 / 1.01	X	X		
18.75 / 1	X	X		
18.73 / 3	X	X		
18.71 / 3	X	X		
18.69 / 3	X	X		
18.67 / 3	X	X		
18.65 / 1	X	X		
18.63 / 3	X	X		
18.61 / 1.02	X	X		
18.59 / 3	X	X		
18.59 / 4	X			
18.57 / 2	X	X		
18.55 / 1	X	X		
18.53 / 3	X	X		
18.51 / 4	X			
18.5[illegible] / 3	X	X		
18.49 / 3	X	X		
18.47 / 3	X	X		
18.45 / 3	X	X		
18.43 / 2	X	X		
18.41 / 1	X	X		
18.39 / 1.03	X	X		
18.37 / 3	X	X		
18.35 / 3	X	X		
18.33 / 1	X	X		
18.31 / 3	X	X		
18.29 / 3	X	X		
18.27 / 3	X	X		
18.25 / 1	X	X		
18.23 / 5	X	X		
18.23 / 6	X			
18.21 / 3	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
18.19 / 3	X	X		
18.17 / 3	X	X		
18.15 / 1.03	X	X		
18.13 / 3	X	X		
18.11 / 4	X	X		
18.09 / 4	X	X		
18.07 / 3	X	X		
18.05 / 1	X	X		
18.03 / 4	X	X		
18.01 / 4	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: DHB

SUBMITTED BY:
G H Barnes
CADASTRAL

RECOMMENDED BY:
Nancy L. Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET
LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

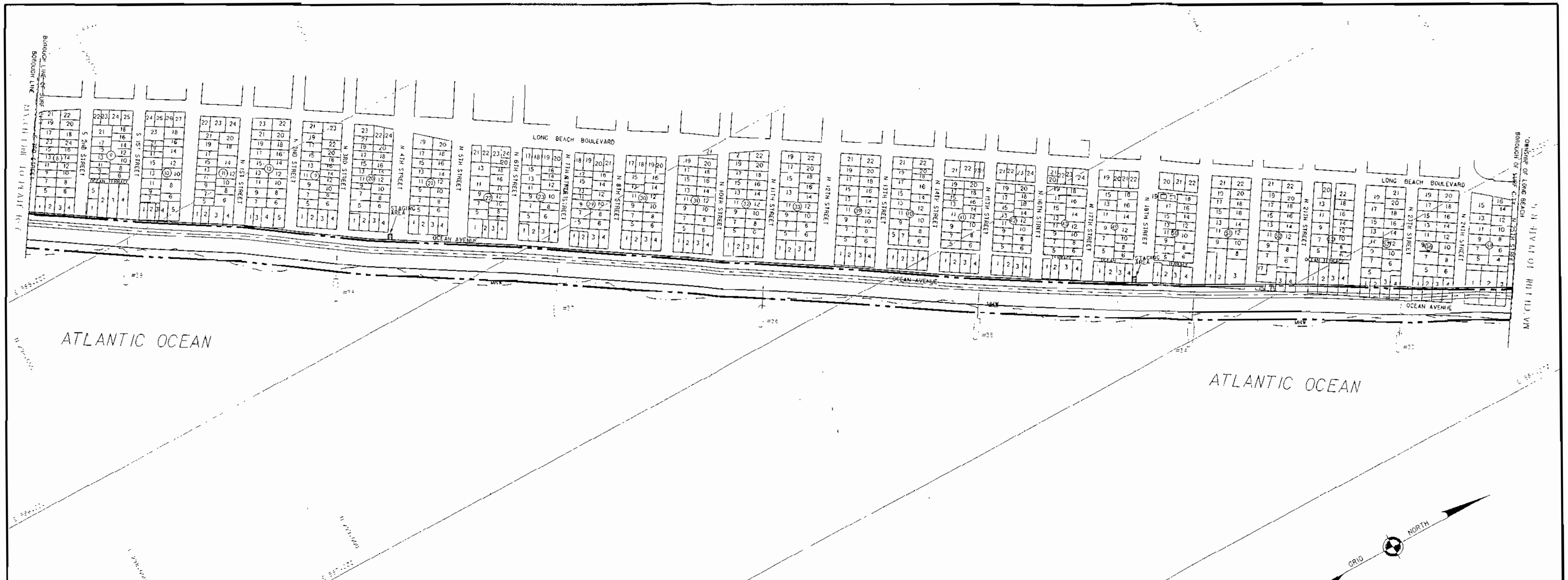
APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE
R-5

SCALE IN FEET
200 100 0 200 400

SHEET 5 OF 13
DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT.	WORK AREA ESMT.	ZONE	REMARKS
59 / 3	X	X		
59 / 2	X	X		
59 / 1	X	X		
56 / 4	X	X		
58 / 3	X	X		
58 / 2	X	X		
58 / 1	X	X		
57 / 4	X	X		
57 / 3	X	X		
57 / 2	X	X		
57 / 1	X	X		
53 / 4	X	X		
53 / 3	X	X		
53 / 2	X	X		
53 / 1	X	X		
52 / 4	X	X		
52 / 3	X	X		
52 / 19	X	X		
52 / 15	X	X		
51 / 3	X	X		
51 / 2	X	X		
51 / 1	X	X		
50 / 4		X		
50 / 3		X		
50 / 2		X		
50 / 1		X		
49/4		X		
49/3		X		
12/3		X		
12/1		X		
11/4		X		
11/3		X		
11/2		X		
11/1		X		
9/3		X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT.	WORK AREA ESMT.	ZONE	REMARKS
9/2		X		
9/1		X		
8/4		X		
8/3		X		
8/2		X		
8/1		X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY | USING SERVICE

LOCATION OF PROJECT		TRANSPORTATION FACILITIES
STATE	NEW JERSEY	RAILROADS
COUNTY	OCEAN	STATE ROADS
DIVISION	NORTH ATLANTIC	FEDERAL ROADS
DISTRICT	BALTIMORE	AIRLINES
ARMY AREA	FIRST	

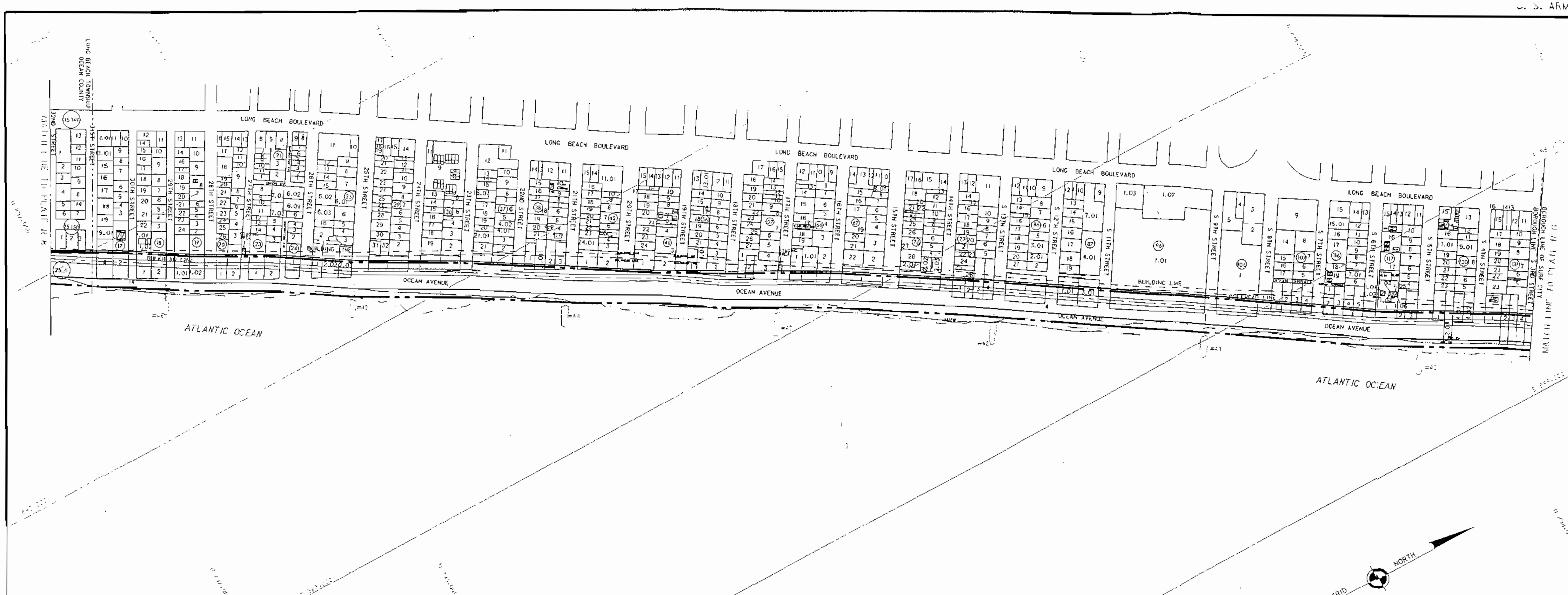
DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLD
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L. Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO
LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO. ______
PLATE R-6
SCALE IN FEET 200 100 0 200 400
SHEET 6 OF 13
DRAWING NO. ______



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
131 / 4	X	X		
131 / 3	X	X		
31 / 2	X	X		
131 / 1	X	X		
130 / 4.02	X	X		
130 / 4.01	X	X		
130 / 2.01	X	X		
130 / 1	X	X		
117 / 3	X	X		
117 / 2	X	X		
117 / 1	X	X		
116 / 5	X	X		
116 / 4	X	X		
116 / 3	X	X		
107 / 4	X	X		
107 / 3	X	X		
107 / 2	X	X		
107 / 1	X	X		
106 / 1	X	X		
96 / 1.01	X	X		
87 / 3.01	X	X		
87 / 1.01	X	X		
86 / 1	X	X		
25.31 / 4	X			
77 / 4	X	X		
77 / 3	X	X		
77 / 2	X	X		
77 / 1	X	X		
76 / 1	X	X		
67 / 1	X	X		
66 / 2	X	X		
66 / 1.01	X	X		
66 / 1	X	X		
57 / 3	X	X		
57 / 2	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
57 / 1	X	X		
56 / 2	X	X		
56 / 1.01	X	X		
56 / 1	X	X		
45 / 1	X	X		
38 / 3	X	X		
38 / 2	X	X		
35 / 1.01	X	X		
36 / 1	X	X		
31 / 1	X	X		
30 / 1	X	X		
29 / 1	X	X		
25 / 2.03	X	X		
25 / 2.02	X	X		
25 / 1	X	X		
24 / 1	X	X		
23 / 2	X	X		
23 / 2	X	X		
20 / 2	X	X		
20 / 1	X	X		
19 / 1.02	X	X		
19 / 1.01	X	X		
18 / 2	X	X		
18 / 1	X	X		
17 / 2	X	X		
17 / 1	X	X		
25.31 / 14		X		
25.31 / 1	X			
15.150 / 3		X		
15.150 / 2		X		
15.150 / 1		X		
116 / 2	X	X		
77 / 26		X		
46 / 2		X		
45 / 2		X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L. Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

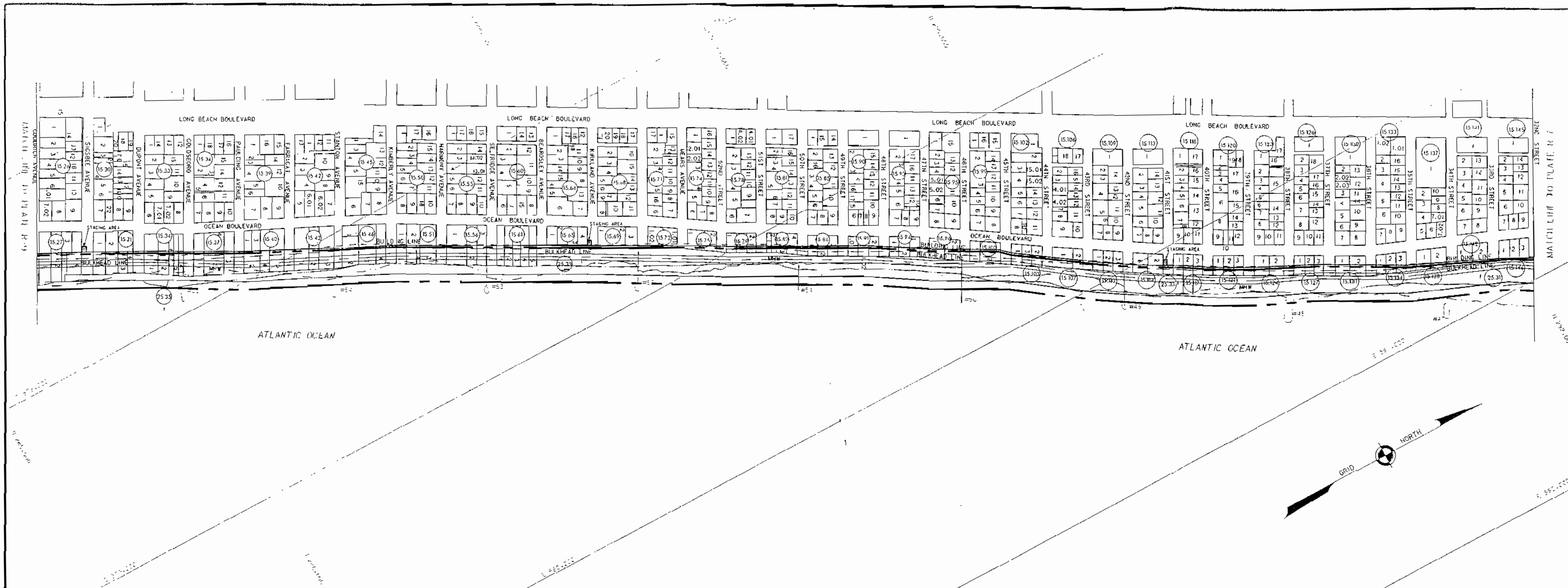
APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE
R-7

SCALE IN FEET
200 100 0 200 400

SHEET 7 OF 13
DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
25.31 / 1	X	X		
15.146 / 2	X	X		
15.146 / 1	X	X		
15.142 / 2	X	X		
15.142 / 1	X	X		
15.138 / 2	X	X		
15.138 / 1	X	X		
15.134 / 3	X	X		
15.134 / 2	X	X		
15.134 / 1	X	X		
15.131 / 2	X	X		
15.131 / 1	X	X		
15.127 / 3	X	X		
15.127 / 2	X	X		
15.127 / 1	X	X		
15.124 / 2	X	X		
15.124 / 1	X	X		
15.121 / 3	X	X		
15.121 / 2	X	X		
15.121 / 1	X	X		
15.117 / 3	X	X		
15.117 / 1	X	X		
25.33 / 1		X		
15.114 / 2	X	X		
15.114 / 1	X	X		
15.110 / 3	X	X		
15.110 / 2	X	X		
15.110 / 1	X	X		
15.107 / 2	X	X		
15.103 / 2	X	X		
15.103 / 3	X	X		
15.103 / 1	X	X		
15.100 / 2	X	X		
15.100 / 1	X	X		
15.96 / 2	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
15.96 / 1	X	X		
15.94 / 3	X	X		
15.94 / 2	X	X		
15.94 / 1	X	X		
15.91 / 2	X	X		
15.91 / 1.02	X	X		
15.91 / 1.01	X	X		
15.88 / 3	X	X		
15.86 / 2	X	X		
15.86 / 1	X	X		
15.82 / 4	X	X		
15.82 / 3	X	X		
15.82 / 2	X	X		
15.82 / 1	X	X		
15.79 / 2	X	X		
15.79 / 3	X	X		
15.79 / 1	X	X		
15.75 / 2	X	X		
15.75 / 1	X	Y		
15.72 / 1.01		X		
115.117 / 2	X	Y		
15.46 / 3		X		
15.107 / 1	X	X		
15.40 / 3		X		
15.27 / 2	X	X		
15.27 / 1	X	X		
25.33 / 1				
15.61 / 5	X	X		
15.61 / 4	X	X		
15.61 / 3	X	X		
15.61 / 2	X	X		
15.61 / 1	X	X		
15.56 / 3	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
15.56 / 2	X	X		
15.56 / 1	X	X		
15.51 / 3	X	X		
15.51 / 4	X	X		
15.51 / 2	X	Y		
15.51 / 1	X	X		
15.46 / 4	X	X		
15.46 / 3	X	X		
15.46 / 2	X	X		
15.43 / 3	X	X		
15.43 / 2	X	X		
15.43 / 1	X	X		
15.40 / 5	X	X		
15.40 / 4	X	X		
15.40 / 3	X	X		
15.40 / 2	X	X		
15.40 / 1	X	X		
15.37 / 4	X	X		
15.37 / 3	X	X		
15.37 / 2	X	X		
15.37 / 1	X	X		
15.34 / 4	X	X		
15.34 / 5	X	X		
15.34 / 3	X	X		
15.34 / 6	X	X		
15.34 / 7	X	X		
15.34 / 2	X	X		
15.34 / 1	X	X		
25.35 / 1	X			
15.31 / 4	X	X		
15.31 / 3	X	X		
15.31 / 2	X	X		
15.31 / 1	X	X		
15.27 / 4	X	X		
15.27 / 3	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

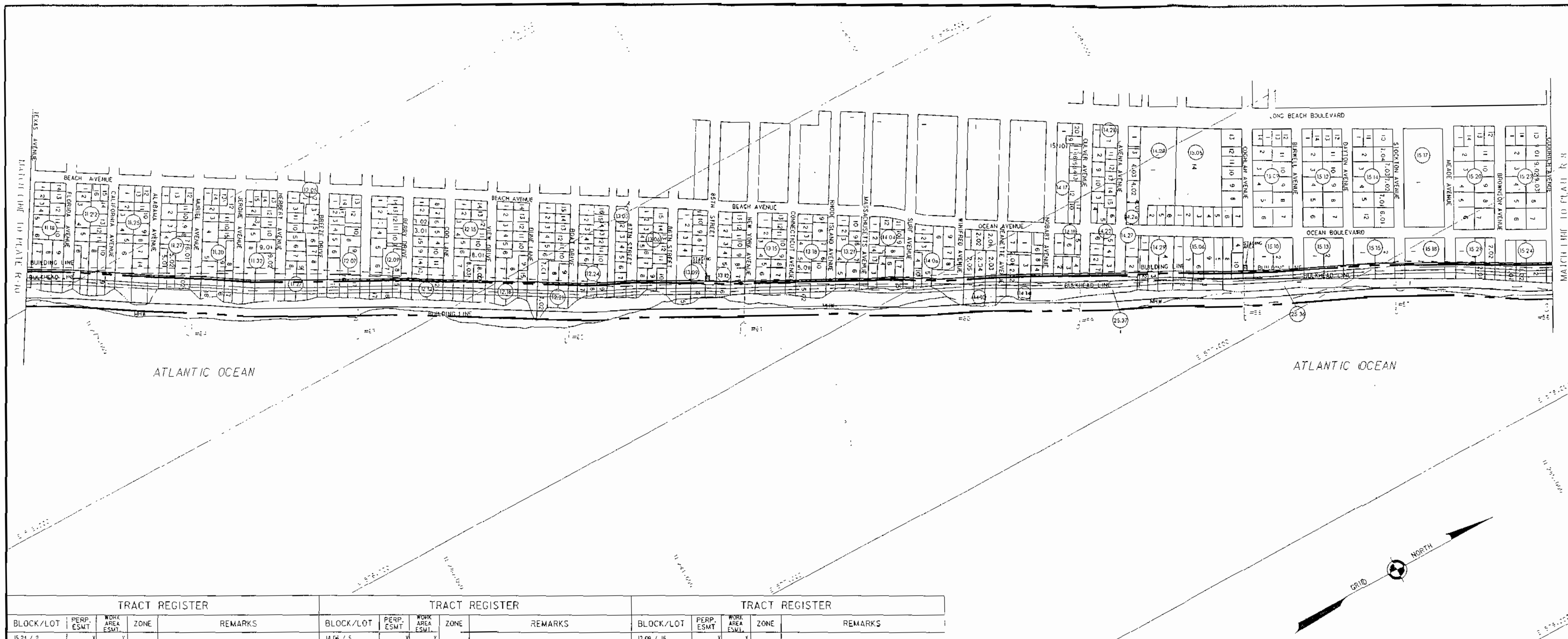
DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY:
G.H. Barnes
CADASTRAL
RECOMMENDED BY:
Nancy L. Roberts
CHIEF, P&C BRANCH
CHIEF, REAL ESTATE DIVISION
US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
DATE 16 FEB 1999

PLATE R-8
SCALE IN FEET 200 100 0 200 400
SHEET 5 OF 13
DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
15.21 / 2	X	X		
5.24 / 1.02	X	X		
15.24 / 1	X	X		
15.18 / 1	X	X		
15.15 / 2	X	X		
15.15 / 1	X	X		
15.13 / 2	X	X		
15.13 / 1	X	X		
15.10 / 2	X	X		
15.10 / 10	X	X		
25.36 / 1	X			
15.06 / 4	X	X		
15.06 / 8	X	X		
15.06 / 5	X	X		
15.06 / 9	X	X		
15.06 / 6	X	X		
15.06 / 7	X	X		
15.06 / 3	X			
15.06 / 2	X			
15.06 / 1	X	X		
14.29 / 4	X	X		
14.29 / 3	X	X		
14.29 / 2	X	X		
14.27 / 2	X	X		
25.37 / 1	X			
14.22 / 3	X	X		
14.22 / 7		X		
14.18 / 4	X	X		
14.18 / 3		X		
14.18 / 2		X		
14.14 / 3	X	X		
14.14 / 2.02	X	X		
14.10 / 2.03	X	X		
14.10 / 2.04	X	X		
14.10 / 2.05	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
14.06 / 5	X	X		
14.06 / 10	X	X		
14.04 / 7	X	X		
14.04 / 6	X	X		
14.04 / 5	X	X		
14.04 / 4		X		
13.21 / 6	X	X		
13.21 / 5	X	X		
13.18 / 10	X	X		
13.18 / 5.02	X	X		
13.15 / 7	X	X		
13.15 / 6	X	X		
13.12 / 7	X	X		
13.12 / 6	X	X		
13.09 / 6	X	X		
13.09 / 5	X	X		
13.06 / 10	X	X		
13.06 / 9	X	X		
13.06 / 8	X	X		
13.03 / 7	X	X		
12.24 / 9	X	X		
12.24 / 8	X	X		
12.24 / 7	X	X		
12.21 /9	X	X		
12.21 / 8	X	X		
12.21 / 7.02	X	X		
12.18 / 15	X	X		
12.18 / 8	X	X		
12.18 / 7	X	X		
12.15 / 8.02	X	X		
12.15 / 8.03	X	X		
12.15 / 7	X	X		
12.12 / 12	X	X		
12.12 / 13	X	X		
12.09 / 15	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
12.09 / 16	X	X		
12.09 / 17	X	X		
12.07 / 17	X	X		
12.07 / 16	X	X		
12.07 / 7	X	X		
11.37 / 9	X	X		
11.37 / 8	X	X		
11.32 / 9.02	X	X		
11.32 / 8	X	X		
11.30 / 7	X	X		
11.30 / 6	X	X		
11.30 / 16	X	X		
11.27 / 6.02	X	X		
11.27 / 5.02	X	X		
11.27 / 5.0[illegible]	X	X		
11.25 / 14	X	X		
11.25 / 6	X	X		
11.22 / 9	X	X		
11.22 / 8	X	X		
11.22 / 7	X	X		
11.22 / 6	X	X		
11.18 / 9	X	X		
11.18 / 8	X	X		
11.18 / 7	X	X		
15.21 / 2.02	X	X		
15.21 / 2.01	X	X		
15.21 / 1	X	X		
14.14 / 4		X		
14.04 / 3	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO
LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

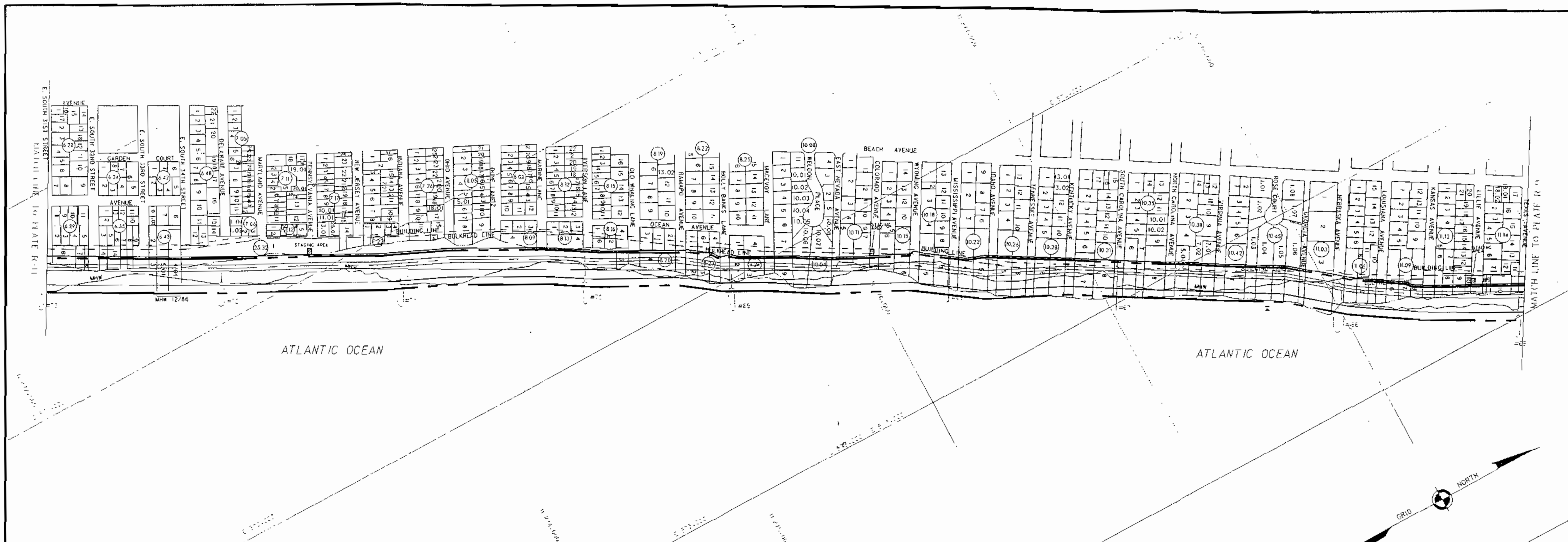
APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE
R-9

SCALE IN FEET
200 100 0 200 400

SHEET 9 OF 13
DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
11.14 / 11	X			
11.14 / 10	X			
11.14 / 9	X			
11.14 / 8	X			
11.12 / 10	X			
11.12 / 9	X			
11.12 / 8	X			
11.12 / 6	X			
11.09 / 8	X			
11.09 / 7	X			
11.09 / 6	X			
11.06 / 10	X			
11.06 / 9	X			
11.06 / 7	X			
11.03 / 3	X			
10.45 / 1.06	X			
10.45 / 1.05	X			
10.45 / 1.04	X			
10.45 / 1.03	X			
10.42 / 7	X			
10.38 / 7.01	X			
10.38 / 7.02	X			
10.38 / 5.01	X			
10.35 / 8	X			
10.35 / 7	X			
10.35 / 6	X			
10.31 / 8	X			
10.28 / 8	X			
10.28 / 6	X			
10.26 / 8	X			
10.26 / 5	X			
10.22 / 5	X			
10.22 / 4	X			

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
10.18 / 7	X	X		
10.18 / 5	X	X		
10.15 / 8	X	X		
10.15 / 6	X	X		
10.11 / 5	X	X		
10.04 / 10.07	X	X		
10.04 / 10.06	X	X		
10.04 / 9	X	X		
8.26 / 4		X		
8.26 / 3	X	X		
8.26 / 2	X	X		
8.26 / 1		X		
8.23 / 4		X		
8.23 / 6		X		
8.23 / 1		X		
8.23 / 5	X	X		
8.23 / 3	X	X		
8.23 / 2	X	X		
8.20 / 4	X	X		
8.16 / 3	X	X		
8.13 / 4		X		
8.09 / 4		X		
25.32 / 1	X	X		
6.43 / 4.01	X	X		
6.43 / 5.01	X	X		
6.43 / 3	X	X		
6.35 / 8	X	X		
6.35 / 7	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
6.35 / 14	X	X		
6.35 / 4	X	X		
6.29 / 8	X	X		
6.29 / 7	X	X		
6.29 / 6	X	X		
10.31 / 7	X	X		
10.11 / 7	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA X	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

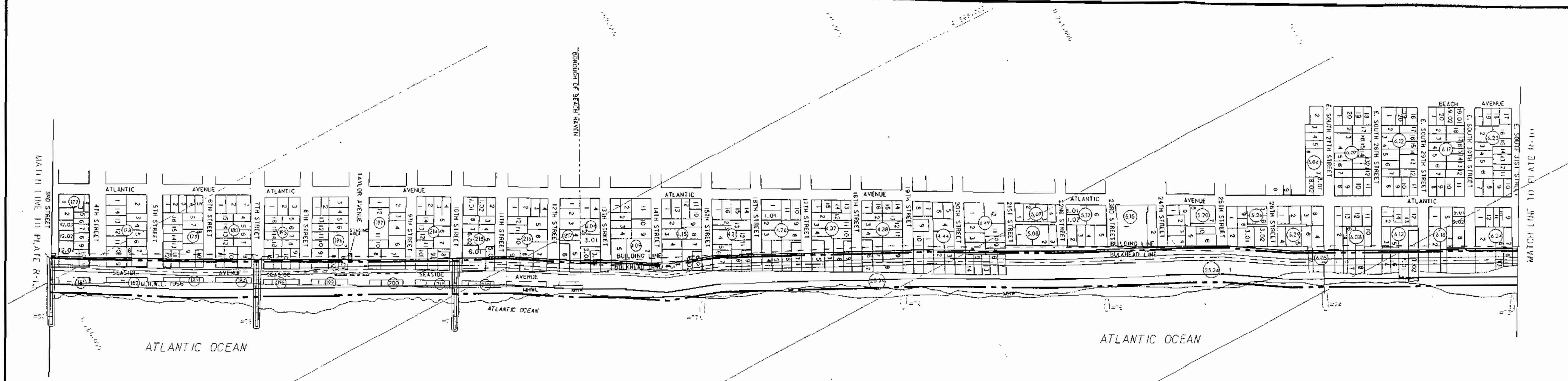
APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

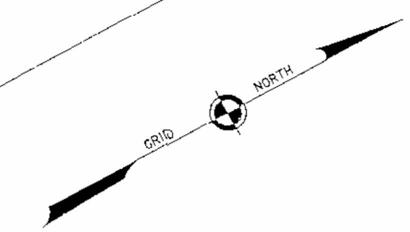
US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-10

SCALE IN FEET
200 100 0 200 400

SHEET 10 OF 13
DRAWING NO.





TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
6.24 / 8	X	X		
6.24 / 13	X	X		
6.24 / 2	X	X		
6.16 / 5	X	X		
6.18 / 2	X	X		
6.13 / 7.02	X	X		
6.13 / 7.01	X	X		
6.13 / 6	X	X		
6.13 / 4	X	X		
6.08 / 8	X	X		
6.08 / 1	X	X		
6.08 / 4	X	X		
6.08 / 2	X	X		
6.05 / 4	X	X		
6.05 / 7	X	X		
25.34 / 1	X	X		
4.49 / 8	X	X		
4.49 / 7	X			
4.49 / 6	X			
4.49 / 13	X			
4.49 / 5	X			
4.49 / 14	X			
4.44 / 3	X	X		
4.44 / 2	X	X		
4.44 / 1	X	X		
4.44 / 10	X	X		
4.38 / 9	X	X		
4.38 / 8	X			
4.38 / 7	X			
4.38 / 6	X	X		
4.38 / 5	X	X		
4.32 / 9	X	X		
4.32 / 8	X	X		
4.32 / 7	X	X		
4.32 / 5	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
4.26 / 7	X	X		
4.26 / 6	X	X		
4.26 / 5	X	X		
4.26 / 4	X	X		
4.21 / 9	X	X		
4.21 / 8	X	X		
4.21 / 7	X	X		
4.15 / 6.01	X	X		
4.15 / 6.02	X	X		
4.15 / 5	X	X		
4.09 / 7	X	X		
4.09 / 5	X	X		
4.04 / 3.03	X	X		
4.04 / 3.02	X	X		
217 / 5	X	X		
217 / 6	X	X		
216 / 7	X	X		
216 / 8	X	X		
216 / 9	X	X		
215 / 5.02	X	X		
215 / 6.01	X	X		
219 / 1	X			
218 / 1	X			
214 / 8	X	X		
214 / 9	X	X		
214 / 10	X	X		
200 / 1	X			
197 / 7	X	X		
197 / 8	X	X		
199 / 1	X			
196 / 8.01	X	X		
196 / 8.02	X	X		
196 / 9	X	X		
198 / 1	X			
195 / 9	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
195 / 10	X	X		
195 / 11	X	X		
195 / 12	X	X		
184 / 1	X			
180 / 8	X	X		
180 / 10	X	X		
180 / 11	X	X		
183 / 1	X			
179 / 10	X	X		
179 / 9	X	X		
179 / 11	X	X		
179 / 12	X	X		
182 / 1	X			
178 / 7	X	X		
178 / 8	X	X		
178 / 9	X	X		
181 / 1	X			
177 / 10	X	X		
177 / 12.01	X	X		
5.20 / 6		X		
4.49 / 4		X		
4.21 / 6		X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS X
COUNTY OCEAN	STATE ROADS X
DIVISION NORTH ATLANTIC	FEDERAL ROADS X
DISTRICT BALTIMORE	AIRLINES X

ARMY AREA X

PROJECT SITE LOCATED APPROXIMATELY X MILES X OF X

PROJECT SITE LOCATED APPROXIMATELY X MILES X OF X

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: CHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY: DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

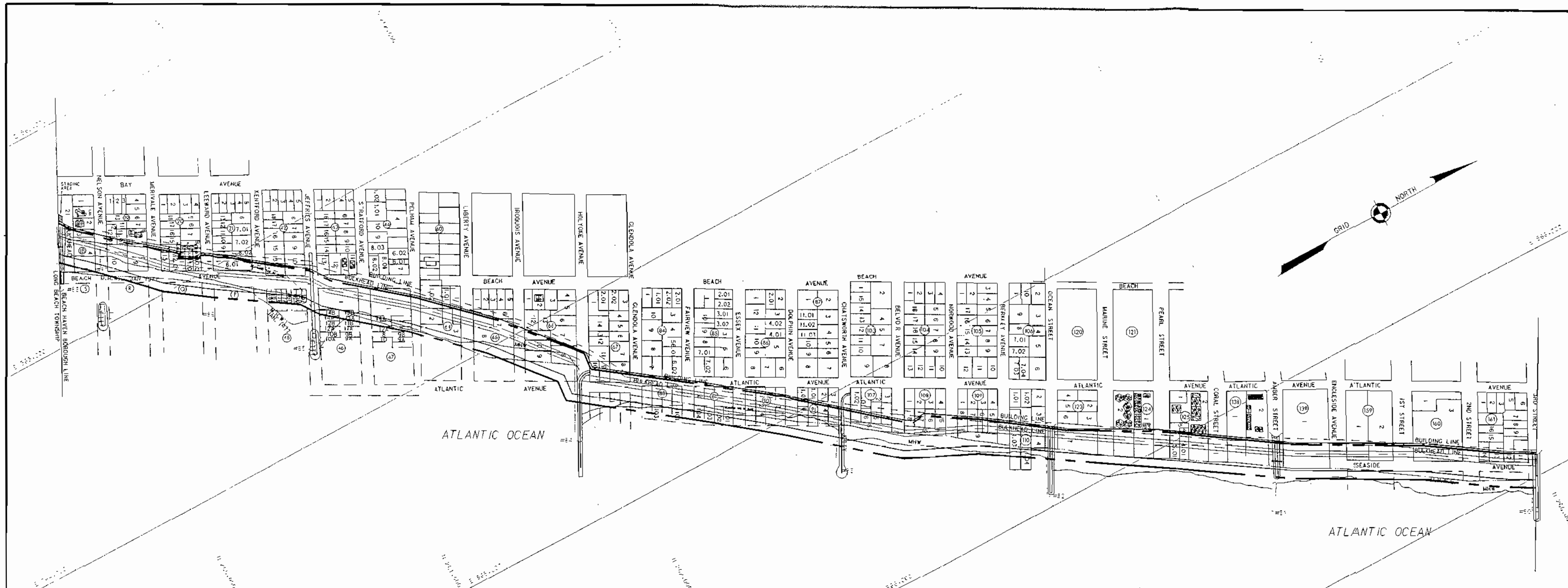
US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-11

SCALE IN FEET 200 100 0 200 400

SHEET 11 OF 13 DRAWING NO

FILE NAME:



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
161 / 11	X	X		
161 / 12	X	X		
161 / 13	X	X		
161 / 14	X	X		
160 / 3	X	X		
159 / 2	X	X		
159 / 1	X	X		
139 / 1	X	X		
138 / 2	X	X		
138 / 1	X	X		
125 / 2	X	X		
125 / 4.01	X	X		
125 / 5	X	X		
125 / 5.01	X			
124 / 1	X	X		
124 / 2	X	X		
123 / 1	X	X		
110 / 4	X	X		
110 / 1.04	X	X		
110 / 1.03	X	X		
109 / 5	X	X		
109 / 9	X			
109 / 6	X	X		
109 / 7	X	X		
109 / 8	X	X		
109 /	X	X		
108 / 5	X	X		
108 / 6	X	X		
108 / 7	X	X		
108 / 8	X	X		
108 / 9	X			
107 / 4	X	X		
107 / 5	X	X		
107 / 6	X	X		
107 / 1.02	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
107 / 8	X			
91 / 3	X	X		
91 / 4	X	X		
91 / 1.01		X		
91 / 1.02	X	X		
91 / 6	X			
91 / 7	X			
90 / 3	X	X		
90 / 2	X	X		
90 / 1	X	X		
89 / 1	X	X		
89 / 2	X			
67 / 8	X	X		
67 / 9	X	X		
67 / 10	X	X		
66 / 7	X	X		
66 / 8	X	X		
66 / 9	X			
66 / 10	X			
65 / 7	X	X		
65 / 8	X	X		
64 / 1	X	X		
64 / .01	X	X		
64 / 1.02	X	X		
64 / 2	X	X		
64 / 3	X	X		
47 / 1	X	X		
46 / 1	X			
42 / 10	X	X		
42 / 13	X	X		
21 / 8.01	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20 / 10.01	X	X		
20 / 11.01	X	X		
20 / 12.01	X	X		
20 / 13	X			
20 / 14.01	X	X		
19 / 9	X	X		
19 / 10	X			
19 / 11.01	X	X		
19 / 12.01	X	X		
18 / 3	X	X		
18 / 4	X			
18 / 21	X	X		
125 / 4		X		
125 / 2.08		X		
90 / 4	X			
66 / 11	X	X		
20 / 10.02		X		
20 / 11.02		X		
20 / 12.02		X		
18 / 2		X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: CHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

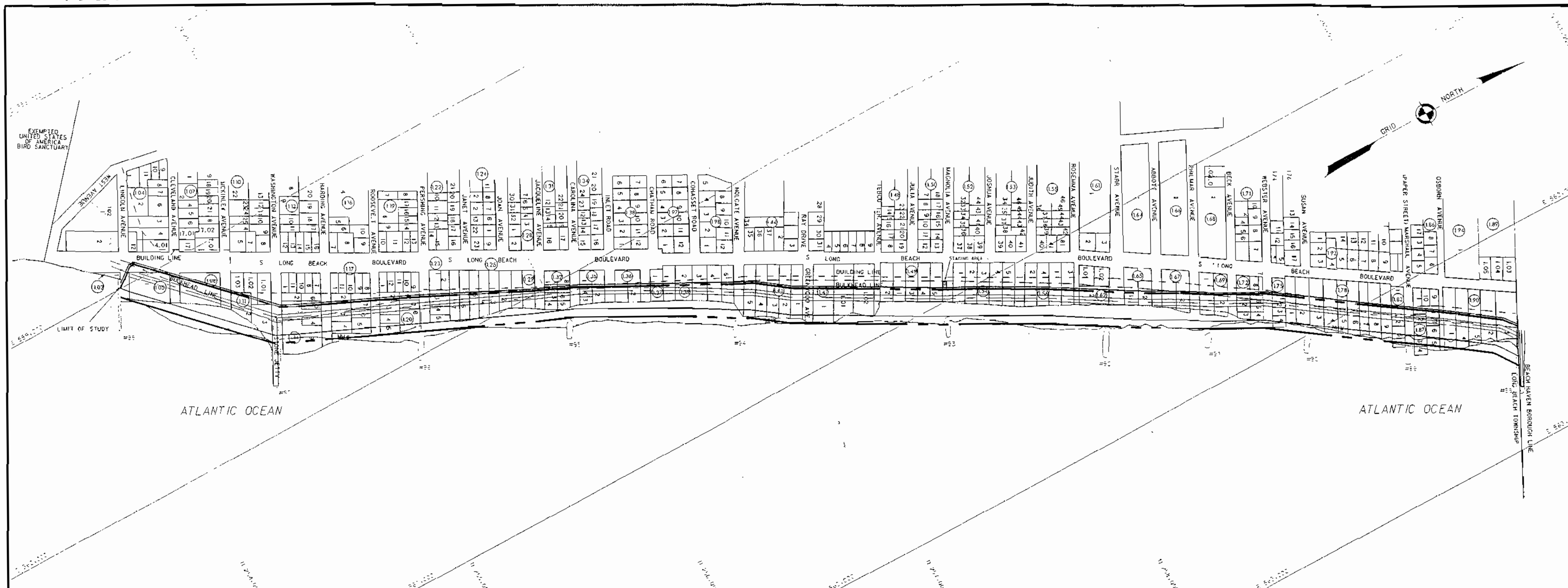
APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-12

SCALE IN FEET
200 100 0 200 400

SHEET 12 OF 13
DRAWING NO



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
1.90 / 3	X	X		
1.90 / 2	X	X		
1.90 / 5	X	X		
1.90 / 4	X	X		
1.90 / 1	X	X		
1.87 / 5	X			
1.87 / 6	X			
1.87 / 7	X			
1.87 / 8	X	X		
1.87 / 1	X	X		
1.87 / 2	X			
1.87 / 3	X			
1.87 / 4	X			
1.83 / 1		X		
1.83 / 2	X	X		
1.83 / 5	X			
1.78 / 9	X	X		
1.78 / 8	X	X		
1.78 / 7	X	X		
1.78 / 6	X	X		
1.78 / 5	X	X		
1.78 / 4	X	X		
1.78 / 3	X	X		
1.78 / 2	X	X		
1.78 / 1	X	X		
1.75 / 1	X	X		
1.75 / 2	X			
1.75 / 3	X			
1.75 / 4	X			
1.72 / 8	X	X		
1.72 / 7	X	X		
1.72 / 6	X			
1.72 / 5	X			
1.72 / 4	X			
1.72 / 3	X			

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
1.72 / 2	X			
.72 / 1	X	X		
1.69 / 2	X	X		
1.69 / 1	X	X		
1.67 / 2	X	X		
1.67 / 1	X	X		
1.65 / 2	X	X		
1.62 / 2	X	X		
1.56 / 3	X	X		
1.56 / 1	X	X		
1.56 / 4	X	X		
1.56 / 2	X	X		
1.54 / 5	X	X		
1.54 / 4	X	X		
1.54 / 3	X	X		
1.54 / 2	X	X		
1.54 / 1	X	X		
1.49 / 5	X	X		
1.49 / 4	X	X		
1.49 / 3	X	X		
1.49 / 2	X	X		
1.49 / 1	X	X		
1.47 / 1.02	X	X		
1.47 / 1.01	X	X		
1.47 / 1	X	X		
1.45 / 1	X	X		
1.45 / 2	X	X		
1.45 / 3	X	X		
1.45 / 4	X	X		
1.45 / 5	X	X		
1.39 / 5	X	X		
1.39 / 4	X	X		
1.39 / 3	X	X		
1.39 / 2	X	X		
1.39 / 1	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
1.37 / 1	X		X	
1.36 / 2	X		X	
1.36 / 1	X		X	
1.35 / 2	X		X	
1.35 / 3	X		X	
1.35 / 4	X		X	
1.32 / 7	X		X	
1.32 / 6	X			
1.32 / 5	X			
1.32 / 4	X			
1.32 / 3	X			
1.32 / 2	X		X	
1.29 / 1	X		X	
1.25 / 1	X		X	
1.25 / 2	X		X	
1.25 / 3	X		X	
1.25 / 4	X		X	
1.25 / 5	X		X	
1.25 / 6	X		X	
1.25 / 7	X		X	
1.23 / 3	X		X	
1.23 / 4	X			
1.23 / 5	X			
1.20 / 8	X			
1.20 / 7	X			
1.20 / 6	X			
1.20 / 5	X			
1.20 / 4	X			
1.20 / 3	X			
1.20 / 2	X		X	
1.17 / 7	X		X	
1.17 / 6	X			
1.17 / 5	X			
1.17 / 4	X			
1.17 / 3	X			

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
1.14 / 9	X			
1.14 / 3	X			
1.14 / 4	X			
1.14 / 5	X	X		
1.11 / 3	X	X		
1.11 / 2	X	X		
1.11 / 1.01	X	X		
1.11 / 1.02	X	X		
1.08 / 1	X	X		
1.05 / 1	X	X		
1.17 / 2		X		
1.62 / 2	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L. Roberts
CHIEF, PAC BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.
PLATE R-13
SCALE IN FEET 200 100 0 200 400
SHEET 13 OF 13 DRAWING NO.

Appendix G

Pertinent Correspondence and Relevant News Articles

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

UNITED STATES DEPARTMENT OF COMMERCE
Office of the Under Secretary for
Oceans and Atmosphere
Washington, D.C. 20230

July 14, 1999

Mr. Robert L. Callegari
Chief, Planning Division
DOA, Philadelphia District, COE
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

Dear Mr. Callegari:

Enclosed are comments on the Draft Environmental Impact Statement for Barnegat Inlet to Little Egg Inlet, New Jersey. We hope our comments can assist you. Thank you for giving us an opportunity to review this document.

Sincerely,

Susan Fruchter

Susan B. Fruchter
Acting NEPA Coordinator

Enclosure

MEMORANDUM FOR:	Susan B. Fruchter Acting NEPA Coordinator
FROM:	Charles W. Challstrom Acting Director, National Geodetic Survey
SUBJECT:	DEIS-9907-02 Barnegat Inlet to Little Egg Inlet, New Jersey

The subject statement has been reviewed within the areas of the National Ocean Service's (NOS') responsibility and expertise and in terms of the impact of the proposed actions on NOS activities and projects.

All available geodetic control information about horizontal and vertical geodetic control monuments in the subject area is contained on the National Geodetic Survey (NGS) home page at the following Internet World Wide Web address: http://www.ngs.noaa.gov. After entering the NGS home page, please access the topic "Products and Services" and then access the menu item "Data Sheet." This menu item will allow you to directly access geodetic control monument information from the NGS data base for the subject area project. This information should be reviewed for identifying the location and designation of any geodetic control monuments that may be affected by the proposed project.

There are no geodetic control monuments that would be affected by the proposed project.

If there are any planned activities which will disturb or destroy these monuments, NGS requires not less than 90 days' notification in advance of such activities in order to plan for their relocation. NGS recommends that funding for this project includes the cost of any relocation(s) required.

For further information about these geodetic monuments, please contact Rick Yorczyk; NOAA, NOS, National Geodetic Survey, N/NGS; SSMC3 8636, 1315 East West Highway; Silver Spring, Maryland 20910; telephone: 301-713-3230 x142; fax: 301-713-4175.

The text of this Draft Environmental Impact Statement does not indicate that the proposed evaluation of shoreline erosion problems between Barnegat and Little Egg Inlets, nor the proposed restoration of berms and dunes using material from off shore borrow areas, will affect the charted hydrography on NOS Harbor Charts 12316, 12323, or 12324, or impact navigational safety.

Bottom topography in the borrow area and placement areas will be affected by the proposed dredging. Navigational safety will not be impacted.

NOS would like U.S. Army Corps of Engineers blueprints of this project upon completion so that any related shoreline changes or deepening in selected borrow areas can be accurately portrayed on future editions of affected NOS Charts.

For further information about these charting activities, please contact Howard Danley; NOAA, NOS, Office of Coast survey, N/CS28; SSMC3 7458; 1315 East West Highway; Silver Spring, Maryland 20910; telephone: (301)713-2732 x105.

The COE will provide NOS surveys of the project area upon completion.

State of New Jersey
Department of Environmental Protection

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

Land Use Regulation Program
P.O. Box 439, Trenton, NJ 08625-0439
Fax # (609) 292-8115
Fax # (609) 777-3656

AUG 23 1999

Robert L. Callegari
Chief, Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

RE: Barnegat Inlet to Little Egg Inlet Revised Draft Feasibility Report
and Integrated Environmental Impact Statement
Application for Federal Consistency Determination and
Section 401 Water Quality Certification
Land Use Regulation Program File No. 1500-99-0001.1

Dear Mr. Callegari:

The New Jersey Department of Environmental Protection, Land Use Regulation Program, acting under Section 307 of the Federal Coastal Zone Management Act (P.L. 92-583) as amended, has reviewed the "Barnegat Inlet To Little Egg Inlet Revised Draft Report and Integrated Environmental Impact Statement" dated June 1999. The Program has also considered information discussed at a November 18, 1998 meeting with Randy Piersol of the ACOE, Mark Mauriello of the Land Use Regulation Program, representatives of New Jersey's Division of Fish, Game and Wildlife, and representatives of the U.S. Fish and Wildlife Service and NOAA. Based on the above, the Program has determined that the draft plan and project as currently designed can not be found consistent, with New Jersey's Rules on Coastal Zone Management N.J.A.C. 7:7E-1.1 et seq. as amended to December 7, 1998 and the applicable Rules guiding issuance of a Section 401 Water Quality Certificate. However, provided that the ACOE can satisfactorily address the issues discussed in this letter at this time, a favorable determination will be made. As per your request, the deadline for a decision on this consistency request is September 3, 1999.

1. **7:7E-3.3 Surf Clam Areas & 7:7E-3.4 Prime Fishing Areas**

Surf clam areas are waters within the territorial sea of the State of New Jersey which can be demonstrated to support significant commercially harvestable quantities of surf clams (Spisula Solidissima), or areas important for recruitment of surf clam stocks. Development which would result in destruction, condemnation, or contamination of surf clam areas is prohibited.

Prime fishing areas include tidal water areas and water's edge areas which have a demonstrable history of supporting a significant local quantity of recreational or commercial

See the following COE response letter.

fishing activity. The area includes all coastal jetties and groins, and public fishing piers or docks. Prohibited uses include sand or gravel submarine mining which would alter existing bathymetry to a significant degree so as to reduce the high fishery productivity of these areas.

During a meeting with NJDEP and Federal Resource agencies, as well as in a follow up letter from Mark N. Mauriello of this Program, the ACOE was notified that the proposed borrow areas "B" and "E" are both prime fishing areas and surf clam area, and that these sites be avoided as part of the project. Also, recommendations in the U.S. Fish and Wildlife Service's Draft Fish and Wildlife Coordination Act Section 2(b) Report, dated March 1999, their recommendations for this project include avoiding the use of Borrow Areas B and E, that are designated as Prime Fishing and Surf Clam Areas, and that the ACOE evaluate alternative borrow areas, such as the Barnegat Inlet. Contrary to the comments and recommendations made by the State and Federal resource agencies the proposed plan entails use of borrow area "E" for the initial fill project.

An additional ground for eliminating use of borrow area "E" is the findings of the ACOE's Waterways Experiment Station technical report entitled "Wave Climate and Littoral Sediment Transport Potential, Long Beach Island, New Jersey", dated April 1999. The ACOE concluded that "removal of the nearshore shoal (Borrow Area E) has a strong negative impact on Reach 11 (Haven Beach to Beach Haven Gardens) and is not recommended".

NJDEP Division of Fish, Game and Wildlife recommends that the final report and plans should not include use of borrow areas "B" or "E", or any other area identified as a "Prime Fishing Area" in Freeman and Walford (1974) and / or Long and Figley (1982). The ACOE should consider alternative sites for utilization. The ACOE shall coordinate the use of other borrow areas with the Division of Fish, Game and Wildlife, and the Historic Preservation Office. The use of other sea lumps / mounds not identified as "Prime Fishing Area" may be acceptable. These areas may provide the same valuable habitat, and therefore, the ACOE shall coordinate with the Division of Fish, Game and Wildlife to develop a dredging plan that includes best management practices that minimize habitat impacts and allow for recovery of resources at these alternative sites.

The ACOE reports that there are 101 groin structures with lengths from 250 to 420 feet. At various times of the year certain groins are completely covered by sand.

NJDEP Division of Fish, Game and Wildlife recommends that the final report and plans should assess impacts / losses to the recreational jetty fishery that may result from the nourishment activities. It should provide recommendations for mitigation if the findings indicate significant losses to the fishery.

2. <u>N.J.A.C. 7:7E-3.12 Submerged Infrastructure Routes</u>

A "submerged infrastructure route" is the corridor in which a pipe or cable runs on or below a submerged land surface. Any activity which would increase the likelihood of infrastructure damage or breakage, or interfere with maintenance operations is prohibited.

It appears from Figure 2-3 that the proposed borrow area D-2 will abut an existing cable line, and D-1 is a short distance from another cable.

The ACOE shall coordinate with the cable owner to determine an appropriate dredging buffer to the cable. The final report and plan shall include documentation to demonstrate that the cable owner(s) agree to the buffer established, and to the proposed dredging operation in close proximity of the cables. Also, please clarify whether one of the cables adjacent to borrow area D is the inactive TAT 3 cable.

3. **N.J.A.C. 7:7-7.11 Coastal Engineering & N.J.A.C. 7:7E-8.11 Public Access to the Waterfront**

Public access, including parking where appropriate, must be provided to publicly funded shore protection structures and to waterfronts created by public projects unless such access would create a safety hazard to the user. Physical barriers with access to, along, or across a structure are prohibited.

As reported, at this time there is only one public access point provided in a 2.1 mile stretch of Loveladies, and one in a 1.3 mile stretch of North Beach. Public funds will be utilized to protect these municipalities over the 50-year project life.

The final report and plan shall include new public access points every .25 mile along the Loveladies and North Beach stretches. Public access must be clearly marked, provide parking (a minimum of 8 parking spaces per access point), be designed to encourage the public to take advantage of the waterfront setting, and must be barrier free where applicable. In addition, please clarify the location of the currently existing public access points in Loveladies and North Beach.

The final location an dimensions of the access points and dune walkovers shall be coordinated with the sponsor, the local community, and the Land Use Regulation Program, and shall be designed in accordance with N.J.A.C. 7:7E-3A.3 Standards Applicable to Dune Creation and Maintenance. Be advised that this rule states that the construction of elevated dune walkover structures, particularly at municipal street ends and other heavily used beach access points, is preferred to the construction of pathways or walkways through the dunes.

4. **N.J.A.C. 7:7E-3.16 Dunes & N.J.A.C. 7:7E-3A.3 Standards Applicable to Dune Creation and Maintenance**

A dune is a wind or wave deposited or man-made formation of sand (mound or ridge), that lies generally parallel to, and landward of the beach, and between the upland limit of the beach and the foot of the most inland dune slope. Development is prohibited on dunes, except for development that has no practicable or feasible alternative in an area other than a dune, and that will not cause significant adverse long-term impacts on the natural functioning of a dune system, either individually or in combination with other existing or proposed structures, land disturbance or activities. In addition, the removal of vegetation from any dune, and the excavation, bulldozing or alteration of dunes is prohibited, unless these activities are a component of a Department approved beach and dune management plan.

At street ends or other traffic areas which currently do not have any existing structural dune walkovers in place the ACOE proposes natural beach walkover paths, at a skewed angle, delineated by sand fencing. The final location and dimensions of dune walkover points will be coordinated with the local sponsor and the local community during the preparation of plans and specifications. Vehicular access will be provided at existing vehicular access points, and will be further coordinated with the local sponsor and community.

The final plan and specifications shall identify the locations of the proposed access-ways, and indicate the type of access proposed at each location. Any community requested special beach access appurtenances that require the construction of additional walkovers, vehicle access points, or the modification of proposed access paths shall be coordinated with, the NJDEP Land Use Regulation Program, and shall comply with the Dunes (N.J.A.C. 7:7E-3.16) and Standards For Beach And Dune Activities (N.J.A.C. 7:7E-3A) rules.

5. **7:7E-3.36 Historic and Archaeological Resources**

Historic and archaeological resources include objects, structures, shipwricks, buildings, neighborhoods, districts, and man-made or man-modified features of the landscape and seascape, including historic and prehistoric archaeological sites, which either are on or are eligible for inclusion on the New Jersey or National Register of Historic Places. Development that incorporates historic and archaeological resources is discouraged.

The following conditions have been recommended by the Historic Preservation Office. These items shall be addressed in the final plans and report. Be advised that if alternative borrow areas are proposed, the ACOE is required to perform the necessary cultural surveys and coordinate with the Historic Preservation Office to develop a plan to avoid potential impacts to the resources.

a) The U.S. Army Corps of Engineers shall complete Section 106 (of the National Historic Preservation Act) coordination with the Historic Preservation Office to identify historic properties and mitigate and/or avoid effects to historic properties. This coordination shall include, but not be limited to the following.

i.) Cultural resource investigations within all areas of potential project effects should be completed. These investigation shall be coordinated with the Historic Preservation Office.

ii.) A program of controlled, periodic archaeological monitoring shall be undertaken during and immediately following the beach replenishment operation to identify any archaeological materials originating in the offshore sand borrow areas. The details of this program shall be coordinated with the Historic Preservation Office.

iii.) A program to ensure protection of magnetic anomalies identified along the shoreline and in near shore areas shall be undertaken during the placement of sand. The details of this program shall be coordinated with the Historic Preservation Office.

iv.) Further investigation of Target 7:614 shall be undertaken if the proposed borrow area within which it is contained remains a potential source of borrow material. If, on the basis of this investigation, the target appears to be a potentially significant property, full evaluation of National Register eligibility (and as necessary, data recovery), *or* removal of much or all of this proposed borrow area from consideration as a source of borrow material will need to be undertaken. This shall be coordinated with the Historic Preservation Office.

6. 7:7E-3.38 Endangered and Threatened Wildlife or Vegetation Species Habitat

Areas know to be inhabited on a seasonal or permanent basis by or to be critical at any stage in the live cycle of any wildlife (fauna) or vegetation (flora) identified as "endangered" or "threatened" species on official Federal or State lists of endangered or threatened species, or under active consideration for State or Federal listing, are considered Special Areas. The definition also includes a sufficient buffer area to insure continued survival of the population of the species.

The project area encompasses and may impact nesting habitat for piping plovers, least terns and black skimmers. It is likely that these species will colonize portions of the newly created / enlarged beach habitat. Potential impacts to these species has been addressed in the Integrated EIS and / or in the included USFWS 2(b) Report (Appendix D). The NJDEP Division of Fish, Game and Wildlife concurs with all USFWS recommendations.

The NJDEP Division of Fish, Game and Wildlife recommends that the final report and plans should include seasonal construction restrictions beyond August 15th for existing and newly created areas used by least terns and / or black skimmers, as the nesting season for these species is later than the season for piping plover.

The NJDEP Division of Fish, Game and Wildlife recommends that the final project and plans should include a commitment by the ACOE to coordinate with the non-federal sponsor, and all of the subject local municipalities, to develop, adopt, and implement a comprehensive beach nesting bird management plan, with the assistance of the USFWS, and NJ Endangered and Nongame Species Program. Be advised that the NJ Endangered and Nongame Species Program is seeking a commitment from the ACOE to obtain permission to access privately held lands for erection of temporary fencing and signage, and to engage in other management activities necessary to protect and prevent illegal "take" of endangered or threatened species.

7. 7:7E-4.2(l) Acceptability Conditions for Uses, Standards relevant to sand and gravel extraction

Sand extraction for beach nourishment is conditionally acceptable provided that special areas are not directly or indirectly degraded. Provided that the ACOE fulfills the recommendations made by the Land Use Regulation Program, as described in this letter, the project will found to be consistent with this rule.

If you have any questions regarding this letter, please do not hesitate to call Helen Fasano of our staff at (609) 292-8262. Please respond to this letter at your earliest convenience. Provided that the ACOE submits a written agreement to address the items as discussed above in the final report and plans, this office will issue a conditional consistency determination prior to the September 3, 1999 decision deadline.

Sincerely,

RJ Brodrick

Richard H. Kropp
Director
Land Use Regulation Program

August 23, 1999
Date

c: Randy Piersol, U.S. ACOE, Philadelphia District
Bernard J. Moore, NJDEP 1510 Hooper Avenue, Toms River, NJ 08625
Lawrence Schmidt, Office of Coastal Planning and Program Coordination

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

August 25, 1999

Robert L. Callegari, Chief
Planning Division
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

ATTN: Mr. Randy Piersol

Dear Mr. Callegari:

We have reviewed the Barnegat Inlet to Little Egg Inlet, New Jersey Draft Feasibility Report and Integrated Environmental Impact Statement and offer the following comments.

We continue to recommend the selection of the Plan B alternative which minimizes impacts to fisheries resources by eliminating borrow sites B and E. The selected plan D would impact essential fish habitat (EFH) in areas A,D_1 D_2 and E. Impacts to EFH in these areas need to be assessed.

The 1996 Sustainable Fisheries Act amendments to the Magnuson-Stevens Act (MSA) require the designation of EFH for federally managed species of fish and shellfish. Pursuant to Section 305 (b)(2) of the MSA, federal agencies are required to consult with NMFS regarding any action they authorize, fund, or undertake that may adversely affect EFH. An adverse effect has been defined in the Act as follows: "Any impacts which reduces the quality and/or quantity or EFH. Adverse effects may include direct (e.g., contamination or physical disruption, indirect (e.g., loss of prey, reduction in species' fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions."

The project's selected borrow areas have been designated as EFH for many species. Enclosed are the pages for EFH designations for the project borrow areas. The species that may be impacted in area A are listed on page 26, the species that may be impacted in area D_1 are on page 34, the species that may be impacted in area D_2 are on pages 34 and 36 and the species that may be impacted in area E are on page 33. These pages were referenced by locating the borrow areas on the map of summarized squares of EFH designation for the New Jersey and Delaware coast lines and selected Atlantic Ocean 10' X 10" latitude and longitude squares.

In accordance with the stated NJDEP's regulation, USFWS recommendations in the FWCA 2(b) Report, and avoidance of Essential Fish Habitat (EFH) under NMFS's Magnuson-Stevens Fishery Conservation and Management Act (MSA), Borrow Area E has been eliminated. Borrow Area B was never part of the former selected plan.

Pursuant to Section 305(b)(2) of the MSA, the COE has initiated consultation with NMFS regarding the proposed project in EFH.

Because this project may adversely affect EFH for the species listed on the above mentioned pages, the MSA requires that the Army Corps of Engineers initiate consultation on this project. The Army Corps of Engineers must provide the National Marine Fisheries Service (NMFS) with a written assessment of the effects of the project on EFH. Although the EFH assessment and the NMFS' conservation recommendations can be incorporated into a DEIS document in the future, the timing of the draft document and the EFH designations made it impossible to do so in this case. Therefore, we recommend that consultation be done by letters (the Corps' EFH assessment and NMFS' subsequent EFH conservation recommendations) and be included in the final EIS document. The section of the document must be clearly identified as an EFH Assessment and include the following components:

1. A description of the proposed action.
2. An analysis of the effects, including cumulative effects of the proposed action on EFH, the managed species, and associated species such as major prey species, including affected life history stages.
3. The Federal agency's views regarding the effects of the action on EFH.
4. Proposed mitigation, if applicable.

Other information that should be incorporated into an EFH assessment for a project of this scope includes the results of site specific effects of the project, the views of recognized experts on the habitat or species affected, a review of pertinent literature and related information and an analysis of alternatives to the proposed action.

If you need additional information regarding this matter, please contact Anita Riportella at (732) 872-3116.

Sincerely,

Stanley W. Gorski
Field Offices Supervisor

enclosures
ar/bartolit.dei
cf: EPA, Region II
FWS, Pleasantville
NJDEP, LURP
NJ, F,G&W

The COE has provided NMFS a written assessment of the effects of the project on EFH. This was conducted subsequent to release of the draft EIS but will be included in the final EIS.

The final EIS includes this information.

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
408 Atlantic Avenue - Room 142
Boston, Massachusetts 02210-3334

August 26, 1999

ER 99/0604

LT. Colonel Debra M. Lewis
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear LT. Colonel Lewis:

The Department of the Interior (Department) has reviewed the Revised Draft Feasibility Report and Integrated Environmental Impact Statement for the Barnegat Inlet to Little Egg Inlet, New Jersey Feasibility Study (DEIS). The subject DEIS addresses shoreline protection within the 17-mile-long project area, which is located on Long Beach Island and incorporates six political jurisdictions in Ocean County, New Jersey including Long Beach Township and the Boroughs of Barnegat Light, Harvey Cedars, Surf City, Ship Bottom, and Beach Haven.

The proposed project would restore berms and dunes through beach nourishment and subsequent renourishment. The Corps proposes to create a 125-foot-wide berm with a top elevation of +8.0 feet based on the North American Vertical Datum (NAVD) for approximately 17 miles along the Atlantic Ocean. The proposed berm and dune restoration extends from groin 4 (Seaview Drive, Loveladies) to the terminal groin (groin 98) in Long Beach Township - Holgate. The northern end of the study area at Barnegat Light has a wide beach and is not in need of shoreline protection. As a result, this area is not included in the project. The Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge (Refuge) (southern end of study area) is also not included in the project. Since both ends of the project terminate at a groin, tapers will not be needed. Berm slopes are proposed at 1:10 (vertical:horizontal). A dune with a top elevation of +22 feet NAVD, side slopes of 1:5 (vertical:horizontal), and a top width of 30 feet would also be constructed. The proposed project life is 50 years (U.S. Army Corps of Engineers, 1999).

The Long Beach Island Project would require approximately 5.0 million cubic yards of sand for the initial berm placement, and 2.45 million cubic yards for dune placement. Subsequent maintenance would require approximately 2.0 million cubic yards of sand every 7 years to renourish the proposed beaches for the project life. The Corps proposes to obtain sand from four offshore borrow sources (U.S. Army Corps of Engineers, 1999).

FEDERALLY LISTED SPECIES

The federally listed (threatened) piping plover (*Charadrius melodus*) nests in two locations within the proposed project area. Piping plovers nest on the beaches of Barnegat Light, and between Harvey Cedars and Loveladies. Piping plovers also nest on the beaches adjacent to the proposed project area within the Holgate Unit of the Refuge. Piping plovers nest on sandy beaches above the high tide line on mainland coastal beaches, sand flats, and barrier island coastal beaches. The proposed project, via construction activities or use of the restored beach by humans, may affect piping plovers. The Department understands that the Corps is currently preparing a Biological Assessment for piping plovers and will implement recommendations developed in the Biological Assessment for this project (U.S. Army Corps of Engineers, 1999).

To minimize impacts to piping plovers associated with proposed beach nourishment and renourishment activities, the U.S. Fish and Wildlife Service (FWS) recommended several project modifications in its Draft Fish and Wildlife Coordination Act, Section 2(b) Report (Arroyo, 1999) including the following: seasonal restrictions, further consultation pursuant to Section 7(a)(2) of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) prior to initial nourishment and all subsequent renourishment activities; and compliance with the FWS's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act," dated April 15, 1994. The Corps has addressed and agreed to implement these recommendations regarding piping plovers (U.S. Army Corps of Engineers, 1999).

In addition, the project may create habitat for the seabeach amaranth (*Amaranthus pumilus*), a federally listed (threatened) plant. The seabeach amaranth is an annual plant, endemic to Atlantic coastal plain beaches, primarily occurring on overwash flats at the accreting ends of barrier beach islands and lower foredunes of non-eroding beaches. The species occasionally establishes small temporary populations in other areas, including bayside beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment or dredge spoil. Although no extant occurrences of the seabeach amaranth are known within the proposed project area, the species has recently recolonized coastal sites within New York and Maryland. Therefore, it is possible that the seabeach amaranth may become naturally reestablished within the project area during the project life.

To minimize impacts to seabeach amaranth associated with beach nourishment and renourishment activities, the FWS recommended conducting surveys for seabeach amaranth prior to initiation of construction activities. If seabeach amaranth is identified in the project area, protective zones should be established around the plants to avoid impacts from construction-related activities. The Corps has addressed and agreed to implement these recommendations regarding seabeach amaranth (U.S. Army Corps of Engineers, 1999).

Other than the piping plover, seabeach amaranth, and an occasional transient peregrine falcon (*Falco peregrinus*) or bald eagle (*Haliaeetus leucocephalus*), no other federally listed or proposed endangered or threatened flora or fauna under FWS jurisdiction are known to occur within the project area.

EXTRACTION FROM BORROW AREAS

The Corps has also addressed and agreed to implement the following recommendations pertaining to dredging activities within the borrow areas:

(1) avoid the creation of excessively deep, poorly flushed borrow sites; and,

(2) avoid dredging during shellfish and finfish spawning activity.

The FWS also recommended the use of hydraulic-pipeline dredging rather than hydraulic-hopper dredging to reduce turbidity and the potential entrainment of federally listed sea turtles (Arroyo, 1999). However, through formal consultation pursuant to the Endangered Species Act, the National Marine Fisheries Service (NMFS) provided a Biological Opinion and an incidental take statement regarding hydraulic-hopper dredge operations. Provided that the Corps adheres to the terms and conditions provided in the Biological Opinion, the Department does not oppose the use of hydraulic-hopper dredging.

A Biological Assessment that discusses Philadelphia District hopper dredging activities and potential effects on Federally threatened and endangered species of sea turtles was prepared and formally submitted to the NMFS. A Biological Opinion was provided by the NMFS in November 1996. As a term and condition of the incidental take statement included in this Opinion, the Corps will monitor all hopper dredge operations in areas where sea turtles are present between June and November by trained endangered species observers. Adherence to the findings of the Biological Opinion would insure compliance with Section 7 of the Endangered Species Act.

Based on potential adverse impacts to benthic macroinvertebrates, the FWS and the New Jersey Division of Fish, Game, and Wildlife strongly discouraged the use of Borrow Areas B and E, which are designated as Prime Fishing and Surf Clam Areas (Arroyo, 1999). Furthermore, Section 7:7E-3.4 of the Rules on Coastal Zone Management, Chapter 7E New Jersey Administrative Code, August 20, 1990 (updated 1994), prohibits uses of Prime Fishing Areas that would alter existing bathymetry to a significant degree and reduce high fishery productivity of the area. However, in the DEIS, the Corps proposes to use Borrow Area E for initial beach fill. The Department opposes use of Borrow Areas B and E and recommends that the Corps redesign project plans to avoid these areas.

In accordance with the NJDEP's regulation, USFWS recommendations in the FWCA 2(b) report, and avoidance of Essential Fish Habitat (EFH) under the NMFS's Magnuson-Stevens Fishery and Conservation Act (MSA), Borrow Area E has been eliminated. Borrow Area B was never part of the former selected plan.

ADDITIONAL COMMENTS AND DEPARTMENTAL POSITION

Several other recommendations were provided by the FWS; however, they were not addressed in the Corps DEIS. The Department recommends that the Corps address the following measures in the Final Feasibility Report and Integrated Environmental Impact Statement and incorporate them into the project design.

1. Conduct each renourishment dredging phase in a limited portion of the borrow area and alternate locations for each subsequent renourishment cycle (rotational dredging).

Concur. Contour dredging will be conducted. This entails utilizing sections of the borrow area with subsequent renourishment cycles so that the actual dredged area is rotated. This also entails avoidance of the creation of deep, poorly flushed pits.

2. Obtain a perpetual deed restriction or conservation easement for the newly created beach and adjacent beach areas.

3. Develop informational materials (e.g., brochures, interpretive signs) to educate beach-users about beachnesting birds.

4. Implement a shorebird monitoring program in coordination with the FWS.

5. Coordinate with the FWS and the New Jersey Endangered and Nongame Species Program on opportunities to enhance habitats for beachnesting birds (e.g., irregular dune configurations, fencing systems to trap sand, removal or burial of vegetation during beach renourishment).

Provided these and other FWS recommendations are implemented and included in the Final Feasibility Report and Integrated Environmental Impact Statement, the Department concurs with the proposed project.

If you have any questions regarding these comments or require further assistance on issues regarding fish and wildlife resources related to the proposed project, including federally listed threatened or endangered species, please contact the FWS at the following address:

Supervisor
U.S. Fish and Wildlife Service
New Jersey Field Office
Ecological Services
927 N. Main Street, Building D-1
Pleasantville, New Jersey 08232
(609) 646-9310

Thank you for the opportunity to provide these comments.

Sincerely,

Andrew L. Raddant
Regional Environmental Officer

Refer to Section 5.2 of the report. The local sponsor NJDEP secures permanent easements for the project.

The local sponsor will address development of informational materials for the purpose of educating the public about beach nesting birds.

In cooperation with the local sponsor, the COE will develop a shorebird monitoring program that is in compliance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act", dated April 15, 1999. No placement of fill is proposed at Barnegat Inlet where piping plovers have been identified. The COE will coordinate with both the USFWS and the NJDEP on threatened and endangered species prior to initial nourishment and all subsequent renourishment activities. If piping plovers are identified at Barnegat Inlet, initial construction can begin in the southern most portion of the project area to avoid the plovers during their breeding season.

The proposed project design incorporates dune fencing and the planting of dune grasses to trap sand. Burial of existing beach vegetation will be minimized.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
927 North Main Street (Bldg. D1)
Pleasantville, New Jersey 08232

FP-99/39

August 30, 1999

Lt. Colonel Debra M. Lewis
District Engineer, Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Colonel Lewis:

This is the final report of the U.S. Fish and Wildlife Service (Service) regarding anticipated impacts on fish and wildlife resources from the U.S. Army Corps of Engineers (Corps) proposed Barnegat Inlet to Little Egg Inlet Feasibility Study, Ocean County, New Jersey. This report was prepared pursuant to Section 2(b) of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 *et seq.*).

This report is provided in accordance with our Fiscal Year-1998 scope-of-work agreement and is based on plans and information provided in the Corps June 1999 Barnegat Inlet to Little Egg Inlet Revised Draft Feasibility Report and Integrated Environmental Impact Statement. The Service (1996) previously provided a Planning Aid Report entitled, "Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey."

The federally listed (threatened) piping plover (*Charadrius melodus*) nests in two locations within the proposed project area. Piping plovers nest on the beaches of Barnegat Light, and between Harvey Cedars and Loveladies. Piping plovers also nest on the beaches adjacent to the proposed project area within the Holgate Unit of the Edwin B. Forsythe National Wildlife Refuge. Piping plovers nest on sandy beaches above the high tide line on mainland coastal beaches, sand flats, and barrier island coastal beaches. The proposed project, via construction activities or use of the restored beach by humans, may affect piping plovers.

In addition, the project may create habitat for the seabeach amaranth (*Amaranthus pumilus*), a federally listed (threatened) plant. The seabeach amaranth is an annual plant, endemic to Atlantic coastal plain beaches, primarily occurring on overwash flats at the accreting ends of barrier beach islands and lower foredunes of non-eroding beaches. The species occasionally establishes small temporary populations in other areas, including bayside beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment or dredge spoil. Although no extant occurrences

The final USFWS 2(b) Report is provided in the Appendix of the FEIS in it's entirety.

of the seabeach amaranth are known within the proposed project area, the species has recently naturally recolonized coastal sites within New York and Maryland. Therefore, it is possible that the seabeach amaranth may become naturally reestablished within the project area during the project life.

The lead federal agency for a project has the responsibility under Section 7(c) of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) to prepare a Biological Assessment, if the proposal is a major construction project that requires an Environmental Impact Statement and if the proposal may affect a federally listed species. Therefore, the Corps must prepare a Biological Assessment to address potential project-related impacts to the piping plover and seabeach amaranth. The assessment should contain information concerning the piping plover and seabeach amaranth within the action area and an analysis of any potential effects of the proposed action on these species. The Service understands that the Corps is currently preparing a Biological Assessment for all of the currently proposed shoreline stabilization projects in New Jersey that may affect piping plovers.

To minimize impacts to piping plovers associated with proposed beach nourishment and renourishment activities, the Corps has agreed to implement several project modifications suggested by the Service including: seasonal restrictions; further consultation prior to initial nourishment and all subsequent renourishment activities; monitoring; and compliance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act," dated April 15, 1994 (Appendix A).

Additionally, to minimize impacts to seabeach amaranth associated with the proposed beach nourishment and renourishment activities, the Corps has agreed to conduct surveys for seabeach amaranth prior to initiation of construction activities (U.S. Army Corps of Engineers, 1999). If seabeach amaranth is identified in the project area we recommend modifying the project to establish a protective zone around any seabeach amaranth sites identified and avoid: construction-related pedestrian and vehicular traffic; placement, movement, or maintenance of pipelines; stockpiling of construction materials and equipment; and pumping, placement, or distribution of sand within such zones.

Other than the piping plover, seabeach amaranth, and an occasional transient bald eagle (*Haliaeetus leucocephalus*), no other federally listed or proposed endangered or threatened flora or fauna under Service jurisdiction are known to occur within the project area.

The federally listed (endangered) Kemp's Ridley turtle (*Lepidochelys kempii*), hawksbill turtle (*Eretmochelys imbricata*), leatherback turtle (*Dermochelys coriacea*) and the federally listed (threatened) green turtle (*Chelonia midas*) and loggerhead turtle (*Caretta caretta*) occur in the

The proposed dredging schedule is April through November. In cooperation with the local sponsor NJDEP, the COE will develop a shorebird monitoring program that is in compliance with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Take Under Section 9 of the Endangered Species Act", dated April 15, 1994. No placement of fill is proposed at Barnegat Inlet where piping plovers have been identified. The COE will coordinate with both the USFWS and the NJDEP on threatened and endangered species prior to initial nourishment and all subsequent renourishment activities. If piping plovers are identified at Barnegat Inlet, initial construction can begin in the southern most portion of the project area to avoid the plovers during their breeding season.

Likewise for the seabeach amaranth. Although no extant occurrences of seabeach amaranth are known within the project area, if the species is found during pre-construction surveys, the COE will modify the project to establish a protective zone around the identified sites to avoid impact.

Atlantic Ocean immediately adjacent to the proposed project area. Except for nesting habitat for sea turtles, principal responsibility for marine turtles and marine mammals is under the jurisdiction of the National Marine Fisheries Service. Additional information regarding this report can be provided by John Staples or Lisa Arroyo of my staff.

Sincerely,

Clifford G. Day
Supervisor

References

U.S. Army Corps of Engineers. 1999. Barnegat Inlet to Little Egg Inlet, Revised Draft Feasibility Report and Integrated Environmental Impact Statement. U.S. Department of the Army, Corps of Engineers, Philadelphia District, Philadelphia, Pennsylvania.

U.S. Fish and Wildlife Service. 1996. Barnegat Inlet to Little Egg Inlet Reconnaissance Study, Ocean County, New Jersey. Planning Aid Report. U.S. Department of the Interior, Fish and Wildlife Service, New Jersey Field Office, Pleasantville, New Jersey. 23 pp. + appendices.

Enclosure

A Biological Assessment that discusses Philadelphia District hopper dredging activities and potential effects on Federally threatened and endangered species of sea turtles was prepared and formally submitted to the NMFS. A Biological Opinion was provided by the NMFS in November of 1996. As a term and condition of the incidental take statement included in this Opinion, the Corps will monitor all hopper dredge operations in areas where sea turtles are present between June and November by trained endangered species observers. Adherence to the findings of the Biological Opinion would insure compliance with Section 7 of the Endangered Species Act.

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3391

31 AUG 1999

REPLY TO ATTENTION OF
Planning Division

SUBJECT: Water Quality Certification and Federal Consistency Determination on the Barnegat Inlet to Little Egg Inlet

Richard H. Kropp
Director, Land Use Regulation Program
P.O. Box 439
Trenton, New Jersey 08625-0439

Dear Mr. Kropp:

This is in response to your letter dated August 23, 1999, regarding Water Quality Certification and Federal Consistency Determination on the Barnegat Inlet to Little Egg Inlet Revised Draft Feasibility Report and Integrated Environmental Impact Statement. Our responses are sequenced to the comments in your August 23rd letter and should reflect recent coordination with your staff. We appreciate your quick response in an effort to meet our current schedule in meeting the Water Resources development Act of 1999 (WRDA 99) deadline. Our goal is to obtain a favorable consistency determination by September 3, 1999

1. 7:7E-3.3 Surf Clam Areas & 7:7E-3.4 Prime Fishing Areas

In accordance with the stated NJDEP's regulation, USFWS recommendations in the FWCA 2(b) report, and avoidance of Essential Fish Habitat (EFH) under National Marine Fisheries Services Magnuson-Stevens Fishery Conservation and Management Act, Borrow Area E is being eliminated. Borrow Area B was never part of the former selected plan.

The revised selected plan uses borrow areas A, D1 and D2 for project construction. The Corps recognizes the regulations and laws in place restricting use of Borrow Area E, however, there are additional cost implications that impact the project. The increase of approximately $10,000,000 for initial construction and $15,000,000 for the total project necessitated an attempt to develop an alternative plan, which may have been acceptable to the resource agencies and the state of New Jersey. The plan called for portioned use of Borrow Area E and contour dredging. A comprehensive monitoring plan would have been included to monitor the impact to critical finfish and surf clam habitat.

Coordination with the non-Federal sponsor, NJDEP, on August 25, 1999 confirmed the State's position. The issue is not resolvable and the increased project costs are acceptable provided that the project meets the National Economic Development criteria, which it does.

Impacts to the recreational fishing habitat adjacent to groins due to the placement of beach fill will be minimal and fully documented in the final report. Profile of the plan design will be compared to the existing profile of the groin to generate volume determinations for sand. Areas immediately adjacent to groins are very dynamic and have been shown to have poor quality biological organisms.

2. N.J.A.C. 7:7E-3.12 Submerged Infrastructure Routes

The Corps will document, phone conversations held with the cable operators. Details of the buffer zone determination for dredging around the cables will be provided in the final report.

3. N.J.A.C.7:7-7.11 Coastal Engineering & N.J.A.C. 7:7E-8.11 Public Access to the Waterfront

The locations of the proposed public access points for Loveladies and North Beach, Long Beach Township, NJ will be detailed in the final report. The Township has indicated it will work with the State and the Corps to provide public access points approximately every quarter mile as well as provide appropriate parking spaces.

The Corps will coordinate the location and dimension of the access points and dune walkovers with the sponsor, the local community and the Land Use Regulation Program. Presently, the plan calls for the use of a "roll out boardwalk" structure. The system follows the contour of the dune. Other structures may be identified during the Preconstruction Engineering and Design (PED) phase.

4. N.J.A.C. 7:7E-3.16 Dunes & N.J.A.C. 7:7E-3A.3 Standards Applicable to Dune Creation and Maintenance

This issue is adequately addressed as part of the response to Comment 3 (above). The Corps will follow the standards as stated in the above regulation.

5. 7:7E-3.36 Historic and Archaeological Resources

Supplemental cultural resources investigations are continuing in the project area and should be concluded by the end of September 1999. Additional remote sensing of Borrow Area "D2" will be conducted during the PED. All results, including the initial Phase I investigation, supplemental investigation, and remote-sensing investigation of Borrow Area "D2" will be coordinated with the NJ SHPO. A Construction Monitoring Program and Magnetic Anomaly

Protection Program will be prepared by the District in consultation with the NJ SHPO, and implemented prior to and during construction. Section 106 coordination will be conducted prior to any project construction activity.

Underwater operations were conducted at Target 7.614 in June 1999. The results of that investigation showed that the target is a navigational Bell Buoy that is not eligible for listing in the National Register of Historic Places.

6. 7:7E-3.38 Endangered and Threatened Wildlife or Vegetation Species Habitat

The District will comply with the Service's "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Illegal Take Under Section 9 of the Endangered Species Act", dated April 15, 1994.

Use of seasonal dredging restrictions and implementation of a Comprehensive Beach Nesting Bird Management Plan will be coordinated with the USFWS and the NJDEP Endangered and Non-Game Species Program.

The Federal project does not involve the placement of sand on private lands. Any placement of temporary fencing and signage as part of management activities necessary to protect and prevent illegal "take" of endangered or threatened species needs to be coordinated with the Corps and local governments.

The project does not call for placement of fill in the Barnegat Light area; therefore, initial construction should have little impact to nesting birds of concern as indicated above.

7. 7:7E-4.2(1) Acceptability Conditions for Uses, Standards relevant to sand and gravel extraction

The Corps has eliminated special areas from being directly or indirectly degraded. Actions to be taken and documented in the Final Report should satisfy the recommendations made by the Land Use Regulation Program.

We thank you for your cooperation and earnest cooperation in this matter. If there are any other deficiencies that may prohibit granting a conditional consistency determination, please contact Randy Piersol of our staff at (215) 656-6577 immediately.

Sincerely,

Paul Dandini
for Robert L. Callegari
Chief, Planning Division

Copy Furnished

Bernard J. Moore, NJDEP 1501 Hooper Avenue, Tome River, New Jersey 08625 08753
Lawrence Schmidt, Office of Coastal Planning and Program Coordination
Helen (Fasano) Owens, Land Use Regulation Program, NJDEP

United States Department of the Interior

MINERALS MANAGEMENT SERVICE
Washington, DC 20240

SEP 01 1999

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District, U.S. Army Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

Dear Mr. Callegari:

Thank you for the opportunity to review the draft report titled "Barnegat Inlet to Little Egg Inlet, New Jersey, Draft Feasibility Report and Integrated Environmental Impact Statement."

The only concern the Minerals Management Service (MMS) has with the report relates to Borrow Area D2. As mentioned in the report, D2 is in Federal waters, approximately 3.5 mil **1.** offshore of Harvey Cedars, New Jersey. If sand is needed from the borrow site, the Philadelphia District, U.S. Army Corps of Engineers (Corps) will have to complete a Memorandum of Agreement (MOA) with MMS. We would also recommend that the Corps engage in an **2.** Essential Fish Habitat Consultation with National Marine Fisheries Service, especially with respect to surf clams.

As you may be aware, the fee requirement for use of Federal sand was removed in the Water Resources Development Act of 1999. However, state or local communities receiving the sand must still complete a Negotiated Agreement (lease) with the MMS.

If you have any questions, contact Roger Amato at (703) 787-1282.

Sincerely,

Carol A. Hartgen

Carol A. Hartgen
Chief, International Activities and
Marine Minerals Division

1. Concur. The Philadelphia District will follow an MOA similar to that which has been signed by MMS and other Corps Districts.

2. Concur. The Philadelphia District has initiated EFH consultation with NMFS.

State of New Jersey
Department of Environmental Protection

Land Use Regulation Program
P.O. Box 439, Trenton, NJ 08625-0439
Fax # (609) 292-8115
Fax # (609) 777-3656

SEP 02 1999

Robert L. Callegari
Chief, Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

RE: Barnegat Inlet to Little Egg Inlet Revised Draft Feasibility Report
and Integrated Environmental Impact Statement
Federal Consistency Determination and Section 401 Water Quality Certification
Land Use Regulation Program File No. 1500-99-0001.1

Dear Mr. Callegari:

The U.S. Army Corps of Engineers has proposed a project intended to provide shore protection and storm damage reduction for the communities between Barnegat Inlet and Little Egg Inlet (Long Beach Island), Ocean County, New Jersey. The feasibility study evaluated alternative plans for improvements formulated on storm damage reduction benefits. The selected plan for hurricane and storm damage protection is berm and dune restoration utilizing sand obtained from offshore borrow sources. The template for the plan is a dune with an elevation of 22-ft NAVD, and a 30-foot dune crest width. The dune slopes from the crest at a 1V : 5H slope to a berm at elevation +8 ft NAVD. The berm width is 125 ft from the centerline of dune. The beachfill continues from MHW at a 1V : 10H slope from the berm to MLW. This plan would require 4.95 million cubic yards of sand for initial berm placement, and 2.45 million cubic yards for dune placement. Approximately 1.9 million cubic yards of sand would be needed for periodic nourishment every 7 years for the 50-year period analysis.

The New Jersey Department of Environmental Protection, Land Use Regulation Program, acting under Section 307 of the Federal Coastal Zone Management Act (P.L. 92-583) as amended, has reviewed the "Barnegat Inlet To Little Egg Inlet Revised Draft Report and Integrated Environmental Impact Statement" dated June 1999. The Program has considered information discussed at a November 18, 1998 meeting with Randy Piersol of the ACOE, Mark Mauriello of the Land Use Regulation Program, representatives of New Jersey's Division of Fish, Game and Wildlife, representatives of the U.S. Fish and Wildlife Service and NOAA. The Program has also considered additional information and project revisions submitted the Army Corps of Engineers by letter dated August 31, 1999. Based on the above, the Program has determined that the draft plan and project, as currently designed, is consistent with New Jersey's Rules on Coastal Zone Management N.J.A.C. 7:7E-1.1 et seq. as amended to December 7, 1998 and the applicable

Rules guiding issuance of a Section 401 Water Quality Certificate. Provided that the Final Report and Plans submitted for a federal consistency adequately addresses the issues discussed below, a favorable determination will be made upon review of that report.

1. <u>7:7E-3.3 Surf Clam Areas & 7:7E-3.4 Prime Fishing Areas</u>

Surf clam areas are waters within the territorial sea of the State of New Jersey which can be demonstrated to support significant commercially harvestable quantities of surf clams (<u>Spisula Solidissima</u>), or areas important for recruitment of surf clam stocks. Development which would result in destruction, condemnation, or contamination of surf clam areas is prohibited.

Prime fishing areas include tidal water areas and water's edge areas which have a demonstrable history of supporting a significant local quantity of recreational or commercial fishing activity. Prohibited uses include sand or gravel submarine mining which would alter existing bathymetry to a significant degree so as to reduce the high fishery productivity of these areas.

In accordance with these regulations, U.S. Fish and Wildlife Service recommendations in the Fish and Wildlife Coordination Act Section 2(b) report, and to avoid Essential Fish Habitat under National Marine Fisheries Services Magnuson-Stevens Fishery Conservation and Management Act, by letter dated August 31, 1999 the ACOE has agreed to eliminate the use of borrow area "E" from the final plan. The revised selected plan will use borrow areas A, D1 and D2 for project construction.

Should the ACOE consider alternative borrow areas for utilization, the ACOE shall coordinate the areas with the Division of Fish, Game and Wildlife, and the Historic Preservation Office. The use of other sea lumps / mounds not identified as "Prime Fishing Area" may be acceptable. These areas may provide the same valuable habitat, and therefore, the ACOE shall coordinate with the Division of Fish, Game and Wildlife to develop a dredging plan that includes best management practices that minimize habitat impacts and allows for recovery of resources at these alternative sites.

The ACOE reports that there are 101 groin structures with lengths from 250 to 420 feet. At various times of the year certain groins are completely covered by sand. Based on comments from the NJDEP Division of Fish, Game and Wildlife, by letter dated August 31, 1999 the ACOE has agreed that the final report and plans will assess impacts to the recreational jetty fishery that may result from the nourishment activities.

The final report shall provide recommendations for mitigation if the findings of the fishery assessment indicate significant losses to the fishery.

2. <u>N.J.A.C. 7:7E-3.12 Submerged Infrastructure Routes</u>

A "submerged infrastructure route" is the corridor in which a pipe or cable runs on or below a submerged land surface. Any activity which would increase the likelihood of infrastructure damage or breakage, or interfere with maintenance operations is prohibited.

See COE response letter dated 31 August 1999.

As shown in Figure 2-3, the proposed borrow area D-2 will abut an existing cable line, and D-1 is a short distance from another cable. By letter dated August 31, 1999 the final report shall include documentation of coordination with the cable operators, and shall include details of the buffer zone for dredging around cables.

3. <u>**N.J.A.C. 7:7-7.11 Coastal Engineering & N.J.A.C. 7:7E-8.11 Public Access to the Waterfront**</u>

Public access, including parking where appropriate, must be provided to publicly funded shore protection structures and to waterfronts created by public projects unless such access would create a safety hazard to the user. Physical barriers with access to, along, or across a structure are prohibited.

As reported, at this time there is only one public access point provided in a 2.1 mile stretch of Loveladies, and one in a 1.3 mile stretch of North Beach, Long Beach Township. Public funds will be utilized to protect these municipalities over the 50-year project life. By letter dated August 31, 1999 the ACOE reports that Long Beach Township has agreed to work with the State and the Corps to provide public access points approximately every quarter mile, as well as provide appropriate parking. The Corps will coordinate the location and dimensions of the access points and dune walkovers with the sponsor, the local community, and the Land Use Regulation Program. Other structures may be identified during the Pre-construction Engineering and Design (PED) phase.

The final report and plan shall include new public access points every .25 mile along the Loveladies and North Beach stretches. Public access must be clearly marked, provide parking (a minimum of 8 parking spaces per access point), be designed to encourage the public to take advantage of the waterfront setting, and must be barrier free where applicable. In addition, the final plan shall identify the location of the currently existing public access points in Loveladies and North Beach.

The final location an dimensions of the access points and dune walkovers shall be coordinated with the sponsor, the local community, and the Land Use Regulation Program, and shall be designed in accordance with N.J.A.C. 7:7E-3A.3 <u>Standards Applicable to Dune Creation and Maintenance</u>. A "roll out boardwalk" structure is proposed for the dune walkovers. Be advised that this rule states that the construction of elevated dune walkover structures, particularly at municipal street ends and other heavily used beach access points, is preferred to the construction of pathways or walkways through the dunes.

4. <u>**N.J.A.C. 7:7E-3.16 Dunes & N.J.A.C. 7:7E-3A.3 Standards Applicable to Dune Creation and Maintenance**</u>

A dune is a wind or wave deposited or man-made formation of sand (mound or ridge), that lies generally parallel to, and landward of the beach, and between the upland limit of the beach and the foot of the most inland dune slope. Development is prohibited on dunes, except for development that has no practicable or feasible alternative in an area other than a dune, and that will not cause significant adverse long-term impacts on the natural functioning of a dune system, either individually or in combination with other existing or proposed structures, land disturbance or activities. In addition, the removal of vegetation from any dune, and the excavation, bulldozing or alteration of dunes is prohibited, unless these activities are a component of a Department approved beach and dune management plan.

At street ends or other traffic areas which currently do not have any existing structural dune walkovers in place the ACOE proposes natural beach walkover paths, at a skewed angle, delineated by sand fencing. The final location and dimensions of dune walkover points will be coordinated with the local sponsor and the local community during the preparation of plans and specifications. Vehicular access will be provided at existing vehicular access points, and will be further coordinated with the local sponsor and community.

The final plan and specifications shall identify the locations of the proposed access-ways, and indicate the type of access proposed at each location. Any community requested special beach access appurtenances that require the construction of additional walkovers, vehicle access points, or the modification of proposed access paths shall be coordinated with, the NJDEP Land Use Regulation Program, and shall comply with the Dunes (N.J.A.C. 7:7E-3.16) and Standards For Beach And Dune Activities (N.J.A.C. 7:7E-3A) rules.

5. **7:7E-3.36 Historic and Archaeological Resources**

Historic and archaeological resources include objects, structures, shipwricks, buildings, neighborhoods, districts, and man-made or man-modified features of the landscape and seascape, including historic and prehistoric archaeological sites, which either are on or are eligible for inclusion on the New Jersey or National Register of Historic Places. Development that incorporates historic and archaeological resources is discouraged.

By letter dated August 31, 1999, supplemental cultural resources investigations are continuing in the project area and are expected to be completed by the end of September 1999. Additional remote sensing of Borrow Area "D2" will be conducted during the PED phase of the project. All results, including the initial Phase I investigation, supplemental investigation, and remote-sensing investigation of Borrow Area "D2" will be coordinated with the NJ SHPO. A Construction Monitoring Program and Magnetic Anomaly Protection Program will be prepared by the ACOE in consultation with the NJ SHPO, and implemented prior to and during construction. Section 106 coordination will be conducted prior to any project construction activity.

Underwater operations were conducted at Target 7:614 in June 1999. The results of that investigation showed that the target is a navigational Bell Buoy that is not eligible for listing in the National Register of Historic Places.

The following conditions have been recommended by the Historic Preservation Office. These items shall be addressed in the final plans and report. Be advised that if alternative borrow areas are proposed, the ACOE is required to perform the necessary cultural surveys and coordinate with the Historic Preservation Office to **develop a plan to avoid potential impacts to the resources.**

a) The U.S. Army Corps of Engineers shall complete Section 106 (of the National Historic Preservation Act) coordination with the Historic Preservation Office to identify historic properties and mitigate and/or avoid effects to historic properties. This coordination shall include, but not be limited to the following.

i.) Cultural resource investigations within all areas of potential project effects shall be completed. These investigations shall be coordinated with the Historic Preservation Office.

ii.) A program of controlled, periodic archaeological monitoring shall be undertaken during, and immediately following, the beach replenishment operation to identify any archaeological materials originating in the offshore sand borrow areas. The details of this program shall be coordinated with the Historic Preservation Office.

iii.) A program to ensure protection of magnetic anomalies identified along the shoreline and in near shore areas shall be undertaken during the placement of sand. The details of this program shall be coordinated with the Historic Preservation Office.

6. 7:7E-3.38 Endangered and Threatened Wildlife or Vegetation Species Habitat

Areas know to be inhabited on a seasonal or permanent basis by or to be critical at any stage in the live cycle of any wildlife (fauna) or vegetation (flora) identified as "endangered" or "threatened" species on official Federal or State lists of endangered or threatened species, or under active consideration for State or Federal listing, are considered Special Areas. The definition also includes a sufficient buffer area to insure continued survival of the population of the species.

The project area encompasses and may impact nesting habitat for piping plovers, least terns and black skimmers. It is likely that these species will colonize portions of the newly created / enlarged beach habitat. Potential impacts to these species has been addressed in the Integrated EIS and / or in the included USFWS 2(b) Report (Appendix D). The NJDEP Division of Fish, Game and Wildlife concurs with all USFWS recommendations.

Based on recommendations made by NJDEP Division of Fish, Game and Wildlife, by letter dated August 31, 1999 ACOE has agreed to coordinate with the USFWS and NJ Endangered and Nongame Species Program to develop and implement a Comprehensive Beach Nesting Bird Management Plan. This plan will include seasonal dredging restrictions. The Federal project does not involve the placement of sand on private lands. The placement of temporary fencing and signage as part of management activities necessary to protect and prevent illegal "take" of endangered or threatened species must be coordinated with the Corps and the local governments. The Corps will comply with the USFWS "Guidelines for Managing Recreational Activities in Piping Plover Breeding Habitat on the U.S. Atlantic Coast to Avoid Illegal Take Under Section 9 of the Endangered Species Act", dated April 15, 1994.

Based on recommendations by NJDEP Division of Fish, Game and Wildlife, the final project and plans shall include a commitment by the ACOE to also coordinate with the non-federal sponsor and all of the subject local municipalities, to develop, adopt, and implement a comprehensive beach nesting bird management plan, with the assistance of the USFWS, and NJ Endangered and Nongame Species Program.

State of New Jersey

Christine Todd Whitman
Governor

Department of Environmental Protection
Office of Coastal Planning and Program Coordination
PO Box 418
Trenton, NJ 08625-0418
Phone 609-292-2662
Fax 609-292-4608

Robert C. Shinn, Jr.
Commissioner

September 21, 1999

Mr. Robert L. Callegari
Chief, Planning Division
Philadelphia District
US Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3391

RE: Barnegat Inlet to Little Egg Inlet (LBI), Ocean County, New Jersey
Draft Feasibility Report and Integrated Environmental Impact Statement

Dear Mr. Callegari:

The Office of Program Coordination of the New Jersey Department of Environmental Protection has completed its review of the Draft Feasibility Report and Integrated Environmental Impact Statement for Barnegat Inlet to Little Egg Inlet (Long Beach Island (LBI)). Our Department supports the proposed project as the non-federal sponsor. The Department's Land Use Regulation Program has also reviewed the proposed shore protection and storm damage reduction project through the Federal Consistency Determination and Section 401 Water Quality Certification review process.

Our Department's Division of Fish, Game and Wildlife provided our Office and the Land Use Regulation Program comments and concerns regarding the location of the proposed borrow areas as presented in the report. Those concerns and others of the Division of Fish, Game and Wildlife were conferred to you on August 23 in a letter from Richard Kropp, Director of the Land Use Regulation Program. Your August 31 response letter and the Land Use Regulation Program's September 2, 1999 reply adequately responds to the comments and concerns of the Division of Fish, Game and Wildlife. As stated in the September 2 letter, "...the Program has determined that the draft plan and project, as currently designed, is consistent with New Jersey's Rules on Coastal Zone Management N.J.A.C. 7:7E-1 et seq, as amended to December 7, 1998 and the applicable Rules guiding issuance of a Section 401 Water Quality Certificate. Provided that the Final Report and Plans submitted for the federal consistency adequately address the issues discussed below, a favorable determination will be made upon review of that report." These issues involve surf clam areas; prime fishing areas; submerged infrastructure routes; coastal engineering; public access to the waterfront;

dune creation and maintenance; cultural resources; endangered and threatened vegetation species habitat; and sand and gravel extraction.

The September 2 latter also adequately addresses other concerns of our Office regarding public access and potential adverse impacts to cultural resources.

We offer the following additional comments regarding the graphics of the draft document:

- The figures of the final report should contain additional keys and/or labels for clarification.
- The boundaries of the bundy's are inconsistent between figures of the document. For example the boundary between Bundy 8 and 9 on Figures 4-1A and 4-1B is 24th Street in Ship Bottom, however on Figure 5-15 it is 21st Street in Ship Bottom.

Thank you for the opportunity to comment on the Draft Feasibility Report and Integrated Environmental Impact Statement for this important project.

Sincerely,

Lawrence Schmidt
Director
Office of Program Coordination

C: Richard Kropp, NJDEP
Robert McDowell, NJDEP
Bernard Moore, NJDEP
Dorothy P. Guzzo, NJDEP

The issues involving surf clams, prime fishing areas, submerged infrastructure routes, coastal engineering, public access, dune creation and maintenance, cultural resource, endangered and threatened vegetation species habitat and sand borrow sources are addressed in the report.

The figures have been revised to correct the inconsistencies.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REG
290 BRC
NEW YORK, N

SEP 24 1999

Class: EC-2

Mr. Robert L. Callegari, Chief
Attn: Mr. Randy Piersol
Planning Division
Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

Dear Mr. Callegari:

The Environmental Protection Agency (EPA) has reviewed the draft environmental impact statement (EIS) for the Barnegat Inlet to Little Egg Inlet (LBI) Feasibility Study (EIS No. 990228), located in Ocean County, New Jersey. This review was conducted in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C. 7609, PL 91-604 12(a), 84 Stat. 1709), and the National Environmental Policy Act (NEPA). 1.

The project area, Long Beach Island, is a sandy barrier island with a total length of 20.8 miles. It is bounded on the north by Barnegat Inlet and on the south by the Little Egg/Beach Haven Inlet complex. The island is separated from the mainland to the west by a shallow, elongated estuary containing salt marsh fringes and islets. The estuary is a continuous water body made up of two integral embayments that are the southern end of Barnegat Bay and Little Egg Harbor, the two largest bays along the New Jersey Coast. These bays are a significant source of fish, shellfish, and recreation, as well as habitat for a variety of species of fish and wildlife, both migratory and native.

The draft EIS evaluates measures to reduce shoreline erosion and provide storm damage protection to Long Beach Island. The following alternatives were evaluated: no action; berm restoration; berm and dune restoration; berm and dune restoration with structurally reinforced dunes at Brant Beach; groin field modifications in combination with berm and dune restoration; nearshore feeder berm; and a sand recycle plant. The preferred plan is berm and dune restoration utilizing sand obtained from offshore borrow sources. This plan would require 4.95 million cubic yards (mcy) of sand for initial berm placement, and 2.45 mcy for dune placement. Approximately 1.9 mcy would be needed for periodic nourishment, which is expected to be every seven years over a 50-year period. The berm and dune restoration would extend from groin 4 (Seaview Drive, Loveladies) to the terminal groin (groin 98) in Long Beach Township - Holgate. The Barnegat Light (northern end of the study area) area would not be included in the project because of low erosion and substantial shore protection. Due to the fact that both ends of the project terminate at a groin, no tapers would be needed. Because the US Fish and Wildlife Service does not consider beach nourishment on the Holgate Unit of the Edwin B. Forsythe

1. No response required.

National Wildlife Refuge necessary, the Holgate Unit (southern end of the study area) would not be included in the project. As part of the berm and dune restoration approximately 1,030.85 acres will be covered, of these, approximately 365.10 acres will be above Mean High Water (MHW) and 665.75 acres will be below MHW. Based on our review, we have the following comments.

2.

Section 5.8 of the DEIS, **Cumulative Effects**, briefly describes a number of past, proposed, and on-going U.S. Army Corps of Engineers (ACE) erosion and storm damage protection projects along the New Jersey coastline, all of which involve beach nourishment with sand dredged from offshore borrow areas. The document acknowledges that this project may result in potential impacts to the benthic resource community of the borrow areas, to the surface clam, and Federally-listed threatened and endangered species. Because appropriate mitigation measures will be implemented, we agree that adverse impacts will be avoided and cumulative impacts to these biological resources should not be adverse. Cumulative impacts to other environmental resources of concern, such as water quality, barrier islands, back bay and intertidal and nearshore zone habitats, however, have not been evaluated. The consideration of cumulative impacts has been a long standing issue. On August 13, 1998, I sent you a letter expressing EPA's concerns and recommending the preparation of a comprehensive NEPA document for the numerous erosion control and beach nourishment projects. I reiterate our position that, in the absence of a comprehensive study, individual project documents, such as the EIS under review, should include an evaluation of cumulative impacts to pertinent resources.

Our review indicates that, though the project sites are located in the New Jersey Coastal Plain Aquifer System, which was designated by EPA as a Sole Source Aquifer on June 24, 1988 (53 F.R. 23791), the project would not adversely impact ground water and satisfies the requirements of Section 1424(e) of the Safe Drinking Water Act.

In conclusion, based on our review and in accordance with EPA policy, we have rated this draft EIS as EC-2 indicating that we have environmental concerns (EC) about the potential cumulative impacts associated with this and other related erosion/storm damage protection projects in the area. Accordingly, additional information (2) should be presented in the final EIS to address this issue.

Should you have any questions concerning this letter, please contact Raymond P. Reyes, of my staff, at (212) 637-3748.

Sincerely yours,

Robert W. Hargrove, Chief
Strategic Planning and Multi-Media Programs Branch

2. We feel that this EIS did evaluate the cumulative impacts of resources pertinent to this study. Resources such water quality, barrier islands, and back bays are not expected to be negatively impacted by anything other than minor and temporary impacts.

Barnegat Inlet to Little Egg Inlet Beach Nourishment Project (LBI)
Communication Log

Participants: Eric J. Charlier, USACE
Robert Wargo, AT&T

Date: 8/27/99 – 9/16/99

Subject: Submarine Trans-Atlantic Cables off of LBI Coast

-----Original Message-----
From: Wargo, Robert (Bob), NCIO [mailto:rwargo@att.com]
Sent: Monday, August 23, 1999 12:48 PM
To: Eric Charlier
Subject: Dredging and Submarine cables

Mr. Charlier,
I received a forwarded message from Mr. Ron Russian that you were interested
in getting information on safe distances to dredge sand from around cables.
I assume this is in relation to the ongoing project to replenish the beaches
all along the coast of New Jersey. I would like a little information
regarding your proposed dredge areas such as type of dredge, depth of water,
location (Lat. Lon.) and how deep the dredge will excavate the sediment. Is
the replenishment scheduled to take place this fall and will the entire
length of Long Beach Island be replenished? Thanks for your interest in
protecting submarine cables. I look forward to hearing from you.
Best regards,
Bob Wargo

-----Original Message-----
From: Charlier, Eric J NAP02
[mailto:Eric.J.Charlier@nap02.usace.army.mil]
Sent: Friday, August 27, 1999 2:40 PM
To: Wargo, Robert (Bob), NCIO
Subject: RE: Dredging and Submarine cables

Bob,
This is for the Long Beach Island Beach Fill project. The borrow areas of
concern ("D1" & "D2") are off of the coast between Harvey Cedars and Surf
City. I believe the depth of water is between 30'-40'. Off of the top of
my head, the depth of sediments removed is approx. 10'-15' deep. The
coords. of both areas are attached. We are still a few years away from any
dredging. The entire beach will get renourishment at some point during the
life of the project, but not all areas will receive any at the initial
construction. We will be dredging with a cutter head dredge which will have
a DGPS (Differential Global Positioning System) on board.

Could you please provide a safe distance to keep away from the cables other
than the typical 1-mile range, for our project.
If you need any further info. please email or call me at (215)656-6668.

thanks,
Eric Charlier

From: Robert Wargo

Mr. Charlier,
Thanks for the prompt reply, however there was no attachment with the
coordinates.
Bob Wargo

-----Original Message-----
From: Charlier, Eric J NAP02
[mailto:Eric.J.Charlier@nap02.usace.army.mil]
Sent: Friday, August 27, 1999 3:28 PM
To: Wargo, Robert (Bob), NCIO
Subject: RE: Dredging and Submarine cables

Bob,
Here you go, sorry, I forgot to attach these.

These are in NJ State Plane NAD 83.

D1	1	611460.562	308547.312
D1	2	609065.938	306527.719
D1	3	601741.812	303618.562
D1	4	605481.625	300837.719
D1	5	608686.312	302994.094
D2	6	609187.8161	303602.3441
D2	7	611582.8466	304735.9865
D2	8	614103.9328	306793.3384
D2	9	618137.6676	311416.0576
D2	10	615910.7087	312717.6472
D2	11	613473.6622	309820.5615
D2	12	611531.6345	308443.9064

thanks,
Eric

From: Robert Wargo

I am unable to convert these state plane coordinates to latitude longitude
pairs without having them end up off Boston, in which case, dredge away. I
have a feeling though they are probably off of NJ. Would it be possible for
you to convert these to Lat-Long pairs and resend?
Bob

From: Eric Charlier

The converted coords. Were provided.

From: Robert Wargo

Eric,
Thanks very much for the coordinates of the planned dredge area. However,
as usual, more information does not clarify the situation, only generate
more questions. Here they are:

After plotting them it looks as if you put the northern boundary on the cable, was this intentional?

How deep of a hole will be excavated by the dredge and does it do multiple
passes? Any information you can provide on the methods and procedures of
dredging in this area will be greatly appreciated.

Do you know the sediment grain size in the area you are dredging? I would
assume it was picked to be similar to that on the beaches of Long Beach
Island which would be that sugary, white, medium grained sand.

How are the dredges monitored to ensure that they stay within the planned
borrow area? My colleagues in the UK have a similar situation in which the
government electronically monitors the dredge with a vessel tracking system.
I believe that dredges that stray out of the planned area are fined and
repeat offenders may loose their license.

I apologize for the additional questions but I am getting very close to a
decision on this one but don't want it to be a hasty or misinformed one.

Best regards,
Bob

THIS IS HOW IT WAS LEFT. ROBERT WARGO HAS NOT REPLIED AS OF 9/23/99.

THE SAFE DISTANCE ASSUMED IN THE CALCULATIONS WAS APPROXIMATELY 200 FEET. If AT&T replies with a greater mandatory safe distance, then the borrow areas will be recalculated to determine their capacity. The potential quantities that may be unavailable due to the cables is very minor. If there is not enough material after recalculating the quantity, there are small portions of D1 & D2 that were not utilized which can be checked for compatibility. These portions were considered to be negligible in comparison to the rest of the borrow areas, but can be used to replace the quantities lost by the AT&T mandate forthcoming.

-----Original Message-----
From: Wargo, Robert (Bob), NCIO [mailto:rwargo@att.com]
Sent: Thursday, October 21, 1999 11:48 AM
To: Eric Charlier
Cc: Wills, Thomas
Subject: Dredging and submarine cables

Eric,
After much thinking about the angle of repose of sand at the bottom of the
ocean, the longshore current off the NJ coast, figuring out just how much
sand will be moved off the sea bed, and a little basic trigonometry and
calculus I am finally prepared to answer your question regarding how close
we think would be acceptable for you to dredge sand next to TAT-11. AT&T is
willing to accept a dredge no closer than one quarter mile from the location
of a submarine cable. You had initially asked for 1000 feet and I have to
say I am not comfortable with that. This primarily due to the fact that the
dredged sand will need to be replaced from somewhere and the knowledge that
in the past cables have been exposed due adjacent to dredged areas and
subsequently broken by fishing activities. Quite frankly, I'm not real
comfortable with a quarter mile either but I am attempting to balance your
needs, the needs of my home state and its dependence on tourism and the
needs of AT&T's customers. I hope this meets with your approval, if not
give me a call and we can talk about it.

I would also request that you keep us informed of the schedule of this
operation. If there is a possibility (as I feel there is in this case) of
an AT&T cable being damaged we can do some things up front that could limit
an outage to AT&T's network should an unfortunate event occur. We would
probably also have a guard vessel nearby just to keep an eye on things for
our own peace of mind.

Best Regards
Bob Wargo
973 326 3398

THE BOARD OF CHOSEN FREEHOLDERS
OCEAN COUNTY
TOMS RIVER, NEW JERSEY 08754

James J. Mancini
Freeholder

November 12, 1998

Randy Piersall
Army Corp. Of Engineers
Wannamaker Bldg.
100 N Square
East Phila., Pa. 19107-3390

Dear Randy:

Just to keep things moving, I am sending you this summarizing fact sheet. It is a summary, but actually very complete.

I hope this is of some benefit to you.

Sincerely,

James J. Mancini
Freeholder

JJM:cj
Enclosure

P.O. BOX 2191 ★ ADMINISTRATION BUILDING, TOMS RIVER, NEW JERSEY 08754-2191 ★ (908) 929-2001 ★ 1(800) 722-0291 ★ FAX # (908) 505-1918

A status report regarding beaches of the Township of Long Beach, Ocean County, State of New Jersey.

1. Largest protected beach in the State of New Jersey and probably in the United States of America.

   - Eleven miles of ocean Beach totally covered by lifeguards and maintained on a daily basis during the summer months.

2. Eleven miles plus of ocean beach is totally open to the public.

3. Beach badge fees are charged. ($12.00 for entire season)

4. There are well over **7500 free parking spaces** available to the general public.

   There are no parking meters in the Township of Long Beach.

   There is in the Township of Long Beach over **150 public accesses** to the ocean beach.

Conclusion.....

The Township of Long Beach offers the greatest length of ocean beach, greatest number of free parking spaces within close proximity to the ocean, and over 150 public accesses to the public beach.

I would be very interested and curious to learn if any other resort beach can equal the factors stated above.

The Township of Long Beach is truly a beach that is accessable in all categories to the general public and superior in all practical and pragmatic respects.

11-12-98

Phone Conversation Record: August 27, 1997

Re: Long Beach Township Projects

With: Mayor Mancini

Project: Brant Beach

Total Cost $500,000 State paid ¾ and the township paid ¼, originally ordered 50,000 cubic yards but then upped it another 10,000. Placement occurred for 38th street to 54th street. (16 blocks) Trucks delivered white sand or washed sand, free of silt and clay. 20 yard trucks.

Mayor Mancini questioned the use of a hopper dredge to take sand from Little Egg Inlet and place along LBI. After the 1962 storm LBI pumped sand from the Bay and created 18 miles of dunes and berms. There are environmental restrictions on such a practice today, including disturbing eel grass and benthic organisms. Mayor Mancini feels the people of LBI should come before the Bay. PL-PC mentioned that that material would not be suitable for the beach, but Mayor Mancini has a different opinion.

PL-PC discussed the use of a hardened core dune or a bulkhead at Brant Beach. The locals prefer a dune with a berm and a steady program of nourishment. However, a dune covered bulkhead would be acceptable. After the 1962 storm, Mayor Mancini put three hardened dunes (with low profile bulkheads) along the reach of three different hotels on the water and they have endured even until today.

Submitted by Randy Piersol 9/5/97

News Release

US Army Corps
of Engineers
Philadelphia District

061896
Release No.

215/ 656-6516
Phone:

now
For Release:

Joseph Morgan
Contact:

Corps' field teams studying Long Beach Island structures

Field teams deployed by the U.S. Army Corps of Engineers will inventory public and private buildings and shore protection structures of the New Jersey boroughs of Barnegat Light, Beach Haven, Harvey Cedars, Ship Bottom and Surf City and of Long Beach Township through the end of July.

The inventorying, which the Corps is conducting for a Long Beach Island shore protection study, may require field personnel of the Corps' Philadelphia District, usually operating in teams of two to four members, to occasionally cross private property.

One aim of the study that requires right-of-entry onto private property is acquisition of beach profiles of the communities. Another is the collection of economic data and structure information, including first-floor elevations.

The data collected by the teams will be used solely for purposes of the study, which is scheduled for completion in 1999 at a cost of $2.8 million. The study is not for flood insurance purposes, nor are houses singled out for study, the Corps emphasizes.

- end -

JIM SAXTON
THIRD DISTRICT, NEW JERSEY

NATIONAL SECURITY COMMITTEE
SUBCOMMITTEES
MILITARY PROCUREMENT
MILITARY INSTALLATIONS AND FACILITIES

MERCHANT MARINE OVERSIGHT PANEL

U.S. House of Representatives
Washington, DC 20515

RESOURCES COMMITTEE
FISHERIES, WILDLIFE AND OCEANS SUBCOMMITTEE
CHAIRMAN

JOINT ECONOMIC COMMITTEE
VICE-CHAIRMAN

REPUBLICAN POLICY COMMITTEE

September 10, 1996

Mr. Bob Callegari
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107

Dear Mr. Callegari,

Enclosed is a letter from a constituent, Mr. Andrew H. Anderson, of Beach Haven, New Jersey.

Mr. Anderson wrote to me with a concern over beach erosion along New Jersey's Coastline. I have also heard from other concerned citizens who feel that New Jersey beaches are in desperate need of being replenished.

Every year erosion depletes the New Jersey coastline. Funding for beach restoration is necessary throughout the state. I appreciate the Army Corps of Engineers considering this important issue carefully and giving this matter the attention it deserves.

Thank you for your time and effort in pursuing this issue.

Sincerely,

Jim Saxton

Jim Saxton
Member of Congress

HJS/lch
Enclosure

REPLY TO:
X 339 CANNON HOUSE OFFICE BUILDING, WASHINGTON, DC 20515-3003, (202) 225-4765
☐ 100 HIGH ST., SUITE 301, MT. HOLLY, NJ 08060-1458, (609) 261-5800
☐ 7 HADLEY AVE., TOMS RIVER, NJ 08753-7539, (908) 914-2020
☐ 1 MAINE AVENUE, CHERRY HILL, NJ 08002-3051, (609) 428-0520

G. ANDERSON AGENCY

August 1, 1996

The Honorable James Saxton
Member of Congress
339 Cannon House Office Building
Washington, D.C. 20515

Dear Congressman Saxton:

Your reports to Ocean County Newsletter of July, 1996 has prompted me to send this letter.

I noted that you head the Fish, Wildlife and Ocean Panel. I would like to solicit your assistance in a jetty modification project that is proposed to be undertaken by my hometown community, the Boro of Beach Haven, New Jersey.

For over twenty years I have been asking our Elected Officials to consider altering the stone and timber groin at Holyoke Avenue in Beach Haven. I was advised by Mayor Peter Butterick, Mayor Watson Pharo, and Mayor William Dondero over the past twenty years that the funds were not available and that the DEP/EPA Corps of Engineers would not approve such a modification. Our most recently elected Mayor, Dr. Victor Sencindiver, took exception to the other Mayors position and has, in fact, started the process of having the jetty modified. This is a beach that is frequented by Surfers and while I have nothing against Surfers they are fearful that their surfing beach will not be as good as it is today if the jetty is modified. They have requested a hearing and I assume they will be granted one.

The beach area on the south side of Holyoke Avenue has experienced considerable erosion, each and every winter, for the past twenty years that I have lived on Holyoke Avenue. I know that my community has spent untold Hundreds of Thousands of Dollars, if not Millions, trying to maintain a beach on Holyoke Avenue.

I am also enclosing a copy of an article which appeared in the Atlantic City Press, August 1st, 1996 edition which touts that the House approved a $52,000,000. Beach Replenishment Project for Atlantic City.

Please reply to:

☐ 12001 Long Beach Blvd. ☐ Haven Beach, NJ 08008 ☐ (609) 492-1277 ☐ Fax: (609) 492-1988

☐ 295 Route 72 East ☐ Manahawkin, NJ 08050 ☐ (609) 597-8507 ☐ Fax: (609) 597-2661

[redacted]

While I do not wish to begrudge the people of Atlantic City it seems to me that the beaches in Atlantic City are substantially larger than any of the beaches on Long Beach Island. It certainly would be nice to see some Federal Dollars come to the assistance Long Beach Island.

Is there anything you can do to assist the short term project of the Holyoke Avenue jetty and the long term efforts of Beach Replenishment for Long Beach Island?

Your response is appreciated.

Respectfully,

Andrew H. Anderson
Certified Insurance Counselor
Executive Vice President

AHA/rh
encl.

P.S. Mayor Victor Sencindiver resigned and his Position is being filled by Commissioner George Kasunich —

House approves $52M for A.C. beach replenishment

By THOMAS PEELE
Staff Writer

ATLANTIC CITY — A bill that passed the U.S. House authorizes the Army Corps of Engineers to spend up to $52 million to replenish beaches here.

While Congress still must pass additional legislation to appropriate the money, Rep. Frank A. LoBiondo heralded the inclusion of the Atlantic City project in the Water Resources Development Act, which passed the house Tuesday.

"I have seen firsthand the extensive storm and erosion damage in the area. This project will protect and restore the coast so it will be available for the enjoyment of residents and tourists alike," LoBiondo said in a prepared statement issued Wednesday.

The bill also directs the army corps to "expedite the implementation" of beach resotoration projects in Avalon, North Wildwood and Stone Harbor, according to LoBiondo's statement.

Mayor James Whelan said the city is prepared to spend $650,000 of its own money later this year to start the project if there are assuraces the federal funds will reimburse it.

Beacuse of damage from last winter's storms, Whelan said, "We've got to dump sand on our beaches. There's no other way."

He said beaches at Rhode Island Avenue, Martin Luther King Boulevard to Ohio Avenue and from Texas Avenue to the front of the Convention Center need the most help.

At Rhode Island Avenue, a giant sand-filled bag, known as a Geotube, washed out in a storm. Tubes elsewhere on the beach held, but Whelan said they need a strong beach in front of them in order for stable dunes to grow on top of them.

JIM SAXTON
THIRD DISTRICT, NEW JERSEY

NATIONAL SECURITY COMMITTEE

SUBCOMMITTEES
MILITARY PROCUREMENT

MILITARY INSTALLATIONS
AND FACILITIES

MERCHANT MARINE
OVERSIGHT PANEL

U.S. House of Representatives

Washington, DC 20515

RESOURCES COMMITTEE
FISHERIES, WILDLIFE AND OCEANS
SUBCOMMITTEE
CHAIRMAN

JOINT ECONOMIC COMMITTEE
VICE-CHAIRMAN

REPUBLICAN POLICY COMMITTEE

July 23, 1996

Lt. Colonel Richard F. Sliwoski
District Engineer
Army Corps of Engineers
Penn Square East
Philadelphia, Pennsylvania 19107

Re: Robert H. Null
SSN: 177-14-8781

Dear Lt. Colonel Sliwoski:

Enclosed please find a copy of correspondence I received from Mr. Null with regard to concerns he has expressed over the management of beach erosion along Long Beach Island.

I would appreciate your checking into this matter and providing me with any information which will help me respond to my constituent. Your response should be directed to my Staff Assistant, Patricia Brogan.

I know that this matter will be carefully and objectively reviewed. Thank you for any assistance you may be able to render.

Sincerely,

Jim Saxton

Jim Saxton
Member of Congress

JS:phb/dl
Enclosure

REPLY TO:

- ☐ 339 CANNON HOUSE OFFICE BUILDING, WASHINGTON, DC 20515-3003, (202) 225-4765
- ☐ 100 HIGH ST., SUITE 301, MT. HOLLY, NJ 08060-1458, (609) 261-5800
- ☑ 7 HADLEY AVE., TOMS RIVER, NJ 08753-7539, (908) 914-2020
- ☐ 1 MAINE AVENUE, CHERRY HILL, NJ 08002-3051, (609) 428-0520

H. JAMES SAXTON
13TH DISTRICT NEW JERSEY

COMMITTEES
HOUSE ARMED SERVICES
SUBCOMMITTEES
RANKING REPUBLICAN—ENVIRONMENTAL PANEL
PROCUREMENT
READINESS
MILITARY PERSONNEL AND COMPENSATION

Congress of the United States
House of Representatives
Washington, DC 20515-3013

COMMITTEES
MERCHANT MARINE AND FISHERIES
SUBCOMMITTEES
RANKING REPUBLICAN
OVERSIGHT AND INVESTIGATIONS
FISHERIES AND WILDLIFE CONSERVATION AND ENVIRONMENT
OCEANOGRAPHY, GREAT LAKES AND OUTER CONTINENTAL SHELF

SELECT COMMITTEE ON AGING
SUBCOMMITTEES
HEALTH AND LONG TERM CARE
HUMAN SERVICES
TASK FORCE ON SOCIAL SECURITY AND WOMEN

WRITTEN AUTHORIZATION UNDER THE PROVISIONS OF THE PRIVACY ACT OF 1974

DATE: 7/18/96

DEAR CONGRESSMAN JIM SAXTON:

I would like to request your assistance with the following problem I am having with the Agency listed below:

Agency Name: ARMY CORPS OF ENGINEERS

To comply with the provisions of the Privacy Act of 1974, I am authorizing you or the appropriate member of your Congressional staff to request pertinent information on me which would be required in your investigation of the matter I have outlined below.

Please give a detailed description of the problem you are experiencing with the above cited agency. If additional space is required, please use the reverse side.

THE ARMY CORPS OF ENGINEERS PERFORMED A "FLOW PATTERN" OF THE TIDES OUT OF BARNEGAT INLET. IT WAS DONE LAST YEAR AND A REPORT WAS DUE IN 12 MONTHS. IS IT AVAILABLE YET? IF SO, MAY I HAVE A COPY.

THE DREDGE "CURRITUCK" HAS BEEN DREDGING BARNEGAT INLET AND DUMPING SAND OFF THE BEACH IN LOVELADIES, NEAR THE PYRAMID HOUSE. AS A RESULT, THE BEACH IS BEAUTIFUL THERE. BUT, ONE BEACH NORTH IS GONE. SHOULDNT THE DUMPING OCCUR OFF THE BEACHES JUST NORTH OF THE PYRAMID.

SIGNATURE: [signature]

Please print or type:

Name: ROBERT H. NULL MD
Address: 133 B LONG BEACH BLVD
City: LOVELADIES State: N.J. Zip: 08008

Home Telephone: 609/494-7085 Bus. Tel.: 908/753-8219
Social Security #: 177-14-8781 Other I.D.

Planning Division

SEP 25 1996

Honorable James Saxton
House of Representatives
339 Cannon House Office Building
Washington, D.C. 20515-3003

Dear Mr. Saxton:

We received your letter dated September 10, 1996, regarding your constituent's inquiry over the proposed Holyoke Avenue Groin notching and shoreline erosion on Long Beach Island. Below is our information on the subject.

A feasibility level study from Barnegat Inlet to Little Egg Inlet was initiated in January 1996. The study is to fully evaluate all reasonable beach protection solutions to the problems identified during the reconnaissance study completed in March 1995. During the feasibility phase we accomplish more detailed analysis. The typical duration for this phase is three years. This feasibility study is cost shared 50/50 with New Jersey as the non-Federal sponsor. We are just completing the first nine months of the feasibility study that focuses mainly on determining without-project conditions.

Future funding for the Barnegat Inlet to Little Egg Inlet study is contingent upon annual Appropriations Act language, due to the Administration's budgetary policy on shore protection projects. With anticipated approval for funding the Barnegat Inlet to Little Egg Inlet Feasibility Study for FY 97, completion of the current and without-project conditions study components will occur by April 1997. The type of information available would consist of: recent beach and offshore surveys; historic beach erosion and accretion rates; a structure inventory within the first four rows of houses from the dune/beach area; and other detailed project condition information.

Assuming the study is continuously funded through completion of the feasibility study (July 1999) and is subsequently approved, the planning process allows appropriate projects to bypass the Preconstruction, Engineering and Design (PED) phase, proceeding directly to Plans and Specifications. This option is useful for projects which are not complex and do not require additional detailed engineering and design work beyond the level of detail found in a feasibility study and report.

If found appropriate, this would accelerate project construction by eliminating typically two to three years for the PED phase of analysis.

Currently the only authorized work the Corps is performing that impacts Long Beach Island Beaches is the periodic disposal of dredge material from dredging activities in Barnegat Inlet using the Corps dredge CURRITUCK. With assistance from your office we used an alternate disposal procedure and periodically have placed approximately 10,000 cubic yards of sand in the surf zone at Loveladies. Material was placed near the beach that appeared to have the most severe erosion. This dredged material will serve to dissipate wave energy, possibly slowing further erosion. In addition, natural littoral processes may move part of the material onto the beach over time.

We are aware of the problems associated with the Holyoke Avenue Groin in Beach Haven Township NJ. The Corps is performing a detailed analysis of all 99 groins within the study area. Our Regulatory Branch is reviewing a permit application for the proposed notching of the Holyoke Avenue groin by the Borough of Beach Haven, New Jersey. Its design is the work of Owen, Little, & Associates, Incorporated, Beachwood, New Jersey, in accordance with FEMA Hazard Mitigation Grant Program (Project #0029; FEMA-DR-973-NJ). The Corps Coastal Planning and Regulatory Branches will continue to coordinate the exchange of information as part of the permit review process. FEMA remains the lead Federal agency of this project.

The Corps' role is strictly one of making a permit decision and as such, the "decision whether to issue a permit will be based on an evaluation of the activity's probable impact including its cumulative impacts on the public interest." (Public Notice No. CENAP-OP-R-199502465-42).

In response to another of your constituent's comments regarding the recent U.S. House authorization for the Army Corps of Engineers to spend up to $52 million to replenish beaches in Atlantic City, the Congress still must pass additional legislation to appropriate the money. Until then, only local and state funds are used to pursue any immediate remedies to Atlantic City's erosion problems.

I hope that this information is satisfactory to your needs and if you have further questions, please feel free to contact us. Our staff contact is Mr. Randy Piersol at 215-656-6577.

Sincerely,

Robert B. Keyser
Lieutenant Colonel, Corps of Engineers
District Engineer

Copy Furnished:

Honorable James Saxton
Representative in Congress
100 High Street, Suite 301
Mount Holly, New Jersey 08060-1458

CENAD-PA
CENAP-PAO
CENAP-DE
CENAD-ET-P
DAEN-CWZ

MFR: Planning coordinated with Regulatory Branch for wording of Congressional response. (Conversation with Dick Hassel, 9/23/96)

Randy Piersol
CENAP-PL-PC

State of New Jersey
Department of Environmental Protection
Division of Science and Research
New Jersey Geological Survey
CN 427
Trenton, NJ 08625-0427
(609) 292-1185
FAX (609) 633-1004

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

MEMORANDUM

TO: Ted Keon, Chief, Coastal Planning, U.S. Army Corps of Engineers, Philadelphia District

FROM: Jane Uptegrove, JU New Jersey Geological Survey

DATE: May 7, 1996.

SUBJECT: NJGS processing vibracores for grain size analysis

Recently, we have discussed the possibility of New Jersey Geological Survey handling the grain-size analysis of vibracores for the Philadelphia District. We were specifically considering your current vibracoring project at Brigantine Inlet. Randy Piersol and Brian Murtaugh sent us copies of your Scope of Work and a sample previous report to describe your needs for analysis.

After reviewing those documents, we have found that we could not complete the analysis in the time needed by your office. Our constraints at this time are that we are not currently equipped to perform the ASTM 2487 protocol, and we have been asked by DEP leadership to be available to collect and analyze up to 22 vibracores and additional seismic data. This work needs to be done in the same time period we discussed for your job (June-Sept., '96).

We very much appreciate the opportunity to discuss this job with the U.S. Army Corps. Please consider us again for future work, particularly offshore seismic data gathering. In the meantime, the NJGS will review our capability to perform these analyses for any future projects. Thank you.

c: Randy Piersol, Coastal Planning, U.S. Army Corps of Engineers, Phila. District
Haig Kasabach, State Geologist
Richard Dalton, Bureau of Geology and Topography

Long Beach Township

CONVERSATION RECORD

TIME	DATE
	1/11/98

TYPE

☐ VISIT ☐ CONFERENCE ☑ TELEPHONE

☐ INCOMING

☑ OUTGOING

Location of Visit/Conference:

ROUTING	
NAME/SYMBOL	INT

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU	ORGANIZATION (Office, dept., bureau, etc.)	TELEPHONE NO.
Mayor Mancini		(609) 361-1000

SUBJECT

Long Beach Township

SUMMARY

Congressman Saxton - big press conference today I should call them

$650,000 cost 12 miles repairs / damages local TV was there

estimate ~~350,000~~ to 400,000 talk to Sandy -

4 ft ocean tide above normal 3½' bay

Brant Beach - homes were undermined only area - needs immediate fill

fill 4x in last 5 yrs - get undermining

40 - 60 mph -

Most of the 12 miles normal dune cuts they plan on

pushing back sand with bull dozers and re contour

State has appropriated money for 46th to ½ mile fill

Beach Haven - Merryville Ave. - they had some chopping cut back

'92 were severe - and no bay damage 6½' bay then

ACTION REQUIRED

NAME OF PERSON DOCUMENTING CONVERSATION	SIGNATURE	DATE
	Randy T. Pursel	1/11/98

ACTION TAKEN

SIGNATURE	TITLE	DATE

Cont.

CONVERSATION RECORD

TIME:

DATE: 1/11/96

TYPE: ☐ VISIT ☐ CONFERENCE ☐ TELEPHONE ☐ INCOMING ☑ OUTGOING

Location of Visit/Conference:

ROUTING	
NAME/SYMBOL	INT

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU: Mancini

ORGANIZATION (Office, dept., bureau, etc.):

TELEPHONE NO:

SUBJECT:

SUMMARY

Harvey Cedars - cliffs of 6, 8, 3, 2 feet
Generally lots of fill yet.

No undermining, lost sand fence and continuing
they will bulldoze and replace sand fence

Steve Kemp + Killam Assoc. Ocean County - all Beach Property
Reg Dir of FEMA now supervisor w/

(908) 292-2147 County Admin Office

ACTION REQUIRED

NAME OF PERSON DOCUMENTING CONVERSATION:

SIGNATURE: [signature]

DATE: 1/11/96

ACTION TAKEN

SIGNATURE:

TITLE:

DATE:

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

REPLY TO ATTENTION OF

NOTICE OF STUDY INITIATION

This notice is to announce the initiation of the feasibility phase for the New Jersey Coast from Barnegat Inlet to Little Egg Inlet shoreline protection study. The Corps of Engineers is conducting this study in response to a resolution adopted by the U.S. House of Representatives Committee on Public Works and Transportation December 10, 1987. This study is being sponsored by the New Jersey Department of Environmental Protection (NJDEP).

The study is the fifth site specific study conducted under the ongoing New Jersey Shore Protection Study, which focuses on the shore protection and water quality problems facing the entire ocean coast and back bays of New Jersey. Specifically this study addresses the shoreline erosion and storm damage vulnerability of the barrier island known as Long Beach Island (LBI) bordered by the two inlets. Included in this study will be an inventory of existing coastal data, establishment of existing conditions along the LBI shoreline, and the identification of specific problem areas, ultimately determining Federal interest for taking actions to reduce shoreline erosion and increase storm protection for this densely developed barrier island.

The first phase of the study, the reconnaissance phase, was completed in March 1995 at 100% Federal cost. The reconnaissance phase determined that there is Federal interest in establishing measures to prevent shoreline erosion, increased storm damage susceptibility and reduce ecosystem degradation within specific areas along LBI. The second phase of the study, the feasibility phase, began in January 1996 and is cost shared 50%-50% between the (NJDEP) and the Federal government. The feasibility study will fully evaluate all reasonable solutions to the problems identified during the reconnaissance study. Detailed studies will be undertaken to better understand the currents, waves and sediment transport affecting the coastline of LBI. Additionally, the feasibility study will include an economic assessment and interest assessment of non-Federal parties for the identified potential solutions, and establish the scope and schedule for construction of recommended measures.

Any pertinent information that Federal, State or local agencies and the private sector can provide will be used to the greatest extent possible. We welcome any assistance and suggestions pertaining to the conduct of this study. All comments should be directed to the above address, Attn: CENAP-PL-PC.

Sincerely,

Robert P. Magnifico
Lieutenant Colonel, Corps of Engineers
District Engineer, Philadelphia

James F. Hall
Assistant Commissioner, New Jersey Department of Environment Protection

NEWSPAPER ARTICLES

(<u>Phocoena</u> <u>phocoena</u>) which has been proposed for listing as threatened under the Endangered Species Act may also be in the project area. While Mid-Atlantic waters are the southern extreme of their distribution, stranding data indicates a strong presence of harbor porpoise off the coast of New Jersey, predominantly during the spring.

Surf clams (<u>Spisula</u> <u>solidissma</u>) may also be found within the study area. The harvest of surf clams is an economically important commercial fishery in New Jersey. As a result, shoreline protection/erosion control options should be designed to minimize impacts to this resource. The New Jersey Department of Environmental Protection, Bureau of Shellfisheries can assist your office in determining the location of commercially valuable surf clam beds. We recommend that you consult with them during the early stages of the feasibility study.

The back bay area west of Long Beach Island supports extensive beds of submerged aquatic vegetation such as eelgrass (<u>Zostera</u> <u>marina</u>) and widgeon grass (<u>Ruppia</u> <u>maritima</u>) and shellfish. Hard clams (<u>Mercenaria</u> <u>mercenaria</u>) and soft clams (<u>Mya</u> <u>arenaria</u>) are harvested commercially from this area. Any projects proposed as part of the feasibility study should avoid impacting these resources.

Thank you for the opportunity to comment on this project. If you have any questions, or need additional information, please contact Karen Wurst at (908) 872-3023.

Sincerely,

Stanley W. Gorski
Assistant Coordinator
Habitat Program

cc: NJDEP, Bureau of Shellfisheries

kmw:bileh.fs

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Habitat and Protected Resources Division
James J. Howard Marine Sciences Laboratory
Highlands, New Jersey 07732

March 12, 1995

Robert Callegari, Chief
Planning Division
Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

ATTN: Mr. Nathan Dayan, Environmental Resources Branch

Dear Mr. Callegari:

We have reviewed your request for information concerning protected species or ecologically and commercially significant species within the study area for the "Barnegat Inlet to Little Egg Inlet Feasibility Study". The study area is located along the Atlantic Coast of Long Beach Island in Ocean County, New Jersey. We offer the following information to assist you in planning this project.

Several species of sea turtles including the threatened loggerhead (Caretta caretta), and endangered Kemp's ridley (Lepidochelys kempii), and green (Chelonia mydas) sea turtles may occur in inshore waters of New Jersey. These turtles feed primarily on mollusks, crustaceans, sponges and a variety of marine grasses and seaweeds. In addition, the endangered leatherback (Dermochelys coriacea) sea turtle may occupy the coastal waters of New Jersey, foraging for jellyfish. These sea turtles may be found in New Jersey waters from late spring to mid-fall.

Dredging has the potential to impact sea turtles adversely through entrainment. This occurs primarily with the use of a hopper dredge. Consequently, if beach nourishment is proposed, additional consultation under Section 7 of the Endangered Species Act may be necessary.

Also, Endangered right whales (Eubalaena glacialis) and humpback whales (Megaptera novaeangaliae) are present in the mid-Atlantic waters off the coast of New Jersey in late winter through early spring. Fin whales (Balaenoptera physalus) which are the most likely species to occur in the coastal waters of New Jersey are present throughout the year. Lastly, the harbor porpoise

CONVERSATION RECORD

TIME | DATE 11-19-98

TYPE ☐ VISIT ☐ CONFERENCE ☑ TELEPHONE ☑ INCOMING ☐ OUTGOING

ROUTING — NAME/SYMBOL | INT

Location of Visit/Conference:

NAME OF PERSON(S) CONTACTED OR IN CONTACT WITH YOU: Mayor Mancini

ORGANIZATION (Office, dept., bureau, etc.)

TELEPHONE NO.

SUBJECT: Re: Request From PL-PC regarding public access

SUMMARY

1. Mayor maintains that over all they provide more public access per mile than any other area
2. He will challenge us / Real Estate on Loveladies and access. "Why are we picking on him.
3. There is no town where everything is the same - you have good parts and bad parts, limited parking and no parking.
4. PLPC - requested additional information so we can honestly evaluate any potential issues that may arise from the public.
5. Re: DuneGuard Testing: EcoSyn arranged to do a test strip. - Townships does not view it as cost effective - they use 3 ft fencing - what ever is most practical - the cheap stuff may not be better but they view it as effective enough + there may be benefits in hot spot areas.
6. Recent Fill at Brant Beach - 1000 truck loads carrying 41.89 cu yd (20,000 cyd/s) of mixed washed fine sand - cost $97,800 - 125,000 with labor

ACTION REQUIRED

- Contact Real Estate
- Give figures to Dan - Bill - John M.

NAME OF PERSON DOCUMENTING CONVERSATION: Randy Piersol

SIGNATURE: Randy T. Piersol

DATE: 11/25/98

ACTION TAKEN

SIGNATURE | TITLE | DATE

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

HASKIN SHELLFISH RESEARCH LABORATORY
INSTITUTE OF MARINE AND COASTAL SCIENCES
BOX B-8, RD #1, PORT NORRIS, NEW JERSEY 08349-9736

February 29, 1996

Mr. Nathan Dayan
Environmental Resources Branch
US Army Corps of Engineers
Philadelphia District
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Dayan:

This letter is in response to a letter from Mr. Robert Callegari (Signed by Mr John Beimer) concerning the "Barnegat Inlet to Little Egg Inlet Feasibility Study". In particular, the letter indicated a desire for input concerning impact on surf clams, minimizing the effects of dredging and the potential for reseeding the disturbed area.

I would be very interested in talking with you about the scope of the project, timing of the studies and how information on the impact on the resources and any resource rehabilitation would be integrated into these studies.

Please let me know how you wish to proceed.

Sincerely yours

John N. Kraeuter

John N. Kraeuter, Ph.D.
Associate Director

FISHERIES AND AQUACULTURE TECHNOLOGY EXTENSION CENTER

TEL: (609) 785-0074, FAX: (609) 785-1544

ENVIRONMENTAL AND NEPA ORIENTED CORRESPONDENCE

State of New Jersey
Department of Environmental Protection

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

Mr. Randy Persel, Project Manager
Army Corps of Engineers
Philadelphia District
100 Penn Square East
Philadelphia, PA 19107

DEC 11 1998

RE: Pre-application Meeting
Long Beach Island Beach Nourishment Borrow Area Investigations

Dear Mr. Persel:

I am writing in response to our November 18, 1998 meeting regarding the referenced project. Specifically, I want to memorialize some of the discussion points and identify issues that should be addressed as part of any application for beach nourishment/sand mining. Some of these issues may affect the acceptability of mining the proposed offshore borrow areas identified by your agency at the meeting. I have enclosed a copy of the meeting attendance sheet for your reference.

Project Description:

The project being contemplated by the ACOE, as presented at the referenced meeting, involves the following:

1. Mining one or more borrow areas offshore of Long Beach Island to obtain the required sand volume necessary to construct the proposed beachfill project.
2. Initial beachfill of 9 – 10 million cubic yards of sand for placement on approximately 12 of the 18 miles of Long Beach Island oceanfront.
3. Construction of a 125 foot wide berm, as measured from the centerline of the dune.
4. Construction of a dune crest elevation of 22 feet (NAVD). There was no specific indication of dune width provided.
5. Periodic renourishment of 2.5 million cubic yards at seven year intervals.
6. Groin modifications: no groins are proposed to be removed and most will be buried by the placement of fill. Some groin structures will be modified (lowered or notched), however, these were not specifically identified.
7. Stormwater outfall modifications: one stormwater outfall may require extension beyond the newly placed fill.

Since the proposed project will require such a large volume of nourishment sand (potentially 25 million cubic yards over the 50-year life of the project), and due to the environmental sensitivity of the proposed offshore borrow areas, the need for the identified sand volume should be clearly justified. Specifically, the damage reduction benefits cited as the basis for the proposed project should be identified based on actual storm damages as documented and recorded by the Division of Engineering and Construction and by FEMA. If portions of the benefits are attributed to recreational beach use, the scope of those benefits should be identified as well.

Project Review Criteria:

The proposed project will be reviewed as a Federal Consistency determination, pursuant to the Department's Rules on Coastal Zone Management (N.J.A.C. 7:7E) in effect at the time the application is received. The following Rules have been identified as being applicable, or potentially applicable to the proposed project, and should be addressed in any forthcoming application for the proposed project:

I. Special Areas

1. Surf Clam Areas, -3.3
2. Prime Fishing Areas, -3.4
3. Finfish Migratory Pathways, -3.5
4. Navigation Channels, -3.7
5. Inlets, -3.9
6. Submerged Infrastructure Routes, -3.12
7. Shipwrecks and Artificial reefs, -3.13
8. Intertidal and Subtidal Shallows, -3.15
9. Dunes, -3.16
10. Beaches, 3.22
11. Historic and Archaeological Resources, -3.36
12. Endangered or Threatened Wildlife or Vegetation Species Habitat, -3.38
13. Critical Wildlife Habitats, -3.39
14. Public Open Space, -3.40
15. Standards for Beach and Dune Activities, Subchapter 3A

Potential impacts to all Special Areas should be fully investigated and addressed in terms of the specific standards and criteria contained in the Coastal Zone Management rules. Of special concern is the potential impact of sand mining to the Prime Fishing Areas, particularly in proposed borrow areas "B" and "E", and the Surf Clam Areas. It is strongly recommended that these specific borrow areas be avoided as part of this project. Please refer to the rules for a discussion of acceptable and prohibited activities.

It is also strongly suggested that the use of Barnegat Inlet as a potential source of nourishment sand not be discounted as indicated during the meeting. This inlet is routinely dredged for navigational purposes and the Coastal Zone Management rules encourage the use of this material for placement along the oceanfront beaches, as part of the initial fill or the proposed 7-year cycle of renourishment.

Regarding any proposed dune construction, the Program suggests that the use of rock cores be avoided. However, if it is documented that there is no alternative to the construction of a reinforced dune, the use of geotube cores for dune construction may be conditionally acceptable. The Program also discourages the use of alternative sand fencing materials that do not readily degrade in the natural environment.

II. General Water Areas

1. Acceptability Conditions for Uses, -4.2(f) Maintenance Dredging
   -4.2(g) New Dredging
   -4.2(h) Dredged Material Disposal
   -4.2(j) Filling
   -4.2(l) Sand and Gravel Extraction
   -4.2(q) Outfalls and Intakes

III. General Location Rules

1. Secondary Impacts, -6.3

IV. Use Rules

1. Coastal Engineering, -7.11(b) Shore Protection
   -7.11© Dune Management
   -7.11(d) Beach Nourishment
   -7.11(e) Structural Shore Protection

Groin modification should be considered as part of the proposed project, based on the size and height of the groin structures and the history of localized erosion at some groin locations. The fact that some groins may be buried by the initial fill should not affect the decision to modify any groin structures, since beach erosion during the course of the project life will undoubtedly expose the groins and lead to the recurring erosion downdrift of the groin structures.

2. Dredged Material Disposal on Land, -7.12

V. Resource Rules

1. Marine Fish and Fisheries, -8.2
2. Water Quality, -8.4
3. Public Access to the Waterfront, -8.11

VI. Monitoring

The proposed project shall include a detailed pre- and post-project monitoring plan and schedule for all areas impacted by the sand mining or sand placement activities.

This monitoring shall include, but may not be limited to, the following: bathymetry, benthos, surf clam areas, shoreline changes, beach and dune profiles, and potential beachnester habitat created as a result of the sand placement. The monitoring plan shall indicate the frequency of monitoring, including long-term monitoring of borrow areas, and the specific locations and methods of data collection. All monitoring data and reports shall be submitted to the Program as they are collected. Specific questions related to the monitoring of benthic habitat, surf clam areas and potential beachnester habitat should be directed to Andy Didun at the address listed below.

VII. Summary

At this point, the Program is unable to determine the acceptability of the proposed project, given the level of detail of the current investigations. It appears that the potential use of borrow areas "A" and "D" may be conditionally acceptable, provided that the sand mining does not alter the existing bathymetry to a significant degree so as to reduce the high fishery productivity of these areas, and provided that the mining does not result in the destruction of surf clam areas. In addition, the use of any of the identified borrow areas must be justified via an analysis of alternatives to the use of these sites, as required by the Coastal Zone Management rules. The additional cost to obtain nourishment material from alternative sources or to pump a greater quantity of finer grained sand may not be sufficient justification to preclude the use of these alternative areas, particularly if the use of alternative areas eliminates the destruction of a Special Area resource. In addition, a reduction in the project scope may also be required in order to minimize impacts to Special Areas associated with the proposed borrow zones.

I hope that this information is useful as you develop the specific project design. Please feel free to contact me or Helen Fasano of my staff at 609-292-8262 if you have additional questions. Also, as discussed at the meeting, please be sure to submit any further environmental impact information directly to Andy Didun, of the Division of Fish, Game & Wildlife's Environmental Review Section (P.O. Box 404, Trenton, NJ 08625). This will ensure that all information is circulated to the appropriate staff for review.

Sincerely,

Mark N. Mauriello

Mark N. Mauriello, Supervisor
Bureau of Coastal Regulation

C: Andy Didun, FG&W
Helen Fasano, DEP, Land Use Regulation
Bill Dixon, DEP, Engineering & Construction
Eric Schrading, USFWS
Anita Riportella, NMFS

Dayan NAP02, Nathan S

From: Virginia Loftin
Sent: Thursday, October 30, 1997 3:20 PM
To: nathan.s.dayan@usace.army.mil
Subject: LBI beach closings

1987 - discretionary closings from Pt. Pleasant through LBI from May 27-29 due to extensive wash-up of floatable debris including plastics (condom and tampon applicators), grease coated organic particles and the decomposing remnants of a major algal bloom. The analyses of the organic particles indicated high internal fecal coliform concentrations. However, of 125 water samples in the area of the most affected beaches of Island Beach State Park, only one bay sample from inside Barnegat Inlet exceeded the PCC. Apparently, the outer grease layers effectively encapsulated the interiors of the particles, isolating the fecal coliforms. The source of the floatables was not detected.

From 1988 through 1997 there were no ocean beach closings at any beach on Long Beach Island.

State of New Jersey
Department of Environmental Protection

Christine Todd Whitman
Governor

Robert C. Shinn, Jr.
Commissioner

DIVISION OF FISH, GAME AND WILDLIFE
CN 400
TRENTON, NEW JERSEY 08625-0400
ROBERT MCDOWELL, DIRECTOR
609-292-2965

June 6, 1996

DEPARTMENT OF THE ARMY
Philadelphia District. Corps of Engineers
Attention: CENAP-PL-PC
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Dear Lt. Col. Magnifico:

This serves to respond to your "Notice of Study Initiation" for the feasibility phase of the New Jersey Coast from Barnegat Inlet to Little Egg Inlet Shoreline Protection Study. The Division of Fish, Game and Wildlife has responded to several reconnaissance study areas along the coast, however, we have not provided such information for this particular study reach. Therefore, this letter informs you of comments/concerns regarding natural resources relative to both phases of the study area.

The study area supports a wide variety of finfish, shellfish and avian species. These include commercially significant finfish/shellfish, recreationally significant finfish/shellfish/ waterfowl, and endangered/threatened birds. Avoiding and/or minimizing impacts to these resources need to be a priority in considering any shoreline protection alternative proposed.

SHELLFISH RESOURCES

The ocean waters off Long Beach Island contain a commercially-viable population of surf clams (Spisula solidissima) characterized by high recruitment and extensive harvest; this is particularly true in the area between one and two miles from shore. Estuarine areas between Barnegat and Little Egg Harbor Inlets contain extensive beds of hard clams (Mercenaria mercenaria) which are harvested by both commercial and recreational fishermen. The estuarine areas adjacent to Long Beach Island also contain extensive beds of submerged aquatic vegetation, the most abundant being eelgrass (Zostera marina).

The surf clam, hard clam and submerged vegetation in the study area should be given extensive consideration relative to any feasibility alternatives being sought. If any specific shellfish information is needed, please contact our Bureau of Shellfisheries at 609-748-2040.

MARINE FISH RESOURCE

The Bureau of Marine Fisheries has the following concerns with regard to finfish resources and the impacts typically associated with shoreline protection proposals:

(1) The prime inshore fishing grounds for summer flounder, weakfish and stripped bass off Long Beach Island consist of shallow water lumps on the sea floor where desirable, large-grain sand is available for beach nourishment. The destruction of these lumps may have a serious impact on fish stocks as well as sport and commercial fisheries.

(2) Sand deposition may cover shipwrecks close to shore; this activity is prohibited by DEP policy. If project impacts compromise these fish habitat areas, the project should supply funds allocated to mitigate for lost fish habitat.

Feasibility studies should address adverse impacts to marine resources relative to the various shoreline protection alternatives considered. Alternatives that avoid/minimize impacts to marine resources should be analyzed as well as methods to mitigate and/or enhance marine habitats. If specific information regarding marine resources is needed, please contact our Bureau of Marine Fisheries at 609-748-2020.

WILDLIFE RESOURCES

The study area attracts large numbers of waterfowl with population peaks from November through January. Principal species include: black duck, brant, Canadian geese, bufflehead, teal, scaup, mergansers, gadwall, wigeon, scoters and mallard. River otter is also noted as utilizing the back-bay areas year-round.

Feasibility studies should address adverse impacts to wildlife resources relative to the various shoreline protection alternatives considered. Alternatives that avoid/minimize impacts to wildlife resources should be analyzed as well as methods to mitigate and/or enhance habitat.

ENDANGERED AND NON GAME RESOURCES

Long Beach Island and the portions of Little Egg Harbor and Barnegat Bay behind this barrier island provide important habitat for a broad range of nongame wildlife, including several endangered or threatened species. Least terns (state endangered), black skimmers (state endangered), and piping plover (state endangered, federally threatened), nest on the beaches at either end of the island at the Holgate Unit of Forsythe National Wildlife Refuge and at Barnegat Light. Although numbers fluctuate widely from year to year, each of these sites has on occasion hosted the largest least tern and black skimmer colonies in the state. More detailed information on nesting locations, population numbers, and breeding success is available by contacting Dave Jenkins of the Endangered and Nongame Species Program at 609-984-1581. In addition to the endangered and threatened beach nesting species, large numbers of common terns and American oystercatchers also nest on these beaches.

Three species of gulls-laughing gulls, great black-backed gulls, and herring gulls - nest on many of the marsh islands lying behind the barrier island. Marsh islands also host nesting common terns, Forsters terns, black skimmers, American oystercatchers, and willets. Long-legged wading birds (herons, egrets and the glossy ibis), including the state threatened yellow-crowned night heron and little blue heron, nest in woody vegetation on higher areas of the marsh. The New Jersey Division of Fish, Game and Wildlife's Endangered and Nongame Species Program periodically conducts aerial surveys of gulls, terns and long-legged wading birds. Information from these surveys, including specific nesting locations and populations numbers, can also be obtained by contacting Dave Jenkins.

Specific shore protection strategies pose the potential to both enhance and degrade habitat for the above mentioned nesting birds. In general, if properly planned and timed, beach nourishment projects tend to increase habitat available for nesting least terns, black skimmers, and piping plover. Certainly, this depends on the sources for the sand used in beach fill projects. Habitat enhancement in heavily populated or heavily used sections of beach can act to draw nesting birds into areas where high levels of human beach use can reduce nesting success and post significant challenges for wildlife managers.

Hard structures such as jetties, groins, and revetments generally result in decreased habitat availability. Other techniques such as dune building or enhancement can provide increased or decreased habitat value depending on the specific design and location.

The woody vegetation that provides nesting habitat for long-legged wading birds in the back bays, is often provided on dredging material disposal sites. Shore protection strategies that increase or decrease the availability of "mature" dredge disposal islands will consequently affect habitat availability for long-legged wading birds.

We hope this information can provide you with enough background information to indicate the extraordinary value of natural resources in the area and to guide your design alternatives to have the least impact upon them.

Sincerely yours,

Robert McDowell
Director, Division of Fish, Game & Wildlife

RM:AD:mac

c: R. Itchmoney, A. Didun, J. Joseph, B. Figley, L. Widjeskog, D. Jenkins

Mancini Says, If Winter Storms Hit, LBT Beaches Will Withstand the Fury

Mayor: Coast Hasn't Looked This Strong in Nearly 10 Years

If or when a northeaster bears down on the area this winter, Long Beach Township Mayor James J. Mancini may be tempted to look it square in the eye and say, "Go ahead, make my day."

That's because the off-season condition of the 12 miles of beaches in his community hasn't looked this good in almost 10 years, Mancini said at Friday's township Board of Commissioners meeting.

"I think we'll do really well with any bad storms this year," said Mancini. "The beaches are in terrific condition.

The mayor said the township is currently wrapping up a major sand replenishment project along the Brant Beach section between 42nd and 47th streets.

He said the township recently purchased 25,000 tons of sand from Phoenix Pinelands Corp. in Warren Grove at a cost of $100,000. The township, he said, could be partially reimbursed by the state Department of Environmental Protection.

The mayor said the area between those streets has the narrowest beach in the township and is susceptible to erosion.

"Last February, we really had some problems there," said Mancini. "There were a lot of places where the ocean ran under the houses and out onto the road, and the beach suffered heavy erosion. Now that this project is about done, that area is well fortified."

Favorable winds have also helped strengthen the beaches, he said. "We've been getting mostly north or south winds. It's northeast winds that mostly cause beach erosion, and we haven't seen too much of them so far this fall."

Commissioner Frank Pescatore added that township workers last week finished erecting sand fencing along three miles of beach dunes in Holgate.

"It's mostly routine maintenance," said Pescatore, public works chairman.

Speaking of beaches, the township also announced that it has purchased a new surf rescue boat for the beach patrol. Asay Boats in Asbury Park will build the 19-foot vessel at a cost of $5,600, according to Mancini.

Don Myers, beach supervisor for the township, said that when the boat arrives in the spring, it will join seven others in the beach patrol's fleet.

"Ideally, you like to have one rescue boat for every mile of beach you patrol," said Myers.

In other business, commissioners awarded a contract of $13,656 to Environmental Tank Systems Inc. of Springfield for removal of an underground tank at the township's public works yard.

According to Pescatore, the work is mandated by federal and state laws that require the removal and upgrading of underground storage tanks by the end of this year.

"We have to have it out of there by Dec. 28," said the commissioner.

Once the 2,000-gallon tank is removed, it will be thoroughly cleaned according to federal and state guidelines and disposed of at an approved facility.

In addition, Pescatore said the soil at the site of the underground tank will undergo thorough environmental testing for contamination.

"If it's found to have been leaking, then there will be more tests," said Pescatore.

The township has already replaced the subterranean tank with two above-ground tanks — a 2,000-gallon tank at the public works complex and another 1,000-gallon structure near the municipal building.

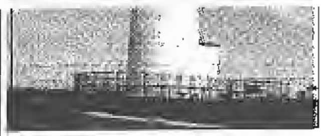
Pescatore said having tanks at separate locations is advantageous, mostly because the public works area is prone to flooding after heavy storms.

"If it looks like the DPW area is going to flood, we can get the vehicles out of there and have them fill up at the municipal building," said the commissioner. "During that December 1992 storm, we had three to four feet of water by the DPW area," he said.

— Eric Englund

Patti Kelly

BEACHY KEEN: Bulldozer spreads newly purchased sand for replenishing Brant Beach area between 42nd and 47th streets.



Devoted ... nce 1923

Playi
Pa

Volume 76 Number 7 | Wednesday, October 7, 1998 | Publis

ADA PROJECT NEARING COMPLETION

Deck with view soon available

By PAULA SCULLY

BRANT BEACH — An oceanfront observation deck behind the Long Beach Township Municipal Complex is expected to be finished this week.

Mayor James Mancini said the deck project has drawn tremendous interest because passers-by do not know what it is and many drivers slow down to take a look at it being built along Ocean Boulevard behind the police station.

The deck for the elderly, disabled and the entire family was designed and built under the auspices of Public Works Commissioner Frank Pescatore and paid for through a $60,000 federal Community Development Block Grant to meet federal Americans with Disabilities specifications, requiring public access for everyone.

"This entire complex, which goes from Barnegat Bay to the ocean, has something for everyone and is all ADA accessible," Mancini said. "This entire area has been designed and built by Commissioner Frank Pescatore, and it's something that we are extremely proud of."

Mancini credited the facility to Pescatore, to the Community Development Block Grant program of Ocean County which is funding the project with federal money, to Gov. Christie Whitman and state officials who have been involved in many aspects of the entire complex.

The observation deck is similar to the raised walkway along the bayfront at Bay View Park.

"We anticipate it is going to be very, very heavily used," Mancini said, "so people who have not been able to sit and look at the ocean will be able to do so."

The deck is 8 feet wide and 125 feet long and had to be built in compliance

See DECK on Page 12

The view from the observation deck being comple Township Municipal Complex in Brant Beach is handic

Soup sippers brave all-day rain to savor chowder at cook-off

Weekend festivals draw crowds

Deck

Continued from Page 1

with building regulations of the state Department of Environmental Protection under CAFRA II (Coastal Area Facilities Review Act reform rules).

Originally, the deck was to extend from the existing handicap ramp at the 68th Street pavilion. The proposal originally was turned down by the DEP because its location would have impacted on vegetation in the area, Mancini said.

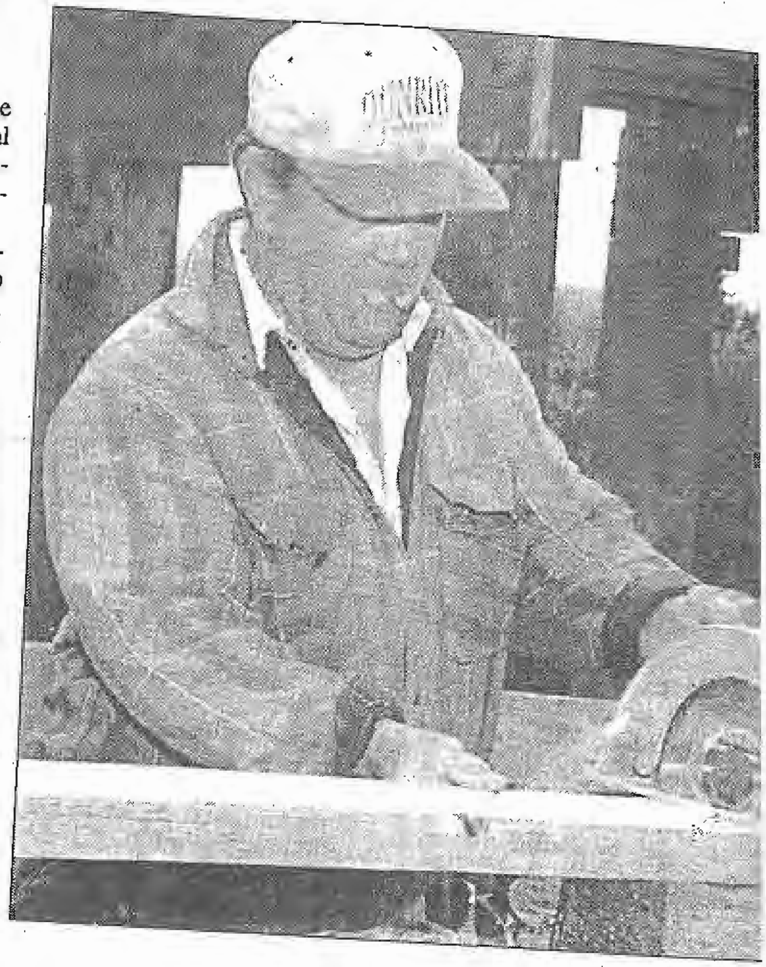
CAFRA and township officials discussed the alternative area with less vegetation just a little south of the originally planned location. The project was not moved onto the dunes, Mancini told the public at municipal meetings earlier this year.

Township officials applied in February for the federal Community Development Block Grant of about $60,000. The money was approved through a county board that distributes the funds to municipalities, and received final approval May 6 from the Ocean County Board of Freeholders, although Mancini, who is also a freeholder, abstained from the vote.

The Community Development Block Grant applications are heavily weighted in favor of handicap accessible projects required by the federal government. In prior years, the municipality applied for money for handicap ramps and has built 35, the mayor said.

"Some people think it's going to be a large boardwalk," he said at an earlier meeting. "We're not going to allow anyone to sell hot dogs on it."

The public has been split on the idea in the past. A neighbor once said he did not see how 10 to 12 handicapped people were going to get to the observation platform since there is not enough handicapped parking. Other residents attending the meetings have spoken in favor of the idea.



Worker Bob Laszlo of Long Beach Township cuts wood Monda
oceanfront observation deck on Ocean Avenue behind the mu

Variance

Continued from Page 1

kept in the borough lot at the water tower can be housed inside the building.

Gee said still to be finished are the interior sheet rock, insulation, both floors and the exterior,

Gruber pointed out that the two ambulances were to be inside the building last December and this December is coming up.

Gee said the first aid squad ran into some problems, not financial, and Shackleton began a fact-finding mission.

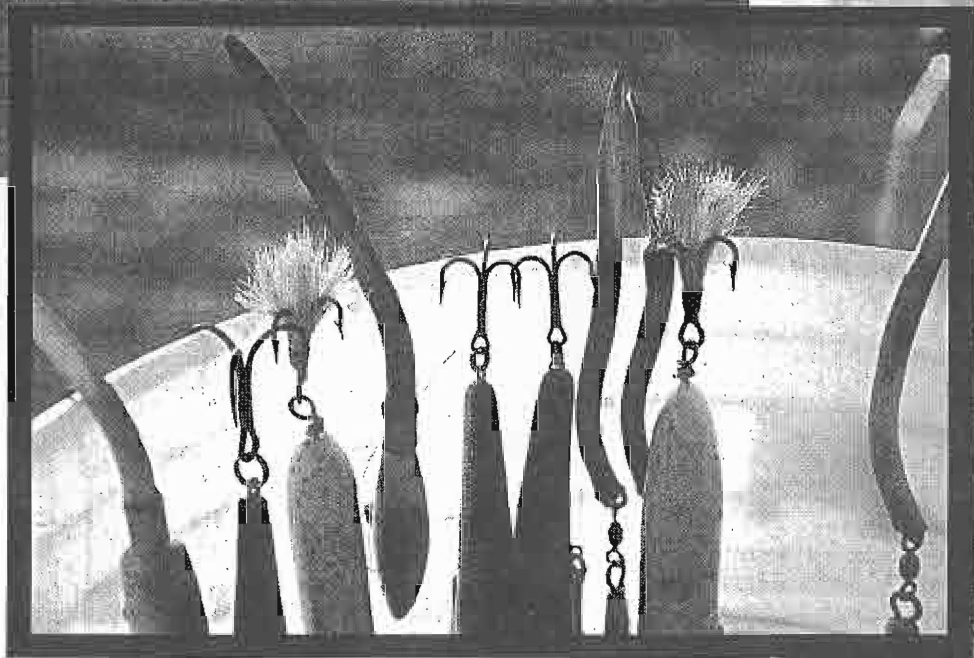
Board member Dan Berry asked if the variance were not granted, would the architect be insured for what he did.

Isherwood said his firm does not represent the first aid squad on any matters other than the variance.

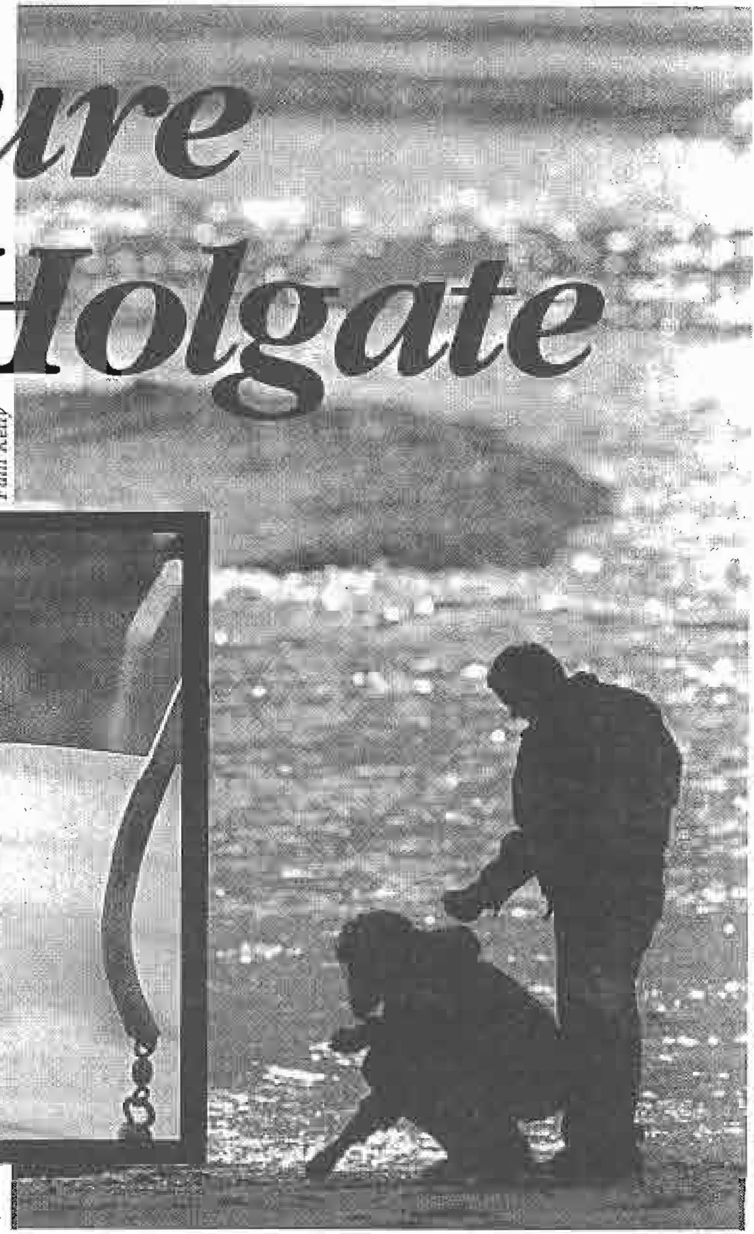
Panzone commented that the first aid squad saves peoples lives, and he did not think the board could have an applicant more dedicated to community services...

The Lure of Holgate

Patti Kelly



Patti Kelly



David Gard

CASTAWAYS: Sharing the autumn sands of Holgate are strollers and surfcasters. Both groups find all the space and solitude they need.

By PAT JOHNSON

As most Long Beach Island beaches settle into slumber mode, there's one spot that starts hopping come autumn: the three miles of wild beach at the southernmost end known as Holgate. This area, as part of the Edwin B. Forsythe National Wildlife Refuge, is closed during the summer so endangered bird species such as the black skimmer and piping plover get a chance to breed. But come autumn, the young birds have fledged, and flocks of anglers take the beachhead in search of the elusive striped bass.

Spurred on by the Southern Ocean County Chamber of Commerce LBI Surf Fishing Tournament, many of these fishermen are following paths as well known to them as the migratory paths of the black ducks currently winging southward.

The tournament is in its 44th year. It runs for six weeks, this year from from Oct. 3 to Nov. 15, and for a fee of $25 for adults and $15 for juveniles, a contestant has a chance at two $1,000 prizes for the biggest bluefish and the biggest striped bass taken from the shore.

Holgate in the fall also draws other visitors – surfers, bird watch- clutch of black-capped scooting surfers who had winged their way east from Allentown College, Pa. They were roosting for the weekend on the mainland in Tuckerton but would spend most of their time submerged in the cold ocean water. Highly migratory, they will make the trek between Allentown and Holgate all year long and can be sighted in the surf almost any weekend.

Donovan Quill, Taylor Fields, P. Gary and Jim Hardcastle said they have surfed in much colder waters

They stood cooing at the edge of the sea, bristling slightly when intruders appeared. "People are drawn to the beauty of the ocean," she said. "We're water people," he said. The usually harsh bleating of this city-dwelling species often turns to poetry during mating season. Courting weekenders will spout such verbiage until left alone, so it's best not to approach them at all.

On the other hand, a solitary soul will most likely be friendly.

end, they were enjoying the warm afternoon. They love the Island in the fall. "This is the best time to be here," one voiced while the others joined the chorus. Since they had been walking an hour, it was time to think about dinner plans. A hike to the end would

"And we try to stay as long as we can in the restaurant," said Mills. "We always take more coffee."

"Holgate is a great place to be," he continued. "You don't turn around and see houses. It's still primitive. If we catch a fish that's an added pleabeach rimmed by bayberry-crested dunes for a taste of what the Island must have looked like before it was called real estate.

A few hardy types will try to hike to the end of the Island, where the beach meets the turbulent inlet and curves to the bayside, but few make it.

The first inhabitants encountered on the trek to the southern tip of the Island Saturday were a juvenile

prefer so they lounged casually, preening their black wetsuits. Between wave sets they fed on the edge of the beach, scarfing down sandwiches from T.C.'s deli. The fun-loving troupe extends its surfing behavior as late in the year as Dec. 30 and as early as Jan. 3, said Quill. Once feeding was over, they harmlessly lolled on their surfboards in the waning sunlight of autumn.

Farther down the beach, despite the unusual time of year, courtship was still being displayed by a pair of tawny, well-feathered tourists.

the beach. She had removed her shoes and dug her toes into the sand for an afternoon of recollection.

Only an occasional visitor, she was pulled by memory to make a day trip to Holgate from her home in Burlington. The last time she sat refreshing herself in ocean breezes was seven years ago, she said. This homing instinct was prompted by the memory of a childhood spent fishing off the Holgate beach.

Her father used to keep a boat in Holgate at Strickland's Marina, but it was washed away in the '62 storm.

Although it took Moyer an hour to drive from Burlington, she thought she would return the next day as well. Moyer became lost in revery. The surf was clean and clear; she heard the sounds of surf-tumbled shells.

Two power walkers quickly passed behind. The sounds of their gossip shattered the moment as they padded on by, displacing sea gulls.

Then a foursome came into view. Two couples from Reading, Pa., Dean and Monica Smith and Chris and Michelle Cable, were returning to nestle in their rooms at the Engleside Inn. Down for the week-

***ACTION:** Surfer Bob Nugent (far left) finds waves at "Wooden Jetty" in Holgate. Joey Pacrari puts his shovel to work filling in the ocean.*

beach, the first Land Rover came into view, a plate on the back reading, "Beach Buggy Association, Fighting for Beach Access since 1954."

The buggy belongs to Ed Youse of Beach Haven. He had been fishing since 8:30 in the morning; now it was past noon. He was fishing primarily for stripers, he said, casting a wicked-looking lure expertly into the waves, but he'd take "anything I can get, really." This morning had been a washout. However, "I'll fish until I get tired or hungry," he said.

'Roughing It'
For Fishing Pleasure

At the next truck stop, Merrill Mills of Belvidere and his friend, Richard Poland of Plainfield, were hacking off chunks of bunker on the tailgate of their new sport utility vehicle.

"I can't buy a hit down here today," said Mills.

"The fish are 2, fishermen 0," Poland agreed.

But earlier in the week they had had better luck.

"We got a couple of fluke dinners," said Mills. The two were roughing it for the week, staying in an unheated house on the Island. "It's not too bad," said Poland. "We each have an electric blanket, and we turn on the gas stove in the morning. We eat out a lot."

something to think about all winter," said Poland.

The stripers were out there. The guys were sure of it. The fish, they noted, were migrating to their winter haunts, probably off the coast of Hatteras. But what would bring them into the beach? Baitfish, currents, tide. It was a mystery of the best kind. Anticipation would keep their adrenaline levels at ready for most of the day.

"You never know when one might hit," said Mills. "Anyway, it beats staying home and painting the house."

"I hear that any time you spend fishing is not deducted from your life," observed Poland.

"Still, I wish they would give us a little scare," said Mills.

Mills and Poland don't participate in the tournament because it's a "kill tournament," not a release tournament. "Freshwater tournaments, you can weigh them and release them. This tournament, you have to take the fish off the beach to a tackle shop to get it weighed, and by that time it would be dead," said Poland.

"Unless it takes two people to lift it, I'd roll it back into the ocean," he said.

Out of earshot of Mills and Poland, Jerry Smith had set his poles in the ocean. He was fishing alone today, but that's how he likes it. A year-

Cook-Off Sunday in Beach Haven, while Jill Siegfried of Ship Bottom, at left, warms up with a hot shot of chowder.

AWLOR
usands of diehard soup
Sunday to cast their
vder at the 10th Annual

big-top circus tents at
rk to escape the rain
from a light mist to

et up shop for the day
Manhattan red and New

nce 6:30 a.m. preparing
r," said Larry Widener,
of Beach Haven which
rcuit. More than 2,000
d the crowds of hungry

stocked with carrots,
nd clams, the tasters

CHOWDA on Page 8

Times-Beacon photo by Robert Ward

Jer... Caporosa of Ship Bottom admires flowers at Sat...day's Merchant Mart where more than 60 Island bus...esses sold wares at the end-of-season sale in Beach Hav...n.

Times-Beacon photo by Don Rocheskey

Judy Rosenberg escorts her cat Boo to the Blessing of the Animals Saturday at St. Francis Church in Brant Beach. The observance marks feast day for the saint who loved animals. More photos on page 5.

vides emergency medical services for Beach Haven, Ship Bottom and the south half of Long Beach Township and that the Beach Haven division covers the borough and the south half of Long Beach Township in particular.

Responding to a question by Isherwood, Gee agreed that the peak of the roof relates to architectural aesthetics, although the original architect Rob Roth of Brant Beach, was not available to testify.

Panzone said "everyone wants to ask why" it happened.

Gee said he cannot answer that and the squad's attorney, Richard Shackleton of the law firm Shackleton, Hazeltine and Bishop, is in the midst of fact finding.

"Our building is at a halt," Gee said of construction. "We can't continue without the variance. I can't say more because there may be litigation down the road."

Board member George Allen asked if there are no more variances down the road, and Gee said there are not.

In answer to Panzone, Isherwood said that when the surveyor came in to do an as-built survey, the peak of the roof exceeded the height ordinance by 3.5 percent.

Board member Mary Gruber asked how much more work is required before the two ambulances

See VARIANCE on Page 12

Bulldozing of dunes angers beachfront residents

By GINA G. SCALA
and PAULA SCULLY

BEACH HAVEN — Bulldozing work at the oceanfront beach on Fifth Street sent residents into a tailspin, prompting them to fear the worst and bringing assurances from the commissioner of public works.

Resident Ann Grieb, whose family has owned a home on Fifth Street for 100 years, said the sand dunes were cut down and the approach on either side of the Fifth Street pavilion was widened, which could create a conduit for the ocean to reach the street.

She said the same was done at the end of Centre Street, and she alleged the state and federal government had not given permission for the dunes to be touched.

"Us taxpayers are pretty upset," she said of the dunes being disturbed. "We sat here in the hurricane of '44 and watched the boardwalk go past our front parlor."

She said they were told that the sand covering the handicapped ramp had to be removed.

"The one cut at Centre Street is going to make a big, wide path for the ocean to come sailing down the street," Grieb said.

At Fifth Street she estimated three feet were bulldozed on one side, four feet on the other, and she had been told it was because local officials did not want the sand to

See DUNES on Page 12

...said still to be finished are interior sheet rock, insulation, floors and the exterior,
...uber pointed out that the two ...lances were to be inside the ...ing last December and this ...mber is coming up.
...e said the first aid squad ran ... some problems, not financial, ... Shackleton began a fact-...ng mission.
...oard member Dan Berry asked ...e variance were not granted, ...d the architect be insured for ... he did.
...herwood said his firm does not ...esent the first aid squad on any ...ers other than the variance.
...nzone commented that the first ... squad saves peoples lives, and ...lid not think the board could ... an applicant more dedicated ...ommunity services seeking a ...ance.
...ruber made a motion to grant ...use variance "because the first ... squad has been put in a bind

noted the cricimstances that the squad serves the public and that

Henson said the memorialization of the variance will incorporate in it wording that the variance is granted only for the continuation of construction, not for occupancy.

Construction on the building ceased late last year.

Shackleton said at a June meeting of the governing body that there had been very significant cost overruns on the building. When the squad took on the project, it had $300,000 available. Shackleton said the architect had quoted less than that.

As the building construction moved along and bills were being paid, it became evident that it was going to cost substantially more than $300,000, Shackleton said.

The squad closed a first mortgage with Commerce Bank Shore and now has ample funds, he said in June, but he advised the squad not to go on with the work "until all the t's are crossed and the i's dotted."

During the mortgage closing, a land surveyor discovered the building as designed exceeded the borough height limitations by three or four feet, Shackleton said.

The architect, Rob Roth of Brant Beach, said in June that the new building is roughly twice the size or close to it of the former structure and was quoted at $480,000.

He added that to replace the building with another of the same size would have cost between $300,000 and $350,000.

what happened was not in the control of the first aid squad.

...performance of their jobs. Public employees would be required to

...bitats and nesting areas for shore birds.

Dunes

Continued from Page 1

go over the ramp.

She said the dune on the north side of the ramp is Green Acres property.

A wooden barrier like the one in the vehicle access ramp at Pearl Street would catch sand, she said, but contended that they do not need another vehicle access in this area.

Tam Jones, also of Fifth Street, said the Public Works Department employees said they were told to bulldoze part of the dunes on Fifth Street.

"We were told 'probably to keep the sand off the walkway,' which is ridiculous," she said.

She has a picture showing the Fifth Street pavilion with no dunes after the '62 storm. She said over the years she, her husband and children and other neighbors have planted dune grass, small cedar trees and cactus on the dunes to build them up, occasionally adding flowers.

"They're taking away that dune grass," she said. "It's hurricane season."

Jones said if a picture were taken from the beach looking up to the dune, it would look like a funnel that would conduct the ocean down the street.

Other coastal areas are interested in building dunes, she said, but in Beach Haven, dunes are being bulldozed down at Fifth and Center streets.

She said when she spoke to the public works employees doing the work, she was told to contact the commissioner. She also was told a wooden barrier would be erected to catch the sand, not now but possibly as late as January.

Her husband and others spoke to the commissioner about the Fifth Street pavilion on Saturday and learned that a barrier will be erected and layers of dune fencing will be replaced.

The concerns are not only that dunes have been disturbed, Jones said, but whether or not they will be repaired now.

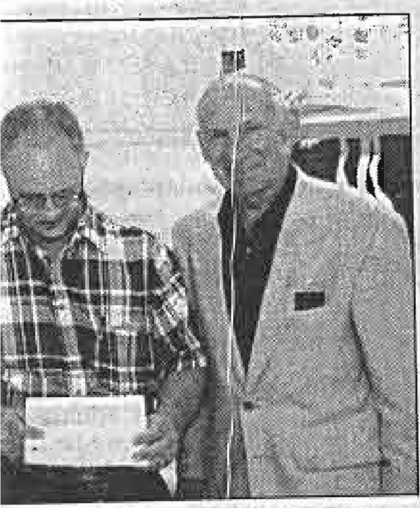
Commissioner Andy Anderson, however, said the work is in preparation for the building of a retention wall there.

Treated lumber is to be used to build the wall from the street to the oceanfront pavilion, Anderson said Monday. Not all of the materials have arrived for the retention wall, he said.

"We pushed some sand away from the walkway on either side," he said. "Admittedly, too much on one side."

But the borough has a plan to rectify that, Anderson said. "We have a plan to make everyone happy."

The work is expected to take about 30 days. When the work will begin has not yet been determined.



Times-Beacon photo by Paula Scully

...vocate newsletter while discussing ...ach replenishment programs are, ...ty Owners Association Vice Presi... ...l Advocate lobbyist Ken Smith and ...Robin after the meeting Sunday at ...ndation of the Arts and Sciences.

'SHORELY' NEEDED

Access sought for Loveladies beaches

By PAULA SCULLY

LOVELADIES — Long Beach Township officials are seeking Loveladies property owners who will allow an equipment access to the beach through their easements.

Commissioner Frank Pescatore wants access to the ocean to drive a truck onto the beach, according to an announcement by Mayor James Mancini at the Loveladies Property Owners Association meeting Sunday.

"We'd appreciate any one who has an easement to think about this," Mancini told about 200 members of the association at the Long Beach Island Foundation of the Arts and Sciences.

Pescatore said the easement will be used only if equipment cannot get over groins, wooden dividers between beaches, in the event of a washout.

"We can't rake the beach because we can't get at it," Pescatore said of daily summer beach maintenance done on all other township beaches but is prevented in Loveladies by the groins and lack of wide access for trucks.

"We want a maintenance access between two groins," the commissioner said.

He said the township beach crews now have equipment access to the Loveladies beach from only two locations, the south end of Harvey Cedars and from Coast Avenue.

As for recent out-of-county newspaper articles alleging Loveladies does not have enough public access to the beach and that Long Beach Island does not have enough parking in general, Mancini said the articles are part of the constant debate between the inland areas and the shore areas.

Mancini also reminded the audience that a $370,000 Ocean County project will start in two weeks to widen Long Beach Boulevard shoulders used for jogging, bicycling and walking. The plan includes narrowing the median strip, adding the footage to the shoulders and creating a turn lane within the median.

As for the cost, he reminded the audience that the project is engineered, constructed and paid for by county money, not township money.

New maternity ward a Labor Day of love for mother and baby

By AMY PASTORE

STAFFORD — Monday literally was Labor Day for a West Creek woman who delivered the first ... in Manahawkin, delivered the Schriever's bundle of joy and said he was very happy with the new facility.

...ed to the interest of Long Beach Island Since 1923

bulking up
Page 13

...er 2 Wednesday, September 2, 1998 Published Weekly 50¢

...es-Beacon photo by Robert Ward
...hed ashore Friday on a ...d two children, Reming-...hick, 4, both of Holgate.

Ocean claims 2 lives

By JOHN LAWLOR

BEACH HAVEN — Rough waters off the beaches of Long Beach Island claimed the lives of two men in their 20s last weekend.

Norman F. Swenson III, 28, of Beach Haven drowned Saturday off the Berkeley Avenue beach, police said.

At approximately 8 a.m., police responding to a call in reference to a possible submersion found Kurt Horenski, 38, of Bay Avenue and Russel Lipko, 32, of Third Street performing CPR in an attempt to resuscitate Swenson.

The two men had seen Swenson out by the jetty when he went under, police said. They looked for him for about five to 10 minutes and then saw his body surface by the pilings approximately 50 feet south of the jetty.

According to police, Horenski and Lipko went into the water to bring him back to shore.

Beach Haven First Aid Squad transported Swenson to Southern

See DROWN on Page 12

Times-Beacon photo by Robert Ward

A Long Beach Township lifeguard patrols Brant Beach Friday, keeping an eye on rough water churned by Tropical Storm Bonnie.

Areas of wildlife refuge eroded

By PAULA SCULLY and JOHN LAWLOR

The Holgate unit of the Edwin B. Forsythe National Wildlife Refuge is closed to vehicles until the refuge staff decides it is safe once again to drive on the beach.

Although the developed areas of Long Beach Island survived the turbulent surf action brought on by Hurricane Bonnie downgraded to a tropical storm, some areas gained beach and the undeveloped refuge was damaged by beachfront erosion.

There are several sections along the Holgate beachfront where vehicles may not pass safely even at mid or low tide, officials reported.

The impact on visitors will differ depending on whether they want to access Holgate on foot or in four-wheel-drive vehicles.

Refuge officials planned to open Holgate beachfront to pedestrians only after the tropical storm passed through and signs could be posted safely to indicate which areas are open.

Refuge staff will continue to monitor erosion conditions to determine when Holgate will reopen to vehicle use.

Fifteen piping plover chicks were hatched and fledged from 17 pairs of endangered plovers at the

See STORM on Page 12

Rink

Continued from Page 1

Whitcraft went on to say that Commissioner Andy Anderson, however, pointed out to his fellow commissioners at an agenda meeting that problems at the bay beach at Taylor Avenue need to be addressed and that the bay beach is in such a state of disrepair it cannot be used.

When resident Mary Ann Berry alleged the chief of police said no municipal funds would be used for the roller rink and said she did not know why the chief was involved in recreation, Whitcraft said Chief James McCaffrey, as well as other officials, had stated that private funding would supplement the $17,500 donation.

Whitcraft said that when officials had meetings prior to the May election the chief had suggested that a donation be made for parks and recreation.

She said that since then she has received many letters, either opposed to the rink and that use of the money or saying, "Let's do it right."

Former Mayor P. Victor Sencindiver commented at the Aug. 24 meeting that the bay beach will require significant dredging of cement material and he advised borough officials to work on obtaining permits.

Anderson said, "The wheels are in motion now."

The chief, responding to the question about his being involved in recreation, said he would take his badge off and address the meeting as Butch McCaffrey, in other words, as a private citizen.

He said when municipal officials met with the cable installation company they had no idea how much money the company would donate to resurface the hockey rink.

Berry said, "I don't wish to get into an argument with you but I don't want
you."

McCaffrey
gotten invol
planning al
volunteers.

"I've take
Butch McCa
frey, who ha
ments earlie
police chief
in the proje

Previously
he has been i
and that this
what prevent
participation.
said.

He said th

Storm

Continued from Page 1

wildlife refuge, but the seasonal reopening of the refuge, originally scheduled for Friday, was delayed by Mother Nature.

After hitting South and North Carolina and Virginia, Hurricane Bonnie was downgraded to a tropical storm before it reached this area and veered past New Jersey on Friday, leaving no serious damage. At one point it was upgraded to a hurricane again at 11 p.m. Thursday but subsided without incident.

There were wind gusts of 30 to 40 mph, with higher gusts, and seas of 12 feet, according to the National Weather Service in Mount Holly.

On Long Beach Island there were reports of arcing wires and wires down and power was lost in an area of Beach Haven Terrace.

The storm built up the beach, Long Beach Township Mayor James Mancini said.

"The storm Bonnie actually helped our beaches," he said. "I was looking for the storm to bring in the sandbar and move the sand onto the side where it had eroded. Bonnie was not really a heavy storm. It was the right length and as a result our beaches were improved by Bonnie rather than hurt."

Mancini said the islanders will see what happens with the next storm, "but we were extremely lucky to escape without any problems of any dimension."

Coast Guard Station Barnegat Light Petty Officer Robert Goley said Tropical Storm Bonnie brought intermittent heavy rain Friday morning.

"It's been raining off and on since early this morning," Goley said last Thursday. "Heavy rains, then they stop, then start again."

In preparation for the hurricane, the personnel had secured everything at the station. "We're ready if anything comes," he said.

Goley said no boaters had been out and in trouble since the Aug. 25 rescue.

The Coast Guard pulled seven people out of Barnegat Inlet at approximately 6 p.m. Aug. 25, the day Hurricane Bonnie came on shore in North Carolina.

Jimmy Schrader of Waretown was operating personal watercraft in Barnegat Inlet with his brother and two friends when they came across a distressed swimmer.

"He said he and a friend were JetSkiing when a rope got tangled in their pump propellers," Schrader said. "The guy said his friend cramped up and was a mile back."

When Shrader came across the next swimmer, he heard faint screams coming from five people about a mile away.

"The people were wearing life jackets and were scattered around their boat, which was swamped," Shrader said.

The Coast Guard received a rescue call from Long Beach Township Police at 5:46 p.m., Petty Officer Dan Payne said.

Two Coast Guard rescue boats were dispatched and the two men riding the personal watercraft were rescued at 6:08 p.m., Payne said.

With their 44-foot motor lifeboat, Payne and Petty Officer Rob Goley approached the fully submerged boat with two people hanging on and the other three a short distance away clinging to an inner tube.

All seven victims were wearing life jackets and were transported back to base, Payne said.

"The water was too rough for their boat," he said. "There was breaking surf in the inlet with 6- to 8-foot swells."

Initially, surfers took advantage of the waves.

In Long Beach Township, which has the largest beach on Long Beach Island, lifeguards put up red flags to indicate restricted swimming last week, according to a lifeguard spokesperson. Each beach and each day was handled differently, depending on the tide, the shore break and other factors, the spokesperson said, but no beaches were closed.

A report of a missing swimmer at Point Pleasant Beach Aug. 24 during the approach of then-Hurricane Bonnie turned out to be a hoax, authorities said.

Anthony Mandarino Jr., 23, of Oakland, allegedly fleeing prior charges of aggravated assault, bounced checks and eluding police, and his fiance, Kimberly Kuda, 21, were arrested after anonymous tips on charges of fourth-degree conspiracy and making a false public alarm, with Kuda also charged with

Drown

Continued fro

Ocean Coun
was pronoun

Following
the cause of
to be asphy
said Gregor
County ex
prosecutor.

"He was
body knew
friendly," sa
ter, general
ing restauran
Swenson w
cook.

"He was g
and very, ve
as the quali
out," Nutter

She said
membered t
ven resident
at the beach

Earlier S
27-year-old
was found
ship public
proximately
shoreline of
in Beach H

According
Finlayson
nearby mo
She last sa
motel at 4:
going to t
sunrise.

Finlayson

philadelphia online

The Inquirer SMARTWIRES July 1, 1998

South Jersey

Beachgoers go along for ride -- on a tractor-tram

Getting to the ocean at Barnegat Light takes a hike. Many become not-so-strange flatbed-fellows.

By Amy S. Rosenberg
INQUIRER STAFF WRITER

BARNEGAT LIGHT -- The shiny new tractor rumbled along, pulling its cargo through a vast expanse of tall grass. But yesterday's bucolic scene was not taking place on a farm in Iowa.

And those people in bikinis, with their flip-flops and boogie boards bouncing up and down on the flatbed behind the royal-blue tractor, were no farmhands.

Unlikely as it may seem, this was a beach at the erosion-wracked Jersey Shore, as Barnegat Light debuted a tractor-tram to be used to drive beachgoers the nearly three-quarter-mile from the dunes to the lifeguard stand.

For Barnegat Light is a town with what some consider to be too much of a good thing -- sand.

A seven-year-old U.S. Army Corps of Engineers navigational project that dredged the Barnegat Inlet and constructed a new south jetty unexpectedly trapped sand at the north end of Long Beach Island. And that created a widening beach where, just a few years ago, waves had lapped up under beachfront porches.

"Houses used to be oceanfront; then they were ocean view; then they were ocean very far from view," Gail O'Donnell, borough administrator, said. "The protection was great, but look how far you had to walk."

Other towns on Long Beach Island and elsewhere at the Shore should have such problems. Farther south on Long Beach Island in Surf City yesterday, lifeguard Catherine Giordano found herself backed up on a sliver of beach barely wide enough for her lifeguard chair.

"I have a hard time figuring out where to sit," she said.

HAVEN
ES
ng Beach Island Since 1923

INSIDE

Victory a breeze Page 10

LIFE

For women only Page 17

SPORTS

Leapin' to first place Page 11

Wednesday, May 20, 1998 Published Weekly 50¢

;roins to be cut at beaches

fforts made counteract orm erosion

By PAULA SCULLY

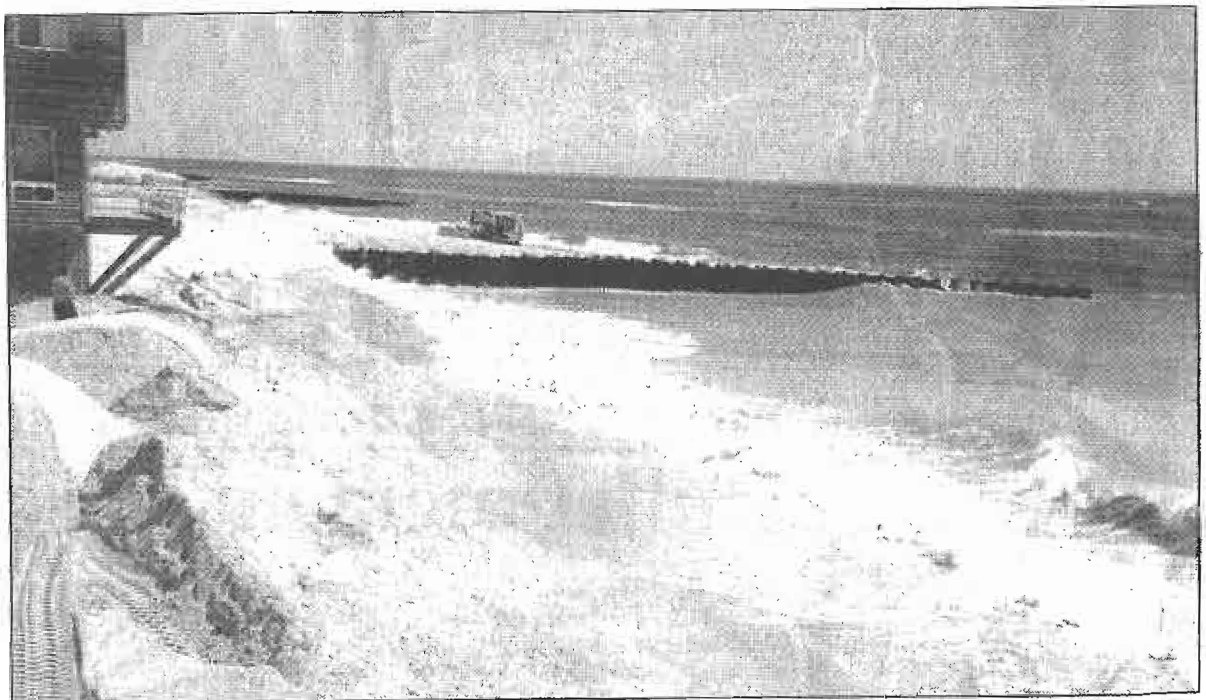
ANT BEACH — Municipal ls rushed to get the beaches in time for Memorial Day nd after 17 northeast storms, fter another, left Long Beach damaged in areas where it ot been damaged before.

ng Beach Township officials decided to cut down wooden , the wooden dividers be- beaches, in three of the -hit locations in an attempt to back the beach.

this Construction was led a contract at Friday's cipal meeting to cut three , one at a time, at 79th Street, Street and Mississippi Av- for $174 a linear foot.

wnship Commissioner Peter hy said he had been ques- l by so many people who said re shocked at the condition of each that at one point he put a explanation on the township one line, 361-1000.

said township officials had ed in 800 loads of fill from Mainland to correct the prob- t a cost of about $700,000 in



Times-Beacon photo by Don Rocheskey

Long Beach Township plans to cut three wooden groins down three feet to allow water and sand to wash over three of the most severely eroded beaches, including this one at 79th Street in Brant Beach.

ered over the area for four days and the hardest hit areas of the beach are being fixed first.

The township public works commissioner, Frank Pescatore, said he brought in two large bulldozers this week in addition to the township bulldozers to rebuild the dunes.

"Our first objective is to get the selves," he said.

"Every municipality on Long Beach Island has been hit in areas they've never been hit before except Barnegat Light."

For example, at 80th Street and the ocean, the dune was cut and sand taken from under houses, leaving one home particularly

the water but it looks bad," Pescatore said.

"The state reported 23 storms," he said. "We recorded 17 northeast storms."

By this time last year all the municipalities on Long Beach Island had their dunes in place and their street ends, or beach en-

Storms costing $300,000

BRANT BEACH — Long Beach Township officials adopted a resolution Friday for emergency funding of up to $300,000 for repairs resulting from two storms, one at the end of January and the other in the first week of February.

Commissioner Frank Pescatore said beach repairs have progressed in Brant Beach to such a point that he has moved two bulldozers to other areas, one to Loveladies and one to North Beach.

Mayor James Mancini said Brant Beach, in the area of 50th Street and south, was the worst hit section of the township beaches in the Feb. 4-5 nor'easter after they had been weakened by a storm the week before.

"If you looked at it today, it is better than it was before the storm," Mancini said.

He said the township trucked in approximately $60,000 worth of gravel with a heavy clay content that was used to make the core of the dune and then white sand from the beach was bulldozed over the core.

Larry Zaccolo of Beach Haven Park brought up the idea of bulkheading oceanfront properties because the bulkheading would prevent water from washing into the property.

He said bulkheading the front and sides of the oceanfront homes would stop the incoming waves and prevent erosion below the bulkhead at these homes.

Mancini agreed that "the water stopped there" at the bulkhead at oceanfront properties around 50th street and south where there is such bulkheading.

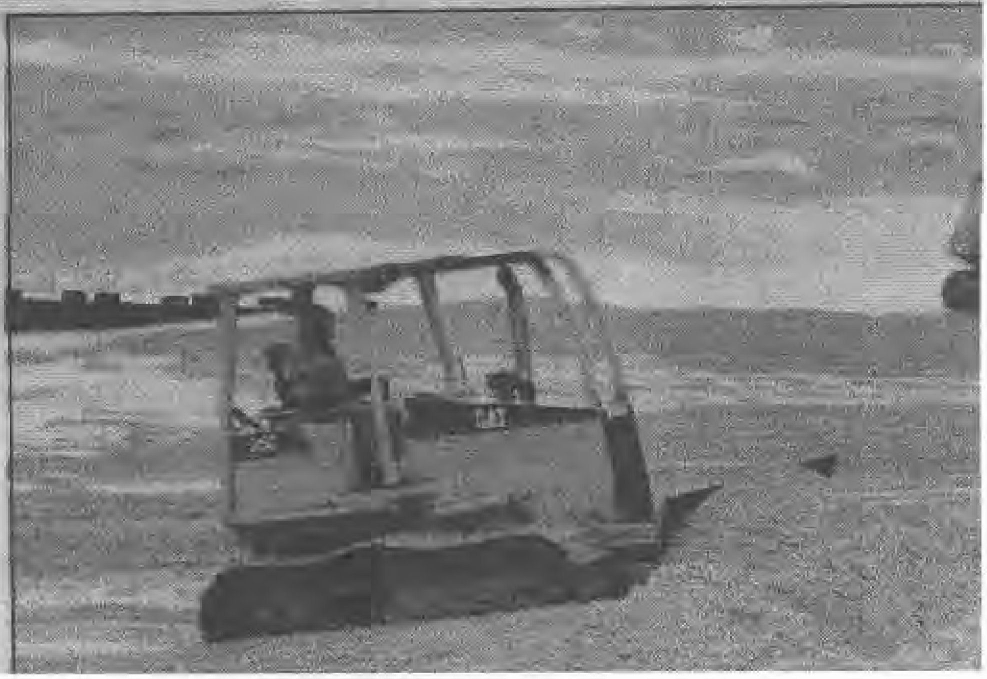
He said several homeowners have indicated their interest in investigating the idea of bulkheading a house and may apply to the township for such a permit.

Although the township would grant the permit, the mayor said, the homeowners also would be required to seek the permission of state and federal agencies.

WHIRR-L WIND OF REP

Tin

Workers at the Ship Bottom traffic circle videotape the final section of the borou collapsing and will undergo up to $2.5 million in repairs. In photo below, three nor'easter, bulldozers are still pushing sand back up the 53rd Street beach in Bran sand is being used to cover a new dune core of heavy gravel and clay fill.



He said the township trucked in approximately $60,000 worth of gravel with a heavy clay content that was used to make the core of the dune and then white sand from the beach was bulldozed over the core.

Larry Zuccolo of Beach Haven Park brought up the idea of bulkheading oceanfront properties because the bulkheading would prevent water from washing into the property.

He said bulkheading the front and sides of the oceanfront homes would stop the incoming waves and prevent erosion below the bulkhead at these homes.

Mancini agreed that "the water stopped there" at the bulkhead at oceanfront properties around 50th street and south where there is such bulkheading.

He said several homeowners have indicated their interest in investigating the idea of bulkheading a house and may apply to the township for such a permit.

Although the township would grant the permit, the mayor said, the homeowners also would be required to seek the permission of state and federal agencies.

He said he knows that under CAFRA II (the Coastal Area Facilities Reform Act regulations), a

See BULKHEAD on Page 12

Index

Also Inside

Beautiful Baby & Cutest Kid Contest

Business To Business Expo

Weekend Islander entertainment guide

Tim

Workers at the Ship Bottom traffic circle videotape the final section of the borou collapsing and will undergo up to $2.5 million in repairs. In photo below, three nor'easter, bulldozers are still pushing sand back up the 53rd Street beach in Bran sand is being used to cover a new dune core of heavy gravel and clay fill.

12-acre Hideway Bay proje

By PAULA SCULLY

BEACH HAVEN PARK — A 12-acre housing subdivision on Long Beach Island has received final site plan approval for the start of construction.

Hideaway Bay, between 100 and 110th streets south of the Acme, initially will have 31 houses ranging in price from $350,000 to $850,000 on bayfront and inside lots.

The land already has been cleared after preliminary approval was received in August and construction has begun on the infrastructure.

There will be one entrance to the development and the street will be constructed in the shape of a loop. Traffic will be one-way on Hideaway Bay Drive.

M&M Developers, developer Frank Muth and builder Patrick Moeller testified before the Land Use Board on Thursday that they had been almost t process of puttin together with the Area Facilities Re rules) approvals a federal regulations met.

The property w April 1995, preli was granted by Board in August 1 proval granted Tl iances were n

And mansions in Harvey Cedars and Loveladies perch perilously close to the surf.

But in Barnegat Light, people cheered sixth-grade teacher-turned-tractor-driver Stuart MacKenzie as he guided the $15,000 Ford New Holland 3430 along the paths through dunes that have become prime nesting spots for piping plovers.

The tractor will do loops continuously from 10 a.m. to 5 p.m. from the base of the dunes between Fourth and Ninth Streets to the Ninth-10th Street lifeguard stands. There will be no charge, but the driver is supposed to check for beach badges.

"It's like a hayride without the hay," said Barbara McGill, who gladly climbed aboard at Eighth Street with her sister, 65-year-old mother, and five children ages 3 to 11.

The flatbed was fitted with benches on three sides to carry about a dozen passengers.

Before, McGill said, "it was a horror. You needed to be a marathon walker."

She said the adults would take the children piggyback and in backpacks. Two people would drag a stroller between them. It made for three quarters of a mile of constant complaining, she said.

Joan Doorly, who gave her age as "65 plus," said she had not been to the beach near her home in a year.

"I can't walk it anymore because of a bum knee," she said.

But yesterday, ski pole in hand, she caught the tram at Ninth Street and enjoyed the bumpy ride out.

The growth in the beach had prompted some of her neighbors to put their homes on the market, Doorly said. Others, meanwhile, were finding it hard to rent properties, with the beach a hike away. And many were simply driving to the south end of town, packing the smaller beaches.

The tram was the idea of Mayor Kirk Larson, who was unavailable for comment yesterday. A tram has been used for several years in Wildwood, where vast stretches of flat sand lie between the street and the ocean.

The landscape in Barnegat Light is not flat, though. As the beach widened, it sprouted dense dune grasses and other vegetation and formed a hilly terrain once common to Jersey beaches but long since eroded or developed away.

Piping plovers and other protected shorebirds, squeezed out of other areas by foxes, eroding dunes and humans, soon discovered Barnegat Light. A beach hard for humans to access can be a piping plover's dream.

Now, more than a third of the new dunes are fenced off as protected nesting areas, according to oceanographer Jeff Gebert of the U.S. Army Corps. That has prevented engineers from carting the gathering sand from Barnegat Light to other towns starving for sand.

Gebert said he was surprised at the speed with which the area had turned into a prime nesting habitat for shorebirds.

"It became more or less untouchable," he said.

Gebert dismissed the griping he had heard from more vulnerable Shore towns that blame the corps' inlet and jetty project for sapping sand from their beaches.

"I think it's largely coincidental," he said.

He attributes the beach erosion to storms and the gradual dissipation of sand pumped in during a major beach-restoration project in 1979.

Barnegat Light residents, he said, should be happy with their new landscape, especially considering the alternative.

"It is," he noted, "immune from storm damage."

NEWS
SPORTS
LIFESTYLE
OBITUARIES
SPECIAL REPORTS
CONTACT US
LINKS
HELP
HOME
AT THE SHORE ENTERTAINMENT WEEKLY
ONLINE CLASSIFIEDS FOR SALE
Golf Guide
Birding Guide
CROSS WORD

PRESS PLUS
THE PRESS OF ATLANTIC CITY ONLINE

Saturday, March 7, 1998

IN THE NEWS

Beach Bound: Shore towns turn to pinelands for sand

By MICHAEL S. YAPLE

Staff Writer

LONG BEACH TOWNSHIP -- Towns in Long Beach Island have been doing something unusual when they need sand to restore their beaches. They look away from the shore -- and go deep into the heart of the pinelands.

Environmental regulations have made it difficult to dredge sand from the sea floor, so more island communities are relying on pinelands mining operations that extract sand from the already grainy soil.

Years ago, coastal communities called for trucked-in sand as "just a quick fix in high tides," said Philip Barber, manager of Phoenix Pinelands Co., a mining operation in Warren Grove.

This year his company will supply Long Beach Township with 20,000 tons of sand.

"We were like, 'Hello! We're right here,' " said Barber. He said it's not much, considering he supplies his typical customer, a concrete or asphalt plant, with more than twice as much as a beach project.

Trucked-in sand isn't necessarily new, and many coastal communities use it for patch-up jobs. But the larger beach-restoration projects using pinelands sand are more common in southern Ocean County.

"It's pretty much unique to Long Beach Island," said Stewart Farrell, director of the Coastal Research Center at Richard S. Stockton State College of New Jersey. "Long Beach Island trucks a lot of sand because there's no other practical way to do it."

He said other coastal communities such as Atlantic City, Ocean City, Brigantine and Avalon pump much of their sand from numerous inlets.

But the 18-miles of Long Beach Island is different. It's too far to pump sand from an inlet to the center of the island, he said. The island's hundreds of side roads that stop at the beach ends are better suited for trucks to dump fill.

"The towns can't get the sand any other way," said Jonathan S. Oldham, mayor of the Long Beach Island community of Harvey Cedars.

In March of 1996, Harvey Cedars completed a \$3.8 million project, hauling in 520,000 cubic yards of sand that left the shores an average of 60 feet wider.

"It was the largest trucked-in project in New Jersey, period," said Farrell.

It was more expensive than dredging,

Oldham said, but the community couldn't get the necessary permits because the state Department of Environmental Protection is concerned about dredging's effects on the bay.

"Possibly we've created too many levels of bureaucracy," he said.

Towns that must use pinelands sand find it's a different product than offshore sand.

In Harvey Cedars, many people complained the sand arrived an odd, reddish yellow. That was iron oxide, a natural coating on the sand that washed away in a few weeks.

Offshore sand arrives naturally washed, but some people complain about the shells that cut their feet.

Sand from the pinelands tends to be more coarse -- "which is good as long as you're not getting a lot of gravel or silt," said Farrell. The state requires at least 90 percent of the shipment to be sand, and officials have turned away loads that have too much silt or gravel.

Sometimes the towns want something tougher than sand. "If we're putting a barrier up, we try to get something with a lot of clay in it and then cover it up," said James J. Mancini, mayor of Long Beach Township.

On Long Beach Island, dredging is limited to a hopper dredge that deepens the Barnegat Inlet channel for boat traffic. But it's not the massive offshore projects seen in other areas.

"For small projects, the trucks make sense," said Farrell. "The only other source is off the ocean, which is more expensive."

The off-shore dredging is cheaper only when it's a major project that pumps in hundreds of thousands of cubic yards of sand. But it will be years before Long Beach Island sees a dredging project that large.

The island is in the middle of a $2.8 million federally funded feasibility study, which is needed before Congress can approve money for the actual work. Farrell said it could cost "easily $150 million from start to finish."

He added, "It could be five years away before it's ready to rock and roll."

Times-Beacon photo by Robert Ward

A bulldozer rented at $5,000 a month but manned by a public works employee plows fill to create a dune on the Cumberland Avenue beach in Harvey Cedars.

F
to

a

Follow
byist said
pressed o
beach rep
They l
pouring
washes a
who close
a time of
to do tha
The an
works and
the publi
dent of C
However,
project to
tive, he s
"Witho
small pro
long. In

Timochko said.

Stein admonished Palczewski for his accusatory comments, advising that Kilmurray was not found guilty of anything.

The case brought by LeTellier and taken over by the state School Ethics Commission against Kilmurray, is not a criminal case and therefore guilt cannot be associated with it, he explained.

Stein said it does not matter what the board decides it would like to do in regard to the matter. "Ultimately it is the commissioner who decides," he said.

Commissioner Leo Klagholz is expected to review the case and recommendations from the state School Ethics Commission and administrative law judge before rendering the final decision on the case by April 16.

TOP News Briefs

Beaches eroded in 2-day storm

By Staff Reports

A slow-moving nor'easter pelted southern Ocean County last Wednesday and Thursday with driving rain and gale force winds, damaging a coast already reeling from a previous storm.

Other area towns did not fair as well, and as the coast recovers from severe damage two weeks in a row, the National Weather Service is predicting thunderstorms this week.

Marker No. 6 on the rocks of the north monument at the Barnegat Light jetty washed away in last week's storm. Petty Officer Steven Coles of Coast Guard Station Barnegat Light said when the Coast Guard went out to assess damages, the marker was gone and the Coast Guard was trying to locate it.

A rumor circulated that a house had collapsed into the sea, either in the severely eroded section of Long Beach Township or at Dolphin Avenue in Beach Haven.

However, officials said no houses collapsed in the storm.

Beach Haven Mayor Robert Bahner said an unoccupied house that had been destroyed by fire on Chatsworth Avenue the previous week was torn down after the storm.

A beachfront house on Dolphin Avenue was saved with the use of emergency fill, brought day and night. Before the storm, the county trucked in emergency fill from Barnegat Township, but after midnight last Thursday the county quickly sent 19 trucks bringing 40 truckloads of fill to Dolphin Avenue in the middle of the night by emergency arrangement with Freeholder James Mancini. Half of the fill had washed away, Bahner said.

The total loss estimate, public and private, in Beach Haven is $150,000, including 10,000 feet of dune fence, according to Emergency Management Coordinator William Tromm. He said the Federal Emergency Management Agency will assess only structural damage, which Beach Haven did not have.

On Monday, two bulldozers continued work on the beach, and the commissioners adopted a $50,000 emergency funding ordinance.

In Long Beach Township, Commissioner Frank Pescatore said the occupants of a home on 80th Street at Brant Beach were evacuated to the Municipal Complex briefly after a nearby telephone pole toppled over as a result of erosion and high winds, and a second pole closer to the house cracked.

Pescatore said the pole was fixed, and that the couple took the evacuation well and were served baked goods as they waited a few hours to be returned home.

The most severe and extensive erosion occurred at the weak spot between 47th and 54th streets in Brant Beach where more than 100 truckloads of sand had been delivered in the wake of the previous storm. Most of the fill was washed away the night of Feb. 11. The area has become a sightseeing attraction for people viewing beachfront damage.

Township workers took pictures and a video of the damage so that future claims could be proved. Pescatore said that in past years FEMA made estimates of sand removed from beach access ramps, for example, since there were no photographs of what had happened.

A FEMA advance team and representatives of the U.S. Army Corps of Engineers, which is conducting a study of Long Beach Island leading eventually to a 50-year beach maintenance plan, and the state Department of Environmental Protection arrived after the storm to make videotape and damage assessments.

Long Beach Township police and Emergency Management reported the storm flooded Long Beach Boulevard and forced closing of the boulevard from Ship Bottom to 95th Street. Severe flooding was reported through Beach Haven. Pescatore said there were 30 houses where the sand was eroded and the water came up.

With Gov. Christie Whitman including Ocean County in the declaration of a state of emergency, officials expressed optimism as they reported the damage.

"We were hit hard, but we're snapping back," Bahner said.

Long Beach Township may be in line in the future for a major state beach fill project of 400 to 500 yards into the ocean at Brant Beach, Mayor James Mancini said after noting the storm did the most wind and beach damage of any of the 10 storms in the past year. He estimated emergency work at $265,000.

Harvey Cedars Mayor Jonathan Oldham said he expects the situation will be remedied by summer, although last week's storm caused a great loss of sand from the Harvey Cedars beaches.

Oldham said the worst damage was done to the dunes and beaches at the south end of the borough. This area typically receives the brunt of winter damage, he said. In some places, enough sand was washed away to expose a gravel base which was constructed several years ago.

Despite the loss of the sand, Oldham said he was relieved there was no real loss of property or life in the storm. Immediate plans calls for obtaining aid from the county to help establish temporary dunes in the affected areas.

As the more favorable winds and tides of spring arrive and bring sand back to the beaches, the borough will be able to push that sand up to replenish the dunes, Oldham said.

Barnegat Township Mayor Dolores J. Coulter said she and Deputy Mayor Gary Bielen drove through that municipality last Wednesday night to assess the situation.

A section of East Bay Avenue near the municipal dock was closed, she said, as tides tore into the public bathing beach.

Surprisingly, an inadequate detention basin near the Mirage development that previously caused water to infiltrate cranberry bogs was able to contain the heavy rainfall and did not flood, Coulter said.

The basin is in the process of being redesigned through a deal with Ocean County that the mayor said will save the township an estimated $150,000.

The county is transporting fill from the basin to replenish beaches on Long Beach Island, she said.

Coulter received a call later that night from Emergency Management Coordinator James McConnell, who said the tides were 4 feet higher than normal.

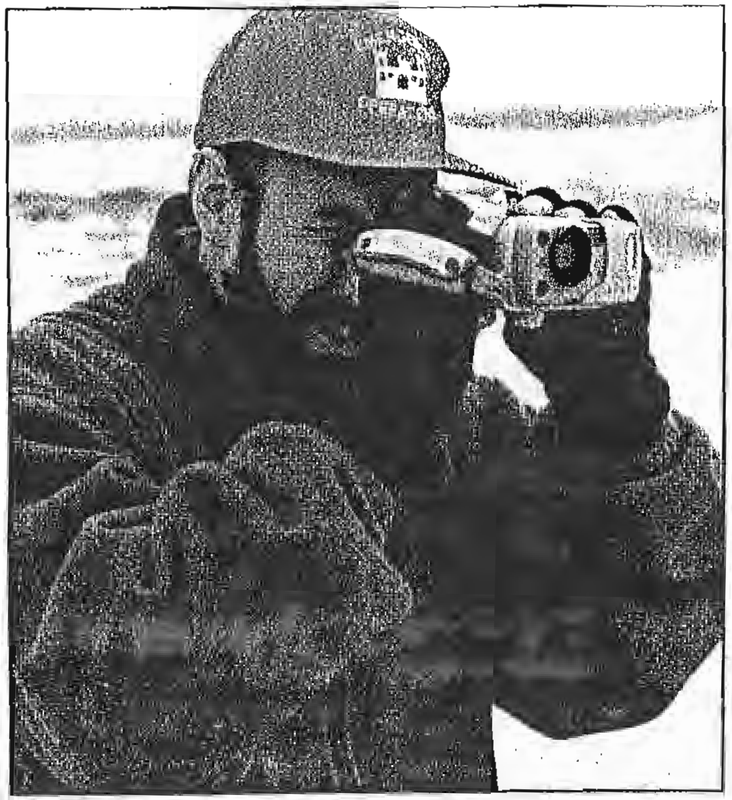
At 4:30 a.m. last Thursday, McConnell told Coulter the situation had stabilized and there

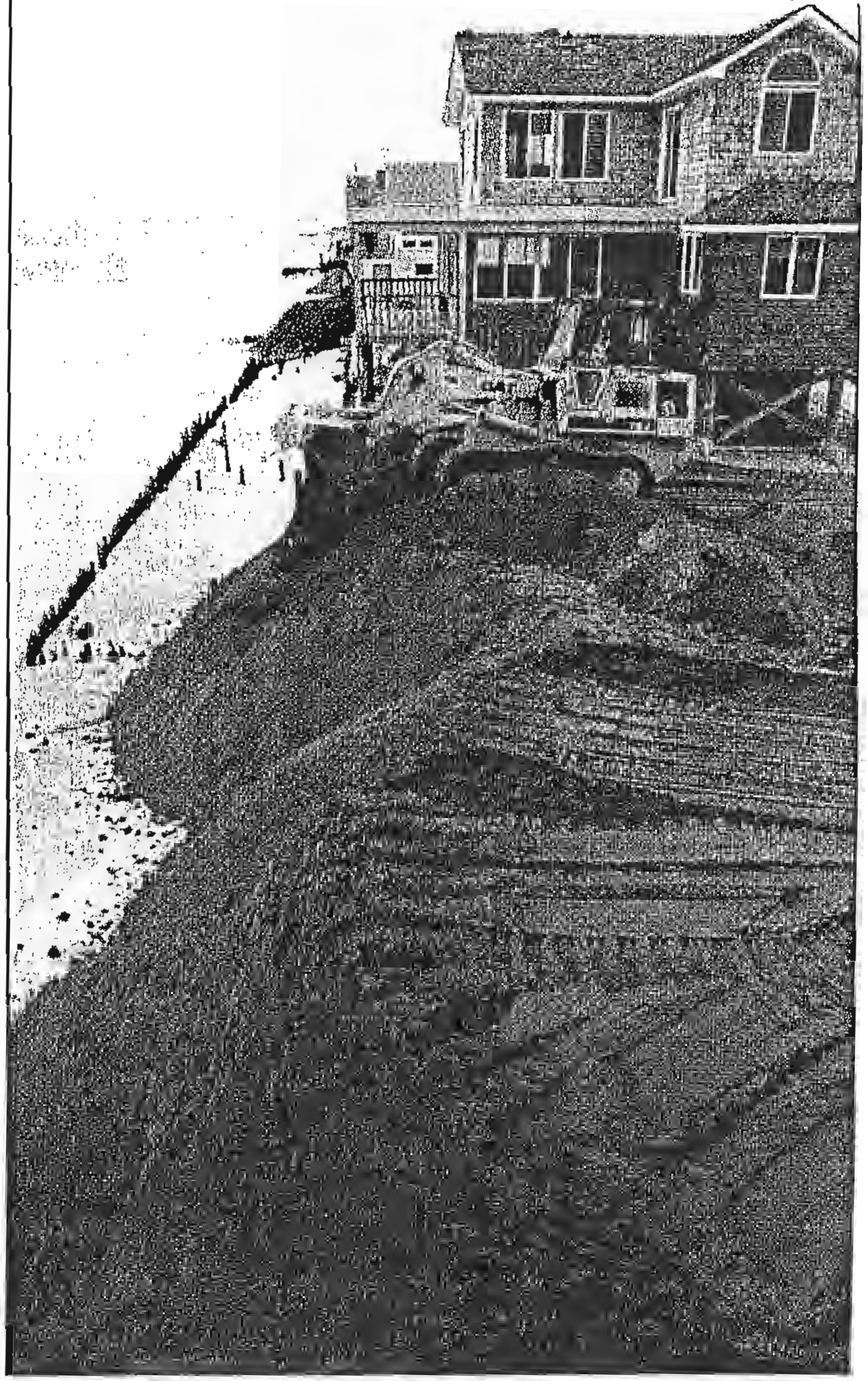
THE PRESS OF ATLANTIC CITY

REGION

SATURDAY, FEBRUARY 7, 1998

1 of 3





An Ocean County bulldozer pushes dirt to rebuild dunes at the end of 47th Street in Brant Beach.

At left, Randy T. Piersol, a planner with the Army Corps of Engineers, takes photos of the storm damage to be used for an ongoing study.

Beaches carved up by storm

Continued from Page 1A

Street beach. "But we'll have plenty of beaches this summer."

Savastano was quick to point out that millions of cubic yards of sand placed along four miles of city beaches in 1991 protected the boardwalk and other property from damage.

The city was largely deserted Friday, save some curiosity seekers and homeowners who came to check on their properties. In some parts of town, construction workers built new homes as though the storm never occurred.

Savastano said some of the lost sand will naturally wash back onto the beaches over the spring and summer. Still, the city will submit a request for Federal Emergency Management Agency funds to replenish some of the lost sand for the summer season.

But it was not clear if the city would seek to push up periodic replenishment under its 50-year agreement with the U.S. Army Corps of Engineers, which rebuilt the downtown beaches at a cost of $20 million. The beaches are not due for replenishment for two years.

A COE

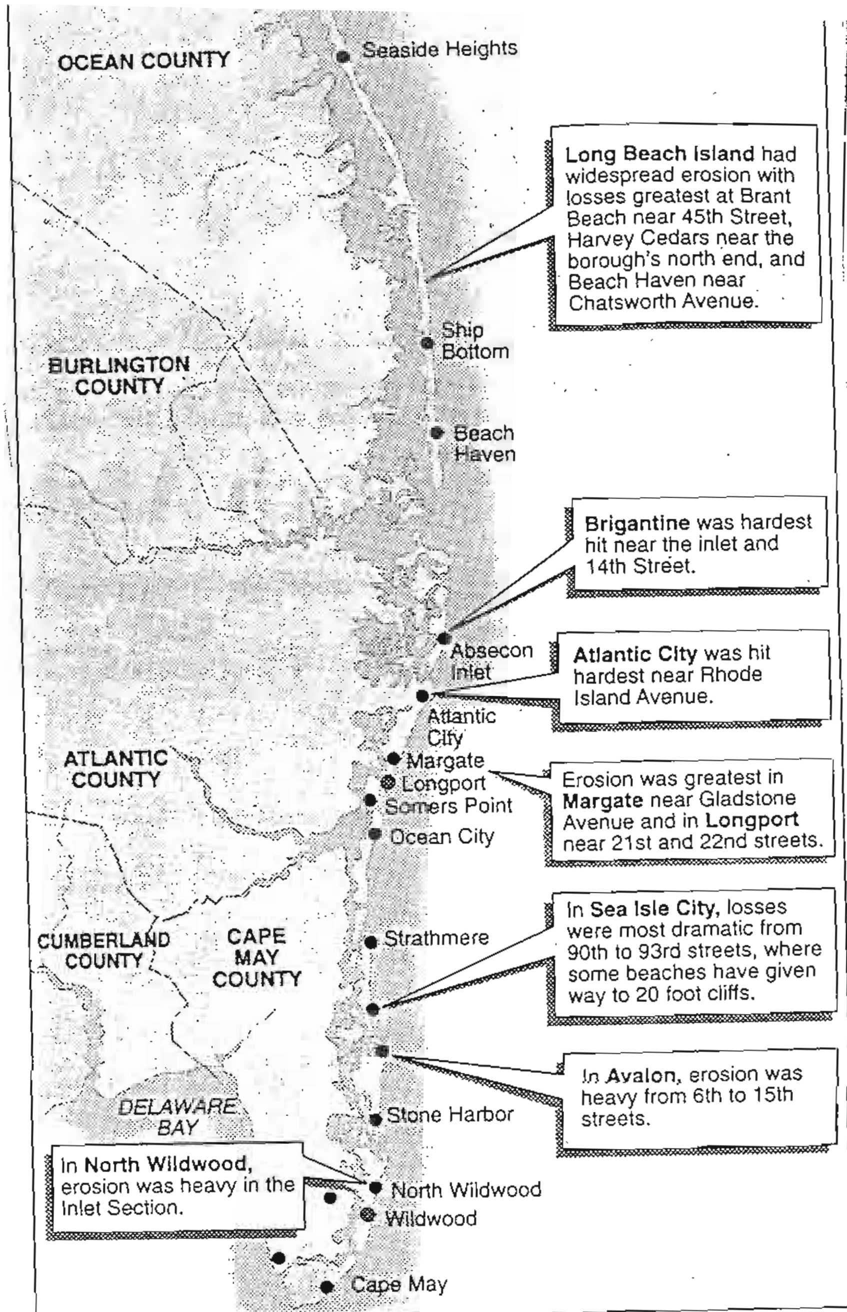
Replenishment is done by a floating dredge that gathers up sand from the ocean floor just offshore and then pumps it onto the beach, where it is spread by construction plows.

"It's a little too early to tell, but the beaches aren't in that grave condition," Savastano said.

But John Quinn, 26, manager of the Fudge Factory at 8th and the Boardwalk was a little unnerved by the surf breaking ever closer to the boardwalk after the storm.

Until the storms hit, Quinn could see the beach stretch beyond the crest of a small dune paralleling the boardwalk. On Friday he could see only water and waves breaking above the dune.

"Another storm like we just had and things could get pretty bad," he said.



Source: Office of Emergency Management in Atlantic, Cape May and Ocean counties.

Of greatest concern are the beaches in the southern part of the city, around Rudder's home. City officials say there isn't enough sand left here on the beaches to rebuild even a small dune.

In addition to washing away the dune, the storm left little more than a ribbon of sand — at low tide — to protect properties in this area. There was no evidence a sand dune ever stood before his house except for tangles of wooden sand fences.

"It just went all to hell," said Rudder.

But Rudder wasn't too concerned, saying he was counting on a bulkhead of wood and rocks erected after the March 1962 storm to protect his house.

Rudder, who weathered that storm as well, said this week's storm was probably as severe. He's seen many other nor'easters strike, but few stayed around quite as long as this one.

Despite his now precarious position at water's edge, he says he wouldn't consider pulling up stakes.

"You take your chances wherever you live," he said.

2 OF 2

Beaches

(Continued from Page C1)

Tolan were renting an oceanside house. Before the storm, there was a 6-foot drop from their deck to the dune below. Now it's about a 20-foot drop.

"It was all the way underneath the house, crashing," Lynda said of the waves. "It was pretty intense."

Some of the oceanside homes in the neighborhood had back patios suspended in midair, their steps leading nowhere. Support columns, with cement still attached to the bottom, dangled several feet above the ground.

Dozens of spectators with videocameras walked the beaches and streets.

The Army Corps of Engineers also visited with a videocamera, using the evidence for part of an ongoing study that may, when complete in coming years, allow for a major beach renourishment project.

"This is real data," said Randy T. Piersol, a corps planner. "This helps us verify the areas of storm damage."

Police shut down nearly 20 blocks of Long Beach Boulevard on Friday morning due to a 2.5 mile long "puddle" that hadn't receded.

The storm also eroded the shores in a part of Beach Haven.

"We have one area where we're bringing in sand and gravel, and bulldozing," said Mayor Robert T. Bahner. "We didn't get hit as bad."

Further south in the coastal area of Tuckerton, homes became islands in the water during the storm. By Friday afternoon, the water had receded to some large pools under houses and across streets.

Greg Prontnicki, 43, of Flamingo Road in Tuckerton Beach, spent part of his day hosing off the dirt left by the 14 inches of water that ran in the garage underneath his raised ranch.

"And this is the highest point," he said of his house. "Down a block, it had to be waist deep."

Decorative pilings that Prontnicki had lined up around his yard appeared to be thrown in a pile like a child's Lincoln Logs. Railroad ties that edged his property floated away, and the low-voltage yard lights once in the ground looked like a pile of Christmas tree lights strewn to the side.

"I'm still missing my patio furniture," he said.

But this week's storm wasn't anything like 1992, when Prontnicki's house wasn't raised on pilings. During that storm, he spent part of the day standing on a bar stool in his house as flood waters rose around him; he recalls splashing the water on electrical outlets that sparked and began to cause fires.

"This storm is more of an inconvenience," he said. "It's not even worth an insurance claim."

Jersey beaches are losing the battle of politics and nature

Sand, funds erode

By Olya Thompson

I walked along the South Jersey Shore the day after last week's Nor'easter to survey the damage. A state of emergency had been declared in Atlantic, Monmouth, Ocean and Cape May Counties. Half the beach was gone; geotubes were left exposed. For miles, the smooth wet landscape was dotted by newly trucked-in piles of sand and gouged by tire marks.

This beach was not your typical wide expanse, bordered by dunes and sea grasses. Rather, it was somewhat narrow, encroached on by an endless row of relatively new, expensive homes. With the last storm, water seemed to come up to their very doorsteps.

Thanks to the Nor'easter, beaches were washed away and houses threatened once again, despite manmade barriers and continuing beach replenishment programs.

In Brigantine, $4.1 million of sand placed recently at the developed section of the island's north end was gone. Atlantic City filed a $2 million insurance claim because of lost sand. Longport's beach suffered a vertical loss of 4 to 5 feet. Damage in Margate and Ventnor, although less severe than in other areas, was obvious along the beach. About 70 miles north, in Sandy Hook, about 80 percent of the sand used in a replenishment program was gone.

As in just about every major storm, this one, the second to hit the area within two weeks, spurred the debate about beach erosion and replenishment.

Derickson Bennett, executive director of the Littoral Society, an environmental group in Sandy Hook, questions the wisdom of a $2 billion, 50-year project that dredges sand from the ocean and pumps it onto shore. The program, he says, allows towns to avoid limiting oceanfront development. "Much of the erosion," he says, "is threatening expensive vacation homes built too close to the ocean."

Studies show that replenished beaches wash away faster than natural beaches. A replenished beach generally takes two years to erode. "Why are we throwing all those tax dollars away?" asks Rider University coastal geologist Mary Jo Hall. She says the government would better serve by using those funds to move houses off the oceanfront.

Of course, state and local officials disagree, saying that replenishment prevents worse devastation.

When you look at this area's current predicament, you might think they were right. Without a doubt, the programs are needed merely to preserve the status quo. But they are only a finger in the dike.

> *Politicians who call the beaches our "lifeblood" aren't protecting them.*

It makes sense, then, to question the motivation of local officials who permit developers to defy natural barriers of dunes and sea grass by building over them and *then* count on government literally to bail them out. Meanwhile, these same officials call the beaches the "lifeblood of the Shore economy."

Towns seem more interested in new, expensive beachfront development than in maintain ing the beaches themselves. Buoyed by federa funds, they seem to care little that they ar using the public's tax money again and again t rescue vulnerable properties from ruin.

But public impatience is growing. Increas ingly, sand-dumping programs are bein dubbed "welfare for the rich." People increas ingly see these programs as benefiting thos who tend to own expensive beachfront pro erty.

And it looks as if funding for beach prote tion is drying up. Following the Nor'easter, o ficials looked to the state again for aid, only t find that funds for beach protection had a ready been allocated. Relief from last week storm would have to be federal. The sta budget for beach protection has not increase In Tuesday's budget speech, Gov. Whitman, d spite lobbying by South Jersey officials, ma no mention of such aid for the coming yea And in President Clinton's new budget, u veiled earlier this month, no funds at all we allocated for ongoing New Jersey beach res ration projects in 1999.

It may well be that Shore areas will no long be able to rely on government benevolence. that case, the only alternatives left may well to start moving houses off the oceanfront — to let nature take its course.

Olya Thompson lives and writes in Margate.

Nor'easter damages beaches; another on the way

Times-Beacon photo by Robert Ward

Tractor pushes fresh fill along section of oceanfront in the Brant Beach section of Long Beach Township, after a storm last week washed away sections of the beach.

By PAULA SCULLY

Coastal communities are bracing for another nor'easter after the one last week brought gale force winds with gusts of 55 to 60 mph...

Although the storm hit hard in areas south of Ocean County such as Wildwood, where bands of sleet and snow mixed with swirling rain the night of Jan. 28, it brought mostly flooding and erosion on Long Beach Island, weakening spots along the beach.

There were two floods on Long Beach Boulevard from the bay at high tide that night and Thursday morning.

The coastal storm ripped out part of Brant Beach in the chronically weak beach section from 47th to 54th streets, where the worst erosion happened on the Island.

"The water was up to the houses and into them," said Mayor James Mancini.

He noted that Commissioner Frank Pescatore, Ocean County and the township contractors moved quickly to order trucked-in fill.

"Well over 100 truckloads of fill have been dropped in," he said.

Although a dollar estimate is not yet available, Mancini said the project is emergency fill and is not part of the planned beach nourishment project scheduled for 1997.

"In our town we do the work and then argue," he said.

"The state has really lauded us," he said. "Of all the damage that was caused along the coast here, and south of us — they had the worst — they're talking about declaring a disaster, we are finished with our repairs already and it's only been less than one week. None of them have started yet, and this storm just happened a few days ago.

"We have the experience to get right on it. We're working full blast now because there is another storm coming," he said.

The project was finished Monday. He said luck is needed now because another storm is predicted for this week.

Beach Haven Mayor Robert Bahner reported damage in the borough's frequently eroded areas around Holyoke and Dolphin avenues.

The erosion was not as severe as two years ago and no houses were undermined, he said.

At the Holyoke Avenue beach, there was an 8- or 9-foot drop to get on the beach, which did not stop the surfers, he noted.

"We're getting phone calls," Bahner said of the erosion. "If the weatherman is right, potentially we're having another storm. We're seeing about getting gravel or fill. We're going to do something."

Meteorologist Jason Franklin said this week's storm came into the eastern Gulf of Mexico on Monday and was forecast to move off the southeast coast of South Carolina and Georgia this morning to arrive here during the day and Thursday in an east-northeast flow.

"The exact track will determine how high the tides will be and if there will be further beach erosion and more tidal flooding," he said.

Times-Beacon photo by Robert Ward

Erosion from last week's nor'easter is apparant at 47th Street beach in Long Beach Township. A storm due today is expected to add to the damage.

Obituaries

Times-Beacon photo by Robert Ward

A bulldozer rented at $5,000 a month but manned by a public works employee plows fill to create a dune on the Cumberland Avenue beach in Harvey Cedars.

F
to

a
Follow
byist said
pressed o
beach rep
They
pouring
washes a
who close
a time of
to do tha
The an
works and
the public
dent of C
However,
project to
tive, he s
"Witho
small pro
long. In

Appendix H

Public Access Plan

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Public Access

The beach access strategy includes natural beach walkover paths, up and over the dunes at a skewed angle and delineated by sand fencing. These walkovers will be strategically placed at the street ends or other traffic areas which currently do not have any existing structural walkover in place. Long Beach Island currently has walkovers has described. Long Beach Township has walkovers in over 80% of their beach access areas. The final location and dimensions of these walkovers and access ways will be coordinated with the sponsor and the local community during the preparation of plans and specifications. Adjustments to existing walkovers will be coordinated at that time.

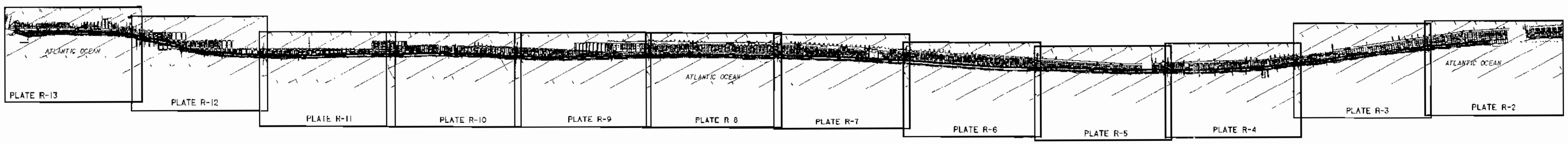
Vehicular access will be provided at existing vehicular access points. The final locations and number of additional vehicular access points will be further coordinated with the sponsor and the local community during the development of plans and specifications, if necessary.

The local community may have special, site specific requirements for beach access appurtenances, which may require the construction of additional or the modification of proposed access paths. This is conditionally acceptable with the Corps of Engineers as long as the access plans are fully coordinated with the Corps of Engineers to ensure no loss of project integrity, and with the NJDEP for adherence to State coastal zone regulations.

Additional details regarding public access issues are covered in the real estate section, Volume 3, Appendix F.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT



LEGEND FOR PLATES

- PROJECT LIMITS
- CENTERLINE AND TOP OF BERM
- SEAWARD TOE OF BERM
- TAX MAP MEAN HIGH WATER LINE
- MHW DESIGN MEAN HIGH WATER LINE
- PARCEL LINE
- STAGING AREA
- PROPOSED ACCESS POINT
- (20) TRACT NUMBER

REAL ESTATE INTERESTS REQUIRED FOR PROJECT

PLATE NUMBER	APPROX. ACREAGE PERP. EASMNT.	WORK AREA ESMT.	PROPOSED ACCESS PTS.	REMARKS
R-2	13.12			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-2		0.83	0.26	WORK AREA EASEMENT INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-3	27.42			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-3		1.75	0.57	WORK AREA EASEMENT INCLUDES 0.01 OF AN ACRE FOR STAGING AREA
R-4	29.62			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-4		1.75		INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-5	29.93			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-5		1.74	0.58	WORK AREA EASEMENT INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-6	29.00			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-6		1.73		INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-7	28.09			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-7		1.71		INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-8	29.64			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-8		1.74		INCLUDES 0.03 OF AN ACRE FOR 3 STAGING AREAS
R-9	23.83			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-9		1.75		INCLUDES 0.02 OF AN ACRE FOR 2 STAGING AREAS
R-10	28.74			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-10		1.73		INCLUDES 0.03 OF AN ACRE FOR 3 STAGING AREAS
R-11	28.39			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-11		1.67		INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-12	30.02			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-12		1.72		INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
R-13	26.70			PERPETUAL RESTRICTIVE DUNE / BEACH NOURISHMENT EASEMENT
R-13		1.60		INCLUDES 0.01 OF AN ACRE FOR 1 STAGING AREA
TOTALS	330.00	19.72	1.41	

NOTES:

THESE PLATES ARE FOR PLANNING PURPOSES ONLY.

THESE PLATES ARE BASED ON INFORMATION PROVIDED BY THE PHILADELPHIA DISTRICT U.S. ARMY CORPS OF ENGINEERS FOR BASE MAPPING AND PROJECT DESIGN AS OF 28 OCT 1998.

TAX MAP INFORMATION IS DERIVED FROM DIGITALLY REPRODUCED (SCANNED) TAX MAPS AS PROVIDED BY THE PHILADELPHIA DISTRICT U.S. ARMY CORPS OF ENGINEERS.

THE TRUE POSITION OF ALL PARCEL LINES CAN ONLY BE DETERMINED BY AN ACCURATE LAND SURVEY PERFORMED BY A NEW JERSEY REGISTERED LAND SURVEYOR.

BASE MAPPING PREDICATED ON THE NEW JERSEY STATE PLANE COORDINATE SYSTEM.

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GBB
SUBMITTED BY:
CADASTRAL
RECOMMENDED BY:
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

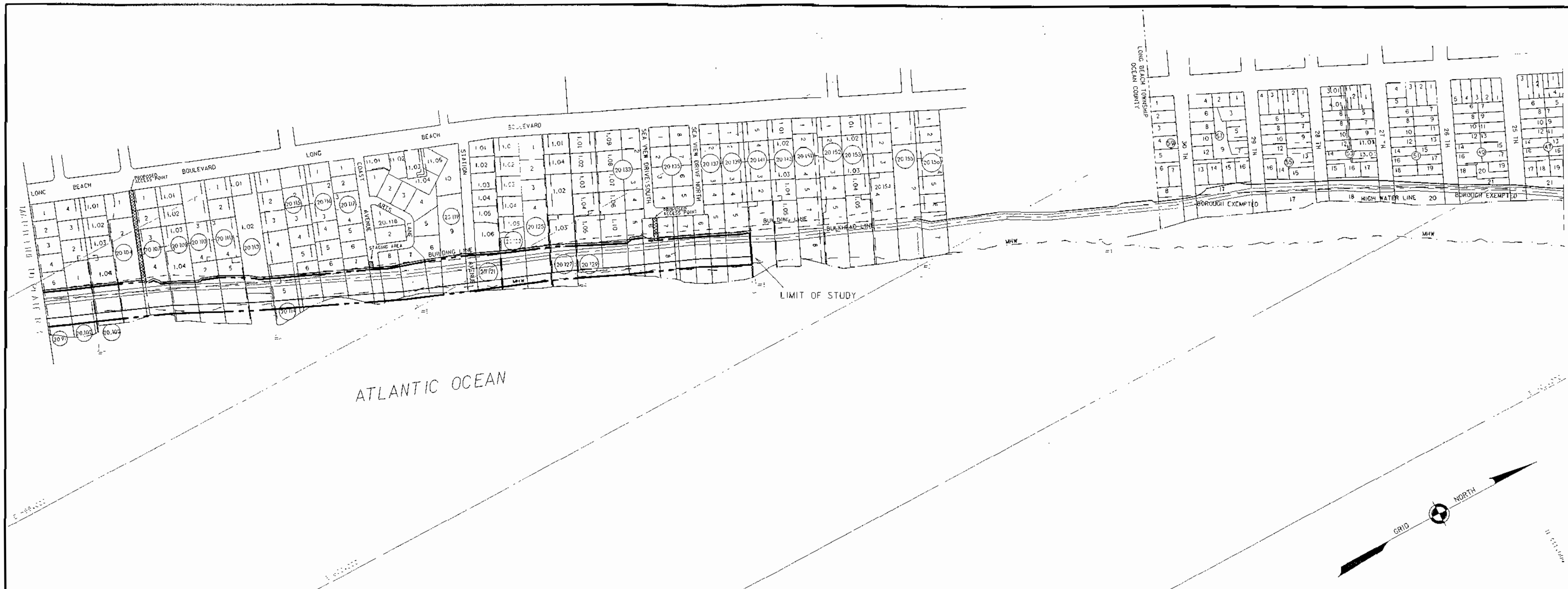
APPROVED BY: DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-1

SCALE IN FEET 2500 1250 0 2500 5000

SHEET 1 OF 13 DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.139/5	X	X		
20.137 / 5	X	X		
20.137 / 6	X	X		
20.137 / 7	X	X		
20.133 / 8	X	X		
20.133 / 7	X	X		
20.133 / 6	X	X		0.05 OF AN ACRE PROPOSED ACCESS POINT
20.133 / 5	X	X		
20.133 / 1.10	X	X		
20.129 / 1.05	X	X		
20.127 / 1.03	X	X		
20.125 / 4	X	X		
20.125 / 1.05	X	X		
20.119 / 9	X	X		
20.119 / 6	X	X		
20.119 / 7	X	X		
20.119 / 8	X	X		
20.117 / 7	X	X		
20.116 / 6	X	X		
20.115 / 5	X	X		
20.115 / 6	X	X		
20.114 / 5	X	X		
20.113 / 1.02	X	X		
20.111 / 5	X	X		
20.110 / 5	X	X		
20.109 / 1.04	X	X		
20.107 / 4	X	X		0.21 OF AN ACRE PROPOSED ACCESS POINT CROSSING LOTS 1-4
20.104 / 2	X	X		
20.103 / 1.04	X	X		
20.102 / 1	X	X		
20.97 / 5	X	X		
20.121/1.06	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB

SUBMITTED BY: G H Barnes
CADASTRAL

RECOMMENDED BY: Nancy L. Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

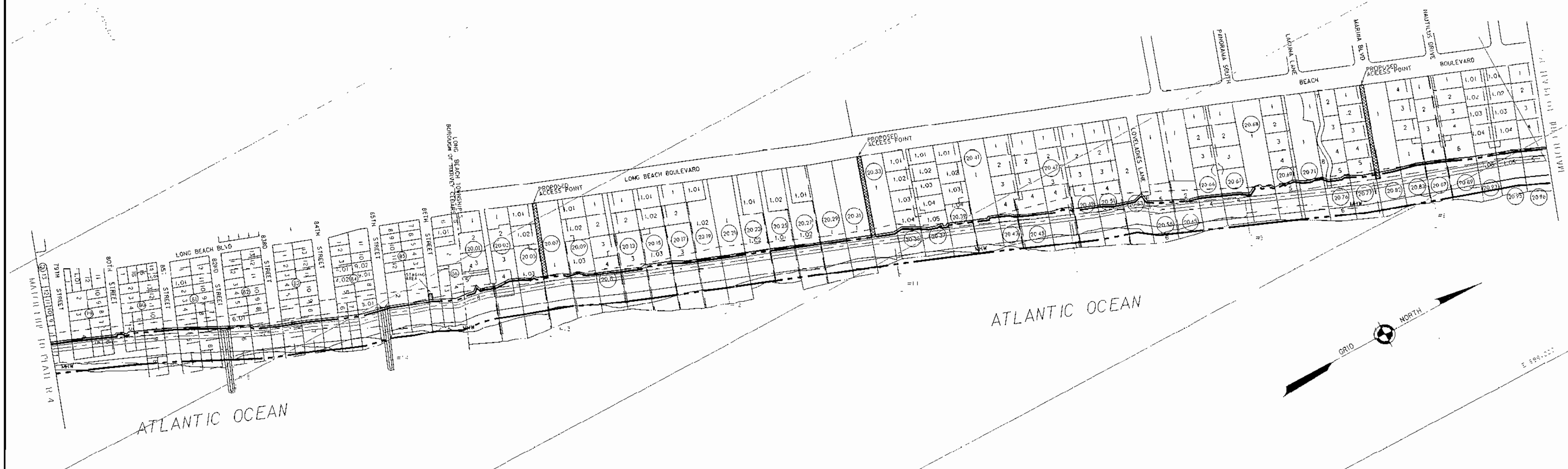
APPROVED BY:
CHIEF, REAL ESTATE DIVISION
DATE 16 FEB 1999

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-2

SCALE IN FEET
200 100 0 200 400

SHEET 2 OF 13
DRAWING NO.



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.96 / 5	X	X		
20.95 / 1.05	X	X		
20.93 / 1.05	X	X		
20.89 / 5	X	X		
20.87 / 4	X	X		
20.83 / 1	X	X		
20.77 / 5	X	X		
20.76 / 6	X			
20.76 / 5	X	X		
20.76 / 7	X	X		
20.76 / 8	X	X		
20.74 / 1	X	X		
20.69 / 5	X	X		
20.68 / 1	X	X		
20.67 / 4	X	X		
20.66 / 4	X	X		
20.65 / 2	X	X		
20.55 / 5	X	X		
20.53 / 2	X	X		
20.51 / 4	X	X		
20.49 / 4	X	X		
20.47 / 4	X	X		
20.45 / 4	X	X		
20.43 / 4	X	X		
20.41 / 1	X	X		
20.39 / 1.04	X	X		
20.37 / 1.05	X	X		
20.35 / 1.04	X	X		
20.33 / 1	X	X		0.19 OF AN ACRE PROPOSED ACCESS POINT
20.31 / 1	X	X		
20.29 / 1	X	X		
20.27 / 1.02	X	X		
20.25 / 1.01	X	X		
20.23 / 1.02	X	X		
20.21 / 1	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
20.19 / 1.02	X	X		
20.17 / 3	X	X		
20.15 / 1.03	X	X		
20.13 / 3	X	X		
20.11 / 4	X	X		
20.09 / 1.03	X	X		
20.07 / 1	X	X		0.17 OF AN ACRE PROPOSED ACCESS POINT
20.05 / 1.03	X	X		
20.03 / 3	X	X		
20.02 / 4	X	X		
20.01 / 6	X	X		
86 / 4	X	X		
86 / 3	X	X		
85 / 1	X	X		
85 / 2	X	X		
84 / 8.01	X	X		
84 / 7	X	X		
84 / 6	X	X		
83 / 7	X	X		
83 / 6	X	X		
82 / 7	X	X		
82 / 6	X	X		
81 / 6	X	X		
81 / 5	X	X		
80 / 9	X	X		
80 / 8	X			
80 / 6	X	X		
80 / 5	X	X		
79 / 6	X	X		
79 / 5	X	X		
79 / 4	X	X		
57 / 8	X	X		
82/6.01		X		
20.82/1	X	X		0.21 OF AN ACRE PROPOSED ACCESS POINT
20.55/6	X			

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY | USING SERVICE

LOCATION OF PROJECT		TRANSPORTATION FACILITIES
STATE	NEW JERSEY	RAILROADS
COUNTY	OCEAN	STATE ROADS
DIVISION	NORTH ATLANTIC	FEDERAL ROADS
DISTRICT	BALTIMORE	AIRLINES
ARMY AREA FIRST		

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET TO LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

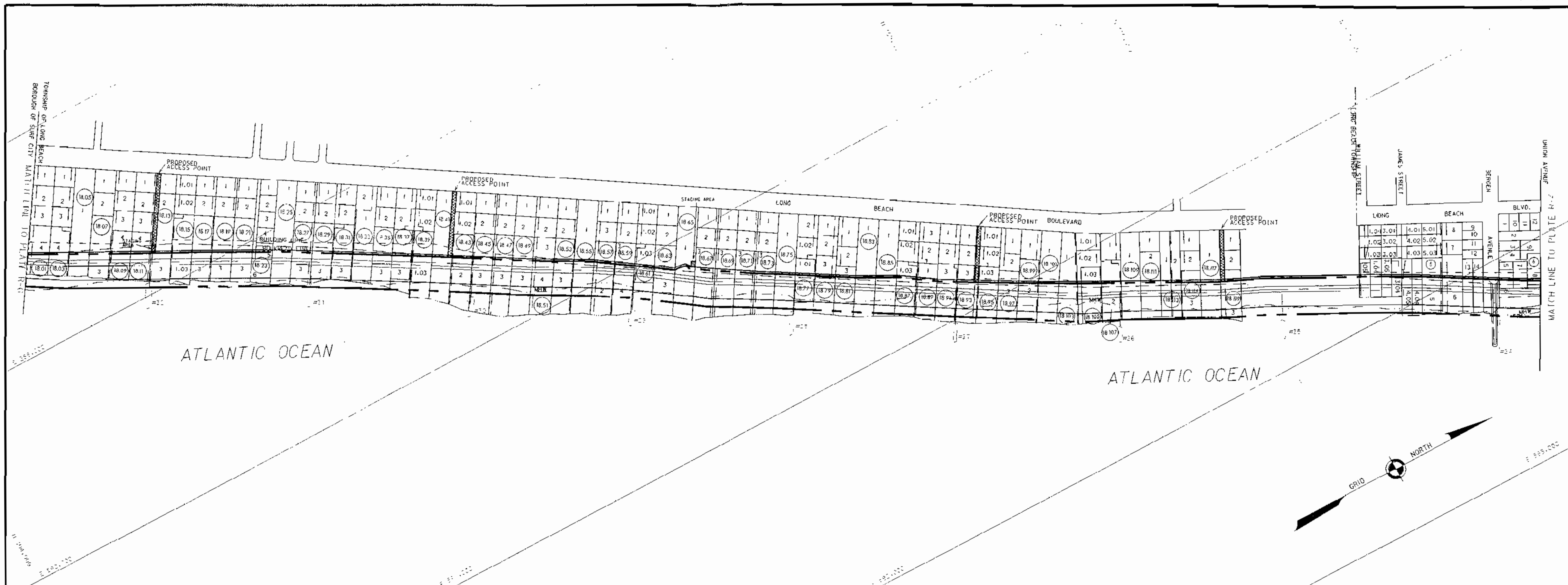
APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-3

SCALE IN FEET 200 100 0 200 400

SHEET 3 OF 13 DRAWING NO



TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
6 / 8	X	X		
6 / 7	X	X		
6 / 6	X			
6 / 5	X	X		
5 / 14	X	X		
5 / 13	X	X		
5 / 6	X	X		
5 / 5	X	X		
5 / 4.04	X	X		
5 / 4.05	X	X		
5 / 3.04	X	X		
5 / 3.05	X	X		
5 / 1.04	X	X		
5 / 1.05	X	X		
18.119 / 3	X	X		0.12 OF AN ACRE PROPOSED ACCESS POINT LOTS 1-3
18.117 / 1	X	X		
18.115 / 3	X	X		
18.113 / 2	X	X		
18.113 / 1	X	X		
18.111 / 2	X	X		
18.109 / 1	X	X		
18.107 / 2	X	X		
18.105 / 1.03	X	X		
18.105 / 1.02	X	X		
18.103 / 1	X	X		
18.101 / 1	X	X		
18.99 / 2	X	X		
18.97 / 3	X	X		
18.95 / 1.03	X	X		
18.93 / 3	X	X		0.13 OF AN ACRE PROPOSED ACCESS POINT LOTS 1-3
18.91 / 3	X	X		
18.89 / 1	X	X		
18.87 / 1.03	X	X		
18.85 / 1	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
18.83 / 1	X	X		
18.81 / 3	X	X		
18.79 / 3	X	X		
18.77 / 1.01	X	X		
18.75 / 1	X	X		
18.73 / 3	X	X		
18.71 / 3	X	X		
18.69 / 3	X	X		
18.67 / 3	X	X		
18.65 / 1	X	X		
18.63 / 3	X	X		
18.61 / 1.03	X	X		
18.59 / 3	X	X		
18.59 / 4	X			
18.57 / 2	X	X		
18.55 / 1	X	X		
18.53 / 3	X	X		
18.51 / 4	X			
18.51 / 3	X	X		
18.49 / 3	X	X		
18.47 / 3	X	X		
18.45 / 3	X	X		
18.43 / 2	X	X		
18.4. / 1	X	X		0.15 OF AN ACRE PROPOSED ACCESS POINT
18.39 / 1.03	X	X		
18.37 / 3	X	X		
18.35 / 3	X	X		
18.33 / 1	X	X		
18.31 / 3	X	X		
18.29 / 3	X	X		
18.27 / 3	X	X		
18.25 / 1	X	X		
18.23 / 5	X	X		
18.23 / 6	X			
18.21 / 3	X	X		

TRACT REGISTER

BLOCK/LOT	PERP. ESMT	WORK AREA ESMT.	ZONE	REMARKS
18.19 / 3	X	X		
18.17 / 3	X	X		
18.15 / 1.03	X	X		
18.13 / 3	X	X		0.18 OF AN ACRE PROPOSED ACCESS POINT LOTS 1-3
18.11 / 4	X	X		
18.09 / 4	X	X		
18.07 / 3	X	X		
18.05 / 1	X	X		
18.03 / 4	X	X		
18.01 / 4	X	X		

DATE	REVISIONS (READ UP)	BY

REAL ESTATE PLANNING MAP

DEPARTMENT OF THE ARMY	USING SERVICE
LOCATION OF PROJECT	TRANSPORTATION FACILITIES
STATE NEW JERSEY	RAILROADS
COUNTY OCEAN	STATE ROADS
DIVISION NORTH ATLANTIC	FEDERAL ROADS
DISTRICT BALTIMORE	AIRLINES
ARMY AREA FIRST	

DEPARTMENT OF THE ARMY
U. S. ARMY ENGINEER DISTRICT, BALTIMORE
CORPS OF ENGINEERS
NORTH ATLANTIC DIVISION

DRAWN BY: SLM
TRACED BY:
CHECKED BY: GHB
SUBMITTED BY: G H Barnes
CADASTRAL
RECOMMENDED BY: Nancy L Roberts
CHIEF, P&C BRANCH

REAL ESTATE
BARNEGAT INLET
LITTLE EGG HARBOR
NEW JERSEY SHORE PROTECTION PROJECT
OCEAN COUNTY, NEW JERSEY

APPROVED BY:
DATE 16 FEB 1999
CHIEF, REAL ESTATE DIVISION

US ARMY CORPS OF ENGINEERS, WASH DC 20314
INSTALLATION OR PROJECT NO.

PLATE R-5

SCALE IN FEET
200 100 0 200 400

SHEET 5 OF 13
DRAWING NO.