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Reconnaissance Report  
Local Study Cost Sharing Agreement  
Shore Protection And Erosion Control Project

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# North Nantasket Beach Shore Protection Study Hull, Massachusetts



**US Army Corps  
of Engineers**  
New England Division

NORTH NANTASKET BEACH SHORE PROTECTION STUDY

HULL, MASSACHUSETTS

Reconnaissance Report

22 June 1988

## EXECUTIVE SUMMARY

This report was prepared by the New England Division, Corps of Engineers at the request of the Board of Selectmen of the town of Hull, Massachusetts. The town had experienced backshore flooding problems caused by ocean wave overtopping and in a letter dated 12 June, 1986 contacted the Corps regarding the availability of beach restoration programs for protection.

Significant backshore flooding of the interior of the study area from wave overtopping the discontinuous line of dunes along the backshore of North Nantasket Beach has occurred in the past and will continue in the future if no protective measures are taken. The most severe damage in modern times occurred during the Blizzard of 1978 when an estimated \$4 to \$6 million dollars in damages due to backshore flooding occurred to the residential, commercial and public property in back of North Nantasket Beach.

North Nantasket Beach is part of a narrow sand spit formed from eroded glacial sediments which extends in a NW-SE direction from the bedrock mainland in the town of Hull. The study area is approximately 10,000 feet in length and lies at the northerly end of the spit just south of Point Allerton Hill. The beach faces the open Atlantic ocean to the northeast and is backed by a discontinuous line of dunes and low concrete walls which separate the beach from Beach Avenue which parallels the dune line. With its immediate exposure to the Atlantic Ocean and its proximity to the urban areas of greater Boston, the study area exhibits a very heavy summer population and an increasing year around population. Use of the beach area and the adjacent land west of Beach Avenue is very intensive in the summer and housing density is high.

This report describes the problem and its effects on the town of Hull and discusses several alternative solutions designed to reduce the damages caused by backshore flooding. The plan put forward in this Reconnaissance Report consists of reconstructing the existing dune line with sandfill and planting to an elevation of 22 feet MLW (17 feet NGVD). Dunes would be 10 feet wide at the top and exhibit average slopes of 1:5 on the seaward side and 1:3 on the landward side. Additionally there would be sandfill to form a 25 foot berm at elevation 13 feet MLW (8.6 NGVD) immediately seaward of the existing discontinuous dune line. The purpose of the relatively narrow berm would be to diffuse storm wave energy before it reaches the dunes. The dune height of 17 feet NGVD was chosen to protect against all but very minimal overtopping even in an event having a 1 percent chance of annual occurrence (100-yr.), such as the storm of 1978.

Environmental field surveys and samples were performed by personnel from the New England Division, Corps of Engineers. These investigations, as well as initial coordination with Federal, State and local agencies have revealed no outstanding or unreasonable issues.

A cost sharing agreement between the U. S. Army Corps of Engineers and the local sponsor, the town of Hull, for the feasibility phase of the study is included. The tasks to be performed by the Corps and the town of Hull, under the cost sharing agreement, are described and the costs for each are detailed.

The total scheduled construction costs of the plan put forward in this report is \$1,890,000 and the total annual charges, consisting of interest and amortization on the first costs and the cost of periodic sand nourishment, is \$215,000. Average annual benefits from damages prevented are estimated at \$280,000. The benefit-cost ratio is 1.3.

The overall financed cost of the project is summarized as follows:

	<u>Federal</u>	<u>Non-Federal</u>	<u>Total</u>
Scheduled Construction			
Cost	1,230,000	660,000	1,890,000
Study Cost (Recon + Feasibility)	187,000	109,000	296,000
Unscheduled Construction			
Cost (Nourishment)	<u>580,000</u>	<u>1,840,000</u>	<u>2,420,000</u>
	2,000,000	2,610,000	4,610,000

The cost of Federal and non-Federal feasibility study services are estimated respectively at \$164,000 and \$54,000.

The reconnaissance study described in this report demonstrates that the project is environmentally, economically and technically feasible and concludes that further planning studies to alleviate damage from backshore flooding are in the Federal interest.

The non-federal sponsor, the town of Hull, Massachusetts, strongly supports the project as evidenced by their letter which is appended to this report.

North Nantasket Beach Shore Protection Study  
Hull, Massachusetts

Reconnaissance Report

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NORTH NANTASKET BEACH SHORE PROTECTION STUDY  
HULL, MASSACHUSETTS

Reconnaissance Report

Introduction

The North Nantasket Beach study area lies in the town of Hull, Plymouth County, Massachusetts. The study area is part of an elongated spit extending along a NW-SE axis into Massachusetts Bay from the Atlantic Hill section of Hull to Point Allerton on the north (see Plate 1). The project includes the entire width of the spit from Phipps Street on the south to X Street on the north, although the area of primary focus is limited to that portion between the Atlantic Ocean and Nantasket Avenue to the west. The study concerns backshore flooding damages to the interior of the spit resulting from storm wave overtopping of a discontinuous line of dunes bordering the beach on the ocean side of the spit.

North Nantasket Beach, with its immediate exposure to the Atlantic Ocean and its proximity to the urban areas of greater Boston, exhibits a very heavy summer population and an increasing permanent population. Use of the beach area and adjacent land is very intensive in the summer. Housing density is high both immediately adjacent to the beach and across the spit to Hull Bay. Wind driven wave damage and interior flooding resulting from wave overtopping from the east has caused substantial property damage to structures in the study area. A letter from the town of Hull dated 12 June 1986 requesting availability of Beach restoration programs administered or financed by the U.S. Army Corps of Engineers initiated this reconnaissance study.

Authority

This report was prepared under the authority of Section 103 of the Rivers and Harbors Act of 1962, as amended, for the purposes of shore protection and flood damage reduction from coastal storms.

Study Purpose and Scope

The purpose of this reconnaissance study is to determine whether further planning to alleviate the damages to the subject area is in the federal interest.

Most damage from past storms has occurred in the area between Nantasket Avenue and North Nantasket Beach and in past studies that particular area has received the most attention. This study reexamines that area and, on a reconnaissance level of detail, examines the entire width of the spit in the project area with respect to flood damage reduction.

Damages that would occur to the study area if no project were constructed have been estimated. Several alternative improvements to alleviate damage to the backshore area were considered and one was examined in sufficient detail to provide a preliminary cost benefit analysis. An Environmental Review for the area was performed.

## Prior Studies

No previous Corps of Engineers studies have been performed exclusively on the North Nantasket Beach study area. Other pertinent studies include:

a. A Beach Erosion Control Report on Cooperative Study of Revere and Nantasket Beaches, Massachusetts, March, 1968, was performed by New England Division, Corps of Engineers in cooperation with the Commonwealth of Massachusetts on 6,800 feet of beach immediately adjacent to the south limit of the current study and currently owned and maintained by the Metropolitan District Commission (MDC). The report, issued in 1968, concluded that beach widening by direct placement of suitable sand along the length of the project be provided. The study was authorized in 1970 but improvements were not implemented. The MDC has recently expressed renewed interest in the project.

b. New England Division, Corps of Engineers Damage Surveys of 1978 Storm damage in Hull.

c. Evaluation of Coastal Protection Measures at Nantasket in Hull, Massachusetts, Vol. 1 and 2, prepared for the Disaster Recovery Team, Commonwealth of Massachusetts, by the Water Resources Division, Environmental Planning Division, Camp Dresser and McKee, Inc. (CDM), June 30, 1980. This report summarizes damage from the February, 1978 blizzard to both the study area and the MDC reservation beach to the south. Most of the report focused on the residential area which is the subject of this current study. The CDM report discussed the type of damages incurred from the storm, the damage costs, and recommended some measures for coastal protection from overtopping. One of the recommendations of this report was that a system be designed and installed to efficiently drain impounded interior waters from any possible future floods.

d. Stormwater Drainage Improvement, Kenberma Area Basis of Design Report, Nov. 25, 1981  
Presentation of Alternatives and Preliminary Design Report, Jan. 27, 1982.  
Walter Hickey Associates

e. Flood Insurance Study, Town of Hull, Massachusetts, 1980  
Federal Emergency Management Agency

## Physical Setting

North Nantasket Beach is located in Hull, Massachusetts, approximately 4 miles southeast of the main entrance to Boston Harbor and 12 miles southeast of the city of Boston. The beach is on the northeast side of a narrow tombolo formed when, following the most recent glaciation in the region, a spit tied the bedrock of the Atlantic Hill section of Hull to several drumlins such as Strawberry Hill and Allerton Hill (see Figure 1). The entire spit is 17,000 feet in length with the study area comprising the northerly 10,000 feet and the MDC reservation the southerly 7,000 feet. The tombolo is 500 feet wide in the MDC area and averages 3,000 feet in width in the study area. The spit faces the Atlantic Ocean to the northeast and encloses Hull Bay on the southwest.

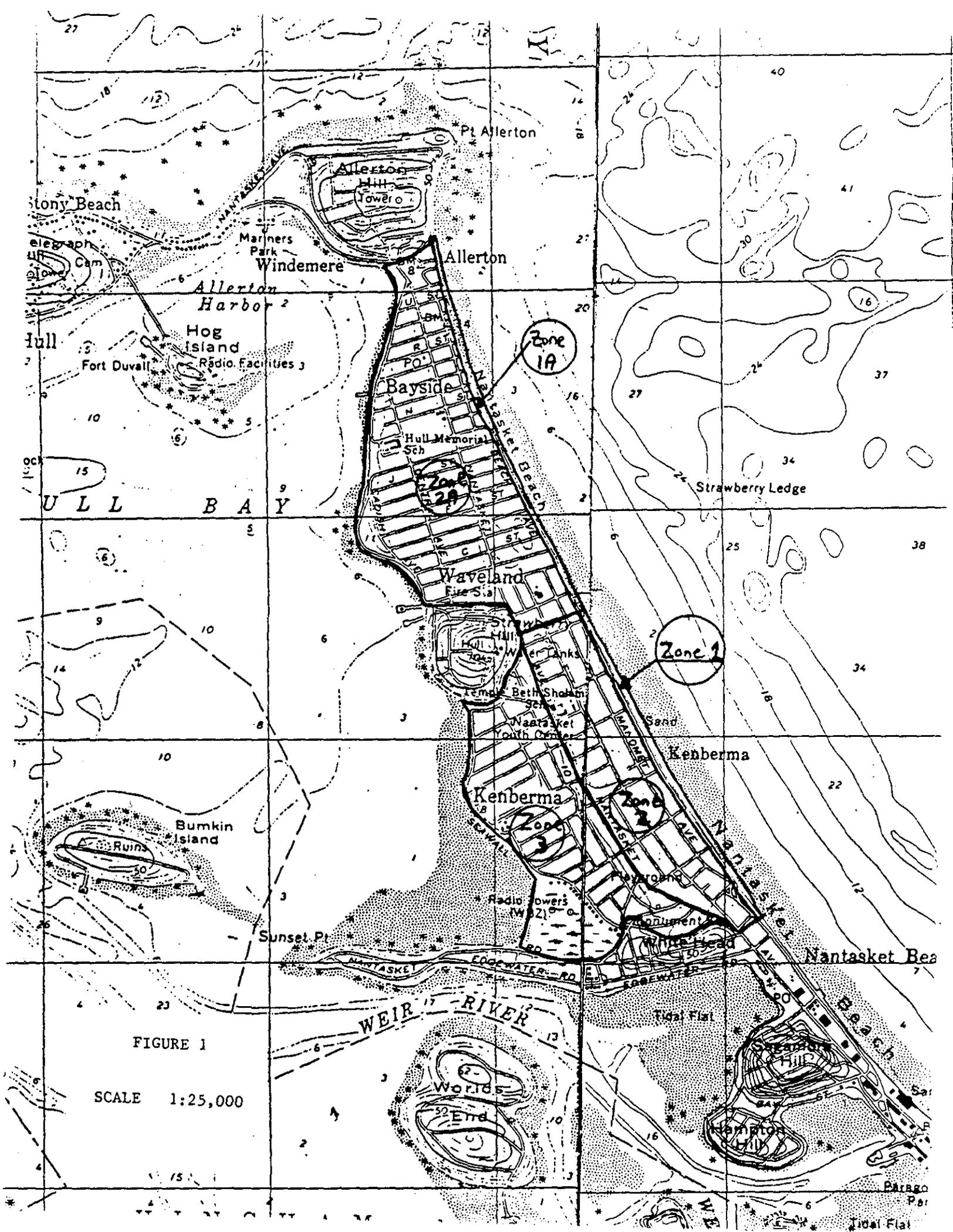


FIGURE 1

SCALE 1:25,000

Stony Beach

elephant  
Cam

Hull

HULL BAY

Allerton Harbor

Hog Island  
Radio Facilities

Zone 2A

Bayside

Hull Memorial Sch

Waveland  
Fire Sta

Hull Hill

Beth Shalom Sch  
Nantasket Youth Center

Kenberma

Zone 3

Radio Towers (WZL)

Sunset Pt

WEIR RIVER

Worlds End

Paragon Hill

Pt Allerton

Allerton Hill  
Tower

Allerton

Zone 1A

Zone 1

Zone 2

Zone 3

Zone 4

Zone 5

Nantasket Beach

Paragon Hill

Paragon Pt  
Jidal Flat

Strawberry Ledge

Sand

Kenberma

Radio towers

Monument

Beach

Tidal Flat

Paragon Hill

Paragon Pt

Jidal Flat

Paragon Pt

Jidal Flat

Paragon Pt

Jidal Flat

Paragon Pt

Jidal Flat

The sand of the present spit was derived by marine erosion of several drumlins in the area, many of which have been completely worn away. The several drumlins still existing are protected in a variety of ways from marine erosion, thus prohibiting any future significant natural replenishment of sand to the spit.

Analysis of shoreline change maps along the entire length of the spit shows the position of the mean high water line to have both advanced and retreated over the period of record. According to the 1968 Corps of Engineers report cited previously there has been no significant net change in the position of the MHW line over the past century. The 1968 report does not, however, relate the position of the MHW line to sea level rise which is estimated at one foot over the past 100 years, and which is assumed to continue at least at the same rate for the next several decades.

Beach profiles reveal slopes that vary from 1:10 at the back shore to flat slopes of 1:30 to 1:90 below the high water line at the study area. The beach is composed of light brown fine sand. The median grain size is about 0.25 mm with cobbles present toward the back shore and in increasing amounts towards the north end of the area. Mean tidal range is 9.4 feet.

The alignment of the spit is such that the dominant high energy waves from the northeast strike the beach with little or no along shore transport component, providing a direct wave attack. The nature of this alignment, the general morphology of the area and field observations strongly suggest that there is little net littoral drift occurring in the area.

The observations stated above as well as the position of the parallel offshore contours to the 30 foot depth contour approximately 3,000 feet offshore, indicate a relatively stable area extending from the back shore 3,000 feet out to sea and extending along the entire length of the spit. Within this cell typical seasonal changes will occur but there will be little overall net natural erosion or accretion under normal circumstances.

Removal of stones and cobbles from the beach by town and state agencies may have contributed to some net lowering of the beach as reported in the 1968 Corps of Engineers report. Storms, usually occurring in the winter season, carry fine materials out to sea from the beach leaving behind a lag deposit of stones and pebbles. These are most evident in late winter and early spring. In order to 'improve' the beach a program of large scale removal of the stones and cobbles was initiated in the 1950's. A consultant to the MDC recommended in 1973 that similar stones be restored to the beach and that sufficient sandfill be placed in order to bring the beach back to the pre cobble removal condition. The 1968 Corps of Engineers report concluded that lack of a sand source for natural replenishment together with the manual removal of material from the beach are factors which contributed to the loss of recreational beach at high tide in the southern MDC portion of the beach.

Limited dry beach area at high tide is also characteristic of much of the North Nantasket area with the condition worsening towards the north. It is possible that the same factors referred to in the earlier Corps of Engineers study for the MDC beach may be responsible for the narrow dry beach area

found at North Nantasket. Additionally the town has for some years, in response to requests by beach users, moved sand from the mean tide level to the backshore area to cover the cobbles. This action may very well have contributed to the relatively steep beach slopes now evident at the backshore. Long time residents claim that concrete walls along the backshore (now almost covered by sand) were once visible several feet above the beach. The narrow dry beach widths and the steep backshore slopes contribute to the wave overtopping and backshore flooding which commonly occurs during medium to intense storms.

A discontinuous line of dunes is found at the landward edge of the beach along the study area except for the northerly 1,500 feet of beach from O Street to X Street where a line of low concrete walls are found. The concrete walls average two to three feet in height above ground level. The dunes range in size from 5-6 feet high by 30 plus feet wide to 1 and 1/2 feet high by 15 feet wide. Several gaps from natural and manual causes are present along the dune line.

For purposes of this report the Nantasket North study area has been subdivided into five zones as seen on figure one. Zones 1 and 1a include North Nantasket Beach and Beach Avenue which runs parallel to and immediately west of the beach. The west side of Beach Avenue is heavily developed with both summer and year around single family residences. Beach Avenue and its 'paper extension' from L Street northward ranges in elevation from 12 feet NGVD at the southerly end to 14 feet NGVD at the north. From Beach Avenue westward the land slopes to 10-12 feet NGVD at Manomet Avenue, to 8-10 feet NGVD at Samoset Avenue and to 6-10 feet NGVD at Nantasket Avenue. This area as well as land further to the west in the northerly part of the spit are included in zones 2 and 2a. Zone 3 encompasses the area west of Nantasket Avenue to Hull Bay in the south part of the study area.

#### Problem Definition

Significant backshore flooding results as storm driven ocean water flows through the gaps in the discontinuous line of dunes paralleling the backshore, overtops Beach Avenue and moves downslope to pond in the low lying areas west of Beach Avenue. If no alternative solutions to the backshore flooding conditions are pursued, wave overtopping with resultant flooding will continue. Assuming only a simple continuation of the rate of sea level rise, estimated at 1 foot over the past century, there is no doubt that the flooding problem will not only continue, but also worsen with the rise in sea level. If, as several scientific agencies contend, sea level rise over the next several decades increases, the problem will be compounded.

#### Environmental Setting

North Nantasket Beach is composed of light sand and dunes of various heights. Thickly settled single family houses and several roads located along the backshore of the beach limit the extensive development of the dunes. Some of the dunes support beach vegetation including American beach grass (*Ammophila brevigulata*) and beachrose (*Rosa rugosa*).

A large intertidal sandflat grades seaward from the beach extending the length of the proposed project area. A site visit by an environmental team from New England Division, Corps of Engineers produced a cursory list of shellfish and meiofauna in the intertidal and subtidal zones.

The only shellfish recovered during the sampling was the surf clam (Spisula solidissima). The highest concentration of clams occurred subtidally. Densities ranged from two to seven clams per square meter. According to representatives from Massachusetts Marine Fisheries surf clams are reported to occur subtidally to the minus ten meter contour line. Concentrations in the low tide zone range from zero to two clams per square meter. While no surf clams were recovered during sampling in the mid tide zone, random clam rakings did reveal the presence of a few scattered surf clams in this area. Adult and juvenile clams uncovered ranged in size from 1 centimeter to over 11 centimeters

Microfauna and macrofauna found in the mid tide zone included a species of amphipod (Amphiporeia virginiana) and two species of polychaetes (Scolecoides vinidis, and Nephtys sp.). A species of amphipod was the only macrofauna species uncovered in the high tide zone.

Waters offshore North Nantasket Beach support a viable lobster (Homarus americanus) population. Several boats were observed depositing lobster pots approximately 50 yards seaward of low tide. No eelgrass (Zostera marina) was found in the project area.

#### Plan Formulation

Certain economic and environmental principles relative to plan formulation were followed in this report so as to adhere to the Federal objective of contributing to the National Economic Development consistent with protecting the National environment. Various alternative plans were formulated in a systematic manner. Each of the several plans formulated were evaluated taking into consideration the four criteria of completeness, effectiveness, efficiency and acceptability.

#### Statement of Problem

Significant backshore flooding of the interior of the study area from wave overtopping the discontinuous line of dunes along the backshore of North Nantasket Beach has occurred in the past and will continue in the future if no protective measures are taken. This section of the report will offer evidence in support of this problem statement, will describe the magnitude of the problem, and will discuss possible alternative proposals to alleviate the problem.

#### Without Project Condition

Cumulative probability curves estimated for significant runup heights (Rs) for beaches of various slopes developed in the CDM study cited

previously and termed reasonable for use in a reconnaissance level study, supply the following runup data for the study area:

Return Period	Surge Elevation	Rs for 1:10 slope	Rs for 1:20 slope
100 years	10.3 feet NGVD	4.0 feet	3.0 feet
50 years	9.9 feet NGVD	3.9 feet	2.8 feet
30 years	9.7 feet NGVD	3.7 feet	2.7 feet
2 years	8.1 feet NGVD	2.3 feet	1.7 feet

Combining the surge elevations (taken from standard New England Division, Corps of Engineers curves for frequency of tidal flooding at Boston Harbor), with significant runup values for 1:10 slopes (typical for backshore beach slopes in the study area), the following stage frequency data can be determined:

Return Period	Wave runup
100 year	14.3 feet NGVD
50 year	13.8 feet NGVD
30 year	13.4 feet NGVD
10 year	12.5 feet NGVD
2 year	10.4 feet NGVD

This data is useful for estimating the frequency of overtopping of Beach Avenue from storms and, more specific to this study, the frequency and severity of backshore flooding in the lower interior areas west of Beach Avenue. In that Beach Avenue varies in elevation from 12-14 feet NGVD, it is apparent that minimal wave overtopping (at 12.5 feet NGVD) has approximately a 10% annual chance of occurring with a 10 year return period. More significant overtopping a (at 13.5 or more feet NGVD) has less than a 3% annual chance of occurring with a 30 year or greater return period.

Formulas described in the Shore Protection Manual (1977) for estimating volumes of water overtopping the beach crest together with surge elevations and significant runup values were used in the CIM report to consider the total volume of water introduced per unit of length of beach per tide cycle. The results of this analysis are depicted as a series of curves in section 5.7 of the CIM report. The curves supply theoretical estimates such as the following for a beach with a 10:1 slope near the backshore.

Crest Elevation (feet NGVD)	Volume of water overtopping (cubic feet per foot per tidal cycle)	
	100 year event	50 year event
16	12	2
15	100	20
14	500	200
13	3000	1100
12	5000(+/-)	>3000

Field observations during the 1978 Blizzard, considered a 100 year event, concluded that 3.7 million cubic feet of water flooded the so called Kenberma section (Phipps Street to A Street) which was fronted at the time by an intermittent dune crest averaging 13-14 feet NGVD. The data curves referred to above would predict an overtopping water volume of 1,000 ft<sup>3</sup>/foot per tidal cycle for such a situation.

Allowing for a reduction of one third for blockage by houses and tall dunes, the total amount of water overtopping along the 5,700 foot length of the Kenberma section would measure 3.8 million cubic feet, very similar to the 3.7 million cubic feet figure arrived at by field observation. Since there was more than one tidal cycle involved and since substantial precipitation fell during this storm, the results of the theoretical curves are most probably high by a factor of 2 or 3 but corroboration by field studies suggest that they are very reasonable order of magnitude indicators. Such data are useful for estimating stage frequency relationships for interior flooding by past storm events as well as planning for future storms.

The flooding from the 1978 storm, along with the relatively minor effects of direct wind driven water, gravel and sand, caused \$4 to \$6 million in damage to the study area of which \$2 to \$4 million were losses suffered by residential homes. Damage survey reports by New England Division, Corps of Engineers for the area conclude that 70,000 cubic yards of beach were destroyed of which half was "totally removed". These conclusions were based upon prestorm photographs and conversations with residents so they may not be entirely accurate, but they underscore the severity of the present problem and its potential future impacts.

#### Alternative Plans Considered

Alternatives to alleviate damages at North Nantasket beach are as follows:

1. Sandfill to form 25 foot berm at elevation 13 feet MLW (8.6 NGVD) immediately seaward of existing discontinuous dune line.
2. Reconstruct existing dune line with sandfill and planting to an elevation of 22 feet mlw (17 feet NGVD). Dunes would have a top width of 10 feet and exhibit average slopes of 1:5 on seaward side and 1:3 on landward side.
3. A combination of #1 and #2 above.
4. No action plan
5. Sea wall along present dune line.
6. Offshore Breakwater

Alternatives 5 and 6 were not pursued in any detail during the reconnaissance study because of anticipated high cost and lack of environmental fit, and/or negative reaction from abutters. The cost of a sea

wall along the length of the project area is estimated at \$530 per linear foot x 10,000 feet or \$5,800,000. This cost and associated contingencies would result in a Benefit-Cost ratio of only 0.5. Alternative 6, an offshore breakwater consisting of 160,000 cubic yards of rock at \$50 per cubic yard, is estimated to have a total first cost, including contingencies, of \$9,600,000 which would produce a Benefit-Cost Ratio of 0.3.

Alternative 4, the no action plan, was rejected based on damages predicted for the future if no action were taken. The frequency and severity of potential losses make this alternative unacceptable.

Final selection of an alternative for construction will require more detailed studies, but based on preliminary studies accomplished in the reconnaissance phase, Plan 3 and was pursued in more detail. Plates 2 and 3 show four representative configurations of the combination dune and berm line along the 10,000 feet of shoreline in the project area. The several configurations are necessitated by the changing elevation of the backshore line as well as the varying heights of the dunes present there.

The berm is designed to diffuse wave energy and reduce the impact of waves on the dune line. The berm will also serve as a supply of sand for equilibrium adjustments brought on by natural coastal processes. The berm height of 8.6 feet NGVD corresponds to the 5 year stillwater storm surge event. The berm at this height is more stable than the 7.7 feet NGVD elevation which corresponds to the one year stillwater level and yet is more economical than a larger berm designed for a less frequent event.

The dune height of 17 feet NGVD was selected to withstand even momentary maximum overtopping in a 100 year event. The stillwater elevation for the 100 year event is 10.3 feet NGVD. The momentary maximum wave runup is approximately twice the significant runup and for the 100 year event this translates to 6.7 feet. Combining stillwater elevation and maximum runup results in a figure of 17 feet NGVD and it was for that level that the dune height was designed.

The landward slope of the dune, 1:3, was selected as being much more stable than the angle of repose of sand (approximately 1:1.5), but still being economical with respect to sandfill volume. The shallower seaward slope of 1:5 was chosen to lessen wave runup.

The dune crest width of ten feet, wider than necessary for simple stability, was chosen to provide enough volume of sand to be able to adjust to storm pressure and also to conform more to the existing dune widths.

Topographic surveys and profiles conducted as part of the reconnaissance study were used as the base upon which to estimate volumes of sandfill necessary to improve the dune line and the berm according to the specifications above. Reconnaissance measurement showed that 19,500 cubic yards of sand are necessary for the berm and 46,300 cubic yards for the dunes. At an estimated cost of \$19 per cubic yard, the berm and dune first cost is estimated at \$1,890,000 including contingencies, engineering design, supervision and administration. The project cost including future nourishment is estimated at \$4.6 million. A more detailed financial analysis of the project cost is presented in table one.

Economic Justification

The reconnaissance level economic analysis compared damages that would occur to structures in the damage zones seen in Figure 1 with the cost of the dune-berm alternative put forth in this study. The damages were calculated based on stage frequency curves prepared by New England Division, Corps of Engineers for each damage zone for interior flooding from wave overtopping.

TABLE 1  
SUMMARY OF PROJECT COSTS

(a) ESTIMATED IMPLEMENTATION COSTS:  
(1987 Price Level)

- Scheduled Construction Costs	
Sandfill 65,000cy x \$19/cy	= \$1,230,000
Planting (12 Acres @ \$10,000/Acre)	= 120,000
Contingencies (25%)	= 340,000
SUBTOTAL	1,970,000
Engineering & Design	40,000
SUBTOTAL	1,730,000
Supervision & Administration	160,000
TOTAL	\$1,890,000

(b) ECONOMIC DATA

(8 5/8%, 50 year life)  
Annual Charges - \$215,000 1/  
Annual Benefits- \$280,000 2/  
Benefit-Cost Ratio: 1.3

'87 UPDATE

- Unscheduled Construction Costs
- Sandfill Renourishment
- 2,600cy/year x 49 years x \$19/cy \$2,420,000
- Total Estimated Implementation Cost \$4,310,000

- Cost Sharing of Estimated Implementation Costs			
	<u>Federal 3/</u>	<u>Non-Federal</u>	<u>Totals</u>
Scheduled Construction Cost	\$1,230,000	\$ 660,000	\$1,890,000
Unscheduled Construction Cost	580,000	1,840,000	2,420,000
TOTALS	\$1,810,000	\$2,500,000	\$4,310,000

(c) NON-FEDERAL REQUIREMENTS:

LERRD <u>4/</u>	
Cash	
Reimbursements	
Totals	\$2,500,000

The issue of how the non-Federal sponsor will meet the obligations for sharing in the implementation costs of the project will be addressed during the feasibility phase.

(d) COST ALLOCATION:

The proposed project has the sole purpose of reducing flood damages from coastal storms.

(e) FEDERAL ALLOCATIONS TO DATE:

Reconnaissance Study: \$78,000

(f) REMAINING FEDERAL REQUIREMENTS:

- Feasibility Phase \$ 109,000  
- Implementation Costs including plans and specifications \$1,813,000

(g) TOTAL FEDERAL INVESTMENTS: \$2,000,000

1/ Annual Charges

- Scheduled Construction Costs  
\$1,890,000 x 0.08765 (int & Amort. @ 8 5/8%) = \$166,000

- Unscheduled Construction Costs (Nourishment is estimated on an average annual basis. It will, however, be carried out after several years of erosional loss.)

2,600cy/year x \$19/cy =  $\frac{\$ 49,000}{\$215,000}$

2/ See Table 3 on following page for the derivation of the annual benefits.

3/ The Federal share of implementation costs for projects resulting in public benefits due to storm damage reduction is 65% including reconnaissance and feasibility costs. The Federal costs respectively of the reconnaissance and feasibility studies are \$78,000 and \$109,000 for a total of \$187,000. Federal Costs are therefore limited to \$1,813,000 rounded to \$1,810,000.

4/ Sponsor anticipates LERRD costs to be minor and agrees that the issue will be fully addressed in the feasibility study (see item 11, Institutional Analysis on page A - 8 of report). The town of Hull is also aware that if LERRD costs are considerable the benefits - cost ratio may be unfavorable and preclude Federal participation in the project.

There are 5 damage zones in the study area. Zones 1 and 1a are east of Beach Avenue, contain no structures, and are not included in the economic analysis. Zones 2 and 2a exhibited the same stage frequency curves and were combined for purposes of damage estimation. There are 1498 structures in zones 2 and 2a. There are 529 structures in zone 3. Single event damages, or recurring damages were calculated for the three zones addressed in the reconnaissance study. Expected annual damages for each zone were estimated and are displayed in table two.

Table 2  
North Nantasket Beach, Hull, Massachusetts  
Recurring Residential and Commercial Damages

Recurrence Interval (in years)	D	A	M	A	G	E	S
	(\$000 November 1987 Prices)						
	Zones 2 and 2a		Zone 3		Total		
10	0		0		0		
25	92		24		116		
50	328		216		544		
100	4,971		2,459		7,430		
200	12,846		7,926		20,772		
1000	30,798		14,607		45,405		

At this stage in the analysis only the dune reconstruction and berm sandfill alternative is under consideration. Consideration will be given in the next phase of the study to establish the National Economic Development (NED) plan will be developed. The NED plan is described as the most economically effective and environmentally sound plan. Project benefits are the difference in expected annual damages obtained from comparing the natural stage damage curve with that resulting from modification by the project. For the purpose of this investigation it has been assumed that the considered project would eliminate all expected annual damages. The expected annual damages therefore are the benefits of the project. A modified stage frequency curve is not considered necessary at this reconnaissance level study and was not estimated for North Nantasket Beach. Thus project benefits may be overstated by not including residual damages in the analysis. However, estimated damages do not include emergency flood-fighting costs and non-physical items such as lost wages, temporary housing and subsistence. These missing elements are estimated to offset each other in their effects and will be addressed in the next study phase.

The findings of the reconnaissance economic analysis are summarized in table 3 below.

Table 3

Expected Annual Damages					
<u>Zones</u>	<u>Without Project</u>	<u>With Project</u>	<u>Annual Benefit</u>	<u>Annual Cost</u>	<u>Benefit-Cost Ratio</u>
2, 2a	\$188,000	0	\$188,000		
3	92,000	0	92,000		
Totals:	\$280,000	0	280,000	\$215,000	1.3

### Environmental Concerns

An assessment of the environmental impacts from the several alternative plans considered for North Nantasket Beach are summarized below.

The no action plan would produce no change to the existing environment and no new impacts are anticipated. The construction of an offshore breakwater would temporarily disrupt and destroy local flora and fauna. Turbidity and possible contamination from construction could reduce water quality. The offshore waters are noted as good surf clam and lobster habitat. Distances from the beach will determine the amount of habitat loss from construction of a breakwater on surf clam and/or lobster populations. Amount of habitat loss will determine whether or not mitigation measures need to be utilized.

Construction of a revetment along the backshore would disrupt the existing beach dunes. Any beach vegetation inhabiting the dunes would be destroyed.

Planting American beachgrass (Ammophila brevigulata) will promote the development and stabilization of beach dunes, and restore a natural environment to the area. Due to the vulnerable nature of beach vegetation, protective measures should be taken to reduce foot and vehicle traffic on the dunes. Best results will be obtained if snow fences and/or board walks are built to control access to the beach. Planting should be done during late fall and early spring to insure the culm's best chance of survival.

The immediate concern regarding application of sand material at North Nantasket Beach is the impact to the surf clam population. Nantasket Beach contains one of the most important commercial surf clam populations in the State of Massachusetts according to a representative of Massachusetts Marine Fisheries. Surf clams become active in the spring and spawn during the months of June, July and August. The best time to nourish the beach is late spring or early summer before the surf clams began to spawn. The clams are also in an active state during this time of year enabling them to move through minimal amounts of sand burial. Depositing sand material to the MHW mark and allowing wave action to disperse the material gradually could further reduce impacts to the clam population.

### Environmental Findings

Initial coordination with Federal, State and local agencies have revealed no outstanding or unreasonable environmental issues. The reconnaissance investigations described above conclude that impacts to the surf clam population are expected to be minor. No federal or state threatened, endangered, or rare species are known to exist in the project area.

### Summary of Local Involvement

The town of Hull first expressed formal interest in the project with their letter to New England Division, Corps of Engineers of 12 June 1986.

Since that time Corps representatives have had several discussions with the Executive Secretary of the town, the Selectmen and town counsel. Several individual discussions with interested citizens have been held on site and several letters have been received and answered from residents of the area. A formal informational session was held with the Beach Advisory Committee, an officially appointed committee of the town of Hull, on June 30, 1987 and a well attended informational session was held with the public at large on July 29, 1987. Town officials completely support the project and understand and agree with local cost sharing provisions. Written assurances were received from the Board of Selectmen in December of 1987 (see letter attached).

### Conclusions

The backshore flooding problem at North Nantasket Beach in Hull, Massachusetts has been studied and alternatives to alleviate these concerns have been formulated. Several meetings and discussions with residents and officials of Hull have been held. Based upon reconnaissance level engineering, economic and environmental study and review of the problem a solution has been developed and with the support of the town of Hull, the New England Division, Corps of Engineers, finds sufficient benefit will accrue to the town of Hull, to warrant a more detailed study.

Federal policy guidelines state that the reconnaissance phase of a study consists of all work and analyses required to determine whether there is an interest in Federal planning and to obtain necessary agreements with the local sponsor. These requirements have been met by this report. The local sponsor has agreed to the Feasibility Cost Sharing Agreement and the Scope of Services as detailed in the next section of this report.

### Recommendations

The Division Engineer recommends that authority and appropriations be delegated to pursue the Section 103 Feasibility Phase Study for North Nantasket Beach, Hull, Massachusetts. This feasibility study will be cost shared on a 50-50 basis with the town of Hull.

### Description of Feasibility Phase Studies Required.

The Feasibility Phase will entail in-depth environmental, engineering, and economic evaluations of the alternate plans described above, each in such detail as is required to first select the best plan and then to develop its specifics. The product will be a Definite Project Report (DPR). If a positive recommendation is forwarded, the DPR will be the basis for preparation of Plans and Specifications. Appendix A, the Scope of Studies, delineates the required tasks to be performed during this phase and details the cost of each task. Appendix B summarizes the feasibility study cost estimate. Appendix C discusses the cost sharing of the feasibility phase.

Acknowledgment and Identification of Personnel

This report was prepared under the supervision and management of the following New England Division personnel:

Colonel Thomas A. Rhen, Division Engineer  
Joseph L. Ignazio, Chief, Planning Division  
John T. Smith, Chief, Coastal Development Branch  
Charles L. Joyce, Acting Chief, Shore Protection Section

The study and report were developed and prepared by Franklin W. Fessenden and Catherine LeBlanc, Project Managers. Thomas Bruha, previously with the Shore Protection Section also contributed to the overall report. Project team members are: Ed O'Leary, Economics; Pam Rubinoff, Coastal Engineering; Catherine Demos, Environmental; Ron DeFilippo, Geotechnical; Charles Wener, Hydraulics and Hydrology; Marie Bourassa, Cultural Resources.



# Town of Hull



BOARD OF SELECTMEN

MUNICIPAL BUILDING  
HULL, MASSACHUSETTS 02045

December 14, 1987

Mr. Frank Fessenden  
U.S. Army Corps of Engineers  
424 Trapelo Road  
Waltham, Massachusetts 02254

Re: Nantasket Beach North Study

Dear Mr. Fessenden:

I have informed the Board of Selectmen of the status of the Nantasket Beach North Study and the requirement of your agency that the Town of Hull make a commitment to obtain whatever legal rights are needed to construct and maintain the beach restoration project.

The Board of Selectmen voted at its November 24, 1987 meeting to inform the Corps of Engineers that it will obtain the aforementioned rights from private property owners after the final design of the project has been approved by the Board of Selectmen and authorization to acquire said rights has been granted by Town Meeting.

It is my understanding that acquisition costs are eligible towards the local matching share of the construction phase of this project.

The Board of Selectmen looks forward to the successful completion of the Nantasket Beach Restoration Project.

Please call me at 925-2000 if you have any questions.

Very truly yours,

  
Christopher J. McCabe  
Executive Administrator

CJM/w

cc: Town Counsel

II  
FEASIBILITY COST SHARING AGREEMENT

DRAFT

JUNE 22, 1988

-DRAFT-  
COST SHARING AGREEMENT  
BETWEEN THE UNITED STATES OF AMERICA  
AND  
THE CITY OF HULL, MASSACHUSETTS  
FOR THE  
NORTH NANTASKET BEACH SHORE PROTECTION  
FEASIBILITY STUDY

THIS AGREEMENT, entered into this \_\_\_\_\_ day of \_\_\_\_\_, 1988 by and between the United States of America (hereinafter called the "Government"), represented by the Contracting Officer executing this Agreement, and the Town of Hull, Commonwealth of Massachusetts (hereinafter called the "Sponsor"),

WITNESSETH, that

WHEREAS, the Congress has authorized the Corps of Engineers to conduct studies of erosion of shores pursuant to the continuing authority provided by Title I, Section 103, 74' Stat. 484, 33USC426: and

WHEREAS, the Corps of Engineers has conducted a preliminary study of wave overtopping and backshore damages at North Nantasket Beach, Hull, Massachusetts, hereinafter referred to as the "Reconnaissance Phase Study", pursuant to this authority, and has determined that further study in the nature of a "Feasibility Phase Study" (hereinafter called the "Study") is required to fulfill the intent of the study authority and to complete the determination of the extent of the Federal interest in alleviating potential backshore damages; and

WHEREAS, the Sponsor considers it in its best interest to have the Study promptly completed, and is willing to contribute fifty (50) percent of the total Study Cost to facilitate its prompt completion; and

WHEREAS, the Secretary of the Army is authorized to receive cash contributions of funds tendered by non-Federal interests and expend them on authorized work pursuant to the Act of July 14, 1960; 33 USC 426.

NOW THEREFORE, the parties agree as follows:

ARTICLES I - DEFINITIONS

For the purpose of this Agreement:

a. The term "Study Cost" shall mean all disbursements pursuant to this Agreement, whether from Federal appropriations or from funds made available to the Government by the Sponsor, and all Negotiated Costs of work performed by or contracted for by the Sponsor pursuant to this Agreement. Such costs shall include, but not be limited to: labor charges; direct costs; overhead expenses; supervision and administration costs; and contracts with third parties, including termination or suspension costs associated with this Agreement. Additionally, the "Study Cost" includes a Review Contingency equal to the lesser of five (5) per centum of the "Study Cost" or \$10,000, such amount to be used in the event of work required as

a result of Division - or Headquarters - level review. Any review costs which exceed this amount or that are incurred after the end of the decision document study phase will be borne entirely by the Federal Government.

b. The term "Study Period" shall mean the time period for conducting the Study commencing when funding from both the Sponsor and the Federal Government is available for expenditure following the execution of this Agreement and ending with the Chief of Engineers' approval of the Study.

c. The term "Negotiated Cost" is the cost of a work item, accomplished other than by contract, to be accomplished by the sponsor as an in-kind services as specified in the Scope of Studies incorporated herein (Appendix A) and which is acceptable to both parties.

## ARTICLE II - OBLIGATIONS OF PARTIES

a. The Sponsor and the Government, using funds contributed by the Sponsor and appropriated by the Congress, shall expeditiously prosecute and complete the Study currently estimated to be completed in 18 months from the commencement of the Study Period ( Article I b. above), substantially in compliance with Article III herein, and in conformance with applicable Federal and state laws and regulations, the Economic and "Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies" and mutually acceptable standards of engineering practice.

b. The Government and the Sponsor shall each provide, in cash, contracts, and in-kind services, fifty (50) percent of all Study Costs, which Study Cost is currently estimated at \$218,000, as specified in Article IV herein; provided, that the Government shall, as specified in Article V herein, periodically give credit against cash contributions required of the Sponsor for any Study Costs of the Sponsor as documented under Article VI (d) herein; provided further, the Government shall not obligate any cash contribution by the Sponsor toward Study Costs until such cash contribution has actually been made available to it by the Sponsor.

c. The award of any contract with a third party of services in furtherance of this Agreement which obligates Federal appropriations shall be exclusively within the control of the government. The award of any contract by the Sponsor with a third party for services in furtherance of this Agreement which obligates funds of the Sponsor and does not obligate Federal appropriations shall be exclusively within the control of the Sponsor.

d. The Government and the Sponsor shall each make every effort to assign the necessary resources to provide for the prompt and proper execution of the Study and shall, within the limits of law and regulation, conduct the study with maximum flexibility as directed by the Executive Committee established by Article VI herein.

e. Entering into this Agreement in no way obligates the Federal Government to construct a project. Whether a project is supported for authorization and budgeted for construction depends on the outcome of the study and whether the proposal is consistent with the Principles and Guidelines and with budget priorities of the Administration. At the present time, favorable budget priority is being assigned to projects providing commercial navigation and flood or storm damage reduction services where the

benefits exceed the cost when future benefits and costs are discounted at a rate of 10 percent per year. Other types of projects are being given a low priority and would not likely be budgeted in the foreseeable future.

#### ARTICLE III - SCOPE OF STUDIES

Appendix A, Scope of Studies and Detailed Costs; Appendix B, Feasibility Phase Study Cost Estimate Summary; and Appendix C, Feasibility Phase Study Cost Sharing; are hereby incorporated into this Agreement. The parties to this Agreement shall substantially comply with the Scope of studies in prosecuting work on the Study. The following modifications shall require an amendment to this Agreement.

- a. any modification which increases the total Study Cost (see Appendices A and B);
- b. any modification in the estimated cost of a Study work item or any obligation for a Study work item, which changes the total cost of that work item by more than twenty-five (25) percent (see Appendices A and B);
- c. any extension of the study completion date of more than thirty (30) days; or
- d. any reassignment of work items between the Sponsor and the Government (see Appendices A, B and C).

#### ARTICLE IV - METHOD OF PAYMENT

- a. The Government shall endeavor to obtain the appropriation for the amount specified in the Scope of Studies incorporated herein. Subject to the enactment of Federal appropriations and the allotment of funds to the Contracting Officer, the Government shall then fund the Study at least in the amounts specified herein.
- b. The Sponsor shall contribute and deliver within thirty (30) days from the signing of this Agreement the cash contribution in the amount specified in the Scope of Studies incorporated herein and, such funds shall be made available to the Government for deposit in the US Treasury. The Government shall withdraw and disburse funds made available by the Sponsor subject to the provisions of this Agreement.
- c. Funds made available by the Sponsor to the Government and not disbursed by the Government within a Government fiscal year shall be carried over and applied to the cash contribution for the succeeding Government fiscal year; provided, that, subject to the availability of funds, upon study termination the excess cash contribution shall be reimbursed to the Sponsor after a final accounting, as specified in Article XI herein.
- d. Should either party fail to obtain funds sufficient to make obligations or cash contributions or to incur Study Costs in accordance with the schedule included in the Scope of Studies incorporated herein, it shall at once notify the Executive Committee established under Article VI herein.

#### ARTICLE V - CREDIT FOR STUDY COSTS

a. The Sponsor shall be credited for the Negotiated Costs, not to exceed twenty-five (25) percent of the total Study Cost, of any work item in proportion to the extent of completion of that work item, as documented under Article VI (d) herein.

b. the Government shall be credited for the completion of any work item in proportion to the extent of that work item, as documented under Article VI (d) herein.

#### ARTICLE VI - MANAGEMENT AND COORDINATION

a. Overall study management shall be the responsibility of an Executive Committee. The Division Commander and the Sponsor will appoint their respective counterparts to the Committee.

b. To provide for consistent and effective communication and prosecution of the items in the Scope of Studies, the Executive Committee shall appoint representatives to serve on a Study Management Team.

c. The Study Management Team will coordinate on all matters relating to prosecution of the Study and compliance with this Agreement, including cost estimates, schedules, prosecution of work elements, financial transactions and recommendations to the Executive Committee for termination, suspension, or amendment of this Agreement.

d. The Study Management Team will prepare periodic reports on the progress of all work items for the Executive Committee.

#### ARTICLE VII - DISPUTES

a. The Study Management Team shall endeavor in good faith to negotiate the resolution of conflicts. Any dispute arising under this Agreement which is not disposed of by mutual consent shall be referred to the Executive Committee. The Executive Committee shall resolve such conflicts or determine a mutually agreeable process for reaching a resolution or for termination under Article XI herein.

b. Pending final decision of a dispute hereunder, or pending suspension or termination of this agreement under Article XI herein, the parties hereto shall proceed diligently with the performance of this Agreement.

#### ARTICLE VIII - MAINTENANCE OF RECORDS

The Government and the Sponsor shall keep books, records, documents and other evidence pertaining to study costs and expenses incurred pursuant to this Agreement to the extent and in such detail as will properly reflect total study costs. The Government and the Sponsor shall maintain such books, records, documents and other evidence for inspection and audit by authorized representatives of the parties to this Agreement.

## ARTICLE IX - RELATIONSHIP OF PARTIES

a. The parties to this Agreement act in an independent capacity in the performance of their respective functions under this Agreement, and neither party is to be considered the officer, agent, or employer of the other.

b. To prevent conclusive findings, recommendations, etc., from being prematurely and or indiscriminately released against the wishes of either party and to avert misinterpretations and misunderstandings, the following is effected for the period of this agreement: Prior to approval for public release, except where Federal law otherwise requires disclosure, final study determinations, including reports, documents, data, findings, conclusions, and recommendations pertaining to the Study, shall not be released without the consent of both parties, nor shall they be represented as presenting the views of either party unless both parties shall indicate explicit agreement.

## ARTICLE X - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or other elected official, shall be admitted to any share or part of this Agreement, or to any personal benefit that may arise therefrom.

## ARTICLE XI - TERMINATION OR SUSPENSION

a. This Agreement shall be terminated at the completion of the Study Period; provided, that upon thirty (30) days written notice, either party may terminate or suspend this Agreement without penalty.

b. Within ninety (90) days following termination of this Agreement the Study Management Team shall prepare final accounting of the Study Cost, which shall display disbursements by the Government of Federal funds, cash contributions by the sponsor, and credits given under Article V herein for Negotiated Costs of the Sponsor. Within thirty (30) days thereafter, the Government shall, subject to the availability of funds, reimburse the Sponsor for the excess, if any, of cash contributions and credits given over fifty (50) percent of the total Study Cost. Within thirty (30) days thereafter, the Sponsor shall provide the government with any cash contributions required so that the total Sponsor share equals fifty (50) percent of the total Study Cost.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

TOWN OF HULL  
BOARD OF SELECTMEN

\_\_\_\_\_  
Colonel, Corps of Engineers  
Division Commander  
Contracting Officer

BY

\_\_\_\_\_  
Name  
Chair, Board of Selectmen

\_\_\_\_\_  
Name

\_\_\_\_\_  
Name

\_\_\_\_\_  
Name

\_\_\_\_\_  
Name

- Appendix A - Scope of Studies
- Appendix B - Study Cost Estimate
- Appendix C - Cost Sharing Description

CERTIFICATE OF AUTHORITY

I, \_\_\_\_\_, do hereby certify that I am the Town Counsel of the Town of Hull, Massachusetts, that the Town of Hull is a legally constituted public body with full authority and legal capability to perform the terms of the agreement between the United States of America and the Town of Hull in connection with the North Nantasket Shore Protection Feasibility Study and to pay damages, if necessary, in the event of the failure to perform, and that the persons who have executed the Agreement on behalf of the Town of Hull have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certificate this \_\_\_\_ day of \_\_\_\_\_, A.D., 1988.

\_\_\_\_\_  
Town Counsel

CERTIFICATE OF AUTHORITY

I, \_\_\_\_\_, do hereby certify that I am the Clerk of the Town of Hull, Massachusetts, named herein; that the Feasibility Study Agreement was duly signed for and on behalf of the Town of Hull by \_\_\_\_\_, who is the duly elected Chairman of the Board of Selectmen of the town of Hull, and by \_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_ who are the duly appointed and qualified members of the Board of Selectmen of Town of Hull and is within the scope of their statutory powers.

IN WITNESS WHEREOF, I have hereunto set my hand and seal of the Town of Hull, this \_\_\_\_ day of \_\_\_\_\_, A.D., 1988.

\_\_\_\_\_  
Town Clerk

## SCOPE OF STUDIES

The Feasibility Phase will entail in depth engineering, environmental, and economic evaluations of the alternative plans identified during the Reconnaissance Phase. Also, additional alternatives to be evaluated are; lower elevation dune lines, higher and lower beach berms, berm sandfill only, and an offshore breakwater. Cost effectiveness and expected plan impacts will be assessed and compared, culminating in a recommended plan of improvement which will satisfy the needs of the town and insure maximum benefits.

Appendix A describes the work projected first for the Corps, and then for the town of Hull as "in kind services" for study cost sharing. Each major task will consist of a description of the overall work to be performed. The several elements of each task will be listed along with their estimated cost. Costs were estimated on the basis of an average of \$40 per hour for Corps personnel. Finally an estimated time schedule will be proposed for each task. Appendix B lists the costs of the work items in tabular fashion.

It is estimated that the Feasibility Phase will be completed 18 months after it's starting date.

TABLE FOUR  
FEASIBILITY STUDY WORK SCHEDULE

		WORK SCHEDULE IN MONTHS FROM START OF PROJECT																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
TASK DESCRIPTION																			
ITEM #	STUDY ELEMENT																		
1	Public Contact and Involvement	***** (CONTINUOUS) *****																	
2	Hydrology Studies	*****																	
3	Survey and Mapping	*****																	
4	Materials Investigations	*****																	
5	Design and Cost Estimates	*****																	
6	Economic Studies	*****																	
7	Environmental studies	*****																	
8	USF&WS Coordination	*****																	
9	Study Management	***** (CONTINUOUS) *****																	
10	Report Preparation	*****																	
11	Institutional Analysis	***** (CONTINUOUS) *****																	
12	Audit	*****																	
13	Financial Study	*****																	
14	Archaeology	*****																	
15	Real Estate	*****																	
16	Review Contingency	*****																	

APPENDIX A

SCOPE OF STUDIES AND DETAILED COSTS

CORPS OF ENGINEERS WORK  
FOR COST SHARED FEASIBILITY PHASE STUDY

NORTH NANTASKET BEACH SHORE PROTECTION STUDY  
HULL, MASSACHUSETTS

Public Contact and Involvement (Item 1)

Much interest in this project has been evidenced both by town officials, appointed or elected town boards, and residents of the town of Hull. Therefore public involvement will be a major work item. Several meetings with concerned citizens are planned. Additionally close coordination with the Selectmen and other town officials will be continued. State and Federal agencies will also be involved. In addition to the time directly spent in meetings, a significant work effort will be needed for planning and coordination.

Element Description	Estimated Cost
* Three informational meetings with the general public. Early in the process, at the middle and end of the study.	\$ 1,440
* Quarterly visits with Selectmen and/or Executive Secretary	\$ 1,900
* Six planning and information gathering visits with town, State and Federal officials.	\$ 960
* Meeting preparation, planning and evaluation of results. Preparation and dissemination of pertinent information.	\$ 3,200
Subtotal	<hr/> \$ 7,500

Hydrology Studies (Item 2)

Technical and engineering information to be compiled by the Hydrologic Engineering and Hydraulics and Water Quality sections will focus on analysis of wind and wave climate, wave overtopping, past flooding, interior drainage and formulation of stage frequency curves for both the shore line and interior areas. Such information will be used in the design of the various plans studied as well as in the economic cost benefit analyses.

- \* Analysis of wave, storm surge and wind frequency \$ 4,800

* Determination of wave overtopping volumes.	\$ 3,200
* Compilation of past flood high watermarks	\$ 1,600
* Review of interior drainage processes and rainfall handling capabilities and requirements.	\$ 2,800
* Development of existing and future stage frequency relationships for both tidal and interior areas.	\$ 4,000
* Preparation of report	\$ 2,800
* Coordination with study team	800
	Subtotal \$20,000

It is estimated that most of the hydrology work will be performed during the middle 6 months of the project. Much of the work can not began until surveying information is complete. A significant amount of the information compiled during the hydrology study must be completed early enough to be used in the economic analysis part of the feasibility study.

#### Surveying and Mapping (Item 3)

Surveying of the interior of the study area will be necessary to determine elevations of buildings and roadways. The elevations of a seawall/dike along the Hull Bay side will also be determined. The survey of the beach, taken in June of 1987, will be updated and new profiles will be determined. The interior elevations are necessary to provide information for use in the determination of stage frequency curves for flooding. Such elevations are also necessary for the formulation of stage damage curves in conjunction with economic and cost benefit analyses.

* Dike and seawall along Hull Bay.	\$ 3,000
* Interior of study area.	\$ 9,000
* Update of beach survey and new profiles.	\$ 6,000
* Preparation of map and profiles.	<u>\$ 2,000</u>
	Subtotal \$20,000

#### Materials Investigation (Item 4)

Sources and cost estimates for sand obtained in the reconnaissance effort will be reviewed and updated as necessary.

\$ 1,500

Design & Cost Estimates (Item 5)

Prepare quantity and cost estimates for alternative plans of improvement. Evaluate alternative plans to arrive at the best plan for the area and maximize benefits. Several different scenarios for design wave and design dune and berm will be prepared. Plans for a breakwater and revetment will be considered. It will be necessary to prepare drawings, draft and layout cross sections, plans and profiles and prepare a report to be used in the feasibility report.

* Design wave analysis - three scenarios.	\$ 1,000
* Design dune and berm - three scenarios.	\$ 2,500
* Breakwater design evaluation.	\$ 1,000
* Backshore seawall evaluation.	\$ 1,500
* Transition (tie in) to existing shoreline.	\$ 2,000
* Coordination	\$ 2,000
* Drafting	\$ 2,000
* Report writing and review.	<u>\$ 2,000</u>
	Subtotal \$14,000

Economic Studies (Item 6)

Assess and evaluate the economic and social effects of the structural and nonstructural alternate plans. Net benefits will be maximized and the most cost effective plan will be determined through economic analyses. A final report will be submitted to be used in the feasibility report. Several field trips will be necessary.

* Determine existing flooding damages.	\$ 5,300
* Determine future flood damages	\$ 1,700
* Refine existing without project stage damage functions.	\$ 7,000
* Determine flood proofing and National flood insurance costs.	\$ 1,600
* Determine socioeconomic effects	\$ 3,000
* Prepare report	<u>\$ 5,400</u>
	Subtotal \$24,000

Environmental Studies (Item 7)

Perform the necessary field surveys including any necessary transects, cores, specimen collection and identification, and biomass assessment. Determine impacts on the environment anticipated as a result of the construction of the project. Coordinate these efforts with state and Federal agencies such as National Marine Fisheries Service, and Massachusetts Coastal Zone Management. Field trips will be necessary to complete this work. Also prepare and submit an Environmental Assessment in accordance with NEPA, MEPA and applicable state laws and regulations for enclosure in the feasibility report.

* Benthic survey; specimen collection, enumeration and identification.	\$ 5,000
* Data acquisition	\$ 2,000
* Coordination with federal, state and local agencies.	\$ 1,000
* Report preparation including environmental assessment, FONSI, 404 (b) (1) evaluation and necessary CZM/WQC material.	\$ 4,500
* Local Cooperation	\$ 1,000
* Public review/revision	<u>\$ 1,500</u>
	Subtotal \$15,000

U.S. Fish and Wildlife Coordination (Item 8)

U.S. Fish and Wildlife Service, in agreement with the Intergovernmental Coordination Act of 1966, will review the project in terms of its environmental acceptability. Includes site visit(s), comment, and correspondence. Two field trips are anticipated, and Planning Aid Letters will be provided.

\$ 7,000

Study Management (Item 9)

The overall management and coordination of the entire project includes several elements.

* Coordination with study team members; team meetings, correspondence, interaction with teams.	\$ 3,000
* Review of work submitted by team members.	\$ 2,600

* Maintenance of financial records and budget; monitoring of expenditures and adherence to work schedules.	\$ 1,600
* Inter/Intra-office correspondence.	\$ 800
* Fact Sheet preparation and update	\$ 1,200
* Monthly Progress Reports	\$ 2,700
* Coordinate assignments for study team members.	\$ 1,600
* Establish work and expenditure schedules.	<u>\$ 1,000</u>
Subtotal	\$14,500

Report Preparation and Corps Review (Item 10)

The compilation of the draft report for review prior to submission entails a variety of tasks including:

* Writing of text (rough, draft and preliminary).	\$ 6,000
* Preparation of figures and tables.	\$ 1,000
* Compilation and review of appendices.	\$ 2,000
* Editing main report.	\$ 1,600
* Corps review and in house coordination with team members.	\$ 3,600
* Word processing.	\$ 2,000
* Reproduction and mailing.	\$ 2,000
* Project Review Board meetings.	<u>\$ 800</u>
Subtotal	\$19,000

Institutional Analysis (Item 11)

Should any questions or problems concerning legalities arise during the study, the Office of Counsel will provide their services and advice. (Office of Counsel expenses are absorbed into overhead costs.) Office of Counsel will assist in preparation of Local Cooperation Agreement for construction activities.

Audit (Item 12)

The Audit Branch will examine, review, and verify the financial accounts of the Corps and local sponsor.

\$ 5,000

Financial Study (Item 13)

Review and evaluation of Financial Study of Hull

\$ 1,000

Archaeology (Item 14)

\* Existing literature will be reviewed as to the historic and prehistoric site potential for possible impacts.

\$ 300

\* A field trip is scheduled to determine effect on historic sites if any are determined to exist at the study area.

\$ 400

\* Completion of Section 106 (National Preservation Act) coordination with Massachusetts state Historic Preservation Officer.

\$ 300

Subtotal \$ 1,000

Archaeology work is scheduled for completion during the fall of 1988.

Real Estate (Item 15)

The Real Estate Office will assure public easements, ascertain property ownership and prepare the items of local assurance and Local Cost Sharing Agreement for construction (to be included in the Definite Project Report).

\$ 4,500

Review Contingency (Item 16)

The "Study Cost" includes a Review Contingency equal to the lesser of five (5) per centum of the "Study Cost" or \$10,000, such amount to be used in the event of work required as a result of Headquarters-level review.

\$10,000

TOWN OF HULL WORK  
 FOR COST SHARED FEASIBILITY PHASE STUDY  
 NORTH NANTASKET SHORE PROTECTION STUDY  
 HULL, MASSACHUSETTS

Public Contact and Involvement (Item 1)

Element Description	Estimated Cost
* Three informational meetings with the general public. Early in the process, at the middle and end of the study.	\$ 1,000
* Quarterly visits of Selectmen with representatives from Corps of Engineers.	\$ 1,000
* Six planning and information gathering visits with town officials and Corps personnel.	\$ 2,500
* Meeting preparation, planning and evaluation of results. Preparation and dissemination of pertinent information.	<u>\$ 1,500</u>
Subtotal	\$ 6,000

Surveying and Mapping (Item 3)

The town of Hull will provide maps and survey results compiled during previous investigations in the town. Additionally the town will provide guidance and help so that the best possible application of these previous studies can be made to the North Nantasket study.

\$ 1,000

Environmental Studies (Item 7)

The town of Hull will edit, compile and submit to the Corps of Engineers ecological and environmental data obtained by the town from previously conducted, non-Federal surveys and investigations. The town will aid in the interpretation of these data as they apply specifically to the North Nantasket study.

\$ 2,000

Study Management (Item 9)

Coordination and interaction with Corps Project manager. Participation in definition of specific tasks to be performed during Feasibility Study. Maintenance of financial records and budgets, and supervision of expenditures. Preparation and writing of progress reports.

\$11,000

Report Preparation (Item 10)

Contribution to, editing and review of Feasibility phase report. Joint review meetings to discuss the report. Compilation and submittal of comments to Corps of Engineers. This task will include support such as secretarial, technical and reproduction services.

\$ 8,000

Institutional Analysis (Item 11)

The town will provide legal counsel support and recommendations during all phases of the study. Major contributions will be in the areas of right of way acquisition and implementing the Local Cost Sharing Agreements.

\$20,500

Audit (Item 12)

The town of Hull may audit financial records and expenditures of parties involved in the study.

\$ 3,500

Financial Study (Item 15)

The town of Hull will undertake a financial study of the proposed project, including implications of project costs and availability of project funds according to guidelines stated in EC 1105-2-180 titled Financial Analyses in Support of Construction Recommendations.

\$ 2,000

The study will include the town's statement of financial capability and financing plan. It will be subject to review evaluation and assessment by the District Engineer, NED.

Point of Contact with the Town of Hull will be:

Mr. Christopher McCabe  
Executive Secretary to the Board of Selectmen  
Town Hall, Hull, Massachusetts

APPENDIX B

NORTH NANTASKET BEACH SHORE PROTECTION STUDY  
FEASIBILITY PHASE STUDY COST ESTIMATE SUMMARY

	<u>COST OF FEDERAL SERVICES</u>	<u>COST OF NON-FEDERAL SERVICES</u>
1. Public Contact and Involvement	\$ 7,500	\$ 6,000
2. Hydrology Studies	20,000	0
3. Survey & Mapping	20,000	1,000
4. Materials Investigations	1,500	0
5. Design and Cost Estimates	14,000	0
6. Economic Studies	24,000	0
7. Environmental Studies	15,000	2,000
8. USF&WS Coordination	7,000	0
9. Study Management	14,500	11,000
10. Report Preparation	19,000	8,000
11. Institutional Analysis	0	20,500
12. Audit	5,000	3,500
13. Financial Study	1,000	2,000
14. Archaeology	1,000	0
15. Real Estate	4,500	0
16. Review Contingency	<u>10,000</u>	<u>0</u>
	SUB-TOTAL	\$164,000
	TOTAL	\$218,000

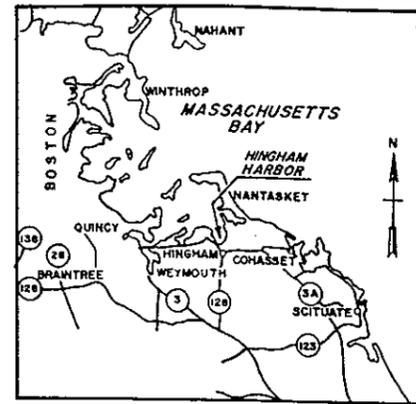
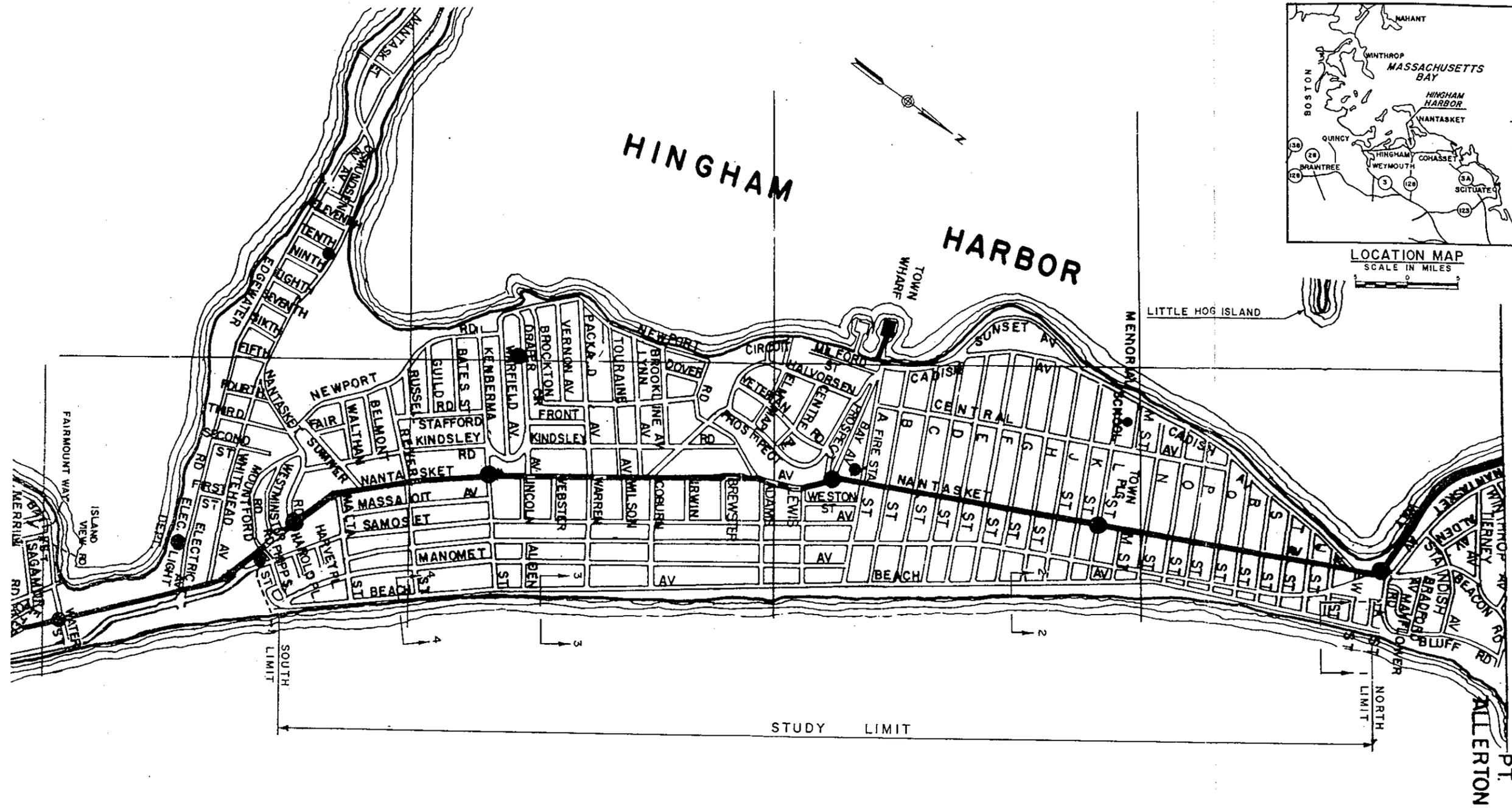
APPENDIX C

NORTH NANTASKET BEACH SHORE PROTECTION STUDY

FEASIBILITY PHASE STUDY COST SHARING

The cost of Federal and non-Federal Services are estimated respectively at \$164,000 and \$54,000. Since the Federal Government and the non-Federal sponsor are required to share equally in the cost of the feasibility phase of the study it is necessary that the local sponsor, in this case the town of Hull, Massachusetts, make a contribution of \$55,000 in order to make each partner's contribution equal to the other. This cost sharing is detailed below.

	Services U.S. Dollars	Apportionment of costs	
		U.S. Dollars	Percent
Federal	\$164,000	\$164,000	
		-55,000	
		\$109,000	50
Non-Federal	54,000	54,000	
		55,000	
		109,000	50
Total	\$218,000	\$218,000	100

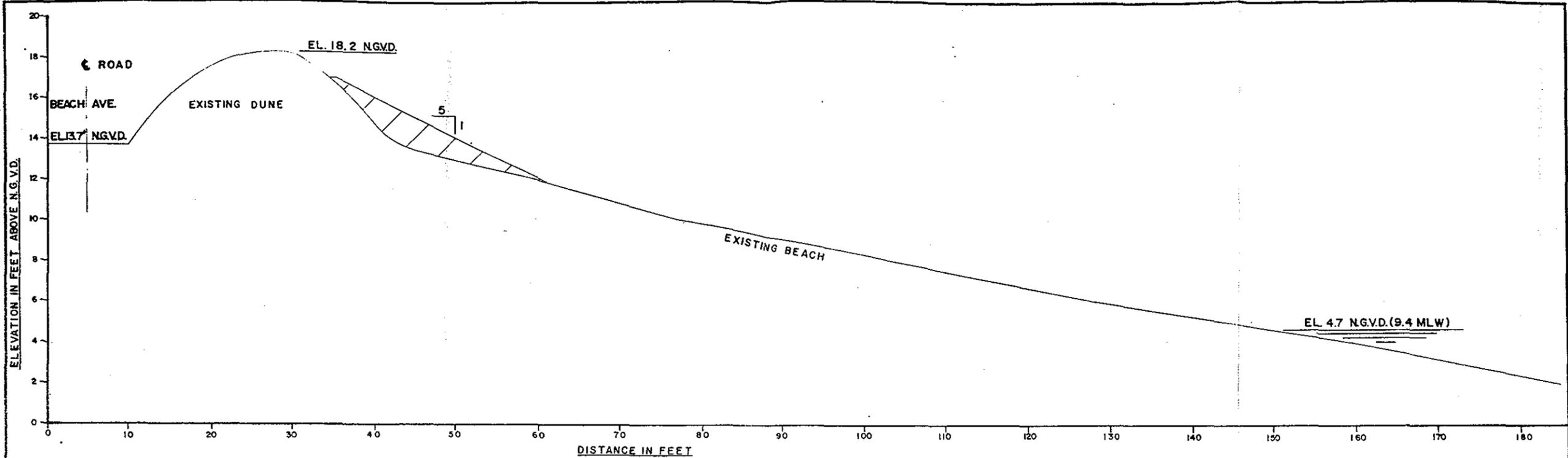


M A S S A C H U S E T T S B A Y

NANTASKET BEACH NORTH STUDY  
 HULL, MASSACHUSETTS  
 STUDY AREA  
 NEW ENGLAND DIVISION, CORPS OF ENGINEERS



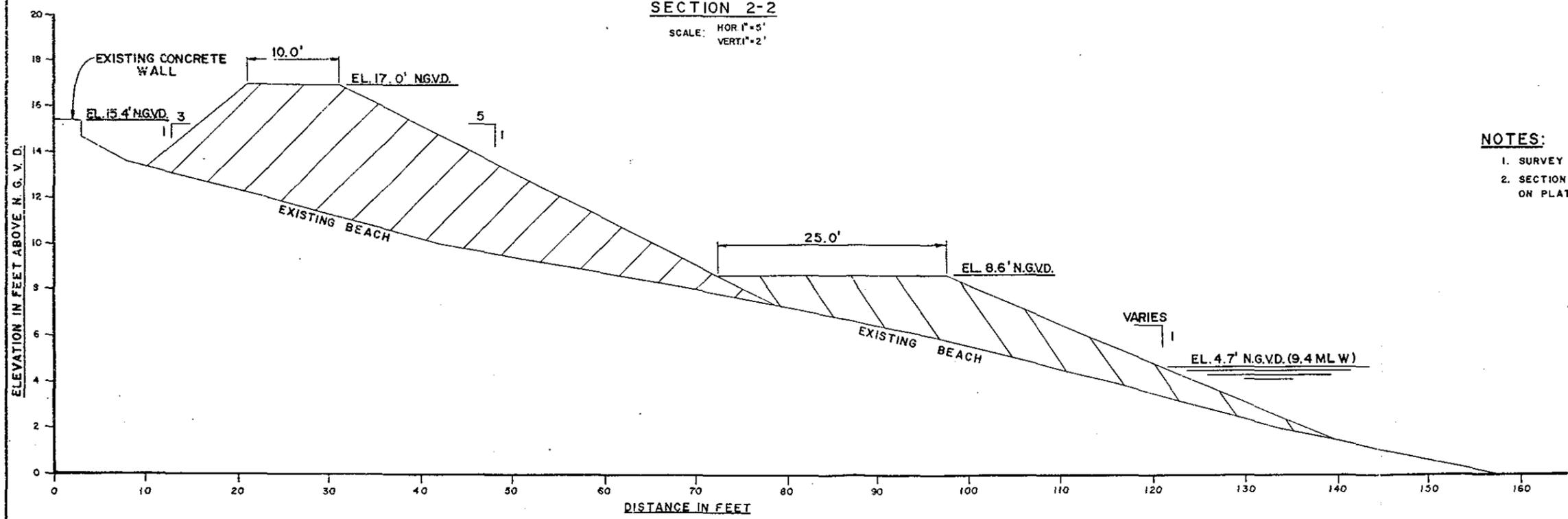
MAP COURTESY OF  
 NEW ENGLAND MAP CO.



DISTANCE IN FEET

SECTION 2-2

SCALE: HOR. 1"=5'  
VERT. 1"=2'



DISTANCE IN FEET

SECTION 1-1

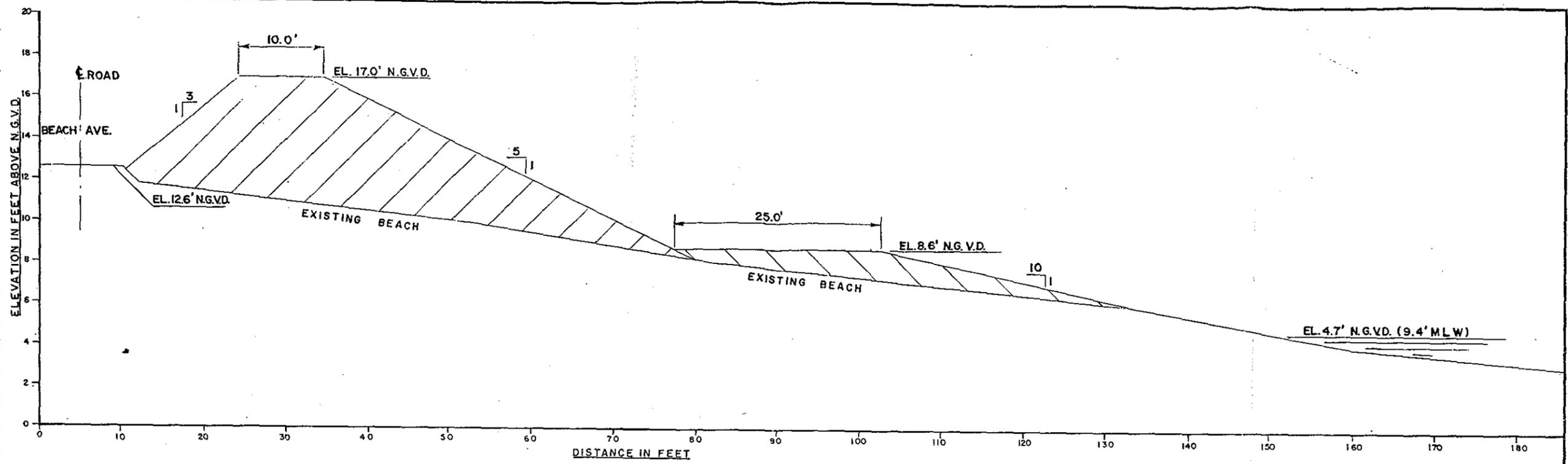
SCALE: HOR. 1"=5'  
VERT. 1"=2'

**NOTES:**

1. SURVEY TAKEN JUNE, 1997.
2. SECTION LOCATION SHOWN ON PLATE 1.

	PROPOSED DUNE NOURISHMENT
	PROPOSED BEACH NOURISHMENT

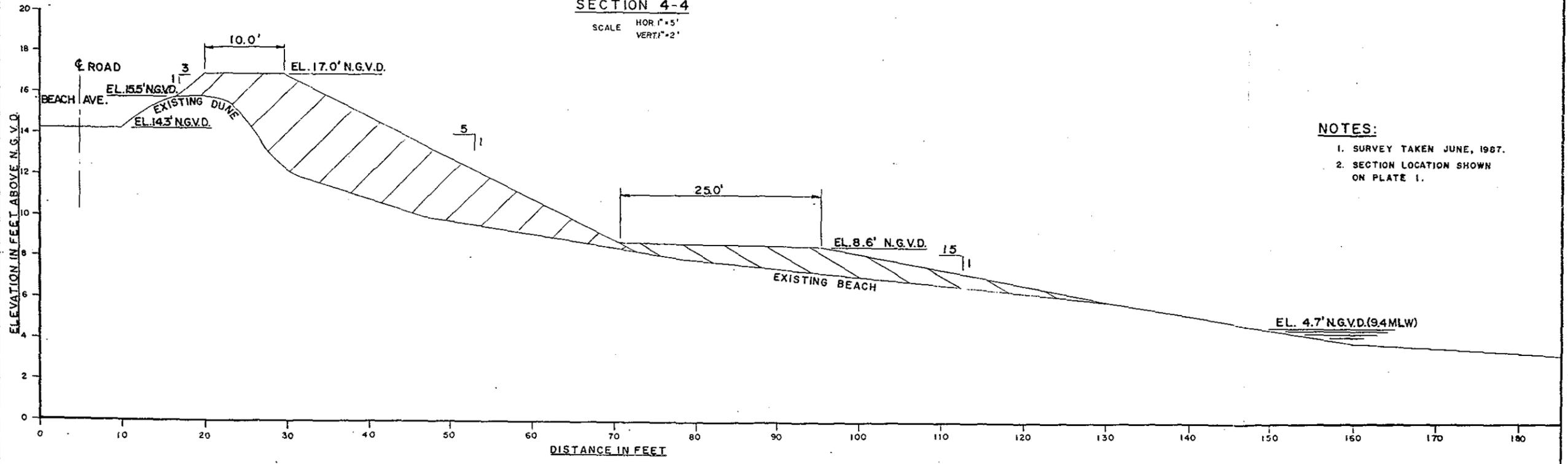
SHORE PROTECTION STUDY  
**NANTASKET BEACH NORTH STUDY**  
 HULL, MASSACHUSETTS  
 DUNE AND BERM SECTIONS  
 NEW ENGLAND DIVISION, CORPS OF ENGINEERS



DISTANCE IN FEET

SECTION 4-4

SCALE HOR 1"=5'  
VERT 1"=2'



DISTANCE IN FEET

SECTION 3-3

SCALE HOR 1"=5'  
VERT 1"=2'

NOTES:

1. SURVEY TAKEN JUNE, 1987.
2. SECTION LOCATION SHOWN ON PLATE 1.

	PROPOSED DUNE NOURISHMENT
	PROPOSED BEACH NOURISHMENT

SHORE PROTECTION STUDY  
**NANTASKET BEACH NORTH STUDY**  
 HULL, MASSACHUSETTS  
 DUNE AND BERM SECTIONS  
 NEW ENGLAND DIVISION, CORPS OF ENGINEERS