BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

AREAS 8 AND 11

SAUGATUCK RIVER TO BYRAM RIVER

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

JULY 27, 1956

Beach Erosion Control Report on Cooperative Study of Connecticut

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CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
150 CAUSEWAY STREET
BOSTON 14, MASS.

NEDGW July 27, 1956

SUBJECT: Beach Erosion Control Report on Cooperative Study of Connecticut, Areas 8 and 11, Saugatuck River to Byram River.

TO: Chief of Engineers, Department of the Army, Washington 25, D. C.

SYLLABUS

This report, the ninth of a series to cover the entire coast of Connecticut, includes study of the shore line of the towns of Westport, Darien and Greenwich and the cities of Norwalk and Stamford lying between Saugatuck River in Westport and Byram River at the Connecticut - New York boundary. The purpose of the study is to determine the most suitable methods of stabilizing and improving the shore line.

The Division Engineer finds that a large part of the shore is irregular and rocky, that continuous shore areas composed of unconsolidated materials are of limited extent, that erosion is generally localized and occurs at a slow rate, that storm damages occur at a number of public and private shore areas, that the principal problems are associated with development, protection and maintenance of public bathing beaches and that there is a need for beach improvement for recreational use. The Division Engineer also finds that the most suitable method of providing beach improvement for recreational use consists of direct placement of sand fill along the shore, that reduction of losses of beach fill or existing beach material can in some locations be provided by construction of groins or jetties. He further finds at one public beach that the danger to bathers from swift inlet tidal currents can be reduced by enlarging the inlet.

A practicable plan for protecting and maintaining a private bathing beach at Byram Point has been developed for use by local interests.

The Division Engineer recommends that the United States adopt projects authorizing Federal participation by the contribution of Federal funds equal to one-third the first cost of construction of the following:

(a) Calf Pasture Beach Park, Norwalk. Widening to a 125-foot width by direct placement of sand fill, approximately 2,200 feet of the east shore of the park and lengthening of two existing groins, each to a 400-foot length.

(b) Cove Island, Stamford. Widening to a 125-foot width by direct placement of sand fill, approximately 1,200 feet of beach and construction of an impermeable jetty 400 feet long at the east limit of the beach, the fill to be obtained, if practicable, by excavation of an enlarged Holly Pond inlet to reduce swift currents close to Weed Beach in Darien.

(c) Cummings Park, Stamford. Widening to a 125-foot width by direct placement of sand fill, approximately 1,000 feet of the public bathing beach, enlargement of the existing groin to a 400-foot length and raising the inshore end of the existing jetty.

(d) Greenwich Point, Greenwich. Widening, generally to a 125-foot width, by direct placement of sand fill, approximately 2,800 feet of the public bathing beach.

The total estimated amount of Federal participation in the above projects is $229,000.

Beach Erosion Control Report on Cooperative Study of Connecticut

Areas 8 and 11

Saugatuck River to Byram River

I - GENERAL

1. Authority. - This report was prepared by the Corps of Engineers, United States Army, in cooperation with the Connecticut State Flood Control and Water Policy Commission under authority of Section 2 of the River and Harbor Act approved July 3, 1930, as amended and supplemented. The basic agreement for the study of the entire Connecticut shore line was approved by the Chief of Engineers on August 28, 1947 and the detailed program for this area on May 1, 1950.

2. Purpose. - The purpose of the study is to determine (1) the most suitable methods of stabilizing and improving the shore line between the Saugatuck River and Byram River, (2) which sections of the shore are desirable locations for beach improvements and the most effective measures for accomplishing the improvements, and (3) the economic justification of protective and improvement measures.

3. Prior Reports. - A private engineering report entitled "Shippan Point Beaches" and a supplement thereto dated January 29, 1941 and March 13, 1941, respectively, were prepared for property owners. The report dealt with reported losses of beach material on the west or Stamford Harbor side of Shippan Point. It consisted largely of a collection and discussion of data related to the problem with a recommendation that the problem and information in the report be placed before the District Engineer of the Corps of Engineers to supplement data already in his files. It was recommended that a proposed plan for placing sand which might be dredged from the anchorage basin in Stamford Harbor in connection with a Federal navigation improvement be brought to the attention of the District Engineer for further study and consideration. Geological information was available from Bulletins No. 46 and No. 47 of the State Geological and Natural History Survey of Connecticut entitled "The Physical History of the Connecticut Shore Line" and "The Glacial Geology of Connecticut." Appendix B of this report is based principally upon the above bulletins.

4. Location. - The study area is located on the north shore of Long Island Sound along the westerly end of the State of Connecticut adjacent to the Connecticut - New York boundary. The shore line is about 35.4 miles in length. It extends from Duck Creek at the entrance to the Saugatuck River in Westport to Byram Point, at the entrance to Byram River in Greenwich. It includes, from east to west, part of the shore of the town of Westport and all the shore of the city of Norwalk, the town of Darien, the city of Stamford and the town of Greenwich. The approximate shore lengths in miles are Westport 2.2, Norwalk 7.3, Darien 6.2, Stamford 7.6 and Greenwich 12.1. The New York, New Haven

and Hartford Railroad runs along the shore within a distance not exceeding 3 miles. United States Highway Route 1 also runs along the shore 1 to 3 miles inland and it is paralleled by the Merritt and Hutchinson River Parkways about 3 to 7 miles inland. Access to the shore is provided from the above highways over numerous public and private roads and streets. The study area is shown on United States Coast and Geodetic Survey Charts 221, 222 and 1213, Army Map Service topographic quadrangles Sherwood Point, Norwalk South, Stamford, Glenville and Mamaroneck and on Plates 1, 1A and 15 to 21, inclusive.

5. Population. - The populations according to the 1950 census and the estimated populations for the years indicated are listed below. There is no appreciable increase in population during the summer within the study area. The population of Westport includes the entire town, most of which is outside the limits of this study.

Location	1950 Census	Estimated Population
Westport	11,667	14,800 (1954)
Norwalk	49,460	60,000 (1955)
Darien	11,767	14,000 (1954)
Stamford	74,293	84,000 (1954)
Greenwich	40,835	42,967 (1954)

6. Description. - The study area is a shore line of submergence. West of Norwalk Harbor there are many outcrops of hard rock at the waters edge so the shore line is irregular in shape and generally lacking in depositional and erosional features. Shore line features which do not owe their shape to rock outcrops are Long Neck, Shippan and Greenwich Points which, at least surficially are composed of unconsolidated materials deposited by glaciers. The shore line of Greenwich is composed of alternate stretches of crystalline rock and drift with the characteristics of a crystalline shore line more prominent. There are many sandy beaches along the rocky shores. They are of the pocket type with sand held within the projections of rock points. The shore east of Norwalk Harbor is low and naturally characterized by marshes and sandy barrier bars. The original features of this shore have been considerably modified by artificial placement of fill. Detailed descriptions of the shore are included in Part III, Plans of Improvement, Paragraphs 14-53 and in Appendix A. The geology of the area is described in Appendix B. Selected photographs of shore areas are included on Plates 23 to 38. Information concerning the condition of shore waters obtained from a sanitary study is included in Appendix J. According to this study none of the shore areas for which plans have been considered were in a questionable category from the standpoint of bathing water safety.

7. Statement of the Problem. - Due to the irregularity of the shore with its numerous outcrops of rock and the lack of long segments of shore composed of unconsolidated material, problems are generally localized and of limited extent. The principal problems are associated with development, protection and maintenance of public bathing beaches at Calf Pasture Beach Park, Norwalk, Weed Beach, Darien, Cove Island and Cummings Park, Stamford

and Greenwich Point, Greenwich. Newly acquired shore front at Calf Pasture Beach has been subject to erosion and recession. In connection with current development of the park, it is desired to improve and protect the newly acquired shore area and the existing bathing beach for increased recreational use. Weed Beach has been recently acquired by the town of Darien and it is being developed as a public bathing beach. A portion of its shore is located close to the Holly Pond entrance channel through which swift tidal currents flow and the use of the area for bathing is therefore hazardous. Cove Island was recently acquired by the city of Stamford which plans to develop a public bathing beach on the property. The bathing beach at Cummings Park has been eroded with consequent recession of the shore and exposure of the park development to storm damages. At the public bathing beach area at Greenwich Point in the town of Greenwich, recurring storm damages occur to roads, parking areas, sea walls and buildings and a sand dune, needed for protection of the backshore development at this low beach area has required repeated artificial restoration. Problems also exist at other locations. In Westport, undeveloped portions of Saugatuck Shores have been subject to erosion. Topsoil has reportedly been eroded from the top of the bedrock at the southerly point of Bell Island. In Darien, erosion and wave attack have damaged or endangered protective structures at Long Neck Point. In Stamford, the public bathing beach at West Beach has eroded and receded and at the west side of Shippan Point, property owners have indicated a desire to prevent further erosion and improve the beach by restoration of past losses of beach material. In Greenwich, erosion necessitates annual replacement of sand at the public bathing beach at Byram Park and it has resulted in a recession of the sandy shore, used as a private bathing beach, adjacent to the jetty at the tip of Byram Point. Little Captain Island, a public park known as Island Beach, also in Greenwich, has a long history of erosion and storm damage.

II - FACTORS PERTINENT TO THE PROBLEM

8. Littoral Materials. - a. Characteristics. The character of littoral material as indicated by mechanical analysis of beach samples taken at mid-tide elevation and by probings in offshore areas is shown in tabular form on Plates 15 to 20, inclusive.

b. Sources. The principal natural sources of supply of beach building materials were the sands and gravels deposited by glaciers. These sources have been depleted by erosion of the mantle of unconsolidated material from the underlying bedrock or they are now protected by structures and the coarse gravelly to bouldery residue and can therefore no longer contribute material to the beaches. The minor streams emptying into Long Island Sound in the area contribute little or no beach material.

9. Littoral Forces. - a. Waves. No wave measurements or statistical wave data are available. Due to the limited fetches across Long Island Sound, waves are short waves generated by local winds. Fetches

range from 85-98 miles to the east northeast, 53-57 east, 8-16 southeast, 8-11 south and 10-26 to the west southwest. Swells do not reach the shore because of the shelter afforded by Long Island. The maximum height of waves breaking inside the low water line at exposed locations with tides 3 feet in excess of the mean height of high water is approximately 8 feet but during infrequent higher tides, larger waves can reach the shore.

b. Currents. Tidal currents in Long Island Sound set to the west during flood and to the east during ebb tides. Maximum currents occur on the ebb. Velocities opposite the study area during spring tidal currents, the strongest ordinarily encountered, are about 1.1 knots.

c. Winds. Winds at New York City are believed to be representative of winds in the study area. The prevailing wind direction at New York City is northwest or offshore. Winds at New York City from the northwest quadrant occur about 36 percent of the time while onshore winds from the southwest and southeast quadrants occur about 28 and 16 percent of the time, respectively. Wind roses compiled from weather bureau records at New Haven and New York City are shown on Plates 4 and 5.

d. Storms. Winds equal to or greater than 40 miles per hour at New York City blow from the prevailing northwest direction about 25 times per year, from the onshore southerly quadrants about 9 times per year and from the directions of greatest fetch, east northeast and east about once every 2 years. At New Haven, the only location within Long Island Sound for which records are available, winds equal to or greater than 32 miles per hour blow from the prevailing northwest direction about once a year and from the onshore southerly quadrants between 2 and 3 times per year. Storm frequency at New Haven may be more representative of conditions in the sheltered Long Island Sound area than that at New York City. Detailed information concerning hurricanes, storms, storm damages and exposure of the shore is contained in Appendix D.

e. Tides. Tides are semi-diurnal. The mean range increases from 7.0 feet at the Saugatuck River entrance to 7.4 feet at Greenwich. The spring range within the same limits increases from 8.3 to 8.7 feet. The maximum tides of record at South Norwalk, Stamford and Greenwich were 13.3, 13.8 and 13.5 feet respectively, above the plane of mean low water. Tides in excess of the mean height of high water occur on an average approximately as follows: 3 feet in excess about once a year, 2 feet in excess about 5 times a year and 1 foot in excess about 98 times a year. More detailed information concerning tides is contained in Appendix C.

10. Shore History. - a. Shore Line and Offshore Depth Changes. Changes in the position of the shore line have occurred principally along low marshy or sandy shores. Much of the study area which is characterized by outcrops of bedrock has been comparatively stable. Changes which have occurred in the latter areas have generally been the result of construction and land reclamation associated with

development of the region. In Westport large shore line changes, principally recession, have occurred along the sandy east and south sides of Saugatuck Shores and along the marshes to the west to and along Shore Haven. In Norwalk, the east shore of Calf Pasture Beach Park moved seaward prior to 1933 and receded landward after 1933 and its south shore receded generally throughout the period of record. During the period 1835-1885 the marshy shore between Harborview and Manrissa Island moved considerably landward and the outer tip of Wilson Point and its east shore adjacent to the tip moved seaward. In Darien, prior to 1885, a large recession of the shore line, probably composed of marsh, occurred in Scott Cove in the vicinity of Great and Hay Islands. In Stamford there was considerable recession of the east and south shores of Cove Island and the north and west shores of Westcott Cove except for accretion effected by artificial filling, at Cummings Park and portions of the west shore of Westcott Cove. A large amount of seaward shore movement was also effected by artificial filling in Stamford, at the south tip of Shippan Point and at Cook and Peck Points. In Greenwich, shore line changes prior to 1886 consisted of recession of extensive shore areas, all probably composed of marsh. Principal shore line changes since 1886 consisted generally of localized seaward movement resulting from construction or land reclamation. Offshore depth changes throughout the study area generally consisted of deepening from 1836-1838 to 1885-1886. From the latter dates to 1933 there was continued deepening opposite Saugatuck Shores, Shore Haven, Calf Pasture Point, Harborview, Manrissa Island, both sides of Shippan Point, Davenport and Cook Points and in the area from Greenwich Cove to Byram River. During the same period shoaling occurred opposite Wilson Point, Butler and Contentment Islands and Great and Hay Islands. Profiles during 1953 indicate that since 1933 or 1941-1942 (the latter dates applicable to the tip and outer end of the west side of Shippan Point) there was no change in offshore depth opposite Bluff Point at Saugatuck Shores, opposite the east side of Bell Island and Long Neck Point, opposite both sides of the outer end of Shippan Point and the east and west sides of Greenwich Point, that there was offshore deepening opposite the west side of Long Neck Point and the south side of Peartree Point and at Profiles 22, 29 and 30 on both sides of Shippan Point and that there was shoaling at Profile 21 on the east side of Shippan Point. More detailed descriptions of shore line and offshore depth changes are contained in Appendix E. Comparative changes are shown on Plates 7 to 14 inclusive. Descriptions of the more significant changes are included in Part III, Plans of Improvement, Paragraphs 14 to 53 inclusive.

b. Existing Protective Structures. Protective structures consisting of sea walls, bulkheads, groins, revetment and breakwaters exist at many locations throughout the study area. They have generally been built to protect the immediate shores which they front and they have had little or no effect on adjacent shore lines. Most structures were constructed by private individuals or groups and historical information concerning them is therefore not readily available. Information about publicly-built breakwaters at Stamford Harbor and Byram

River and a bulkhead at Little Captain Island and details about selected private structures are included in Appendix G. Pertinent descriptions or discussions of existing structures in regard to beach erosion and protection problems are included in Part III, Plans of Improvement, Paragraphs 14 to 53 inclusive.

c. Profiles. - Beach profiles were run at selected locations as shown on Plates 15 to 19 inclusive. They ranged in length from 400 to 2,200 feet and extended seaward from the berms of beaches or from the tops of sea walls to depths of 2 to 22 feet below mean low water. Beach slopes from the landward to the seaward ends of the profiles are included in the following tabulation. They are designated as fractions thus: 1/11 (to be read as 1 vertical to 11 horizontal). Figures in parenthesis following the slopes represent elevations above mean low water and they indicate the zone of the beach to which the slope is applicable. Slopes of 1/100 or flatter are designated as level.

Slopes on Beach Profiles

Profile No.	Slopes
1	1/11 (above 0.0), then level
2	1/10 (above +2.0), 1/50 (+2.0 to +0.5), then level
3	1/10 (above +5.0), 1/80 (+5.0 to 0.0), then level
4	1/8 (above +7.0), 1/37 (+7.0 to +1.0), then level
5	1/12 (above 0.0), 1/24 (0.0 to -1.5), then level
6	1/12 (above +1.0), 1/65 (+1.0 to -3.0), then level
7	1/16 (above 0.0), then level
8	1/19 (above -1.0), then level
9	1/8 (above +4.0), 1/37 (+4.0 to 0.0), then level
9A	1/4 (above +1.0, ledge @ shore), 1/17 (+1.0 to -2.0), then level
10	1/6 (above +6.0), 1/32 (+6.0 to -20.0), then level
11	1/20 (above -3.0), 1/40 (-3.0 to -10.0), then level
12	1/5 (above 0.0), 1/30 (0.0 to - 2.0), then level
13	River Section
14	River Section
15	1/20 (+3.0 to -2.0), 1/11 (below - 2.0)
16	1/18 (above 0.0), 1/82 (0.0 to - 2.5), 1/3 (-2.5 to -16.0, channel)
17	1/10 (above +2.0), then level
18	1/7 (above +3.0), 1/46 (+3.0 to 0.0), 1/5 (0.0 to -5.0, channel)
19	1/11 (above +1.0), then level to channel
20	1/40 (+7.0 to 0.0), irregular), 1/4 (0.0 to -10.0, channel)
21	1/8 (above 0.0), 1/24 (0.0 to -10.0), 1/60 (-10.0 to -17.0), then level
22	1/9 (above 0.0), 1/30 (0.0 to - 7.5), then level
23	1/6 (above 0.0), 1/50 (0.0 to -17.0, irregular)
24	1/6 (above 0.0), 1/28 (0.0 to -13.0), 1/90 (-13.0 to -18.0)
25	1/6 (above 0.0), then level
26	1/9 (above 0.0), then level

Profile No.	Slopes
27	1/10 (above 0.0), then level
28	1/9 (above 0.0), 1/85 (0.0 to -3.0), then sharp drop
29	1/12 (above 0.0), 1/55 (0.0 to -4.5), then sharp drop
30	1/14 (+7.0 to +0.0), then level
31	1/36 (+7.0 to -10.0), then level
32	1/44 (+5.0 to -11.0)
33	1/40 (+7.0 to -12.0 irregular)
34	1/50 (+6.0 to - 9.0)
35	1/8 (+14.0 to +4.0), 1/70 (+4.0 to -12.0)
36	1/54 (+ 2.0 to -5.0), then level
37	1/11 (+7.0 to 0.0), then level

11. Analysis of the Problem. - The loss of beach material is caused by wave action. The general features of the problem are essentially the same but detailed features vary throughout the area. Ordinary short storm waves cause littoral drift and offshore loss of beach material. Absence of swells probably precludes the possibility of return of material from offshore by wave action. Ordinary onshore winds have a definite prevalence from westerly directions and onshore storm winds from the westerly directions are slightly predominant over easterly storm winds. Fetches to easterly directions are much longer than to the west and this results in wave generated littoral currents which move predominantly westward. The predominant movement of littoral drift along shores which trend generally east and west is therefore westward while along shores which run generally north and south, littoral drift moves northward. The irregularity of the coast with the consequent variations in exposure and the shelter afforded by islands, result in movement of littoral drift at localized areas in directions different from the predominant directions. Due to the absence of natural sources of supply of beach building materials, the quantity of littoral drift is small. Streams contribute little material to the beaches. A tabulation of the direction and evidence of littoral drift at various locations is included in Appendix F.

12. In general, the rate of supply of beach material cannot be increased except by artificially placing material directly on the beach or in stockpiles to be distributed by wave action. The usefulness of groins is limited to the reduction of losses of existing or artificially placed beach material. Loss of land has been prevented, except during the most severe storms and hurricanes, by armoring the shore against wave attack by sea walls, revetment and bulkheads in those areas where the supply of material has been inadequate to maintain a protective beach. Such structures have reduced the supply of material available for beaches by protecting former sources of supply. Other methods of protection, such as offshore breakwaters are not considered applicable in this area.

13. Design Criteria. - Proposed protective measures are designed to provide protection against ordinary conditions of comparatively frequent occurrence (at least once a year). They are not intended to

provide protection to waterfront structures in the event of hurricanes or exceptional storms of infrequent occurrence although even under those conditions some protection will be afforded. Specific design criteria used for protective works are as follows:

a. Design Tide. - The design tide is the maximum elevation of tides which occurs at least once a year. Tide records at New London, Bridgeport and Cos Cob indicate that this elevation is 3 feet above the plane of mean high water.

b. Groins. - The horizontal shore section should ordinarily have a top elevation not lower than the general height of existing berms of beaches and a length equal to that of the berm of the anticipated beach. In this study area, the top elevation should be approximately 5 feet above the plane of mean high water. Barrier groins which are intended to completely block passage of littoral drift or to reduce it considerably should be higher than the anticipated beach berm. The intermediate sloped section should be not steeper than the slope of the existing bottom. The top elevation of the outer section should be not lower than 1 foot above the plane of mean low water. For riprap construction, the minimum height of groins should be 3 feet. Groins should be sand tight and firmly anchored at their shore ends to prevent flanking. Groin lengths are generally determined by the toe of the anticipated beach or sand fill. Stone sizes and slopes for groins are computed using the Iribarren method as described in Technical Report No. 4 of the Beach Erosion Board entitled "Shore Protection Planning and Design." The design wave used is the maximum wave that can break in the depth of water at the groin if the fetch is not a limiting factor. With the fetch available in Long Island Sound, such maximum waves can generally be generated. Blankets of spalls, or crushed stone are used under riprap groins or jetties to minimize settlement due to scour.

c. Sand Fills. - Berm elevations of proposed fills are based on those of existing beach berms. The minimum width of fills is based on widths found to afford protection in the area. Computed volumes of fills are based on slopes similar to existing slopes but fills can be placed initially to a steeper slope and permitted to take a natural slope under wave action. Based on these criteria berm elevations are approximately 5 feet above mean high water and beach widths above mean high water are approximately 125 feet with fill slopes of 1 on 20 to 1 on 30. Suitable sand for beach fills would have size and gradation characteristics similar to those of the sand components of the existing materials on the beaches. For the purpose of detailed design of beach fills, the investigations of materials on the beaches and in proposed borrow areas given in this report must be supplemented when plans and specifications are being prepared.

III - PLANS OF IMPROVEMENT

14. Saugatuck Shores. (Plates 15 and 23) - Saugatuck Shores is a low sandy and marshy peninsula at the Saugatuck River entrance. The

shore line is generally composed of sand and gravel which along the outer or east end of the peninsula is in the form of a bar fronting marsh. Public ownership is limited to a canal and a short length of shore frontage opposite its south end. Portions of the area which were improved by dredging and artificial filling around 1925 have been developed for residential use. Such areas exist along the north and south shores and in the central part of the peninsula east of the canal. Residences and shore roads along the north and south shores are protected by groins, low walls, bulkheads and riprap revetment. The undeveloped east shore is partially protected by groins. Erosion between 1835 and 1933 caused the east shore to recede 1 to 5 feet per year and 700 feet of the east end of the south shore about 1½ feet per year. During the same period there was some accretion along part of the south shore west of and adjacent to the erosion area probably resulting from artificial filling and construction of protective works. Since 1933 the only appreciable change in the shore line position consisted of continued recession of the east shore in the vicinity of Bluff Point and recession and westward growth of the spit which trails westward from the south shore. Both of the latter areas are undeveloped and the shore line recession has therefore not created any serious problem. Due to the lowness of the peninsula, the residential development is subject to flooding by high storm tides, necessitating evacuation of residents. Existing structures along developed shore areas appear to have provided adequate protection against erosion and should continue to do so, if maintained. The more serious problem, that of protection against flooding, is not regarded as being within the scope of this study.

15. Shore Haven. (Plates 15 and 23) - Shore Haven consists of Canfield Island and the shore to the southwest to Calf Pasture Beach Park. The shore of the island is composed mostly of marsh with sand and gravel in pockets. There is a complex system of groins, dikes, revetment, bulkheads and walls along the shore of the island. The mainland portion of Shore Haven is protected by sea walls, solid piers and groins with heavy riprap revetment fronting sea walls along the north end of the area. Walls are generally at the waters edge except for short sections of beach held above high water at projecting structures. Beach and foreshore material is sand and gravel with gradation finer to the southwest. Ownership is private and development is residential. The only appreciable change in shore line position during the period of record occurred along the marshy shore of Canfield Island during the period 1835-1933 and it consisted of irregular recession of up to 1,300 feet. There is no known erosion or shore protection problem. Existing structures if maintained should provide adequate protection against conditions which ordinarily occur although some damages, principally associated with flooding, can still occur during exceptional storms or hurricanes accompanied by extreme high tides.

16. Calf Pasture Beach Park. (Plates 15 and 24) - The composition of the shore of Calf Pasture Beach Park changes progressively from cobbles, gravel and a small amount of sand at its northeast end adjacent to Shore Haven to sand at and around its southeast end and it thence becomes

coarser to the west with increasing quantities of gravel and cobbles. The park belongs to the city of Norwalk. The area at its southwest end is occupied by a United States Coast Guard Station and a private pier and boat landing. The northeasterly 1,200 feet of the park is known as Shady Beach and it is used as a picnic area. The remainder of the east shore of the park is a public bathing beach. Public facilities consist of parking areas, comfort stations and picnic tables. There is some riprap along the toe of the grass behind the shore in the Shady Beach area, two riprap groins along the east shore and three timber groins along the south shore. Shore line changes in the period 1835-1933 indicate a small amount of accretion occurred along the east shore while the south and west shores generally receded. Between 1933 and 1953, the east shore and the south shore between groins generally receded indicating that erosion is occurring. Minor erosion also occurs to the topsoil along the Shady Beach area. Due to its low elevation, the park is subject to flooding and storm damages during extreme high tides which result from hurricanes and exceptional storms. The city of Norwalk is in the process of developing the park for greater recreational use. Shady Beach, a recent addition to the park, has a coarse gravelly shore, generally unsuitable for bathing and officials are particularly desirous of improving it. A development plan of the City Planning Commission adopted during 1954 includes construction of a new bathhouse and concession building, an improved roadway system, widening and improvement of the bathing beach along the east shore and improvement of a portion of the south shore for limited bathing and boat use. The plan also includes improvement of the south shore by extension of the two most easterly timber groins. The problem of tidal flooding is regarded as beyond the scope of this study. Plans have been considered for protection and improvement of the bathing beach by direct placement of sand fill along the east shore of the park and extension of existing riprap groins to reduce fill losses. A probing south of the park indicates that material suitable for beach fill exists offshore within a practicable distance for dredging and pumping to the beach. Consideration has also been given to construction of longer groins along the south shore of the park to reduce erosion and loss of existing beach area. The plans are shown on Plate 22A.

17. Gregory Point. (Plates 15 and 24) - The south shore of Gregory Point is sandy and the west shore is generally covered with gravel. Except for a small pocket bathing beach between two riprap groins at the south end of the point at a private beach club, the waters edge is at sea walls which extend continuously along the south and west shores. The area east of the pocket beach is composed of marsh. Shore ownership is private and the development is residential. There has been no appreciable change in the position of the shore line in recent years. Existing structures are providing adequate protection and should continue to do so, if maintained. No plan of protection is needed and none has been developed.

18. Harborview. (Plates 15 and 25) - Harborview is a residential development at low elevation near the west side of the Norwalk Harbor

entrance. The development is fronted by sea walls along its north and east shores. The north shore is gravelly with no width of beach above high water. There is a narrow sand and gravel beach fronting walls along the east shore. A large marsh area borders Harborview to the west and south. Ownership is entirely private. The east shore moved seaward, indicating accretion, between 1885 and 1933 and moved slightly landward indicating erosion from 1933 to 1953. Local officials report that the area is subject to accretion and formation of objectionable shoals offshore. The residential development has been flooded repeatedly by extreme high tides during storms or hurricanes. Existing sea walls are too low to prevent overtopping by such high tides. Protection against this condition would require construction of flood control works, either higher walls or dikes, around all low portions of the development. Since problems involving flood protection are beyond the scope of this study, no plans of this type have been developed. Existing structures are adequate for protection against erosion and wave attack except during exceptional storms and tides. Maintenance of existing walls and raising their elevations to provide protection against overtopping waves should provide all the shore protection needed.

19. Manrissa Island. (Plates 16 and 25) - This is a low island connected to the mainland to the north by marsh and a causeway. Its shore line is generally marshy. There are a few outcrops of bedrock along the south shore and a sandy beach area at the southeast end of the island east of two solid piers or groins. There is a low sea wall along the south and west shores generally at the waters edge. Ownership is entirely private. Development consists of a former church institute. The island has recently been purchased by a power company. Recession of the shore during the period of record appears to have been limited to marshy areas. Due to its low elevation, the island is subject to flooding during extreme high tides. The island is not in use at present. There is no known need for protection or improvement and no plan has been developed.

20. Wilson Point. (Plate 16) - The entire west shore of Wilson Point and most of its east shore are marshy. There are a number of rock outcrops along the east shore. The only sandy beach in the area exists in a pocket about 1,200 feet northeast of the outer tip of the point and there is a beach club at this location. Shore ownership is private. Development along the east side and inland is residential. There is an oil receiving wharf at the outer tip with pipelines extending along the west shore which is otherwise undeveloped. Sea walls protect the southerly 1,200 feet of the east side and at the south end the walls are fronted by heavy riprap. Concrete piers and timber piles, the remains of former structures, exist along the west shore and above the row of piles the marshy foreshore is protected by riprap revetment. Ownership is entirely private. Considerable seaward movement of the shore line occurred, probably as a result of artificial filling, along both sides of the outer end of the point between 1835 and 1885 while the rest of the shore generally receded. Shore line changes since 1885 have been minor. Existing structures, if maintained, should provide adequate protection. No plan of protection or improvement is needed and none has been developed.

21. Wilson Cove (West Shore).(Plate 16) - The west shore of Wilson Cove from its head southward to the bridge leading to Bell Island is mostly fronted by marsh with some bedrock outcrops along the south end. Sandy areas are limited to small pockets, the largest of which, adjacent to the bridge, known as Hickory Bluff Beach, is developed as a commercial bathing establishment. General development is residential. There is a yacht club and pier in the area. Residences are fronted by sea walls and the bridge embankment is protected by sloped stone paving. Ownership of the shore is private. Existing structures if maintained should provide adequate protection. No plan of protection or improvement is needed and none has been developed.

22. Bell Island.(Plates 16 and 25) - Bell Island, east and north of Pine Point, has an irregular bedrock shore with sand only in indentations. There is a small sandy pocket beach in the east shore, another west of and adjacent to Noroton Point and a larger one east of and adjacent to Pine Point. The shore is owned by the Bell Island Improvement Association with use restricted to members. Development of the area is residential. The shore is protected by various types of sea walls. There has been little or no change in the position of the shore line in recent years. The only reported problem consists of erosion of the topsoil and grassy area from the top of the bedrock behind the tip of Noroton Point. Resulting damage is minor and can be prevented by construction of a low wall on the bedrock at the edge of the topsoil to act as a barrier against wave uprush. The shore is naturally stable. Existing structures if maintained should provide adequate protection for the development.

23. Pine Point to Five Mile River. (Plates 16 and 26) - The shore from Pine Point to Five Mile River is a series of sandy pocket beaches between projecting points composed of bedrock. From east to west the shore consists of privately owned Roton Point Park from Pine Point to Roton Point, Bailey Beach owned by the 6th Taxing District of the city of Norwalk, located west of and adjacent to Roton Point and the Wee Burn Beach Club and Rowayton Beach Association, both privately owned. Roton Point Park is an amusement park and bathing beach. Bailey Beach is a public bathing beach with parking area, fireplaces, benches and concession stand. The Wee Burn Beach Club has bathhouses and a clubhouse. The general development behind the beaches is residential. Portions of the sandy beaches front low sea walls. There is a higher wall around Roton Point fronted along the south and west side by riprap. There is also a wall around the rocky point at the Five Mile River entrance. Shore line changes from 1885 to 1953 have been small, consisting of small seaward movements indicating accretion in the sandy pocket beaches. There is no known beach erosion problem in the area and no plan of protection or improvement has been considered.

24. Butler and Contentment Islands. (Plates 16, 26 and 27) - Butler and Contentment Islands are connected land areas having an irregular shore line largely composed of exposed bedrock. Sand beaches are small and they are held in indentations of the rocky shore. Development consists of large widely spaced residences and a beach club, the latter at one of the sandy pocket beaches at Butler Island. Ownership of the shore

is private. Walls front portions of the residential development at Butler Island and they project normal to the shore and act as groins at the limits of the beach club. There is a groin at the beach club and walls, generally at sandy pocket beaches to the west along Contentment Island. Due to its rocky composition, the shore is naturally resistant to erosion. No plan of protection is needed and none has been developed. A portion of the foreshore of the pocket beach at the beach club is composed of mud and marsh. Improvement of the beach for recreational use, if desired, can be effected by direct placement of sand fill. Because of the natural stability of the pocket beach no structure should be needed to reduce losses of the fill.

25. Great and Hay Islands. (Plates 17 and 27) - Great and Hay Islands have an irregular bedrock shore line fronted in many places by marsh. Great Island is developed as one large estate. There is one residence on Hay Island. Ownership is private. Most of the shore is unprotected. At Great Island there is a low wall behind a small sandy pocket beach and a higher wall along the edge of a road and boat landing at a small harbor. A causeway at Hay Island is lined with walls and it is protected by a riprap mound or breakwater. Existing structures appear adequate to provide needed protection. Due to the lack of development and the natural resistance of most of the shore to erosion, there is no need for additional protective works and none have been considered.

26. Long Neck Point. (Plates 17 and 28) - The shore line of Long Neck Point south of the Hay Island causeway and Peartree Point is generally at or near the foot of a continuous system of sea walls. A narrow gravelly beach fronts a part of the east shore and small accumulations of beach material are held on the south side of solid projecting structures. Elsewhere there is no beach above high water. Development consists of the Sacred Heart Academy at the outer tip of the point, large widely-spaced residences to the north generally well behind the shore and a number of piers. Along the Sacred Heart Academy property there is a riprap mound a few feet in front of the sea wall and stone paving protecting the bluff above the wall at its northeast end. Shore line changes between 1835 and 1953 were too small to permit measurement on available comparative maps. The foreshore has reportedly been lowered gradually by erosion causing undermining of sea walls. Wave attack, particularly along the east shore, has caused erosion of the bluff above the wall and has damaged walls and piers necessitating periodic maintenance. Since 1953 the riprap mound and stone slope paving of the bluff described above have been constructed at the Sacred Heart Academy. These works should provide adequate protection for the walls, and bluff against wave attack and reduce erosion of the foreshore. The use of riprap revetment in front of the toe of sea walls is a practicable and probably the most economical method of protecting them against wave attack and undermining.

27. Peartree Point. (Plate 17) - There is a public bathing beach belonging to the town of Darien located at Peartree Point. This shore area projects from the west side of Long Neck Point near the Darien River entrance. It consists of a sandy shore which on the south side of the

point trends generally east and west with a bedrock outcrop at its west end. The sandy shore thence continues northward to a sand spit trailing northwestward into the Darien River. The beach is provided with a bathhouse, parking area and fireplaces. There is a private boat club and pier at the tip of the spit. Seaward movement of the south shore indicates accretion between 1835 and 1933 but during the period 1933-1953 the shore line position did not change much. Larger changes in position have occurred along the west shore during recent years, the most significant of which was recession in the vicinity of the bathhouse which threatened to undermine the structure. A riprap breakwater extending northwestward into Darien River from the rock outcrop at the west end of the south beach was constructed for protection of the bathhouse during 1929. It failed to stop the erosion and other shorter temporary timber groins were tried along the west shore with not too much success. A stone groin was built at the west end of the south shore during 1953 and it is successfully maintaining the south beach. According to local officials, during 1955, there is no longer any serious erosion problem at Peartree Point so it is assumed that the former erosion problem along the west shore has been corrected by existing structures or the shore line has reached a state of equilibrium. Maintenance of the bathing beach by annual placement of 300-400 cubic yards of sand fill is still required. The only improvement contemplated by the town consists of filling the marshy area between the spit and the mainland to provide additional space for parking. No plan for protection or improvement is needed and none has been considered.

28. Noroton Neck. (Plates 17 and 27) - Noroton Neck is a low land area bordered by the Darien River on the east and Cove Harbor on the west. It has little or no beach fronting an irregular system of walls fronted in places by short groins. There is a narrow sand and gravel beach opposite Peartree Point on the east shore and another sandy beach on the west shore north of a long pier. The south shore east of the Pratt Island causeway is marshy. Development is residential and shore ownership is private. There is a yacht club and pier at the southeast side of the neck and a private association pier and bathing beach at the southwest side. Shore line changes from 1933 to 1953 were small and consisted of an irregular seaward movement of the south shore, probably effected artificially by construction and a slight recession along about 400 feet of the west shore north of the association pier. Records show that considerable land area was made with hydraulic fill around 1927 but available maps do not indicate any resulting large changes in the shore line position. Erosion of the association beach at the west side of the neck has occurred at a comparatively slow rate requiring annual replacement of sand reportedly at a cost of $100 per year. Reduction of this loss of material can be effected by construction of an impermeable groin at the north end of the beach to prevent northward drifting but some maintenance of the beach will still be required. Since the annual loss of material is small, direct replacement of losses is probably more economical than groin construction. Elsewhere existing structures, if maintained, should provide adequate shore protection.

29. Pratt Island. (Plates 17 and 28) - This is a low island connected to the mainland at Noroton Neck by a causeway. Its shore is irregular in

shape and largely composed of bedrock and marsh. There is a sandy pocket beach at the west side of the causeway. Ownership is all private and development is residential. Lawns at residences along the shore are generally protected by low walls. The causeway is protected by riprap revetment. Low areas of the island are subject to flooding by extreme high tides. Erosion is minor consisting of loss of some overburden from the bedrock and the gradual breaking away of rock fragments. The flooding problem is beyond the scope of this study. Protection against the erosion which occurs at small scattered locations can best be provided by individual owners by construction of light walls or riprap revetment along the affected areas. No comprehensive plan of shore protection is needed.

30. Weed Beach. (Plates 17 and 29) - Weed Beach is located at the west side of Noroton Neck adjacent to the Holly Pond entrance. The shore, now undeveloped, was formerly a commercial bathing beach. It was acquired by the town of Darien which is improving it for use as a public bathing beach. The shore line is generally sandy with some gravel and marsh below the high water line. The southerly portion of the beach fronts a vegetation covered dune while the north end of the beach consists of a bar fronting marsh. The improvement by the town includes placement of 40,000 cubic yards of fill and construction of roads and a bathhouse. Swift tidal currents at the entrance to Holly Pond make it hazardous to use the northern portion of Weed Beach for bathing. Two jetties deflect currents from this shore. The beach reportedly requires maintenance by annual replacement of sand losses. The small amount of shore line movement which has occurred during the period of record indicates that beach material is lost at a slow rate and that beach maintenance by direct replacement of losses is probably more economical than construction of groins or other structures to reduce losses. The hazard to bathers resulting from swift currents close to the shore can be reduced by widening and deepening the Holly Pond entrance by dredging a channel and removing the end of the spit which trails eastward from Cove Island. Fill has already been taken by the town of Darien by excavation of the end of the spit. Officials at Stamford have expressed an interest in removal of the existing breached dam at the Holly Pond entrance and excavating a straight channel into the pond including removal of the end of the spit so that the area can be used as a harbor by small boats. Darien and Stamford therefore have a common interest in providing a new entrance channel into Holly Pond. A joint project of this type could therefore result in benefits to both communities. A project which could be constructed jointly, is discussed in the following paragraph in connection with a plan of improvement for a bathing beach at Cove Island and it is shown on Plate 22.

31. Cove Island. (Plates 17 and 29) - Cove Island is located west of and adjacent to the Holly Pond entrance. It is low and flat and until recently was part of a large private estate. It is now owned by the city of Stamford. Sandy shore areas exist in the pocket between the two southerly bedrock tips and along the east end of the island which is a sand spit trailing into the Holly Pond entrance. The shore west of the spit to the bare bedrock southeast tip of the inland is fronted by marsh

grass and its high water line is at or close to riprap revetment and a sea wall. Bedrock at the southwest tip of the island is surrounded by marsh largely covered with gravel and cobbles. There is one residential building near the southeast tip and a few residences at the north end of the island. Protective structures consist of riprap revetment and steel boilers along the top of the spit, riprap revetment and a sea wall along the adjoining shore to the west, a riprap jetty at the southeast tip of the island and riprap revetment around the southwest tip. Comparative maps show a shore line recession of 300 to 1,000 feet occurred along the southerly side of the island between 1835 and 1933. The magnitude of the changes indicates that they were due to loss of material that was eroded easily, probably marsh, rather than to fast land. The city of Stamford plans to develop the island as a public park containing a bathing beach. Interest has been shown by city officials in the development of Holly Pond as a small boat harbor by removal of the breached dam at its entrance and excavation of a straight entrance channel. Similar improvement for navigation desired by local interests resulted in preliminary examination reports in 1912 and 1947. At both times the reports were unfavorable to improvement by the Federal Government. If such an improvement should be made, sandy material excavated could be deposited along the adjoining shore to the west to form a bathing beach. A probing just south of the Holly Pond entrance at Profile 16 indicates that the bottom material consists at least in part of sand. The desired straight entrance channel could be dredged through the spit at the east end of Cove Island as a joint project with the town of Darien as discussed in the preceding paragraph. A groin which could also serve as a jetty would be necessary to reduce eastward drifting and loss of material into the entrance channel from the area proposed to be filled at Cove Island to prevent formation of a new spit. Material from the dredging could also be placed, if desired, in the pocket between the two southerly projecting points of the island. A bathing beach in this latter location, due to its natural protection, could probably be maintained most economically by periodic replacement of beach losses. A plan of improvement and protection which could be constructed jointly by the town of Darien and the city of Stamford including excavation of a new entrance channel to Holly Pond construction of a groin or jetty at the west side of this channel and placement of fill along the shore west of the groin has been considered and it is shown on Plate 22.

32. Cove Harbor. (Plate 17) - The shore along the west end of Cove Harbor from Cove Island to Green-A-Way Island varies from east to west from a low undeveloped cobbly and sandy area fronted by marsh to a shore covered with gravel and cobbles with small pockets of sand above high water, the latter area fronting a residential development protected by sea walls, riprap revetment and groins. The foreshore along the west end of the residential development is marshy. There are a few rock outcrops, both on and offshore. A short length of the east end of the shore belongs to the city of Stamford and the remainder is private. Existing protective works, if maintained, should adequately protect the development. Due to the lack of any natural source of supply of beach building material which can be impounded by groins, use of such structures for beach building purposes has not been successful. Improvement and maintenance of the shore

for the limited recreational use of residents, if desired, can be effected by direct placement of small quantities of sand as needed.

33. Green-A-Way Island. (Plate 17) - This is a small privately owned island with a bedrock shore line. Development consists of one residence. The island is connected to shore by a causeway and is sheltered by an offshore riprap breakwater. There is no erosion problem and no plan of protection has been considered.

34. Westcott Cove. (Plates 18 and 29) - The shore of Westcott Cove from the bridge at Green-A-Way Island to the east end of Cummings Park is generally low and marshy. There are occasional rock outcrops and little or no sandy beach along the east portion, a fairly wide sandy beach behind the marsh in the central portion and a narrow irregular sandy beach in front of sea walls at the west end with a greater width of beach held on the east side of groins. Development is residential with only one cottage near the shore at the east end, a new housing development well behind the central portion and an older development at the west end behind the sea walls close to the shore. There is a riprap dike across the entrance of a low marshy area near the east end and riprap revetment fronting the walls adjacent to Cummings Park. Comparative maps show a landward movement of the shore line occurred between 1835 and 1933, the average movement ranging from about 1 to 3 feet per year. The shore line of the western half of the area only was located during 1953 and it showed that the recession of the shore continued at a rate of about 1 foot per year during the period 1933-1953 along some of the area east of the existing sea walls and groins. Some of the residences are located on low ground which is subject to flooding during extreme high tides, a problem which is not regarded as being within the scope of this study. Existing walls and groins adjacent to Cummings Park, if maintained, should provide adequate protection against erosion. The new residential development is set far enough behind the shore so as not to be in any immediate danger from erosion. Limited improvement of the shore for recreational use by residents can be effected by direct placement of sand on the beach. Due to the lack of a natural source of supply of material, groins cannot impound much material for creation of new beach area but they can reduce losses of existing or artificially placed material. No plan of protection or improvement is needed and none has been developed.

35. Cummings Park and West Beach. (Plates 18 and 30) - Cummings Park and West Beach, both public bathing beaches belonging to the city of Stamford, extend east and south, respectively, from the entrance to a small boat basin off Westcott Cove. Cummings Park has parking areas, playgrounds, and a bathhouse which is not used. Its beach is protected by a riprap groin near its center and a riprap jetty at its west end at the boat basin entrance. West Beach has a parking area and bathhouse and there is a timber groin at its south limit. Both beaches are composed of sand but the area below the low water line in the central portion of Cummings Park is muddy. The Cummings Park shore line receded at an average rate of 3 feet per year from 1835 to 1933 east of the location of the riprap groin and a like amount from 1835 to 1885 between the location of the groin and jetty. Changes indicated in the latter area from 1885 to

1933 resulted principally from closure of the easterly of two openings into the present boat basin area by artificial filling around 1924 and construction of the jetty and groin around 1927. Since 1933 the shore at and east of the groin has continued to recede while the shore line to the west has been comparatively unchanged. The West Beach shore line receded about 300 to 700 feet between 1835 and 1885, moved seaward up to about 100 feet between 1885 and 1933, probably as a result of artificial filling during 1927, and since 1933 has receded up to about 125 feet. Both beach areas are low and subject to flooding during extreme high tides with resulting damages to the bathhouses and other public facilities. Both beaches have an erosion problem with loss of sand occurring along the eastern end of Cummings Park and along most of West Beach. Boats using the basin entrance endanger bathers at West Beach particularly during low stages of the tide when the water line moves out to the edge of the channel. Bathing conditions are unsatisfactory along part of Cummings Park during low tide because of the muddy bottom below the low water line. The disused bathhouse at Cummings Park is at the waters edge during high tide and therefore subject to wave attack and damage. The jetty and groin are useful in reducing erosion of the beach at Cummings Park. It was noted during the Spring of 1955 that the inshore end of the groin was flanked during high tide. This condition permits littoral drift to pass westward around the inshore end of the groin and is at least partly responsible for the failure of the groin to prevent erosion of the beach to the east. The inshore end of the jetty is also too low to prevent westward movement and loss of beach material. The loss of material from West Beach is largely due to northward drifting resulting from wave generated littoral currents with the material probably deposited in the boat basin. Shoaling of the boat basin reportedly requires dredging about every four years. A plan of improvement which could benefit both West Beach and Cummings Park was discussed with local interests in Stamford. It consisted of closure of the existing inlet to the boat basin at Cummings Park, dredging a new inlet through the park beach farther to the east at the west side of the existing groin, enlargement of the groin to act as a jetty and construction of a new, shorter jetty at the west side of the inlet. The above would also necessitate relocating the entrance channel through Westcott Cove which has been authorized as a Federal navigation project. The improvement would eliminate the hazard to bathers at West Beach, change the area west of the new inlet to one of accretion by impounding northward drifting sand, reduce shoaling of the boat basin and move the bathing area at Cummings Park westward away from the objectionable muddy bottom condition. Local interests at Stamford indicated that they preferred not to cut a new channel through Cummings Park in order to benefit West Beach but would rather concentrate on improvement of the Cummings Park beach which is more popular. A plan has therefore been considered involving restoration, improvement and protection of the bathing beach at Cummings Park by direct placement of sand fill and reduction of losses of the fill from westward drifting by enlargement of the existing groin and raising the inshore end of the existing jetty. The plan is shown on Plate 22.

36. Dredging of the Federal navigation channel through Westcott Cove into the boat basin is scheduled for accomplishment during 1956. Probings indicate that the bottom material in the outer reaches of the channel is sandy and therefore probably suitable for beach fill. It is estimated that

the quantity of suitable beach material to be dredged is about two-thirds the quantity required for the above considered improvement of Cummings Park. The distance from the outer reaches of the channel makes it uncertain whether it will be practicable to pump the material to Cummings Park with available dredging plant. If practicable, suitable sandy material obtained from the dredging of the navigation improvement should be placed along the shore of Cummings Park to restore and improve it and reduce the cost of the beach improvement project which has been considered.

37. Westcott Cove (West Shore). (Plates 18 and 31) - The west shore of Westcott Cove from West Beach southward for about 2,500 feet is privately owned. There are two small commercial bathing beaches at the north end and the remainder of the shore is developed for residential use. The commercial beaches are fairly wide and sandy in composition, but to the south sandy beaches are small and of the pocket type held at the south side of groins. The commercial beaches are protected by groins. An irregular system of walls and a series of groins front residences to the south. Comparative maps show that the shore line receded about 300 feet at the north end of the area between 1835 and 1885 and progressively lesser amounts to the south. Between 1885 and 1933, the shore line along the south half of the area moved seaward, apparently a result of artificial filling during various periods. From 1933 to 1953, the shore receded again, with its largest landward movement about 150 feet. Existing sea walls and groins, if maintained, should provide adequate shore protection. Some losses of beach material will probably still occur at a slow rate. Maintenance of the small pocket beaches for the limited use of the shore by residents can best be effected by direct placement of sand to restore the losses.

38. Shippan Point (East Shore). (Plates 18, 31 and 32) - The east side of Shippan Point, including the entire walled projecting shore at and north of Hobson Street and the shore southward to the outer tip of the point is developed for residential use. Residences are larger than average and generally set well behind the shore. Public ownership is limited to a few city owned street ends. There is a private beach club south of and adjacent to Hobson Street. Sandy beach areas are limited to about 1,000 feet of shore at the private beach club and about 900 feet of shore between groins in the indentation northeast of the outer tip of the point. The water line north of Hobson Street is at sea walls fronted by riprap revetment. South of Hobson Street, except for the sandy beaches mentioned above, the shore is generally covered with boulders and gravel with only occasional patches of sand. There are outcrops of bedrock in the vicinity of Hobson Street and also a few hundred feet to the south. There is a continuous system of protective works including sea walls, riprap revetment and groins north of Hobson Street and southwest of Shippan Avenue, while the intervening shore is only partly protected. The only appreciable change in the position of the shore line occurred prior to 1933 and it consisted of soundward movement resulting from artificial filling of the area in the vicinity of the tip of the point. Since 1933, comparative maps indicate practically no change.

Existing protective works, if maintained, should adequately protect the shore. Segments of shore along which there are no protective structures are naturally stable or protected by the coarseness of the beach material and they require no artificial protection.

39. Shippan Point (West Shore). (Plates 18 and 32) - The west side of Shippan Point from its outer tip northward to opposite Jack Island is irregular in shape as a result of a system of closely spaced groins which hold beach material on their south sides. Development is residential except for a few yacht and beach clubs. Public shore ownership is limited to street ends. The shore is composed of marsh, sand and gravel along the south end and of sand and gravel to the north with finer beach material held as fillets at the south side of groins. Beach widths vary irregularly in front of low sea walls along most of the shore. In general the beach is narrow. Along the southerly 500 feet of shore there is no dry beach at high water, the wall in this area being fronted with riprap revetment. Comparative maps indicate that there has been little or no change in the position of the shore line since 1933. Private property owners, as a result of concern over loss of beach material, had a private engineering study made of the west side of Shippan Point during 1941. Data collected was compiled in a report and furnished to the District Engineer, at Providence, Rhode Island, for his consideration of the problem and to supplement data already in his files. The report recommended that the District Engineer give consideration to placing sand which might be dredged from an anchorage basin in Stamford Harbor, in connection with a Federal navigation improvement, along the west side of Shippan Point to restore losses and widen the beach. The anchorage has since been dredged but the dredged material was removed in scows and therefore could not be placed along the shore of Shippan Point as desired by the property owners. The west side of Shippan Point is naturally sheltered from the more severe easterly storms. Shelter from the south is provided by Long Island and by the breakwaters at the Stamford Harbor entrance. In general only small waves generated across short fetches, principally within Stamford Harbor, can affect the shore. Profiles 26, 27 and 28 surveyed during 1953 compared with similar profiles run during 1942 within a zone 220 to 400 out from the high water line showed that there was no measurable change in depth. Existing groins have been effective in holding beach material but due to lack of any natural source of supply, which can be transported by littoral currents, there is little drifting material which can be impounded to form an appreciable amount of additional beach area. The type of improvement apparently desired would require direct placement of sand fill along the shore to improve the composition of the beach for the limited recreational use of residents. Due to its sheltered location, the area does not generally require widening of the beach for protective purposes. The amount of material needed would therefore be comparatively small and would generally not exceed the impounding capacity of existing groins. Probings indicate that sand exists in Stamford Harbor within a practicable distance for hydraulic dredging and pumping to shore. Unless a sufficiently large quantity of sand is needed, however, it may be more economical to obtain the sand fill by trucking from some inland borrow area rather than use the hydraulic dredging process. Sand losses will occur but they will probably be at a slow enough rate so that it will be more economical to periodically replace losses than

to try to prevent them by additional construction of groins or other structures. No specific detailed plan has been developed since the type of improvement suitable for different properties along the shore will depend on the desires and needs of the property owners.

40. Dyke Park. (Plates 18 and 33) - Dyke Park is located at Cemetery Point at the junction of the East and West Branches within Stamford Harbor. It belongs to the city of Stamford and is used as a playground. There is a short extent of sandy beach along the west shore used to a limited extent for bathing. The south and east shores of the park are marshy and the offshore harbor bottom is generally muddy. There is a low wall behind the sandy shore and a row of stones in the form of a groin at its south end. Due to its sheltered location within the harbor, the park is not exposed to severe wave attack or erosion. The muddy offshore bottom makes the location unsatisfactory for development as a bathing beach. No plan of protection or improvement is needed and none has been developed.

41. Southfield Park. (Plate 18) - Southfield Park located at the west side of Stamford Harbor adjacent to Cook Point belongs to the city of Stamford. Its shore is sandy and has several outcrops of bedrock. The foreshore in the vicinity of and below the low water line is marshy and covered with boulders, gravel, silt and vegetation. The shore is used to a limited extent as a public bathing beach. There is a riprap groin at the north end of the beach. The park also has a small boat basin and mooring area. There are no public facilities for recreational use of the bathing beach. The shore is comparatively stable due to its sheltered location and does not require construction of any additional protective works. The unsatisfactory composition of the fronting foreshore detracts from the attractiveness of the beach for bathing and motivates against its development for this purpose. No plan of protection or improvement has been considered.

42. Cook and Davenport Points. (Plates 18 and 33) - Cook and Davenport Points are located on the west side of Stamford Harbor. They are privately owned and developed for residential use. There is a sand and gravel shore behind a riprap mound along the north end of the area. Elsewhere the water line is at walls and fronting riprap revetment. Bedrock is exposed at the tip and in the vicinity of Davenport Point. Principal shore line changes have resulted from construction of walls or other protective works and by artificial filling. The largest movement of the shore, which occurred at Cook Point, probably was the result of construction around 1910. So far as is known there is no beach erosion problem in the area. Existing structures, if maintained, should provide adequate protection. No plan of protection has been considered.

43. Peck Point to Cummings Point. (Plates 18, 19 and 34) - The shore west of Davenport Point to the Stamford - Greenwich boundary consists alternately of two sandy pocket beaches and two projecting points. The easterly pocket beach is narrow and bounded on the west by Peck Point. The westerly pocket beach is larger, ranging up to 100 feet in width. It is bounded on the west by Cummings Point. Peck Point was enlarged around 1929 by artificial filling and construction of a sea wall along its east

side, south end and part way along its west side terminating at a groin. The waters edge is at the face of the sea wall. A considerable extent of shore north of the wall along the west side of Peck Point is protected by riprap revetment. There are groins and a pier along the sandy pocket beach to the west which merges into the bedrock shore at Cummings Point. Shore line changes at Cummings Point have been small during the period of record and they probably resulted from artificial filling and construction of sea walls. Development consists of large residences set well behind the shore along the westerly half of the area. Existing structures, if maintained, should provide adequate protection. No plan of protection or improvement is needed and none has been considered.

44. Old Greenwich (East Shore). (Plates 19 and 34) - The shore line of Old Greenwich bordering the west side of the outer part of Stamford Harbor and extending about 3,000 feet southward from opposite Cummings Point is composed almost continuously of bedrock with sand only in a few small indentations. The remainder of the east shore of Old Greenwich continuing westward and then southwest to the public park at Greenwich Point is characterized by occasional outcrops of rock with small sandy beach areas in pockets or held at structures. There is more marsh in the foreshore towards the south end of the latter area. The shore is privately owned and developed for residential use. Residences are fronted by an almost continuous system of walls which are lower in elevation along the central shore area which is oriented in a general east-west direction and also to the south. There are a number of piers along the north half of the shore and a few groins and short offshore breakwaters along the south half. Shore line changes between 1885 and 1953 were generally small and localized, probably resulting more from construction or artificial filling than from natural processes. There is no known beach erosion problem. Some residences, particularly along the central and southern portion of the area are on low ground fronted by low walls and therefore subject to flooding during extreme high tides, a problem considered to be beyond the scope of this study. The shore is oriented so that it is exposed to wave attack by waves approaching across the length of Long Island Sound to the east. This wave action damages walls and hurls water and debris over them. Protection against this form of damage can be provided by the placement of riprap revetment along toes of walls wherever necessary to dissipate the energy of wave attack. In general, maintenance of existing structures should provide adequate protection. No plan of protection appears necessary and none has been developed.

45. Greenwich Point (East Shore). (Plates 19 and 35) - Greenwich Point is a large public park owned by the town of Greenwich. The east shore is mostly sandy in composition with marsh below high water along its north end. The shore becomes coarser at its south end, the sandy beach merging into a marsh and boulder covered shore at the southeast tip of the point. The sandy beach is used for public bathing and it is provided with a bathhouse, concession stand, comfort stations and parking areas. Protective structures consist of a rubble masonry wall fronted by dumped stone revetment at the bathhouse. Shore line changes between 1933 and 1953 consisted of a small seaward movement or accretion of the shore of the public bathing beach. The problem of greatest concern has

been the maintenance of sand dunes at the bathing beach for protection of the backshore. The dunes have been restored annually by pushing up sand from the foreshore. Due to the narrowness of the fronting beach, the dunes are within the reach of waves and they have consequently been washed down repeatedly to form a more natural beach profile. Damages due to wave attack have occurred during storms to sea walls, roads, parking areas and buildings. Protection can be provided by direct placement of sand fill along the shore to form a wider sand beach. Probings indicate that sand exists offshore within a practicable distance for dredging and pumping to the beach. A plan of improvement involving beach widening has been considered and it is shown on Plate 22. Such enlargement of the bathing beach will provide recreational benefits in addition to those from protection.

46. Greenwich Point (South and West Shore). (Plate 19) - The south shore of Greenwich Point is generally coarse and gravelly and it is characterized by numerous boulders on and offshore with considerable marsh in the foreshore. The coarse gravelly shore continues along the west side of the point and becomes finer to the north. The northwest tip of the point at the Greenwich Cove entrance is a sandy beach area. The Greenwich Cove shore of the park is marshy with only a small amount of sand along the causeway at the north end. There is a pier and boat club building at the northwest tip of the point at the Greenwich Cove entrance. The park is also provided with picnic tables, fireplaces and small boat storage areas. There is riprap and boulder revetment and a wall along a large part of the south shore, heavy riprap revetment continuing around Flat Neck Point northward along most of the west shore and lighter revetment and a low wall in the vicinity of the beach opposite Pelican Island. There are also low walls and riprap behind the marsh along the shore road bordering Greenwich Cove. Comparative maps indicate that between 1885 and 1933 the principal shore line changes consisted of landward movement at the southeast tip and south shore and seaward movement along the west shore. Changes between 1933 and 1953 were small, the principal change consisting of a northward growth of the sandy shore area opposite Pelican Island. The shore line is not subject to rapid recession. Areas which due to their exposure would ordinarily be subject to erosion are protected by a natural cover of boulders and gravel, the residue of past erosion or they are adequately protected by revetment and walls. The only problem reported has been shoaling which has occurred at the boat basin in Greenwich Cove in the vicinity of and east of Pelican Island. This problem which involves protection for navigation rather than beach erosion is not considered to be within the scope of this study and no detailed plan has been considered for its correction. It can be pointed out, however, that the problem arises largely from the northward drifting of material along the west side of Greenwich Point and the subsequent deposition of material. The shoaling can be lessened by construction of a groin from the northwest tip of Greenwich Point to or towards Pelican Island to impound drifting material before it reaches the boat basin.

47. Elias Point and Todd Point to Cos Cob Harbor Entrance. (Plates 20 and 35) - The irregular shore line extending westward from Elias Point to

Todd Point and thence northward to the pier and boat slip at the Cos Cob Harbor entrance is composed principally of exposed bedrock. Narrow sandy beaches exist in the pockets at the west side of Elias and Todd Points. Shore ownership is entirely private. Development consists of a few large residences set well behind the shore. Unoccupied land had been subdivided into lots for additional residential construction during the Spring of 1955. Walls protect both sides of the causeway to Elias Point and the shore westward to and around Todd Point. There are two piers, one at the first land projection west of Todd Point, the other at the west limit of the area. There is no known beach erosion or shore protection problem in the area and no plan for protection or improvement has been considered.

48. Mead Point. (Plates 20 and 36) - The shore from the west side of the Cos Cob Harbor entrance opposite Goose Island to and around the tip of Mead Point is irregular in shape and characterized by numerous outcrops of bedrock. Sandy shore areas exist only in small pockets. The shore is privately owned. Development consists of large widely spaced residences set well behind the shore line. Considerable lengths of shore east of Indian Field Road and at Saw and Horse Islands are protected by walls which are generally low and front lawns near the waters edge. During the Spring of 1955 construction was in progress involving the placement of fill to connect the tip of Mead Point with Brush Island to the west and a smaller island to the southwest and to reclaim the marshy shore along the east side of Indian Harbor north of Brush Island. A riprap breakwater extended part way across the opening of the small harbor formed between Mead Point and Brush Island by the filling operation. There is no known beach erosion or shore protection problem in the area and no plan for protection or improvement has been considered.

49. Benedict Point and Steamboat Road Point. (Plates 20, 21 and 36) - Most of the shore line of Benedict and Steamboat Road Points bordering Indian and Greenwich Harbors and Smith Cove is naturally sheltered. The exposed southern end of Benedict Point is composed of bare bedrock and it is therefore not subject to erosion. Development at Benedict Point consists of large widely spaced residences with lawns portected by sea walls. There is a timber wharf at its east side opposite Brush Island. The only known damage occurs to lawns as a result of water overtopping walls during exceptional storms accompanied by extreme high tides. The exposed outer end of Steamboat Road Point is composed of bedrock, stone fragments and small amounts of sand and gravel in indentations. It is faced with high walls. There is a publicly owned solid fill pier at the outer end of the point. The coarse nature of the shore and the existing structures provide protection against erosion and wave attack. Maintenance of existing protective works at both points should continue to provide adequate protection against ordinary conditions.

50. Field Point and Belle Haven. (Plates 21, 36 and 37) - The shore of Field Point and Belle Haven between the Greenwich and Byram Harbor entrances is generally coarse in composition with sandy beach areas limited to small pocket beaches, one at the south side of Round Island, the other at the head of the large indentation in the middle of the area. Exposed

bedrock is almost continuous around the outer tip of Field Point and occurs at numerous locations throughout the rest of the area. The east and west sides of Field Point are covered with gravel, marsh, and scattered boulders. There is also some marsh fronting the rocky Belle Haven shore. Ownership is entirely private. Development consists of large widely spaced residences generally well behind the shore and of yacht and beach clubs. Portions of the bluffs along the east and west sides of Field Point are protected by walls and riprap revetment. There are a number of open piers around Field Point. Most of Belle Haven is protected by sea walls. Due to its coarse composition, the shore is generally resistant to erosion. Existing protective works, if maintained, should provide adequate protection against ordinary wave attack.

51. Byram Park. (Plates 21 and 37) - The town of Greenwich owns Byram Park, located in the lee of a group of small islands at the west side of Byram Harbor. The park shore consists of a short sandy beach at its north end and a muddy cove to the south. The sandy shore is used as a public bathing beach and it is provided with a bathhouse. There is a groin at the north limit of this beach. The muddy cove is used as a basin and storage area for small boats. A stone wall borders the cove with little or no dry shore fronting it during high water. The entire area is naturally sheltered and requires little additional protection. The sandy bathing beach is maintained annually by replacement of sand losses. It is doubtful if construction of additional protective works would be justified for reduction of these losses. Maintenance of existing structures and continued addition of sand to the beach as required should adequately serve the needs of the park.

52. Byram Shore. (Plates 21 and 37) - The shore extending southward from Byram Park to Byram Point is privately owned and developed for residential use. At its north end in the vicinity of Huckleberry and Shore Islands there are mud flats at low water. Sandy beach areas above high water generally exist only in small pockets in the irregular rocky shore. Byram Point at the south limit of the area is composed of sand and gravel, with some cobbles below high water. The shore at Byram Point is a bathing beach controlled by the Hawthorne Beach Association. The shore to the north is partly protected by stone walls. There are many light piers along the shore and a riprap jetty at the tip of Byram Point, the latter built by the United States for navigation improvement of Byram River. Shore line changes have not generally followed any particular pattern. Small localized changes at many localities appear to be the result of shore construction and land reclamation. The largest shore line change shown by comparative maps occurred between 1933 and 1953 when the shore line along the outer 100 feet of shore on the east side of the Byram Point jetty receded up to 300 feet and the shore of an indentation located adjacent to and north of this area moved seaward about 200 feet. The sandy shore of Byram Point adjacent to the jetty has reportedly receded about 150 feet during a recent 3 to 4 year period. The only reported problem is located at this sandy shore and it consists of the above erosion, shifting about of beach material and inundation of the beach during fall and winter storms. The Hawthorne Beach Association has expressed an interest in the maintenance and improvement of this beach. Development in the area is set well behind the shore line and it is

in no immediate danger from the results of erosion. Local people have reportedly requested the United States, without success, to repair and raise the jetty at Byram Point to prevent loss of beach material. It appeared from inspection of the area during 1955 that material passes around or through the structure resulting in a wide sandy deposit on the west or Byram River side of the jetty.

A plan of protection involving landward extension and repairs to the existing jetty to make it impermeable to the passage of sand has been developed and it is shown on Plate 22A. The proposed work should reduce losses of beach material which now occur through westward drifting during the more severe easterly storms. The authorized Federal project height of the jetty of 13 feet above mean low water appears adequate for the type of protection needed. Some losses of beach material will still occur but it should be practicable to maintain an adequate bathing beach for limited private use by periodically restoring losses by placement of sand fill. Other portions of Byram Shore are adequately protected by existing sea walls or need no protection due to their rocky composition.

53. Little Captain Island (Island Beach). (Plates 20 and 38) - Little Captain Island, a small island about 600 feet long and 200 to 400 feet wide is located about one and one-half miles offshore opposite Greenwich Harbor. It is owned by the town of Greenwich and it is used as a public park and bathing beach. There is a bathhouse and caretaker's building on the island. The bathing beach is along the sandy north and east shores. The south and west shores are gravelly and boulder strewn. Shore structures consist of a low stone wall behind the sand beach along the north and east shores, an open pier at the east end and a riprap groin at the west end of the north shore. A newly constructed steel sheet pile bulkhead fronted by riprap revetment throughout most of its length and by masonry slope paving at its east end protects the south and west shores. Comparative maps indicate that between 1836 and 1885, Little Captain Island decreased considerably in size by recession of its entire shore generally in excess of 100 feet and that between 1885 and 1933 changes in the position of the shore line were small. Estimates by local people indicate a 50 to 100-foot recession of portions of the shore occurred since about 1905. It is definitely known that at one location on the south shore, at an incinerator, that the beach level has been lowered over 3 feet since 1936. The south shore is the most exposed portion of the island. It is subject to its most severe wave attack during easterly storms. The island is low in elevation and has been subject to flooding by extreme high tides and overtopping waves. Buildings on the island have been damaged or destroyed during hurricanes and exceptionally severe storms. The steel sheet pile bulkhead constructed during 1954-1955 replacing a deteriorated timber bulkhead should generally be adequate to prevent erosion. During an extreme high tide similar to the one which occurred during the hurricane of September 1938, the island would be under water with resulting damages to buildings and structures. During storms with tides of lesser heights, the bulkhead should provide a large measure of protection against damaging wave attack. Its effectiveness in this respect can be increased by adding additional riprap revetment along its toe. It is advisable to ship stone to the island for this purpose rather

than obtain it by stripping the foreshore of its natural protective cover. Existing protective structures, if maintained, should provide adequate protection from all but the most severe storms and hurricanes. It is doubtful if construction of works to provide protection against every possible condition would be justified. No additional protective works are regarded as necessary and none have been considered.

IV - ECONOMIC ANALYSIS

54. General. - Detailed estimates of costs are included in Appendix H and detailed estimates of benefits are included in Appendix I. First costs and benefits have been estimated for all projects involving publicly owned shores and first costs have been estimated for a project for a private beach at Byram Point. Estimates are based on price levels prevailing during January 1956. Projects have been considered as follows:

Area	Ownership	Paragraph Reference	Plate No.
Calf Pasture Beach Park, Norwalk			
(a) East Shore	Public	16	22A
(b) South Shore	Public	16	22A
Cove Island, Stamford	Public	31	22
Cummings Park, Stamford	Public	35	22
Greenwich Point, Greenwich	Public	45	22
Byram Point, Greenwich	Private	52	22A

55. First Costs. - The first costs of projects computed in detail in Appendix H, are as follows:

Project	Work Items	Cost
Calf Pasture Beach Park, Norwalk		
(a) East Shore	Beach fill and extension of 2 groins	$230,000
(b) South Shore	2 Groins	40,000
Cove Island, Stamford	Jetty and beach fill	207,000
Cummings Park, Stamford	Beach fill and enlargement of groin and jetty	102,000
Greenwich Point, Greenwich	Beach fill	150,000
Byram Point, Greenwich	Jetty extension and repairs	19,000

56. Benefits. - The estimated benefits are based on the recreational value of increased public beach space and on direct damages prevented. The recreational benefit has been evaluated for increased public beach area based on probable beach use by assigning a per capita value for beach

use estimated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. Direct damages prevented have been estimated on the value of annual losses of beach area prevented and on the reduction of storm damages. Estimated annual benefits computed in detail in Appendix I, are as follows:

Project	Recreational	Direct Damages Prevented	Total
Calf Pasture Beach Park, Norwalk			
(a) East Shore	$51,800	$2,400	$54,200
(b) South Shore	0	1,080	1,080
Cove Island, Stamford	51,200	2,880	54,080
Cummings Park, Stamford	16,800	1,800	18,600
Greenwich Point, Greenwich	32,430	2,700	35,130
Byram Point, Greenwich		Not evaluated	

57. Interests. - There is no Federal interest in any of the projects considered since none of the shore is owned by the United States. Non-Federal public interest is defined as, (a) the benefits accruing to a State or political subdivision thereof as a land owner and, (b) the benefits accruing to the general public. Private interest is defined as the benefits derived by individuals or non-public groups of individuals on account of ownership of lands and business enterprises affected. All estimated benefits are classified as non-Federal public benefits.

58. Allocation of Costs. - Public Law 727, 79th Congress, 2nd Session, established a policy of Federal aid in the protection and improvement of shores owned by States, municipalities and other political subdivisions. In accordance with this policy the Federal share of the cost can equal but not exceed one-third of the first cost of construction, but not the maintenance, of works for the protection and improvement of publicly-owned shores. No policy has been established for Federal participation in the cost of works for the protection and improvement of privately-owned shores. Factors governing the allocation of the Federal and non-Federal share of cost of contemplated projects are discussed in Section V of this report entitled "Conclusions and Recommendations." The estimated allocations of costs are summarized below:

Project	Federal Share	Non-Federal Share	Total
Calf Pasture Beach Park, Norwalk			
(a) East Shore	$76,000	$154,000	$230,000
(b) South Shore	0	40,000	40,000
Cove Island, Stamford	69,000	138,000	207,000
Cummings Park, Stamford	34,000	68,000	102,000
Greenwich Point, Greenwich	50,000	100,000	150,000
Byram Point, Greenwich	0	19,000	19,000

59. Annual Costs. - Interest has been computed at a rate of 2.5 percent on all funds. A useful life of 50 years has been assumed in determining amortization charges. Maintenance estimates of sand fills are based on maximum rates of loss determined from past shore recession with an assumed minimum rate of one foot per year. Estimated annual costs are summarized below:

Project	Interest	Amortization	Maintenance	Total
Calf Pasture Beach Park, Norwalk				
(a) East Shore	$5,700	$2,350	$1,950	$10,000
(b) South Shore	1,000	400	300	1,700
Cove Island, Stamford	5,200	2,100	2,200	9,500
Cummings Park, Stamford	2,550	1,050	900	4,500
Greenwich Point, Greenwich	3,760	1,540	3,600	8,900
Byram Point, Greenwich	475	195	150	820

60. Justification. - The estimated annual benefits and costs and the resulting ratios of benefits to costs are summarized below:

Project	Estimated Annual Benefits	Estimated Annual Costs	Ratio of Benefits to Costs
Calf Pasture Beach Park, Norwalk			
(a) East Shore	$54,200	$10,000	5.4
(b) South Shore	1,080	1,700	0.6
Cove Island, Stamford	54,080	9,500	5.7
Cummings Park, Stamford	18,600	4,500	4.1
Greenwich Point, Greenwich	35,130	8,900	3.9
Byram Point, Greenwich	Not evaluated	820	-

61. Coordination with Other Agencies. - Close coordination has been maintained with the Connecticut State Flood Control and Water Policy Commission, the official agency representing the State of Connecticut in this cooperative study. Officials of the towns concerned have been contacted and their views sought. The Connecticut Development Commission, State Park Department, State Highway Department, and State Board of Fisheries and Game have been contacted concerning aspects of the study pertaining to their interests. In addition, personal contact has been made with shore residents to obtain data concerning their problems.

62. Comments by Local Interests. - The cooperating agency, the Connecticut State Flood Control and Water Policy Commission, has been informed of the findings and recommendations contained in this report. It considers the report satisfactory and furthermore feels that the proposed plans of protection and improvement are desirable and necessary.

63. Responsibilities of Local Interests. - In regard to the proposed plans for protection of the bathing beaches at Calf Pasture Beach Park,

Norwalk, Cove Island, Stamford, Cummings Park, Stamford and Greenwich Point, Greenwich, the cooperating agency reports that it has considered the views of local authorities and found them to be in agreement with the findings of the report. Local authorities have indicated to the cooperating agency that the responsibilities which they will be required to assume upon execution of the program which is recommended will be met. The cooperating agency also reports that the conditions which are required of the State to insure Federal participation in the authorized projects will be fulfilled in accordance with existing legislation. Local interests are required to:

a. Assure maintenance of the protective and improvement measures during their useful life as may be required to serve their intended purpose;

b. Provide, at their own expense, all necessary lands, easements, and rights-of-way;

c. Assure that water pollution that would endanger the health of bathers will not be permitted;

d. Assure continued public ownership of the shore and its administration for public use during the economic life of the project. The recommendations are further subject to the conditions that the adequacy of the work proposed by local authorities, detailed plans, specifications, assurances that the requirements of local cooperation will be met and arrangements for prosecuting the work be approved by the Chief of Engineers prior to commencement of work.

V - CONCLUSIONS AND RECOMMENDATIONS

64. Conclusion. - The Division Engineer concludes that the following are practicable plans for protection and improvement of shore areas which merit consideration, all as shown on Plates 22 and 22A.

(a) Calf Pasture Beach Park - East Shore, Norwalk. Widening approximately 2,200 feet of beach to a 125-foot width by direct placement of sand fill and lengthening two existing riprap groins to a 400-foot length.

(b) Calf Pasture Beach Park - South Shore, Norwalk. Constructing two impermeable groins to a 350-foot length.

(c) Cove Island, Stamford. Widening to a 125-foot width by direct placement of sand fill, 1,200 feet of the east shore of Cove Island and construction of an impermeable jetty 400 feet long at the east limit of the fill, the fill material to be obtained by excavation of a wider and straighter entrance channel to Holly Pond in a manner that will reduce the swift currents close to Weed Beach.

(d) Cummings Park, Stamford. Widening to a 125-foot width in front of the existing bathhouse by direct placement of sand fill approximately 1,000 feet of the public bathing beach, lengthening of the existing groin to a 400-foot length, and raising the inshore end of the existing jetty.

(e) Greenwich Point, Greenwich. Widening, generally to a 125-foot width by direct placement of sand fill, approximately 2,800 feet of the public bathing beach.

(f) Byram Point, Greenwich. Landward extension and repairs to the existing jetty to make it impermeable to the passage of sand.

65. Due to the lack of development in the affected areas, erosion at Saugatuck Shores has not created any serious problem and construction of additional protective works for prevention of this erosion does not appear warranted. Existing structures along developed portions of Saugatuck Shores, if maintained, should generally provide adequate protection.

66. Erosion of the topsoil at Noroton Point on Bell Island constitutes a minor problem for which development of a detailed plan of protection is not necessary.

67. Recent revetting of the toe of the sea wall and the bluff above the sea wall with riprap has provided adequate protection for the most seriously affected problem area at Long Neck Point. Similar construction at other areas at Long Neck Point which may require it should provide a practicable and probably the most economical method of protection.

68. Losses of beach material from the west shore of Shippan Point occur at a slow rate. The type of improvement needed for the limited recreational use of the shore can generally be provided by individual property owners by direct placement of small quantities of sand fill, not to exceed the impounding capacity of existing groins, and periodic replacement of fill losses. A detailed plan is not necessary for this type of improvement and none has been developed.

69. Maintenance of existing structures and periodic replacement of sand losses at the public beach at Byram Park should provide adequate and probably the most economical form of protection.

70. The recently constructed steel sheet pile bulkhead and fronting riprap revetment at Little Captain Island should provide adequate protection against erosion. The effectiveness of the bulkhead in providing protection against wave attack can be increased by the placement of additional riprap revetment along its toe.

71. The projects considered for the east shore of Calf Pasture Beach Park, Cove Island, Cummings Park, and Greenwich Point are justified by evaluated benefits. The nature and amount of benefits are sufficient to warrant the maximum one-third participation by the United States in the first cost of construction in accordance with the policy established by Public Law 727, 79th Congress, 2nd Session. It is advisable for the United States to adopt a project authorizing Federal participation to the extent of one-third the first cost of the proposed projects. When the authorized Federal project for navigation improvement of Westcott Cove is constructed, suitable material which will be available from dredging

the entrance channel should, if practicable, be placed on the Cummings Park Beach to reduce the cost of the project considered for its protection and improvement.

72. The project considered for the south shore of Calf Pasture Beach Park is not justified by evaluated benefits. Benefits which have not been evaluated or cannot be evaluated in monetary terms may make it advisable for local interests to adopt the project considered.

73. Benefits to be derived from the project considered for Byram Point were not evaluated due to lack of necessary detailed quantitative information concerning recent beach changes. The shore involved is all privately owned. Under the policy established by Public Law 727, 79th Congress, privately owned shores are not eligible for Federal assistance in the construction of protective works. The proposed project would therefore have to be constructed entirely at the expense of local interests.

74. Recommendations. It is recommended that protective measures which may be undertaken by local interests based upon their determination of economic justification be accomplished in accordance with methods proposed and projects considered in this report.

75. It is recommended that the United States adopt projects authorizing Federal participation by the contribution of Federal funds in an amount equal to one-third the first cost of construction of the following generally as shown on Plates 22 and 22A.

(a) Calf Pasture Beach Park - East Shore, Norwalk. Widening to a 125-foot width by direct placement of sand fill, approximately 2,200 feet of beach and lengthening two existing riprap groins, each to a 400-foot length.

(b) Cove Island, Stamford. Widening to a 125-foot width by direct placement of sand fill, approximately 1,200 feet of beach and construction of an impermeable jetty, 400 feet long, at the east limit of the beach, the fill to be obtained, if practicable, by excavation of an enlarged Holly Pond inlet to reduce swift currents close to Weed Beach in Darien.

(c) Cummings Park, Stamford. Widening to a 125-foot width by direct placement of sand fill, approximately 1,000 feet of the public bathing beach, enlargement of the existing groin to a 400-foot length and raising the inshore end of the existing jetty.

(d) Greenwich Point, Greenwich. Widening generally to a 125-foot width by direct placement of sand fill, approximately 2,800 feet of the public bathing beach.

76. The recommended Federal participation is subject to the conditions that local interests will:

(a) Assure maintenance of the protective and improvement

measures during their useful life as may be required to serve their intended purpose.

(b) Provide at their own expense, all necessary lands, easements and rights-of-way.

(c) Assure that water pollution that would endanger the health of bathers will not be permitted.

(d) Assure continued public ownership of the shore and its administration for public use during the economic life of the projects. The recommendations are further subject to the conditions that the adequacy of the work proposed by local authorities, detailed plans, specifications, assurances that the requirements of local cooperation will be met and arrangements for prosecuting the work be approved by the Chief of Engineers prior to commencement of work.

77. The estimated amounts of Federal participation in accordance with the foregoing recommendations, are as follows:

Calf Pasture Beach Park, Norwalk	$ 76,000
Cove Island, Stamford	69,000
Cummings Park, Stamford	34,000
Greenwich Point, Greenwich	50,000
Total	$229,000

GEORGE N. KIBLER
Colonel, Corps of Engineers
Acting Division Engineer

49 Inclosures:
10 Appendices
39 Plates

APPENDIX A

DESCRIPTION AND COMPOSITION OF BEACHES

1. General. - Detailed descriptive data concerning the entire shoreline of Areas 8 and 11 were obtained from field inspections, ground and aerial photographs, topographic maps and coast charts and from discussions with and information furnished by officials of the cities and towns included. Descriptions of the shoreline divided generally into areas in accordance with the physical character of shore features are given below in geographic sequence from the Saugatuck River in Westport to Byram River in Greenwich. In addition, samples of surface beach material were obtained and analyzed to determine median diameter and size classification. Beach sample analysis results and locations are shown on Plates 15 - 19. A complete photographic record was made of the shore. Selected photographs are shown on Plates 23 - 38.

Westport

A. Saugatuck Shores

(1) Location: Between Duck Creek on the Saugatuck River shore and the marsh west of the spit on the south shore.

(2) Shore Length: 10,500 feet, approximate.

(3) Beach Width Above H. W.: Spit at Duck Creek 100' ±, north shore fronting road and residences generally less than 50', a narrow barrier bar along the east shore, varies irregularly between 0 and 150' fronting the road and residential development along the south shore and up to 100' along the spit at the west limit of the south shore.

(4) Ownership: Private except for the canal and beach opposite the south end of the canal which belong to the Town of Westport.

(5) Beach Use: Limited use by area residents.

(6) Public Facilities: None.

(7) Composition of Shore: The north shore is principally gravel and marsh with small amounts of sand just west of the canal. Fine to coarse sand and gravel bar above high water along the east shore with exposed wave cut marsh near Seymour Point. The south shore consists of medium to coarse sand and gravel below low water near Seymour Point. The spit trailing west from the south shore consists of coarse sand and gravel above high water with mud flats below low water.

(8) Protective Structures: Low concrete, rubble masonry and loose stone walls fronting residences along the north shore with riprap revetment along the road west of the canal, timber bulkheads and rubble masonry wall at the canal entrance and a riprap

groin east of the canal. Along the east shore a new timber groin about 100 feet north of Seymour Point and two short closely spaced riprap groins to the north. A heavy riprap groin at Seymour Point. Along the south shore dumped riprap revetment, timber and riprap groins, concrete and rubble masonry walls front the shore road and residences. A rubble masonry wall along the shore end of the spit fronted by three timber groins. Another new timber groin on the spit to the west of the wall.

(9) Character of Development: Residential.

Westport and Norwalk

B. Shore Haven (East)

(1) Location: Canfield Island.
(2) Shore Length: Approximately 2,500 feet facing Long Island Sound.
(3) Beach Width Above H. W.: Generally no sand beach.
(4) Ownership: Private.
(5) Beach Use: None.
(6) Public Facilities: None.
(7) Composition of Shore: Mostly marsh. Sand and gravel in pockets between structures.
(8) Protective Structures: A complex system of riprap groins, dikes and revetment, timber groins and bulkheads and rubble masonry and loose stone walls.
(9) Character of Development: Large residences, private boat basin and swimming pool.

Norwalk

C. Shore Haven (West)

(1) Location: Between bridge leading to Canfield Island and the north limit of Calf Pasture Beach Park.
(2) Shore Length: 1,750 feet.
(3) Beach Width Above H. W.: Generally none except adjacent to and north of projecting structures.
(4) Ownership: Private.
(5) Beach Use: Limited use by residents.
(6) Public Facilities: None.
(7) Composition of Shore: Generally no beach above high water. Sand and gravel below high water. Material gradation finer to the south.
(8) Protective Structures: Concrete capped stone pier at north limit. Rubble masonry walls front residences fronted by heavy riprap revetment along northern end. Three groins or piers, one of concrete, one timber encased and one at the south limit of riprap.
(9) Character of Development: Residential.

D. Calf Pasture Beach Park (Formerly Shady Beach)

(1) Location: Southwest and adjacent to Shore Haven.

(2) Shore Length: 1,200 feet.

(3) Beach Width Above H. W.: 30 feet along most of the beach widening to about 100 feet at the groin at the south limit.

(4) Ownership: City of Norwalk.

(5) Beach Use: Recently acquired shorefront to be used as a picnic area. The northerly 100 feet to be a landscaped preserve in accordance with deed restrictions.

(6) Public Facilities: New comfort station. Picnic tables and benches.

(7) Composition of Shore: Sand, gravel and cobble shore. North end of beach below high water is covered with cobbles with some sand above high water. Beach gradation finer to the south with coarse sand and gravel below high water adjacent to and north of groin at south limit.

(8) Protective Structures: Deteriorated riprap revetment along the toe of lawn. A riprap groin at the south limit.

(9) Character of Development: A public park.

E. Calf Pasture Beach Park

(1) Location: Eastern and outer end of Calf Pasture Point.

(2) Shore Length: Approximately 3,300 feet.

(3) Beach Width Above H. W.: 75 to 100 feet along the east shore north of the riprap groin. Varies between 0 and 150 feet around the outer end of Calf Pasture Point with the greater width at the east side of groins. No beach fronting the bulkhead along the west side of the point.

(4) Ownership: City of Norwalk except for a few hundred feet of privately-owned shore adjacent to the park at the west side of the point.

(5) Beach Use: Public bathing beach.

(6) Public Facilities: Parking areas and new comfort station.

(7) Composition of Shore: Medium sand to gravel above and coarse sand to gravel below high water at the northeast end changing to fine sand above and medium sand below high water to the first groin to the south. Marsh in the foreshore in the vicinity of and west of the two most westerly groins at the outer end of the point. The beach above the marsh is sandy. The shore becomes coarser to the west of the groins as evidenced by increasing quantities of gravel and cobbles.

(8) Protective Structures: Riprap groin at southeast side and three timber groins along outer end. Steel sheet pile and timber bulkhead along privately-owned west shore to a wooden barge embedded in the shore. Some riprap along west side of timber groins.

(9) Character of Development: A public bathing beach and park. U. S. Coast Guard Station at west end of park. A pier and boat landing at the west side of the point.

F. Gregory Point

(1) Location: South end of point and shore along west side to opposite Fitch Point.

(2) Shore Length: 3,000 feet.

(3) Beach Width Above H. W.: 40 to 50 feet along about 200 feet of shore between groins at south side. Generally no beach above high water elsewhere.

(4) Ownership: Private.

(5) Beach Use: Private bathing beach at south end.

(6) Public Facilities: None. Private bathhouse and clubhouse at south end.

(7) Composition of Shore: Medium sand above and medium to coarse sand below high water at private bathing beach at south end. Gravelly foreshore along the west side of the point. A small sandy pocket beach just south of the shore road along the north end.

(8) Protective Structures: Two riprap groins at south end. Rubble masonry and concrete walls along the shore west of the groins along the south and west sides of the point.

(9) Character of Development: Private beach club at south end. Residential to the north.

G. Harborview

(1) Location: West side Norwalk River entrance from bridge east and south to marsh.

(2) Shore Length: 2,500 feet.

(3) Beach Width Above H. W.: None along the north shore. Varies between 0 and 40 feet along the east shore.

(4) Ownership: Private.

(5) Beach Use: Limited to residents.

(6) Public Facilities: None.

(7) Composition of Shore: Gravelly along north side. Coarse sand and gravel beach along the north half of the east shore. Fine sand above and coarse sand and gravel below high water along the south half of the east shore. A southward trailing spit at the south end. Marsh to the south and west of Harborview.

(8) Protective Structures: Rubble masonry and concrete walls front lawns and residences. Walls are highest around the northeast point and generally low along the east shore to the south.
(9) Character of Development: Residential.

H. Manrissa Island
(1) Location: West side of Norwalk River entrance south of Harborview.
(2) Shore Length: Approximately 4,000 feet.
(3) Beach Width Above H. W.: Generally none except east of the pier or groin at the southeast part of the island.
(4) Ownership: Private.
(5) Beach Use: None.
(6) Public Facilities: None.
(7) Composition of Shore: Marshland around the northern part of the island. A sandy beach east of the most easterly pier or groin on the south shore. Marshy foreshore along the south side of the island with occasional outcrops of bedrock through the marsh. Generally marshy along the east and west shores.
(8) Protective Structures: A low rubble masonry wall along the south and west shores. Two rubble masonry piers or groins near the east end of the south shore.
(9) Character of Development: Manrissa Institute (a church institution). Property recently acquired by Connecticut Light and Power Company. Most buildings uninhabited.

I. Wilson Point
(1) Location: Entire shore including east side to point opposite Hoyt Island and west side to head of cove.
(2) Shore Length: Approximately 8,800 feet.
(3) Beach Width Above H. W.: Small sandy pocket beach 20-30 feet wide and about 200 feet long along the south side of the east shore projection about 1,200 feet northeast of the tip of Wilson Point. Generally no sand beach elsewhere.
(4) Ownership: Private.
(5) Beach Use: Private bathing beach (Wilson Point Association) at the sandy pocket described in (3) above.
(6) Public Facilities: None. Clubhouse at the association beach.
(7) Composition of Shore: The west shore and the east shore north of the first projection north of the southerly tip are generally marshy. Rock outcrops occur at a number of locations along

the east shore. Protective structures generally line the east shore from the south tip to the first shore projection to the north. The pocket beach at the south side of this projection between rock outcrops is composed of medium sand above and coarse sand below high water.

(8) Protective Structures: Rubble masonry walls generally line the east shore from the outer tip northward to the first shore projection. Heavy riprap revetment fronts the wall along the east side of the outer tip. Concrete piers and timber piles, the remains of a wharf along the west side of the tip of the point. Two rows of deteriorated timber piles along the west shore. Riprap revetment above the marshy foreshore landward of the old piles along the west shore.

(9) Character of Development: Residences and beach club along the east shore. Oil receiving wharf at the outer tip with pipelines extending northward along the west shore.

J. Wilson Cove

(1) Location: West shore north of bridge connecting to Bell Island.

(2) Shore Length: Approximately 4,000 feet.

(3) Beach Width Above H. W.: Generally no sandy beach except for small pockets.

(4) Ownership: Private.

(5) Beach Use: Bathing at small sandy pocket adjacent to the bridge at the south end.

(6) Public Facilities: None. Bathhouses at private commercial bathing beach at south end (Hickory Bluff Beach).

(7) Composition of Shore: Most of the shore is lined with marsh. The bottom of the cove is muddy. Bedrock is exposed along the south end of the area where there is generally no beach above high water in front of walls except for a sandy pocket beach about 100 feet long north of the bridge.

(8) Protective Structures: Residences fronted by rubble masonry sea walls which are low north of the Norwalk Yacht Club (at the pier about 700 feet north of bridge) and higher south of the club. The Bell Island bridge embankment is protected by sloped stone paving set in mortar.

(9) Character of Development: Residences, yacht club and commercial bathing beach.

K. Bell Island

(1) Location: Bell Island bridge to and including Pine Point.

(2) Shore Length: Approximately 6,000 feet.

(3) Beach Width Above H. W.: Pocket beach east shore, 20' ±. Pocket beach adjacent to and east of Pine Point 20-30 feet. Little or no sand beach elsewhere.
(4) Ownership: Private. Bell Island Improvement Association.
(5) Beach Use: Bathing by association members.
(6) Public Facilities: None
(7) Composition of Shore: An irregular bedrock shore with sand only in pockets or indentations. Fine to medium sand above and medium to coarse sand below high water in the east shore pocket beach. In the small pocket west of and adjacent to Noroton Point there is fine sand above and coarse sand below high water and finer sand, boulders and other coarse material immediately seaward in the nearshore zone. In the larger pocket beach east of Pine Point there is fine to medium sand above high water while below high water the material varies from coarse sand at the east end to gravel at the west end.
(8) Protective Structures: An irregular system of rubble masonry walls along the north and east shore. High rubble masonry walls around Pine Point and the first point to the east and a low rubble masonry wall behind the intervening pocket beach. Timber piles, the remains of a pier at the outer end of Pine Point. Stone pier at outer end and stone groin nearer inshore end of west side of first point west of Noroton Point. Light stones, probably revetment front Pine Point walls.
(9) Character of Development: Residential.

L. Roton Point Park
(1) Location: West of Pine Point to and including Roton Point.
(2) Shore Length: 1,000 feet.
(3) Beach Width Above H. W.: 40-50 feet in the pocket between Pine and Roton Points. No sand beach elsewhere.
(4) Ownership: Private.
(5) Beach Use: Bathing beach at amusement park.
(6) Public Facilities: None. Private bathhouse, fireplaces and benches.
(7) Composition of Shore: Fine to medium sand above and coarse sand below high water in the pocket beach between bedrock points. Gravel and boulder foreshore around Roton Point.
(8) Protective Structures: A low rubble masonry wall behind the sand pocket beach. A higher rubble masonry wall around Roton Point fronted along

south and west shore by riprap revetment. A riprap groin at Roton Point at the west end of the pocket beach.

(9) Character of Development: An amusement park and bathing beach.

M. Bailey Beach

(1) Location: West of and adjacent to Roton Point.
(2) Shore Length: 350 feet.
(3) Beach Width Above H. W.: 50-70 feet.
(4) Ownership: 6th Taxing District of the city of Norwalk.
(5) Beach Use: Public bathing beach.
(6) Public Facilities: Parking area, fireplaces, benches and concession stand.
(7) Composition of Shore: Fine to medium sand above and coarse sand below high water.
(8) Protective Structures: Low concrete wall behind the beach.
(9) Character of Development: Public bathing beach.

N. Wee Burn Beach Club and Rowayton Beach Association

(1) Location: Between Bailey Beach and Fivemile River.
(2) Shore Length: 1,200 feet.
(3) Beach Width Above H. W.: 80-90 feet along Wee Burn Beach Club and 60-90 feet in the sandy pocket adjacent to Fivemile River (Rowayton Beach Association, Inc.)
(4) Ownership: Private.
(5) Beach Use: Private bathing beaches.
(6) Public Facilities: None. Private bathhouses and clubhouse in the east pocket beach (Wee Burn Beach Club).
(7) Composition of Shore: Fine to medium sand above and coarse sand below high water. Some gravel below high water in the east pocket. Bedrock exposed at Fivemile River and between the two pocket beaches.
(8) Protective Structures: Rubble masonry walls behind sand beaches and around rocky point at river mouth - the latter, higher walls, fronted by heavy riprap revetment.
(9) Character of Development: Beach club and private association bathing beach with residences well behind the shore.

Darien

O. Butler and Contentment Islands

(1) Location: Entire south shore from Fivemile River to Scott Cove.
(2) Shore Length: Approximately 7,500 feet.

(3) Beach Width Above H. W.: Generally no sand beach except in pockets. The east pocket between Butler and Contentment Islands (Tokeneke Club area) varies between 50 and 100 feet. The pocket at the west end of Contentment Island is 20-40 feet wide.
(4) Ownership: Private.
(5) Beach Use: Bathing at east pocket (Tokeneke Club). Probably limited bathing by area residents at smaller pocket beaches.
(6) Public Facilities: None. Private bathhouses and clubhouse in east pocket beach.
(7) Composition of Shore: An irregular bedrock shore with sand beaches held only in pockets. The largest pocket at the Tokeneke Club consists of fine sand above and medium to coarse sand and gravel below high water with some marsh and mud in the foreshore at its east end. There are a number of smaller sandy pocket beaches to the west, the largest near the southwest end of Contentment Island.
(8) Protective Structures: Rubble masonry and concrete walls front portions of the residential development along Butler Island. A riprap groin to bedrock offshore at Tokeneke Club. Rubble masonry walls normal to shore acting as groins, mark east and west limits of club. Occasional rubble masonry walls west of club along Contentment Island, generally at sandy pocket beaches.
(9) Character of Development: Large widely spaced residences generally set well behind the shore. A beach club and private bathing beach in the easterly pocket.

P. Great and Hay Islands:
(1) Location: The east and south shores of the islands including the east shore of the causeway to Hay Island.
(2) Shore Length: Approximately 7,000 feet.
(3) Beach Width Above H. W.: Generally none. A small sandy pocket on Great Island about 20 feet wide and 100 feet long.
(4) Ownership: Private.
(5) Beach Use: Limited private use.
(6) Public Facilities: None.
(7) Composition of Shore: An irregular bedrock shore fronted in many places by marsh. A gravelly beach accumulated at the south side of the Hay Island causeway.

(8) Protective Structures: Most of shore unprotected. Low rubble masonry walls at sandy pocket beach at Great Island. Higher rubble masonry wall along edge road and boat landing at private small boat harbor at south side of Great Island. The Hay Island causeway is lined with rubble masonry walls and it is protected by a riprap mound along its soundward side.

(9) Character of Development: A large estate on Great Island. One residence on Hay Island.

Q. Long Neck Point

(1) Location: Between the shore end of the Hay Island causeway on the east side to the south limit of Peartree Point on the west side.

(2) Shore Length: 6,700 feet.

(3) Beach Width Above H. W.: Generally none fronting sea walls. A 20-30 foot gravelly beach fronts walls on east side along about 1,300 feet of shore south of rock outcrop to the Sacred Heart Academy property. Small accumulations elsewhere on south side of solid fill structures.

(4) Ownership: Private.

(5) Beach Use: Limited to residents.

(6) Public Facilities: None.

(7) Composition of Shore: Gravelly beach on east side north of Sacred Heart Academy. Sand and gravel beach impounded on west side south of Academy pier. Foreshore generally coarse in composition. Bedrock exposed at one point on east side.

(8) Protective Structures: An almost continuous system of rubble masonry and concrete walls extends around the point. A riprap mound recently constructed a few feet in front of the sea wall around the entire outer portion of Long Neck Point at the Sacred Heart Academy. The bluff along the north end of the east side of the Academy property above the sea wall recently revetted with stone slope paving.

(9) Character of Development: Large residences generally well behind the shore. A few small boat piers. Sacred Heart Academy at outer end.

R. Peartree Point

(1) Location: Entire Darien River shore of Peartree Point.

(2) Shore Length: 1,200 feet.

(3) Beach Width Above H. W.: South Beach is about 90-100 feet wide. The spit trailing northward is about 60-70 feet wide.

(4) Ownership: Public. Town of Darien.

(5) Beach Use: Public bathing beach except for the outer end of the spit which is leased to the Darien Boat Club.

(6) Public Facilities: Bathhouse, parking area and fireplaces.
(7) Composition of Shore: South Beach consists of medium to coarse sand above and coarse sand and fine gravel below high water. The spit consists of fine to coarse sand and gravel above and coarse sand and gravel below high water. There is an outcrop of bedrock at the west end of South Beach.
(8) Protective Structures: A riprap groin normal to the shore at the west end of South Beach and a riprap breakwater extending northwest from vicinity of bathhouse. A timber bulkhead at boat club on spit and a short timber groin at south side of end of spit. An open pile pier at end of spit.
(9) Character of Development: A public bathing beach and a boat club.

S. Noroton Neck
(1) Location: From Darien River entrance opposite Peartree Point, south and west to Pratt Island causeway and north along west shore to Weed Beach.
(2) Shore Length: Approximately 3,000 feet.
(3) Beach Width Above H. W.: Varies irregularly from 0 to about 50 feet along the east and south shore. On the west shore the width increases northward from no beach at the long pier to over 100 feet at the north limit of the Noroton Bay Association Beach and it is 40-50 feet in front of cottages north of this beach.
(4) Ownership: Private.
(5) Beach Use: Private bathing beach on west side north of the pier with use restricted to Noroton Bay Association members.
(6) Public Facilities: None.
(7) Composition of Shore: Sandy beach above and gravelly below high water opposite Peartree Point. Beach on west side north of pier is composed of medium sand above high water and is marshy and gravelly below high water. Marsh east of Pratt Island causeway.
(8) Protective Structures: The east and south shore is protected by an irregular system of rubble masonry, loose stone, and concrete walls, riprap, rubble masonry, concrete and timber groins. There is steel sheet piling around the Darien Yacht Club. On the west shore, north of the pier, there is a rubble masonry wall along the edge of the road.
(9) Character of Development: Residential along the east and south shore with a yacht club at the pier at the southeast point. A private bathing beach along the west shore.

T. Pratt Island

(1) Location: The entire land area south of Noroton Neck.
(2) Shore Length: Approximately 5,500 feet.
(3) Beach Width Above H. W.: None except in pockets along west side of island.
(4) Ownership: Private.
(5) Beach Use: Probably limited use by residents.
(6) Public Facilities: None.
(7) Composition of Shore: An irregular shore composed largely of bedrock and marsh. The pocket beach on the west side of the causeway consists of fine sand above and medium to coarse sand below high water.
(8) Protective Structures: The causeway is revetted with riprap on both sides. Lawns at residences are protected by rubble masonry and concrete walls. Rubble masonry and concrete groins on the east side.
(9) Character of Development: Residential.

U. Weed Beach

(1) Location: West side of Noroton Neck south of the Holly Pond dam.
(2) Shore Length: 1,800 feet.
(3) Beach Width Above H. W.: Up to about 50 feet fronting vegetation covered dune along south part of beach south of rock outcrop and narrower to the north.
(4) Ownership: Town of Darien and private.
(5) Beach Use: Formerly a commercial bathing beach. To be developed by town of Darien into a public bathing beach.
(6) Public Facilities: None.
(7) Composition of Shore: From the south limit to the first rock outcrop the beach consists of medium sand above and coarse sand and gravel below high water with gravel and marsh at the low water line all fronting a grass and bush covered dune. The beach to the north is a bar fronting marsh. It is composed of medium to coarse sand above high water and is marshy and gravelly below high water. There are some small rock outcrops at the north end of the area.
(8) Protective Structures: Remains of a riprap groin at the south end. Two riprap spur jetties near the pond entrance. A low concrete wall fronts a lawn at the north end.
(9) Character of Development: Public shore to be developed into a public bathing beach. One residence at the north end.

Stamford

V. Cove Island
(1) Location: Entire south shore from tip of spit at east end to entrance of canal-like waterway at west side of island.
(2) Shore Length: 4,200 feet.
(3) Beach Width Above H. W.: Spit at each end up to 100' wide. Generally no sand beach west of spit in front of seawall along east side of island and around the southeast tip of the island. A sandy beach up to 50 feet wide in the pocket between the two southerly points.
(4) Ownership: City of Stamford.
(5) Beach Use: None. City plans to develop a public bathing beach.
(6) Public Facilities: None.
(7) Composition of Shore: The spit at the east end consists of sand and gravel with a marshy gravelly foreshore. There is little or no sand beach above high water west of the spit to and around the southeast tip of the island. The southeast tip consists of bedrock. The pocket beach between the two south tips of the island consists of fine to medium sand above and coarse sand and gravel below high water with offshore flats of silt, fine sand and gravel. There is some marsh in the foreshore of the west end of this pocket and bedrock at the southwest tip of the island surrounded by marsh covered with gravel and cobbles.
(8) Protective Structures: Riprap and steel boilers along the top of the spit. A wide band of riprap west of the spit to a rubble masonry wall which fronts the east side of the island. The wall is fronted by riprap. An old riprap jetty at the southeast tip of the island. Riprap at the west end of the island extends out toward the west tip.
(9) Character of Development: Formerly one estate. An old residence near the southeast tip. A few residences at the north end of the island. The island to be developed into a public park.

W. Cove Harbor
(1) Location: West of Cove Island to Green-A-Way Island bridge.
(2) Shore Length: 2,500 feet.
(3) Beach Width Above H. W.: The east end is a sandy beach of varying width fronting and along a marshy shore. The high water beach fronting residences is generally not more than 50 feet

wide with sand only in small pockets between groins. No beach fronting walls and riprap east of and adjacent to Green-A-Way Island bridge.

(4) Ownership: Mostly private. East end of area belongs to city of Stamford.
(5) Beach Use: Probably limited use by residents.
(6) Public Facilities: None.
(7) Composition of Shore: Cobbly shore at extreme east end (no sand) fronted by marsh. From east end to residences beach consists of medium sand above and coarse sand and gravel below high water. Shore fronting residences covered with gravel and cobbles with small sandy pockets above high water only between groins. A marshy foreshore along the west end of the area. A few rock outcrops along the residential development both on and offshore.
(8) Protective Structures: The residential area is protected by rubble masonry walls, riprap revetment, riprap and rubble masonry groins.
(9) Character of Development: Large widely spaced residences set well behind the shore except for undeveloped easterly 1,000 feet of shore on which there is one cottage at the east end.

X. Green-A-Way Island
(1) Location: Entire shore of island.
(2) Shore Length: 1,600 feet.
(3) Beach Width Above H. W.: No sand beach.
(4) Ownership: Private.
(5) Beach Use: None.
(6) Public Facilities: None.
(7) Composition of Shore: Bedrock shore.
(8) Protective Structures: Riprap breakwater offshore. Concrete capped rubble masonry pier. Rubble masonry wall.
(9) Character of Development: Large residence.

Y. Westcott Cove
(1) Location: Green-A-Way Island bridge to east limit of Cummings Park.
(2) Shore Length: 2,500 feet.
(3) Beach Width Above H. W.: Varies. Little or no sand beach along marshy east half of shore. A sandy beach about 100 feet wide along the west half of the area except in front of sea walls adjacent to Cummings Park where width varies irregularly from 0 to 60-70 feet, the greater width impounded on the east side of groins.
(4) Ownership: Private.
(5) Beach Use: Limited to area residents.
(6) Public Facilities: None.

(7) Composition of Shore: A low marshy shore area with occasional rock outcrops along the east end and a sandy beach along the west half. Sand beach fronted by marsh. Beach above high water in vicinity of first street end east of Cummings Park consists of fine to medium sand.

(8) Protective Structures: A riprap dike across the entrance of a low marshy area near the east end. Concrete and rubble masonry walls and rubble masonry groins along the west end of the area adjacent to Cummings Park. Riprap in front of the concrete wall.

(9) Character of Development: Residential. A new residential development set well behind the central portion of the area. One cottage near the shore at the east end and residences close to the shore behind the sea walls at the west end.

Z. Cummings Park

(1) Location: Between east limit and jetty at entrance to boat basin.

(2) Shore Length: 1,300 feet.

(3) Beach Width Above H. W.: About 100 feet at the east end and 75-100 feet fronting the parking lot west of the bathhouse. One corner of the bathhouse is close to the high water line.

(4) Ownership: City of Stamford.

(5) Beach Use: Public bathing beach.

(6) Public Facilities: Parking, refreshment stand, playgrounds. The bathhouse is deteriorated and not in use.

(7) Composition of Shore: Fine to medium sand above high water at the east end. Medium to coarse sand above high water at the west end. Mud flats reported below low water opposite the central part of the beach.

(8) Protective Structures: Riprap groin near center of beach and riprap jetty at boat basin entrance.

(9) Character of Development: A public park and bathing beach.

AA. West Beach

(1) Location: North from timber groin at south limit of public beach to and along west shore of boat basin entrance.

(2) Shore Length: 500 feet.

(3) Beach Width Above H. W.: Sandy area about 300 feet wide at north end, about 60 feet fronting the bathhouse and over 100 feet at the south end.

(4) Ownership: City of Stamford.
(5) Beach Use: Public bathing beach.
(6) Public Facilities: Bathhouses and parking area.
(7) Composition of Shore: Medium to coarse sand above high water.
(8) Protective Structures: A timber groin at the south limit.
(9) Character of Development: A public bathing beach.

BB. Westcott Cove (West Shore)
(1) Location: South from West Beach.
(2) Shore Length: 2,500 feet.
(3) Beach Width Above H. W.: Varies. Along commercial beaches at north end beach is about 50 to 200 feet wide with greater width at south side of groins. Little or no high water beach to the south except for small pockets or fillets held at south side of groins. A small pocket beach at the south limit about 50 feet wide and 150 feet long.
(4) Ownership: Private
(5) Beach Use: Bathing at commercial beaches at north end. Use of remainder of shore limited to residents.
(6) Public Facilities: None. Private bathhouses at commercial beach.
(7) Composition of Shore: Fine to medium sand above high water. Bedrock exposed at the north end of the small pocket beach near the south limit of the area.
(8) Protective Structures: Timber groin at south end of most northerly commercial beach. Rubble masonry and riprap groin at south end of other commercial beach. An irregular system of rubble masonry and concrete walls to the south fronted by a series of rubble masonry and concrete groins.
(9) Character of Development: Two commercial bathing beaches at the north end. Residential development to the south.

CC. Shippan Point (East Side)
(1) Location: North from Shippan Avenue
(2) Shore Length: 4,600 feet.
(3) Beach Width Above H. W.: None around the easterly projecting point at the north end of the area. A sandy beach up to 100 feet wide extends about 1,000 feet southward from the point. Generally no sand beach along the remainder of shore except for small area on north side of groin at Shippan Avenue.
(4) Ownership: Private except for city-owned street ends.

(5) Beach Use: Private bathing beach at sandy shore. Limited use elsewhere.
(6) Public Facilities: None. Beach club and bathhouses at private bathing beach.
(7) Composition of Shore: Medium sand above and coarse sand and gravel below high water at the north end of the private bathing beach. A boulder covered shore south of the sand beach except for coarse sand and gravel adjacent to the groin at the south limit and in patches along the bouldery shore for a short distance north of the south limit. Bedrock outcrops at the tip of the point at the north end and also a few hundred feet to the south of the point.
(8) Protective Structures: Concrete and rubble masonry walls fronted by riprap along the north end of the area. A timber and riprap groin near the southern end of the private bathing beach and a combination timber and stone wall and groin at its north limit. Considerable riprap revetment along the foot of a bluff and short lengths of concrete and rubble masonry walls along the southerly part of the shore. Also one concrete groin and a rubble masonry groin, the latter at the south limit.
(9) Character of Development: Large residences and a private beach club.

DD. Shippan Point (East Side)
(1) Location: Shippan Avenue to and around the tip of Shippan Point.
(2) Shore Length: 3,200 feet.
(3) Beach Width Above H. W.: None except along 900 feet of the shore located about 500 to 1,400 feet north of the tip of the point where the beach width varies from 20 to 50 feet.
(4) Ownership: Private except for city owned street end.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: Mostly gravel to boulders with coarse sand in patches on the north side of groins. The beach described in (3) above consists of fine to medium sand above and coarse sand and gravel below high water.
(8) Protective Structures: A continuous system of concrete and rubble masonry walls and groins. Some of the walls are fronted by riprap revetment. The riprap is particularly heavy fronting the wall around the tip of the point.
(9) Character of Development: Residential.

EE. Shippan Point (West Side)

(1) Location: Tip of Shippan Point to opposite Jack Island.
(2) Shore Length: 6,100 feet.
(3) Beach Width Above H. W.: Varies irregularly between 0 and 100 feet with larger width on south side of groins.
(4) Ownership: Private except for city owned street ends.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: Marshy, gravelly, medium sand foreshore along south end. Most of shore to the north consists of coarse sand and gravel below high water with sandy fillets or pockets at the south side of groins. Gradation of beach finer with less gravel from Stamford Yacht Club southward for about 1,000 feet. Less sandy beach above high water north of the Stamford Yacht Club where the foreshore is gravelly and contains some marsh. A stubby northward trailing spit at the north end consists of coarse sand above and gravel below high water.
(8) Protective Structures: Rubble masonry and concrete walls line most of the shore. Riprap revetment fronts wall at south end. A system of closely spaced groins of timber, riprap, rubble masonry and concrete throughout the area impound material on their south sides.
(9) Character of Development: Residential and yacht and beach clubs.

FF. Dyke Park

(1) Location: At Cemetery Point.
(2) Shore Length: 2,200 feet.
(3) Beach Width Above H. W.: Generally no sand beach except for a short length of shore 20-30 feet wide along the west side of the point.
(4) Ownership: City of Stamford.
(5) Beach Use: Public bathing beach.
(6) Public Facilities: Playing field, swings, benches, slides, etc.
(7) Composition of Shore: Marshy along the south and east sides of the point. Fine to medium sand above and coarse sand and gravel below high water at the bathing beach at the west side of the point.
(8) Protective Structures: Row of dumped stones at southwest tip of point acts as a groin. Riprap and low walls behind the sand beach.
(9) Character of Development: A public playground and bathing beach.

GG. Southfield Park

(1) Location: West side of Stamford Harbor.
(2) Shore Length: 500 feet.
(3) Beach Width Above H. W.: Varies from north to south between 0 and 30 feet.
(4) Ownership: City of Stamford.
(5) Beach Use: Public bathing beach.
(6) Public Facilities: None.
(7) Composition of Shore: Medium sand above and coarse sand below high water. Several bedrock outcrops. Some marsh in foreshore. Boulders, gravel, weeds, moss and silt below low water.
(8) Protective Structures: Riprap groin at north end.
(9) Character of Development: A public bathing beach and small boat basin.

HH. Cook and Davenport Points

(1) Location: Between Southfield Park and east end of pocket beach on west side of Davenport Point.
(2) Shore Length: 3,500 feet.
(3) Beach Width Above H. W.: None.
(4) Ownership: Private.
(5) Beach Use: None.
(6) Public Facilities: None.
(7) Composition of Shore: Coarse sand and gravel shore behind riprap mound at north end. Exposed bedrock at tip of Davenport Point and at first point to the north. High water generally at walls and riprap.
(8) Protective Structures: A riprap mound and an irregular system of rubble masonry walls line the shore with riprap along the front of walls which generally face open water to the south.
(9) Character of Development: Residential.

II. Peck Point

(1) Location: Between west side of Davenport Point and the tip of Cummings Point.
(2) Shore Length: 5,000 feet.
(3) Beach Width Above H. W.: Narrow sandy beach between Peck and Davenport Points. None around east side and south end of Peck Point. Beach width varies irregularly from 0 to over 100 feet along the west side of Peck Point and westward to the base of Cummings Point with greater width at east side of groins. None along the east side and outer end of Cummings Point.
(4) Ownership: Private.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.

(7) Composition of Shore: Sandy pocket beach east end. Medium sand above and coarse sand below high water along the sandy shore along west side of Peck Point to Cummings Point. Bedrock outcrops along east side and outer end of Cummings Point.

(8) Protective Structures: Concrete wall faced with granite blocks around east side and outer end of Peck Point to a stepped groin of similar construction. Riprap revetment along west side Peck Point north of stepped groin. Rubble masonry and steel sheet pile groins and pier along sandy beach to the west. Low dry stone and rubble masonry walls front lawns west of Peck Point to and along Cummings Point.

(9) Character of Development: Residential. Large houses set well behind the shore.

Greenwich

JJ. Old Greenwich

(1) Location: East shore between Stamford-Greenwich boundary and north limit of the park at Greenwich Point.

(2) Shore Length: 8,500 feet.

(3) Beach Width Above H. W.: Generally no sand beach.

(4) Ownership: Private.

(5) Beach Use: Limited to residents.

(6) Public Facilities: None.

(7) Composition of Shore: Generally no sand beach above high water. Almost continuous bedrock shore along northerly 3,000 feet facing Stamford Harbor with a few small sandy pockets. Occasional outcrops of rock and small sandy pockets in shore indentations or at structures along the rest of the shore. Increasing amounts of marsh in the foreshore to the south.

(8) Protective Structures: The shore is lined with an almost continuous system of walls of rubble masonry, concrete, loose stone and rubble mound construction with walls lower along the south end of the area. A number of piers mostly along the north end. Two offshore riprap breakwaters and a stone groin along the south end. A solid concrete and riprap pier and a riprap groin in the central portion of the area along the shore oriented generally east and west.

(9) Character of Development: Residential. A private bathing club.

KK. Greenwich Point

(1) Location: Entire shore of the park.

(2) Shore Length: 16,400 feet.

(3) Beach Width Above H. W.: Along bathing beach at east side of point: about 100 feet wide north of the large bathhouse and 150 feet and more, including the dune, in front of parking areas south of the bathhouse. A small sandy beach up to 100 feet wide at the northwest tip of Greenwich Point at the Greenwich Cove entrance. Generally no sandy beach elsewhere.

(4) Ownership: Town of Greenwich.

(5) Beach Use: Public bathing beach along sandy east shore.

(6) Public Facilities: Bathhouse, comfort stations, parking and boat storage areas, fireplaces, picnic tables, boat club building with pier and float.

(7) Composition of Shore: Coarse sand above and marsh below high water along north end of east shore. Wide low water flats of medium sand along bathing beach from the vicinity of the bathhouse and south thereof with coarse sand above the flats and increasing amounts of gravel to a marsh and boulder covered shore at the southeast tip of Greenwich Point. The east half of the south shore is very coarse in composition with numerous boulders in the foreshore and offshore and considerable marsh in the foreshore while the beach above high water ranges from boulders to coarse sand, in places in the form of barrier bars fronting marsh. The coarse gravelly shore continues along the west half of the south side and along the west side of the point with the gradation finer to the north to a sandy beach at the northwest tip. The Greenwich Cove shore along the north and west sides of Greenwich Point is composed of marsh with a small amount of sand above the marsh along the causeway or neck along the north end.

(8) Protective Structures: Dumped stone fronting rubble masonry wall at bathhouse and concession stand (east shore). Dumped boulder revetment along a considerable portion of the east half of the south shore. Rubble masonry wall along edge of road at south shore south of large pond. Riprap protects the shore to the west of the wall along the south and west sides of the point, the revetment much heavier around the southwest tip. Riprap discontinued along about 400 feet of the west shore opposite small pond. North end of west shore protected by riprap and low dry stone wall.

(9) Character of Development: A large public park for bathing, boating and picnicking.

LL. Elias Point - Todd Point - Cos Cob Harbor

(1) Location: From the tip of Elias Point to Todd Point and the pier and boat slip at the Cos Cob Harbor entrance.
(2) Shore Length: Approximately 6,000 feet.
(3) Beach Width Above H. W.: None except in pockets. Pocket at west side Elias Point causeway 10-15 feet. Pocket beach west of and adjacent to Todd Point 15-20 feet.
(4) Ownership: Private.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: Exposed bedrock at tip of Elias and Todd Points and generally along the shore westward into Cos Cob Harbor. Fine to medium sand above and coarse sand and gravel below high water along the west side of Elias Point. Fine to coarse sand above high water in the pocket west of Todd Point.
(8) Protective Structures: Rubble masonry walls line the Elias Point causeway, the shore westward to Todd Point and the shore behind the pocket west of Todd Point. The pier with boat slip at the west end is earth filled behind a dry stone wall. A rubble masonry and concrete pier at the southwest point.
(9) Character of Development: Residential. Large houses well behind the shore. Open land newly subdivided into lots.

MM. Mead Point

(1) Location: From Cos Cob Harbor entrance opposite Goose Island to and around the tip of Mead Point and Brush Island.
(2) Shore Length: Approximately 9,500 feet (Excluding Saw and Horse Islands).
(3) Beach Width Above H. W.: No sand beach except in small pockets.
(4) Ownership: Private.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: An irregular shore characterized by numerous outcrops of bedrock. A small sandy pocket beach at the foot of Indian Field Road consists of medium to fine sand above and coarse sand and gravel below high water. Artificial filling connecting the mainland near the end of Mead Point to Brush Island and reclaiming marshy area along east side of Indian Harbor north of Brush Island in progress during May 1955.

(8) Protective Structures: Considerable portions of the shores of Saw and Horse Islands and the mainland north and east of the foot of Indian Field Road are lined with rubble masonry walls, generally low and fronting lawns near the water's edge. Considerable riprap piled at the end of Mead Point. A riprap jetty or breakwater from Mead Point part way across boat basin formed between the point and Brush Island.

(9) Character of Development: Residential. Large houses, mostly set well behind the shore.

NN. Benedict Point

(1) Location: The outer end of the point between Indian Harbor and Smith Cove.

(2) Shore Length: Approximately 1,800 feet (about 1,200 feet along east side and 600 feet along west side).

(3) Beach Width Above H. W.: No sandy beach.

(4) Ownership: Private.

(5) Beach Use: Limited to residents.

(6) Public Facilities: None.

(7) Composition of Shore: A bedrock point.

(8) Protective Structures: Concrete and dry stone walls protect lawns. A timber crib wharf and fender on east side.

(9) Character of Development: Large widely spaced residences.

OO. Steamboat Road Point

(1) Location: Outer end.

(2) Shore Length: Approximately 900 feet.

(3) Beach Width Above H. W.: None.

(4) Ownership: Private except for town pier at end of Steamboat Road.

(5) Beach Use: None.

(6) Public Facilities: Pier.

(7) Composition of Shore: Bedrock and stone fragments with small amounts of coarse sand and gravel in indentations.

(8) Protective Structures: High rubble masonry walls along the east and west sides. Rubble masonry and dry stone wall around solid pier capped with concrete.

(9) Character of Development: Yacht Club at west side of outer end of Point. Residential northward along east shore. Commercial harbor area northward along west side.

PP. Field Point

(1) Location: The east and west shores including Round Island at the Greenwich Harbor entrance and the shore to the start of the sandy beach at the head of the cove on the west side.

(2) Shore Length: 5,600 feet.
(3) Beach Width Above H. W.: Generally none. A small sandy pocket on south side of Round Island up to 50 feet wide and about 300 feet long.
(4) Ownership: Private.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: Bedrock and rock fragments at Round Island. A small sandy pocket beach at the south side of Round Island. A marshy and gravelly shore with scattered boulders to the south of the pocket beach. Bedrock at the first projection south of Round Island and along the shore to and around the south tip of Field Point, the bedrock in places exposed continuously. Composition coarser around the south end. No marsh at the outer tip. Marsh in the foreshore near the head of the pocket or cove along the west side along with boulders, cobbles, gravel and small amounts of coarse sand.
(8) Protective Structures: Portions of the bluffs along the east and west shores are protected by loose stone or rubble masonry walls or riprap revetment. Rubble masonry walls south of Round Island are exceptionally high. Many open piers along the shore.
(9) Character of Development: Large residences set well behind the shore.

QQ. Belle Haven
(1) Location: From east end of pocket beach adjacent to Field Point westward to Byram Harbor.
(2) Shore Length: 4,100 feet.
(3) Beach Width Above H. W.: About 60 feet at the sandy pocket adjacent to Field Point. Little or no beach fronting walls elsewhere.
(4) Ownership: Private.
(5) Beach Use: Private beach club at east end.
(6) Public Facilities: None.
(7) Composition of Shore: Medium sand above and coarse sand below high water at pocket beach at east end. A generally coarse shore to the west with occasional outcrops of bedrock and some marsh in the foreshore.
(8) Protective Structures: Shore generally lined with rubble masonry walls. Dry stone walls enclose a small boat basin at the east side of the Belle Haven shore.
(9) Character of Development: Private beach club and yacht club along east shore. Large private residences along the south and west shore.

RR. Byram Park

(1) Location: West side of Byram Harbor.
(2) Shore Length: 1,200 feet.
(3) Beach Width Above H. W.: Bathing beach along northerly 300 feet varies from about 150 feet at north limit to 75-100 feet in front of the bathhouse and no beach at the south end. The rest of the park area is a muddy cove with generally no beach fronting walls above high water.
(4) Ownership: Town of Greenwich.
(5) Beach Use: Public bathing beach at north end. Small boat storage area and boat basin along cove south of bathing beach.
(6) Public Facilities: Bathhouse.
(7) Composition of Shore: Fine to coarse sand above and coarse sand, gravel and rock fragments below high water along north end. Muddy shore and bottom in cove south of bathing beach.
(8) Protective Structures: Rubble masonry groin at north end and a shorter concrete capped stone groin at the south end of the bathing beach. Stone wall along shore to the south.
(9) Character of Development: A public bathing beach and small boat basin.

SS. Byram Shore

(1) Location: Between Byram Park and Byram Point.
(2) Shore Length: Approximately 8,000 feet.
(3) Beach Width Above H. W.: Generally none except in small pockets and at Byram Point at the south end which has a width of sandy beach fronting a lawn of up to about 150 feet.
(4) Ownership: Private.
(5) Beach Use: Limited to residents.
(6) Public Facilities: None.
(7) Composition of Shore: Mud flats at low water at the north end in the vicinity of Huckleberry and Shore Islands. Shore characterized by rock outcrops to the south with water generally at sea walls at high tide. At the south end at Byram Point, there is a fine to medium sand beach above high water and medium sand, gravel and cobbles below high water.
(8) Protective Structures: Dry stone and rubble masonry walls protect part of the shore. There are many light piers along the shore. A riprap jetty at the tip of Byram Point.
(9) Character of Development: Residential.

TT. Little Captain Island (Island Beach)

(1) Location: In Long Island Sound opposite Greenwich Harbor.

(2) Shore Length: Approximately 1,700 feet.

(3) Beach Width Above H. W.: Sand beach along north shore about 100' wide at east end at pier, decreases westward to 15' ± and then increases to 50' ± at west end at groin. Along east shore sand beach about 50' wide near pier and decreases southward to no beach at south end. No sand beach along south and west shores.

(4) Ownership: Town of Greenwich.

(5) Beach Use: Public bathing beach.

(6) Public Facilities: Bathhouse, restaurant, pavilion and pier.

(7) Composition of Shore: Sandy beach along the north and east shore. A coarse gravelly boulder strewn shore along the south and west side of the island with high water generally at protective structures.

(8) Protective Structures: A rubble masonry wall behind the sand beach and in the vicinity of the bathhouse along the north and east shores. A steel sheet pile bulkhead along the south and west shore fronted throughout most of its length by riprap and by masonry slope paving at its east end. A riprap groin at the west end of the north shore.

(9) Character of Development: A public park and bathing beach.

APPENDIX B

GEOLOGY

1. General. - The shore line of Connecticut is the result of a complicated series of geological changes. One of these changes led to the erosion of a lowland known as the Sound Lowland. This erosion was interrupted by a climatic change which resulted in the formation of a great ice sheet. This ice sheet or glacier, moving under the impulse of gravity, carried a tremendous amount of debris gathered from the country over which it passed. In Connecticut, it scraped away almost all of the thick mantle of soil and decomposed rock in its path. Much of the material was strewn over the surface of the state as the glacier advanced and retreated and it forms the present unevenly distributed soil which varies in depth from 0 to 20 or more feet. In addition to glacial erosion and deposition, a subsidence of this region occurred which might have been due to the enormous weight of the ice sheet. When the ice disappeared, the Sound Lowland was below sea level and the invading waters separated Long Island from the mainland. These waters now constitute Long Island Sound.

2. Since the withdrawal of the glacier from Connecticut, there has been a change in the level of the land with respect to the level of the sea. This resulted in the submergence of land masses. The most recent submergence is estimated as about 20 to 25 feet. Since that period relative movements of the land and sea ceased and the relation of the elevation of the land to the waters of Long Island Sound has remained constant. The last change in level of the land masses with respect to the level of the sea resulted in the present day shore line of submergence having all the irregularities of such a shore line due to the drowning of coastal valleys.

3. Connecticut is at present in a period of erosion. Erosional forces are working to the reduction of land masses to a surface worn down nearly to a plain with streams transporting materials from the uplands to the lowlands. Along the coast waves attack the shore line tending to cut back all headlands, building and rebuilding bars and spits of materials from eroded headlands until a regular even shore line is produced.

4. The shore line of Connecticut is in a youthful stage of development. The bedrock along the shore even on the most exposed promontories, has not been so much as trimmed by wave erosion. Beaches around the headlands are composed of boulders and cobbles from the reworking of the local till and along the shores of embayments of sand and gravel from the reworking of the lowest

glaciolacustrine deposits left unsubmerged. These unconsolidated deposits have been gently cliffed and have retrograded but slightly while the stretches of bedrock have not been retrograded at all. The depositional shore features are derived almost entirely from the unconsolidated glacial deposits and are therefore best developed where the latter are most abundant.

5. The shore line of the study area gains its dominant traits from the occurrence of many hard rock outcrops at the waters edge. It is therefore more irregular and more lacking in depositional and erosional features than the shore adjoining it to the east. The Norwalk Islands off the mouth of the Norwalk River are composed of glacial debris and have therefore suffered extensive erosion. Material derived from their erosion has formed numerous depositional shore features. Long Neck and Shippan Points are the only shore line features between Norwalk and Stamford which do not owe their shape mainly to the outcropping of hard rock at the waters edge. Both points are at least surficially composed of glacial drift. Artificial filling has altered the natural depositional features of the outer end of Shippan Point. West of Stamford the shore is composed alternately of crystalline rock and drift with the characteristics of a crystalline shore line somewhat more prominent. Greenwich Point is the most noticeable feature of glacial origin and presents the typical, even, mature shore line of most forms composed of unconsolidated material. Depositional features are not as common as along shores composed largely of unconsolidated materials but good bathing beaches exist, frequently of the pocket beach type where the sand is held within the projections of two rock points.

APPENDIX C

TIDES

1. General Characteristics. - The tides along the shore of the State of Connecticut are of two types. The eastern sector from Watch Hill Point, Rhode Island, to Cornfield Point, Connecticut, is subject to the normal ocean or progressive wave type of tide which causes high water to occur at increasingly later times as it progresses from east to west. The western sector from Cornfield Point, Connecticut, to the entrance to East River, New York, is subject to the stationary wave type of tide which causes high and low waters to occur almost simultaneously at all points within this sector, while the range of tide increases in a fairly uniform manner from east to west.

2. Tidal Range. - Tidal range data for points along the shore of Connecticut are given in tide tables published by the United States Department of Commerce, Coast and Geodetic Survey. These are tabulated below:

Location	Mean Range	Spring Range	Reference Station	Time Interval
Stonington, F. Is. Sd.	2.7	3.2	New London	-0 35
Noank, Mystic R. Entrance	2.6	3.1	" "	-0 30
New London, State Pier	2.6	3.1	" "	0 00
Millstone Point	2.7	3.2	" "	+0 05
Saybrook Jetty	3.5	4.2	" "	+1 00
Duck Island	4.5	5.3	Bridgeport	-0 35
Madison	4.9	5.8	"	-0 30
Falkner Island	5.4	6.4	"	-0 25
Money Island, The Thimbles	5.6	6.6	"	-0 20
Branford Harbor	5.9	7.0	"	-0 15
New Haven Harbor, Entrance	6.2	7.3	"	-0 15
Milford Harbor	6.6	7.8	"	-0 10
Stratford, Housatonic River	5.5	6.5	"	+0 40
Bridgeport	6.8	8.0	"	0 00
Black Rock Harbor, Entrance	6.9	8.1	"	-0 05
Saugatuck River, Entrance	7.0	8.3	"	-0 05
South Norwalk	7.1	8.4	"	+0 10
Greens Ledge	7.2	8.5	"	-0 05
Stamford	7.2	8.5	"	0 00
Coscob Harbor	7.2	8.5	"	+0 05
Greenwich	7.4	8.7	"	0 00

3. Tidal Observations - New London, Bridgeport and Coscob. - A primary tide station is maintained by the United States Coast and Geodetic Survey at New London. Daily tidal observations at New London for a nine-year period, from June 12, 1938 to June 30, 1947, show that tides exceeded the height of the plane of mean high water by one foot or more 880 times, by two feet or more 44 times and by three feet or more 9 times. The average annual frequencies of these high tides during the above period were 98, 5 and 1, respectively, for tides 1, 2 and 3 feet or more in excess of the mean high water plane. Daily tidal observations were taken in Bridgeport Harbor during the periods from January 1911 to June 1915 and from July 1932 to October 1935. Analysis of these observations shows that the average annual frequencies of the high tides were 86, 6.5 and 0.7, respectively, for tides 1, 2 and 3 feet or more in excess of the mean high water plane. Comparison of the New London and Bridgeport observations indicates that the frequencies of occurrence and excess heights of extreme high tides are similar. The only daily tidal observations available within the study area are those taken at Coscob Harbor during May 1 - September 30, 1933. A comparison was made between corresponding high tides during the above period at Coscob and Bridgeport Harbors which exceeded the height of the plane of mean high water by one foot or more to determine whether variations from the mean range were alike. The largest difference between the variations was 0.3 of a foot and it occurred 6 times. A difference of 0.2 of a foot occurred 11 times, of 0.1 of a foot 33 times and the variation was exactly alike 13 times. The close agreement between the variations in tidal heights from the planes of mean high water at Coscob and Bridgeport indicates that observations at either location can be used for determining the height of extreme high tides at the other locations. Similarly, since the frequency and height of extreme high tides at Bridgeport are similar to those at New London, it is considered that observations at New London, for which a longer period of record is available are applicable to the study area.

4. Extreme Hurricane and Storm Tides. - Elevations of high water marks referred to the plane of mean low water have occurred as follows:

Location	Hurricane 21 Sept 1938	Hurricane 14-15 Sept 1944	Southeast Storm 25 Nov 1950	Northeast Storm 7 Nov 1953	Hurricane 31 Aug 1954
	High Water Elevations Above Mean Low Water				
Stonington	11.0	7.7	7.6		
Mystic	10.8				
Noank	10.3				
New London	11.1	7.6	8.1	7.1	10.5
Old Lyme				7.7	
Saybrook	13.4	8.0	8.75	9.5	10.8
Clinton			9.0	9.7	11.1
Branford	11.8		10.9		
New Haven	13.0		10.6	11.7	13.9
Milford			11.3	11.3	12.3
Housatonic R.				12.1	
Bridgeport	13.8		12.0	12.1	12.6
Southport	13.4				
Black Rock Hbr			12.2		
Saugatuck R.			12.0		
South Norwalk	11.6		12.1	12.8	13.3
Five Mile R.			12.1	12.3	
Rowayton	14.3				
Stamford	15.6		12.9		13.8
Greenwich	15.0		13.5	12.2	11.2

APPENDIX D

STORMS

1. Tropical Storms. - Hurricanes can be defined as tropical cyclones with a central barometric pressure of 29.0 inches or less and winds near the center 75 miles per hour or more in some points in the path. In the northern hemisphere they are known to consist of winds revolving in a counter-clockwise direction about a calm center or "eye." This calm center has an average diameter of approximately 14 miles. The diameter of hurricanes varies considerably, some being 50 to 75 miles; the majority greater in many instances exceeding 500 miles. Winds at the outer limits are usually light increasing to moderate and gusty toward the center, and they blow with great fury adjacent to the "eye." Hurricanes move bodily along a path in a motion of translation at an average speed of approximately 12 miles per hour. The greatest damage caused by these tropical cyclones to shore areas is due to the inundation which usually accompanies them. This is especially true where there is a bay to the right of the point where the hurricane center moves inland. The rise of water in Narragansett Bay, Rhode Island, during the hurricane of September 1938, which moved inland west of this bay is an example of the devastating effect which such a condition can engender. The strong currents created by hurricanes is an important factor in the destruction caused by such storms. Only a few hurricanes which have passed through the New England area are known to have caused considerable destruction. Ivan Ray Tannehill, in his book "Hurricanes," mentions ten which occurred between 1635 and 1944. The paths of several of these and some more recent ones are shown on Plate 2. The most destructive in New England struck on September 21, 1938 and August 31, 1954. Past hurricanes point to certain attendant characteristics which can be expected to result in great damage. The 1938 and 1954 hurricanes struck about normal to the shore line at a time when tides were high. The 1944 hurricane struck obliquely to the shore at low tide. The latter hurricane did not produce the inundation and consequent destruction which occurred during the former.

2. Hurricane of September 21, 1938. - On September 21, 1938, the New England area was struck by a devastating hurricane which originated around the Cape Verde Islands. It traveled in a curved path in a northwesterly and then northerly direction, arriving in the New England area during mid-afternoon of the 21st of September. It entered Connecticut with its center just west of New Haven at 3:30 p.m., E.S.T., and continued northward at 50 to 60 miles per hour. Its eye was clearly observed at New Haven. Winds that were easterly since noon died down between 3:00 and 4:00 p.m., and were then followed by increasing southwesterly winds. The region of strongest wind lay in the dangerous semi-circle about 75 miles to

the right of the storm center. Minimum barometric pressures were reported as follows: at Bridgeport 28.30 inches, at New Haven 28.11 inches at 3:50 p.m., at Hartford 28.04 inches at 4:17 p.m. They dropped gradually until noon, and then dropped rapidly to their lowest pressures until about 4:00 p.m. Pressures then rose rapidly until 8:00 p.m., when the noon pressure was attained, then rose gradually. Maximum wind veolcities in miles per hour for five minute periods and for gusts, respectively, were observed as follows: New Haven 38 and 46, Hartford 46 and 59, over an area 80 miles wide from Saybrook, Connecticut, to Marthas Vineyard, Massachusetts, 70 to 90 and probably in excess of 100. The precipitation directly attributable to the hurricane is difficult to determine due to the fact that it rained for two days before it reached New England. The total precipitation ranged from 2 to 5 inches along the Connecticut shore, the major portion of which was probably directly due to the storm. Tides rose above their predicted heights. Tidal heights were increased more to the east of thehurricane center than to the west because of the counter-clockwise wind rotation. Reported high tide during the hurricane occurred 2 to 2-3/4 hours before the time of predicted tide. The effect of the hurricane was an addition of about 9 to 10 feet to the predicted high tide at the entrance to Long Island Sound, this addition decreasing to 7 feet at Bridgeport and increasing to 9 feet at the west end of the Sound. Wave action accompanying the storm produced a devastating effect upon the shore line, pounding it mercilessly and resulting in widespread damage. Wave heights ranged from 10 feet at New London to 15 feet at New Haven and Bridgeport.

3. Hurricane of September 14-15, 1944. - On September 14, 1944, the New England area was struck by a tropical hurricane which originated in the West Indies. This hurricane traveled in a northwesterly then northerly direction to Cape Hatteras, thence swerved north northeast across Long Island, reaching the mainland in the vicinity of Westerly, Rhode Island about 11:00 P.M., E.S.T. From there, it proceeded northeastward across Providence, Rhode Island, and thence followed closely along the New England coast and passed over Newfoundland and out to sea. The greatest wind intensities occurred to the east of the storm center. The calm during the passage of the "eye" and the shift in the wind direction after its passage, were clearly noted at Westerly and Providence. The following minimum barometric pressures in inches were reported in the Connecticut area on September 14: New Haven 28.86 at 9:50 p.m.; Hartford 28.94 at 10:50 p.m.; Fishers Island 28.41 at 10:45 p.m.; Groton 28.40 at 11:00 p.m. Westerly 28.30 at 11:00 p.m.; Block Island 28.34 at 11:09 p.m. Maximum wind velocities in miles per hour for five minute periods and for gusts, respectively, were reported as follows: New Haven N 33 and NE 38, Hartford N 50 and N 62, Block Island SE 82 and SE 88, gusts only New London 70 and Westerly 75. Gusts were mostly estimated. Heavy rainfall was reported practically throughout the coastal portion of the Providence District, which extended from New York State to Cape Cod. In

Providence, a total of 4.49 inches fell from 5:55 p.m. to midnight on 14 September. Tides rose above their predicted heights. The hurricane effect occurred on the ebb tide from about 3 to 5 hours after predicted gravitational high water in the area from Watch Hill, Rhode Island to Woods Hole, Massachusetts.

4. Storm of November 25, 1950. - On November 25, 1950, the New England area was struck by an east to southeast storm which moved north northwestward from Virginia, reaching Connecticut during the early hours of the morning and continuing through Massachusetts until the early hours of the 26th. Interior Connecticut, nearer to the storm center, recorded gusts up to 100 miles per hour. Sustained five-minute winds of 34 miles per hour and greater were recorded at New Haven during each hour from 4:00 a.m. to 5:00 p.m. The prevailing wind direction was southeast. Maximum velocities recorded at New Haven were as follows: fastest mile, 57 m.p.h. and maximum gusts, 66 m.p.h. and 77 m.p.h. (5-second gust). The above maximums were probably exceeded between 8:00 p.m. and 9:00 p.m., a period for which no veolcities were recorded. The wind died down suddently after the above period. Heavy rainfall generally exceeding two inches occurred during the night of the 25th-26th in southern New England. Tides rose in Long Island Sound above their predicted heights. Flood tides which occurred about midday of the 25th exceeded predicted tides by about 5 feet from Bridgeport eastward along the Connecticut shore and up to 6 feet west of Bridgeport to Greenwich. At 9:18 p.m., on the 25th at New London, the flood tide reached 6.1 feet above its predicted height. The storm subsided before the time of high tide along the western part of Connecticut, and the night tides did not reach the maximum heights which occurred during midday. Shore damage along the Connecticut shore was widespread. The greatest amount of shore damage occurred west of New Haven. Wave action was exceptionally violent causing considerable destruction to coastal highways, sea walls, cottages and small craft.

5. Hurricane of August 31, 1954. - Hurricane Carol entered southern New England on August 31, 1954. It traveled in a north northeastward direction from a central position about 100 miles off the Virginia Capes at midnight of August 30th and swept over the extreme eastern end of Long Island nine hours later. Its center moved on a northward course up the Connecticut-Rhode Island border into east central Massachusetts. Sustained winds and gusts, respectively, were recorded as follows: New Haven 40 N and 65 N; Block Island 100 SE and 135 SE; Providence 90 ESE and 105; Nantucket 72 SE and 77 ESE; Boston 86 SE and 100 SE; Portland 69 E and 78 E. Minimum barometric pressures and total precipitation, respectively, were recorded in inches as follows: New Haven 28.77 (0910 EST) and 2.75; Block Island 28.40 (1000 EST) and 3.31; Providence 28.69 (1045 EST) and 2.79; Nantucket 29.32 (1100 EST) and 1.89; Boston 28.83 (1148 EST) and 2.60; Portland 29.15 (1412 EST) and 2.26. The hurricane was most violent during the morning

over the region extending eastward 100 miles from the center line of passage. Sustained hurricane winds ravaged extreme eastern Connecticut, Rhode Island and Massachusetts. Similar but lesser devastation occurred in the strip of Massachusetts and Connecticut west of the hurricane's center line to the Connecticut River. Damages from flooding occurred at low shore areas throughout Connecticut as a result of extremely high tides. Damages from wave attack were particularly severe only east of the Connecticut River, increasing in severity to the east with the greatest damages in the town of Stonington. Some damages due to wave attack occurred between New Haven and the Connecticut River at shore developments which were particularly vulnerable because of their locations at low beach areas. The greater part of all statewide losses resulted from water damage to industrial plants, business establishments and shorefront residences while east of the Connecticut River heavy losses resulted from damages to fishing and pleasure craft and harbor facilities and physical destruction of shorefront residences and bathing beach establishments.

6. Storm Data. - Summaries of records of winds equal to or greater than 40 miles per hour at New York City and 32 miles per hour at New Haven and Block Island, compiled from United States Weather Bureau data covering the periods indicated, are tabulated below:

Winds Equal To or Greater Than 40 Miles per Hour

New York City, N. Y., 1911-1947

Direction	Number	Percent of Total	Probable Number in 100 Years
N	73	5	197
NE	29	2	80
E	15	1	40
SE	44	3	118
S	117	8	316
SW	88	6	236
W	161	11	434
NW	934	64	2527
TOTAL	1461	100	3948

Winds Equal To or Greater Than 32 Miles Per Hour

New Haven, Connecticut, 1905-1947

Direction	Number	Percent of Total	Probable Number in 100 Years
N	38	15	88
NE	41	15	90
E	12	5	28
SE	24	9	56
S	40	15	93
SW	25	10	58
W	34	13	79
NW	46	18	107
TOTAL	260	100	599

Winds Equal To or Greater Than 32 Miles Per Hour

Block Island, Rhode Island, 1936-1945

Direction	Number	Percent of Total	Probable Number in 100 Years
N	78	10	780
NE	102	13	1020
E	63	8	630
SE	45	6	450
S	24	3	240
SW	35	4	350
W	117	14	1170
NW	341	42	3410
TOTAL	805	100	8050

7. Analysis of Storm Data. - From the observed data the probable 100-year frequency of occurrence of storm winds from various directions has been estimated. Storm winds occurring at New York and Block Island are similar in that they show a high preponderance in a northwest direction but their frequency of occurrence is not comparable since 40 mile per hour winds are listed for New York and 32 mile per hour winds are listed for Block Island. At New York City during 1947 there were 110 winds of 32 miles per hour or greater, as against only 42 winds equal to or greater than 40 miles per hour. Applying the ratio (110/42 = 2.6) to the total number of winds listed in the table above for New York City (2.6 x 3948), it appears that approximately 10,300 winds of intensity equal to or greater than 32 miles per hour can be expected during a 100-year period as against 8050 at Block Island.

Storm winds at New Haven occur without any marked differences in frequency from the west clockwise around to northeast and from the south. New Haven is located in a lowland which runs generally north and south. Winds in the lowland are directed in a north-south direction, creating wind conditions that are peculiar to New Haven. Records for Block Island and New York City give a more accurate picture of the direction of wind expectancy in Long Island Sound. The Connecticut shore is well sheltered by Long Island, Fishers Island, and other islands extending to the east. Therefore, neither the frequency nor intensity of storms occurring at Block Island and New York City can be expected to occur along the Connecticut shore.

8. Storm Damage. - The following selected accounts, mostly condensed from newspaper reports, indicate the type of storm damage experienced in the study area.

Location	Account
Norwalk	Dec. 14, 1917. Southwest storm, heavy seas. Much property damage along shore.
Norwalk	Oct 1. 1920. Southwest storm, heavy sea. A record storm. A number of cottageswrecked on Bell Island.
Stamford	Nov. 17, 1926. Southeast storm, 50 m.p.h. gusts, heavy rains. Halloween Park Beach damaged. Much shore property and small craft damage.
Greenwich	Oct. 13, 1927. Southeast storm, heavy seas. Much damage to shore dwellings. Yachts driven ashore.
Norwalk	Mar. 28, 1932. Northeast storm, high tides, huge seas, heavy rain. Flooding of Meeker foundry causes $5,000 damage.
Norwalk	Nov. 17-18, 1935. Northeast storm, heavy sea, tides above normal. Cellars on Bell Island flooded.
Stamford	Nov. 17-18, 1935. Same storm as above. Shore homes damaged by waves.
Greenwich	Nov. 17-18, 1935. Same storm as above. Pier and sea wall destroyed.
Darien	Sept. 19, 1936. Northeast storm, 45 m.p.h. gusts, hurricane in Atlantic. Several docks destroyed.
Norwalk	Jan. 25, 1938. Southeast storm, heavy seas and rain. Dock and piling at Yacht Club destroyed. Wooden abutment swept away at Crescent Beach, Bell Island.
Stamford	Nov. 30, 1944. Northeast storm, high tides, huge waves. Heavy damage to boatyards.
Norwalk	Nov. 29, 1945. Northeast storm, huge waves, extreme high tides. Sections flooded at Bell Island and Rowayton.
Norwalk	Nov. 25, 1950. Southeast storm. Estimated damages $500,000. Buildings, sidewalks and pier damaged at Calfpasture Beach. Bridge washout at Shore Haven. Harborview inundated and buildings damaged. Bath-house, pier and sea walls damaged at Roton Point. Houses damaged on Sheffield Island.

Location	Account
Darien	Nov 25, 1950. Same storm as above. Estimated damages $150,000. Pratt Island inundated and one home lost. Sand blown onto parking area at Pear Tree Point Beach. Fences, front porch and accessories damaged at Tokeneke Beach Club. Tides swept through first floor of Noroton Yacht Club, causing excessive damage.
Stamford	Nov. 25, 1950. Same storm as above. Cummings Park and nearby Quonset Hut housing project flooded, 350 homes under five feet of water. Sea wall knocked out at Southfield Beach. Bath-houses at Iriquois Beach Club severely damaged.
Greenwich	Nov. 25, 1950. Same storm as above. Bath-houses washed away, bungalows battered, pier destroyed, sea wall slipped and land washed away at Island Beach. Part of Greenwich Point causeway washed out. Sea walls destroyed between Byram Point and Rocky Neck. Parts of sea wall washed out at Belle Haven Beach Club and dance floor submerged. Bath-houses and other buildings smashed at Rocky Point Beach Club.
Norwalk	Nov. 6-7, 1953. Northeast storm. Homes and buildings flooded along the waterfront. Minor damage to sea walls and roads.
Stamford	Nov. 6-7, 1953. Northeast storm. Homes and buildings flooded along the waterfront. Minor damage to sea walls and roads.
Greenwich	Nov. 6-7, 1953. Northeast storm. Flooding of homes in low sections. Minor damage to roads, piers and sea walls. Erosion at Island Beach.

9. Exposure of the Shore. - The shore line has a general east northeast to west southwest orientation with open water to the south and east. Storms causing damages reportedly approach from the northeast, southeast and southwest. The fetches over which waves can be generated are limited by the length and width of Long Island Sound. The longest fetches exist to the east northeast and east. Due to the narrowing of Long Island Sound to the west, fetches to the southerly and southwesterly directions are greater opposite the east end of the study area than opposite the west end. The lengths and directions of fetches are approximately as follows:

Direction	Fetch (Miles) From East Limit	Fetch (Miles) From West Limit
East Northeast	85	98
East	53	57
Southeast	16	8
South	11	8
West Southwest	26	10

Records of winds at New York City (Plate 5 and Paragraph 6, Appendix D) indicate that the prevailing winds and the greatest frequency of storms occur from the northwest, a direction from which the shore line is sheltered. Winds and storms from the south, clockwise around to the west occur next in the order of frequency. Waves generated by such winds can attack the shore. Winds and storms approaching from the directions of greatest fetch, northeast to east, occur less often than from any other quadrant. All shore areas are not exposed to wave attack from all the directions listed above. Natural protection is afforded the east end of the study area by the Norwalk Islands. Due to its irregularity much of the study area is sheltered by adjacent projecting shores and headlands. The intensity and frequency of storms which can affect the shore are less than at New York City because of the shelter provided by Long Island. The shore is sheltered from the prevailing storm direction and storms from directions which can cause damage are relatively infrequent.

APPENDIX E

SHORE LINE AND OFFSHORE DEPTH CHANGES

1. Basic Data. - Plans showing the locations of the shore line and the 6, 12 and 18-foot depth contours during the years 1835-38, 1884-86 and 1933 were prepared by the Beach Erosion Board from United States Coast and Geodetic Survey data. For this study a field survey was run during 1953 locating portions of the shore line and determining elevations and depths on selected profiles. Locations of other portions of the shore were determined from aerial photographs flown during 1949. Shore line and offshore depth changes are shown on Plates 7 to 14, inclusive. Due to the scale (1:10000) used on available maps, it is obviously difficult to measure small changes with accuracy. Change descriptions contained in the following paragraphs have therefore been limited to those large enough to permit measurement. Amounts of change when given in feet are necessarily scaled distances and, therefore, approximate. Due to the irregular manner in which many of the changes have occurred, no attempt has been made to describe all changes in minute detail. The changes described can generally be considered accurate in indicating the trend in the area and approximate only in indicating the actual quantitative change.

2. Saugatuck Shores. - This area includes the peninsula extending eastward from Shore Haven to the mouth of the Saugatuck River. The principal shore line changes since 1835 have occurred along the outer or eastern end of the peninsula and along its south shore. Shore line changes between 1835 and 1933 consisted of recession of Bluff Point of about 550 feet, a small amount of recession, generally less than 100 feet, along the north half of the eastern end of the peninsula adjacent to Bluff Point and continuous recession, varying between 200 and 500 feet, along the south half of the eastern end of the peninsula adjacent to Seymour Point. Shore line changes along the south side of Saugatuck Shores, also between 1835 and 1933, consisted of recession of up to 150 feet along the 700 feet of shore adjacent to Seymour Point, accretion or seaward movement of the next westerly 1500 feet of shore, generally less than 100 feet, and thence a large irregular recession in places exceeding 1000 feet along the marshy shore area adjacent to Shore Haven. The only appreciable shore line changes between 1933 and 1953 consisted of recession of 50 to 150 feet along the northerly half of the east end of the peninsula adjacent to Bluff Point and northward recession of about 150 feet and westward growth of about 850 feet of the spit trailing westward from the south shore. Some of the changes in the Saugatuck Shores area resulted from artificial filling around 1925 and construction of groins and other protective works following this period. Available data does not permit separation of changes due to natural processes from those effected artificially.

3. The principal offshore depth changes between 1838 and 1933 opposite the south side of Saugatuck Shores consisted of deepening resulting in the formation of a channel with depths between 6 and 12 feet

extending westward between Sprite and Calfpasture Islands and westward movement, varying between 0 to 1500 feet, of the 12-foot depth contour towards Goose Island. A profile run northeastward from Bluff Point during 1953 indicates that there was practically no change in the position of the 6-foot contour after 1933. Other profiles run during 1953, one eastward from Seymour Point and two profiles southward from the south side of Saugatuck Shores, did not extend seaward far enough to permit depth comparisons with previously located contours.

4. Shore Haven and Calfpasture Point. - The portion of Shore Haven adjacent to and west of Saugatuck Shores but east of the bridge connecting with the Calfpasture Point area to the west is low and marshy. Its shore line receded irregularly landward between 1835 and 1933 for varying distances up to 1300 feet. During the same period there was little change in the position of the shore line extending 1800 feet west of and adjacent to the bridge, there was accretion and seaward movement of up to 100 feet along the shore between profiles 5 and 6 and recession of the shore along the south and west sides of Calfpasture Point varying from about 50 to 250 feet. Between 1933 and 1949, shore line changes in the Shore Haven area, east of the bridge were generally small in magnitude. During the period 1933-1953 the shore between profiles 5 and 6 generally moved landward for a distance up to about 50 feet while along the southeast face of Calfpasture Point, between groins, the shore receded 50 to 75 feet.

5. The only appreciable change in offshore depths during the period 1838-1933 consisted of deepening and formation of a channel with depths between 6 and 12 feet opposite Shore Haven and the east side of Calfpasture Point, the channel extending westward between Sprite and Calfpasture Islands. Depth changes in the vicinity of the 12 and 18-foot contours were irregular due to the existence of islands and reefs in the offshore area and do not appear to have any significance in so far as the shore of the mainland is concerned. Deepening is indicated in the vicinity of the islands by a decrease in the area around the islands having a depth less than 6 feet. Three profiles were run during 1953 but they did not extend seaward far enough to permit comparison with previously located contours.

6. Gregory and Fitch Points. - The only appreciable changes in the position of the shore line resulted in the formation of the indentation between Gregory and Fitch Points between 1835 and 1885. Between 1885 and 1933 the only large shore line change consisted of seaward movement of about 500 feet along a portion of the indentation formed in the period described above. Other changes since 1885 have been small and apparently effected by construction.

7. No significant offshore depth changes are indicated by depth contours for the years 1838 and 1884. No contours are included within the harbor after 1884. Changes are known to have been effected in the harbor by the dredging of navigation channels and

anchorages to depths of 10 and 12 feet through the center of the harbor and 6 feet near the East Norwalk shore along and north of Fitch Point.

8. Harborview and Manrissa Island. - This area is located at the west side of the Norwalk Harbor entrance. Harborview and Manrissa Island are low land areas separated by marsh. Comparison of shore line positions indicates that a large irregular recession of this marshy shore, in places exceeding 1000 feet, occurred between 1835 and 1885. During the same period, recession, probably of marsh occurred west of Manrissa Island and north of Harborview, the former varying between 400 and 900 feet, the latter between 350 and 700 feet. The east shore of Harborview also receded between 1835 and 1885, the amount of shore movement increasing from no change at the north end to about 200 feet at the south end. The only appreciable changes in the location of the shore line at Manrissa Island between 1835 and 1885 appear to have consisted of recession of the marsh by which it was flanked. Shore line changes between 1885 and 1933 consisted of accretion along the east shore of Harborview, the amount of shore movement varying from about 25 to 100 feet. During the same period the south shore of Manrissa Island moved 50 to 100 feet seaward and changes elsewhere around the island were generally small and irregular. Between 1933 and 1953 the east shores of Harborview and Manrissa Island receded, the former generally not more than 25 feet, the latter up to about 100 feet.

9. Offshore depth changes during the period 1838-1933 generally indicated deepening. Movements of the 6-foot depth contour closest to Harborview and Manrissa Island were small and irregular. The area of a shoal southeast of Manrissa Island within the 6-foot depth contour decreased in size. Some decrease in area also occurred within the 6-foot contour around nearby islands to the south. A channel with depths between 6 and 12 feet existed between Ram and Chimon Islands connecting with deep water in Long Island Sound during 1884 and 1933 through an area shown as less then 6 feet deep in 1838. A profile run at Harborview during 1953 did not extend seaward far enough to permit comparison with previously located contours.

10. Wilson Point. - Shore line comparisons indicate the following changes occurred between 1835 and 1885 at Wilson Point; seaward movement of 400 feet at the tip of the point, less than 50 feet along about 700 feet of the shore extending northward along the west side of the point and about 100 feet along 1200 feet of shore extending northeastward from the tip of the point. Elsewhere, the shore generally receded, the landward movement along the east shore varying generally between 0 and 250 feet while along the west shore it varied from 0 to about 100 feet. The shore line changes between 1885 and 1933 were smaller in magnitude. The principal changes consisted of localized recession at the tip of the point and landward shore line movements in two indentations, one each located on the east and west sides of the point.

11. Between 1838 and 1884 offshore deepening resulted in a small landward movement of the 6-foot depth contour opposite the east side of Wilson Point while a wide channel 12 to 18 feet in depth was

formed, probably for navigation purposes, from deep water to and along the west side of the tip of Wilson Point in an area where some depths were less than 6 feet in 1838. During the same period a considerable area of Sheffield Island Harbor north of Sheffield Island increased from a 6 to 12-foot depth to a 12 to 18-foot depth. During the period 1884-1933 the only significant change appears to have been shoaling of the channel leading to the tip of the point. No information is available concerning offshore depth changes since 1933.

12. Bell Island to Five Mile River. - The location of the 1835 shore line in this area is subject to question as evidenced by apparent seaward movement of its position at projecting points which are now composed of bedrock. Shore line changes between 1885 and 1933 were generally small. Principal changes during this period were as follows: Recession of about 50 feet along the north side of Bell Island and along the south half of the pocket beach along its east side north of Noroton Point and accretion or seaward movement, also about 50 feet, along the westerly portions of the two pocket beaches between Roton Point and Five Mile River. During the period 1933-1953 shore line changes were minor with probable accretion of 25 feet in the small pocket beach east of Roton Point and accretion of up to 50 feet in the pocket beach adjacent to the entrance of Five Mile River.

13. Offshore depth changes from 1838 to 1884 consisted of deepening with irregular and in some places large landward movements of the 6, 12 and 18-foot depth contours. The largest amount of deepening was effected opposite the east side of Bell Island in the area where a wide channel leading to the tip of Wilson Point was formed. Offshore depth changes between 1884 and 1933 were smaller in magnitude. There was some shoaling of the channel leading to Wilson Point and shoaling in the vicinity of the 12 and 18-foot depths opposite the Five Mile River entrance. A profile run during 1953 indicates that there has been little change in the vicinity of the 6-foot depth opposite the east shore of Bell Island since 1933.

14. Butler and Contentment Islands. - The shore line of Butler and Contentment Islands is largely composed of bare bedrock with sandy beaches held only in indentations. Changes in the position of the shore line can therefore be expected to be small. The apparent irregular changes in shore line positions in this area shown by available comparative maps are believed to be largely the results of differences in the topographer's or cartographer's interpretation of the shore line position or to errors involved in matching various surveys for comparison rather than to any actual physical change. Records show that dredged fill was placed on the west end of Contentment Island around 1910. This probably accounts for the accretion or filling of the large indentation in this area shown between 1885 and 1933.

15. Offshore depth changes between 1838 and 1884 consisted of deepening and general landward movement of the 12 and 18-foot depth

contours while the 6-foot contour moved irregularly with no predominant movement either landward or seaward. Between 1884 and 1933 contour movements were not as large. Seaward movements of the 12 and 18-foot contours indicated shoaling while small landward movements of the 6-foot contour opposite Butler Island and the east end of Contentment Island indicated deepening. No information is available concerning offshore depth changes since 1933.

16. Scott Cove, Great and Hay Islands. - This area includes the shore of Scott Cove and the shore to the south and west including Great Island and Hay Island. Between 1835 and 1885, the shore line change map shows a large recession occurred which separated Great Island from the mainland, formed the cove west of Hay Island and caused the shore of Scott Cove in places to recede over 1000 feet generally forming the shore configuration that exists today. The magnitude and nature of the changes suggests the possibility that the difference in the locations of the 1835 and 1885 shore lines may not be due to an actual physical change but rather to the interpretation of the location of the shore by the topographer, the 1835 line probably representing the edge of marsh and the 1885 the shore of the land area. Shore line changes between 1885 and 1933 were generally small and irregular, the larger changes consisting of accretion, probably resulting from construction and artificial filling following development of the area. Records indicate that the accretion along the northwest shore of Great Island in the period 1885-1933 resulted from placement of dredged fill about 1929 and that the indentation on the southwest end of Great Island was similarly filled around 1912.

17. Offshore depth changes between 1838 and 1884 consisted of deepening. Channels between 6 and 12 feet in depth were formed in an area which in 1838 was shallower than 6 feet, one channel extending northward into Scott Cove east of Great Island, the other westward between Great and Hay Islands. There was also a fairly large general landward movement of the 12 and 18-foot depth contours. Offshore depth changes from 1884 to 1933 did not result in as large changes in the positions of depth contours. In general contours moved slightly seaward indicating shoaling. No information is available concerning offshore depth changes since 1933.

18. Long Neck and Peartree Points. - Changes in the position of the shore line south of Hay Island to and around the tip of Long Neck Point and thence northward to Peartree Point between 1835 and 1953 were generally too small to permit measurement from comparative maps. At Peartree Point, a sand spit trailing northwestward grew about 200 feet between 1933 and 1953 while the west or Darien River shore of the spit receded up to about 50 feet. Along the south side of the point south of the spit, along the town bathing beach accretion of about 75 feet is indicated between 1835 and 1933 with no change between 1933 and 1953. The accretion prior to 1933 may have resulted from artificial filling in this area around 1926.

19. Offshore depth changes between 1838 and 1884 consisted

principally of deepening as indicated by landward movement of the 6 and 12-foot depth contours opposite the southeast tip and west side of Long Neck Point and of the 18-foot contour opposite most of the shore. Between 1884 and 1933 contour movements were small and generally landward indicating that there was practically no change in offshore depths or just a small amount of deepening. A profile run from the east side of Long Neck Point indicated that offshore depths changed little from 1933 to 1953. Profiles, one from the west side of Long Neck Point and another southward from Peartree Point indicated deepening in the vicinity of the 6-foot depth.

20. Noroton Neck. - The location of the 1838 shore line in this area which extends from Darien River westward to the entrance to Holly Pond appears in places to represent the edge of marsh rather than the land and is therefore of questionable value for comparative purposes. Changes between 1933 and 1953 were generally too small to permit measurement. Immediately north of Profile 14 recession of up to 100 feet occurred during the period 1933-1953 forming a small indentation in the east shore of Noroton Neck. During the same period, along the south face of the Neck the shore line was moved irregularly seaward for short distances by construction while recession of about 25 feet occurred along 400 feet of the west shore of Noroton Neck extending 150 feet north and 250 feet south of Profile 16. Records indicate that large quantities of hydraulic fill were placed at Noroton Neck around 1927. Considerable land area was made by this filling. The results of this filling in changing the shore line position are not evident from the shore lines shown on the comparative map.

21. Offshore depths increased considerably between 1838 and 1884. This is shown by large landward movements of the 6, 12 and 18-foot contours. An unusually large area west of Pratt Island was deepened from less than 6 feet to a depth between 6 and 12 feet. Offshore depth changes between 1884 and 1933 were generally confined to small areas and do not appear to have been significant. No information is available concerning offshore depth changes since 1933.

22. Cove Harbor. - This area includes the shore extending west from the Holly Pond entrance at the Darien-Stamford boundary to Green-A-Way Island. Cove Island at the Holly Pond entrance, appears to have been subject to shore recession between 1835 and 1933 as follows: East shore up to 300 feet, south tip up to about 1000 feet. About 1500 feet of shore extending westward from the west side of Cove Island receded up to about 150 feet from 1835 to 1933 while the next 700 feet of shore adjacent to the bridge leading to Green-A-Way Island experienced little if any change.

23. Offshore depth changes between 1838 and 1884 consisted generally of deepening with particularly large landward movements of the 6 and 18-foot depth contours. Positions of the 6, 12 and 18-foot contours changed little between 1884 and 1933. No information is available concerning offshore depth changes since 1933.

24. Westcott Cove - North Shore. - This area includes the shore extending west from Green-A-Way Island to the entrance of the boat basin at Cummings Park. Between 1835 and 1953 the shore generally receded from 200 to about 350 feet, the larger recession occurring along the western portion of the area. Formerly there were two entrances to the boat basin. The eastern entrance is now closed. The closure may have been effected by placement of dredged fill around 1924. The accretion at Cummings Park indicated by the change in shore line position from 1885 to 1933 in the vicinity of the east entrance was therefor probably the result of this artificial filling. The principal shore line change from 1933 to 1953 consisted of recession of up to 50 feet along the east end of Cummings Park and of a smaller amount along the shore to the east.

25. Offshore depth changes between 1838 and 1884 consisted generally of deepening resulting in landward movement of the 6, 12 and 18-foot depth contours, the movement of the latter being particularly large. Movements of the 6, 12 and 18-foot contours between 1884 and 1933 were small indicating a lack of change in offshore depths. A profile run southward from the east end of Cummings Park during 1953 did not extend far enough seaward to permit comparison with previously located depth contours.

26. Westcott Cove - West Shore. - This area includes the shore from the entrance of the boat basin at Cummings Park southward to the point projecting farthest east from Shippan Point between Profiles 20 and 21. Between 1835 and 1885 the shore line generally receded, the movement decreasing from about 700 feet at the entrance to the boat basin to no change about 2600 feet southward, little change along the next southerly 900 feet and recession of 50 to 100 feet along the remaining 1200 feet adjacent to the concrete pier. Between 1885 and 1933, the principal changes consisted of accretion or seaward movement of the shore line. This movement was up to 100 feet along 400 feet of shore at the boat basin entrance, no change along the next southerly 800 feet, thence accretion varying from 0 to slightly over 100 feet along the next southerly 2500 feet of shore which is oriented generally north and south and up to 250 feet along approximately 1000 feet of shore adjacent to the south limit. The accretion during the period 1885-1933 apparently resulted from artificial filling and construction along the shore rather than to natural processes. Records indicate that large quantities of fill were placed in the vicinity of the boat basin entrance during 1927 and along the west shore of the cove during 1909 and 1913. Between 1933 and 1953 that portion of the shore which is oriented in a north-south direction generally receded, the greatest movement of about 150 feet occurring near the boat basin entrance. There was no apparent change in the position of the 1200 feet of shore adjacent to the south limit, an area in which sea walls at the water's edge now constitute the shore line.

27. Offshore depth changes from 1838 to 1884 consisted generally of deepening as evidenced by landward movement of the 6, 12 and 18-foot depth contours. The small movements of the same contours from 1884 to

1933 indicate that there was little change in offshore depths during this period. Three profiles run during 1953 show the existence of a channel 6 to 10 feet deep close to the shore in an area where no depth contours are shown from previous periods. It is known from soundings on old charts that depths in excess of 6 feet existed in this area prior to 1933 so that the channel shown by the 1953 profiles is apparently not of recent origin.

28. Shippan Point. - This area extends from the south end of Westcott Cove to the tip of Shippan Point and thence northward along the east side of Stamford Harbor to opposite the East Branch Channel entrance. The only appreciable changes in the position of the shore line occured prior to 1933. Between 1835 and 1885, comparison of shore positions indicates accretion or seaward movement occurred along most of the east and south shore of Shippen Point, the seaward movement of the shore line generally not exceeding 100 feet. During the same period, the south tip of the point was extended or grew southward about 650 feet while recession of about 300 feet along the east shore of the tip and up to 200 feet along the west shore gave the outer tip the form of a tombolo or spit about 1200 feet long. During the period 1835-1885 most of the west shore of Shippan Point receded for a distance generally less than 100 feet. An exception to this recession was the accretion or seaward movement of up to about 100 feet along approximately 850 feet of shore located 1950 to 2800 feet north of the tip of the present point. Between 1885 and 1933 the only appreciable shore line change occured in the indentation adjacent to and immediately east of the tip of the point. The change resulted in a seaward movement of the shore of 700 feet to the position which it occupies today. Shore line changes since 1933 have been too small to measure on available maps. The present shore line is strongly held by sea walls, groins and other protective works so that rapid changes are now unlikely.

29. Offshore depth changes between 1838 and 1884 consisted generally of deepening resulting in landward movements of the 6, 12 and 18-foot depth contours. From 1884 to 1933 additional deepening occurred opposite the east shore of Shippan Point resulting in small landward movements of the 6-foot depth contour and irregular movements of the 12 and 18-foot contours, mostly in a landward direction. Contour movements during the same period opposite the west or Stamford Harbor shore were more irregular, with the largest movements in a landward direction. Profiles run during 1953 compared with 1933 positions of depth contours indicate the following: Shoaling in the vicinity of the 6-foot and no change at the 12-foot contour on Profile 21, deepening at the 12-foot and no change at the 6 and 18-foot contours on Profile 22 and little change at the 6 and 12-foot contours on Profiles 23 and 24. Profile 25 run from the tip of Shippan Point across the gap to the east breakwater indicates that depths have not changed materially since the breakwaters were built. Profiles 26, 27 and 28, also run during 1953, were compared with profiles run during 1942 out to distances of 400, 360 and 220 feet, respectively, from the high water shore line. Within this zone there was no

measurable change in depth. This is particularly significant since it shows that deepening of the offshore area, located about 300 to 500 feet from the highwater shore line, by dredging during 1942, had no apparent effect on the beach. Profiles 29 and 30 indicate that deepening, evidenced by landward movement of the 6-foot contour, occurred between 1933 and 1953.

30. Stamford Harbor - West Shore. - This area includes the shore extending westward from Cook Point opposite the West Branch channel of Stamford Harbor to Davenport, Peck and Cummings Points, the latter at the Stamford-Greenwich boundary. The 1835 shore line appears to be of questionable value of comparative purposes, the magnitude and nature of the shore line changes shown between 1835 and 1885 indicating that the former line was probably not the high water line. Shore line changes between 1885 and 1933 consisted principally of accretion resulting from construction of walls, bulkheads and artificial filling. At Cook Point where the shore line was moved seaward up to 350 feet, a bulkhead was constructed around 1910. At Peck Point where the shore line was extended southward about 200 feet and the point was widened from a width generally less than 200 feet to a width varying from 300 to 1000 feet, sea walls were constructed and dredging and filling accomplished around 1929. The small amount of shore line movement at Cummings Point was probably effected by sea wall construction and filling some of which was done around 1901 and 1915.

31. Offshore depth changes between 1838 and 1884 resulted in generally small landward movements of depth contours indicating deepening. The existence of shoals less than 6 feet deep southeast and southwest of Peck Point during 1884 in areas where such shoals are not shown by 1838 contours is believed to be due to omission of the contours for the earlier date rather than to any actual change in depth. Contour movements between 1884 and 1933 were small and generally in a landward direction indicating continued deepening. The northward movements of the 6-foot depth contours east of Davenport and Cook Points and west of Peck Point probably resulted from dredging in connection with filling of adjacent land areas.

32. Old Greenwich (Sound Beach) and Greenwich Point. - This area includes the shore extending south and west from the Stamford-Greenwich boundary along Old Greenwich (Sound Beach) to and around Greenwich Point to the entrance of Greenwich Cove. The 1835 shore line appears to be of questionable value for comparative purposes. Shore line changes along Old Greenwich between 1885 and 1933 were generally small and not measurable on available maps. The changes which did occur consisted principally of recession of various shore projections and seaward movement of the shore line at localized areas resulting from construction and filling. During this period the shore extending about 2800 feet northward from the southeast tip of Greenwich Point receded generally less than 50 feet, the southeast tip receded about 300 feet and the south shore extending westward to Flat Neck Point receded up to 150 feet, averaging about 100 feet. The west shore extending north from Flat Neck Point to the Greenwich Cove entrance generally moved slightly seaward and a pond was formed by closure of the entrance of an indentation in the shore. Changes in the shore line

position between 1933 and 1953 were generally minor. There was a seaward movement of 100 to 200 feet along approximately 450 feet of shore at the east side of the narrow neck connecting Old Greenwich and Greenwich Point and a growth of about 100 feet at the northern tip of the toe of Greenwich Point at the Greenwich Cove entrance. A small seaward movement of shore line is also indicated along 3000 feet of shore extending northward from the southeast tip of Greenwich Point and along a considerable portion of the shore extending westward to Flat Neck Point while a small shore recession is indicated along most of the west side of Greenwich Point north of Flat Neck Point.

33. During the period 1836-1886 offshore depth changes consisted principally of deepening. The 12 and 18-foot depth contours, except for a few minor exceptions, moved landward along the entire area. Movements of the 6-foot contour varied with landward movement predominant opposite the north part of Old Greenwich, around the southeast and southwest tips of Greenwich Point and along the east half of the south shore of Greenwich Point. Seaward movement of the 6-foot depth contour was predominant opposite the south half of Old Greenwich and along the east side and the west half of the south side of Greenwich Point. During the period 1886-1933 there was no such predominance in the direction of movement of contours. The 18-foot contour generally moved seaward opposite Old Greenwich, changed little opposite the east side of Greenwich Point, moved landward opposite the east half of the south shore of Greenwich Point and alternately moved seaward and landward to the west. Movement of the 6 and 12-foot depth contours were small and alternately seaward and landward. Profiles 31 through 37 inclusive were run during 1953 around the Greenwich Point area. The only depth changes since 1933 indicated by these profiles consisted of deepening in the vicinity of the 6-foot depth on Profiles 33 and 35 and shoaling in the vicinity of the 12-foot contour on Profile 34. Little change is indicated by the other profiles.

34. Greenwich Cove. - This area includes the north or inner shore of Greenwich Point, the west shore of Old Greenwich and the east shore of Riverside all within the cove whose entrance is bounded by Elias Point and top of the toe or northwest corner of Greenwich Point. The apparent magnitude of the changes between 1836 and 1885 indicate that the 1836 line probably does not represent the high water shore position and is therefore of questionable value for comparative purposes. Shore line changes during the period 1885-1933 were generally minor along the south side of Greenwich Cove along the inner shore of Greenwich Point. Considerable accretion or seaward movement of the shore was effected along the east side of Greenwich Cove in the area north of the narrow neck connecting Old Greenwich and Greenwich Point as a result of construction of sea walls and bulkheads and placement of dredged fill. Records indicate that operations of this type were carried on at least during the period 1901-1909. Shore line changes along the west side of the cove also consisted largely of accretion or seaward movement, again apparently the result of construction or filling.

35. During the period 1886-1933 the 6 and 12-foot depth contours in the entrance channel of Greenwich Cove moved southward approximately 200 feet. Comparative depth contours are not available from the area inside the cove.

36. Between Greenwich Cove and Byram River. - This area extends westward from Elias Point at the Greenwich Cove entrance and includes the shore bordering Captain and Byram Harbors and the shore west thereof to Byram Point. The shore line is very irregular in shape consisting of a series of projecting points of land separated by coves, harbors and other waterways. The magnitude and type of apparent shore line changes between 1836 and 1885 indicate that the 1836 line does not everywhere represent the high water line so this early shore line position is of questionable value for comparative purposes. Shore line changes since 1885 have not generally followed any particular pattern or trend. Changes in many localities have resulted from construction of sea walls, piers, wharves and filling of land. Between 1885 and 1933, a small amount of recession occurred along the southeast shore of Mead Point and a recession of up to 250 feet occurred along 1100 feet of the east shore of Indian Harbor adjacent to Mead Point. Accretion during the same period occurred at localized areas, at the entrance to Cos Cob Harbor, in Indian and Greenwich Harbors, along the shore of Belle Haven, Byram Harbor and the adjoining area to the southwest. Between 1933 and 1953 the shore line along the outer 100 feet of shore on the east side of the Byram Point jetty receded up to 300 feet and the shore of an indentation located adjacent to and north of this area moved seaward about 200 feet. Shore line changes elsewhere were generally too small to permit measurement.

37. During the period 1836-1886 the predominant change in offshore depths consisted of deepening. In the Captain Harbor area bounded on the south by Little Captain and Great Captain Islands and on the north by the shore from Belle Haven to Byram Point, depth contours generally moved landward. An entrance channel with depths in excess of 18 feet was formed between Great Captain Island and Byram Point where depths in 1836 were between 12 and 18 feet. Large areas increased in depth from less than 12 feet forming a wide continuous area with depths greater than 12 feet throughout the entire length of Captain Harbor. Offshore depth changes during the period 1886-1933 did not result in as large movements of depth contours. The area around Little Captain Island inside the 6-foot depth contour decreased considerably in size. A shoal or bar with depths between 12 and 18 feet formed across the entrance channel between Byram Point and Great Captain Island and the area in the channel within the 18-foot depth contour decreased in size indicating shoaling.

APPENDIX F

LITTORAL DRIFT

1. Listed below are indices of littoral drift obtained from field inspections supplemented by aerial photographs. Direction of littoral drift was interpreted as being in the direction of growth of sand spits, toward the sides of groins or other projecting structures at which accretion was found or toward the ends of beaches where material was finer as shown by variation of beach composition from coarser to finer material.

Indices of Drift

Shore Area	Indicated Direction of Drift	Evidence	Date	Authority
Northwest end of Saugatuck Shores	North	Northward trailing gravelly spit	April 18, '55 Feb. 2, '49	Inspection Aerial Photo
South side of Saugatuck Shores	West	Material accumulated on east side of groins. Westward trailing spit.	April 18, '55 Feb. 3, '49	Inspection Aerial Photo
Shore Haven south of bridge	Southwest	Accumulation of drift at northeast side of groins	April 18, '55 Feb. 6, '49	Inspection Aerial Photo
Calf Pasture Beach	South	Wider beach north side of groin	April 18, '55	Inspection
Calf Pasture Point (South End)	West	Accumulation of drift east side of groins	April 18, '55 Feb. 6, '49	Inspection Aerial Photo
West side Gregory Point	North	Drift impounded south side of groins	April 19, '55	Inspection
South end of Harborview	South	Southward trailing spit	April 19, '55	Inspection
Pocket Beach east of Pine Point	East	Beach composition finer to the east	April 19, '55	Inspection
Hay Island Causeway	North	Gravelly bar accumulated south side causeway	April 20, '55	Inspection

Indices of Drift

Shore Area	Indicated Direction of Drift	Evidence	Date	Authority
West Side Long Neck Point	North	Accumulation sand and gravel south side of pier	April 20, '55	Inspection
Peartree Point Beach	North	Northward trailing sand spit	April 20, '55 Feb. 6, '49	Inspection Aerial Photo
East shore Noroton Neck	North	Accumulation of drift south side of groin	April 20, '55 Feb. 6, '49	Inspection Aerial Photo
East end of Cove Island	East	Eastward trailing sand and gravel spit	April 20, '55 Feb. 6, '49	Inspection Aerial Photo
West shore Cove Harbor	North	Drift held south side of groins	Feb. 6, '49	Aerial Photo
Westcott Cove	West	Accumulation of drift on each side of groins	April 21, '55 Feb. 16, '49	Inspection Aerial Photo
Cummings Park (Westcott Cove)	West	Accumulation of drift east side of groin and jetty	April 21, '55 Feb. 16, '49	Inspection Aerial Photo
West Beach (Westcott Cove)	North	Accumulation of drift south side of groin at south limit	April 21, '55 Feb. 16, '49	Inspection Aerial Photo
West Shore of Westcott Cove	North	Accumulation of drift south side of groins	April 21, '55 Feb. 16, '49	Inspection Aerial Photo
East Shore Shippan Point South of beach club	South or Southwest	Drift accumulated on north or northeast side of groins	April 21, '55 Feb. 2, '49	Inspection Aerial Photo
West Shore Shippan Point	North	Drift accumulated south side of groins	April 21, '55 Feb. 2, '49	Inspection Aerial Photo
West Shore of Peck Point	Northwest	Drift accumulated on southeast side of structures	April 22, '55 Feb. 16, '49	Inspection Aerial Photo

Indices of Drift

Shore Use	Indicated Direction of Drift	Evidence	Date	Authority
East side of Greenwich Point	North	Foreshore at south end coarser in composition	May 2, '55	Inspection
Byram Park	North	Beach higher on south side groin	May 3, '55	Inspection

APPENDIX G

Existing Protective Structures

1. General. Protective structures consisting of sea walls, bulkheads, groins, revetment and breakwaters exist at many locations throughout the study area. Structures have generally been built to protect the immediate shores which they front. In most cases they have had little or no effect on adjacent shore lines. Most structures have been built by individuals or private groups and detailed information concerning them is not readily available. Breakwaters at the entrance to Stamford Harbor and at Byram Point were constructed by the United States in connection with navigation improvements and information concerning these works is included in the following paragraphs. Information is also included about a bulkhead at Little Captain Island constructed by the town of Greenwich for shore protection. Some information concerning private structures is available from Federal permits issued for construction seaward of the high water shore line. Selected details from Federal permits for structures whose locations are shown on Plates 15 to 21 are included in the following tabulation. The details which have been obtained from the original permits for the original structures are not necessarily true for the present structures which may have been modified.

DETAILS CONCERNING PRIVATE STRUCTURES FROM FEDERAL PERMITS

NO.	LOCATION	STRUCTURE	CONSTRUCTION OR PERMIT DATE	DIMENSIONS (FEET)		
				LENGTH	TOP WIDTH	TOP ELEV. & DATUM
S 1	Saugatuck Shores	Riprap Groin	1932	130	15	12.5 M.L.W.
S 2	Shore Haven	Stone Breakwater	1935	200	10	4.0 M.L.W.
S 3	Shore Haven	Masonry Pier	1931	200	4	4.25 M.H.W.
S 4	Shore Haven	Masonry Wall	1937	150	2	8.0 M.H.W.
S 5	Calf Pasture Point	Riprap Groin	1931	200	20	4.0 M.H.W.
S 6	Calf Pasture Point	Timber Groin	1942	110	-	-
S 7	Bell Island	Masonry Wall	1927	200	2	4.6 M.H.W.
S 8	Bell Island	Masonry Wall	1937	650	2	7.0 M.H.W.
S 9	Peartree Point	Riprap Groin	1929	100	12	3.0 M.H.W.
S 10	Noroton Neck	Stone Wall	1947	100	8	5.0 M.H.W.

DETAILS CONCERNING PRIVATE STRUCTURES FROM FEDERAL PERMITS

NO.	LOCATION	STRUCTURE	CONSTRUCTION OR PERMIT DATE	DIMENSIONS (FEET) LENGTH	TOP WIDTH	TOP ELEV. & DATUM
S 11	Green-A-Way Island	Stone Breakwater	1906	725	4 to 6	-
S 12	Green-A-Way Island	Breakwater Extension	1922	225	8	6.0 M.H.W.
S 13	Cummings Park	Riprap Groins	1927	300	6	11.0 M.L.W.
S 14	Shippan Point	Wall and Fill	1914	-	-	-
S 15	Cook Point	Wall and Fill	1910	1000	-	-
S 16	Peck Point	Masonry Breakwaters	1929	270 and 180	4	5.2 M.H.W.
		Stone Sea Wall	1929	2300	4	4.2 M.H.W.
S 17	Old Greenwich	Riprap Bulkhead	1937	325	14	9.0 M.L.W.
S 18	Old Greenwich	Stone Breakwater	1927	-	6	3.0 M.H.W.
S 19	Byram Harbor	Dry Rubble Wall	1922	500	3	4.0 M.H.W.

2. Stamford Harbor Breakwaters. - Two rubble mound breakwaters were constructed by the United States at the entrance to Stamford Harbor during the period June 27, 1940 to September 13, 1941. They were authorized by the River and Harbor Act of August 26, 1937 to provide for protected anchorage. The breakwaters were built, one on each side of the entrance channel with a gap of about 800 feet. The east breakwater with a length of about 1200 feet required 36,000 long tons of riprap. The west breakwater with a length of about 2900 feet took 105,000 long tons of riprap. The structures have a rounded convex shape at the top with a crest elevation 12 feet above the plane of mean low water, a width of 10 feet at an elevation 10 feet above mean low water, side slopes of 1 on 1 on the harbor side and 2 on 3 on the soundward side. They incidentally provide considerable protection to the Stamford Harbor shore line from waves in Long Island Sound approaching from southerly directions.

3. Breakwater at Byram Point. - A breakwater was constructed by the United States at Byram Point at the Byram River entrance extending from the shore to Sunken Rock. The breakwater was initially authorized in 1871 for a length of 400 feet and a modification in 1888 increased its length. The breakwater was constructed in 1893 to an elevation of one foot above mean high water, with a top width of five feet and side slopes of 1 on 1. It is a rubble mound structure 855 feet long. The authorized Federal project

height was 13 feet above mean low water but the outer end at Sunken Rock was built to 15 feet to serve as a base for a beacon. The sand has built up to about 6 feet above mean low water at the inshore end with the high water line extending 40 to 50 feet beyond the inshore end of the breakwater.

4. Bulkhead at Little Captain Island. - A steel sheet piling bulkhead was constructed by the town of Greenwich during 1954-1955 along the south shore of Little Captain Island. Its purpose was to protect the upland from erosion and the structures on the island from wave attack. The bulkhead is the first stage of a general plan of protection recommended by a private engineer with breakwater and groin construction as the second stage. The length of the bulkhead is approximately 650 feet. Its top elevation above mean low water is stepped down from 17 feet at its more exposed east end to 14 feet at its west end. The bottom of piling is 10 feet above mean low water along its easterly 111 feet where it is fronted by stone sloped paving. To the west the bottom is stepped down to 3.0 feet and then up to 4.0 feet above mean low water. Penetration of piling is about 4.5 to 7.0 feet. The piling is capped with a steel channel. The bulkhead is anchored to concrete deadmen with steel channels 10 to 17 feet long spaced about 10 to 13 feet apart along its central portion with no deadmen along the ends. The toe of the bulkhead is fronted by riprap revetment except along its east end where the stone slope paving makes it unnecessary.

APPENDIX H

ESTIMATES OF COSTS OF IMPROVEMENTS

1. General. - A useful life of 50 years has been assumed in determining amortization charges. A rate of interest of 2.5 percent per annum has been used. Maintenance requirements of sand fills are based on maximum rates of loss determined from past shore recession with a minimum rate of one foot per year. It has been assumed that beach fill losses will be reduced one-half by jetty or groin construction. Annual maintenance costs of groins and jetties have been estimated as one percent of the first cost of construction.

2. Calf Pasture Beach Park - East Shore. - The plan of protection and improvement consists of direct placement of sand fill and extension of two existing groins.

(a) First Cost of Construction

Sand fill, 150,000 cu. yds. @ $1.00	$150,000
Groin extension, 2,000 tons riprap @ $15.00	30,000
Contingencies	27,000
Subtotal	$207,000
Engineering and design	6,000
Subtotal	$213,000
Supervision and administration	17,000
Total First Cost	$230,000

(b) Annual Charges

Interest	$ 5,700
Amortization	2,350
Sand fill, 1,100 cu. yds. @ $1.50	1,650
Groins, 20 tons riprap @ $15.00	300
Total Annual Charges	$ 10,000

3. Calf Pasture Beach Park - South Shore. - The plan of protection consists of construction of two groins.

(a) First Cost of Construction

Groins, 2,100 tons riprap @ $15.00	$ 31,500
Contingencies	4,700
Subtotal	$ 36,200
Engineering and design	1,100
Subtotal	$ 37,300
Supervision and administration	2,700
Total First Cost	$ 40,000

(b) Annual Charges

Interest	$ 1,000
Amortization	400
Maintenance	
Groins, 20 tons of riprap @ $15.00	300
Total Annual Charges	$ 1,700

4. Cove Island - The plan of protection and improvement consists of construction of a jetty and direct placement of sand fill along the shore of Cove Island west of the jetty.

(a) First Cost of Construction*

Riprap jetty, 4,600 tons @ $12.00	$ 55,200
Sand fill, 107,000 cu. yds. @ $1.00	107,000
Contingencies	24,300
Subtotal	$186,500
Engineering and design	5,600
Subtotal	$192,100
Supervision and administration	14,900
Total First Cost	$207,000

(b) Annual Charges

Interest	$ 5,200
Amortization	2,100
Maintenance	
Jetty, 46 tons of riprap @ $15.00	700
Sand fill, 1,000 cu. yds. @ $1.50	1,500
Total Annual Charges	$ 9,500

*Use of timber piling and sheeting or other materials for jetty construction might result in a lower first cost. The determination of the practicability of driving piling or sheeting requires subsurface investigations, not included in this study. Consideration should be given to use of other materials during the construction planning stage based on necessary construction investigations and surveys.

5. Cummings Park. - The plan of protection and improvement consists of direct placement of sand fill and enlargement of the existing riprap groin and jetty.

(a) First Cost of Construction

Sand fill, 48,000 cu. yds. @ $1.20	$ 57,600
Groin enlargement, 1,200 tons @ $15.00	18,000
Jetty enlargement, 300 tons @ $15.00	4,500
Contingencies	11,900
Subtotal	$ 92,000
Engineering and design	2,800
Subtotal	$ 94,800
Supervision and administration	7,200
Total First Cost	$102,000

(b) Annual Charges

Interest	$ 2,550
Amortization	1,050
Maintenance	
Sand fill, 450 cu. yds. @ $1.50	675
Groin and jetty, 15 tons @ $15.00	225
Total Annual Charges	$ 4,500

6. Greenwich Point. - The plan of protection and improvement consists of direct placement of sand fill.

(a) First Cost of Construction

Sand fill, 130,000 cu. yds. @ $0.90	$117,000
Contingencies	18,000
Subtotal	$135,000
Engineering and design	4,000
Subtotal	$139,000
Supervision and administration	11,000
Total First Cost	$150,000

(b) Annual Charges

Interest	$ 3,760
Amortization	1,540
Maintenance	
Sand fill, 2,400 cu. yds. @ $1.50	3,600
Total Annual Charges	$ 8,900

7. Byram Point. - The plan of protection consists of landward extension and repairs to the existing jetty.

(a) First Cost of Construction

Jetty, 1,000 tons riprap @ $15.00	$ 15,000
Contingencies	2,200
Subtotal	$ 17,200
Engineering and design	500
Subtotal	$ 17,700
Supervision and adminstration	1,300
Total First Cost	$ 19,000

(b) Annual Charges

Interest	$ 475
Amortization	195
Maintenance	
10 tons riprap @ $15.00	150
Total Annual Charges	$ 820

APPENDIX I

ESTIMATES OF BENEFITS FROM IMPROVEMENTS

1. General. - The benefits computed herein are based on the promotion and encouragement of the healthful recreation of the people by protection and improvement of public beaches and prevention of direct damages to public property. The intangible benefit from the reduction of the hazard to human life at Weed Beach by the proposed improvement at Cove Island could not be evaluated. The United States does not own any land in any of the areas considered for protection or improvement. Therefore, no Federal benefit will result from the plans considered. All benefits evaluated are non-Federal public benefits.

2. Calf Pasture Beach Park - East Shore. - Non-Federal Public Benefit.

(a) Direct Damages Prevented. The proposed project will prevent loss of beach area. Comparative shore line maps indicate that erosion between 1933 and 1953 resulted in a shore recession averaging 2 feet per year along approximately 1,500 feet of shore. Based on the recent cost of acquiring the Shady Beach area, the value of the land is about $0.80 per square feet. The annual benefit from prevention of loss of beach area is evaluated as:

$$2 \times 1{,}500 \times \$0.80 = \$2{,}400.$$

(b) Recreational. The proposed sand fill will result in a benefit due to recreational use of the additional beach space made suitable for bathing. The annual patronage of public beaches in Connecticut shore towns, based on available attendance records, has been found to be at least 10 times the population. Norwalk, with a population of 60,000 would therefore have a potential annual attendance of 600,000 persons. Beach space in Norwalk at Calf Pasture Beach Park and Bailey Beach, suitable for bathing, is approximately 90,000 square feet. The proposed sand fill will provide an additional 205,000 square feet. The capacity of the existing and additional space at a desirable space standard of 75 square feet per person and a daily turnover of 2 is as follows:

Capacity of existing space	$\frac{90{,}000}{75} \times 2 =$	2,400 persons
Capacity of additional space	$\frac{205{,}000}{75} \times 2 =$	5,400 persons (approx)
Total capacity		7,800 persons

According to available records in Connecticut, actual beach capacity equals about 36% of peak attendance. Therefore peak attendance is estimated as $\frac{7{,}800}{0.36} = 21{,}700$ persons

Assuming an attendance distribution similar to Eastern Point Beach Park in Groton for which detailed records are available, the existing and additional beach space capacity will be exceeded by attendance on 35 days and the existing beach space will be equalled or exceeded on 61 days during a season. The beach attendance or usage of the additional space to be provided is therefore estimated as follows:

35 days at 5,400 persons per day	189,000 persons
61 - 35 = 26 days at $\frac{5,400}{2}$ persons per day	70,000 persons
Total attendance or usage of the additional beach area	259,000 persons

The above estimated attendance is well within the potential attendance which could be developed if space were available. The recreational value per person for beach use is evaluated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. This is estimated as $0.20 per person. The annual non-Federal public recreational benefit therefore becomes:

259,000 x $0.20 = $51,800

(c) Summary of Benefits - Calf Pasture Beach Park - East Shore

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	$ 2,400	0	$ 2,400
Recreational	51,800	0	51,800
Total	$54,200	0	$54,200

3. Calf Pasture Beach Park - South Shore. - Non-Federal Public Benefit.

(a) Direct Damages Prevented. The proposed groin construction will reduce erosion and loss of the existing beach. Comparative shore line maps indicate erosion and loss of beach area occurred between 1933 and 1953 at an average annual rate of approximately 2,700 square feet. Based on an assumption that future losses of beach area would be equal to the above and that the proposed groins would reduce losses by 50%, an annual benefit would result equal to the value of 1,350 square feet of land. This is estimated at $0.80 per square foot, the recent cost of acquiring the Shady Beach area. The annual benefit is therefore evaluated as:

1,350 x $0.80 = $1,080.

4. Cove Island - Non-Federal Public Benefit

(a) Direct Damages Prevented. The proposed project will prevent loss of beach area. Comparative shore line maps indicate that erosion between 1835 and 1933 resulted in a shore recession averaging 3 feet per year along approximately 1,200 feet of the project area. At an estimated value of $0.80 per square foot, the annual benefit from prevention of loss of beach area is evaluated as:

$$3 \times 1{,}200 \times \$0.80 = \$2{,}880$$

(b) Recreational. The proposed sand fill will result in a benefit due to recreational use of the shore. The annual patronage of public beaches in Connecticut shore towns, based on available attendance records, has been found to be at least 10 times the population. Stamford with an estimated population in 1954 of 84,000 people, could, on this basis, produce a potential annual beach attendance of 840,000 persons. Lack of public beach space precludes the possibility of development of such a beach attendance without overcrowding. Annual attendance at existing public beaches in Stamford is estimated by lifeguards at approximately 157,000 persons. The proposed improvement will provide 150,000 square feet of additional beach space. At a desirable space standard of 75 square feet per person, this space can accommodate 2,000 persons at one time or assuming a daily turnover of 2, the capacity of this space will be 4,000 persons. Analysis of attendance records at Eastern Point Beach Park in Groton shows that the average daily attendance for a 93-day season was 31% of the peak attendance and that the capacity was 36% of the peak. Assuming a similar pattern for the proposed additional area at Cove Island, the attendance for the new beach is estimated as follows:

Space capacity based on 75 square feet per person	4,000 persons
Estimated peak attendance, $\frac{1}{0.36}$ of space capacity	11,000 persons
Estimated number of days when space capacity will be equalled or exceeded according to Eastern Point Beach attendance records	35 days
Estimated number of days when attendance will be equal to or less than space capacity, 93 - 35	58 days
Estimated number of persons who will use the added beach area at desirable space standards $35 \times 4{,}000 + 58 \times \frac{4{,}000}{2}$	256,000 persons

The above estimated seasonal attendance is well within the potential attendance which could be developed if space were available. The recreational value per person for beach use is evaluated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. This is estimated as $0.20 per person. The annual non-Federal public recreational benefit therefore becomes:

256,000 x $0.20 = $51,200

(c) Summary of Benefits - Cove Island, Stamford

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	$ 2,880	0	$ 2,880
Recreational	51,200	0	51,200
Total	$54,080	0	$54,080

5. Cummings Park. - Non-Federal Public Benefit

(a) Direct Damages Prevented. The proposed project will provide a protective beach which will reduce damages to the existing park development (bathhouse, parking area, concession stand, etc.) and will also provide a more effective groin and jetty for reduction of losses of beach material. Erosion of the beach has moved the high water line close to the existing bathhouse which is a large brick structure. Storm damage over a period of years has made the bathhouse unusable. No actual figures are available concerning the monetary value of storm damages but from inspection it appears that such damages have been of considerable magnitude. It is conservatively estimated that provision of a protective sand beach will reduce storm damages at least $1,000 per year. Shore recession between 1933 and 1953 has resulted in an average annual loss of beach area of approximately 1,000 square feet. At an estimated value of $0.80 per square foot, the annual benefit from prevention of loss of beach area is evaluated as:

1,000 x $0.80 = $800

The total direct non-Federal public benefit from prevention of direct damages is therefore:

$1,000 + $800 or $1,800

(b) Recreational. Public beaches in Stamford do not have sufficient space to accommodate the existing or potential beach attendance without overcrowding. The existing beach space at Cummings Park is approximately 105,000 square feet and the proposed beach widening will provide an additional 75,000 square feet. At a desirable beach space standard of 75 square feet per person with a daily turnover of 2, the existing beach will have a capacity of $\frac{105,000}{75} \times 2 = 2,800$ persons and the additional space will have a capacity of $\frac{75,000}{75} \times 2 = 2,000$ persons. Using the same basis described in the preceding section on recreational benefits for Cove Island, the beach attendance is estimated as follows:

Estimated peak attendance, $\frac{1}{0.36}$ of entire space capacity (2,800 ÷ 2,000)	13,300 persons
Estimated number of days when entire space capacity will be equalled or exceeded	35 days
Estimated number of days when existing space capacity will be equalled or exceeded	49 days
Estimated seasonal attendance at desirable space standard, attributable to the additional beach space 35 x 2,000 ÷ $\frac{49-35}{2}$ x 2,000	84,000 persons

The above estimated seasonal attendance due to the increased beach area is well within the potential attendance which could be developed if space were available. The recreational value per person for beach use is evaluated based on the minimum fee which patrons would be required to pay if the beach was a private enterprise. This is estimated as $0.20 per person. The annual non-Federal public recreational benefit therefore becomes:

84,000 x $0.20 = $16,800

(c) Summary of Benefits - Cummings Park, Stamford

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	$ 1,800	0	$ 1,800
Recreational	16,800	0	16,800
Total	$18,600	0	$18,600

6. Greenwich Point. - Non-Federal Public Benefit

(a) Direct Damages Prevented. The proposed placement of sand fill will provide a protective beach which will reduce recurring damages to roads, parking areas, sea walls, bathhouse and other smaller buildings and it will reduce the expense attendant upon maintenance of sand dunes in front of low park areas which are used for parking and roadways. Expenditures by the town of Greenwich because of erosion and storm damages were reported as follows:

Year	1950	1951	1952	1953	1954	1955	Total
Expenditure	$11,000	8,000	200	500	1,500	450	$21,650

Restoration of sand dunes by pushing up material from the foreshore or picking up sand from the roadways and parking areas behind the beach and returning it to the beach and dunes from which it was washed or blown constitutes an annual item of expense. This item represents most of the small expenditure during 1952, 1953 and 1955 and a part of the expenditure for

each of the other years. The major damage during 1950 and 1951 consisted of destruction of hundreds of feet of sea wall by wave attack and damage to surfaces of roadways. Some of the damages during these two years were due to wind alone. Such damages consisted of loss of shingles and windows. During 1954, in addition to movement of sand, damages occurred to parking area pavements and to roofs. Town officials estimate that at least 90% of the damages reported above were due to wave attack. Some of the damages occurred during exceptional storms accompanied by extreme high tides and probably would not have been entirely prevented by the proposed project. Assuming that the proposed project would have prevented 75% of the reported damages, the average annual benefit is estimated as approximately $\frac{.75 \times 21,650}{6}$ or $2,700.

(b) Recreational. The recreational benefit to be derived from the proposed improvement is of considerable magnitude. During 1954 the total beach attendance at Greenwich Point was 498,471 with a peak daily attendance of 13,226 persons. Assuming a 100-day season, the average daily attendance was 4,985 persons or 38% of the peak attendance. The additional beach space to be provided by the proposed fill will more than double the existing beach area. This additional beach space is approximately 260,000 square feet. At a desirable space standard of 75 square feet per person, it will have a capacity at any one time of 3,450 persons or a capacity, with a daily turnover of 2, of 6,900 persons. The existing area is estimated to be 139,000 square feet with a capacity at any one time of 1,850 persons or a capacity with a daily turnover of 2, of 3,700 persons. The additional space plus the existing area is insufficient to accommodate present patronage without overcrowding during periods of peak use. It is estimated that the capacity of both existing and additional space will be equalled or exceeded 4 days during the season and that the capacity of the existing space will be equalled or exceeded 43 days during the season. The beach attendance or usage of the additional space to be provided is therefore estimated as follows:

4 days at 6,900 persons per day	27,600 persons
$43 - 4 = 39$ days at $\frac{6,900}{2}$ persons per day	134,550 persons
Total attendance or usage of the additional beach area	162,150 persons

The recreational benefit consisting of reduction of overcrowding by an improvement of the standards of beach space is evaluated as the minimum fee which patrons would be required to pay if the beach was a private enterprise. This is estimated as $0.20 per person. The annual non-Federal public recreational benefit therefore becomes 162,150 x $0.20 = $32,430.

(c) Summary of Benefits - Greenwich Point, Greenwich

Benefit	Non-Federal Public	Private	Total
Direct damages prevented	$ 2,700	0	$ 2,700
Recreational	32,430	0	32,430
Total	$35,130	0	$35,130

APPENDIX J

SANITARY STUDY OF THE CONNECTICUT SHORE

1. General. - The Department of Health of the State of Connecticut has periodically conducted bacterial and sanitary surveys of shore bathing waters to obtain specific information concerning their condition. The surveys have served to point out to municipal authorities and other interested persons the "danger spots" along the shore which are seriously affected by sewage pollution.

2. Bacterial Survey. - The bacterial survey consists of sampling of the water at approximate 1000-foot intervals along the shore in water depths of from 2 to 6 feet, such depths covering most of the areas used for bathing. The samples are taken as nearly as possible at four stages of the tide; namely, high, low, one-half ebb and one-half flood. Wind direction at the time of sampling is recorded but no attempt is made to take samples under different wind conditions as it is believed that the run of the tide is the principal factor influencing the travel of pollution along the shore. Three 10 milliliter, three 1 milliliter and three 0.1 milliliter portions of each sample are examined and the concentration of coliform organisms per 100 milliliter is reported. The most probable number of coliform organisms for each station is obtained by averaging the figures for the four tidal stages. The analytical figure for a shore section is obtained by averaging the results for different stations included. Classification is made as follows:

Bacterial Classification	Most Probable Number of Coliform Organisms for 100 Ml.
A	0-50
B	51-500
C	501-1000
D	over 1000

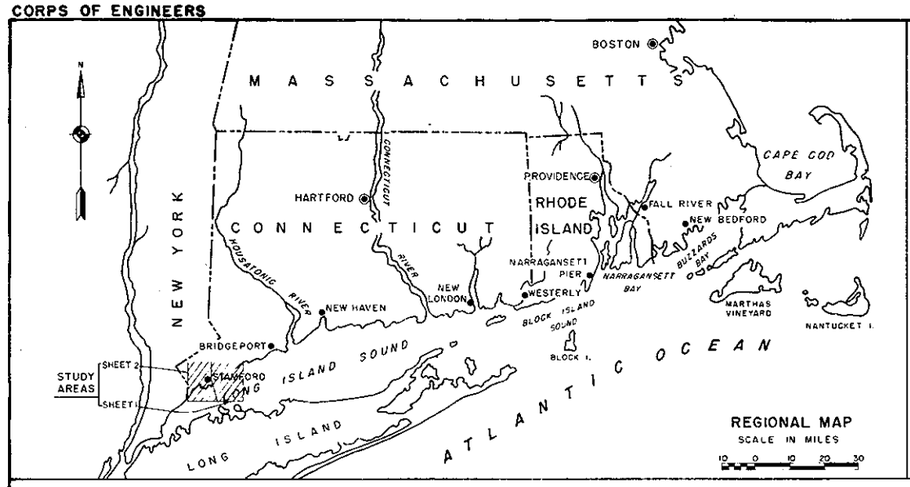
Class D waters are considered to be in a questionable category from the standpoint of bathing water safety.

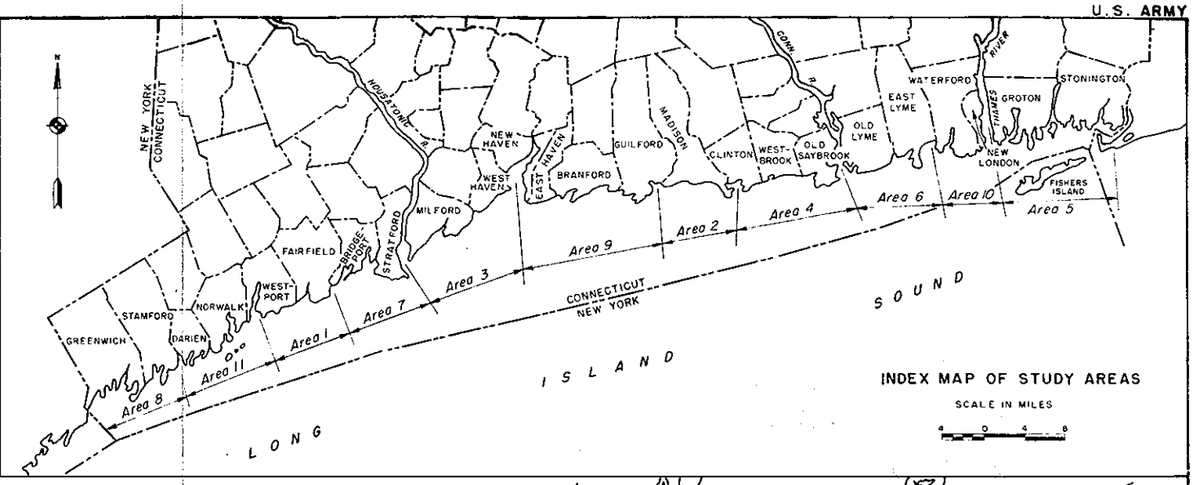
3. Sanitary Survey. - In addition to the bacterial survey, a sanitary survey has been conducted. This includes the location of sewer outlets with data as to flows and character of untreated and treated sewage. The nearness of polluting influences and possibilities of shifting direction of travel of pollution under different wind conditions were taken into account in this part of the study. In connection with studies of shellfish areas in many harbors, floats had been set out to measure the rapidity of water travel and these data were available in considering bathing waters in these localities. The sanitary survey was used to classify waters and afforded comparison with results obtained by the bacterial survey.

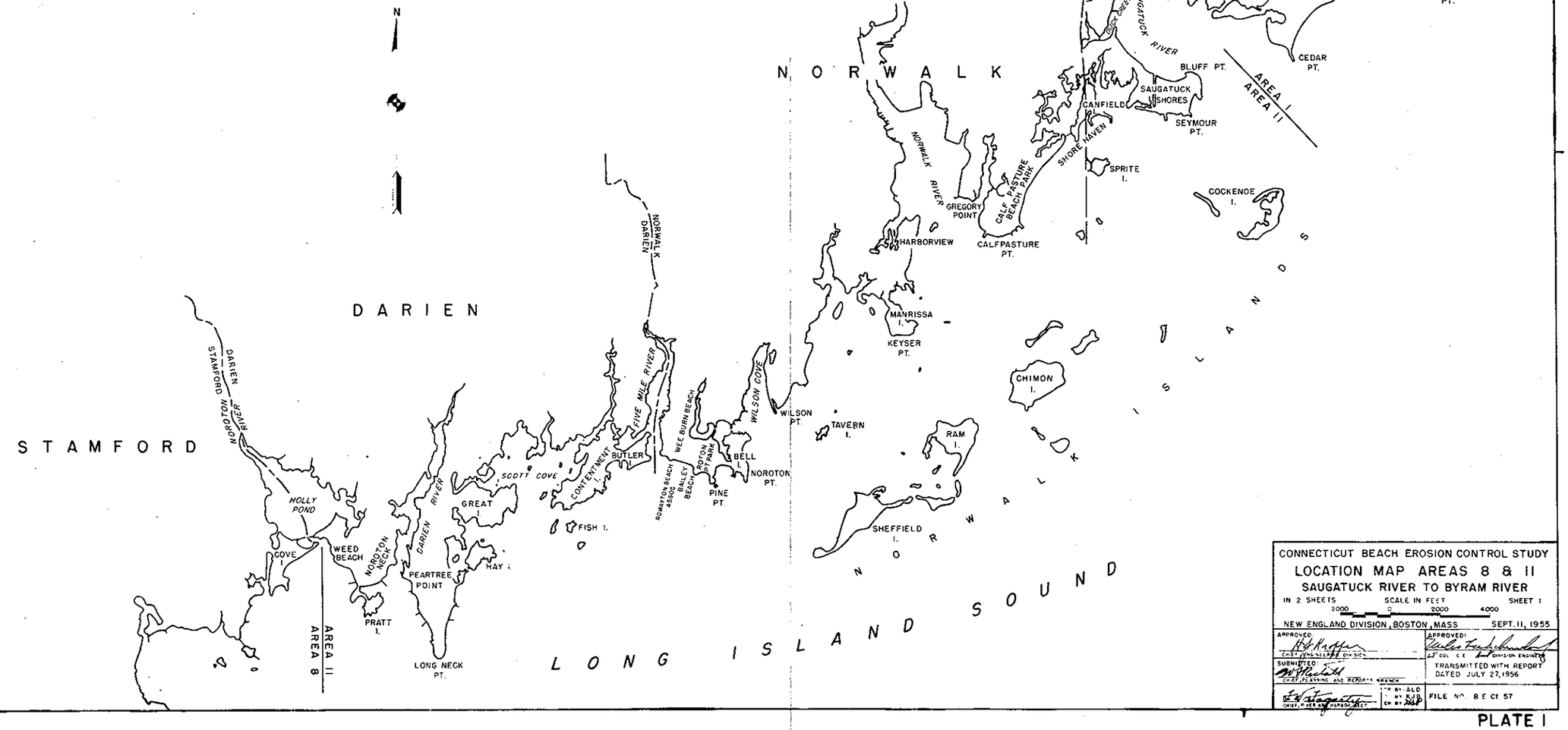
4. Classification of the Shore. - The shore was classified by bacterial analysis of samples collected during 1953 and 1954 and by the sanitary survey. According to this classification all shore area for which plans of protection or improvement have been developed were rated as A, B, or C. None of these shore areas were found to be in a questionable category from the standpoint of bathing water safety.

CORPS OF ENGINEERS

U.S. ARMY







CONNECTICUT BEACH EROSION CONTROL STUDY

LOCATION MAP AREAS 8 & II

SAUGATUCK RIVER TO BYRAM RIVER

IN 2 SHEETS — SCALE IN FEET — SHEET 1

2000 0 2000 4000

NEW ENGLAND DIVISION, BOSTON, MASS — SEPT. 11, 1955

APPROVED: H.F. Kaffer, CHIEF, NEW ENGLAND DIV. SEC.

APPROVED: Carlos Fenchbuch, LT COL C.E. AND DIVISION ENGINEER

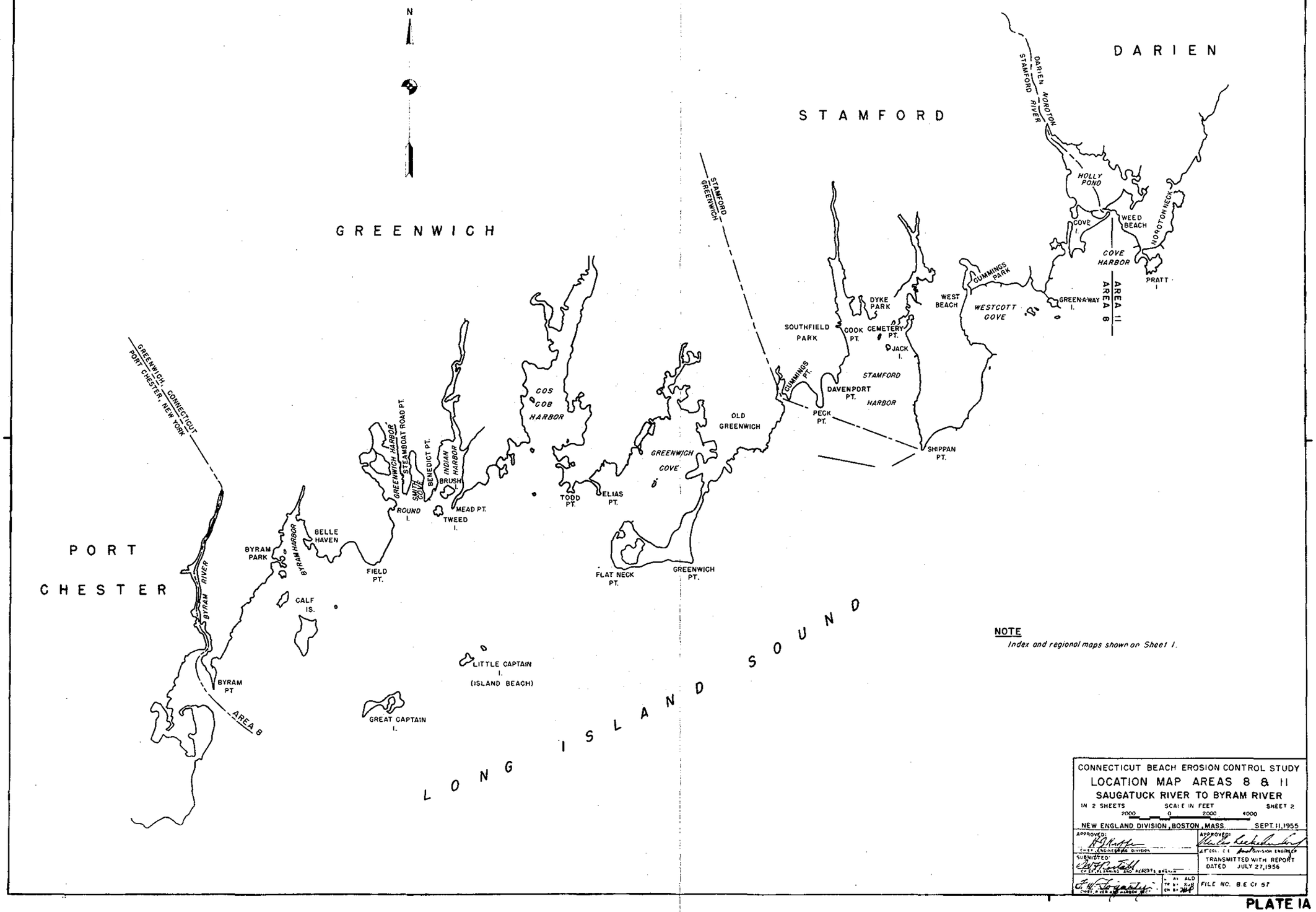
SUBMITTED: M. Plaisted, CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED JULY 27, 1956

CHIEF, PLANNING SECTION — DR BY ALD, TR BY KJS, CH BY JHP

FILE NO. B E Ct 57

PLATE I



NOTE

Index and regional maps shown on Sheet 1.

CONNECTICUT BEACH EROSION CONTROL STUDY

LOCATION MAP AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 2 SHEETS SCALE IN FEET SHEET 2

2000 0 2000 4000

NEW ENGLAND DIVISION, BOSTON, MASS. SEPT 11, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: COL. C.E. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED JULY 27, 1956

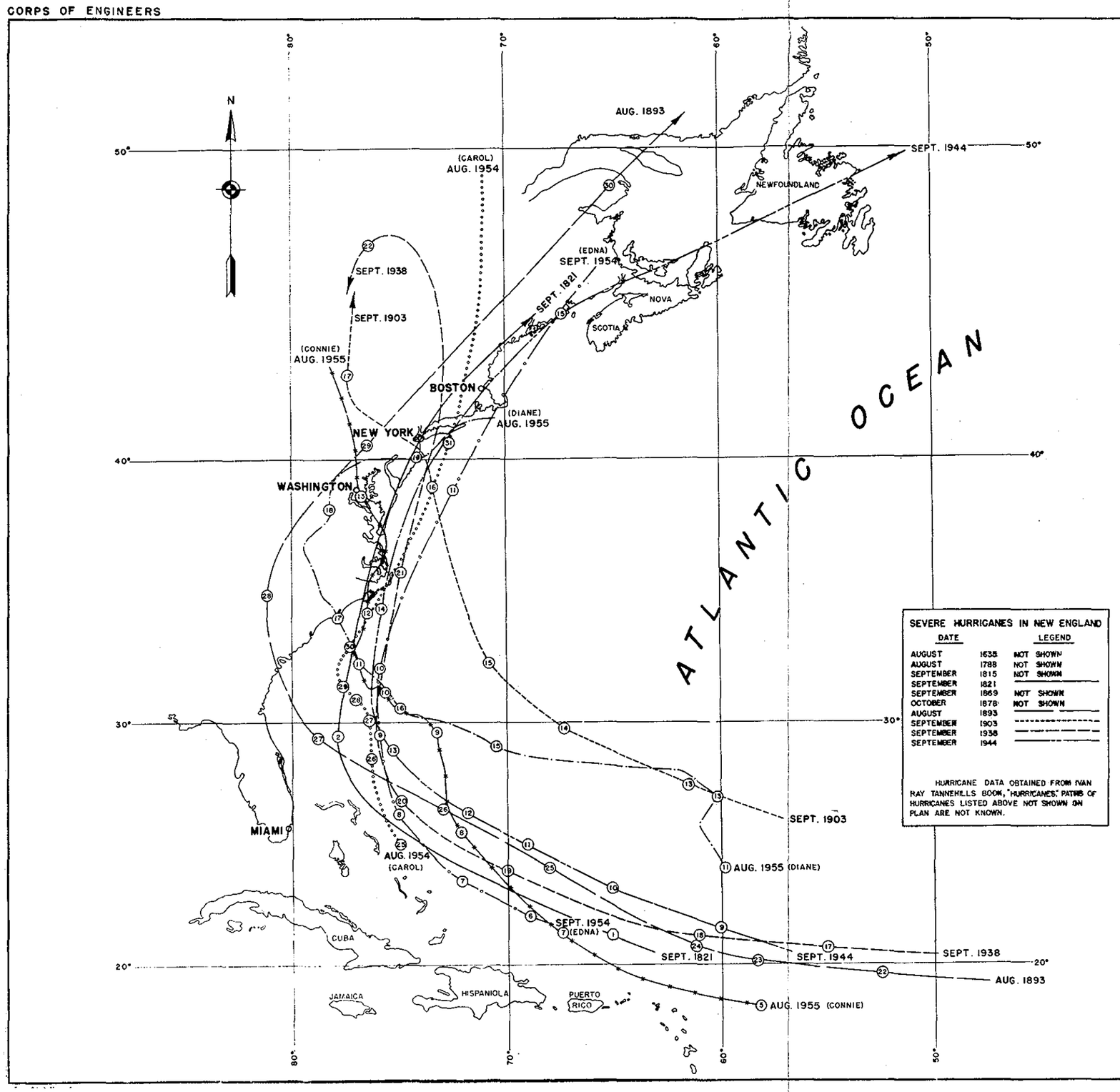
BY: ALD TR BY: K-B CH BY:

FILE NO. 8 E Ct 57

PLATE IA

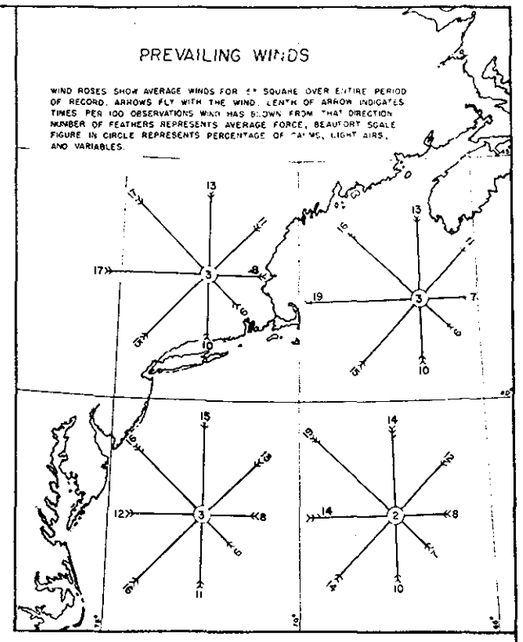
CORPS OF ENGINEERS

U.S. ARMY



PREVAILING WINDS

WIND ROSES SHOW AVERAGE WINDS FOR 1° SQUARE OVER ENTIRE PERIOD OF RECORD. ARROWS FLY WITH THE WIND. LENGTH OF ARROW INDICATES TIMES PER 100 OBSERVATIONS WIND HAS BLOWN FROM THAT DIRECTION. NUMBER OF FEATHERS REPRESENTS AVERAGE FORCE, BEAUFORT SCALE. FIGURE IN CIRCLE REPRESENTS PERCENTAGE OF CALMS, LIGHT AIRS, AND VARIABLES.



RECENT HURRICANES

DATE	LEGEND	CODE NAME
AUG. 25-31, 1954	○○○○○○○○○○	CAROL
SEPT. 6-11, 1954	——○——	EDNA
AUG. 5-13, 1955	—×—×—×—	CONNIE
AUG. 11-19, 1955	——·——·——	DIANE

SEVERE HURRICANES IN NEW ENGLAND

DATE		LEGEND
AUGUST	1635	NOT SHOWN
AUGUST	1788	NOT SHOWN
SEPTEMBER	1815	NOT SHOWN
SEPTEMBER	1821	———
SEPTEMBER	1869	NOT SHOWN
OCTOBER	1878	NOT SHOWN
AUGUST	1893	———
SEPTEMBER	1903	- - - - -
SEPTEMBER	1938	——·——·——
SEPTEMBER	1944	——··——

HURRICANE DATA OBTAINED FROM IVAN RAY TANNEHILLS BOOK, "HURRICANES." PATHS OF HURRICANES LISTED ABOVE NOT SHOWN ON PLAN ARE NOT KNOWN.

NOTE

Figures in circles shown thus (13) represent location of the center of hurricane on the day of month of its occurrance.

REVISION	DATE	DESCRIPTION	BY
1	10/6/55	Hurricane paths during 1954 and 1955 added.	C.T.M

CONNECTICUT BEACH EROSION CONTROL STUDY

HURRICANES AND PREVAILING WINDS

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED: Harry A. Hollmann, CHIEF, R.B.&H. OPERATIONS DIVISION

APPROVED: [illegible], LT. COL., C.E., ASST. DIVISION ENGINEER

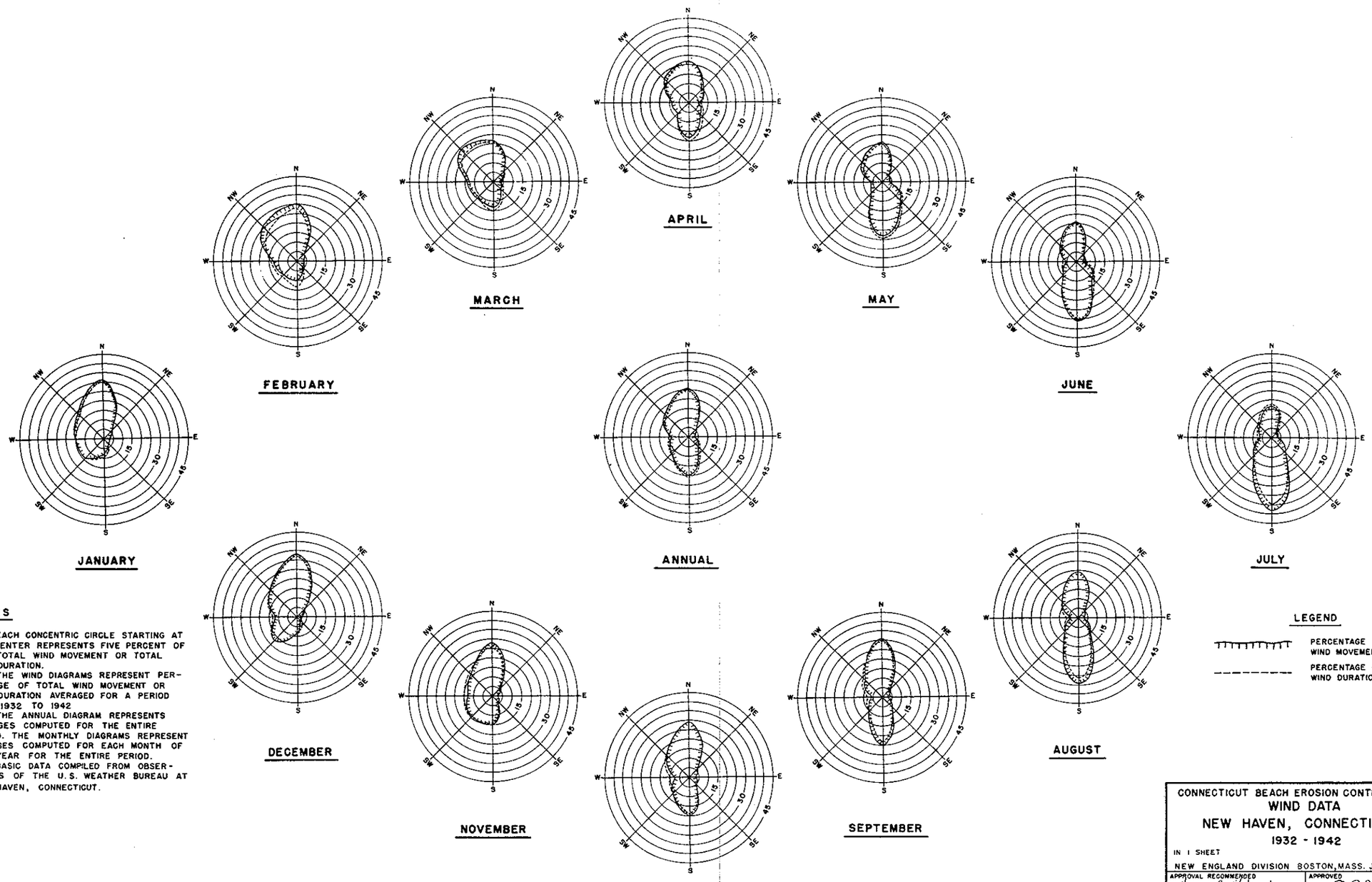
SUBMITTED: [illegible], R.B.&H. PROJECTS AND REPORTS BRANCH

DR. BY H.S.E. TR. BY E.J. CH. BY J.W.P.

TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949

FILE NO. B.E.C1.2

PLATE 2



NOTES

EACH CONCENTRIC CIRCLE STARTING AT THE CENTER REPRESENTS FIVE PERCENT OF THE TOTAL WIND MOVEMENT OR TOTAL WIND DURATION.

THE WIND DIAGRAMS REPRESENT PERCENTAGE OF TOTAL WIND MOVEMENT OR WIND DURATION AVERAGED FOR A PERIOD FROM 1932 TO 1942

THE ANNUAL DIAGRAM REPRESENTS AVERAGES COMPUTED FOR THE ENTIRE PERIOD. THE MONTHLY DIAGRAMS REPRESENT AVERAGES COMPUTED FOR EACH MONTH OF THE YEAR FOR THE ENTIRE PERIOD.

BASIC DATA COMPILED FROM OBSERVATIONS OF THE U.S. WEATHER BUREAU AT NEW HAVEN, CONNECTICUT.

LEGEND

PERCENTAGE OF TOTAL WIND MOVEMENT

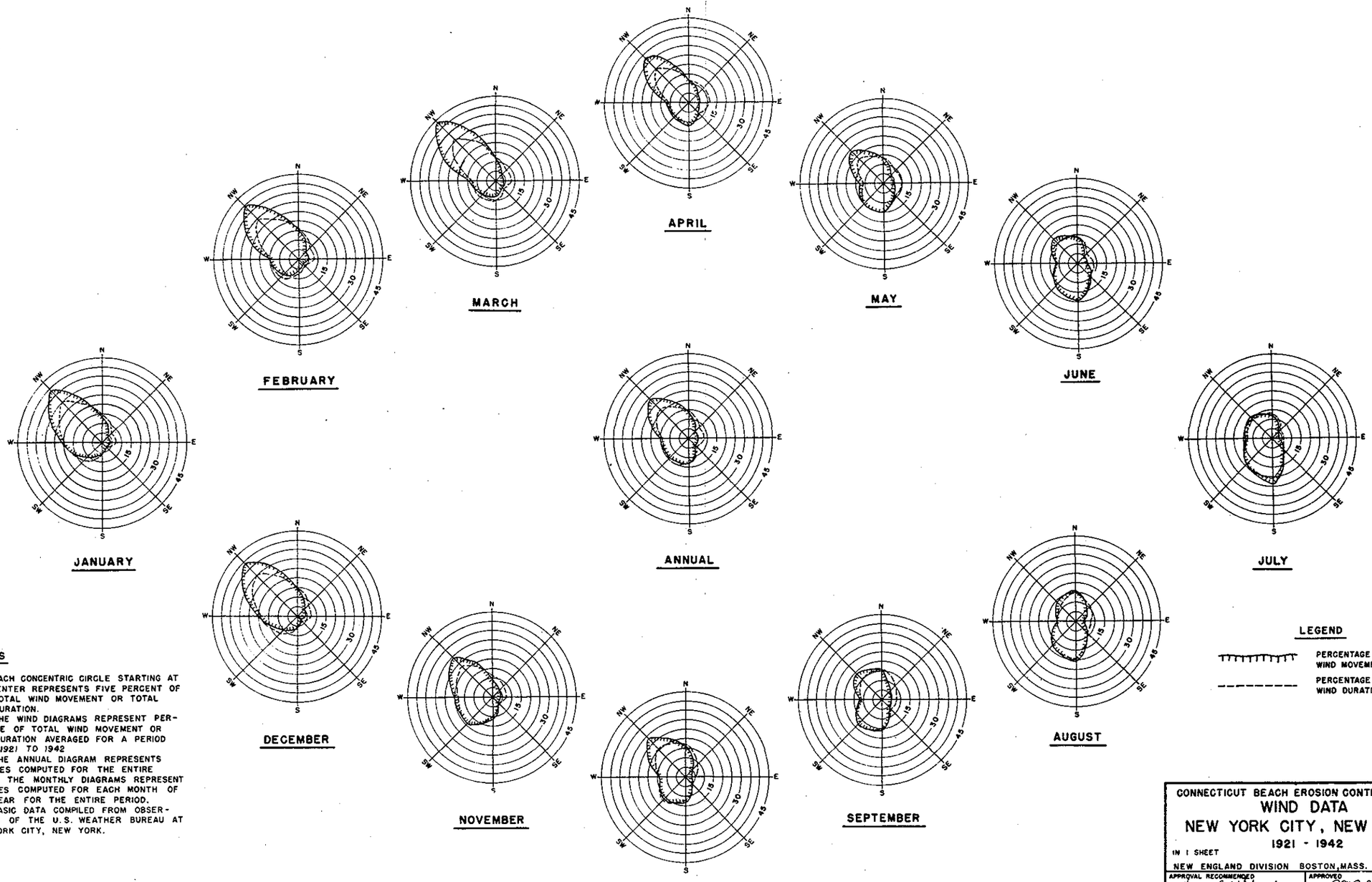
PERCENTAGE OF TOTAL WIND DURATION

CONNECTICUT BEACH EROSION CONTROL STUDY
WIND DATA
NEW HAVEN, CONNECTICUT
1932 - 1942

IN 1 SHEET

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED	APPROVED
Henry A. Whitcomb CHIEF, R & H OPERATIONS DIVISION	LT COL, C.E., ASST DIVISION ENGINEER
SUBMITTED F. M. Rice R & H PROJECTS AND REPORTS BRANCH	
DR. BY H.S.P. TR. BY M.K. CH. BY [illegible]	FILE NO. B.E.Ct.4



NOTES

EACH CONCENTRIC CIRCLE STARTING AT THE CENTER REPRESENTS FIVE PERCENT OF THE TOTAL WIND MOVEMENT OR TOTAL WIND DURATION.

THE WIND DIAGRAMS REPRESENT PERCENTAGE OF TOTAL WIND MOVEMENT OR WIND DURATION AVERAGED FOR A PERIOD *FROM 1921 TO 1942*

THE ANNUAL DIAGRAM REPRESENTS AVERAGES COMPUTED FOR THE ENTIRE PERIOD. THE MONTHLY DIAGRAMS REPRESENT AVERAGES COMPUTED FOR EACH MONTH OF THE YEAR FOR THE ENTIRE PERIOD.

BASIC DATA COMPILED FROM OBSERVATIONS OF THE U.S. WEATHER BUREAU AT NEW YORK CITY, NEW YORK.

LEGEND

PERCENTAGE OF TOTAL WIND MOVEMENT

PERCENTAGE OF TOTAL WIND DURATION

CONNECTICUT BEACH EROSION CONTROL STUDY

WIND DATA
NEW YORK CITY, NEW YORK
1921 - 1942

IN 1 SHEET

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED Henry A. Whitcomb CHIEF, R & H OPERATIONS DIVISION	APPROVED [signature] LT COL., C.E., ASST DIVISION ENGINEER
SUBMITTED F. M. Rice R & H PROJECTS AND REPORTS BRANCH	
DR. BY H.S.P. TR. BY R.B. CH. BY [illegible]	FILE NO. B.E.C1.5

PLATE 5

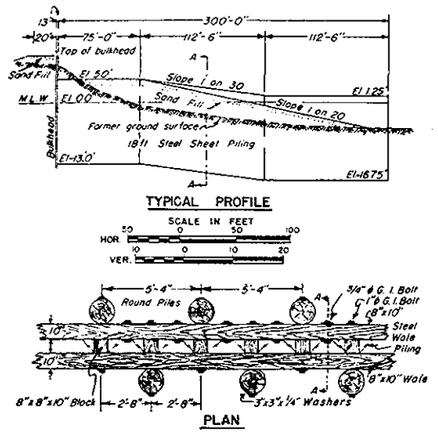


FIGURE 1

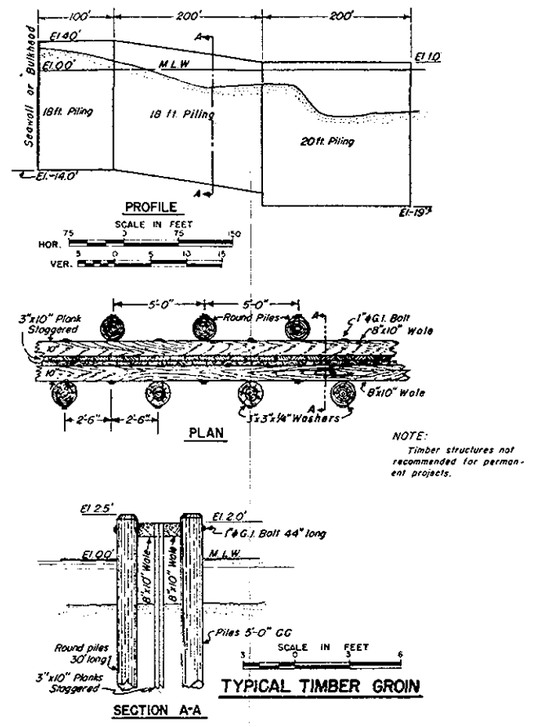


FIGURE 2

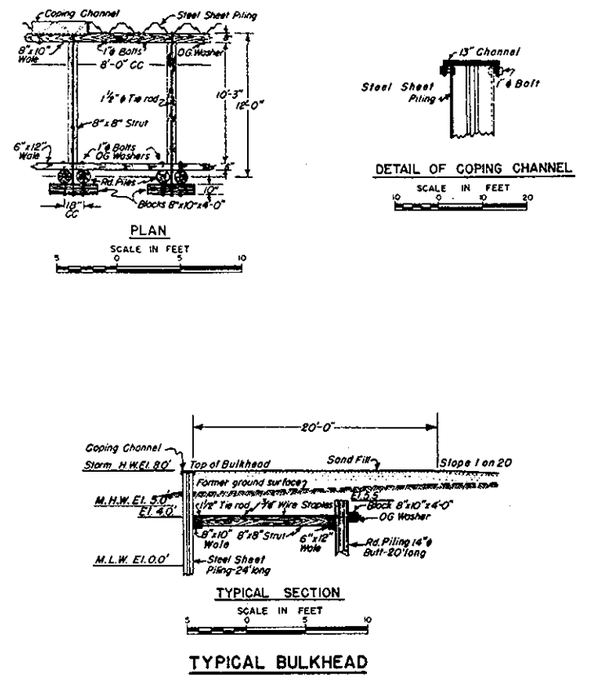


FIGURE 3

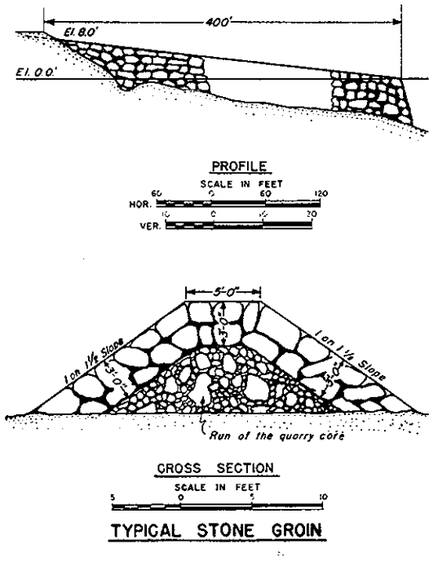


FIGURE 4

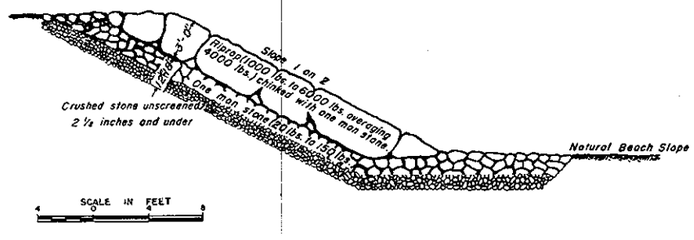


FIGURE 5

NOTE

Typical construction details reproduced from "Engineering Manual for Civil Works, Beach Erosion Studies," Part CXXXIII dated April 1947.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORE STRUCTURES

TYPICAL CONSTRUCTION DETAILS

IN 1 SHEET SCALE AS SHOWN

NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

APPROVAL RECOMMENDED: Henry C. Whitman, CHIEF, R.&M. OPERATIONS DIVISION

APPROVED: LT COL, C.E., ASST. DIVISION ENGINEER

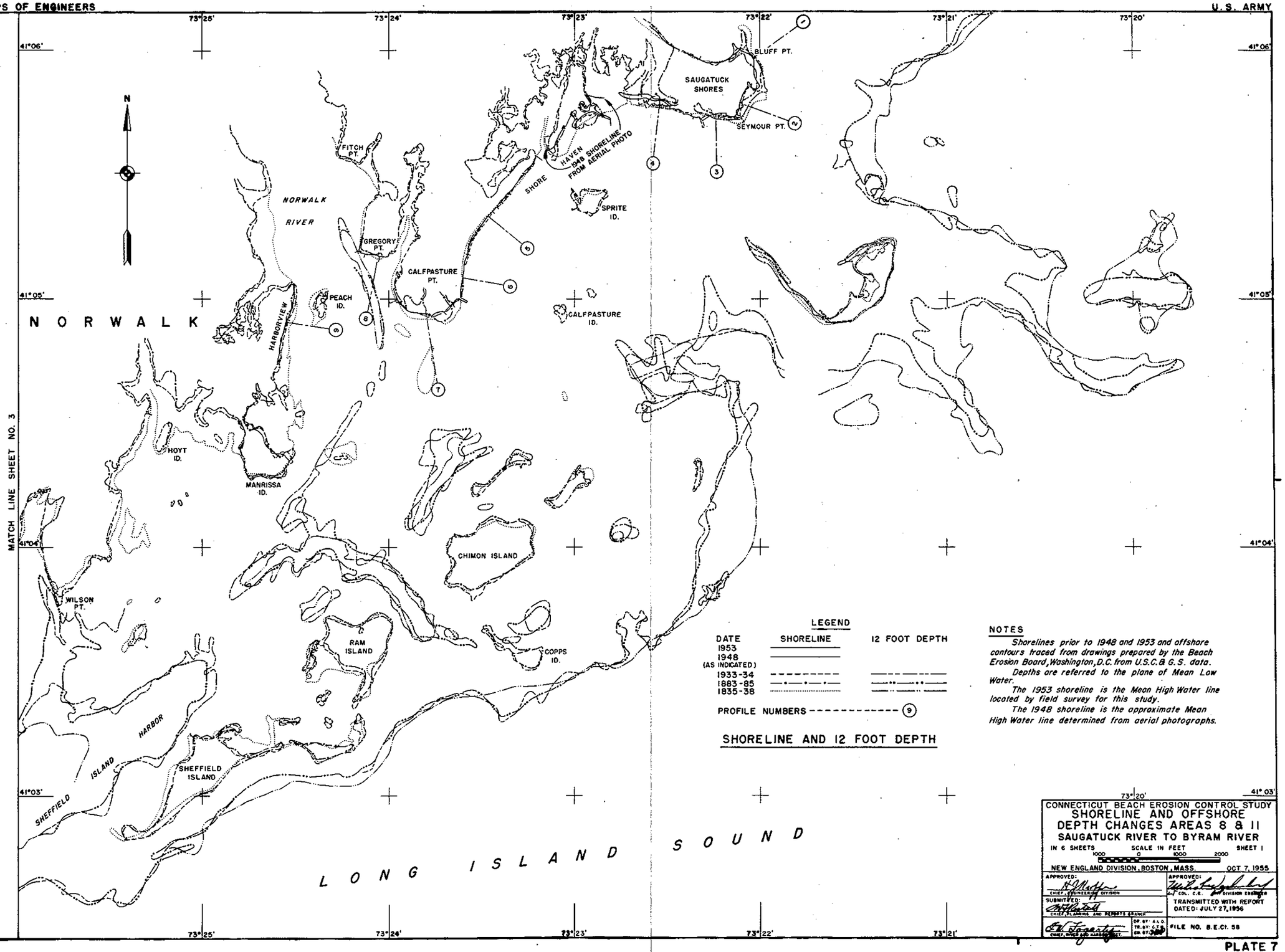
SUBMITTED: F. M. Rice, R & M PROJECTS AND REPORTS BRANCH

DR. BY M.S.P. TR. BY M.D. CH. BY

FILE NO. B.E.C. 1. 6

PLATE 6

CORPS OF ENGINEERS U.S. ARMY



NOTES

Shorelines prior to 1948 and 1953 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C. from U.S.C.& G.S. data.

Depths are referred to the plane of Mean Low Water.

The 1953 shoreline is the Mean High Water line located by field survey for this study.

The 1948 shoreline is the approximate Mean High Water line determined from aerial photographs.

CONNECTICUT BEACH EROSION CONTROL STUDY
SHORELINE AND OFFSHORE
DEPTH CHANGES AREAS 8 & 11
SAUGATUCK RIVER TO BYRAM RIVER

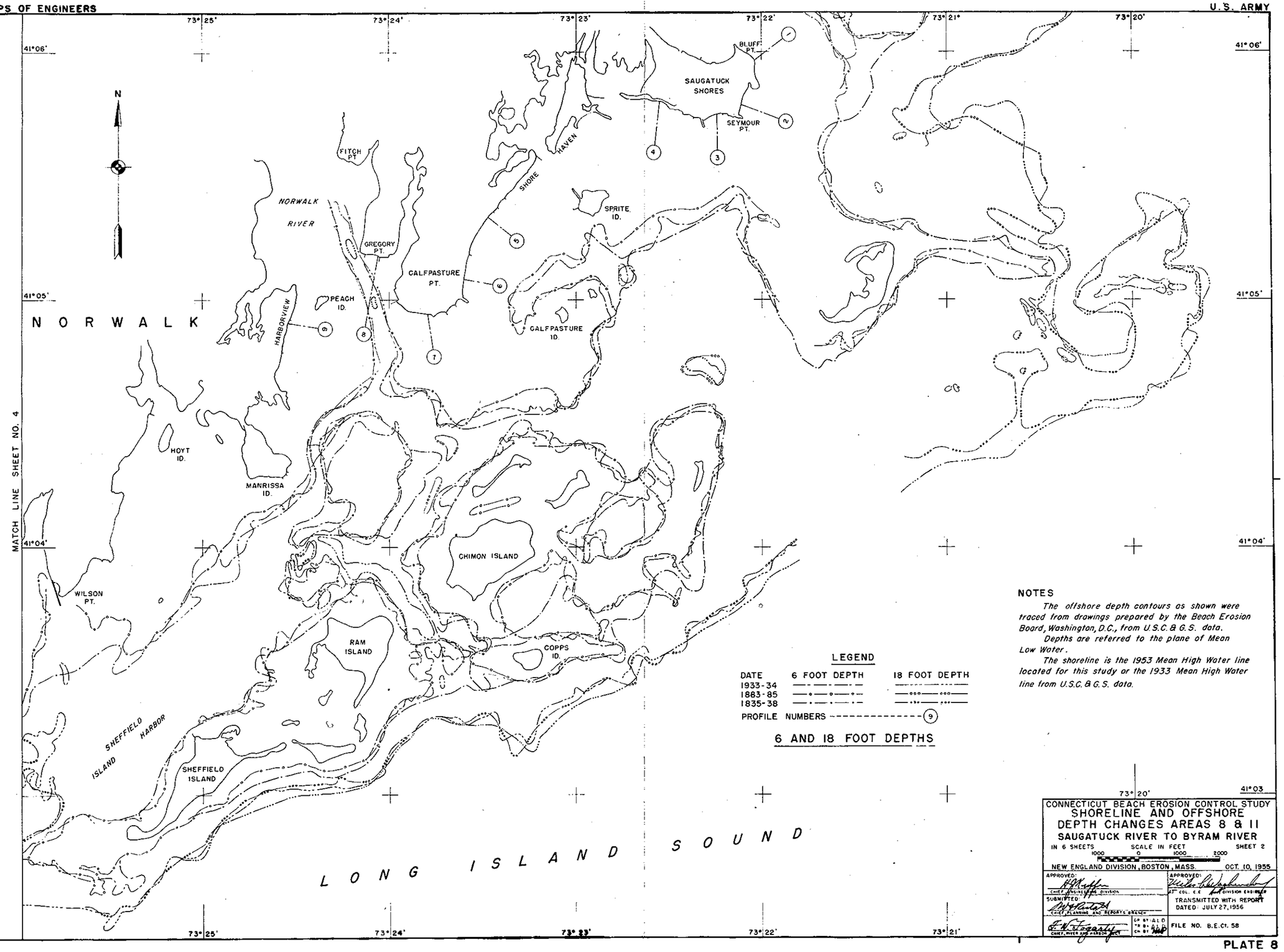
IN 6 SHEETS SCALE IN FEET SHEET 1
1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 7, 1955

APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL. C.E. DIVISION ENGINEER
SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH
TRANSMITTED WITH REPORT DATED: JULY 27, 1956
CHIEF, RIVER AND HARBOR SECT.
DR. BY: A.L.O. TR. BY: C.T.H. CH. BY:
FILE NO. B.E.Ct. 58

PLATE 7

CORPS OF ENGINEERS U.S. ARMY



NOTES

The offshore depth contours as shown were traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. data.

Depths are referred to the plane of Mean Low Water.

The shoreline is the 1953 Mean High Water line located for this study or the 1933 Mean High Water line from U.S.C. & G.S. data.

CONNECTICUT BEACH EROSION CONTROL STUDY
SHORELINE AND OFFSHORE
DEPTH CHANGES AREAS 8 & 11
SAUGATUCK RIVER TO BYRAM RIVER

IN 6 SHEETS SCALE IN FEET SHEET 2
1000 0 1000 2000

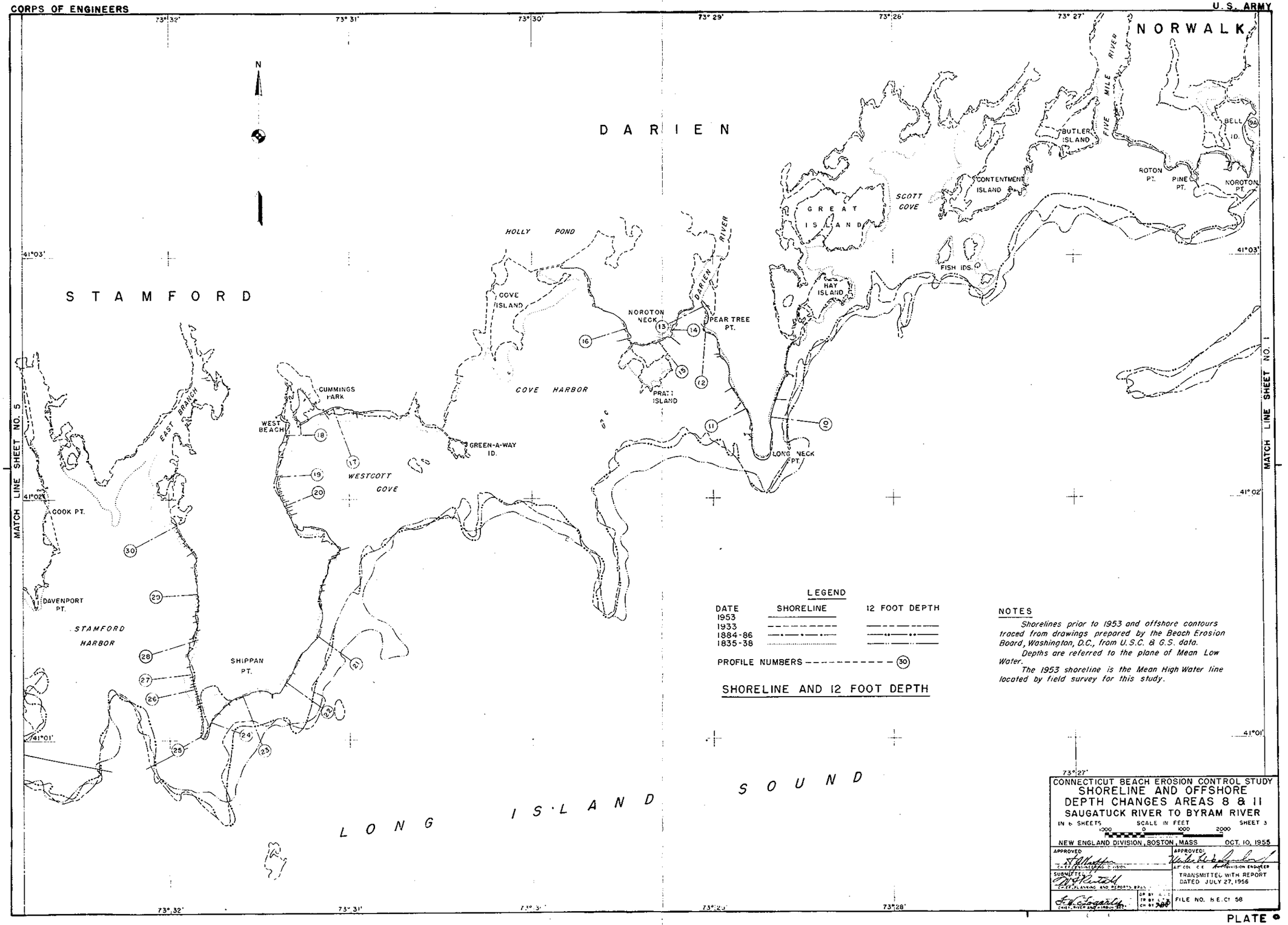
NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 10, 1955

APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: COL. C.E. DIVISION ENGINEER
SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH
TRANSMITTED WITH REPORT DATED: JULY 27, 1956
CHIEF, RIVER AND HARBOR SECT.
DR BY: A.L.D. TR BY: A.L.D. CH BY:
FILE NO. B.E.Ct. 58

PLATE 8

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

DATE	SHORELINE	12 FOOT DEPTH
1953	———	———
1933	- - - - -	- - - - -
1884-86	—•—•—	—••—••—
1835-38	·····	·····

PROFILE NUMBERS ---------- (30)

SHORELINE AND 12 FOOT DEPTH

NOTES

Shorelines prior to 1953 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. data.

Depths are referred to the plane of Mean Low Water.

The 1953 shoreline is the Mean High Water line located by field survey for this study.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 6 SHEETS — SCALE IN FEET 1000 0 1000 2000 — SHEET 3

NEW ENGLAND DIVISION, BOSTON, MASS — OCT. 10, 1955

APPROVED: Col. C.E. Division Engineer

SUBMITTED: Chief, Planning and Reports Branch

Chief, River and Harbor Br.

TRANSMITTED WITH REPORT DATED JULY 27, 1956

DR BY A.J.S. TR BY A.J.S. CH BY [illegible]

FILE NO. 6 E.Ct 58

PLATE 6

CORPS OF ENGINEERS

U.S. ARMY

73° 32' 73° 31' 73° 30' 73° 29' 73° 28' 73° 27'

41° 03'

41° 02'

41° 01'

N

STAMFORD

DARIEN

NORWALK

LONG ISLAND SOUND

COOK PT.

EAST BRANCH

STAMFORD HARBOR

SHIPPAN PT.

CUMMINGS PARK

WEST BEACH

WESTCOTT COVE

GREEN-A-WAY ID.

COVE HARBOR

COVE ISLAND

HOLLY POND

NOROTON NECK

PEAR TREE PT.

PRATT ID.

DARIEN RIVER

GREAT ISLAND

HAY ISLAND

LONG NECK PT.

SCOTT COVE

CONTENTMENT ISLAND

BUTLER ISLAND

FIVE MILE RIVER

BELL ID.

MATCH LINE SHEET NO. 6

MATCH LINE SHEET NO. 2

LEGEND

DATE	6 FOOT DEPTH	18 FOOT DEPTH
1933		
1884-86		
1835-38		

PROFILE NUMBERS ---------- (10)

6 AND 18 FOOT DEPTHS

NOTES

The offshore depth contours as shown were traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. data.

Depths are referred to the plane of Mean Low Water.

The shoreline is the 1953 Mean High Water line located for this study or the 1933 Mean High Water line from U.S.C. & G.S. data.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

SCALE IN FEET 1000 0 1000 2000 SHEET 4

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 10, 1955

SUBMITTED

APPROVED

TRANSMITTED WITH REPORT DATED JULY 27, 1956

FILE NO. B.E.CT. 58

PLATE 10

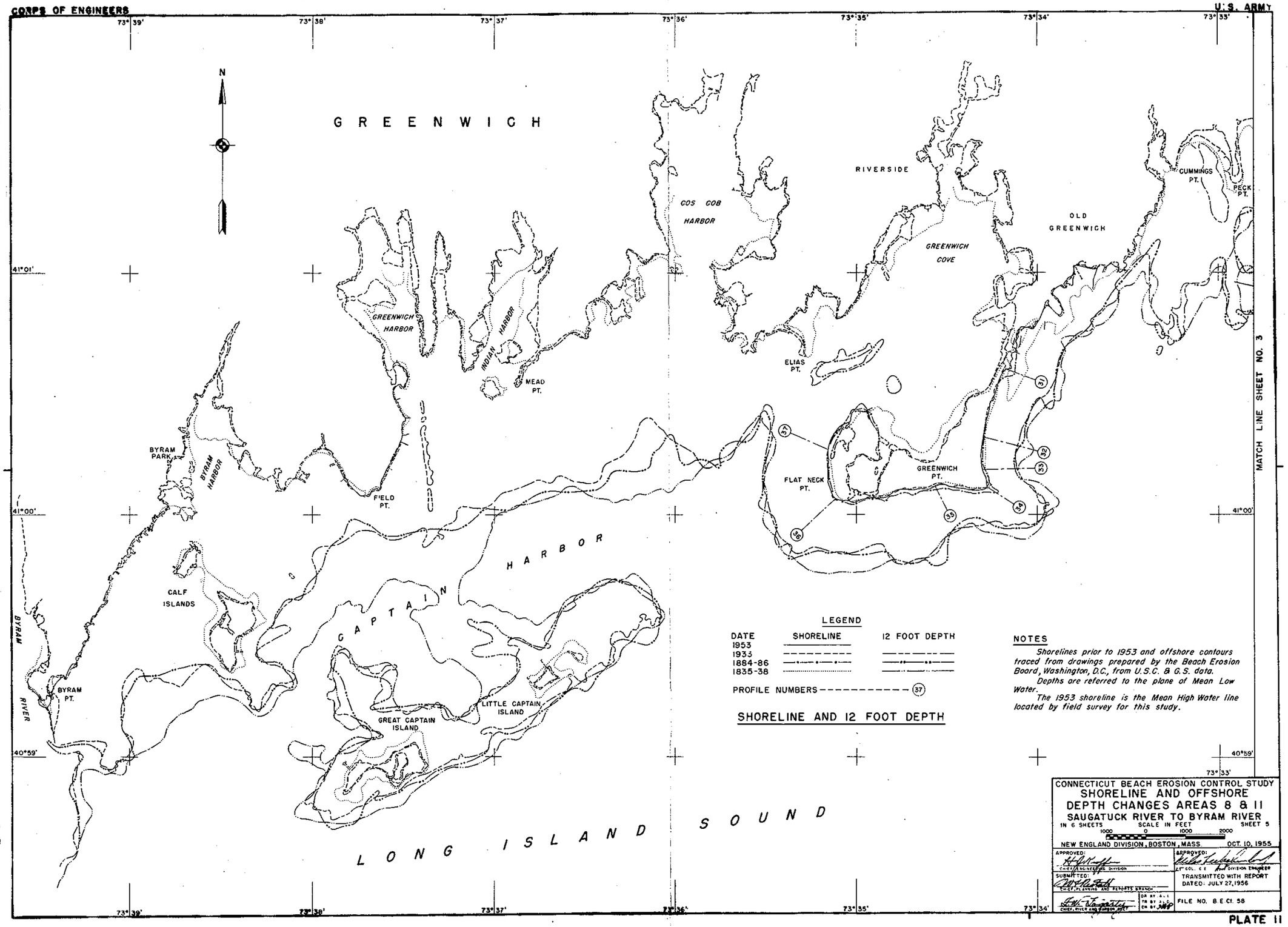

CORPS OF ENGINEERS
U.S. ARMY
73° 39'
73° 38'
73° 37'
73° 36'
73° 35'
73° 34'
73° 33'
41° 01'
41° 00'
40° 59'
N
GREENWICH
RIVERSIDE
COS COB HARBOR
GREENWICH COVE
OLD GREENWICH
CUMMINGS PT.
PECK PT.
GREENWICH HARBOR
INDIAN HARBOR
MEAD PT.
ELIAS PT.
BYRAM PARK
BYRAM HARBOR
FIELD PT.
FLAT NECK PT.
GREENWICH PT.
CALF ISLANDS
CAPTAIN HARBOR
BYRAM RIVER
BYRAM PT.
GREAT CAPTAIN ISLAND
LITTLE CAPTAIN ISLAND
LONG ISLAND SOUND
MATCH LINE SHEET NO. 3
LEGEND
DATE
SHORELINE
12 FOOT DEPTH
1953
1933
1884-86
1835-38
PROFILE NUMBERS
37
SHORELINE AND 12 FOOT DEPTH
NOTES
Shorelines prior to 1953 and offshore contours traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. data.
Depths are referred to the plane of Mean Low Water.
The 1953 shoreline is the Mean High Water line located by field survey for this study.
CONNECTICUT BEACH EROSION CONTROL STUDY
SHORELINE AND OFFSHORE
DEPTH CHANGES AREAS 8 & 11
SAUGATUCK RIVER TO BYRAM RIVER
IN 6 SHEETS
SCALE IN FEET
SHEET 5
1000 0 1000 2000
NEW ENGLAND DIVISION, BOSTON, MASS.
OCT. 10, 1955
APPROVED:
CHIEF, ENGINEERING DIVISION
APPROVED:
COL. C.E. DIVISION ENGINEER
SUBMITTED:
CHIEF, PLANNING AND REPORTS BRANCH
TRANSMITTED WITH REPORT DATED: JULY 27, 1956
CHIEF, RIVER AND HARBOR SECT.
DR. BY A.L.C.
TR. BY A.L.C.
CK. BY
FILE NO. 8.E.Ct. 58

PLATE 11

CORPS OF ENGINEERS

U.S. ARMY

73°39' 73°38' 73°37' 73°36' 73°35' 73°34' 73°33'

41°01'

41°00'

40°59'

N

GREENWICH

GREENWICH HARBOR

INDIAN HARBOR

MEAD PT.

COS COB HARBOR

ELIAS PT

RIVERSIDE

GREENWICH COVE

OLD GREENWICH

CUMMINGS PT.

PECK PT.

BYRAM PARK

BYRAM HARBOR

FIELD PT.

CAPTAIN HARBOR

CALF ISLANDS

BYRAM RIVER

BYRAM PT.

LITTLE CAPTAIN ISLAND

GREAT CAPTAIN ISLAND

LONG ISLAND SOUND

FLAT NECK PT.

GREENWICH PT.

37 31 32 33 34 36 35

MATCH LINE SHEET NO. 4

LEGEND

DATE	6 FOOT DEPTH	18 FOOT DEPTH
1933	———	———
1884-86	—·—·—	—···—
1835-38	— — —	· · ·

PROFILE NUMBERS ----------(22)

6 AND 18 FOOT DEPTHS

NOTES

The offshore depth contours as shown were traced from drawings prepared by the Beach Erosion Board, Washington, D.C., from U.S.C. & G.S. data.

Depths are referred to the plane of Mean Low Water.

The shoreline is the 1953 Mean High Water line located for this study or the 1933 Mean High Water line from U.S.C. & G.S. data.

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 6 SHEETS SCALE IN FEET SHEET 6

1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 10, 1955

APPROVED: CHIEF ENGINEERS

APPROVED: LT. COL. C.E. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED JULY 27, 1956

CHIEF, RIVER AND HARBOR SECT.

DR BY PAC
TR BY PAC
CH BY JHP

FILE NO. 8 E Ct 58

PLATE 12

CORPS OF ENGINEERS

U.S. ARMY

DISTANCES OUT FROM BASE LINE IN FEET

DEPTHS IN FEET REFERRED TO M.L.W.

PROFILE NO. 10

TOP OF CONCRETE WALL

APRIL 1953

PROFILE NO. 16

APRIL 1953

PROFILE NO. 22

RIP RAP

CONCRETE SLAB

MARCH 1953

PROFILE NO. 11

TOP OF WALL

LAWN

MARCH 1953

PROFILE NO. 14

TOP OF WALL

NOROTON NECK

STONE WALL

MARCH 1953

PEARTREE POINT

LEDGE

PROFILE NO. 18

CONCRETE SLAB S. SIDE IRIQUOIS ST.

MARCH 1953

PROFILE NO. 1

APRIL 1953

PROFILE NO. 3

APRIL 1953

PROFILE NO. 5

APRIL 1953

PROFILE NO. 9

CONCRETE WALK

LAWN

APRIL 1953

PROFILE NO. 12

LEDGE

MARCH 1953

PROFILE NO. 6

PARKING APRON

STONE WALL

APRIL 1953

PROFILE NO. 7

℄ PAVED ROAD

℄ PAVED ROAD

APRIL 1953

PROFILE NO. 9A

LEDGE

TOP OF WALL

APRIL 1953

PROFILE NO. 17

CONCRETE PORCH WALL

MARCH 1953

LEGEND

LOCATION OF 6, 12, AND 18 FOOT DEPTHS PRIOR TO 1953 SHOWN THUS:

DATE	SYMBOL
1838	⊙
1884	▫
1933	△

SURVEY OF 1953 BY CORPS OF ENGINEERS, U.S. ARMY. PRIOR SURVEYS BY U.S.C.&G.S.

NOTE:
FOR LOCATION OF PROFILES, SEE PLATES 15-19.

CONNECTICUT BEACH EROSION CONTROL STUDY

COMPARATIVE PROFILES AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 2 SHEETS SCALES AS SHOWN SHEET 1

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 26, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: BRIG. GEN., USA DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

DR. BY: A.L.D. TR. BY: A.L.D. CH. BY:

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

FILE NO. B.E.C.t. 89

PLATE 13

PLATE 13

CORPS OF ENGINEERS

U. S. ARMY

DISTANCES OUT FROM BASE LINE IN FEET

DEPTHS IN FEET REFERRED TO M.L.W.

PROFILE NO. 32 — EDGE OF PARKING APRON — MARCH 1953

PROFILE NO. 19 — MARCH 1953

PROFILE NO. 35 — FEBRUARY 1953

PROFILE NO. 25 — TOP OF WALL — RIP RAP — MARCH 1953

PROFILE NO. 37 — SHORE ROAD — TOP OF BANK — RIP RAP — FEBRUARY 1953

PROFILE NO. 31 — MARCH 1953

PROFILE NO. 15 — LAWN — STONE WALL — ROCK — APRIL 1953

PROFILE NO. 24 — TOP OF WALL — RIP RAP — MARCH 1953

PROFILE NO. 29 — TOP OF WALL — MARCH 1953

PROFILE NO. 34 — RIP RAP — MARCH 1953

PROFILE NO. 23 — TOP OF WALL — CONCRETE WALK — RIP RAP — MARCH 1953

PROFILE NO. 26 — TOP OF WALL — LAWN — MARCH 1953

PROFILE NO. 28 — TOP OF WALL — MARCH 1953

PROFILE NO. 30 — TOP OF STONE WALL — LAWN — RIP RAP — MARCH 1953

PROFILE NO. 36 — RIP RAP — FEBRUARY 1953

LEGEND

LOCATION OF 6, 12, AND 18 FOOT DEPTHS PRIOR TO 1953 SHOWN THUS:

DATE	SYMBOL
1838	⊙
1884	▫
1933	△

SURVEY OF 1953 BY CORPS OF ENGINEERS, U.S. ARMY. PRIOR SURVEYS BY U.S.C.&G.S.

NOTE:
FOR LOCATION OF PROFILES, SEE PLATES 15-19.

CONNECTICUT BEACH EROSION CONTROL STUDY

COMPARATIVE PROFILES AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 2 SHEETS — SCALES AS SHOWN — SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 26, 1955

APPROVED: CHIEF, ENGINEERING DIVISION

APPROVED: MAJOR GEN., U.S.A. DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECT.

DR. BY: A.L.D. TR. BY: R.A.D. CH. BY:

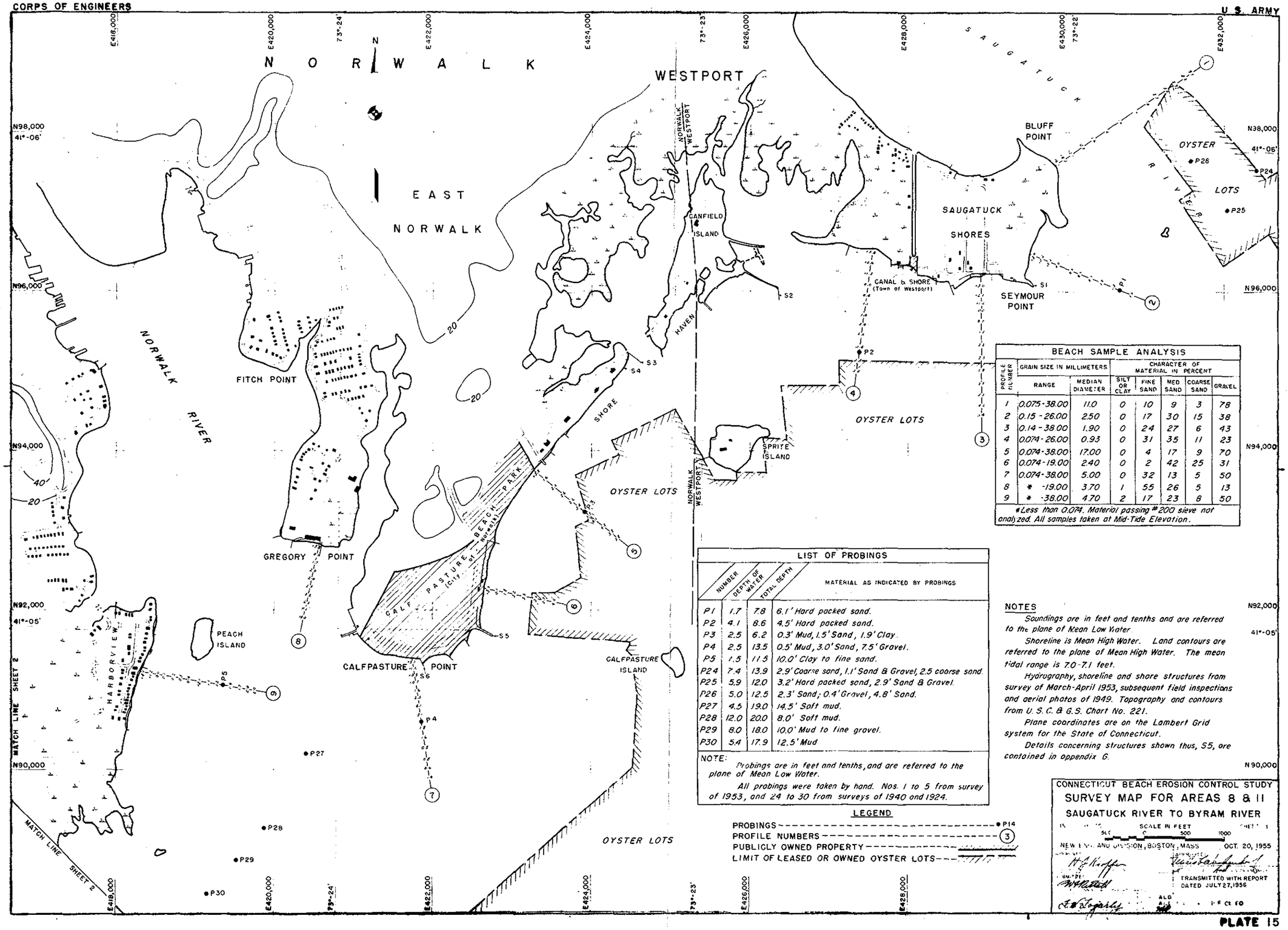
TRANSMITTED WITH REPORT DATED: JULY 27, 1956

FILE NO. B.E.C.I. 59

PLATE 14

PLATE 14

CORPS OF ENGINEERS — U.S. ARMY



BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT				
	RANGE	MEDIAN DIAMETER	SILT OR CLAY	FINE SAND	MED SAND	COARSE SAND	GRAVEL
1	0.075-38.00	11.0	0	10	9	3	78
2	0.15-26.00	2.50	0	17	30	15	38
3	0.14-38.00	1.90	0	24	27	6	43
4	0.074-26.00	0.93	0	31	35	11	23
5	0.074-38.00	17.00	0	4	17	9	70
6	0.074-19.00	2.40	0	2	42	25	31
7	0.074-38.00	5.00	0	32	13	5	50
8	* -19.00	3.70	1	55	26	5	13
9	* -38.00	4.70	2	17	23	8	50

*Less than 0.074. Material passing #200 sieve not analyzed. All samples taken at Mid-Tide Elevation.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P1	1.7	7.8	6.1' Hard packed sand.
P2	4.1	8.6	4.5' Hard packed sand.
P3	2.5	6.2	0.3' Mud, 1.5' Sand, 1.9' Clay.
P4	2.5	13.5	0.5' Mud, 3.0' Sand, 7.5' Gravel.
P5	1.5	11.5	10.0' Clay to fine sand.
P24	7.4	13.9	2.9' Coarse sand, 1.1' Sand & Gravel, 2.5 coarse sand.
P25	5.9	12.0	3.2' Hard packed sand, 2.9' Sand & Gravel.
P26	5.0	12.5	2.3' Sand; 0.4' Gravel, 4.8' Sand.
P27	4.5	19.0	14.5' Soft mud.
P28	12.0	20.0	8.0' Soft mud.
P29	8.0	18.0	10.0' Mud to fine gravel.
P30	5.4	17.9	12.5' Mud

NOTE: Probings are in feet and tenths, and are referred to the plane of Mean Low Water.

All probings were taken by hand. Nos. 1 to 5 from survey of 1953, and 24 to 30 from surveys of 1940 and 1924.

LEGEND

PROBINGS ---------- ● P14
PROFILE NUMBERS ---------- (3)
PUBLICLY OWNED PROPERTY ----------
LIMIT OF LEASED OR OWNED OYSTER LOTS ----------

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.0-7.1 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U.S.C. & G.S. Chart No. 221.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S5, are contained in appendix G.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

SCALE IN FEET 0 500 1000

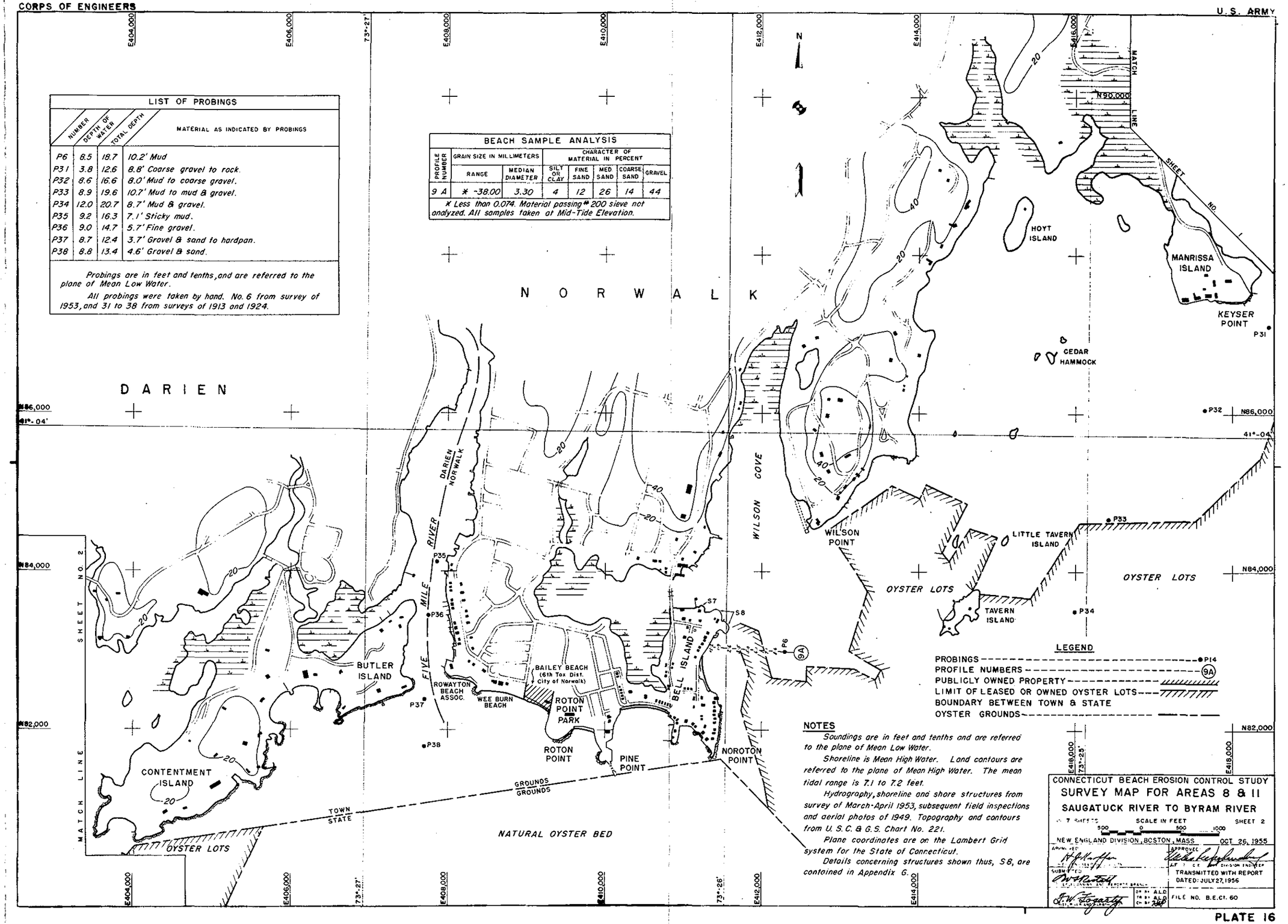
NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 20, 1955

TRANSMITTED WITH REPORT DATED JULY 27, 1956

PLATE 15

CORPS OF ENGINEERS

U.S. ARMY



LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P6	8.5	18.7	10.2' Mud
P31	3.8	12.6	8.8' Coarse gravel to rock.
P32	8.6	16.6	8.0' Mud to coarse gravel.
P33	8.9	19.6	10.7' Mud to mud & gravel.
P34	12.0	20.7	8.7' Mud & gravel.
P35	9.2	16.3	7.1' Sticky mud.
P36	9.0	14.7	5.7' Fine gravel.
P37	8.7	12.4	3.7' Gravel & sand to hardpan.
P38	8.8	13.4	4.6' Gravel & sand.

Probings are in feet and tenths, and are referred to the plane of Mean Low Water.

All probings were taken by hand. No. 6 from survey of 1953, and 31 to 38 from surveys of 1913 and 1924.

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT				
	RANGE	MEDIAN DIAMETER	SILT OR CLAY	FINE SAND	MED SAND	COARSE SAND	GRAVEL
9 A	* -38.00	3.30	4	12	26	14	44

** Less than 0.074. Material passing # 200 sieve not analyzed. All samples taken at Mid-Tide Elevation.*

LEGEND

PROBINGS ---------- P14
PROFILE NUMBERS ---------- 9A
PUBLICLY OWNED PROPERTY
LIMIT OF LEASED OR OWNED OYSTER LOTS
BOUNDARY BETWEEN TOWN & STATE
OYSTER GROUNDS

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.1 to 7.2 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U. S. C. & G. S. Chart No. 221.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S8, are contained in Appendix G.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

7 SHEETS — SCALE IN FEET 500 0 500 1000 — SHEET 2

NEW ENGLAND DIVISION, BOSTON, MASS — OCT. 26, 1955

APPROVED: H. J. Kaffer — APPROVED: Walter Kaufmann, Lt. Col. C.E. Division Engineer

SUBMITTED: W. J. Nestel, Chief, Planning and Reports Branch

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

DR. BY: A.L.D. TR. BY: A.L.D. CH. BY: [illegible]

FILE NO. B.E.Ct. 60

PLATE 16

CORPS OF ENGINEERS

U.S. ARMY

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P7	21.3	29.1	3.2' Mud, 4.6' Sand.
P8	10.1	17.5	3.0' Mud, 4.4' Sand.
P9	8.6	17.0	5.0' Mud, 3.4' Clay.
P10	11.5	17.7	1.0' Mud, 5.2' Sand to mud.

NOTE:
Probings are in feet and tenths, and are referred to the plane of Mean Low Water.
All probings were taken by hand from survey of 1953.

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT				
	RANGE	MEDIAN DIAMETER	SILT OR CLAY	FINE SAND	MED SAND	COARSE SAND	GRAVEL
10	0.074-38.00	6.60	0	4	31	9	56
11	* -12.00	3.20	27	29	27	7	10
12	0.074-38.00	4.00	0	14	26	12	48
13	0.074-19.00	1.40	0	28	34	20	18
14	0.074-25.00	1.70	0	6	48	14	32
15	* -38.00	0.74	11	30	24	12	23
16	0.074-38.00	9.30	0	19	18	6	57

*Less than 0.074. Material passing #200 sieve not analyzed. All samples taken at Mid-Tide Elevation.

N84,000 E390,000 E392,000 73°-30' E394,000 E396,000 73°-29' E398,000 E400,000 E402,000 73°-28' E404,000 N84,000

N80,000 41°-03'

N78,000

N76,000

N74,000 41°-02'

MATCH LINE SHEET NO. 4

MATCH LINE SHEET NO. 2

STAMFORD

DARIEN

HOLLY POND

DARIEN STAMFORD

COVE ISLAND (City of Stamford)

(City of Stamford)

WEED BEACH (Town of Darien)

NOROTON NECK

DARIEN RIVER

(Town of Darien) PEARTREE POINT

SOUTH BEACH

THE GUT

COVE HARBOR

PRATT ISLAND

SCOTT COVE

GREAT ISLAND

HAY ISLAND

FISH ISLANDS

GREEN-A-WAY ISLAND

LONG NECK POINT

OYSTER LOTS

GROUNDS

TOWN STATE

P7 P8 P9 P10 S9 S10 S11 S12

LEGEND

PROBINGS ---------- P9
PROFILE NUMBERS ---------- (10)
PUBLICLY OWNED PROPERTY ----------
LIMIT OF LEASED OR OWNED OYSTER LOTS ----------
BOUNDARY BETWEEN TOWN AND STATE ----------
OYSTER GROUNDS ----------

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.2 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U.S.C. & G.S. Chart No. 221.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S9, are contained in appendix G.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 7 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 3

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 25, 1955.

APPROVED: W. H. Kaffen, Division Engineer

W. P. Rutch, Major, Corps of Engineers

F. W. Fogarty, Chief, Engineering Division

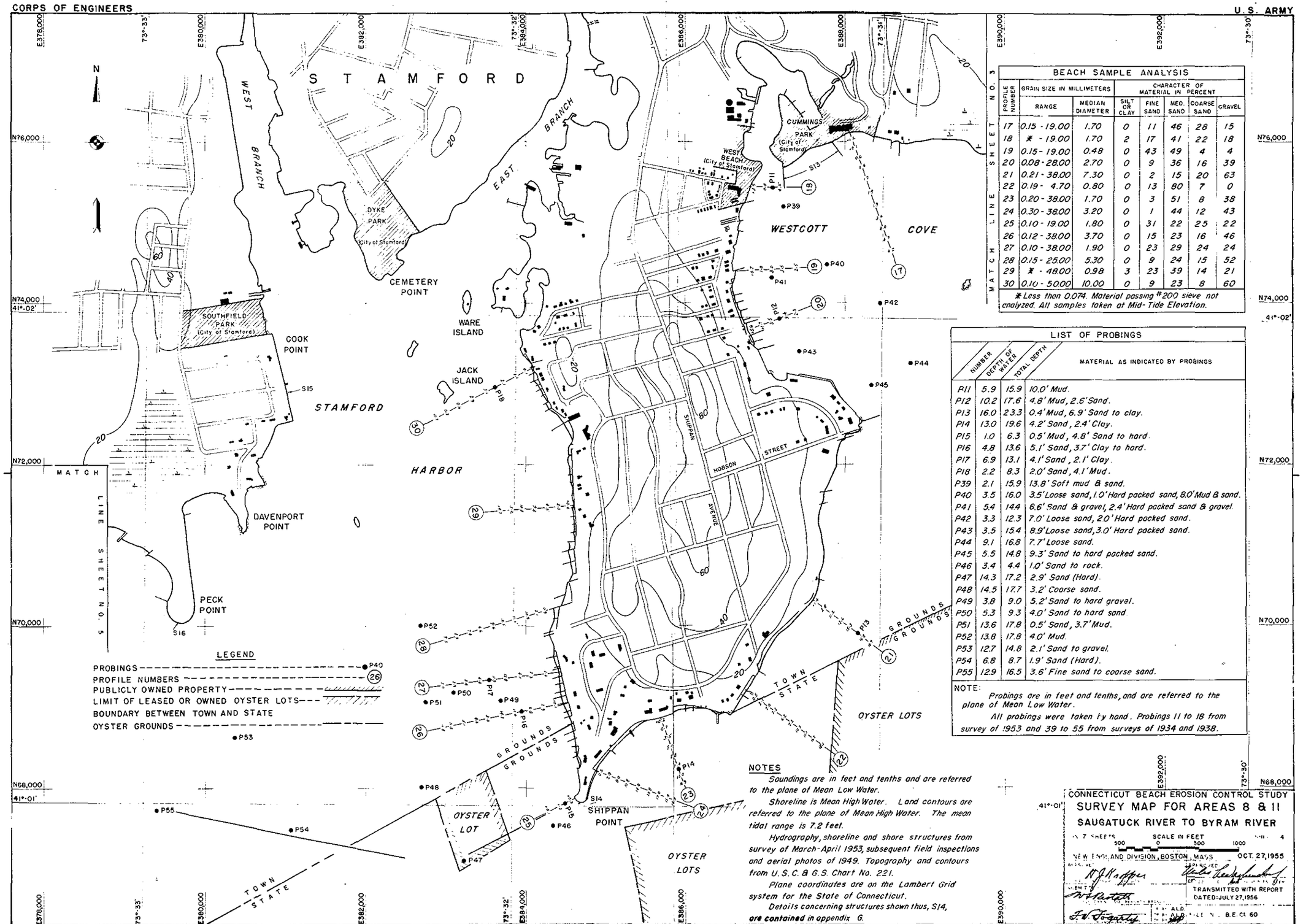
TRANSMITTED WITH REPORT DATED: JULY 27, 1956

A.L.D. FILE NO. B.E.Ct. 60

PLATE 17

CORPS OF ENGINEERS

U.S. ARMY



LEGEND

PROBINGS ---------- P40

PROFILE NUMBERS ---------- (26)

PUBLICLY OWNED PROPERTY ----------

LIMIT OF LEASED OR OWNED OYSTER LOTS ----

BOUNDARY BETWEEN TOWN AND STATE

OYSTER GROUNDS ----------

P53

BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT				
	RANGE	MEDIAN DIAMETER	SILT OR CLAY	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
17	0.15 - 19.00	1.70	0	11	46	28	15
18	* - 19.00	1.70	2	17	41	22	18
19	0.15 - 19.00	0.48	0	43	49	4	4
20	0.08 - 28.00	2.70	0	9	36	16	39
21	0.21 - 38.00	7.30	0	2	15	20	63
22	0.19 - 4.70	0.80	0	13	80	7	0
23	0.20 - 38.00	1.70	0	3	51	8	38
24	0.30 - 38.00	3.20	0	1	44	12	43
25	0.10 - 19.00	1.80	0	31	22	25	22
26	0.12 - 38.00	3.70	0	15	23	16	46
27	0.10 - 38.00	1.90	0	23	29	24	24
28	0.15 - 25.00	5.30	0	9	24	15	52
29	* - 48.00	0.98	3	23	39	14	21
30	0.10 - 5.00	10.00	0	9	23	8	60

*Less than 0.074. Material passing #200 sieve not analyzed. All samples taken at Mid-Tide Elevation.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P11	5.9	15.9	10.0' Mud.
P12	10.2	17.6	4.8' Mud, 2.6' Sand.
P13	16.0	23.3	0.4' Mud, 6.9' Sand to clay.
P14	13.0	19.6	4.2' Sand, 2.4' Clay.
P15	1.0	6.3	0.5' Mud, 4.8' Sand to hard.
P16	4.8	13.6	5.1' Sand, 3.7' Clay to hard.
P17	6.9	13.1	4.1' Sand, 2.1' Clay.
P18	2.2	8.3	2.0' Sand, 4.1' Mud.
P39	2.1	15.9	13.8' Soft mud & sand.
P40	3.5	16.0	3.5' Loose sand, 1.0' Hard packed sand, 8.0' Mud & sand.
P41	5.4	14.4	6.6' Sand & gravel, 2.4' Hard packed sand & gravel.
P42	3.3	12.3	7.0' Loose sand, 2.0' Hard packed sand.
P43	3.5	15.4	8.9' Loose sand, 3.0' Hard packed sand.
P44	9.1	16.8	7.7' Loose sand.
P45	5.5	14.8	9.3' Sand to hard packed sand.
P46	3.4	4.4	1.0' Sand to rock.
P47	14.3	17.2	2.9' Sand (Hard).
P48	14.5	17.7	3.2' Coarse sand.
P49	3.8	9.0	5.2' Sand to hard gravel.
P50	5.3	9.3	4.0' Sand to hard sand.
P51	13.6	17.8	0.5' Sand, 3.7' Mud.
P52	13.8	17.8	4.0' Mud.
P53	12.7	14.8	2.1' Sand to gravel.
P54	6.8	8.7	1.9' Sand (Hard).
P55	12.9	16.5	3.6' Fine sand to coarse sand.

NOTE:

Probings are in feet and tenths, and are referred to the plane of Mean Low Water.

All probings were taken by hand. Probings 11 to 18 from survey of 1953 and 39 to 55 from surveys of 1934 and 1938.

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.2 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U.S.C.&G.S. Chart No. 221.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S14, are contained in appendix G.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 7 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 4

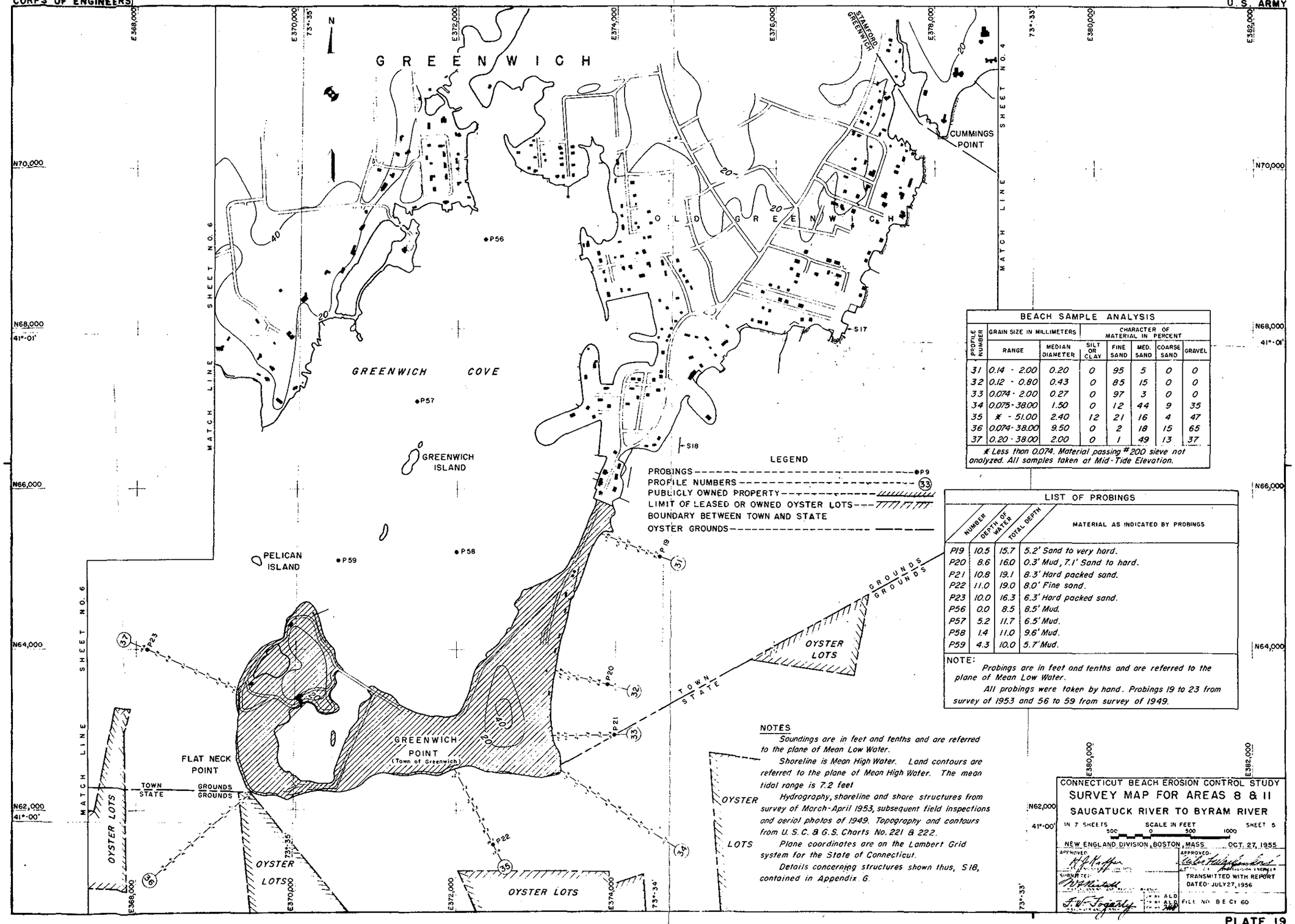
NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 27, 1955

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

PLATE 18

CORPS OF ENGINEERS

U. S. ARMY



BEACH SAMPLE ANALYSIS

PROFILE NUMBER	GRAIN SIZE IN MILLIMETERS		CHARACTER OF MATERIAL IN PERCENT				
	RANGE	MEDIAN DIAMETER	SILT OR CLAY	FINE SAND	MED. SAND	COARSE SAND	GRAVEL
31	0.14 - 2.00	0.20	0	95	5	0	0
32	0.12 - 0.80	0.43	0	85	15	0	0
33	0.074 - 2.00	0.27	0	97	3	0	0
34	0.075 - 38.00	1.50	0	12	44	9	35
35	* - 51.00	2.40	12	21	16	4	47
36	0.074 - 38.00	9.50	0	2	18	15	65
37	0.20 - 38.00	2.00	0	1	49	13	37

* Less than 0.074. Material passing #200 sieve not analyzed. All samples taken at Mid-Tide Elevation.

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P19	10.5	15.7	5.2' Sand to very hard.
P20	8.6	16.0	0.3' Mud, 7.1' Sand to hard.
P21	10.8	19.1	8.3' Hard packed sand.
P22	11.0	19.0	8.0' Fine sand.
P23	10.0	16.3	6.3' Hard packed sand.
P56	0.0	8.5	8.5' Mud.
P57	5.2	11.7	6.5' Mud.
P58	1.4	11.0	9.6' Mud.
P59	4.3	10.0	5.7' Mud.

NOTE:
Probings are in feet and tenths and are referred to the plane of Mean Low Water.
All probings were taken by hand. Probings 19 to 23 from survey of 1953 and 56 to 59 from survey of 1949.

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.2 feet

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aeriol photos of 1949. Topography and contours from U. S. C. & G. S. Charts No. 221 & 222.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S18, contained in Appendix 6.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 7 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 5

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 27, 1955

APPROVED: H. P. Hoppin, Colonel, Corps of Engineers, Division Engineer

SUBMITTED: W. P. Mitchell, Chief, Beach Erosion Board

APPROVED: Wilbur Hall Ferguson, Brigadier General, U. S. Army, Chief of Engineers

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

F. V. Fogarty, Lt. Col., C. E., Executive Officer, Beach Erosion Board

FILE NO. BEC 60

PLATE 19

CORPS OF ENGINEERS

U. S. ARMY

N72,000 N70,000 N68,000 41°-01' N66,000 N64,000 N62,000 41°-00' N60,000 N58,000

MATCH LINE SHEET NO. 5

ELIAS POINT

TODD POINT

40 20

E368,000

COS COB HARBOR

P60 P61 P62

E366,000

73°-36'

GOOSE ISLAND P63

20

P64

SAW ISLAND

HORSE ISLAND P65

GREENWICH

INDIAN FIELD ROAD

40 20

E364,000

E362,000

MEAD POINT

BRUSH ISLAND

INDIAN HARBOR

73°-37'

TWEED ISLAND

40 20

E360,000

BENEDICT POINT

SMITH COVE

MATCH LINE SHEET NO. 7

N

GROUNDS GROUNDS

TOWN STATE

OYSTER LOTS

LEGEND

PROBINGS ●P63

PUBLICLY OWNED PROPERTY

LIMIT OF LEASED OR OWNED OYSTER LOTS

BOUNDARY BETWEEN TOWN AND STATE

OYSTER GROUNDS

LIST OF PROBINGS

NUMBER	DEPTH OF WATER	TOTAL DEPTH	MATERIAL AS INDICATED BY PROBINGS
P60	6.1	9.4	3.3' Mud & Sand.
P61	7.1	9.7	2.6' Mud & Sand.
P62	6.3	10.5	4.2' Mud & Sand.
P63	8.8	15.7	6.9' Mud & Sand.
P64	9.0	16.5	7.5' Mud & Sand.
P65	8.8	15.2	6.4' Soft mud.

Probings are in feet and tenths and are referred to the plane of Mean Low Water.

All probings were taken by hand from survey of 1938.

OYSTER LOTS

LITTLE CAPTAIN ISLAND (Town of Greenwich)

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.2 - 7.4 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U.S.C. & G.S. Chart No. 222.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

IN 7 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 6

NEW ENGLAND DIVISION, BOSTON, MASS. OCT. 27, 1955

APPROVED: APPROVED:

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

FILE NO. B.E.Ct. 60

PLATE 20

CORPS OF ENGINEERS

U. S. ARMY

MATCH LINE
STEAMBOAT ROAD
POINT

SHEET NO. 6

STATE TOWN

GREENWICH HARBOR

ROUND ISLAND

FIELD POINT

OYSTER LOTS

OYSTER GROUNDS

BOWERS ISLAND

OYSTER LOTS

GREAT CAPTAIN ISLAND

OYSTER LOTS

OYSTER LOTS

OYSTER LOTS

BELLE HAVEN

GREENWICH

BYRAM HARBOR

HUCKLEBERRY ISLANDS

SHORE ISLAND

S19

BYRAM (PARK) (Town of Greenwich)

CALF ISLANDS

OYSTER LOTS

STATE TOWN

GROUNDS

BYRAM

POINT

CONNECTICUT
NEW YORK

BYRAM RIVER

41°-01'
73°-38'
73°-39'
41°-00'
40°-59'

N68,000
N66,000
N64,000
N62,000
N60,000
N58,000
N56,000
N54,000

E358,000
E356,000
E354,000
E352,000
E350,000

LEGEND

PUBLICLY OWNED PROPERTY
LIMIT OF LEASED OR OWNED OYSTER LOTS
BOUNDARY BETWEEN TOWN AND STATE
OYSTER GROUNDS

NOTES

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Shoreline is Mean High Water. Land contours are referred to the plane of Mean High Water. The mean tidal range is 7.3 to 7.4 feet.

Hydrography, shoreline and shore structures from survey of March-April 1953, subsequent field inspections and aerial photos of 1949. Topography and contours from U. S. C. & G. S. Chart No. 222.

Plane coordinates are on the Lambert Grid system for the State of Connecticut.

Details concerning structures shown thus, S19, are contained in appendix G.

CONNECTICUT BEACH EROSION CONTROL STUDY

SURVEY MAP FOR AREAS 8 & 11

SAUGATUCK RIVER TO BYRAM RIVER

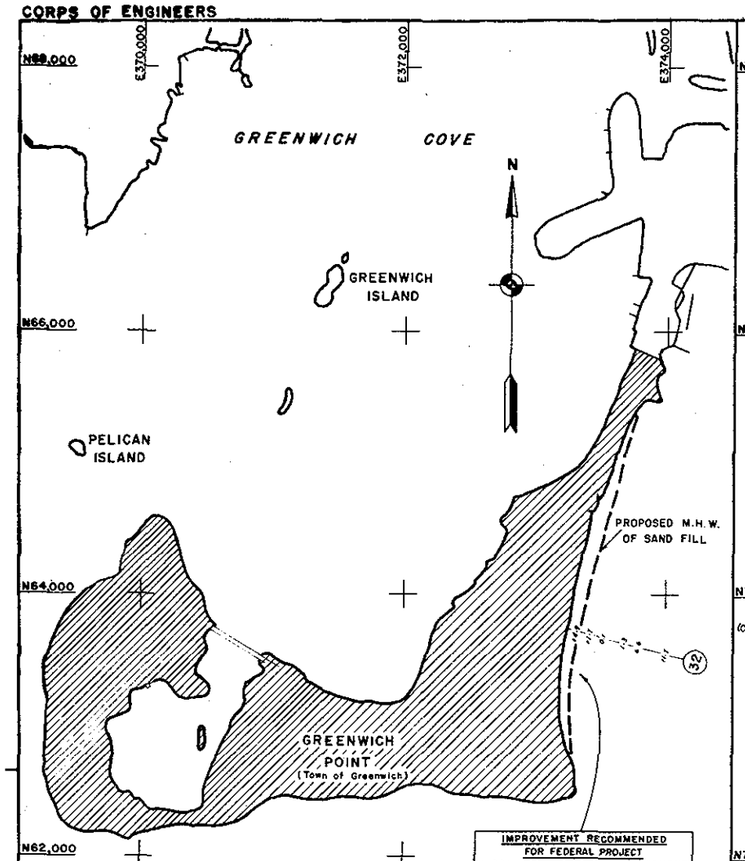
SCALE IN FEET 500 0 500 1000

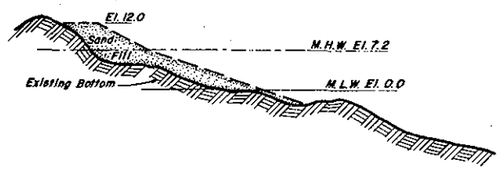
NEW ENGLAND DIVISION, BOSTON MASS. OCT. 28, 1955

TRANSMITTED WITH REPORT DATED: JULY 27, 1956

FILE NO. B.E.C.I. 60

PLATE 21

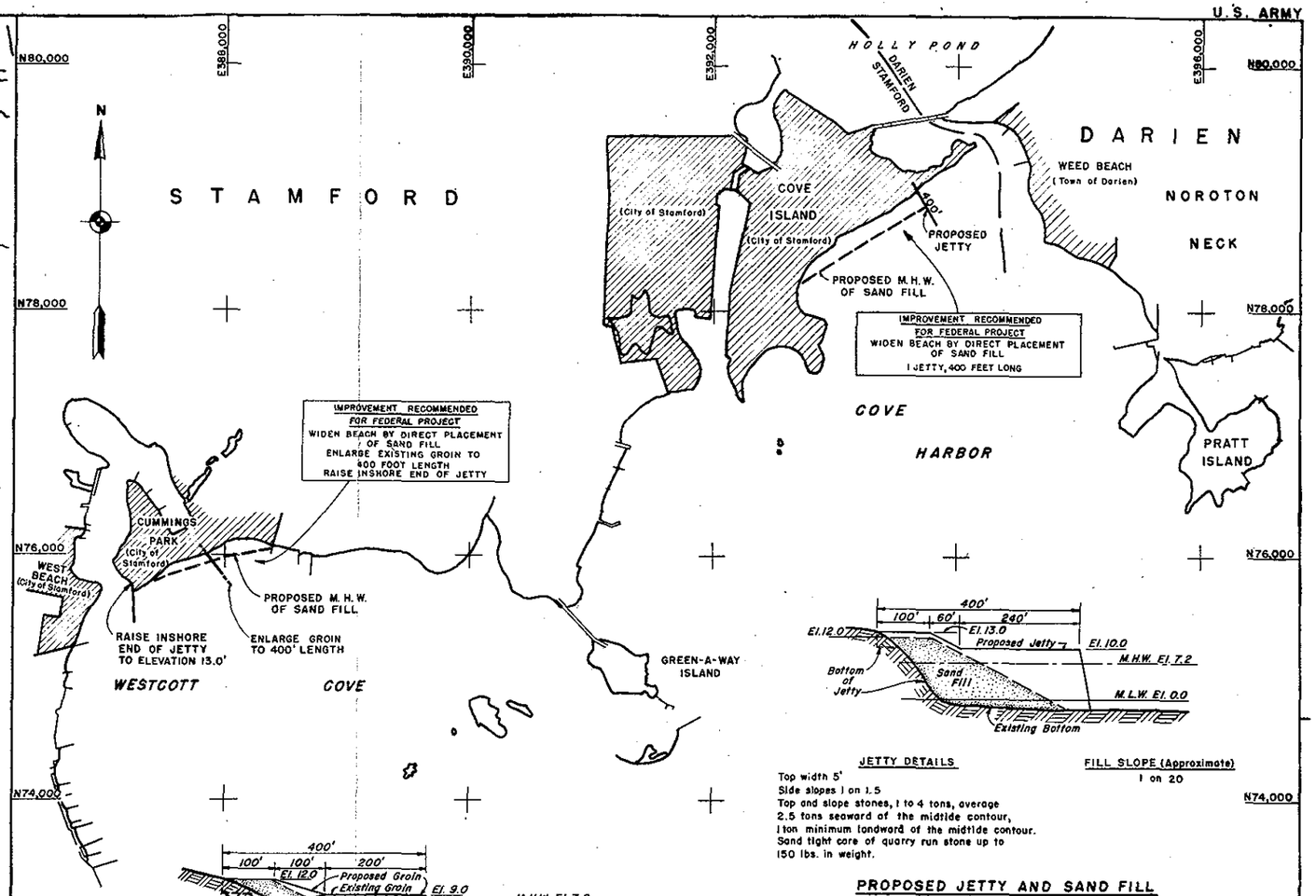




FILL SLOPES (Approximate)
1 on 20 above M.H.W.
1 on 30 below M.H.W.

PROPOSED SAND FILL
(PROFILE 32)
PROFILE AT GREENWICH POINT

SCALE IN FEET
HOR. 100 0 100 200
VERT. 10 0 10 20

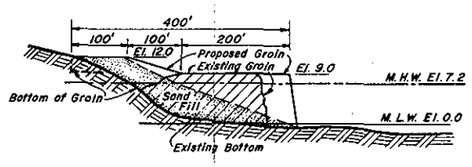


JETTY DETAILS
Top width 5'
Side slopes 1 on 1.5
Top and slope stones, 1 to 4 tons, average 2.5 tons seaward of the midtide contour, 1 ton minimum landward of the midtide contour.
Sand tight core of quarry run stone up to 150 lbs. in weight.

FILL SLOPE (Approximate)
1 on 20

PROPOSED JETTY AND SAND FILL
PROFILE AT COVE ISLAND

SCALE IN FEET
HOR. 100 0 100 200
VERT. 10 0 10 20



GROIN DETAILS
Top width 5'
Side slopes 1 on 1.5
Top and slope stones, 1 to 4 tons, average 1 3/4 tons.
Sand tight core of quarry run stone up to 150 lbs. in weight.

FILL SLOPE (Approximate)
1 on 20 above M.H.W.
1 on 30 below M.H.W.

PROPOSED GROIN ENLARGEMENT AND SAND FILL
PROFILE AT CUMMINGS PARK

SCALE IN FEET
HOR. 100 0 100 200
VERT. 10 0 10 20

NOTES

Shoreline and shore structures from 1953 survey and aerial photographs of 1949.

Coordinates are on the Lambert Grid System for the State of Connecticut.

For additional construction details for shore structures, see Plate 6.

Publicly owned portions of shore shown thus:

CONNECTICUT BEACH EROSION CONTROL STUDY
PLANS OF IMPROVEMENT AREAS 8 & 11
SAUGATUCK RIVER TO BYRAM RIVER
IN 2 SHEETS SCALE IN FEET SHEET 1
500 0 500 1000
NEW ENGLAND DIVISION, BOSTON, MASS. JAN. 31, 1956

APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: LT. COL. C.E. ARMY, DIVISION ENGINEER
SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH
TRANSMITTED WITH REPORT DATED: JULY 27, 1956
CHIEF, RIVER AND HARBOR SECT.
DR BY S.Z.
TR BY S.Z.
CH BY
FILE NO. B.E.Ct. 61

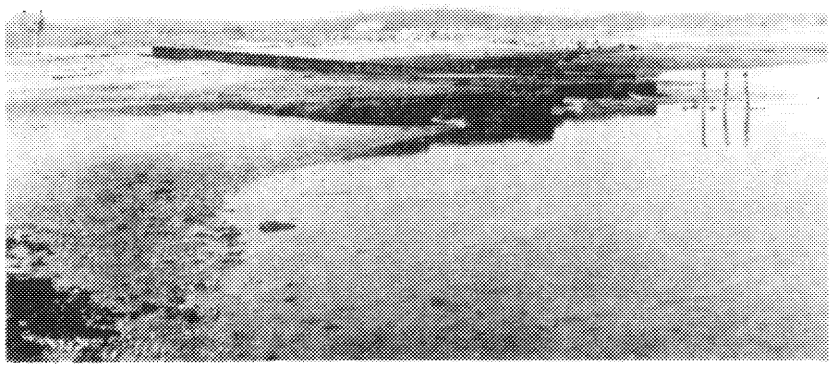


FIG. 1. SAUGATUCK SHORES, WESTPORT. Apr. 18, 1955. North from Seymour Point. Sandy shore retreating over marsh.

FIG. 2. SAUGATUCK SHORES, WESTPORT. Oct. 19, 1948. Protective structures fronting road along south shore.

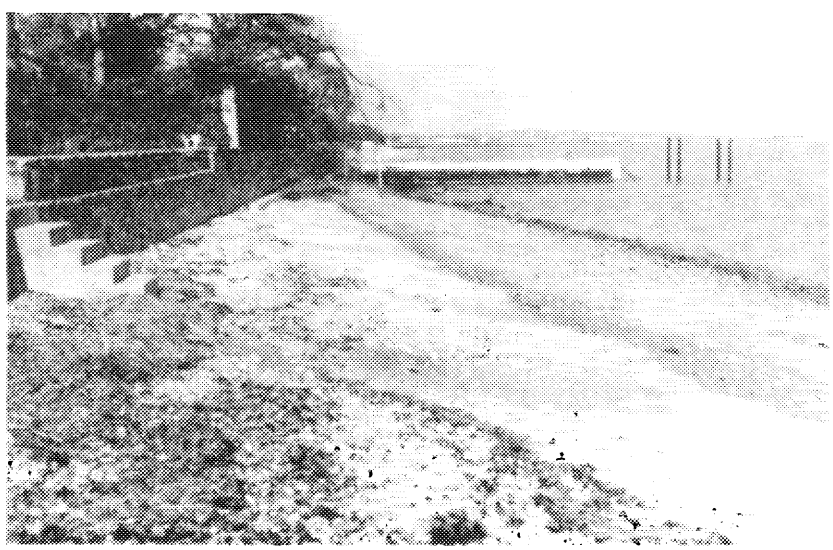


FIG. 3. SHORE HAVEN, NORWALK. Oct. 19, 1948. North from solid pier which impounds beach material.

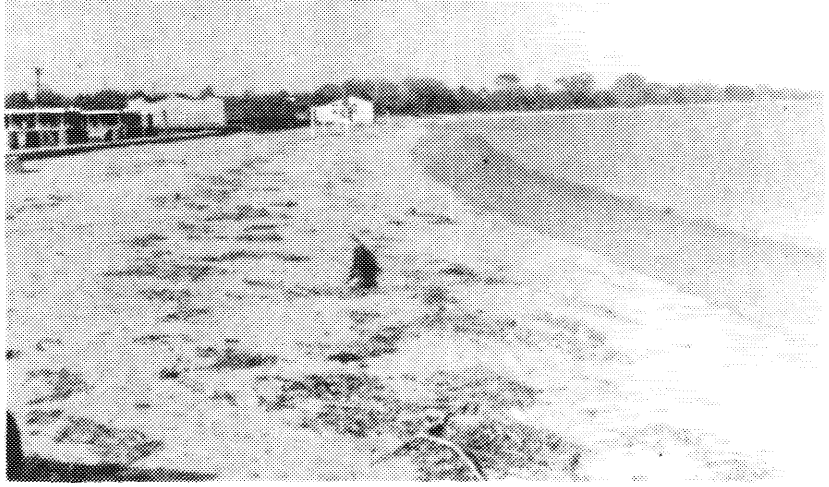


FIG. 1. CALF PASTURE BEACH PARK, NORWALK. Oct. 19, 1948. North from stone groin at south end of bathing beach.

FIG. 2. CALF PASTURE BEACH PARK, NORWALK. Nov. 30, 1950. Bathhouse damaged by southeast storm. Compare with Figure 1, above.

FIG. 3. GREGORY POINT, NORWALK. Nov.30,1950. Damage from severe southeast storm at private beach club.

FIG. 1. HARBORVIEW, NORWALK. Oct.19,1948. Residences on low beach close to the water's edge.

FIG. 2. MANRISSA ISLAND, NORWALK. Oct. 19, 1948. Low wall along south shore of island.

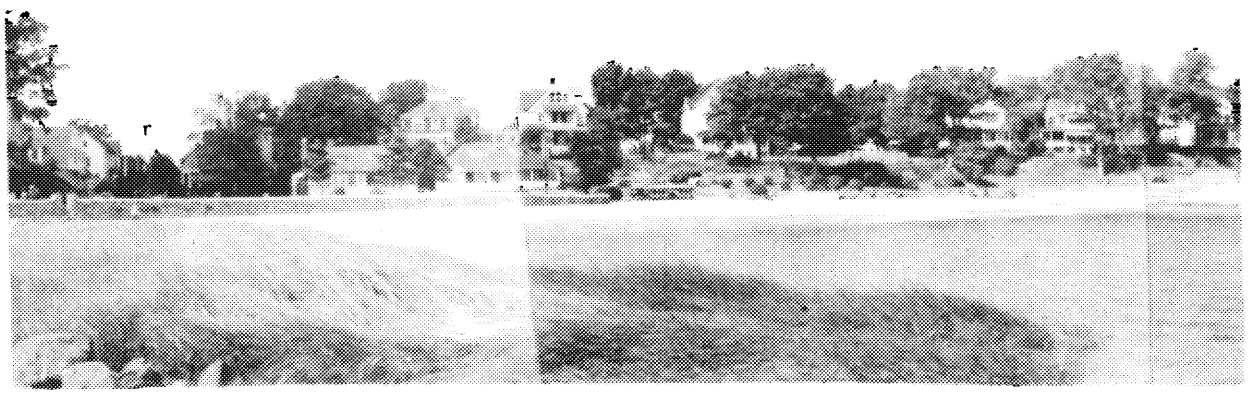


FIG. 3. BELL ISLAND, NORWALK. Sept. 24, 1948. Sandy pocket beach along east shore.

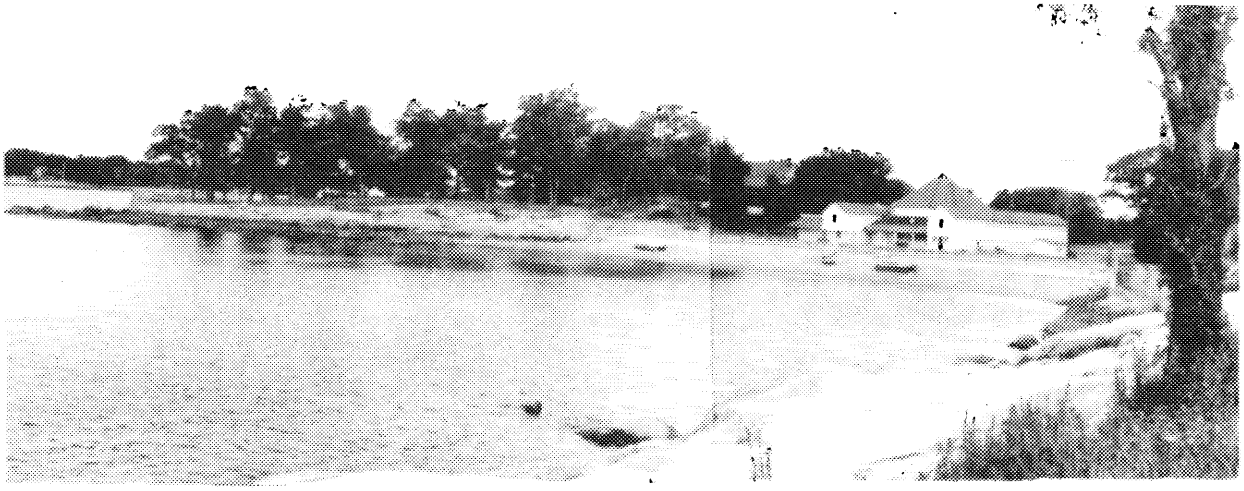


FIG. 1. ROTON POINT PARK, NORWALK. Sept.24,1948. Sandy pocket beach between rock outcrops.

FIG. 2. WEST OF ROTON POINT, NORWALK. Sept. 24, 1948. Bailey Beach adjacent to point. Wee Burn Beach Club in foreground.

FIG. 3. BUTLER ISLAND, DARIEN. Sept. 24, 1948. Sandy pocket beach at Tokeneke Club.

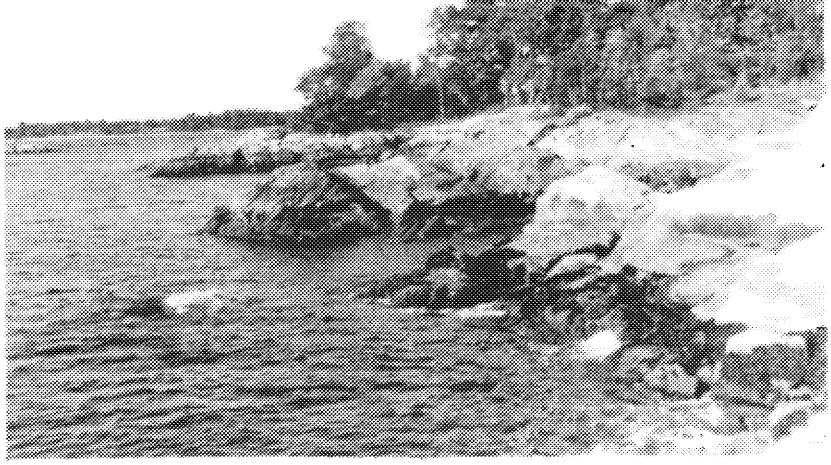


FIG. 1. CONTENTMENT ISLAND, DARIEN. Sept. 24, 1948. Irregular rocky south shore of island.

FIG. 2. GREAT ISLAND, DARIEN. Sept.23,1948. Irregular rocky east shore of island.

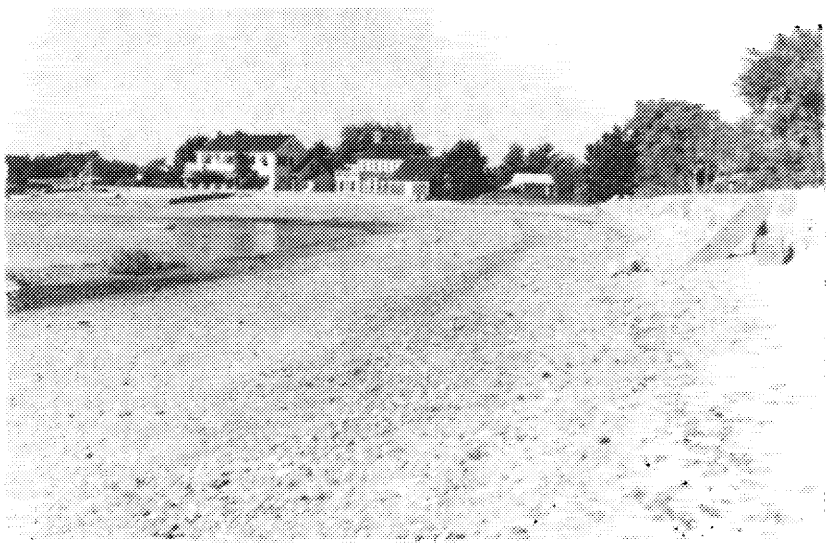


FIG. 3. NOROTON NECK, DARIEN. Sept. 23, 1948. Sandy east shore at mouth of Darien River opposite Peartree Point.

FIG. 1. LONG NECK POINT, DARIEN. Dec. 19, 1953. Storm erosion along east side of Point above sea wall.

FIG. 2. LONG NECK POINT, DARIEN. Apr.20,1955. Recently placed riprap revetment along east side of Point.Compare with Figure 1, above.

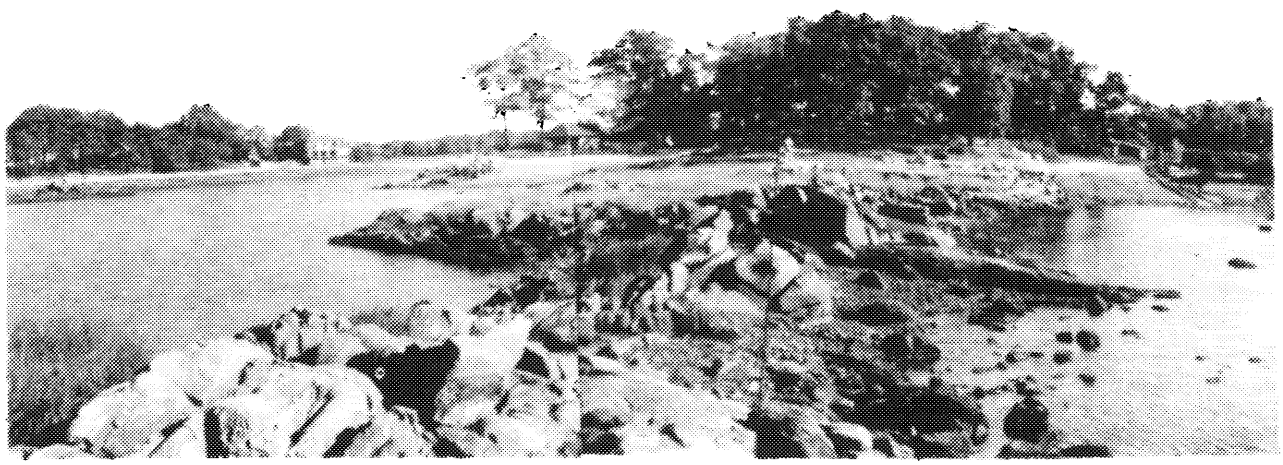


FIG. 3. PRATT ISLAND, DARIEN. Sept.23,1948. Irregular rocky shore of island.

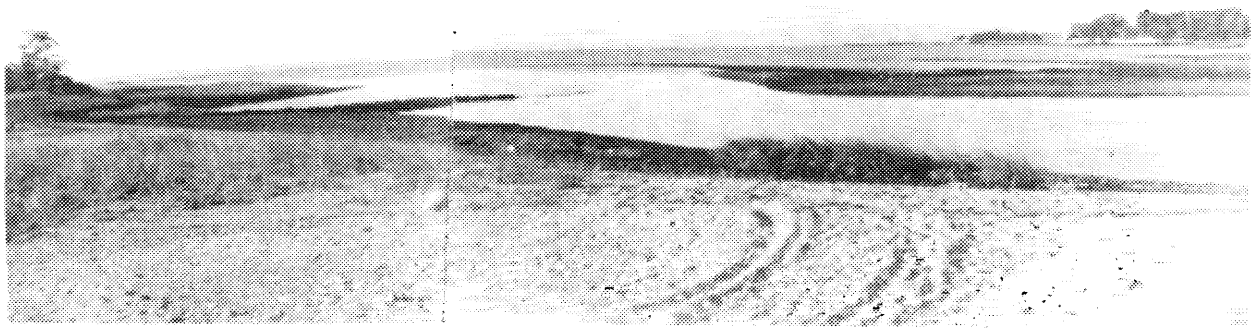


FIG. 1. WEED BEACH, DARIEN. Sept. 23, 1948. Swift tidal currents in Holly Pond entrance channel opposite Weed Beach.

FIG. 2. COVE ISLAND, STAMFORD. Sept. 22, 1948. East shore looking towards Holly Pond entrance.

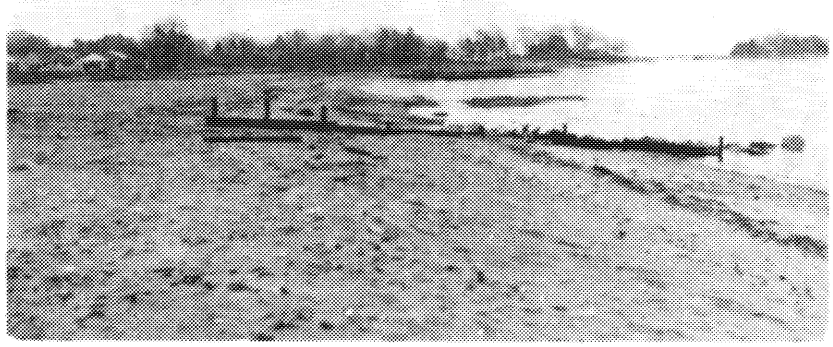


FIG. 3. WESTCOTT COVE, STAMFORD. Apr. 21, 1955. Sandy north shore east of Cummings Park.

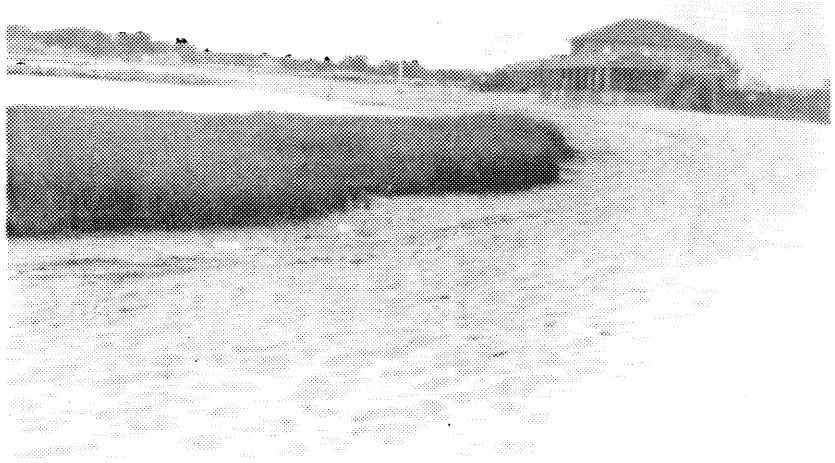


FIG. 1. CUMMINGS PARK, STAMFORD. Sept. 22, 1948. Looking west along sandy shore.

FIG. 2. CUMMINGS PARK, STAMFORD. Apr. 21, 1955. Comparison with Figure 1, above, shows shore recession. Note flanking of groin.

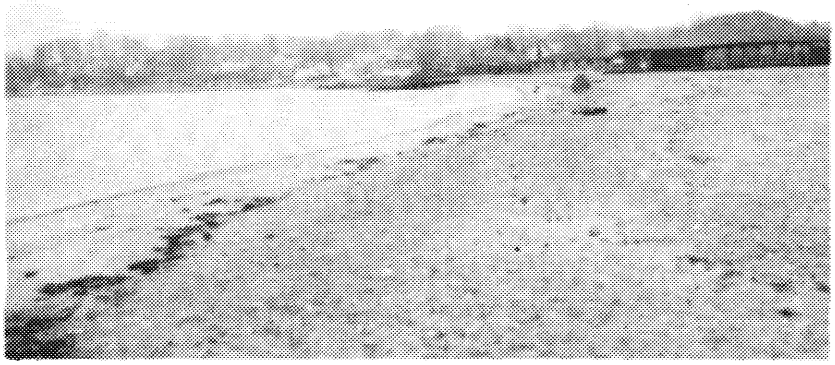


FIG. 3. WEST BEACH, STAMFORD. Apr. 21, 1955. South along public bathing beach.

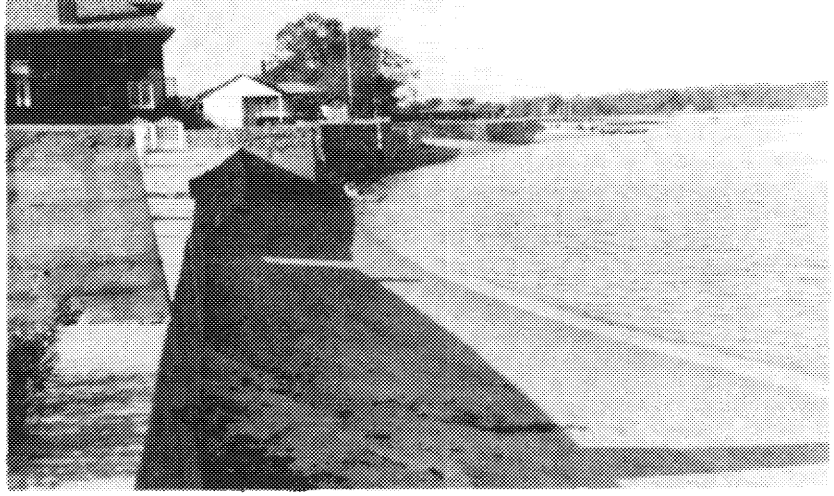


FIG. 1. WESTCOTT COVE, STAMFORD. Sept. 22, 1948. Narrow beach fronting walls along west shore of cove.

FIG. 2. EAST SHORE SHIPPAN POINT. Apr. 21, 1955. Coarse shore south of Shippan Avenue.

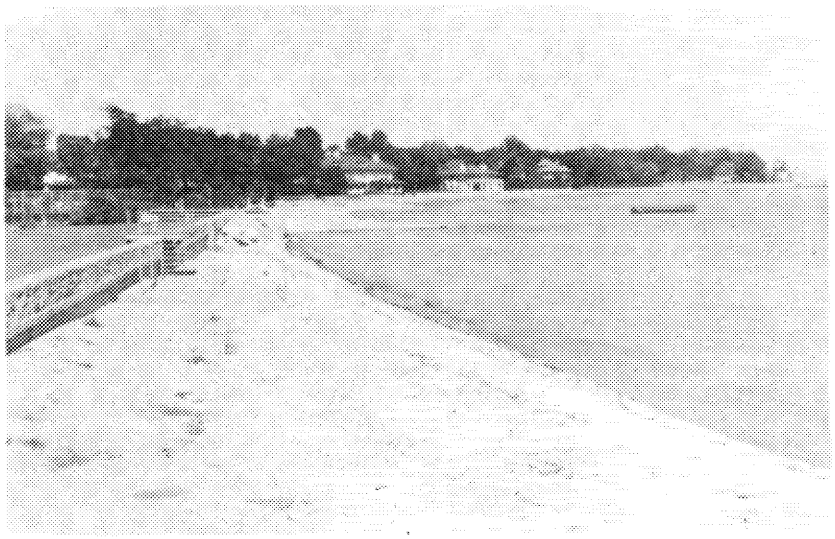


FIG. 3. EAST SHORE SHIPPAN POINT. Sept. 22, 1948. Beach held by groins in indentation north of tip of point.

FIG. 1. EAST SHORE SHIPPAN POINT. Sept. 22, 1948.
Heavy riprap fronting wall at tip of point.

FIG. 2. WEST SHORE SHIPPAN POINT. Apr. 21, 1955. Shore south of Stamford Yacht Club.

FIG. 3. WEST SHORE SHIPPAN POINT. Apr. 21, 1955.
Coarse shore near East Branch Channel entrance.

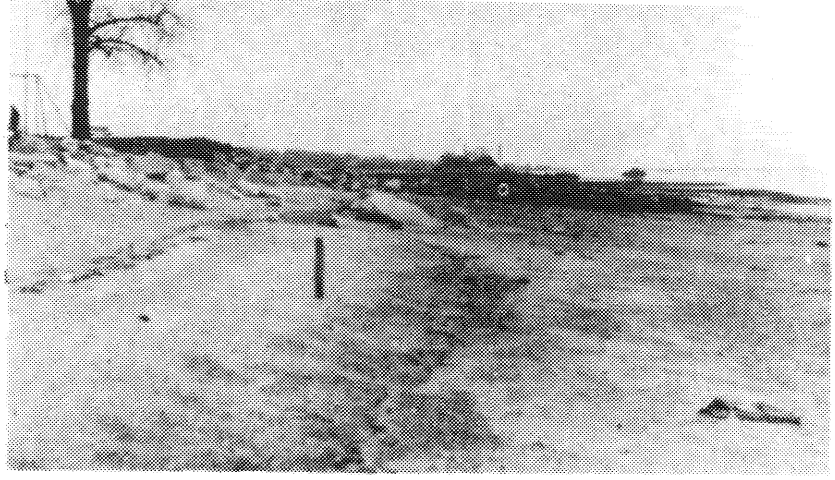


FIG. 1. DYKE PARK, STAMFORD. Apr. 21, 1955. Small sandy beach at west side of tip of Cemetery Point.

FIG. 2. COOK POINT, STAMFORD. Sept. 22, 1948. Riprap fronting wall at the water's edge.

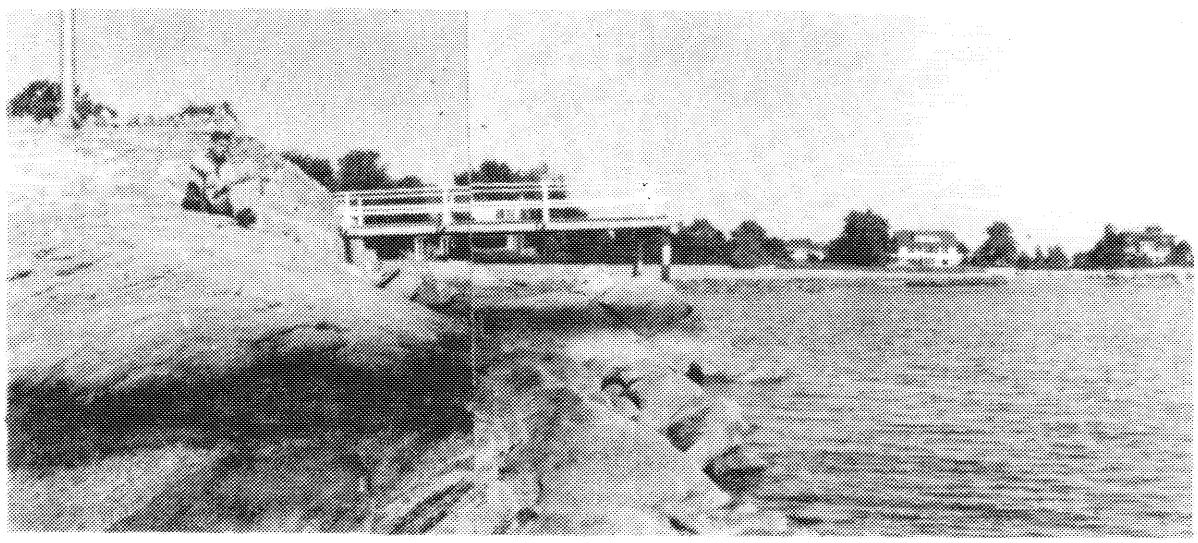


FIG. 3. BETWEEN COOK AND DAVENPORT POINTS, STAMFORD. Sept. 22, 1948. Looking north. Bedrock at first shore projection north of Davenport Point.

FIG. 1. BETWEEN PECK AND CUMMINGS POINTS, STAMFORD. Sept. 22, 1948. Sandy pocket beach adjacent to coarse rocky Cummings Point shore.

FIG. 2. OLD GREENWICH, GREENWICH. Sept. 22, 1948. Rocky east shore adjacent to Greenwich-Stamford boundary.

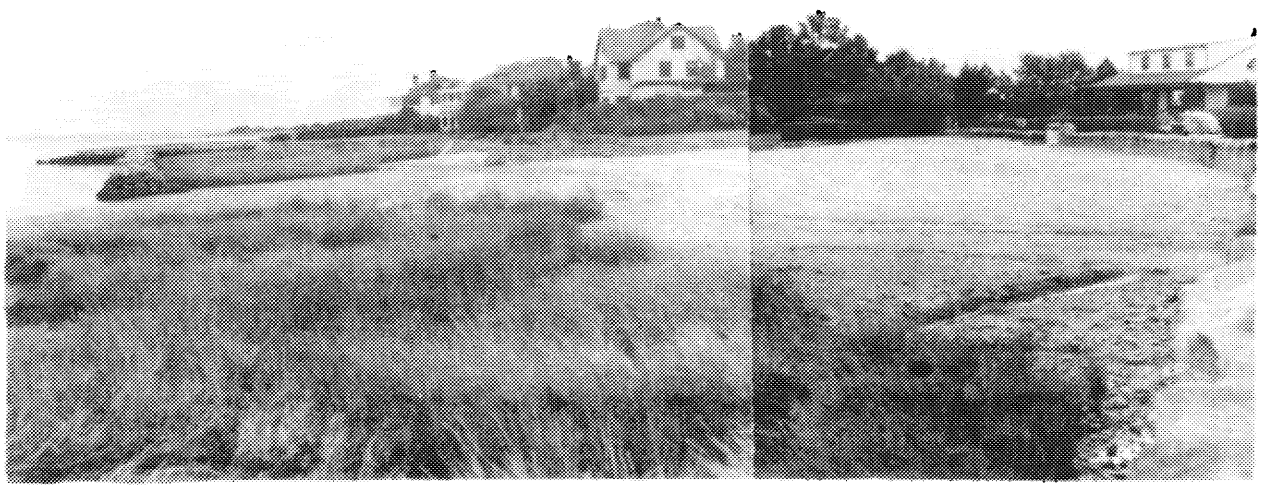


FIG. 3. OLD GREENWICH, GREENWICH. Sept. 21, 1948. Structures protect low residential development adjacent to Greenwich Point.

FIG. 1. GREENWICH POINT, GREENWICH. May 2, 1955.
Northerly end of public bathing beach.

FIG. 2. GREENWICH POINT, GREENWICH. May 2, 1955.
Southerly end of public bathing beach.

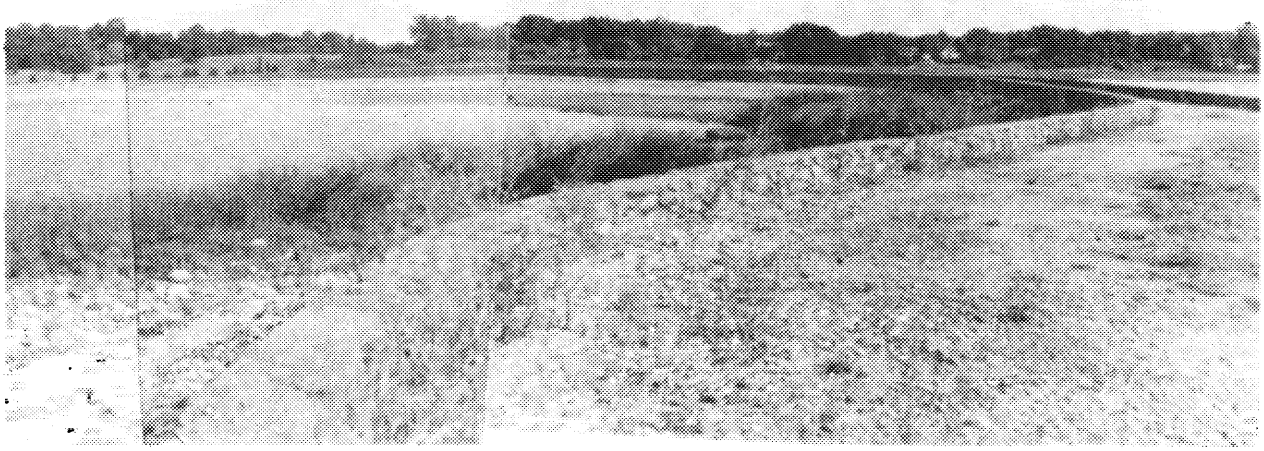


FIG. 3. ELIAS POINT, GREENWICH. Sept. 21, 1948. Sandy pocket beach at west side of point.

FIG. 1. MEAD POINT, GREENWICH. May 3,1955. Breakwater and fill connecting point to Brush Island, at left, form a small harbor.

FIG. 2. STEAMBOAT ROAD POINT, GREENWICH. Sept.20,1948. Rocky east shore of outer tip of point.

FIG. 3. FIELD POINT, GREENWICH. May 3, 1955. Looking south along east shore below Round Island.

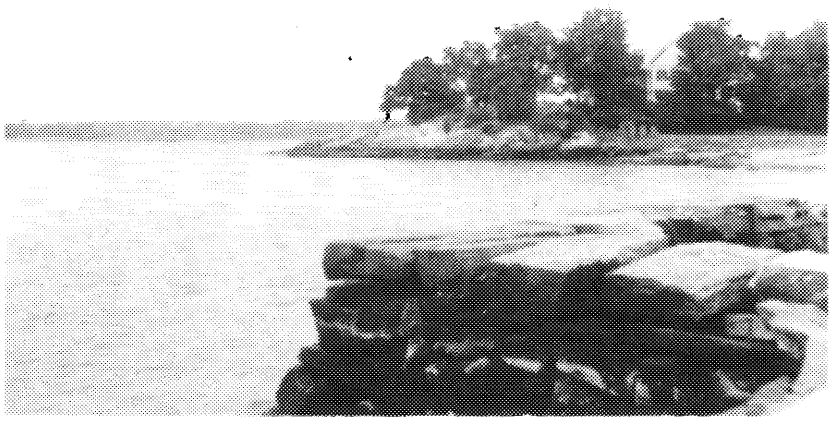


FIG. 1. BELLE HAVEN, GREENWICH. Aug. 20, 1948. Rocky south tip of Belle Haven.

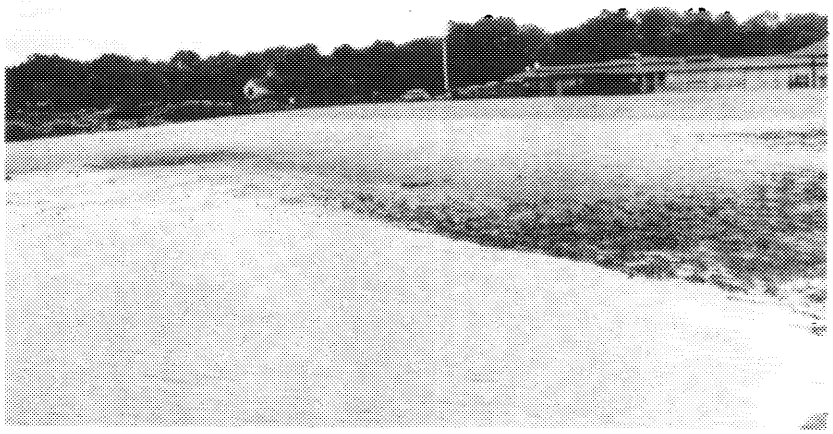


FIG. 2. BYRAM PARK, GREENWICH. Aug. 19, 1948. Small artificial bathing beach at muddy shore area.

FIG. 3. BYRAM POINT, GREENWICH. Aug. 19, 1948. North along jetty at Byram River entrance.

FIG. 1. LITTLE CAPTAIN ISLAND, GREENWICH. May 4, 1955. Sandy public bathing beach along north side of island.

FIG. 2. LITTLE CAPTAIN ISLAND, GREENWICH. May 4, 1955. New steel bulkhead and revetment along west end of south shore.

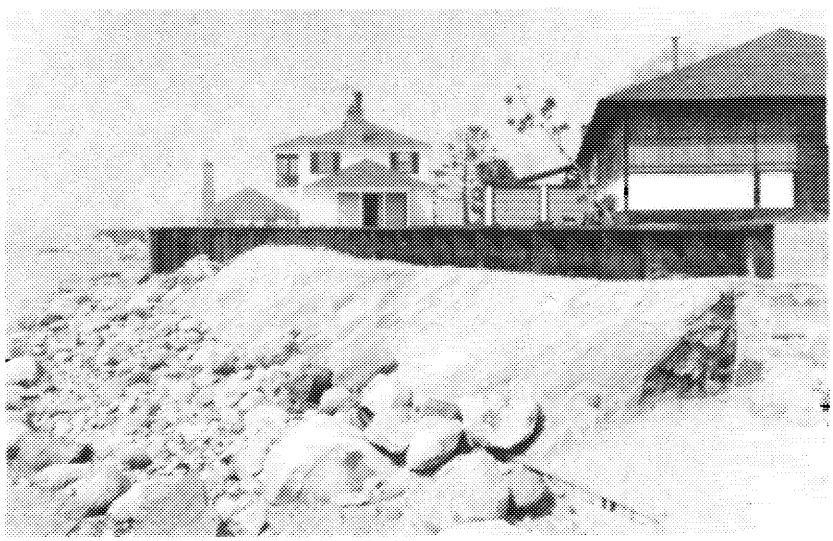


FIG. 3. LITTLE CAPTAIN ISLAND, GREENWICH. May 4, 1955. New steel bulkhead, sloped paving and revetment along east end of south shore.