# BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

# AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

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

JANUARY 4, 1952

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SUBJECT: Beach Erosion Control Report on Cooperative Study of Connecticut, Area 5, Pawcatuck River to Thames River.

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

## SYLLABUS

This report, the fifth of a series to cover the entire coast of Connecticut includes study of the shore line of the towns of Stonington and Groton lying between the Pawcatuck River and the Thames River. The purpose of the study is to determine the most suitable methods of stabilizing and improving the shore line.

The Division Engineer finds that there is a scarcity of beaches suitable for recreational use, that large extents of shore cannot justifiably be improved due to their physical character, inaccessibility and limited development and that there is a need for protection and improvement of localized areas now suffering from erosion. The Division Engineer also finds that in general, the most suitable method of stabilizing and improving the shore consists of restoration of beach losses by direct placement of sand and the construction of groins to retard future losses.

The Division Engineer recommends that local interests adopt a project for protection and improvement of the publicly-owned bathing beach at Eastern Point Beach Park, the project to consist of direct placement of sand fill along the narrow westerly end of the 400-foot beach east of and adjacent to Eastern Point and enlargement of the existing impermeable groin located at the east limit of the beach to a 300-foot length. The need for protection of publicly-owned shores is insufficient to warrant adoption of a project by the United States authorizing Federal participation in the cost of construction.

BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT.

Area 5

Pawcatuck River to Thames 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 September 9, 1948.

2. Purpose. - The purpose of the study is to determine, (1) the most suitable methods of stabilizing and improving the shore line between the Pawcatuck River and Thames 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 Report. - Bulletin No. 46 of the State Geological and Natural History Survey of Connecticut, published in 1929, is a paper by Henry Staats Sharp, A.M., titled, "The Physical History of the Connecticut Shore Line". This paper describes the geological history of Connecticut and the various topographical features of the shore line. The geological history contained in Appendix B is based principally upon this report.

4. Location. - The portion of the Connecticut shore considered in this report is an extent of about 31.5 miles located between Pawcatuck Point at the mouth of the Pawcatuck River and a point on the east shore of the Thames River located about 4,500 feet north of Eastern Point. The area includes the entire shore of the towns of Stonington and Groton bordering on Little Narragansett Bay and Fishers Island Sound. The included shore of Stonington is approximately 19.3 miles in length and that of

Groton is about 12.2 miles. The area is adjacent to New London and extends eastward to the Connecticut-Rhode Island State line. The New York, New Haven and Hartford Railroad runs along the shore within a distance of about two miles and is closely paralleled by United States Route 1. Access to the shore is provided from Route 1 by a connecting system of state highways, town, borough and private roads. Large portions of the shore are not easily accessible.

5. Population. - The permanent population of Stonington in 1950 was 11,775 and that of Groton was 9,091. Summer increases in population are estimated as 700 for Stonington and 3,500 for Groton.

6. Description. - The shore line of the study area is a shore line of submergence. It is predominantly a shore line bordering unconsolidated glacial drift materials. Erosion and drifting of these materials has resulted in the formation of existing beaches largely in the form of barrier bars, spits and tombolos. Areas behind these barrier beaches have filled and become marshy. Numerous exposures of bare bedrock exist along the shore throughout the study area. Projecting points of land not composed of bedrock are generally fronted by protective barriers of boulders. Detailed descriptions of specific beach areas are included in the discussion of methods of protection in a later section and in Appendix A.

## II. FACTORS AFFECTING SOLUTION OF PROBLEMS

7. Source of Supply. - Headlands composed of unconsolidated glacial till were formerly the principal source of supply of beach material. Past erosion has largely removed the finer materials so that the shores of these headlands consist of bare bedrock or are protected by boulders and other coarse material. Protective structures have also contributed to the elimnation of the source of beach material.

8. Rates of Supply and Loss. - The rate of loss of beach material in general slightly exceeds the rate of supply. Over the period of record, a large part of the shore line has receded at rates of 1 to 3 feet per year.

Minor accretion areas have resulted from structures or by trapping of material in indentations of the shore. Detailed descriptions of shore line and offshore depth changes at specific beaches are included in Appendix E.

9. Mechanism of Loss. - 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. The waves are short waves caused by local winds. Due to the natural and man-made protection of shore areas, waves generated by ordinary prevailing winds have little effect in removing and transporting material along the shore. Movement of materials is principally due to waves generated by winds of storm intensity. The shore is exposed to appreciable fetches or open bodies of water only in the southerly directions. Storms from these directions are relatively infrequent. Tides are semi-diurnal. The mean range is 2.7 feet at the village of Stonington, and 2.6 feet at the mouth of the Mystic River in Noank and at the state pier in New London Harbor. The maximum tide of record above the plane of mean low water was 11.0 feet at Stonington, and 11.1 feet at New London. Tides in excess of the mean height of high water at New London occur 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. The maximum height of breakers inside the low water line with tides 3 feet in excess of the mean height of high water is approximately 4.5 feet, but during infrequent higher tides, larger waves can reach the shore. The movement of material by wave action is diverse in character. 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. Along shores which run generally north and south, the predominant direction of littoral drift is northward. Due to the irregularity of the shore characterized by numerous indentations and projections, there is no general movement of littoral drift eastward or westward. Movement of material along shores which run generally east and west is largely influenced by the direction of the maximum lengths of

open bodies of water opposite these shores across which waves can be generated.

10. Methods of Modifying Rates of Supply and Loss. - 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. Sources of sand have been determined to exist in some areas within practicable distance for hydraulic dredging and pumping to shore. Where such sources are lacking, sand must be trucked in from outside the area. In a few instances, small accretion areas have resulted from groin construction. Creation of beaches by construction of groins to impound drifting sand is not in general a practicable method in this area. Loss of land has been prevented, except during the most severe storms or hurricanes, by armoring portions of the shore against wave attack by revetments and sea walls in those areas where supply of material has been inadequate to maintain a protective beach. Sea walls and revetments have not contributed to the creation or maintenance of protective beaches. Such structures have actually reduced the supply of material available for beaches. Construction of sea walls, revetments and breakwaters are considered applicable only where the construction of protective beaches are not practical.

11. 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 these conditions some protection will be afforded. Specific design criteria used for protective works in this study area are as follows:

(a) Design Tide. - The maximum elevation of tides which occur at least once a year. Tide records at New London indicate that this elevation is 3 feet above the plane of mean high water.

(b) Sea Wall Elevations. - The top elevation of sea walls to be

not less than the height of the design tide plus three-fourths the maximum height of breaking waves at the location of the proposed wall when the water elevation is at design tide level. For walls constructed at the mean high water line, the top elevation to be not less than 7.5 feet above the plane of mean low water.

(c) Groins. - A top elevation of the inshore end of groins not less than the general height of existing berms of beaches or 5 feet above the plane of mean high water. This elevation may be limited where backshore areas and fronting walls are lower than indicated above. A width of inner horizontal section not less than the width of berm of the proposed beach. A slope of intermediate section not steeper than the slope of the existing bottom. A top elevation of the outer end of the groin not lower than the plane of mean low water. For riprap construction, a minimum height of groins of 3 feet. Groins to be sand tight and firmly secured to bulkheads or to high land in the rear. Groins to extend out to a depth of 6 feet below mean low water if practicable. In shallow areas where such groin lengths would be excessive, the length to be determined by the width of the proposed fill.

(d) Sand Fills. - Berm elevations of proposed fills not less than the general height of existing berms of beaches or 5 feet above the plane of mean high water. This elevation may be limited where backshore areas and fronting walls are lower than indicated above. A minimum berm width of 25 feet. Slopes of fill of 1 on 20 to 1 on 40, generally 1 on 30.

## III. PLANS OF IMPROVEMENT

12. Little Narragansett Bay (Between Pawcatuck Point and the Village of Stonington). - This area includes the western side of Pawcatuck Point, the Barn Island Waterfowl Area, Elihu Island and the shore lying between Elihu Island and the village of Stonington. The Barn Island Waterfowl Area belongs to the State of Connecticut. Other areas are privately-owned. The present condition of the shore indicates that during some past period the forces of erosion were more active here. The shores of

Pawcatuck Point, Barn Island and the point at the east side of the mouth of Wequetequock Cove are strewn with boulders, apparently left as a result of removal of finer materials. The seaward shore of Elihu Island now consists largely of bare bedrock. Bedrock is exposed at points along the shore west of Elihu Island. Available data indicates that the only appreciable shore line recession during recent years has occurred along areas now composed of marsh. The area is sheltered by Napatree Beach and Sandy Point and offshore breakwaters. It is very sparsely settled. In 1950, it was noted that construction of the first two houses was underway at Pawcatuck Point. There were no buildings along the shore of the Barn Island Waterfowl Area. Elihu Island and the shore west of it known as the Stuart Estate were each occupied by one residence and some farm buildings. The only sandy beaches existed in the form of two sandy barrier bars in indentations of the marsh of the Barn Island Waterfowl Area. Due to widespread pollution from the Pawcatuck River, the area is considered unsafe for bathing although limited use is made of the shore for this purpose. No plan of improvement is considered necessary at the present time.

13. Village of Stonington. - The area considered includes the east shore of the village of Stonington between Stonington Point and East Grand Street and the west shore of the village between Stonington Point and the mouth of Quanaduck Cove. The shore is largely protected by sea walls, revetment, piers, wharves, bulkheads and breakwaters. The Town of Stonington owns property having a shore frontage of approximately 200 feet located at the northeast side of the village between Church and East Grand Streets. The property is occupied by a public school. There is a low sea wall along the shore and dumped riprap revetment in front of the wall. The Borough of Stonington owns a small vacant lot having a 50-foot shore frontage on the east side of the village at the end of Wall Street and another vacant piece of land at the tip of Stonington Point having a shore frontage of approximately 360 feet. The 50-foot lot is fronted by riprap revetment and the property at Stonington Point is protected by a

loose stone seawall which was originally constructed by the United States to stop erosion of the point when it was occupied by a lighthouse. The Stonington Historical Society owns a vacant lot on the east side of the village between Omega Street and Stonington Point having a shore frontage of about 120 feet. This land is listed in the town assessor's office as belonging to the United States. The shore fronting all the above properties is coarse in composition. There is practically no beach fronting protective structures at high tide. The coarseness of the foreshore material makes this entire area unsuitable for recreational use. Two undeveloped sections of shore, one at the tip of Stonington Point, the other at the foot of Wall Street are low in elevation and subject to flooding during extreme tides. Present and prospective benefits do not justify consideration of protective works for prevention of this flooding. The area does not require shore protection against erosion.

14. Officials of the Town of Stonington have indicated that there is a need for a public bathing beach in the vicinity of the village. The only appreciable extents of publicly-owned shore property are located at Stonington Point and at the public school at East Grand Street. It would be difficult to hold a sand beach at Stonington Point. The school area at East Grand Street and the adjacent privately-owned shore south of the East Grand Street causeway would probably be stable if developed by placement of a sandy beach. Other stable areas are located in the shore identation south of Wall Street on the east side of the village and south of and adjacent to the inner breakwater on the west side of the village. Due to the existence of deep water close to the shore south of the inner breakwater, large quantities of fill would be required for a stable beach and the cost of the development would be high. Maintenance of such a beach would also be higher than at the sites referred to on the east side of the village. The waters around the village are polluted so as to endanger the health of bathers. Unless this pollution is abated, the areas mentioned above are considered to be undesirable locations for development of a recreational

bathing beach. An existing privately-owned sandy beach which might serve the needs of the community is located at Wamphassuck Neck at the northwest corner of Stonington Harbor. Additional data concerning this beach is contained in Paragraph 15.

15. Wamphassuck Neck. - The shore considered consists of the west side of Stonington Harbor between the railroad causeway and Wamphassuck Point and the shore west of Wamphassuck Point to Lords Point. This entire area is privately-owned and sparsely settled. The shore is generally coarse and boulder strewn or consists of marsh. The Stonington Harbor breakwaters afford shelter to the shore east of Wamphassuck Point along which the greater part of the development has occurred. Due to the lack of development close to the shore, there are no urgent erosion problems in this area which require the construction of additional protective structures. As has already been done in a few instances, groins can be built to hold small sandy beaches on their south sides to provide for recreational use by residents. There is a natural sandy beach at the east side of Wamphassuck Neck adjacent to the railroad causeway formed by the accumulation of sand due to northward drifting. This beach has experienced accretion continuously since 1838 and can be expected to remain stable. It is a desirable location for development of a bathing beach and merits consideration for this purpose in view of the need for such a beach to serve the residents of the village of Stonington. Safe means of access would have to be provided for such a development since none exists at present.

16. Lords Point. - This privately-owned area lies between the marshy shore west of and adjacent to Wamphassuck Neck and Quambaug Cove. It consists of two projecting rocky points forming a pocket or cove between them and a sandy barrier bar fronting marsh and a pond located west of these points. The barrier bar is known as White Beach. The entire area has been developed into a colony of summer cottages.

17. The easterly projecting rocky point is low in elevation and subject to flooding during extreme high tides. The shore of the point is com-

posed of bare bedrock and scattered boulders and does not require protection against erosion. No specific plan has been considered since protection against flooding is not regarded as being within the scope of this study.

18. Comparison of shore line positions indicates that since 1838 the shore of the cove between the projecting rocky points has receded 100 to 200 feet. A shore road closely parallels the northwest shore of the cove and it is protected by a masonry wall. The high water line is at or close to the foot of this wall. The beach material fronting the wall is coarse in composition, consisting largely of gravel and cobbles. This coarse material and the wall appear to have adequately stabilized the shore so that no additional protection is necessary. The shore fronting the wall lines in a well-sheltered indentation and could be developed into a comparatively stable sandy bathing beach by the direct placement of sand. The rate of loss of such a beach would probably be low. The beach could be most economically maintained by periodic replacement of sand losses.

19. White Beach is partially occupied by cottages. The beach is comparatively stable and there are no serious problems which require the development of plans for protective works. If the need arises for protection or enlargement of the beach area, it is practicable to effect this by direct placement of sand along the shore. A small amount of maintenance will probably be required.

20. Shore Between Quambaug Cove and Latimer Point. - This privately-owned shore area consists of a coarse boulder strewn headland and a sandy spit which has grown westward from it. The headland is naturally protected from erosion by the coarse nature of the foreshore material. The spit has been retreating continously landward since 1838. The area behind the spit consists of marsh. Due to the coarse nature of the foreshore of the headland which formerly supplied material to build up the spit, this source of supply no longer contributes any appreciable amount of material to the spit. It is expected that the spit will continue to deteriorate through erosion and will retreat further across the marsh. Since there is no development along this shore, there is no apparent need for con-

struction of protective works. If the area is developed at some future date, stabilization of the spit will be required, the type of protection being dependent on the nature of the development. No plan of improvement is necessary at the present time.

21. Latimer Point. - The south and east side of Latimer point was subject to erosion between 1838 and 1883, resulting in a shore line recession of 100 to 300 feet. There has been little apparent shore line change since 1883. The west side of the point is well sheltered and, therefore, not subject to erosion. The eroded south and east shore is characterized by large scattered boulders and ledge rock outcrops which protect the area against further recession, accounting for the apparent stability of the shore in recent years. The area is privately-owned. Development consists of a few cottages. The area appears to be suitable for development of a cottage community and it is quite likely that more intensive development will occur. The low ground in the vicinity of the southern tip of the point should not be developed for residential use unless adequate protection against flooding is provided. The existing riprap revetment and masonry walls are not adequate for this purpose. No additional protective works are necessary at the present time. Possible future development may require a plan of protection. Actual development of such a plan must necessarily be postponed until information becomes available concerning the specific purpose to be served.

22. Shore Between Latimer Point and Mason Island. - The privately-owned shore extending westward from Latimer Point to the causeway connecting the mainland to Mason Island is generally composed of marsh. Recession of the shore line varying between 100 and 300 feet has occurred since 1838 and is expected to continue. The area is undeveloped and in its present state is unsuitable for development. No plan of protection or improvement has been considered.

23. Shore Between the Mason Island Causeway and Pequotsepos Brook.- This shore area is generally composed of marsh. A sand bar fronts the marsh extending south from Williams Point. A community recreational center is being developed, based upon the use of this bar as a bathing beach. The

Mystic Community Center has requested advice and assistance in removing mud flats from the foreshore area of the community center beach down to underlying sand in order to improve the area for recreational use. Since this problem is not one of protection against erosion, it is felt that the type of improvement desired cannot properly be considered in this study. There are no erosion problems in this area which require consideration of plans for protection.

24. Murphy Point. - This is a low, marshy shore area fronted by a westward trailing sand spit. There are no buildings or structures near the edge of the water. Portions of the point have been staked out into lots. Due to the low elevation of shore land, it is considered generally unsuitable for development and no plan of improvement has been considered.

25. Mason Island. - This is a large, privately-owned island. The shore is irregular in shape, with points generally composed of bedrock or boulders and the indentations of marsh. The only appreciable extent of sandy shore exists in the form of a bar or tombolo between Ram and Clam Points. There is a short stretch of coarse sand beach north of and adjacent to the causeway leading to Baker Island. The east shore of the island varies in composition from a blanket of boulders at the south end opposite Dodge Island to marsh and boulders and marsh alone further north adjacent to the causeway connecting to the mainland. Development consists of cottages and residences, most of which are located along the southern end of the island and along the east shore. The exposed shore of Mason Island has generally been eroded in the past until it now consists of bare bedrock or a protective layer of boulders. The only appreciable recession of the shore in recent years has occurred in marshy indentations or along the undeveloped sand and shingle bar between Ram and Clam Points. Considerable portions of the shore are devoid of any form of development. There is no apparent need for protection against erosion. Small sandy beaches suitable for recreational use by residents have been developed along the southeast half of the island opposite Dodge and Andrews Islands by removal of boulders and coarse material from short stretches of shore down to the underlying sand, and the construction of groins at the north limit of

these clearings. Additional small sandy beaches can be provided in a similar manner. Care should be exercised in any such undertaking since an increased rate of erosion can result from such clearing.

26. West Mystic. - This area includes Willow and Spence Points, Sixpenny Island, the point projecting east of the railroad north of Sixpenny Island, and the shore of Bebee Cove. The area in the vicinity of Willow and Spence Points possesses practically no beach at high water. Protective structures consist of short riprap groins north of, and the remains of stone walls south of Willow Point, masonry walls and short riprap groins around, and loose stone walls along the west side of Spence Point. There are a shipyard and piers at Willow Point. The area is principally residential in character. The foreshore consists of coarse sand and gravel with some marsh west of Spence Point near the railroad. Willow and Spence Points lie in a sheltered harbor area. Existing sea walls and groins in this area will provide adequate protection if maintained. The projecting point between Spence Point and Sixpenny Island consists of high ledge rock, occupied by a few residences. Sixpenny Island is composed of marsh. The shore around Bebee Cove is protected by stone walls and riprap revetment and is developed for residential use. There is no need for additional protection of these areas.

27. Noank. - This area includes the east and west shores of the village of Noank running southward from the railroad causeway at Bebee Cove to Morgan Point and thence northward to the head of West Cove. Noank is a residential community. The east shore between Bebee Cove and Morgan Point and the southerly half of the west shore extending northward from Morgan Point is largely developed as a commercial harbor and consists of sea walls, riprap revetment, piers, wharves and the remains of old shipyards. Morgan Point is composed of bare bedrock. The northerly half of the west shore is protected by riprap and masonry walls, and is developed for residential use. The foreshore is coarse in composition, consisting of boulders, cobbles, shingle and ledge rock outcrops. There is no sandy beach in this area although some sand is held in indentations in the shore. Between 1838 and 1883, this entire area was eroding and the shore line was receding. This shore was developed by the construction of piers, wharves, bulkheads and

shipyards, starting sometime between 1838 and 1883. The only change in the shore line since the latter date is attributed to this development. Structures now existing should be sufficient to protect the shore if properly maintained.

28. West View and Esker Point. - This shore is located between West Cove and Palmer Cove. The head of West Cove consists of a coarse sand bar fronting marsh. The west side of the cove is coarse in composition, consisting of boulders, cobbles, shingle and ledge rock, and a bluff protected by riprap revetment. The shore of West View consists of shingle with small amounts of fine sand held on the east side of groins constructed in front of masonry and concrete walls. There is a medium to fine sand bar in front of marsh adjacent to and east of Esker Point. Esker Point possesses a shingle, cobble, and boulder shore except at its west side adjacent to the highway causeway where there is a small medium sand beach known as Legion Beach. There are a few small boat yards at West Cove. The West Cove and West View areas contain a small group of cottages. Esker Point is undeveloped. The shore has been subject to varying amounts or erosion. The west side of West Cove is now adequately protected. The shore of the West View development receded at a rate of 1 to 3 feet per year during the period 1838 to 1883. Additional recession at a slower rate occurred up to 1949. The high water shore line is very close to the base of sea walls fronting the cottages. Continued erosion can undermine the walls. Consideration has been given to a plan providing additional protection to this area by direct placement of sand in front of the sea walls, and construction of an impermeable groin at the west limit of the fill to reduce westward drifting of material from the shore fronting the cottages. In addition to providing protection, the fill will improve the beach for recreational use. The plan is shown on Plate 16. Due to lack of development, no protective works are needed at Esker Point. It is practicable to enlarge Legion Beach by the direct placement of sand if desired. The causeway would act as a groin to hold a slightly enlarged sandy beach.

29. Groton Long Point. - The Borough of Groton Long Point is a summer colony containing a large number of cottages. Population during the summer

is about 2,000 people. There are only a few year-round residents. The borough owns large extents of shore frontage. The longest of these is located along the west shore of Palmer Cove on the seaward side of a shore road. It is approximately 4,000 feet in length and consists of a narrow strip of land, varying in width from 0 to 100 feet. This shore is composed of boulders, cobbles, gravel and small amounts of sand. Riprap revetment has been placed along low lying portions of the shore to protect the shore road. The borough owns about 800 feet of shore frontage in an indentation of the shore between Groton Long Point and Western Point known as South Beach. This beach is composed of fine and medium sand and has a width in front of a newly constructed sea wall varying between 10 and 50 feet. This beach receives limited use by area residents. The main bathing beach of the borough is located between Western Point and Buddington Point. It has a length of approximately 2,500 feet and a width in front of a wooden bulkhead and boardwalk of about 50 feet throughout most of its length. The beach is composed of fine to medium sand. It is used by the entire borough for bathing. Use of the shores of the Groton Long Point Association is restricted to residents. Privately-owned areas consist of about 1,000 feet of shore on the west side of Palmer Cove adjacent to and south of the highway causeway and the projecting points of land known as Groton Long Point, Western Point and Buddington Point. These shore areas are generally very coarse in composition, characterized by gravel, cobbles and boulders. Some fine sand is held on the south side of groins along the east shore adjacent to the causeway and on the south side of the south jetty at Venetian Harbor. Protection is afforded privately-owned areas by sea walls and riprap revetment. Venetian Harbor is a small boat basin which has been developed by the Groton Long Point Association.

30. The east shore of the borough has experienced erosion which removed finer materials, leaving the area strewn with boulders and gravel and only small amounts of sand. The coarse nature of the present beach supplemented in places by groins, sea walls and riprap revetment, provides considerable protection against continuing erosion. The principal problem has resulted from construction of a road closely paralleling the shore. Portions

of this road are low in elevation and subject to flooding. Cottages have been built along the landward side of the road at these low-lying areas. Dumped riprap has been placed along the edge of the road, but this form of protection is inadequate to prevent flooding. Complete protection requires the construction of some form of water-tight barrier. The flooding of this area is regarded as creating a temporary inconvenience and nuisance. So far as is known, there are no costly damages resulting which would justify the expenditure needed for the type of protection required. No definite plan of protection has been considered. Construction of groins along the shore in an effort to build up sandy beaches has not achieved the desired result, except along the northerly end of the area. This is due to lack of available sources of supply of littoral drift material. Improvement of the composition of the shore would require direct placement of sand and the construction of groins at the north limit of fill areas to retard the movement of sand northward by littoral currents. Since sufficient recreational area is available for residents at the nearby main bathing beach, no consideration has been given to development of additional areas.

31. South Beach is a low, sandy barrier bar fronting a marsh and a lagoon. This bar is occupied by a shore road and cottages. The area was formerly subject to flooding and washing of sand landward over the road. During the latter part of 1949 a concrete sea wall was constructed along the south side of the road. The beach fronting the wall is narrow and sandy. Shore line comparisons indicate that this beach has been stable since 1838. The new sea wall reduces loss of sand from the beach by landward movement and protects the shore road and cottages. No other protective measures appear necessary.

32. Comparative shore line data since 1838 indicates that the main bathing beach between Western and Buddington Points has been stable. The beach is now in good condition. No improvements are desired and none have been considered.

33. Shore Between Mumford Cove and Bushy Point. - This region consists of a large undeveloped headland between Mumford Cove and the Poquonock River and a sand bar or tombolo extending westward connecting Bluff Point to a small island known as Bushy Point. Bluff Point is a high eroded bluff fronted by massive boulders. The shore eastward from Bluff Point to Mumford Point diminishes in elevation and the fronting boulders likewise decrease in size and are mixed with shingle in the vicinity of Mumford Point. Ledge rock is exposed at a number of places along this shore. The shore composition gets finer north and east of Mumford Point along Mumford Cove where the shore merges into shingle and sand bars fronting marsh. The tombolo extending westward from Bluff Point is composed of fine to medium sand. The shore of Bushy Point is boulder strewn. There is no development along this entire extent of shore. The shore of the projecting headland from Bluff Point eastward to and around Mumford Point exhibits evidences of past erosion which has left the foreshore strewn with boulders and other coarse material and exposed bedrock at a number of places. The coarseness of the shore material and the ledge rock have reduced erosion of the headland. The finer material eroded from the headland has contributed to the formation of a sand bar or tombolo connecting Bluff Point and Bushy Point known as Bluff Point and Bushy Point Beaches, and sand and shingle bars along the west shore of Mumford Cove. Between 1846 and 1949 the easterly half of the tombolo west of Bluff Point retreated landw ard about 150 feet resulting in a junction of the bar with marsh lying behind it. During the same period, the seaward shore of the westerly half of the tombolo receded about 150 feet resulting in a narrowing of this portion of the bar. During the hurricane of September 1938 the western end of the tombolo adjacent to Bushy Point was breached and it is now awash at high tide. Local interests have indicated that there is need for closure of this breach to protect the south shore of Trumbull Airport. No harmful effects were noted as having resulted to the shore of the airport and it is not anticipated that any will occur. The cooperating agency has

indicated that the State Park and Forest Commission has an interest in this entire shore area based on possible future acquisition for public recreational use. For this reason the cooperating agency requested that consideration be given to development of plans for protection of the shore based on possible future use as a public park. In the event that the area is acquired and developed by the State of Connecticut, it would be desirable to close the breach in the tombolo at Bushy Point to insure against its widening by tidal and wave generated currents. This can be accomplished by construction of a riprap dike from Bushy Point Island across the breach to Bushy Point Beach. The plan of protection is shown on Plate 16. It is conceivable that in the development of a public park that it will be necessary to construct facilities for bathers in close proximity to Bluff and Bushy Point Beaches. It is important to note that the history of these beaches since 1846 has been one of continued landward movement of the shore line. Material for formation of the beaches was probably supplied by the headland at Bluff Point which is now largely protected against erosion by exposed bedrock and a fringe of very coarse material. The loss of this former supply of material can be expected to result in further retreat of the beaches. It is, therefore, not advisable to construct any buildings or facilities of a permanent nature on the tombolo which constitutes the beaches since this would eventually necessitate the stabilization of the tombolo for protection of these structures. Stabilization of the tombolo would be costly. It would probably involve the construction of some form of barrier to prevent landward movement of sand and also periodic replacement of sand losses which might occur as a result of erosion. If the tombolo is allowed to retreat gradually through natural processes it will probably be suitable for recreational use for a long time without construction of protective works. It is possible that erosion of beach material may eventually endanger the existence of the tombolo but this cannot be foreseen with present knowledge. Should this possibility materialize, preservation of the tombolo could probably be effected by periodic replacement of beach losses. Benefits to be derived

from any protective works would be contingent upon future use of the area. These benefits cannot be evaluated at the present time. The shore area between Mumford Cove and Bushy Point is considered to be a desirable location for development. The tombolo constitutes an excellent beach suitable for recreational use and the headland possesses a large area suitable for residential or park use.

34. Shore Between Baker Cove and Avery Point. - This area includes Jupiter Point and the shore extending westward to Avery Point. Jupiter Point contains a small colony of cottages. There are a few light fishing piers along its east shore. This east shore is composed of marsh in the vicinity of the cottages and of coarse sand along a low, narrow, tongue-shaped projecting tip south of the cottages. The west shore consists of boulders along the southerly tip, and boulders and other coarse material fronting the cottages, except at the northern end where the shore consists of a low, coarse sand barrier bar. The cottages are largely protected by light walls and riprap revetment. There are no protective structures fronting cottages built on the barrier bar. The southerly tip is low and awash at high tide. Shore line comparisons indicate that recession of 50 to 250 feet has occurred along the west side of Jupiter Point since 1846. Continuing erosion can undermine the existing walls and endanger the cottages. Protection is needed for unprotected cottages and existing walls along the west shore. These walls are generally low in elevation, having a top height between 5 and 6 feet above the plane of mean low water. Higher structures are needed to prevent their being overtopped by tides and waves which occur during times when the design tide level of 5.6 feet above mean low water is reached. The most economical method of protection consists of construction of a dumped riprap wall along the high water line of the unprotected barrier bar and the placement of riprap in front of existing walls so as to form a continuous barrier having a top elevation of at least 8.0 feet above the plane of mean low water. The plan of protection is shown on Plate 16. There is no apparent need for protection of the

naturally sheltered east shore of Jupiter Point or of the marshy, largely undeveloped shore extending westward from Jupiter Point to Avery Point.

35. Avery Point. - This entire point is owned by the United States and is occupied by a United States Coast Guard Training Station. The east face of the point consists entirely of a masonry sea wall, the south face largely of bare bedrock and the west face of a bluff protected by riprap revetment and a masonry sea wall. There is a short, coarse sand beach fronting concrete and masonry walls in an indentation of the shore at the southeast corner of the point. The west end of the point adjoins Shenecossett Beach, and about 50 feet of this fine, sandy beach is contained within the Government reservation. The area is protected against erosion by exposed bedrock, sea walls and dumped riprap revetment. A small amount of additional riprap revetment along the west side of the point was needed during 1950 to fully protect the eroding bluff. Maintenance of the present system of protective structures is all that is required.

36. Shenecossett Beach and Eastern Point Beach Park. - Shenecossett Beach consists of a barrier bar composed of fine sand. The bar extends westward from Avery Point to Eastern Point. The eastern end of Shenecossett Beach has been developed into a private beach club. There are a few residences west of this club. Protective structures consist of concrete steps in front of the beach club bath houses and a masonry wall in front of the most westerly residence. Eastern Point and a 400-foot extent of shore adjoining it to the east is owned by the Borough of Groton and has been developed into a public bathing beach known as Eastern Point Beach Park. The publicly-owned shore front has a length of about 2,000 feet. Of this frontage, only 400 feet located east of Eastern Point is used for bathing. Most of the remainder of the shore consists of irregular ledge rock outcrops. Small sandy pockets in indentations along the west and north sides of Eastern Point are not used due to pollution from New London Harbor. The usable beach is composed of fine and medium sand and varies in width

from 30 to 150 feet. The park contains a small parking area. An old mansion at Eastern Point has been converted into a bath house. This beach is the only one in the Town of Groton which is open to the general public. Protective structures at Eastern Point Beach Park consist of a low wall behind the sandy bathing beach, a short dumped boulder breakwater extending southward from the southeast end of Eastern Point, a longer rip-rap breakwater extending northward from the northwest side of Eastern Point and a short dumped rock groin at the eastern boundary of the public beach.

37. Since establishment of the public beach at Eastern Point Beach Park. attendance has increased from 25,000 persons per year during 1946 to 85,000 during 1949. This intensive beach use has resulted in serious overcrowding of the limited beach area. The problem has been accentuated through loss of beach material by eastward drifting and landward movement, necessitating annual replenishment. The foreshore of the bathing beach was covered with boulders and other coarse material prior to development of the public beach. This coarse material was largely removed from the west end of the beach during the initial development and was used to construct the short breakwater at the southeast corner of Eastern Point. During the winter of 1950-51, additional stones were cleared from this end of the beach and used to build up the breakwater. At the same time, some stones were cleared from the foreshore at the east end of the bathing beach and used to construct a groin about 100 feet long at the east boundary of the park. Up to that time, the foreshore at this easterly end of the beach was so coarse that recreational use was discouraged. The area had not been cleared before because it was feared that erosion and loss of beach material might result. Insufficient time has elapsed to determine the ultimate effect of the groin. Some accretion of sand has already occurred, resulting in widening of the beach on both sides of the groin and covering of some of the stones in the foreshore by the impounded sand. The

sand bar lying between Avery Point and Eastern Point receded between 1846 and 1883 by amounts varying between 75 and 200 feet, the greatest movement occurring along the westerly end of the beach. Shore line comparisons indicate that little change has occurred in the position of the high water line since 1883, except adjacent to Eastern Point where a 50-foot recession was effected. Past shore line changes indicate that the western end of the bar, now used as a public beach, is particularly susceptible to erosion. In addition to sand losses resulting from drifting, material is occasionally lost during severe storms by being washed landward over the low, narrow beach and the sea wall. The problem consists of stabilizing the shore to prevent losses of sand and to permit enlargement of the beach area for recreational use. Consideration has been given to enlarging of the impermeable groin at the east limit of the public beach to stabilize the shore by intercepting eastward drifting sand. This will permit clearing of the coarse material in the foreshore along this part of the beach if the impounded sand fails to cover this coarse material. In addition, consideration has been given to direct placement of sand to raise and widen the low, narrow westerly end of the beach. The sand beach so placed should reduce landward losses of sand since it would not be so easily overtopped. It would further increase the available beach area for recreational use by the general public. The plan of improvement is shown on Plate 16.

38. East Shore of Thames River. - The shore extending about one mile north of Eastern Point is irregular in shape and consists largely of ledge rock. Some sand is held in indentations of the shore. Development consists of a large summer hotel and private residences. The hotel and residences are protected by masonry sea walls and riprap revetment. There are a few solid fill piers and one riprap groin along this shore. Because of existing pollution, this area is not a desirable location for the development of beaches for recreational use. The shore is not subject to erosion. In places, sea walls are low in elevation and are occasionally overtopped, resulting in minor flooding. No plan of protection has been considered.

## IV. ECONOMIC ANALYSIS

39. General. - Economic analyses have been made for all contemplated projects. Detailes estimates of costs are included in Appendix H and detailed estimates of benefits are included in Appendix I. A cost estimate has been made for construction of a dike to close the breach at Bushy Point Beach and it is also included in Appendix H. Since no project is presently contemplated for Bushy Point Beach, no cost data have been included in the following pages for this work. Estimates of cost are based on present day price levels. Estimates of benefits are average benefits for the life of the projects. Projects have been contemplated as follows:

PROJECTS CONSIDERED

| Area | Ownership | Paragraph Reference | Plate No. |
|---|---|---|---|
| West View, Groton | Private | 28 | 16 |
| Jupiter Pt. Groton | Private | 34 | 16 |
| Eastern Point Beach Park, Groton | Public | 36 | 16 |

COSTS

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

| Project | Quantity | Cost |
|---|---|---|
| West View | 26,000 cubic yards sand and 1,300 tons riprap | $ 44,000 |
| Jupiter Point | 3,000 tons riprap | 17,000 |
| Eastern Point Beach | 13,000 cubic yards sand and 1,000 tons riprap | 30,000 |

BENEFITS

41. General. - The benefits anticipated from the contemplated projects are estimated on the recreational value of increased public beach area, direct damages prevented, and increased earning power or value of shore lands. Benefits from increased value of areas behind and adjacent to improved shore property, increased business returns and recreational value in improvement of private beaches, although known to exist, have not been estimated. Recreational benefit has been evaluated for increased public beach area based on improvement of the standards of beach space by as-

signing 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 evaluated as a saving in maintenance cost of existing protective structures, as the annual expenditure made for replacement of beach losses and the saving effected through prevention of damages to buildings located close to the shore. Benefits from increased earning power or value of shore lands have been evaluated by estimating the gain represented by interest on increase in land value which could be realized by sale of such land and investment of the additional money so obtained.

42. Benefits. - Detailed estimates of annual benefits are included in Appendix I and are summarized below:

ESTIMATED ANNUAL BENEFITS

| Project | Recreational | Direct Damages Prevented | Increased Earning Power | Total |
|---|---|---|---|---|
| West View | $ 0 | $ 500 | $ 362 | $ 862 |
| Jupiter Pt. | 0 | 650 | 251 | 901 |
| Eastern Point Beach Park | 1,934 | 1,000 | 0 | 2,934 |

INTERESTS

43. Federal, Non-Federal, Public and Private Interests. - The Federal interest in a shore protection project is considered to be essentially the benefit secured by the United States as a land-owner. Non-Federal public interest is defined as, (a) the benefits accruing to a State or a political subdivision thereof as a land-owner and, (b) the benefits accruing to the general public. Private interest is defined as the benefit derived by individuals or non-public groups of individuals on account of ownership of lands and business enterprises affected.

44. The classification of benefits to be derived from the proposed projects in accordance with the interest involved is as follows:

ESTIMATED ANNUAL BENEFITS

| Project | Federal | Non-Federal Public | Private | Total |
|---|---|---|---|---|
| West View | 0 | $ 0 | $ 862 | $ 862 |
| Jupiter Point | 0 | 0 | 901 | 901 |
| Eastern Point Beach Park | 0 | 2,934 | 0 | 2,934 |

ALLOCATION OF COSTS

45. General. - The Federal policy for the expenditure of Federal funds for the protection and improvement of shores owned by states, municipalities and other political subdivisions is set forth in Public Law 727, 79th Congress, 2nd Session. 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 first cost of works for the protection and improvement of privately-owned shores and no Federal contribution of funds has been considered for this purpose.

46. Allocation. - The Federal and non-Federal share of the costs of contemplated projects are estimated in detail in Appendix H and are summarized below:

ALLOCATION OF COSTS

| Project | Federal Share | Non-Federal Share | Total |
|---|---|---|---|
| West View | $ 0 | $ 44,000 | $ 44,000 |
| Jupiter Pt. | 0 | 17,000 | 17,000 |
| Eastern Point Beach Park | 0 | 30,000 | 30,000 |

ANNUAL COSTS

47. Federal and Non-Federal Annual Costs. - Annual costs are based on the Federal and non-Federal share of the estimated costs of proposed projects. The detailed estimates are included in Appendix H. Interest has

been computed at a rate of 3.5 percent on non-Federal funds. A useful life of 50 years has been assumed in determining amortization charges. Annual maintenance costs are included as a non-Federal charge. A summary of annual costs is given below:

ANNUAL COSTS

| Project | Federal | Non-Federal | Total |
|---|---|---|---|
| West View | $ 0 | $ 2,880 | $ 2,880 |
| Jupiter Pt. | 0 | 965 | 965 |
| Eastern Point Beach Park | 0 | 2,320 | 2,320 |

## JUSTIFICATION

48. Benefit and Cost Ratio. - The estimated annual benefits and costs and the resulting ratio of benefits to costs are summarized below:

BENEFITS AND COSTS

| Project | Estimated Annual Benefits | Estimated Annual Costs | Ratio of Benefits to Costs |
|---|---|---|---|
| West View | $ 862 | $ 2,880 | 0.30 |
| Jupiter Point | 901 | 965 | 0.93 |
| Eastern Point Beach Park | 2,934 | 2,320 | 1.26 |

## COORDINATION WITH OTHER AGENCIES

49. General. - 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. The Selectmen 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 as to aspects of the study pertaining to their interests. In addition, widespread personal contact has been made with the shore residents to ascertain data concerning the problem.

50. Comments by Local Interests. - The results of this study have been discussed with the cooperating agency, the Connecticut State Flood Control

and Water Policy Commission. This agency requested that consideration be given to development of plans for protection of the undeveloped shore between Mumford Cove and Bushy Point because State interests are interested in acquiring and developing this property for public recreational purposes. In accordance with this request, consideration was given to protection of this shore based on possible future use. The cooperating agency also pointed out that pollution in the Little Narragansett Bay-Stonington region which now makes this area unsuitable for development of recreational beaches is expected to be corrected in the future, but since development in this area was not disregarded in the study solely because of pollution, no objection was raised to the treatment of this area in the report. Apart from the comments mentioned above, the results of the study were satisfactory to the cooperating agency.

## V. DISCUSSION AND CONCLUSIONS

51. West View. - The plan considered consists of direct placement of sand in front of the sea walls at the West View cottage development and construction of an impermeable groin at the west limit of the fill. The shore involved was subject to erosion between 1838 and 1883 which caused a shore recession averaging 1 to 3 feet per year. A survey, run during 1949, indicates that the shore recession continued at a slower rate between 1883 and 1949. There is practically no beach fronting the walls at the cottage development at high tide. Sections of the sea walls are being undermined by loss of shore material. The proposed sand fill will provide additional protection to the area. It will also provide a beach suitable for recreational use. The proposed impermeable groin will reduce losses of the sand fill through westward drifting.

52. The estimated first cost of construction of the protective sand beach and groin is $44,000, and the estimated annual maintenance is $1,005. The estimated annual cost is $2,880 and the annual benefit is $862. The ratio of benefits to costs is 0.30 to 1. The shore area is all privately-owned. No Federal participation in the cost of protective works has been considered.

53. Jupiter Point. - The plan considered consists of construction of a dumped riprap mound along the shore fronting cottages on the west side of Jupiter Point. Shore recession since 1846 has moved the shore line 50 to 250 feet landward. Cottages are situated close to the shore on land which is low in elevation. Some of these cottages are fronted by low walls. Others are entirely unprotected. The existing walls are generally so low that they can be overtopped by extreme high tides and by waves occurring during these tides. Sections of sea walls are being undermined due to loss of shore material. The riprap mound will provide protection for cottages which are now unprotected. It will also, due to its location in front of existing walls, protect these structures against undermining. The proposed mound is generally higher than existing walls and will provide protection to cottages against damage during ordinary storms. Some overtopping of walls may occur during exceptional storms, resulting in minor damage. Complete protection against all possible conditions is not regarded as being economically justifiable.

54. The estimated first cost of construction of the riprap mound is $17,000, and the estimated annual maintenance is $240. The estimated annual cost is $965, and the annual benefit is $901. The ratio of benefits to costs is 0.93 to 1. The shore area is all privately-owned. No Federal participation in the cost of protective works has been considered.

55. Eastern Point Beach Park. - The plan considered consists of direct placement of sand to widen the narrow west end of the bathing beach and enlargement of an impermeable groin at the east boundary of the park. The bathing beach is the south shore of the park extending 400 feet eastward from Eastern Point. The west end of the beach is subject to erosion by eastward drifting of sand, necessitating annual r eplacement of losses by artificial means. Beach losses are also effected by waves washing sand over the narrow beach and low wall and road behind it. The amount of beach area available for recreational use is small. This area is further limited by the existence of boulders and other coarse material in the fore-

shore at the east end of the beach. Some of this material has been removed and used to construct the groin at the east limit of the park. It is feared that removal of all the coarse material from the foreshore will result in an accelerated loss of beach sand. The bathing beach receives intensive use, resulting in serious overcrowding. Local interests desire additional beach area. Enlargement of the groin at the east end of the park will stabilize the shore, making it practical to remove all coarse material now fronting the beach if this material is not covered by drifting sand impounded by the groin. The sand fill will widen and raise the narrow west end of the beach, thereby providing a better to prevent waves washing material landward. The fill will also enlarge the usable beach area and reduce the overcrowding which now occurs during periods of peak use. The groin and Eastern Point will create a pocket which should reduce losses of sand from the bathing beach.

56. The beach belongs to the Borough of Groton and it is used as a public bathing beach. On account of this public ownership, consideration has been given to Federal participation in the first cost of construction of protective works in accordance with Public Law 727, 79th Congress. Projects for protection of existing publicly-owned beaches are considered to be eligible to receive Federal aid up to a maximum equal to one-third the first cost of construction of protective works. The proposed project consists of two parts. The first part is enlargement of an existing groin, the principal purpose of which is to stabilize the existing shore. The second part is placement of sand fill, the principal purpose of which is to enlarge the beach area for recreational use. The proposed project is considered eligible to receive Federal aid for protection of the shore by construction of the groin but not for enlargement of the present beach for recreational use.

57. The estimated first cost of construction of the fill and groin is $30,000, and the estimated annual maintenance is $1,040. The estimated annual cost is $2,320 and the annual benefit $2,934. The ratio of benefits

to costs is 1.26 to 1. Ownership of the shore is entirely public. Evaluated benefits are non-Federal public benefits limited largely to residents and property owners of the Town of Groton. The principal purpose of the proposed project is enlargement of the beach for recreational purposes. The maximum amount of Federal funds which can be contributed based on protection of the existing shore by construction of the proposed groin is small (approximately $3,800). As the cost of maintaining the present width of beach has been relatively low, the public interest in an alternative method of protection is correspondingly small. This limited public interest, the local nature of the public interest, and the minor amount of Federal aid that could be recommended under the policy established by existing laws do not warrant adoption of a Federal project for the locality. However, the public interest in additional beach area for recreation is recognized. Evaluated benefits indicate that construction of the project at local expense is amply justified.

58. Conclusions. - The Division Engineer concludes that, (1) the scarcity of beaches suitable for recreational use has intensified the need for preserving and improving those which are available, (2) there exist large extents of shore for which improvements cannot be justified due to their unsatisfactory composition, inaccessibility and/or limited development, (3) extensive pollution motivates against development of bathing beaches between the Pawcatuck River and Stonington Harbor, (4) there are no adequate sources of material to supply littoral drift for creation of sandy beaches by natural processes, (5) improvement of beaches for recreational use generally requires direct placement of sand fill, (6) improvement of beaches with sand fill will generally require the construction of groins or other structures to retard the processes of erosion, (7) only a few locations adjacent to developed shores merit consideration for protection and improvement, and (8) no cases of pollution exist to prohibit any of the improvements considered.

59. The Division Engineer concludes that the best plans for protection and improvement of shore areas which merit consideration, all as shown on

Plate 16, are as follows:

a. West View. - Direct placement of a sand beach in front of sea walls and cottages, and construction of an impermeable groin at the west limit of the fill.

b. Jupiter Point. - Construction of a dumped riprap mound in front of the cottages along the west side of Jupiter Point.

c. Eastern Point Beach Park. - Direct placement of sand along the narrow west end of the bathing beach and enlargement of the impermeable groin at the east limit of the park.

60. Enlargement of Eastern Point Beach for recreational purposes is justified by evaluated benefits. Adoption of a Federal project therefor is not warranted in view of the limited public interest other than recreational, the local character of the public interest, and the minor Federal aid for which the project would be qualified. The recreational value of the project warrants its construction at local expense.

61. The proposed projects for West View and Jupiter Point are 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 projects considered.

## VI. RECOMMENDATIONS

62. It is recommended that no project be adopted by the United States at this time for protection or improvement of the shores of Stonington or Groton, Connecticut. It is also recommended that local interests consider adoption of a project for protection and improvement of Eastern Point Beach by widening the narrow westerly end of the bathing beach by direct placement of sand fill and extension of the groin at the east limit of the beach to a length of 300 feet, and further, that protective measures which may be undertaken by local interests from time to time at other localities within the study area, based upon their determination of economic justification, be accomplished in accordance with methods proposed in this report.

H. J. WOODBURY
Colonel, Corps of Engineers
Division Engineer

33 Incls:
10 Appendices
23 Plates

BEACH EROSION CONTROL REPORT ON COOPERATIVE STUDY OF CONNECTICUT

AREA 5

PAWCATUCK RIVER TO THAMES RIVER

Appendices A - J

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# APPENDIX A

## DESCRIPTION AND COMPOSITION OF BEACHES

1. General. - Detailed descriptive data of the entire shore line of Area 5 was obtained by field inspections. The shore line was then divided consecutively from the Pawcatuck River to New London Harbor in accordance with the physical character of shore features. Descriptions of these subdivisions are given below. In addition to visual inspection, samples of beach material were obtained at selected locations throughout the area and a mechanical analysis of these samples was made to determine median diameter and classification. Beach sample analysis results and locations are shown on Plates 11 - 15. A complete photographic record was made of the shore. Selected photographs are shown on Plates 18 - 24.

STONINGTON

A. Pawcatuck Point

(1) Location: East limit study area and State of Connecticut.

(2) Extent: 800 feet east and 2500 feet north of southerly tip of point.

(3) Width - Above H.W.: No beach

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Boulder strewn shore. Size of boulders larger along west side diminishing towards the point and east of the point. Some marsh mixed with the boulders at the tip of the point and along the bank of the Pawcatuck River.

(8) Protective Structures: None

(9) Character of Development: Area undeveloped. Newly constructed dirt road to point and construction of two houses in progress during January 1950, apparently the start of a new real estate development.

B. Barn Island Waterfowl Area

(1) Location: Between Wequetequock Cove and Pawcatuck Point.

(2) Extent: 17,000 feet

(3) Width Beach - Above H.W.: No sand beach except in two small pockets fronting marsh, 20 to 30 feet wide.

(4) Ownership: State of Connecticut

(5) Use: Waterfowl and hunting area. Limited amount of bathing and picknicking.

(6) Public Facilities: None

(7) Composition of Shore: Principally marsh. Boulder strewn shore at Barn Island. Boulders and marsh and some medium sand at point adjacent to Wequetequock Cove with some ledge rock along southwest side. The two small pockets fronting marsh are composed of coarse sand. There are low dunes behind these pockets.

(8) Protective Structures: None

(9) Character of Development: None

C. Elihu Island

(1) Location: West side Wequetequock Cove.

(2) Extent: Entire

(3) Width Beach - Above H.W.: 30-40 feet in small pocket on east side (75 feet long). No beach elsewhere.

(4) Ownership: Private

(5) Use: One estate. Some farming on island.

(6) Public Facilities: None

(7) Composition of Shore: The southern arm of the island consists of marsh, boulders, small patches of coarse sand in indentations and numerous ledge rock outcrops. The eastern shore of the northern part of the island consists almost continuously of ledge rock. There is one small fine sand pocket beach on this side. The western shore of the northern part of the island consists of marsh, numerous boulders and some ledge rock outcrops.

(8) Protective Structures: Low masonry wall behind, and a short riprap groin at north end of small sandy pocket beach.

(9) Character of Development: Residence and farm buildings

D. Shore West of Elihu Island

(1) Location: Elihu Island Causeway to Stonington Borough School.

(2) Extent: 5200 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Mostly marsh. A few ledge rock outcrops. Boulder strewn shore and short stretch of sand beach east of breakwater at Stuart estate.

(8) Protective Structures: Masonry walls along causeway adjacent to borough school and along west side Stuart estate. Riprap fronting causeway wall. Riprap breakwater extending southerly from Stuart estate. Riprap along toe of bank and marsh east of breakwater.

(9) Character of Development: Large residence and farm buildings.

E. Village of Stonington (East Shore)

(1) Location: Stonington Borough School to 150 feet south of Omega Street.

(2) Extent: 3100 feet

(3) Width Beach - Above H.W.: Practically none. One small pocket about 30 feet wide in indentation west of riprap breakwater. Water generally at sea walls.

(4) Ownership: Stonington Borough School, 200 feet ±; Borough of Stonington 50 feet ±, remainder private.

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Fine sand in small pocket west of riprap breakwater. Small sand pocket in corner of cove at causeway and school. Elsewhere shingle, boulders and riprap.

(8) Protective Structures: Low masonry sea wall and riprap revetment at Stonington Borough School, high masonry walls south of school, loose stone wall and riprap breakwater north and east of sandy pocket beach, masonry walls and riprap along portions of sandy pocket, masonry walls south of sandy pocket.

(9) Character of Development: School, fishing piers, residential.

F. Village of Stonington: (Stonington Point)

(1) Location: From east side of Stonington Point, 150 feet south of Omega Street to inner breakwater in Stonington Harbor.

(2) Extent: 1700 feet

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

(4) Ownership: Stonington Historical Society (U. S.) 120 feet ±, Borough of Stonington 360 feet ±, remainder private.

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Shingle, cobbles, boulders.

(8) Protective Structures: Loose stone wall around tip of point, short riprap groin, masonry walls and cut stone and riprap breakwater along west side of point.

(9) Character of Development: None at tip of point. Residences along west shore.

G. Village of Stonington (East side of Stonington Harbor)

(1) Location: Inner breakwater to railroad embankment.

(2) Extent: 5000 feet

(3) Width Beach - Above H.W.: Water at walls, wharves, piers and bulkheads. Small pocket beach at Wadawanuck Yacht Club 40-50 feet wide and less than 100 feet long.

(4) Ownership: Private

(5) Beach Use: Bathing beach at Wadawanuck Yacht Club.

(6) Public Facilities: None. Private bathhouses and club house at Yacht Club.

(7) Composition of Shore: Fine sand in pocket beach. No beach elsewhere.

(8) Protective Structures: This is a harbor area with the shore continuously developed with piers, wharves, bulkheads and walls.

(9) Character of Development: A harbor adjacent to a small residential community.

H. Wamphassuck Neck (East Shore)

(1) Location: West side Stonington Harbor from railroad embankment to Wamphassuck Point.

(2) Extent: 7000 feet

(3) Width Beach - Above H.W.: Generally no sand beach. Some sand caught on south side of groins and piers form small sandy beaches of varying width. There is a northward trailing bar or spit about 600 feet long and 50 feet wide in central portion of area. North of this spit there is a cuspate shaped bar about 700 feet long and 75 to 100 feet wide. North of the cuspate bar, sand is trapped by groins and the railroad embankment forming three sandy stretches of shore, the two southerly ones being comparatively small while the northerly one forms a beach about 350 feet long varying in width from 0 feet at the south end to 150 feet adjacent to the embankment.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Generally coarse boulder strewn shore with ledge rock outcrops at Wamphassuck Point. Material caught on south side of structures is mostly fine sand. Some marsh interspersed with boulders in foreshore in central portion of area. The sand spit and cuspate bar consist of medium and coarse sand and gravel. The gradation of material is finer to the north. The foreshore is strewn with cobbles and boulders except in front of the sandy stretches of shore at the north end of the area.

(8) Protective Structures: Most of shore unprotected. Short riprap groins, loose stone and masonry walls in vicinity of cottages at north end of area and riprap revetment south of the groins. Remains of two wrecks imbedded near apex of cuspate bar. A few widely spaced groins and solid fill piers south of bar to Wamphassuck Point. A masonry wall around the tip of Wamphassuck Point. An earth dike with riprap toe protects a short stretch of shore north of the point.

(9) Character of Development: A small group of residences in the vicinity of Wamphassuck Point. Remainder of area consists of large estates containing a few widely spaced residences.

I. Wamphassuck Neck (West Shore)

(1) Location: Between Wamphassuck Point and Lords Point.

(2) Extent: 4800 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Ledge rock at Wamphassuck Point and boulder strewn shore north of point. Boulder strewn shore around low-lying island forming a secondary point west of Wamphassuck Point. This island is connected to the mainland by marsh. This marsh extends westward forming the shore to Lords Point.

(8) Protective Structures: Loose stone and masonry walls in vicinity of Wamphassuck Point.

(9) Character of Development: Small group of residences in vicinity of Wamphassuck Point; elsewhere no development.

J. Lords Point

(1) Location: Between Wamphassuck Neck and White Beach.

(2) Extent: 5500 feet

(3) Width Beach - Above H.W.: 75 feet at head of cove formed by two projecting rocky points. Elsewhere generally no beach except for small pockets of sand held in indentations of shore.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Two ledge rock points. Some scattered boulders in foreshore of westerly point, numerous boulders in foreshore of easterly point. A fine sand bar fronted by marsh, mud flats and boulders along eastern half of head of cove between the rocky points, boulders and cobbles fronting wall along west half of head of cove. The remainder of the shore consists of irregular ledge rock outcrops with some small fine sand pockets in indentations.

(8) Protective Structures: Low masonry walls behind small sand pocket on west side of western point. A masonry wall protecting road along west side of cove. A masonry wall around eastern point and in front of some of the cottages.

(9) Character of Development: Summer cottages.

K. White Beach

(1) Location: Adjacent to and east of Quambaug Cove

(2) Extent: 1400 feet

(3) Width Beach - Above H.W.: 30-35 feet.

(4) Ownership: Private

(5) Beach Use: Private beach

(6) Public Facilities: None

(7) Composition of Shore: Fine sand above high water at west end and coarse sand at east end. Coarse sand and fine gravel foreshore. Rock outcrop near west end of beach. This is a barrier bar fronting marsh and a pond.

(8) Protective Structures: Masonry walls fronting cottages along west half. Riprap along toe of sand dune along east half.

(9) Character of Development: Summer cottages.

L. Between White Beach and Latimer Point

(1) Location: Adjacent to and west of Quambaug Cove.

(2) Extent: 3000 feet

(3) Width Beach - Above H.W.: Width of sand bar, 100-200 feet along westerly 2000 feet, no sand beach elsewhere.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Easterly 500 feet, riprap revetment along railroad embankment; next westerly 500 feet, eroded boulder strewn shore; westerly 2000 feet, a medium and coarse sand bar containing considerable gravel and a grass-covered dune 3 to 4 feet above the level of marsh on its landward side. There are mud flats, wave cut marsh, shingle, fine gravel and boulders in the foreshore.

(8) Protective Structures: Riprap revetment along railroad embankment; roughly built groins (lines of boulders) along sand bar.

(9) Character of Development: None

M. Latimer Point

(1) Location: Northeast of Andrews and Dodge Islands.

(2) Extent: Entire, 5500 feet +

(3) Width Beach - Above H.W.: Generally no sand beach. One small pocket about 100 feet long and 30 to 40 feet wide in indentation east of tip of point.

(4) Ownership: Private

(5) Use: Small private bathing beach.

(6) Public Facilities: None

(7) Composition of Shore: Marsh and scattered boulders along both east and west shores at north end of point. Composition coarser to the south consisting of large scattered boulders and ledge rock outcrops. Some fine sand amongst boulders. The small pocket beach east of the south tip of the point consists of medium and fine sand above high water and coarse sand below high water. There is a smaller medium sand pocket on the west side of the point opposite the most southerly cottage.

(8) Protective Structures: Riprap revetment and masonry walls around south tip of point. One small riprap groin at east side.

(9) Character of Development: A few cottages at south end of point.

N. Between Latimer Point and Causeway to Mason Island

(1) Location: East of Mason Island

(2) Extent: 3500 feet +

(3) Width Beach - Above H.W.: There is a sand bar about 300 feet long and 50 to 75 feet wide fronting marsh on the west side of the first point east of Mason Island. No sand beach elsewhere.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: First point west of Latimer Point; a small island fronted by marsh and boulders connected to the mainland by marsh. First point east of the causeway to Mason Island; a marshy point fronted by a medium and coarse sand bar along a portion of its west side. The marsh is fronted by scattered boulders along the east side of the point.

(8) Protective Structures: None

(9) Character of Development: None

O. Mystic

(1) Location: Between the causeway to Mason Island and Murphy Point.

(2) Extent: 3000 feet +

(3) Width Beach - Above H.W.: There is a sand bar 75 to 150 feet wide fronting marsh at Williams Point.

(4) Ownership: The Williams Point area known as Williams Park belongs to the Mystic Community Center. Remainder of shore private.

(5) Use: Williams Park being developed as a bathing beach and recreation center.

(6) Public Facilities: Construction of parking areas, field house, lockers, toilets, playing field, tennis courts and picnic grounds planned for Williams Park. Some fill for parking area recently placed. No facilities elsewhere.

(7) Composition of Shore: The sand bar consists of medium and coarse sand with mud flats offshore. Remainder of shore is marshy with some coarse sand and gravel at the south end near Mason Island.

(8) Protective Structures: Stone wall around residences at shore road south of Williams Point. Some riprap along road.

(9) Character of Development: Residential along road south of Williams Point. Factory landward of Williams Park.

P. Mystic

(1) Location: Murphy Point

(2) Extent: Entire

(3) Width Beach - Above H.W.: Generally no sand beach. A narrow sandy bar or spit fronts the marsh at the south end of the point.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Coarse sand and fine gravel bar fronting south end of point. Remainder of shore consists of marsh.

(8) Protective Structures: None

(9) Character of Development: A few cottages in northerly portion, none in southern part. The southern area is staked out into house lots.

Q. Mason Island

(1) Location: Mystic River

(2) Extent: Entire

(3) Width Beach - Above H.W.: Generally no sandy beach. A narrow sand and shingle bar 50 to 75 feet wide fronts marsh between Clam Point and Ram Point. A small coarse sand beach 30 to 40 feet wide north of and adjacent to the bridge to Baker Island. Small sandy pockets held in indentations of shore.

(4) Ownership: Private

(5) Beach Use: Limited to residents

(6) Public Facilities: None

(7) Composition of Shore: Northeasterly point adjacent to causeway, marsh merging westward into coarse sand and gravel and heavy boulder strewn shore with numerous boulders offshore; north shore of island, points consist of heavy boulders, coves of marsh and some coarse sand and gravel with boulders offshore; Pine Point, ledge rock outcrops; south of Pine Point, coarse sand and gravel, some boulders; first point south of Pine Point, northside consists of coarse sand and gravel, west and south sides of shingle with dumped quarry waste in southeast indentation; south of above point to cove north of Clam Point, shingle at north end changing to ledge rock to cove containing a small coarse sand pocket beach; Clam Point, a shingle cuspate bar fronting marsh; Clam Point to Ram Point, a bar fronting marsh, alternately shingle and coarse sand, the coarse sand lying south of groins and ledge rock outcrops; Ram Point, a coarse sand bar around marsh with ledge rock at the south tip. The bar between Clam Point and Ram Point constitutes a tombolo. South end of island, the points consist of bare bedrock, the indentations of marsh and the entire area contains numerous large scattered boulders; north of and adjacent to bridge to Baker Island, a small coarse sand beach with shingle and boulder foreshore, boulders near bridge, ledge rock outcrop north of sand beach; some coarse sand north of pier at club house; east shore of island north to causeway, a boulder strewn shore at the south end mixed with marsh further north becoming all marsh at the north end. Small fine sand pockets where boulders have been cleared away.

(8) Protective Structures: Northeasterly point, loose stone walls and some riprap; north shore, a riprap groin in easterly cove and some riprap along shore; Pine Point, short groins east side, loose stone walls and remains of wharf to the south; cove north of Clam Point, masonry walls and short groin south of residence; Clam Point to Ram Point, short riprap groins; south end of island, short sections of masonry and concrete walls; at sand beach north of bridge to Baker Island, low concrete wall along edge road, masonry and timber pier at north end at club house, riprap groin north of pier; east shore of island, a few piers and short riprap groins.

(9) Character of Development: Cottages and large residences.

GROTON

R. West Mystic

(1) Location: Willow and Spence Points

(2) Extent: 4000 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Coarse sand and gravel, marsh at south end near railroad, ledge rock outcrop near north end.

(8) Protective Structures: Short riprap groins north of Willow Point, piers at Willow Point, remains of stone walls south of Willow Point, masonry walls and short riprap groins around Spence Point. Loose stone walls along west side of Spence Point.

(9) Character of Development: Largely residential. A shipyard at Willow Point.

S. West Mystic

(1) Location: Between Spence Point and Noank

(2) Extent: Sixpenny Island, railroad embankment, Bebee Cove.

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Sixpenny Island consists of marsh with some boulders on north side. The projecting point north of Sixpenny Island consists of high rock outcrops.

(8) Protective Structures: Riprap revetment along railroad embankment. Riprap and stone walls around Bebee Cove.

(9) Character of Development: None on Sixpenny Island. A few residences on point north of Sixpenny Island. Residential around Bebee Cove.

T. Noank (East side)

(1) Location: Between Bebee Cove and Morgan Point.

(2) Extent: 5600 feet

(3) Width Beach - Above H.W.: None. Small pockets of sand at groins or indentations of shore.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Generally coarse consisting of boulders, cobbles, shingle and riprap and rock outcrops. Morgan Point consists of ledge rock.

(8) Protective Structures: Remains of old stone walls, riprap revetment, masonry walls, small riprap groins, remains of old shipyards.

(9) Character of Development: Commercial in vicinity of shore, residential behind the shore.

U. Noank (West side)

(1) Location: Morgan Point to head of West Cove.

(2) Extent: 3000 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Boulders, shingle, cobbles. Some sand caught in indentations of shore.

(8) Protective Structures: Southern half, remains of old shipyards, loose stone walls, riprap. Northern half, riprap and masonry walls.

(9) Character of Development: Old shipyards and residential. Small fishing community.

V. West View and Esker Point

(1) Location: Between West Cove and Palmer Cove.

(2) Extent: 5500 feet

(3) Width Beach - Above H.W.: Generally none. A sand bar fronting marsh at the head of West Cove. A narrow beach, 0 to 15 feet wide in front of walls at West View and a sand bar adjacent to the east side of Esker Point fronting marsh, a small sand beach adjacent to road on west side of Esker Point.

(4) Ownership: Private

(5) Beach Use: American Legion picnic and bathing area at Esker Point.

(6) Public Facilities: None

(7) Composition of Shore: Coarse sand bar at head of West Cove, riprap protecting eroding bluff along west side of Cove, ledge rock point at east end of West View, shingle, a few boulders, rock outcrops and some fine sand at groins along West View, a medium and fine sand bar fronting marsh east of and adjacent to Esker Point, a coarse shore consisting of boulders, cobbles and shingle around Esker Point, a medium sand beach adjacent to road on west side of Esker Point. The foreshore generally consists of shingle and cobbles.

(8) Protective Structures: Short riprap groins, low masonry wall and riprap revetment along west shore of West Cove, masonry walls around tip of point on west side of West Cove, masonry and concrete walls and short riprap and masonry groins along West View and a short riprap groin on east side of Esker Point.

(9) Character of Development: Cottages and small boat yards along West Cove. Cottages at West View. Esker Point undeveloped except for one small building at south end.

W. Groton Long Point (Borough)

(1) Location: East shore from highway to Groton Long Point.

(2) Extent: 5300 feet

(3) Width Beach - Above H.W.: Sand beach varies from 0 to 50 feet at groins along the northerly 1000 feet of shore. Elsewhere the coarse shore extends 0 to 100 feet from the edge of the shore road.

(4) Ownership: Northerly 1000 feet ± private, remainder Borough of Groton Long Point.

(5) Beach Use: Limited use by residents.

(6) Public Facilities: None

(7) Composition of Shore: Northerly 1000 feet fronting cottages, fine sand on south side groins, shingle on north side; area generally coarse consisting of shingle and some boulders. South of cottages, boulder strewn shore, shingle and small amounts of sand.

(8) Protective Structures: Loose stone wall and riprap along road at north end, low masonry and concrete walls, riprap and masonry groins in front of cottages, riprap revetment along low stretches of the shore road. Some short riprap groins.

(9) Character of Development: Summer cottages. Road closely bordering shore except along northerly 1000 feet.

X. Groton Long Point (Borough)

(1) Location: Groton Long Point.

(2) Extent: 900 feet

(3) Width Beach - Above H.W.: 0 - 15 feet except south of pier on east side of point, 50 feet ±.

(4) Ownership: Private, except easterly pier belonging to Borough.

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Shingle on south side of pier on east side of point, remainder of area consists of numerous boulders, cobbles and shingle.

(8) Protective Structures: Solid fill masonry pier with timber extension protected by riprap revetment at east limit, masonry walls around the point, a solid L-shaped masonry pier near west limit.

(9) Character of Development: Large summer residences.

Y. Groton Long Point (Borough)

(1) Location: South Beach between Groton Long Point and Western Point.

(2) Extent: 800 feet

(3) Width Beach - Above H.W.: 50 feet at east end, 30 feet in center of beach decreasing to 10-15 feet to the west, 30 feet at the west end.

(4) Ownership: Borough of Groton Long Point.

(5) Beach Use: Bathing beach.

(6) Public Facilities: None

(7) Composition of Shore: Fine and medium sand with some gravel at east end.

(8) Protective Structures: Newly constructed concrete wall behind beach along edge of sidewalk.

(9) Character of Development: Cottages on landward side of road bordering the beach.

Z. Groton Long Point (Borough)

(1) Location: Western Point between South Beach and the main bathing beach.

(2) Extent: 2000 feet

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

(4) Ownership: Private, except for a few rights of way belonging to the Borough of Groton Long Point.

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Boulders and shingle. No sand. Boulders in immediate offshore area.

(8) Protective Structures: Masonry sea walls and some riprap revetment.

(9) Character of Development: Large summer residences.

AA. Groton Long Point (Borough)

(1) Location: Main bathing beach between Western Point and Buddington Point.

(2) Extent: 2500 feet

(3) Width Beach - Above H.W.: 50 feet throughout most of the beach increasing to 60-70 feet along the westerly 100 feet and decreasing to 15-20 feet along the easterly 200 feet.

(4) Ownership: Borough of Groton Long Point.

(5) Beach Use: Borough bathing beach.

(6) Public Facilities: Sanitary facilities and first aid available at municipal building.

(7) Composition of Shore: Fine to medium sand.

(8) Protective Structures: Wooden bulkhead fronting wooden boardwalk.

(9) Character of Development: Summer cottages behind beach.

BB. Groton Long Point (Borough)

(1) Location: Buddington Point between main bathing beach and entrance to Venetian Harbor.

(2) Extent: 1000 feet

(3) Width Beach - Above H.W.: 20 to 30 feet adjacent to jetty at Venetian Harbor, none in front of walls to Buddington Point, 20 feet east of breakwater at Buddington Point.

(4) Ownership: Private

(5) Beach Use: Adjacent owners.

(6) Public Facilities: None

(7) Composition of Shore: Fine sand adjacent to jetty. Shingle, cobbles and boulders in front of walls. Some sand east of breakwater at Buddington Point. Coarse boulder strewn foreshore.

(8) Protective Structures: Short masonry wall acting as a groin at east limit, riprap breakwater at Buddington Point, low masonry walls, riprap jetty at west limit at entrance to Venetian Harbor.

(9) Character of Development: Summer cottages.

CC. Groton Long Point (Borough)

(1) Location: North of and adjacent to the entrance to Venetian Harbor.

(2) Extent: 1500 feet

(3) Width Beach - Above H.W.: 30 to 40 feet between jetty and creek. No beach north of creek.

(4) Ownership: Private and Borough of Groton Long Point.

(5) Beach Use: Adjacent owners.

(6) Public Facilities: None

(7) Composition of Shore: Medium and coarse sand adjacent to jetty. Marshy shore adjacent to and north of creek.

(8) Protective Structures: Riprap jetty at entrance to Venetian Harbor. Low masonry wall and riprap north of creek along edge of road.

(9) Character of Development. Summer cottages.

DD. Mumford Cove (West shore)

(1) Location: North of Mumford Point.

(2) Extent: 4300 feet

(3) Width Beach - Above H.W.: No sand beach along southerly 1300 feet, thence a sand and gravel bar 50 to 150 feet in width borders the shore to the north limit of the area.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: The southerly 1300 feet consists of shingle, cobbles and boulders. The next northerly 1100 feet consists of a bar fronting a shallow pond composed of shingle at its south end changing to fine and medium sand and gravel to the north where it connects with a nest of boulders. The most northerly 1900 feet consists of a bar fronting marsh. This bar is composed of sand and gravel. At its northerly end, the bar has taken the form of a coarse sand tombolo connecting to a small offshore island.

(8) Protective Structures: None

(9) Character of Development: None

EE. Mumford and Bluff Points

(1) Location: Between Mumford Cove and Bluff Point Beach.

(2) Extent: 2400 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: An eroded shore composed of huge boulders, ledge rock outcrops and cobbles. At the west end at Bluff Point the backshore consists of a high bluff which diminishes in elevation to Mumford Point. The size of boulders diminishes to the east. The gradation changes from a continuous blanket of large boulders at Bluff Point to a cobble and shingle shore with scattered boulders at Mumford Point.

(8) Protective Structures: None

(9) Character of Development: None

FF. Bluff Point and Bushy Point Beaches

(1) Location: Between Bluff Point and Bushy Point.

(2) Extent: 4500 feet

(3) Width Beach - Above H.W.: A sand bar 100 to 300 feet wide.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: The beach changes rapidly from a boulder strewn shore at Bluff Point to coarse sand and fine gravel west of and adjacent to Bluff Point and fine and medium sand throughout most of the length of the bar. There is a breach at the western end of the bar which is awash at high water. The shore along this breach consists of shingle and cobbles.

(8) Protective Structures: None

(9) Character of Development: None

GG. Trumbull Airport

(1) Location: North of Bushy Point Beach, between the Poquonock River and Baker Cove.

(2) Extent: South of the runways.

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

(4) Ownership: State of Connecticut.

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Wide marshes.

(8) Protective Structures: Riprap revetment along shore of Poquonock River opposite south end of NW-SE runway. Elsewhere none.

(9) Character of Development: Practically none.

HH. Jupiter Point

(1) Location: West side of Baker Cove.

(2) Extent: 600 feet along east side and 1400 feet along west side of point.

(3) Width Beach - Above H.W.: A sandy bar about 30 feet wide and 200 feet long at the outer tip and a narrow sandy beach about 250 feet long at the inshore end of the west side of the point.

(4) Ownership: Private

(5) Beach Use: By residents of Jupiter Point.

(6) Public Facilities: None

(7) Composition of Shore: Marshy shore along east side of point in front of cottages. A coarse sand beach along the east side of the outer tip, a boulder strewn shore along the west side of the outer tip, boulders and coarse material fronting cottages along the west side and a coarse sand beach at the north end of the west side of the point.

(8) Protective Structures: The shore fronting the cottages is protected by light walls and riprap.

(9) Character of Development: A small fishing community along the east shore containing a number of light piers. Summer cottages throughout.

II. Between Jupiter Point and Avery Point

(1) Location: The indented shore north of Pine Island.

(2) Extent: 1800 feet

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

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Wave cut marshes. One short stretch in front of a boat club artificially filled.

(8) Protective Structures: Light riprap revetment along fill area at boat club.

(9) Character of Development: Small boat storage areas and boat club.

JJ. Avery Point

(1) Location: East of Shenecossett Beach.

(2) Extent: 4200 feet

(3) Width Beach - Above H.W.: A small sandy pocket beach 20 to 30 feet wide west of the pier at the southeast corner of the point. A small sandy beach 40 feet wide (about 50 feet long) at the west limit of the area.

(4) Ownership: United States (Coast Guard Training Station).

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: Coarse sandy beach adjacent to pier, fine sand at small beach at west limit, boulders, riprap revetment, concrete and masonry walls and bare ledge rock elsewhere.

(8) Protective Structures: Masonry and concrete walls and riprap revetment. Short groins west of pier.

(9) Character of Development: Coast Guard Training Station.

KK. Shenecossett Beach

(1) Location: Between Eastern and Avery Points.

(2) Extent: 1300 feet

(3) Width Beach - Above H.W.: About 30 feet along east half in front of bathhouses, 20 feet in front of projecting sea wall and 50 feet at the west end.

(4) Ownership: Private

(5) Beach Use: Private bathing beach

(6) Public Facilities: None. Private beach club.

(7) Composition of Shore: Fine sand.

(8) Protective Structures: Concrete steps in front of bathhouses. A masonry wall along a portion of the westerly half.

(9) Character of Development: Beach club and residences.

LL. Eastern Point Beach Park

(1) Location: Eastern Point.

(2) Extent: 1500 feet

(3) Width Beach - Above H.W.: Easterly 400 feet, 30 to 40 feet wide at the west end increasing to 150 feet at the east end. Generally no sand beach elsewhere.

(4) Ownership: Borough of Groton.

(5) Beach Use: Borough bathing beach.

(6) Public Facilities: Parking area, bathhouse, picnic tables, sanitary facilities, refreshments.

(7) Composition of Shore: Easterly 400 feet consists of medium and fine sand. There are small fine sand pockets in indentations of the shore on the north side of Eastern Point. The greater part of Eastern Point consists of ledge rock.

(8) Protective Structures: Low masonry and concrete walls. A short riprap breakwater on the south side of Eastern Point and a longer one on the north side. A dumped rock groin at east limit of park.

(9) Character of Development: Public facilities housed in an old mansion on Eastern Point.

MM. Thames River (East shore)

(1) Location: North of and adjacent to Eastern Point.

(2) Extent: 5200 feet

(3) Width Beach - Above H.W.: Generally none. A small sandy pocket beach 15 to 30 feet wide and 150 feet long on the north side of Eastern Point adjacent to the Eastern Point Beach Park. Elsewhere high water is at the foot of sea walls or at a ledge rock shore.

(4) Ownership: Private

(5) Beach Use: None

(6) Public Facilities: None

(7) Composition of Shore: A ledge rock shore. There is a short fine sand pocket beach on the north side of Eastern Point.

(8) Protective Structures: Masonry sea walls and a few solid fill piers. Portions of the shore protected by riprap revetment. One riprap groin.

(9) Character of Development: None along northerly 1000 feet. Large residences and large hotel along remainder of area.

# APPENDIX B

## GEOLOGY

1. General. - The coastal formation in Connecticut is the result of a complicated series of geological changes. That portion of the geological history which is significant in explaining the physiography of the area is discussed briefly in chronological sequence.

2. Pre-Cambrian and Paleozoic Period. - During this period, through endless ages, series after series of sediments were deposited, injected by liquid magmas and under the influence of heat and mountain making pressures, were folded, broken and profoundly altered so that their original character can no longer be recognized. The only semblance of unity in the rocks underlying the New England Province seems to be the general presence of a north, northeast trend in the direction of the rock structure.

3. Triassic Period. - At the end of the Paleozoic Period, this complex structure was worn down at least in part to a peneplane and deposits of Triassic clastic sediments were laid down. Simultaneously with this deposition of great thicknesses of Upper Triassic shales and limestones, the intrusion and extrusion of massive layers of trap occurred. Faulting took place throughout this period and was pretty well distributed over the area. By means of great north-south boundary faults, which to this day separate the sediments from the crystallines on the east, the net result in Connecticut was to low er all strata differentially and give them a regional dip of 5 to 20 degrees east.

4. Fall Zone Cycle. - After this period of disturbance, an era of great quiet prevailed during which for countless centuries erosion worked on the highlands, reducing them to a low and rolling country just a few feet above sea level. Regardless of geologic structure and differences in rock hardness, a peneplane was formed across the great faults which separate the sediments from the harder crystallines. Great thicknesses of Triassic rock were removed. That which is still preserved in the Connecticut Valley lowland owes its existence to the faulting which dropped it below the base level of erosion. The extensive surface formed at this time is called the Fall Zone peneplane.

5. Burial of the Fall Zone Peneplane. - The long period of quiet drew to a close and the great peneplane was slowly covered by a thick series of deposits derived from the waste of the land. In Connecticut, these deposits were apparently of Upper Cretaceous age, probably largely marine in origin. Earth movements resulted in uplift in the north and northwest, while seaward the surface was depressed to near or below sea level. In Connecticut, the depression carried the peneplane below sea level. Thus, toward the north a new cycle of erosion was started by the streams rejuvenated by uplift and the Fall Zone surface began to be destroyed, while the wastes from this destruction with the aid of marine sediments buried the lower surface in the south. When the submergence in the Connecticut area had reached its greatest extent, the streams once emptying into the ocean considerably to the south found that their mouths had moved to the north with the advancing shore line. This shore line was probably even more irregular than that of today.

6. The New England Upland Cycle. - At or near the end of the tilting which started the destruction of the Fall Zone peneplane, a new movement of the earth's surface occurred, resulting in uplift. Coincident with the movement raising the land above sea level, the shore line retreated toward the southeast and the streams extended their lower courses across the young coastal plain thus exposed. At this early date, the Connecticut River left its course across the soft Triassic rocks in the vicinity of Middletown and made a sharp bend to the southeast over the newly uncovered sediments of the coastal plain, assuming the course which, with few exceptions, it follows to this day. The uplift initiated a new cycle of erosion which wore down the land mass and a peneplane, the most extensive of any in New England, was formed. Today, the remnants of this surface are known as the New England Upland peneplane.

7. The Connecticut Valley Lowland Cycle. - Another uplift accompanied by tilting terminated the Upland cycle of erosion. This tilting appears to have been to the southeast about 15 feet per mile. The uplift started another cycle of erosion, during which the Coastal Plain deposits were removed most rapidly, while the Triassic shales and limestones, being more resistant,

remained somewhat longer. The Upland, underlain by the more resistant crystalline rocks, were still far from total destruction when the Coastal Plain and Triassic areas were reduced almost to sea level. It was during this period that the Connecticut Valley lowland was formed by the erosion of the Triassic rocks. This lowland, which now follows the Connecticut River to about Middletown and enters Long Island Sound at New Haven, is essentially the same as when originally formed.

8. The Sound Valley Cycle. - The Lowland cycle was terminated by another uplift, by which the land was raised in reference to the sea. This uplift raised the surface of the Connecticut Lowland peneplane, which continued as a Coastal Plain along the entire southern edge of the State in a belt about as wide as the present Long Island Sound. The forces of erosion renewed their work and cut a valley in the inner lowland, called the Sound Valley, which was eventually to become the present Long Island Sound.

9. Formation of Long Island Sound. - The cutting of the inner lowland was interrupted by a climatic change which resulted in the formation of a great ice sheet covering the northeastern United States and Canada. This glacier, moving under the impulse of gravity, carried a tremendous amount of debris gathered from the country over which it passed. In passing over Connecticut, the glacier scraped away practically every bit of the thick mantle of soil and decomposed rock in its path. All the material was not carried to its terminal moraine, which followed a line from the northern fluke of Long Island, through Fishers Island to Watch Hill and the southern coast of Rhode Island. Much of the material was strewn over the surface of Connecticut as the glacier advanced and retreated, and forms the present unevenly distributed soil of Connecticut which varies in depth from 0 to 20 or more feet. In addition to eroding and depositing of materials, a sinking of this region occurred which might have been due to the enormous weight of the ice sheet. The exact amount of submergence occurring is not known but when the ice disappeared, the inner lowland or Sound Valley was below sea level. These waters are what now constitute Long Island

Sound, while Long Island is that part of the cuesta and glacial drift which remained above sea level.

10. Postglacial Changes of Level. - Since the withdrawal of the glacier from Connecticut, one small diastrophic movement has occurred. This resulted in the submergence of land masses for a depth generally determined and accepted to be 20 feet. After this movement, authorities generally agree that movements of the land and sea ceased and the relation of the elevation of the waters in Long Island Sound and Connecticut have remained constant. Minor local changes in water elevation may have occurred in restricted areas due to localized conditions. This last lowering of the land masses resulted in the present day shore line of Connecticut being a shore line of submergence, having all the irregularities of such a shore line due to the drowning of coastal valleys.

11. Present Day Trends. - Connecticut at present is in the period of sub-aerial erosion which follows a diastrophic change. During this period erosional forces will work to the reduction of land masses to another peneplane with the streams transporting materials from the uplands to the lowlands. Along the coast, waves attacking the shore line will tend to cut back all headlands, building and rebuilding bars and spits of materials from eroded headlands until a regular, even shore line is produced. This regular shore line will be landward of the present day shore line since the beaches, bars and spits will recede landward as the headlands are lost.

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 as 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 |
| Green Ledge | 7.2 | 8.5 | " | -0 05 |
| Stamford | 7.2 | 8.5 | " | 0 00 |
| Coscob Harbor | 7.2 | 8.5 | " | +0 05 |
| Greenwich Harbor | 7.4 | 8.7 | " | 0 00 |

3. Tidal Observations - New London. - A primary tide station is maintained by the United States Coast and Geodetic Survey at New London, Connecticut. 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 3 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 or 3 feet or more in excess of the mean high water plane. The frequencies of occurrence and excess heights of extreme high tides at New London are considered to be similar to those occurring throughout the study area.

4. Extreme Hurricane Tides - September 1938. - Elevations of high water marks referred to the plane of mean low water occurring during the hurricane of 21 September 1938 at selected locations along the shore of Connecticut are tabulated below:

| Location | Actual High Water | Predicted High Water |
|---|---|---|
| Stonington | 11.0 | 3.2 |
| Mystic | 10.8 | |
| Noank | 10.3 | 3.1 |
| New London | 11.1 | 3.0 |
| Saybrook | 13.4 | 4.1 |
| Branford | 11.8 | 6.9 |
| New Haven | 13.0 | 7.2 |
| Bridgeport | 13.8 | 7.8 |
| Southport | 13.4 | |
| South Norwalk | 11.6 | 8.1 |
| Rowayton | 14.3 | |
| Stamford | 15.6 | 8.2 |
| Greenwich | 15.0 | 8.4 |

5. Extreme Hurricane Tides - September 1944. - Elevations of high water marks referred to the plane of mean low water occurring during the hurricane of 14-15 September 1944 were reported as follows:

| Location | Actual High Water |
|---|---|
| Stonington | 7.7 |
| New London | 7.6 |
| Saybrook | 8.0 |

6. Storm Tides - November 1950. - Reported elevations of high water marks referred to the plane of mean low water occurred during the southeast storm of 25 November 1950 as follows:

| Location | Actual High Water | Predicted High Water |
|---|---|---|
| Stonington Harbor | 7.6 | 3.0 |
| New London Harbor | 8.1 | 2.0 |
| Saybrook Point | 8.75 | 3.8 |
| Clinton Harbor | 9.0 | |
| Branford River | 10.9 | 6.0 |
| New Haven Harbor | 10.6 | 6.4 |
| Milford Harbor | 11.3 | 6.7 |
| Bridgeport Harbor | 12.0 | 6.9 |
| Black Rock Harbor | 12.2 | 7.0 |
| Saugatuck River | 12.0 | 7.1 |
| South Norwalk Harbor | 12.1 | 7.2 |
| Five Mile River | 12.1 | |
| Stamford Harbor | 12.9 | 7.3 |
| Greenwich Harbor | 13.5 | 7.5 |

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 of more than 60 miles per hour 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.

2. Severe Hurricanes in New England. - 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 such tropical cyclones as occurring between 1635 and 1944. The paths of several of these are shown on Plate 2. The 1944 hurricane has been described as the most violent in history but it did not cause as much destruction in New England as the one which struck in 1938. A comparison of these storms indicates certain attendant characteristics which

can be expected to result in great damage. The 1938 hurricane 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. Very little information is available concerning the damage caused by most of the hurricanes which have passed through or near New England. This lack of detailed information makes it difficult, if not impossible, to draw conclusions concerning probable shore damage which can be expected from such storms.

3. Hurricane of 21 September 1938. - On 21 September 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. The hurricane entered the State of Connecticut with its center just west of New Haven at 3:30 P.M., E.S.T., and continued its progress northward at the rate of 50 to 60 miles per hour. The eye of the storm 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 at a distance of about 75 miles to the right of the storm center. Barometric pressures reported indicate the severity of the storm along the Connecticut shore. Minimum 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. Barometric pressures dropped gradually until 12:00 noon, and then dropped rapidly until about 4:00 P.M., when the lowest pressures were reached. Pressures then rose rapidly until 8:00 P.M., when the 12:00 noon pressure was attained; thence rose gradually. Wind velocities were observed as follows: maximum for a five minute period, 38 miles per hour at New Haven, 46 miles per hour at Hartford, 70 to 90 miles per hour over an area 80 miles wide from Saybrook, Connecticut, to Marthas Vineyard, Massachusetts; maximum gust velocites, 46 miles per hour at New Haven, 59 miles per hour at Hartford, probably in

excess of 100 miles per hour in the area from Saybrook to Marthas Vineyard. The amount of precipitation directly attributable to the hurricane is difficult to determine due to the fact that it rained for 2 days prior to the storm. 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. The hurricane increased tidal heights above their predicted ranges. Its approach was manifested in the higher water levels of the preceding low and high water. During these preceding tides, tidal heights were increased more to the east of the hurricane 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.

4. Hurricane of 14-15 September 1944. - On 14 September 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. 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 hurricane reached Westerly, Rhode Island, about 11:00 P.M., E.W.T. The greatest wind intensities occurred to the east of the storm center. The calm during the passage of the "eye" of the storm, with the shift in the wind direction after its passage, was clearly noted at Westerly and Providence, Rhode Island. The following minimum barometric pressures were reported in the Connecticut area on 14 September; at New Haven, Connecticut, 28.86 inches at 9:50 P.M.; at

Hartford, Connecticut, 28.94 inches at 10:50 P.M.; at Fishers Island, New York, 28.41 inches at 10:45 P.M.; at Groton, Connecticut, 28.40 inches at 11:00 P.M.; at Westerly, Rhode Island, 28.30 inches at 11:00 P.M.; at Block Island, Rhode Island, 28.34 inches at 11:09 P.M. Wind velocities reported for the Connecticut area are as follows: New Haven, maximum five minute wind, N 33 m.p.h. and extreme wind NE 38 m.p.h.; Hartford, maximum five minute wind, N 50 m.p.h. and extreme wind, N 62 m.p.h.; New London, extreme wind 70 m.p.h.; Westerly, Rhode Island, extreme wind, 75 m.p.h.; Block Island, Rhode Island, maximum five minute wind, SE 82 m.p.h. and extreme wind, SE 88 m.p.h. Extreme winds 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. The following elevations of high water in feet above mean high water were reported: Saybrook, Connecticut, 4.5; New London, Connecticut, 5.0; Stonington, Connecticut, 5.0; Watch Hill, Rhode Island, 6.9; Providence, Rhode Island, 8.0. 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.

5. Storm of 25 November 1950. - On 25 November 1950, New England 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. Winds continued in northern Maine until the 27th. Hurricane velocities in the gusts were attained at many points, both coastal and inland. 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, Connecticut during each hour of the 25th of November 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. at 1:56 P.M., maximum gusts, 66 m.p.h. at 1:35 P.M., 4:20 P.M. and 7:40 P.M., and 77 m.p.h. (5-second gust) at 4:45 P.M. The above maximums were probably exceeded between 8:00 P.M. and 9:00 P.M., a

period for which no velocities were recorded. The wind died down suddenly after the above period. Heavy rainfall generally exceeding two inches occurred during the night of the 25th-26th in southern New England, and as much as four inches in parts of Maine, New Hampshire and Massachusetts on the following day. The storm increased tidal heights 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. Shore damage in Groton and Stonington was comparatively light. Large quantities of sand were washed landward from Shenecossett Beach. A short section of sea wall was damaged at Avery Point. Two cottages were moved from their foundations at Jupiter Point. The cottage areas at Jupiter Point and Lords Point were flooded. Debris and small boats were thrown up on Mason Island. Some erosion and damage to protective structures were reported at Latimer Point.

6. Storm Data. - Summaries of records of winds equal to or greater than 40 miles per hour at New York City, New York, and of winds equal to or greater than 32 miles per hour at New Haven, Connecticut, and Block Island, Rhode 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 frequency of occurrence of storm winds from various directions has been computed on the basis of a 100 year period and the results are shown in the last column of the above tabulations. It should be noted that the storm winds occurring at New York and Block Island are similar in that they show a high preponderance in a northwest direction. The frequency of occurrence at these stations 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) determined between 32 and 40 m.p.h. winds in 1947 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.

Due to the location of New Haven about midway between New York City and Block Island, it would be natural to expect the wind frequency and direction at New Haven to be somewhere between those for New York City and Block Island. This is definitely not so. Storm winds occur here without any marked differences in frequency from the west clockwise around to northeast and from the south. It is the stated opinion of weather bureau officials that winds at New Haven are peculiar to that area alone and do not indicate the winds which can be expected along Long Island Sound. This is because New Haven is located in a lowland which runs generally north and south through Connecticut, the winds in this lowland being directed in a north-south direction creating a condition which is not typical of wind expectancy along Long Island Sound. Records for Block Island and New York City give a more accurate picture of the direction of wind expectancy in Long Island Sound. It should be borne in mind that 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 winds occurring at Block Island and New York City can be expected to occur along the Connecticut shore.

8. Exposure of Shore to Storm Attack. - The shore line generally faces open bodies of water only to the south. It is, therefore, not exposed to attack by waves generated by winds from the northerly quadrants. Storm records at Block Island indicate that storms from the southwest, south and southeast, the only directions in which appreciable open expanses of water exist opposite the study area, occur less often than from any other quadrant (Appendix D, Paragraph 6). Due to the protection afforded by offshore islands, the intensity and frequency of storms along the shore is less than at Block Island which is exposed to the open ocean. The shore is very irregular. Large portions of the shore lie in indentations or in the lee of adjacent headlands and shores and are therefore sheltered from most quadrants. The Little Narragansett Bay area is almost landlocked by Napatree Beach and Sandy Point and is not exposed to serious attack from any direction. All shore areas are sheltered from the prevailing storms which approach from the northwest. Severe shore damage from storm attack is relatively infrequent and generally occurs only during exceptional storms.

APPENDIX E.

## SHORE LINE AND OFFSHORE DEPTH CHANGES

1. Basic Data. - Plans showing the location of the shore line and the 6, 12, and 18-foot depth contours have been prepared from United States Coast and Geodetic Survey data by the Beach Erosion Board for the period 1838 to 1886. For this study, a survey run during 1949, supplemented by aerial photographs, located the entire shore line and offshore depths on selected profiles. Shore line and offshore depth changes are shown on Plates 7-9. Due to the scales (1:10000 and 1:20000) used on these plans, it is obviously difficult to measure small changes with accuracy. Change descriptions are therefore limited to those which are large enough to permit reliable measurement. Amounts of change when given in feet are necessarily scaled distances, and therefore approximate. The changes described can generally be considered accurate insofar as they indicate the trend in the area described and approximate only in indicating the actual quantitative change.

2. Little Narragansett Bay. - This shore extends from Pawcatuck Point at the entrance to the Pawcatuck River westward to the Wequetequock River. The only large changes in the position of the shore line since 1838 occurred as a result of recession of the extensive marshes located north and west of Barn Island. This recession was very irregular, in places amounting to as much as 500 feet. Practically no change occurred along shore areas which are composed of unconsolidated glacial materials. The shore north of Pawcatuck Point and around the south end of Barn Island are strewn with boulders indicating that they have been subjected to erosion which removed the finer materials, leaving a protective blanket of coarse material.

3. Changes in offshore depths between 1839 and 1884 consisted of deepening which greatly enlarged the area of the bay having a depth greater than 6 feet at mean low water. The navigation channel was being deepened artificially prior to 1876. It is not known how much of the deepening which occurred is due to this development. Judging from the extensive changes which occurred and the likelihood that navigation improvements were con-

fined to a narrow channel, it is assumed that offshore deepening occurred largely as a result of natural processes.

4. Elihu Island. - There was little change in the shore line of Elihu Island between 1883 and 1949. Prior to this period, from 1838 to 1883, erosion apparently caused a recession of approximately 100 feet along the entire east shore, 200 feet around the southeasterly point and about 400 feet west of this point forming a marked indentation in the shore which gives the island the appearance of a boot with the toe pointing westward and the heel at the southeast corner. The heel and the entire east shore north of the heel consisted almost continuously of bare bedrock in 1949. The toe of the island consisted of marsh, exposed bedrock, scattered boulders and small pockets of coarse sand. The toe was separated from the heel by a low marshy swale. The sheltered west shore of the island north of this swale consisted of marsh, scattered boulders and some ledge rock outcrops. There is very little unconsolidated material left which can be eroded and consequently little change can be expected to occur in the future.

5. Offshore deepening opposite the south and southeast shore of Elihu Island resulted in a landward movement of the 6-foot contour of 150 to 300 feet between 1839 and 1884.

6. Wequetequock Cove to Stonington Point. - The principal shore line changes in this area from 1838 to 1949 were as follows: recession of approximately 100 feet along the greater part of the marshy shore located west of and opposite Elihu Island; accretion varying between 100 and 200 feet along the west side of the point located at the east end of the causeway leading to the village of Stonington between 1838 and 1886 with practically no change thereafter to 1949; recession of 200 to 300 feet along the marshes south of the causeway; recession of about 150 feet along 400 feet of shore located north of the stone pier or breakwater at the first point of land south of the causeway; accretion of about 100 feet along 400 feet of shore west of the above breakwater; recession varying between 0 and 150 feet along 1100 feet of shore located 500 to 1600 feet north of Stonington Point between the years 1838 and 1886 with very little change thereafter until 1949.

7. Offshore depth changes between 1839 and 1884 resulted in irregular movements of the position of the 6-foot depth contour as follows: landward movement varying between 0 and 300 feet from Elihu Island westward to the breakwater at the Stuart estate; landward movement of 0 to 200 feet changing to seaward movement of 0 to 150 feet for a distance of about 1500 feet west of the breakwater; seaward movement varying from 0 to 400 feet opposite 600 feet of shore in the vicinity of the fishing piers on the east side of the village of Stonington; landward movement varying between 0 to 150 feet around the southeasterly tip of Stonington Point. Profiles run during 1949 indicate that since 1883 there has been shoaling and northward movement of the navigation channel located between Sandy Point and the mainland and that little change has occurred in the position of the 6-foot depth contour opposite the east side of the village of Stonington.

8. East Shore of Stonington Harbor. - This shore area extends from the tip of Stonington Point northward to the railroad causeway. Between 1838 and 1883 there was a recession of the shore of about 100 feet at Stonington Point decreasing northward to about 50 feet and increasing to about 100 feet south of and adjacent to the inner breakwater. Changes along the shore for about 2500 feet north of the inner breakwater represent construction of piers, wharves and development of the area as a commercial port. For about 1000 feet north of the most northerly wharf, there was accretion of approximately 150 feet between 1838 and 1883. This accretion is believed to represent artificial filling of the shore. The northerly 1400 feet of shore adjacent to the causeway receded 150 to 200 feet during this period. Only slight changes occurred in the position of the high water line between 1883 and 1949. These changes appear as recession of the shore, generally not more than 25 feet, along 400 feet of shore north of a short pier or breakwater located about 500 feet north of Stonington Point and also along the 1400 feet of shore at the north limit of the area adjacent to the railroad causeway.

9. Offshore depth changes between Stonington Point and the inner breakwater have resulted in shoaling or seaward movement of the 6 foot contour of 50 to 100 feet since 1839. There was little change in the position of the

12-foot contour during this period. A considerable area of the upper harbor deepened to over 6 feet at mean low water between 1839 and 1884. This was probably due to the construction of the railroad causeway across the upper end of the harbor and the concentration of the tidal flow thru the narrow causeway openings. The depth change map shows this deepening at the easterly opening. A survey made during 1946 (not shown on the map) shows that similar deepening has occurred at the westerly opening.

10. East Shore of Wamphassuck Neck. - This extent of shore is about a mile long and is located between the railroad causeway at the head of Stonington Harbor and Wamphassuck Point. The principal changes in the position of the shore line between 1838 and 1883 were as follows: accretion up to 50 feet immediately adjacent to the causeway; erosion of 50 to 75 feet between points 300 and 1500 feet south of the causeway ending at a cuspate-shaped point in the shore; practically no change for a distance of 1200 feet south of this point; accretion up to 150 feet along the next southerly 800 feet resulting in the filling out of an indentation of the shore; thence irregular changes, alternately accretion and erosion to Wamphassuck Point, the predominant change being accretion resulting in shore line movements generally not exceeding 50 feet; recession of the tip of Wamphassuck Point of about 150 feet. Between 1883 and 1949 additional accretion of 25 feet occurred adjacent to the causeway, a 100-foot recession took place at and for about 500 feet south of the cuspate point mentioned above, and small amounts of erosion occurred along the remainder of the shore, generally not exceeding 25 feet.

11. The principal change in offshore depths since 1839 occurred south of the westerly opening of the railroad causeway and consisted of deepening, probably caused by construction of the causeway and the restriction of tidal flow through the narrow opening. Only small changes in the position of the 6-foot contour occurred elsewhere along the shore, the predominant trend being towards shoaling resulting in a maximum seaward movement of about 150 feet. Considerable deepening was effected in the lower part of the harbor to a depth of 12 feet in connection with dredging of the harbor.

12. Between Wamphassuck Point and Lords Point. - This is an irregular shore consisting of the west side of Wamphassuck Point, and a point located to the west formed by a low lying island connected to the mainland by marsh which extends westward to the cottage settlement at Lords Point. Shore line changes between 1838 and 1949 were as follows: continuous recession of the west side of Wamphassuck Point resulting in a shore line movement of 75 to 100 feet; accretion of 150 to 200 feet along the east shore of the low lying island from 1838 to 1883 with very little change thereafter to 1949; irregular shore line movements along the southerly and westerly sides of the island resulting in a shore recession varying between 25 and 300 feet; recession of 100 to 250 feet along the marshes extending westward to the Lords Point development.

13. Offshore depth changes between 1839 and 1883 resulted generally in deepening and movement of depth contours as follows: landward movement of the 6-foot contour of 0 to 2000 feet; irregular movements of the 12-foot contour 300 feet landward opposite the easterly half of the area and 100 feet seaward opposite the westerly half of the area; minor, irregular movements of the 18-foot contour. Profiles run during 1949 indicate that deepening occurred since 1883 in the vicinity of the 6-foot depth contour south of the low lying island and very little change occurred in the vicinity of the 6 and 12-foot contours south of Wamphassuck Point.

14. Lords Point. - This is an extent of shore extending eastward from Quambaug Cove consisting of a sand bar known as White Beach, fronting a pond and marsh, two projecting rocky points forming a small cove between them and an irregular ledge rock shore east of these points to the beginning of marsh. This entire area has been subject to erosion between 1838 and 1949 resulting in varying amounts of shore recession. White Beach has receded about 50 feet throughout its extent. The west and south sides of the rocky point adjacent to White Beach have receded in an irregular manner, the greatest movement being about 50 feet while the east side of this point and the head of the cove adjacent to it have experienced a shore recession ranging from 100 to 200 feet. The shore of the west side of the easterly rocky point has receded

about 50 feet while the southeast end of this point appears to have prograded about 150 feet between 1838 and 1883 with little change occurring thereafter to 1949. The southeast end of this point at the present time consists of bare, low lying bedrock indicating that no accretion could have occurred. The change in the position of the high water line between 1838 and 1883 as shown by available data probably represents the manner in which the topographer interpreted the location of this line, rather than any actual physical change which occurred. East of the rocky point the shore receded irregularly, the amount of shore line movement varying considerably, in no place exceeding 100 feet.

15. Offshore depth changes between 1838 and 1883 consisted principally of deepening with landward movement of depth contours as follows: 6-foot, 300 to 900 feet; 12-foot, 0 to 1000 feet; 18-foot, 0 to 400 feet. Profiles run during 1949 indicate that there has been practically no change in the position of the 6-foot depth contours opposite Lords Point and White Beach since 1883.

16. Between Quambaug Cove and Latimer Point. - This is an extent of shore about 2500 feet long located west of and adjacent to Quambaug Cove consisting of an eroded boulder strewn shore and a bar or spit which has grown westward from it. This bar fronts a marsh. The entire shore has been subject to erosion. Between 1838 and 1883 the easterly 800 feet of shore receded from 50 to 100 feet but very little change occurred from the latter date until 1949. The shore in 1949 consisted of a protective blanket of boulders, all fine unconsolidated material apparently having been eroded and moved westward to form the above mentioned spit. This spit has retreated landward continuously since 1838 resulting in a shore line movement of 150 to 200 feet up to 1949 except at its westerly end. The westerly tip of the spit in 1838 and 1883 was located 600 to 700 feet southwest or seaward of its position in 1949 and had a tendency to recurve to the north. Northerly recurvature is evident in the present spit which bends around the westerly side of the marsh which lies behind it. The existence of a submarine bar from the end of the spit to Lyddy Island suggests the probability that

at one time Lyddy Island was connected to the spit by a tombolo.

17. Offshore depth changes between 1839 and 1883 resulted in a landward movement of the 6-foot contour of 900 feet at the east end of the area decreasing to about 400 feet at its west end. Accretion on the soundward side of Lyddy Island moved the 6-foot contour irregularly seaward for a maximum distance of 400 feet. During the above period, the 12-foot contour moved up to 250 feet landward opposite the eastern and central portions of this area and up to 200 feet seaward opposite the westerly portion of the shore. Changes in the vicinity of the 18-foot contour were irregular consisting of deepening opposite the easterly portion of the shore and shoaling opposite the westerly portion.

18. Latimer Point. - The southerly tip and the east side of Latimer Point have been subject to considerable erosion which resulted in a shore line recession of 100 to 300 feet between 1838 and 1883. Very little change occurred between 1883 and 1949. Some localized accretion was effected at the tip of the point between 1883 and 1949, but the existence of protecting sea walls and riprap revetment at the point indicates that this accretion is due to artificial filling rather than natural shore processes. The east shore of the point is characterized by numerous boulders, undoubtedly left by erosion of the finer material. These boulders serve to protect the shore from further recession. The west side of Latimer Point has changed very little since 1838. This shore is well sheltered from all directions and consequently has not experienced the large changes which have occurred along the south and west shore of the Point due to their exposure to ocean waves.

19. Offshore depth changes between 1839 and 1883 resulted in a landward movement of the 6-foot depth contour of about 1000 feet opposite the southeast shore of the point, a slight landward movement of the 12-foot contour and landward movement of the 18-foot contour of about 1000 feet. Profiles run during 1949 indicate that a small amount of deepening has occurred in the vicinity of the 6-foot contour along the south and east shore of Latimer Point since 1883.

20. Shore Between Latimer Point and Mason Island. - This is an irregular shore line extending westward from Latimer Point to the causeway leading to Mason Island. The shore and the backshore is composed principally of marsh. There is a small island set in the marsh immediately west of Latimer Point. This island and the surrounding marsh forms a projecting point. Near the west limit of the area, the marsh is fronted by a sand bar. There were irregular changes in the position of the high water line along this entire shore area between 1838 and 1883 resulting in a shore recession averaging about 100 feet except near the west limit of the area where the shore in the vicinity of the sand bar receded up to 300 feet. The sand bar receded another 100 feet between 1883 and 1949. This shore is sheltered by Latimer Point and surrounding islands so the changes in the position of the high water line must be attributed to the fact that it is composed of material subject to rapid change rather than to any severe attack by waves.

21. Since the water depths opposite this extent of shore are less than 6 feet, offshore depth changes are not apparent from available data.

22. Mason Island. - The following changes in the position of the shore line of Mason Island occurred between 1838 and 1883: recession of 100 to 400 feet around the marshy point located adjacent to and south of the causeway connecting to the mainland; practically no change along the adjacent 1200 feet south of this point; recession up to about 200 feet, averaging about 100 feet, along the next southerly 3000 feet of shore to a point about due west of the south tip of Dodge Island; recession varying between 0 and 50 feet along the 1000 feet of shore adjacent to and north of the bridge to Baker Island; recession of 150 feet along the south side of the point of land located immediately south of the bridge to Baker Island; recession varying between 50 and 200 feet along the east side of Mason Point; recession varying between 0 and 100 feet along the west side of Mason Point; irregular movements of the shore line, generally recession, not exceeding 50 feet, around the large point of land east of Ram Point; recession of 300 to 400 feet in the marshy coves formed by the projecting southerly points of Mason

Island; small, irregular changes around Ram Point resulting in a recession averaging less than 50 feet; recession of 50 to 100 feet at and adjacent to Clam Point increasing to 200 feet along the south side of the cove located north of Clam Point; small amounts of recession generally not exceeding 50 feet along 1000 feet of shore located south of and adjacent to an unnamed projecting point of land lying about midway between Ram and Pine Points; recession varying from 25 to 75 feet around this unnamed point; recession varying from 25 to 100 feet along 1000 feet of shore adjacent to and south of the tip of Pine Point; recession of 350 feet in the first cove located east of Pine Point; small amounts of recession generally not exceeding 50 feet around the first point of land east of Pine Point and along the shore of the cove adjacent to the east side of this point; recession varying between 50 and 200 feet along the west side of the point of land forming the northeast corner of Mason Island; recession up to 200 feet along the shore adjacent to and extending 400 feet north of the causeway connecting to the mainland. The only major change in the position of the shore line between 1883 and 1949 occurred at Ram Point where erosion removed from 50 to 250 feet from its south shore. The south shore of Mason Island in 1949 consisted almost continuously of exposed bedrock and numerous scattered boulders, while the more exposed southerly half of the east shore of the island was protected by a blanket of boulders left as a result of erosion of the finer beach materials. Except for the shore between Ram Point and Clam Point, and marsh deposits existing in the various coves and along the northerly half of the east shore of the island, it is unlikely that any rapid erosion will occur in the future.

23. Offshore depth changes between 1839 and 1883 resulted in deepening and landward movement of the 6-foot depth contour of 1400 feet between Andrews Island and Mason Island, of 800 feet between Baker Island and Mason Point and 300 to 1500 feet opposite the shore from Mason Point to Ram Point. Shoaling occurred during this period between Ram and Pine Points, the greatest movement of the 6-foot depth contour being about 300 feet opposite the shore between Ram and Clam Points. The 12-foot depth contour moved irregularly

landward opposite the south end of Mason Island, the greatest movement of about 400 feet occurring southeast of Mason Point. Between Ram Point and Pine Point, shoaling moved the 12-foot contour westward, the greatest movement of 250 feet occurring between Ram and Clam Points. Movements of the 18-foot depth contour opposite the south end of Mason Island were very irregularly landward during the above period. Shoaling moved the 18-foot contour along the west side of Mason Island between Ram and Clam Points up to 250 feet westward, while only small movements occurred north of Clam Point.

24. Willow and Spence Points. - Comparison of the 1883 and 1949 positions of the shore lines around Willow and Spence Points indicates that there was very little erosion in this area. A recession of the shore, not exceeding 25 feet, may have occurred for a distance of 300 to 400 feet south of the piers at Willow Point. Spence Point was extended about 400 feet south of its 1883 position by construction of walls and artificial filling. This extension of the point is believed to have been effected between 1891 and 1910.

25. Offshore depth changes between 1839 and 1883 were shoaling opposite Willow Point changing to deepening opposite Spence Point with a landward movement of the 6-foot depth contour of 200 feet opposite Willow Point and a channelward movement of about 300 feet opposite Spence Point. Similar movements occurred in the position of the 12-foot depth contour.

26. Sixpenny Island. - This is a low island composed of marsh. Between 1838 and 1949 the shore of the island receded irregularly resulting in shore line movements east of the railroad averaging about 100 feet.

27. Offshore depth changes between 1839 and 1883 resulted in shoaling and channelward movement of 400 to 500 feet in the position of the 6 and 12-foot depth contours opposite the east side of Sixpenny Island, a small movement of these contours landward opposite the southeast corner of the island and slight shoaling or seaward movement of the contours opposite the south side of the island.

28. Noank. - This shore area extends from the railroad causeway connecting with Sixpenny Island southward to Morgan Point and thence northward from Morgan Point to the head of West Cove. Between 1838 and 1883 the position of the shore line receded between the causeway and Morgan Point, the amount of movement varying from 0 to 125 feet. The southerly tip of Morgan Point receded about 150 feet and the shore from Morgan Point to the head of West Cove receded from 50 to 250 feet. Very little change in the position of the shore line attributable to natural processes occurred between 1883 and 1949. This entire shore area was developed starting sometime prior to 1883 by the construction of piers, wharves, bulkheads and shipyards, and changes shown by comparison of old surveys are attributed to this development. The principal change noted was effected by construction which widened the narrow portion of the Noank peninsula located from 600 to 1200 feet north of Morgan Point from a width of about 150 feet in 1883 to a width of about 400 feet in 1949.

29. Only small changes occurred in offshore depths opposite the east shore of Noank between 1839 and 1883. The principal changes were shoaling resulting in seaward movements of the 6 and 12-foot depth contours for distances up to 200 feet along short stretches located at the northern end of the shore adjacent to the railroad causeway and opposite the narrow peninsula near the south end of the shore. Deepening to 6 feet or more was effected over a large area opposite the west shore of Noank during the above period. This deepening also resulted in large, irregular landward movements of the 12-foot contour while little change occurred in the position of the 18-foot contour.

30. West Cove and West View. - This area includes the head and west side of West Cove and the shore of the adjoining West View development extending westward to Esker Point. The shore line at the head of West Cove receded continuously between 1838 and 1949 resulting in a movement of 50 to 75 feet. There was accretion varying from 25 to 100 feet, averaging less than 50 feet, along the northerly 800 feet of shore along the west

side of West Cove between 1838 and 1883. A small amount of shore recession, probably not exceeding 25 feet occurred along this 800 feet of shore between 1883 and 1949. A small amount of shore recession occurred along the southerly 300 feet of shore forming the west side of West Cove between 1838 and 1949. Shore line movements along this shore varied from about 25 to 50 feet. The shore of the West View development located between the small rocky point on the east and Esker Point on the west receded between 1838 and 1883, the amount of movement varying from about 50 feet in the center of the area to about 150 feet at the east and west ends. A small amount of additional recession occurred along this shore from 1883 to 1949, the amount of the shore movement averaging less than 25 feet.

31. Offshore depth changes between 1839 and 1883 consisted of deepening of a large area at the entrance to West Cove to a depth of 6 or more feet and deepening opposite the shore of West View with resulting landward movement of the 6-foot contour of about 200 feet. During the above period, the 12-foot depth contour moved irregularly landward for distances varying up to 1000 feet while only small, irregular changes occurred in the position of the 18-foot depth contour. A profile run during 1949 indicates that there has been practically no change in the position of the 6-foot contour opposite the central portion of West View since 1883.

32. Esker Point. - This narrow point of land is located between West View and Palmer Cove. Shore line changes between 1838 and 1883 indicate that erosion occurred along the northerly half of the east shore of the point and accretion along the southerly half, the maximum amount of shore recession of 150 feet, occurring adjacent to West View and diminishing southward, while the accretion varied irregularly between 50 and 100 feet, the maximum accretion occurring at the southeast tip of the point. Between 1883 and 1949, the only appreciable change in the position of the east shore occurred at the southeast tip of the point where recession of about 50 feet occurred. The southwest tip of the point and the west shore receded continuously between 1838 and 1949, the amount of shore movement being as follows:

200 feet at the southwest tip; 50 to 100 feet along the entire west shore south of the causeway crossing Palmer Cove.

33. There were small, irregular movements in the position of the 6-foot depth contour between 1839 and 1883 opposite Esker Point and large, irregular landward movements in the position of the 12-foot contour.

34. East Shore of Groton Long Point. - The east shore of the Borough of Groton Long Point located between the causeway crossing Palmer Cove and the point known as Groton Long Point has been subject to irregular shore line changes. The principal changes between 1838 and 1949 were as follows: accretion along 200 feet of shore south of the causeway; recession varying between 25 and 100 feet along 800 feet of shore located 200 to 1000 feet south of the causeway; recession of 100 to 150 feet along 700 feet of shore located 1000 to 1700 feet south of the causeway; thence recession of about 25 feet for the next southerly 300 feet; recession varying between 0 and 300 feet along 800 feet of shore located 2000 to 2800 feet south of the causeway; accretion varying between 0 and 200 feet along the next southerly 800 feet between 1838 and 1883 changing to recession of 50 feet along the northerly half of this section between 1883 and 1949; small, irregular amounts of erosion varying from 0 to 100 feet along 1200 feet of shore located north of the pier on the east side of Groton Long Point; accretion of about 50 to 100 feet around the tip of Groton Long Point between 1838 and 1883 with little change thereafter until 1949 except for a small amount of accretion at the south side of the above mentioned pier.

35. Offshore depth changes between 1839 and 1883 resulted in a seaward movement of the 6-foot depth contour of 150 to 300 feet, a landward movement of the 12-foot depth contour of 100 to 250 feet and irregular movements of the 18-foot depth contour, principally landward. Profiles run during 1949 indicate that there has been little change in the position of the 6-foot contours since 1883.

36. South Beach (Borough of Groton Long Point). - This is a pocket beach lying between Groton Long Point and Western Point. There was practically no change in the position of the high water line of this beach between 1838 and 1949.

37. Offshore depth changes between 1839 and 1883 resulted in shoaling in the vicinity of the 6 and 12-foot depth contours and deepening in the vicinity of the 18-foot depth contour. Movements of contours during the above period were as follows: 6-foot, seaward movement of 100 to 200 feet; 12-foot, seaward movement of 150 to 300 feet; 18-foot, landward movement of 50 to 300 feet. A profile run during 1949 indicates that there has been little change in offshore depths since 1883.

38. Western Point (Borough of Groton Long Point). - Shore line changes at Western Point between 1838 and 1949 were as follows: accretion varying between 0 and 200 feet along 300 feet of shore adjacent to South Beach; small, irregular changes along the remainder of the point, the net effect of which is that the position of the shore remained practically unchanged except for recession of about 100 feet along 200 feet of shore adjacent to the main borough bathing beach.

39. Offshore depth changes between 1839 and 1883 resulted in the following movements of depth contours: 6 and 12-foot, a small landward movement opposite the tip of the point gradually increasing westward to a movement of about 250 feet adjacent to the main bathing beach and changing to a seaward movement up to 300 feet along the east side of the point; 18-foot, a landward movement of about 500 feet opposite the tip of the point changing rapidly to alternate landward and seaward movement of 100 feet to the westward and decreasing gradually to the east to a landward movement of about 50 feet.

40. Main Beach (Borough of Groton Long Point). - This is a sandy bathing beach located between Western and Buddington Points. Only small changes have occurred in the position of the shore line of this beach between 1838 and 1949. The net effect of these changes is that the shore line at the ends of the beach in 1949 was in about the same position it occupied in 1838 while accretion had moved the shore line in the central portion of the beach about 75 feet seaward.

41. Offshore depth changes between 1839 and 1883 resulted in landward movement of the 6-foot contour of 250 feet along the eastern end of the beach changing gradually to seaward movement of 300 feet along the western end with no change opposite the middle of the beach. The 12 and 18-foot contours moved landward, the greatest movement occurring opposite the central part of the beach. These movements of contours were as follows: 12-foot, up to 350 feet; 18-foot, up to 150 feet. Profiles run during 1949 indicate that since 1883 deepening has occurred in the vicinity of the 6 and 12-foot contours at the east end of the beach and in the vicinity of the 6, 12 and 18-foot contours at the west end while practically no change took place near the center of the beach.

42. Buddington Point (Borough of Groton Long Point). - This point of land lies between the main borough bathing beach and the jetties fixing the entrance to Venetian Harbor. The principal change in the position of the shore line between 1838 and 1883 occurred along the west face of the point resulting in accretion varying from 0 to 75 feet. Between 1883 and 1949 a 100-foot elongation of the south tip of the point was effected and accretion occurred at the south side of the south jetty resulting in a 200-foot growth of the shore adjacent to this jetty.

43. Offshore depth changes between 1839 and 1883 opposite the tip of the point consisted of shoaling and seaward movement of about 200 feet in the vicinity of the 6-foot contour, practically no change in the vicinity of the 12-foot contour and deepening and landward movement of about 300 feet in the vicinity of the 18-foot contour.

44. Venetian Harbor Inlet. - The inlet to Venetian Harbor in 1838 was located about 400 feet northeast of its present position. From 1838 to 1883 it shifted about 250 feet to the southwest. The inlet was fixed in its present position sometime around 1915 by the construction of jetties. Some accretion has occurred north and adjacent to the north jetty; some shore recession, generally not exceeding 100 feet has occurred along the 700 feet of marshy shore extending northward of the jetties.

45. West Shore of Mumford Cove. - This shore area is about 4000 feet long and extends from Mumford Point northeastward to the remains of a small offshore island. The southerly third of this shore is strewn with cobbles and boulders indicating that it has been subject to erosion rather than accretion of 100 to 150 feet as shown on the shore line change map. The northerly two thirds of this shore consists of sand and shingle bars fronting marsh. Recession of these bars has occurred in the indentations of the shore and accretion at the projecting points, the amounts of movement varying between 100 and 150 feet. The bar is connected at its northern end by a tombolo formation to the remains of a small offshore island which in 1838 was many times larger than that which exists today.

46. Offshore depth changes between 1839 and 1883 resulted in shoaling in the vicinity of the 6-foot contour and movement of this contour seaward of 100 to 150 feet, irregular landward movement of the 12-foot contour varying between 0 and 200 feet and deepening in the vicinity of the 18-foot contour with landward movement of this depth curve of 200 to 400 feet. A profile run during 1949 indicates that there has been practically no change in the location of the 6 and 12-foot depth contours since 1883.

47. Mumford Point to Bluff Point. - This is a shore area about 2500 feet long. Bluff Point is a high eroded bluff fronted by a blanket of boulders which have been left as a result of the erosion of finer materials. This bluff diminis hes in altitude towards Mumford Point and the size of the fronting boulders also decreases. Bedrock is exposed near the water's edge at several locations. The entire shore is naturally protected by boulders and bedrock so that there is little likelihood that rapid recession of the shore will occur in the future. According to the shore line change map, accretion occurred along this shore after 1838 moving the high water line as much as 150 feet seaward. The existing condition of the shore indicates that the occurrence of such accretion is very unlikely. Comparison of the 1883 and 1949 shore lines indicates that practically no change has occurred since 1883.

48. Offshore depth changes between 1839 and 1883 resulted in the following movements of depth contours: 6-foot, landward movement of 400 feet opposite Mumford Point gradually diminishing westward to Bluff Point where practically no change occurred; 12-foot, irregular landward movement varying between 0 and 300 feet with no change at Bluff Point; 18-foot, no change opposite Mumford and Bluff Points and landward movement gradually increasing to about 300 feet midway between these points. Profiles run during 1949 indicate that only minor dep th changes have occurred at Mumford and Bluff Points since 1883.

49. Bluff Point and Bushy Point Beaches. - This shore area consists of a bar or tombolo, about 4500 feet long, varying in width from 100 to 250 feet, connecting Bluff Point and an island known as Bushy Point. Between 1846 and 1949 the easterly half of this bar retreated landward about 150 feet and the seaward shore of the westerly half receded about 150 feet, resulting in a diminished width of this end of the tombolo. During the hurricane of September 1938 the western end of the tombolo was breached, separating it from Bushy Point. During 1949, this breach was about 650 feet w ide and just barely awash at high tide. The retreat of the easterly end of the bar has resulted in a junction of the bar with marsh lying behind it and the closure of a channel which formerly connected a body of water lying behind the bar to Poquonock River, in effect making a pond of this body of water.

50. Offshore depth changes from 1839 to 1883 consisted principally of deepening, resulting in movements of the depth contours as follows: 6-foot contour, landward movement varying from none at Bluff Point to 50-150 feet opposite the 2000 feet of shore west of Bluff Point increasing to 250-500 feet further westward to Bushy Point; 12-foot contour, landward movement gradually increasing from none at Bluff Point to 900 feet at Bushy Point; 18-foot contour, seaward movement of 0 to 250 feet for a distance of 1000 feet west of Bluff Point changing to landward movement of 200 to 600 feet further westward to Bushy Point. Comparison of profiles run during 1949 with depths in 1883 indicates that some shoaling occurred soundward of the western

end of Bushy Point, little change in depth occurred in the position of the 6 and 12-foot contours in the vicinity of the breach east of Bushy Point, shoaling occurred in the vicinity of the 12 and 18-foot contours and deepening in the vicinity of the 6-foot contour at the easterly end of the beach at a profile located about 2000 feet west of Bluff Point.

51. Shore between Baker Cove and Avery Point. - This area includes Jupiter Point and the marshy shore extending westward from it to Avery Point. The principal changes in the position of the shore line in this area between 1846 and 1949 were as follows: recession of the west shore of Jupiter Point increasing from about 50 feet at the southerly tip to about 250 feet at its inshore end; recession of the shore west of Jupiter Point varying between 0 and 250 feet, averaging over 100 feet.

52. Offshore depth changes between 1839 and 1883 consisted of deepening of the area between Avery Point and Pine Island and eastward movement of depth contours as follows: 6-foot, about 500 feet; 12-foot, about 250 feet; 18-foot, 0 to 100 feet.

53. Avery Point. - Shore line changes along the east shore of Avery Point since 1838 were as follows: recession of the shore of 100 to 500 feet up to 1883; continued recession of the southerly 300 feet of this shore of 50 to 75 feet, and accretion along the remainder of the shore of 100 to 200 feet between 1883 and 1949. The east face of Avery Point in 1949 consisted of a masonry sea wall and the accretion noted as occurring here between 1883 and 1949 is probably due to artificial filling behind the wall rather than to natural processes. Recession of the shore is shown as occurring along 500 feet of shore located at the east end of the south face of the point between 1846 and 1949. This recession formed a concave indentation in the shore with a maximum depth of about 150 feet. This area is now protected by concrete and masonry sea walls. The remainder of the south face of Avery Point consists of exposed bedrock. The high water line in 1949 along this shore was in the same position as in 1883. According to the shore line change map, accretion of the shore line occurred between 1838 and

1883. The present character of this shore indicates that occurrence of such accretion is very unlikely. The shore line of the west face of Avery Point moved seaward between 1846 and 1883 and again between 1883 and 1949. This side of the point in 1949 was protected along its inshore end by a masonry sea wall and along the adjoining shore by dumped riprap revetment. The coarseness of fronting shore material, the exposure of the shore to wave action and the existing protective structures indicate that erosion rather than accretion occurs here. Any accretion of the shore line in this area must be attributed to artificial filling rather than to natural processes.

54. Only small, minor depth changes occurred offshore opposite the south face of Avery Point between 1839 and 1883. During this period, depth changes along the west side of Avery Point resulted in a seaward movement of the 6-foot contour up to 250 feet, a landward movement of the 12-foot contour of about 500 feet and of the 18-foot contour up to about 700 feet.

55. Shenecossett Beach and Eastern Point Beach Park. - This area extends westward from Avery Point to Eastern Point. Shore line movements between 1846 and 1883 were as follows: recession of 75 to 100 feet along the easterly 1500 feet of shore occupied by the United States Coast Guard, a private bathing beach and private residences; recession of 150 to over 200 feet along the westerly 500 feet of shore occupied by a private residence and a borough bathing beach known as Eastern Point Beach Park. Only minor changes in the position of the shore line occurred between 1883 and 1949.

56. Offshore depth changes between 1839 and 1883 resulted in landward movement of the 12-foot contour of about 400 feet east and west of the small, rocky island known as Black Rock while only small changes occurred around Black Rock. During this period, the 18-foot depth contour also moved landward, the greatest movement of about 700 feet occurring opposite the east end of Shenecossett Beach, the amount of change decreasing eastward to Avery Point and westward to Eastern Point. Profiles run during 1949 indicate that a small amount of shoaling has occurred along the eastern end and deepening along the western end since 1883.

57. Eastern Point and the East Shore of New London Harbor. - This shore consists of the rocky headland known as Eastern Point and the shore extending about 4500 feet northward from it along the east side of New London Harbor. The entire area is characterized by outcrops of bedrock and irregular indentations in the shore where erosion has removed the unconsolidated materials. These indentations have been cut to varying depths ranging up to as much as 300 feet since 1838. In 1949, practically all sections of the shore which did not consist of bedrock were protected by sea walls or revetment so that it is unlikely that any extensive shore line movements will occur in the future.

# APPENDIX F

## LITTORAL DRIFT

1. Listed below are indices of littoral drift obtained from field inspection supplemented by study of shore line change maps and aerial photographs. Direction of littoral drift was interpreted as being in the direction of growth of sand spits, towards the side of groins, jetties or other structures at w hich accretion was found or towards the ends of beaches where material was finer as show n by variation of beach composition where there was a change in gradation from coarser to finer material.

### Indices of Drift

| Shore Area | Indicated Direction of Drift | Evidence | Date | Authority |
|---|---|---|---|---|
| West side Stonington Harbor | North | Material caught south side of groins and railroad embankment | Jan.12,1950 | Inspection |
| White Beach | West | Gradation slightly finer at west end | Jan.12,1950 | Inspection |
| Shore west of Quambaug Cove | West | Westward growth of spit | Jan.12,1950 | Inspection |
| Latimer Point (East side) | North | Material a little higher on south side of groin | Jan.12,1950 | Inspection |
| East Shore Mason Island | North | Material caught south side groins. Gradation finer to north | Jan.11,1950 | Inspection |
| West Shore Mason Island | North | Material caught south side groins and rock outcrops | Jan.11,1950 | Inspection |
| Murphy Point | West | Westward growth of spit | Jan.11,1950 | Inspection |
| Point of marsh south of Mystic Community Beach | South | Southward trailing underwater spit | Jan.11,1950 | Inspection |

| Shore Area | Indicated Direction of Drift | Evidence | Date | Authority |
|---|---|---|---|---|
| Shore northwest of Willow Point | South | Material held north side groins | Jan.11,1950 | Inspection |
| East side Spence Point | North | Sand caught south side groins | Jan.11,1950 | Inspection |
| East shore of Noank | North | Small amount sand caught on south side groins and walls | Jan.11,1950 | Inspection |
| West shore of West Cove | North | Material caught on south side groins | Jan.11,1950 | Inspection |
| West View | West | Sand caught on east side of groins | Jan.11,1950 | Inspection |
| West View (west end) | West | Westward growing spit at mouth of creek | Jan.11,1950 | Inspection |
| East side Esker Point | North | Sand caught on south side of groin | Jan.11,1950 | Inspection |
| West side Esker Point | North | Gradation of beach finer to north | Jan.11,1950 | Inspection |
| East shore of Groton Long Point | North | Material caught on south side of piers and groins | Jan.10,1950 | Inspection |
| At south jetty at entrance to Venetian Harbor | North | Material accumulated south side of jetty | Jan.10,1950 | Inspection |
| At north jetty at entrance to Venetian Harbor | South | Material accumulated north side of jetty | Jan.10,1950 | Inspection |
| West side Mumford Cove | North | Northward growth of tombolo and bars. Gradation of material finer to north | Jan.10,1950 | Inspection |
| Between Bluff and Mumford Points | East | Gradation of beach a little finer to east | Jan.10,1950 | Inspection |
| Bluff Point Beach | West | Gradation of beach finer to west | Jan.10,1950 | Inspection |

| Shore Area | Indicated Direction of Drift | Evidence | Date | Authority |
|---|---|---|---|---|
| Shenecossett Beach | East | Accumulation of sand at wall at east end of beach | Jan. 9,1950 | Inspection |
| Eastern Point Beach | East | Sand beach widens to the east | Jan. 9,1950 | Inspection |

## APPENDIX G

## EXISTING PROTECTIVE STRUCTURES

1. Stuart Breakwater. - A riprap breakwater was constructed during 1947 extending southward from the Stuart Estate, located east of the village of Stonington, to protect the causeway connecting the village and estate. The breakwater was built to a length of about 450 feet, with top width of about 12 feet and top elevation about 6.5 feet above the plane of mean low water. It consists of quarry run stone and earth fill and connects the shore with a cluster of projecting rocks which existed offshore. The structure shelters the causeway and a portion of the east shore of the village of Stonington from winds having an easterly component. In conjunction with Sandy Point, Napatree Point and the eastern Stonington breakwater, the Stuart breakwater shelters the causeway from winds from nearly all directions except SSE from which direction there is a small opening to Block Island Sound.

2. Stonington Point Sea Wall. - A sea wall authorized by the River and Harbor Act of June 3, 1896 was constructed as a Federal project around the southerly tip of Stonington Point during 1897 to stop the rapid erosion which was occurring at the old light house. The wall was built along the line of ordinary high water to a length of 385-1/2 feet. The wall was constructed in a trench two feet deep to a height of eight feet. The material consisted of beach boulders placed as dry rubble surmounted by a coping of heavy split granite blocks. The wall has effectively stopped erosion so that the position of high water has not changed since its construction. The wall has been damaged by storms, particularly the hurricane of September 1938, which resulted in displacement of coping stones. A limited amount of maintenance has been done by the town. The wall is not high enough to protect the area behind it from wave wash during storms. Some material has been washed out from behind the wall.

3. Stonington Harbor Breakwaters. - There are three breakwaters, constructed as Federal projects to protect Stonington Harbor. The inner breakwater or pier authorized in 1828 was built from the east side of the inner harbor in 1828-30 for protection of general anchorage. It was built to a length of 740 feet with a top width of 12 feet at an elevation about 8.5 feet above mean low water. The substructure consisted of angular stone thrown in and the superstructure of seven courses of split granite, the top course laid as headers, the other courses as headers and stretchers. The north side of the breakwater was built with a vertical face and the south side in the form of steps. The western breakwater authorized by the River and Harbor Act of March 3, 1875 was built in 1875-80 at the western side of the entrance to the harbor southeast of Wamphassuck Point out to a depth of 18 feet at mean low water. It was built to a length of 2025 feet with a top width of 12 feet at an elevation 9.75 feet above mean low water with side slopes of 1 on 2 on the seaward side and 1 on 1 on the harbor side. The eastern breakwater authorized by the River and Harbor Act of June 14, 1880 was built in 1880-94 from Bartlett Reef to Middle Ground Shoal. It was constructed to a length of 2900 feet with a top width of 12 feet at an elevation 9 feet above mean low water except for about 600 feet of its easterly end which had a top width of 8 feet at an elevation 2.7 feet above mean low water. The side slopes were 1 on 2 on the seaward side and 1 on 1 on the harbor side. The eastern and western breakwaters were built of riprap to provide a larger harbor of refuge than was afforded by the inner breakwater. The breakwaters provide protection from southerly winds. This protection has undoubtedly reduced wave attack on the shore of the harbor but the effect of this protection cannot be determined from available data.

4. Groins along east shore of Wamphassuck Neck. - There are a few widely spaced short riprap groins and solid piers along the east shore of Wamphassuck Neck. These structures hold fine sand on their south sides indicating the existence of northerly littoral drift. None of these

structures is long enough to effect any appreciable amount of accretion. The existence of a fine sandy beach about 350 feet long formed by the trapping of littoral drift adjacent to the railroad embankment at the north end of Stonington Harbor indicates that the construction of longer groins might result in the formation of small sandy beaches on their south side.

5. Lords Point Sea Walls. - The outer end of the eastern point of the settlement, Lords Point, is partially protected by a low masonry sea wall. The fronting shore consists of a shelf of bedrock and large boulders. All unconsolidated material has been eroded away. The point is exposed to the action of ocean waves approaching from a southeasterly direction. The wall serves to protect the residential area along the shore from attack by these waves. The wall has an elevation of 6.5 feet above the plane of mean low water and is too low to give full protection against the breaking of waves over it. The bedrock and boulders in the foreshore provide natural protection so that it is unlikely that erosion resulting in recession of the shore can occur.

6. Latimer Point Sea Wall and Revetment. - The southerly tip of Latimer Point is protected by riprap revetment and a masonry wall. The wall was damaged during the hurricane of September 1938. Evidence of this damage is still apparent along the east side of the point where breaks in the wall exist. Existing sections of the wall have a top elevation of about 9.0 feet above the plane of mean low water. The area behind the wall is comparatively low, having an elevation of 5 to 7 feet above mean low water. The dumped riprap revetment is about one to two feet lower than the sea wall. Existing structures are inadequate to provide full protection to the low-lying land at the tip of Latimer Point.

7. Groins at east side of Mason Island. - There are a few solid fill piers and roughly built short boulder groins along the east shore of Mason Island. A small amount of sand exists on the south side of these structures. It is evident that there is very little littoral drift material

moving along the shore which can be trapped and held by groins. Properly constructed groins might trap more sand than the existing structures but it is doubtful if any large amount of accretion could be effected in this manner. The principal value of groins would be to prevent rapid erosion of the shore in the event that the present protective blanket of boulders was removed in order to create small sandy pocket beaches.

8. Wall and Groins - Spence Point. - The southern tip of Spence Point in Mystic Harbor is protected by a low masonry wall fronted by short riprap groins. There is some evidence of lowering of the beach level in front of the wall. The groins along the east side of the point hold a small amount of material on their south sides indicating the existence of northward drifting. Old maps indicate that Spence Point was artificially reclaimed sometime between 1891 and 1910. A search of available data failed to reveal any specific information concerning the exact date and manner in which this was accomplished. It is unlikely that any accretion of the shore can be affected at Spence Point by construction of groins due to the absence of any available source of supply of littoral drift material. The point is well sheltered from all directions and little erosion is expected to occur.

9. Sea Walls and Groins at West View. - There is a small cottage development known as West View, located immediately east of Esker Point in Groton. The cottages are fronted by low concrete and masonry walls and short riprap and masonry groins. The beach fronting the walls is very narrow, generally not exceeding 15 feet in width at high tide. Material caught on the east side of groins indicates the existence of westward littoral drift. The area is not particularly exposed to wave attack. It is sheltered from all directions except south to southeast in which directions there is an open fetch of three to four miles to Fishers Island. There are no apparent sources of supply of littoral drift material to supply the beach and consequently, groin construction cannot be expected to result in any appreciable amount of accretion. If properly maintained, walls of the type in use should adequately protect the development.

10. Groins - East Shore Groton Long Point. - There are a number of short riprap and masonry groins along the east shore of Groton Long Point. These structures hold material on their south sides indicating the existence of northward littoral drift. The groins along the northerly end of the shore hold fine sand. Accretion at these groins has resulted in the formation of an irregular sawtooth-shaped shore line. The material caught by the groins further south is coarse in composition and small in quantity. Construction of longer, properly designed groins along the northerly portion of the shore might result in a substantial amount of accretion. Further south, groin construction supplemented by direct placement of sand would probably be required to create a sandy beach.

11. Sea Wall at South Beach, Groton Long Point. - During 1949, a concrete sea wall was built along South Beach by the Borough of Groton Long Point to protect the shore road and the low-lying property behind it from the action of waves which formerly washed material from the beach across the road and the adjoining property which is occupied by cottages. The wall has a top elevation of about 8.0 feet above the plane of mean low water. The sand beach in front of the wall is narrow. It appeared from inspection during April 1951 that a small amount of accretion has occurred in front of the wall. The structure should adequately fulfill its intended purpose.

12. Jetties - Venetian Harbor, Groton Long Point. - Two riprap jetties were constructed during 1930 at the entrance to Venetian Harbor, a small boat basin, located on Groton Long Point. These structures were built as 300-foot extensions of an existing timber bulkhead and riprap jetty. The exact date of construction of the previous structures is not known. It was reported that the harbor was originally dredged 15 to 18 years prior to 1930 and the wooden bulkhead which formed the north jetty was built about 3 years prior to 1930. The jetties were built of large angular stones dumped in place. They contained numerous voids. Rapid shoaling of the channel occurred as a result of sand drifting through the north jetty,

necessitating frequent periodic dredging. Surveys on the south side of the south jetty, made several years apart, showed that no changes in depth occurred there, indicating the absence of drift from this direction. During 1950, work was in progress to remove the outer 300 feet of the south jetty, using the stone to reconstruct the north jetty to make it sand tight and relocate its inshore end to a position further north. These structures are not expected to have any harmful effect on the adjacent shore. Some accretion may result north of the north jetty. No changes are expected to occur south of the south jetty.

13. Sea Walls and Revetment - Jupiter Point. - The inshore end of the western shore of Jupiter Point which is occupied by a cottage development is protected by light sea walls and riprap revetment. The walls generally have a top elevation of 5 to 6 feet above the plane of mean low water. This height is inadequate to protect the low-lying cottage development from overtopping by waves during times of extreme high tides. In view of past shore recession and evidence of continuing erosion of the shore fronting the walls, more substantial protective works are needed to insure against future losses.

14. Sea Walls and Revetment at Avery Point. - Avery Point is well protected by a masonry wall and dumped riprap revetment along its west side, by a masonry sea wall along its east side, and by bedrock along its south face. The occurrence of erosion along portions of the bank comprising the west side of the point was evident during January 1950. The addition of small amounts of riprap revetment is all that is needed to protect against this erosion.

15. Sea Wall at Shenecossett Beach. - There is a stepped concrete sea wall at the east end of Shenecossett Beach approximately 400 feet long fronting the bath houses at a private bathing beach. Comparison of the beach in January 1950 with photographs taken in January 1947 indicates that there has been practically no change in the condition of the beach during

this period. During the hurricane of September 1938, bath houses which formerly existed in this area were entirely demolished leaving the beach bare of any structures. It is doubtful if the present wall could protect against recurrence of such damage but it appears adequate to protect the area from the type of storms which normally occur.

16. Sea Wall and Breakwater at Eastern Point Beach Park. - There is a low masonry wall behind the bathing beach at Eastern Point Beach Park. This wall extends westward from the beach part way around the ledge rock projection which constitutes Eastern Point. A small breakwater, less than 100 feet long, has been built in a southeasterly direction from the south side of Eastern Point. This breakwater was constructed with cobbles and boulders which were cleaned off the beach. The beach is exposed to wave action generated by winds from the south to southeast direction. This wave action moves beach material landward causing it to overtop the low wall. Wave generated currents cause movement of sand from west to east along the public beach so that the west end of the beach becomes narrow. The short breakwater has reportedly helped to cut down sand losses effected in this manner.

# APPENDIX H

## ESTIMATES OF COSTS OF IMPROVEMENTS

1. General. - The estimated life of the considered projects is 50 years. The rate of interest on non-Federal investments is computed at 3.5 percent. Maintenance requirements of sand fills are based on maximum rates of loss determined from past shore recession. Where sand fill is proposed for a shore composed of coarse material which is now more resistant to erosion than sand, an estimated rate of loss twice as large as previously experienced has been used. Where sand fill is proposed for a shore now sandy in composition, a rate of loss equal to the maximum estimated past rate has been used. A minimum rate of shore recession of one foot per year has been used as a basis for estimates of losses for all sand fills.

2. West View. - The plan of protection and improvement considered consists of direct placement of sand along 650 feet of shore fronting the cottage development and construction of an impermeable groin at the west limit of the fill.

a. First Costs

| | |
|---|---|
| 26,000 cubic yards sand at $1.00 | $ 26,000 |
| 1,300 tons riprap at $10.00 | 13,000 |
| Engineering and contingencies | 5,000 |
| Total Cost | $ 44,000 |

b. Non-Federal Annual Charges

| | |
|---|---|
| Interest | $ 1,540 |
| Amortization | 335 |
| Maintenance | |
| 700 cubic yards sand at $1.25 | 875 |
| 10 tons riprap at $10.00 | 130 |
| Total Annual Charges | $ 2,880 |

3. Bushy Point Beach. - The plan of protection consists of construction of a riprap dike 800 feet long across the breach at Bushy Point Beach.

a. First Costs

| | |
|---|---|
| 3,500 tons riprap at $8.00 | $ 28,000 |
| Engineering and contingencies | 4,000 |
| Total Cost | $ 32,000 |

b. Non-Federal Annual Charges

| | |
|---|---|
| Interest | $ 1,120 |
| Amortization | 245 |
| Maintenance | |
| 35 tons riprap at $10.00 | 350 |
| Total Annual Charges | $ 1,715 |

4. Jupiter Point. - The plan of protection considered consists of construction of a dumped riprap mound along 900 feet of shore on the west side of Jupiter Point.

a. First Costs

| | |
|---|---|
| 3,000 tons riprap at $5.00 | $ 15,000 |
| Engineering and contingencies | 2,000 |
| Total Cost | $ 17,000 |

b. Non-Federal Annual Charges

| | |
|---|---|
| Interest | $ 595 |
| Amortization | 130 |
| Maintenance | |
| 30 tons riprap at $8.00 | 240 |
| Total Annual Charges | $ 965 |

5. Eastern Point Beach Park. - The plan of protection and improvement consists of widening the beach by direct placement of sand and enlargement of an impermeable groin at the east limit of the public beach.

a. First Costs

| | |
|---|---|
| 1,000 tons riprap at $10.00 | $ 10,000 |
| 13,000 cubic yards sand at $1.25 | 16,250 |
| Engineering and contingencies | 3,750 |
| Total Cost | $ 30,000 |

b. Non-Federal Annual Charges

| | |
|---|---|
| Interest | $ 1,050 |
| Amortization | 230 |
| Maintenance | |
| 10 tons riprap at $10.00 | 100 |
| 750 cubic yards sand at $1.25 | 940 |
| Total Annual Charges | $ 2,320 |

# 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 beaches, on protection of shore property and increased earning power or value of shore lands. Benefits accruing from increased value of areas behind and adjacent to shore property and increased business returns have not been evaluated.

2. West View. - a. Federal Benefit. - The United States does not own land in this area. Therefore, no Federal benefit will result from the improvement.

b. Private Benefit. -

(1) Average Annual Direct Damages Prevented. - Privately-owned property is protected by sea walls. The improvement will provide additional protection, resulting in savings in the maintenance cost of these structures computed as follows:

| | |
|---|---|
| Estimated value of sea walls | $10,000 |
| Estimated annual maintenance | 5% |
| Estimated annual savings | $ 500 |

(2) Increased Earning Power or Value of Land. - The improvement will result in increased value of privately-owned shore land. The assessed value of this land is $4,350, and the real value is $7,250. The estimated increase in value is 100%, or $7,250. Benefit from this increase is computed as a gain of 5% per annum which could be realized by sale of the land and investment of the increase in value. The annual benefit, therefore, becomes

$$\$ 7,250 \times .05 = \$362$$

c. Summary of Benefits, West View. -

| Benefit | Federal | Non-Federal Public | Private | Total |
|---|---|---|---|---|
| Direct damages prevented | $ 0 | $ 0 | $ 500 | $ 500 |
| Increased earning power | 0 | 0 | 362 | 362 |
| Total | $ 0 | $ 0 | $ 862 | $ 862 |

3. Jupiter Point. - a. Federal Benefit. - The United States does not own land in this area. Therefore, no Federal benefit will result from the improvement.

b. Private Benefit. -

(1) Average Annual Direct Damages Prevented. - The riprap mound will provide additional protection. Benefit therefrom is computed as a saving in the maintenance cost of existing structures and prevention of damage to cottages.

| | |
|---|---|
| **Saving in Maintenance of Existing Structures** | |
| Estimated value of sea walls | $ 8,000 |
| Estimated annual maintenance, 5% or | $ 400 |
| Estimated annual benefit | $ 400 |
| **Prevention of Damage to Cottages** | |
| Number of cottages | 10 |
| Estimated annual damage per cottage prevented | $ 25 |
| Estimated annual damage and benefit | $ 250 |

(2) Increased Earning Power or Value of Shore Land. - The improvement will result in increased value of privately-owned shore land. The estimated increase in assessed value is $3,100 and the estimated increase in real value is $5,100. Benefit from this increase is computed as a gain of 5% per annum which could be realized by sale of the land and investment of the increase in value. The annual benefit, therefore, becomes

$$\$ 5,100 \times .05 = \$251$$

c. Summary of Benefits, Jupiter Point. -

| Benefit | Federal | Non-Federal Public | Private | Total |
|---|---|---|---|---|
| Direct damages prevented | $ 0 | $ 0 | $ 650 | $ 650 |
| Increased earning power | 0 | 0 | 251 | 251 |
| Total | $ 0 | $ 0 | $ 901 | $ 901 |

4. Eastern Point Beach Park. - a. Federal Benefit. - The United States does not own land in the area. Therefore, no Federal benefit will result from the improvement.

b. Non-Federal Public Benefit. -

(1) Average Annual Direct Damages Prevented. - The Borough of Groton spent $3,000 during the years 1946, 1947 and 1948 for replenishment of sand losses on the public beach or an average annual expenditure of $1,000. The proposed plan of improvement will stabilize the beach, resulting in a saving of this annual expenditure. Therefore,

Public benefit = $1,000

(2) Recreational Benefit. - The annual beach use has increased from 25,000 persons in 1946 to 40,000 in 1947; 75,000 in 1948 and 85,000 in 1949. The available beach area above high water of 22,000 square feet is too small to adequately provide for present use. Serious overcrowding results during periods of peak use. The recreational benefit is computed on improving the standards of beach space. The improvement will provide an additional 17,500 square feet of beach area. This space can accommodate 233 persons at 75 square feet per person, a space allowance considered to be a desirable optimum. Daily beach attendance figures for the summer season of 1949 indicate that peak attendance exceeded the present capacity of the beach on 47 separate days, and that the capacity of the proposed enlarged beach would have been exceeded on 30 separate days and equalled or exceeded on 36 separate days. Benefit from the additional beach area proposed, expressed in visitor days, is computed as 36 x 233 or 8,388. This figure would be increased during 11 additional days (47-36) when the present beach capacity is exceeded but the proposed beach capacity is not reached. This increase is estimated as one-half of 11 x 233 or 1,281 visitor days. The total number of visitor days applicable to the additional beach area is, therefore, 9,669. 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 recreational benefit, therefore, becomes

9,669 x $0.20 = $1,934

c. Summary of Benefits, Eastern Point Beach Park. -

| Benefit | Federal | Non-Federal Public | Private | Total |
|---|---|---|---|---|
| Direct damages prevented | $ 0 | $ 1,000 | $ 0 | $ 1,000 |
| Recreational | 0 | 1,934 | 0 | 1,934 |
| Total | $ 0 | $ 2,934 | $ 0 | $ 2,934 |

# APPENDIX J

## POLLUTION ALONG THE CONNECTICUT SHORE

1. Pollution Study. - A sanitary study of shore bathing waters was carried out by the State of Connecticut, Department of Health, during the summers of 1949 and 1950. The purpose of the study was to obtain specific information concerning the sanitary condition of bathing areas and to notify local authorities and interested persons about "danger spots" along the shore which are seriously affected by sewage pollution. The entire shore line of the State of Connecticut, including a number of small coves and the lower part of some tidal streams, was examined during this period.

2. Bacterial Survey. - A bacterial survey was made consisting of water samples taken at approximately 1000-foot intervals along the shore at over 1000 stations in water depths of from 2 to 6 feet, such depths covering most of the areas used for bathing. These samples were taken at four stages of the tide; namely, high, low, one-half ebb and one-half flood. Wind direction at the time of sampling was recorded. No attempt was made to take samples under different wind conditions as it was believed that the run of the tide was the principal factor influencing the travel of pollution along the shore. A laboratory analysis in each of three dilutions of 10 ml., 1.0 ml. and 0.1 ml. was made for each sample obtained. From this analysis the most probable number of coliform organisms per 100 ml. was computed. The final result for each sampling station was obtained by averaging the computed most probable numbers for the four samples at each station.

3. Sanitary Survey. - In addition to the bacterial survey described above, a sanitary survey of shore areas was conducted. This included the location of sewer outlets, with data as to flows and character of untreated and treated sewage. Much of this data was already available from previous detailed studies. 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.

4. Comparison of Bacterial and Sanitary Surveys. - The entire shore area was divided into sections varying in length from 2000 feet to one or more miles for the purpose of classification. The shore was classified as A, B, C or D, representing good, fair, doubtful to poor, and poor conditions, respectively. From the bacterial survey, Class A was considered to include samples containing from 0 to 50 coliform organisms per 100 ml.; Class B, 51 to 500; Class C, 501 to 1000; and Class D, over 1000. From the sanitary survey data the shore sections were also classified into the four groups described above. A tabulation of the results of these two classifications is given below.

| | Bacterial Analysis Classification | | Sanitary Survey Classification | |
|---|---|---|---|---|
| | Mileage | Percentage | Mileage | Percentage |
| Class A | 49.1 | 19.4 | 73.4 | 29.0 |
| Class B | 133.2 | 52.7 | 75.4 | 29.8 |
| Class C | 31.7 | 12.5 | 69.2 | 27.4 |
| Class D | 39.0 | 15.4 | 35.0 | 13.8 |
| | 253.0 | 100.0 | 253.0 | 100.0 |

A comparison of the bacterial analysis and sanitary survey classifications shows that 63.7 percent of the shore was graded the same in both classifications; 19.2 percent of the shore falls into one grade lower according to the sanitary survey classification than according to the bacterial analysis classification, and 17.1 percent of the shore falls into one grade higher according to the sanitary survey classification. In general, then, it can be said that the bacterial analysis classification grades the shore the same as or one class higher or lower than the sanitary survey classification.

5. Spread of Disease at Bathing Places. - The Joint Committee on Bathing Places of the American Public Health Association and the Conference of State Sanitary Engineers published a comprehensive report in which is

reviewed the possibilities of the spread of disease through the use of bathing places. This review was prepared after a comprehensive survey of reported cases of illness attributed to such waters. Although recognizing the possibilities of transmission of disease at bathing places, the Joint Committee concludes that there is little known evidence that this has occurred. They point out that careful surveillance and proper sanitary control should be excercised and recommend against bathing in grossly polluted waters.

6. Polluted Shore Areas in Connecticut. - In general, from the Connecticut study it was found that pollution existed principally in harbor waters and in waters in close proximity to harbors. This pollution is rapidly dissipated by dilution in Long Island Sound so that many miles of Connecticut shore line are in excellent condition. Considerable progress has been made in the improvement of conditions in harbors through sewage treatment plant installations. Due to a tendency toward extensive use of bathing beaches near urban centers, a few bathing places are located in areas close to the border line of safety. Although this condition is undesirable and indicates a need for improvement, no alarm is felt at present in view of the absence of reported cases of illness acquired at these localities. Many individual cases of local pollution have been disclosed by the survey. These sources, though small in magnitude, are considered more dangerous due to their proximity to bathing areas than larger sources of pollution at a greater distance. The two principal rivers entering Long Island Sound, the Connecticut and the Housatonic, receive a large amount of pollution. Due to self-purification and later dilution in Long Island Sound, these rivers are not appreciable factors in the pollution of the waters along the Connecticut shore. The following areas in Connecticut were classified as being in poor condition:

a. Vicinity of sewer outlets at New London and Groton

b. Localized areas at Bridgeport and New Haven

c. Byram River between Portchester, N. Y., and Greenwich

d. The upper part of Cos Cob Harbor in Greenwich

e. The easterly section of Stonington, particularly the vicinity of the mouth of the Pawcatuck River

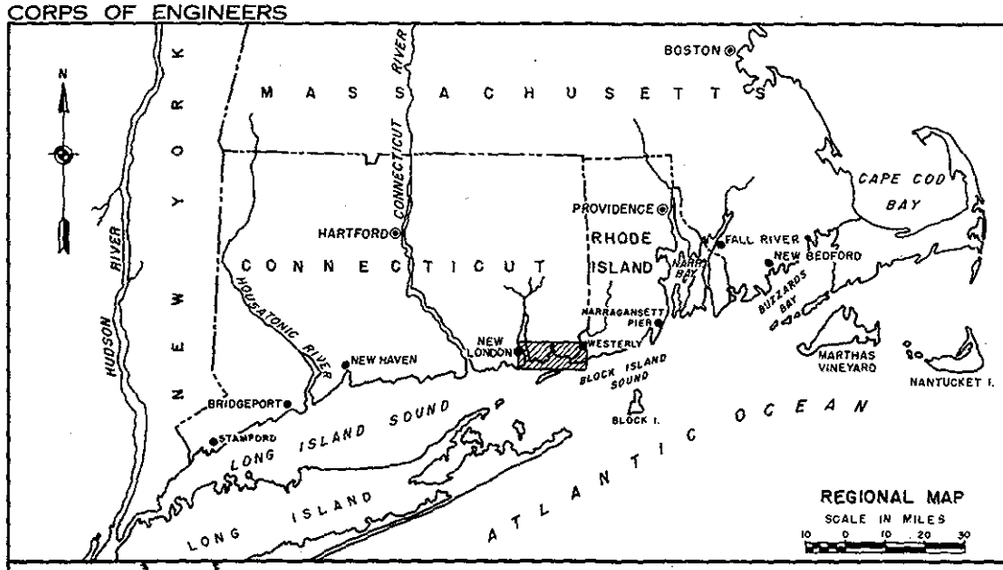
f. Many sewer outlets in Mystic and Stonington Harbor

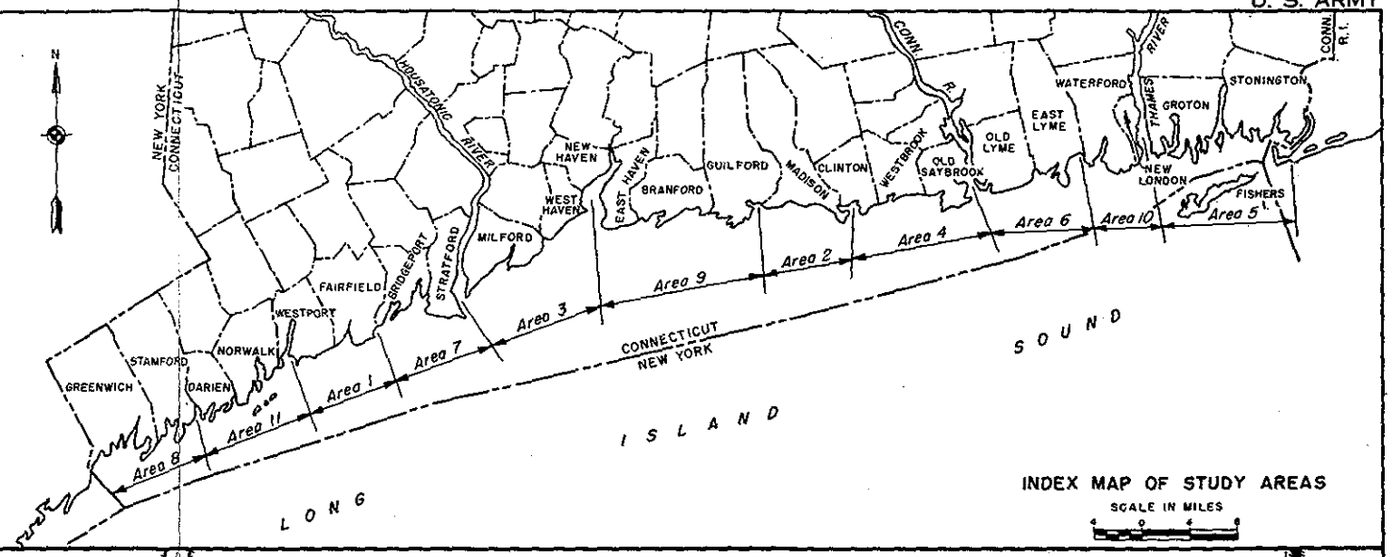
The pollution in the above areas is very local with little pollution effect noticeable at relatively short distances away, with the exception of the Pawcatuck River area where the pollution carries for a considerable distance.

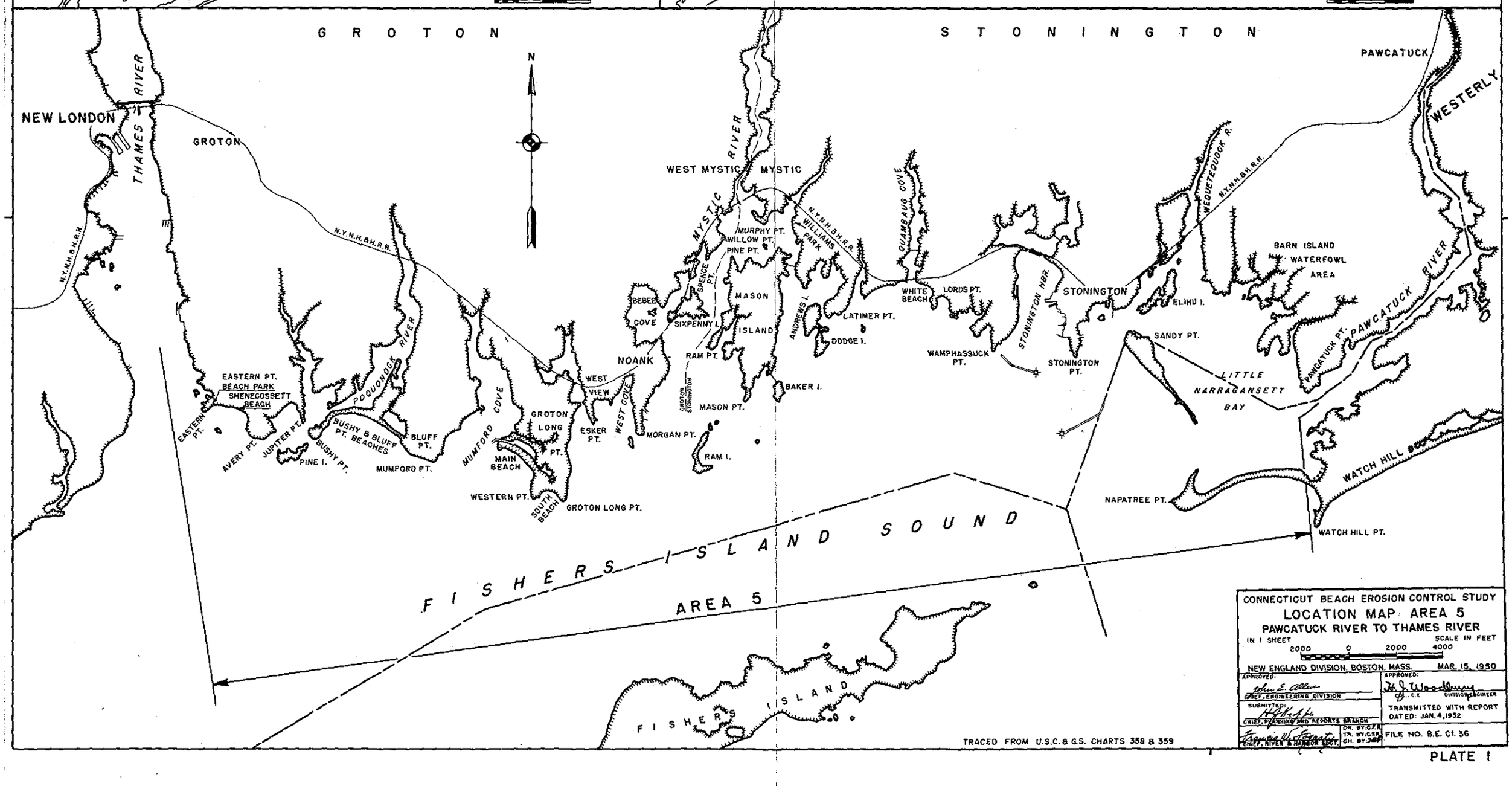
7. Recent Progress in Pollution Abatement. - Information furnished by the State Water Commission of Connecticut during December 1951 indicates that progress has been made in abating pollution along the shore since the above described sanitary study was conducted. Two treatment plants have been put into operation at Bridgeport, and additions and alterations have been made to the plant at West Haven. Construction of plants is in progress as follows; Norwalk - sewage plant being rebuilt, Fairfield - sewers and treatment plant being built, Stratford - alterations and additions being carried out by sections, Milford - second plant and sewers being built, New Haven - third plant 80% complete. New London is about to start construction of two pumping stations and a force main. Plans and specifications have been approved for construction of new plants at Westport and Branford, and are being prepared for Groton. Of the latter three locations, construction is anticipated in the near future only at Groton. Plans have been approved for treatment of sewage from Pawcatuck and steps are being taken through the New England Interstate Water Pollution Control Commission to solve the interstate pollution problem on the Pawcatuck River.

CORPS OF ENGINEERS

U. S. ARMY




TRACED FROM U.S.C.& G.S. CHARTS 358 & 359

CONNECTICUT BEACH EROSION CONTROL STUDY

LOCATION MAP: AREA 5

PAWCATUCK RIVER TO THAMES RIVER

IN 1 SHEET — SCALE IN FEET 2000 0 2000 4000

NEW ENGLAND DIVISION, BOSTON, MASS. MAR. 15, 1950

APPROVED: John E. Allen, CHIEF, ENGINEERING DIVISION

APPROVED: H. J. Woodbury, Lt. Col., C.E., DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

Francis W. Fenton, CHIEF, RIVER & HARBOR BRCH.

OR. BY C.E.R. TR. BY C.E.R. CH. BY

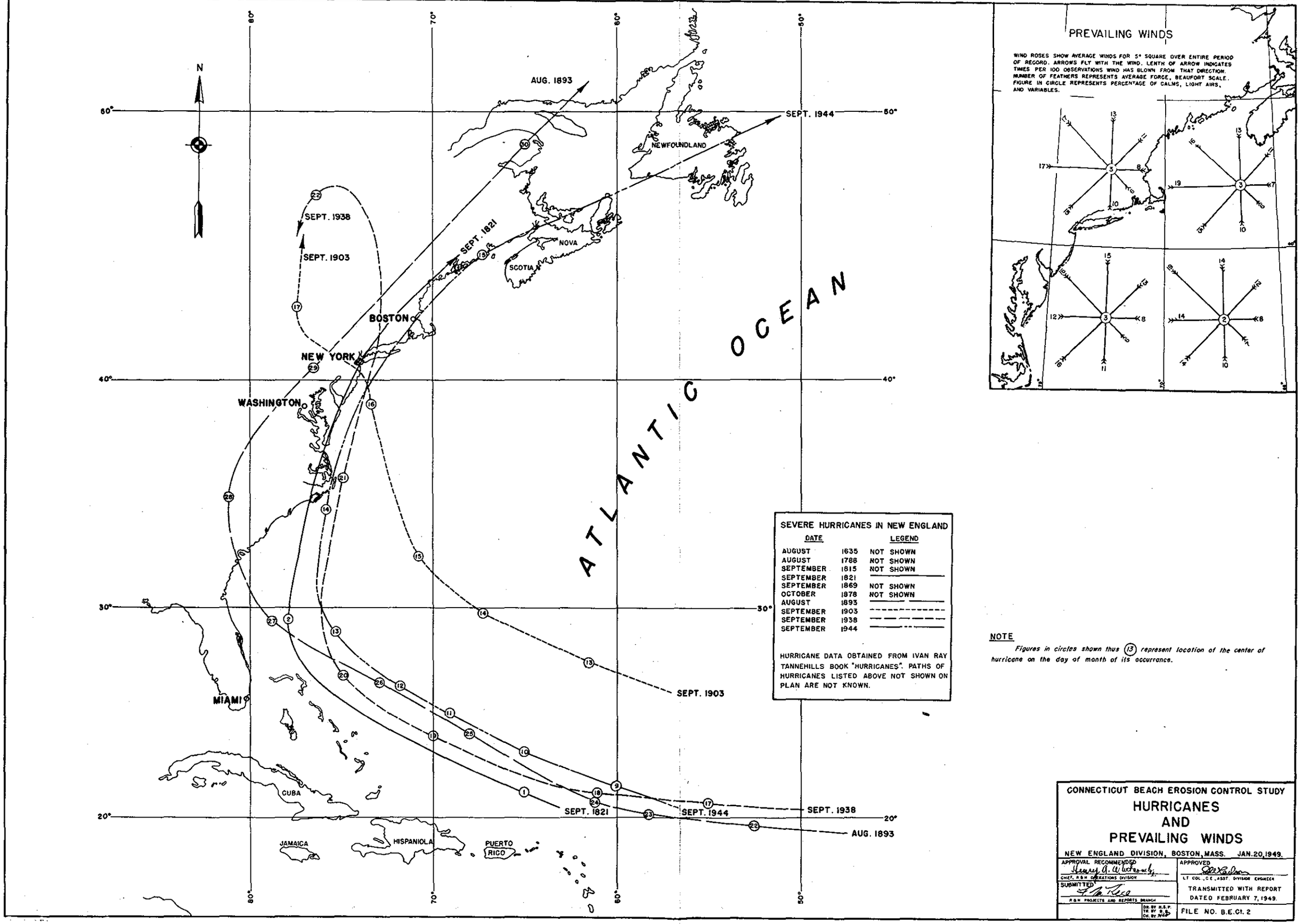
TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

FILE NO. B.E. Ct. 36

PLATE 1

CORPS OF ENGINEERS

U.S. ARMY




## PREVAILING WINDS

WIND ROSES SHOW AVERAGE WINDS FOR 5° SQUARE OVER ENTIRE PERIOD OF RECORD. ARROWS FLY WITH THE WIND. LENTH 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.



### 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.*

CONNECTICUT BEACH EROSION CONTROL STUDY

# HURRICANES AND PREVAILING WINDS

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

APPROVAL RECOMMENDED
Henry A. Whitworth
CHIEF, R&H OPERATIONS DIVISION

APPROVED
Lee Kadson
LT COL., C.E., ASST. DIVISION ENGINEER

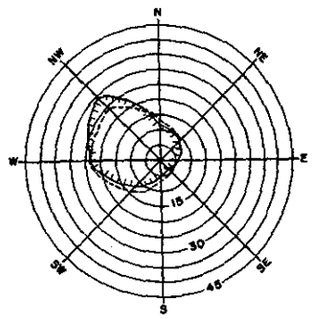
SUBMITTED
F. M. Reed
R&H PROJECTS AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949.

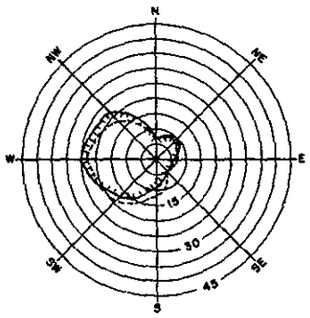
DR. BY H.S.P.
TR. BY D.S.
CH. BY [illegible]

FILE NO. B.E.Ct. 2

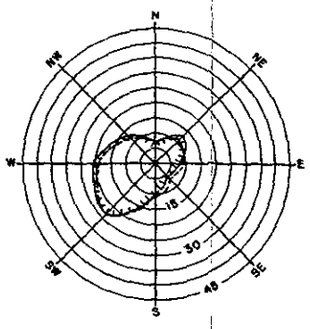
PLATE 2



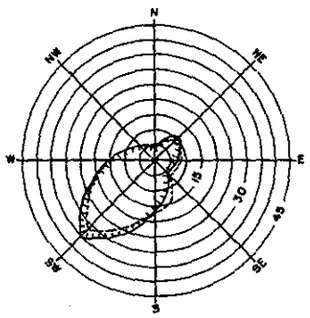

FEBRUARY



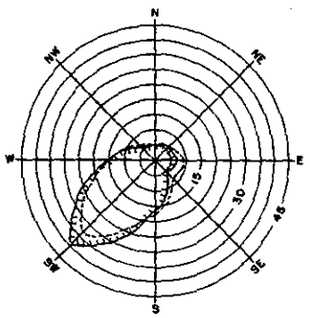

MARCH



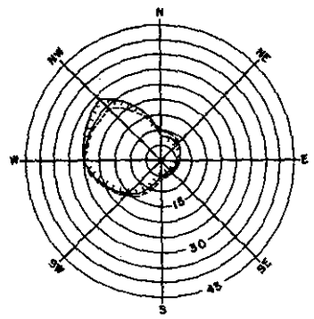

APRIL



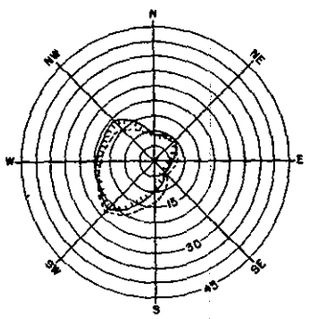

MAY



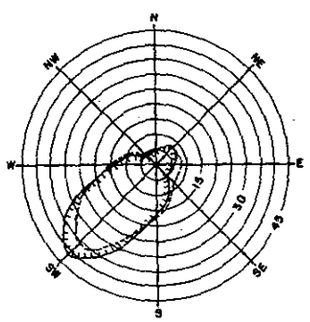

JUNE



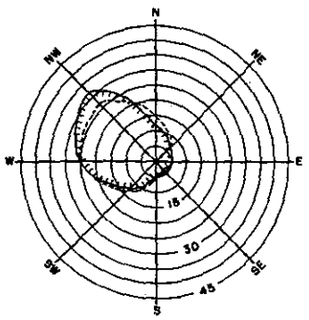

JANUARY



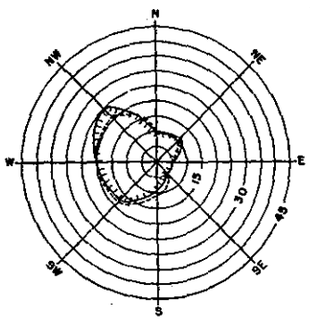

ANNUAL



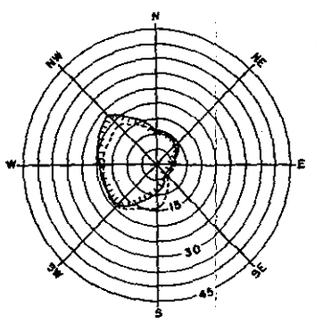

JULY



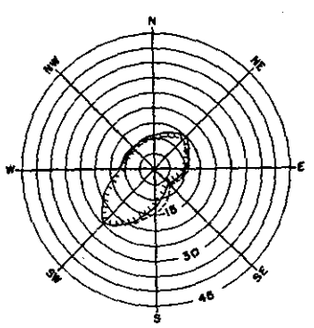

DECEMBER



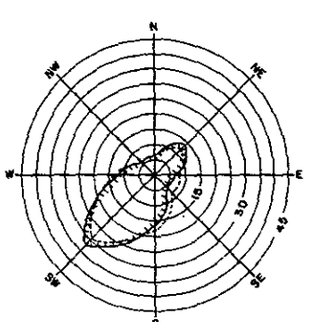

NOVEMBER




OCTOBER




SEPTEMBER




AUGUST

**LEGEND**

PERCENTAGE OF TOTAL WIND MOVEMENT

PERCENTAGE OF TOTAL WIND DURATION

**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 1939.

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 BLOCK ISLAND, RHODE ISLAND.

CONNECTICUT BEACH EROSION CONTROL STUDY

# WIND DATA

## BLOCK ISLAND, RHODE ISLAND

1921 - 1939

IN 1 SHEET

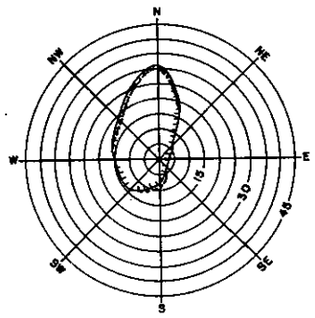
NEW ENGLAND DIVISION BOSTON, MASS. JAN. 20, 1949

| | |
|---|---|
| APPROVAL RECOMMENDED<br>Henry A. Whitcomb<br>CHIEF, R & H OPERATIONS DIVISION | APPROVED<br>LT COL, CE, ASST DIVISION ENGINEER |
| SUBMITTED<br>R & H PROJECTS AND REPORTS BRANCH | |
| DR BY N.S.P.<br>TR. BY J.J.<br>CH. BY | FILE NO. B.E.Gt.3 |

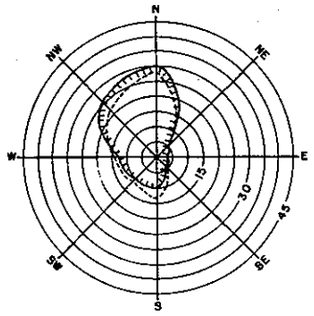
PLATE 3

CORPS OF ENGINEERS

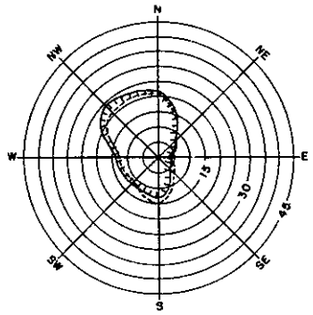
U.S.ARMY



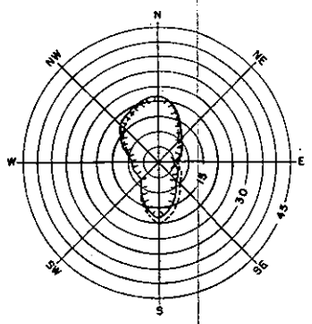

JANUARY



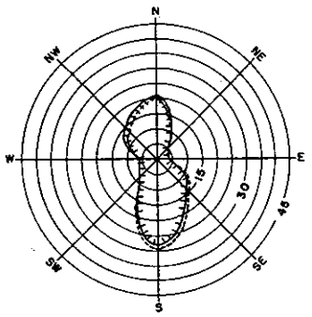

FEBRUARY



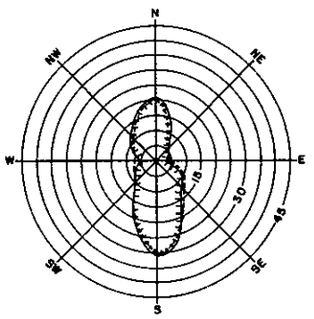

MARCH



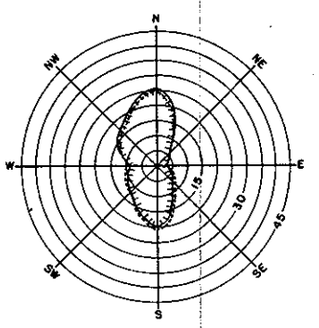

APRIL



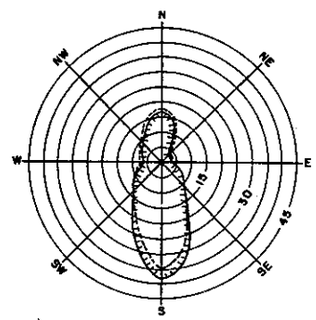

MAY



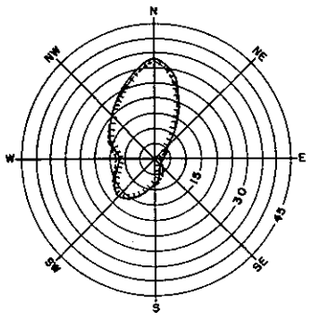

JUNE



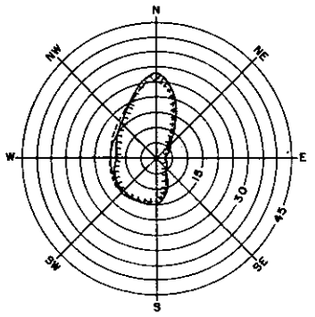

ANNUAL



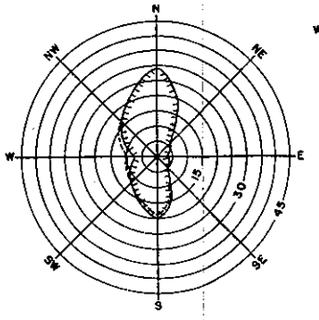

JULY



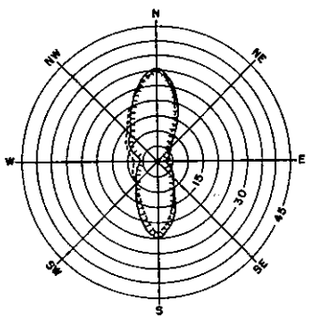

DECEMBER



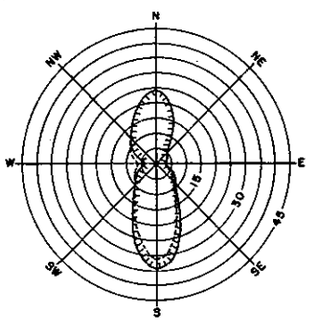

NOVEMBER




OCTOBER




SEPTEMBER




AUGUST

## 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
Henry A Whitcomb
CHIEF, R & H OPERATIONS DIVISION

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

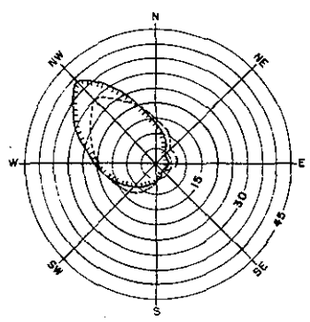
SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949.

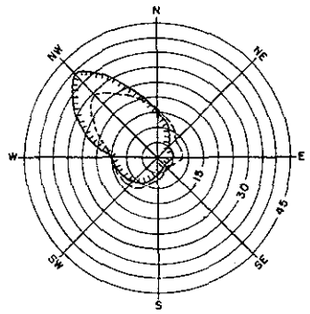
DR. BY H.S.P.
TR. BY M.S.
CH. BY

FILE NO. B.E.C1.4

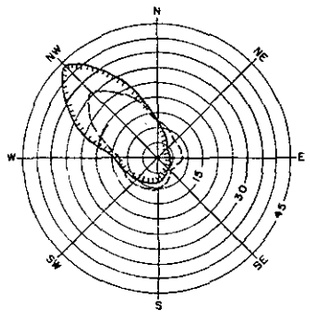
PLATE 4




JANUARY




FEBRUARY

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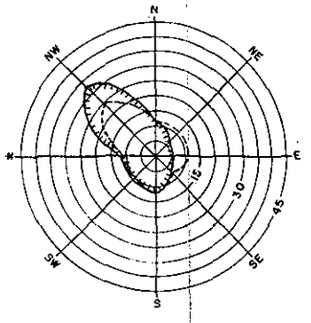
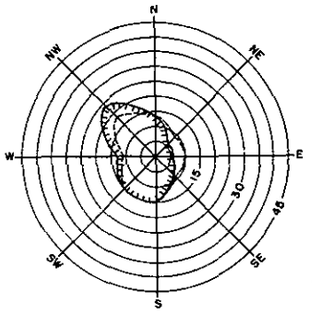
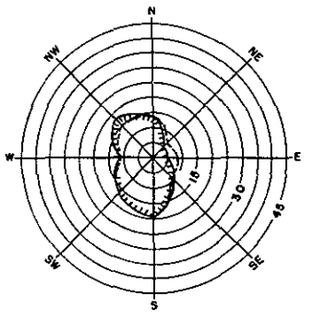



APRIL




MAY

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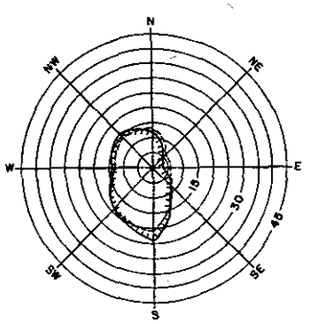
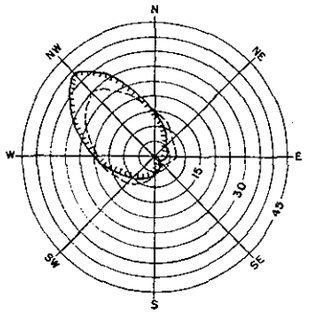
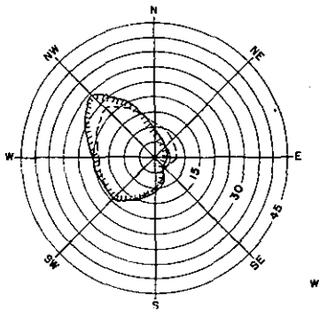


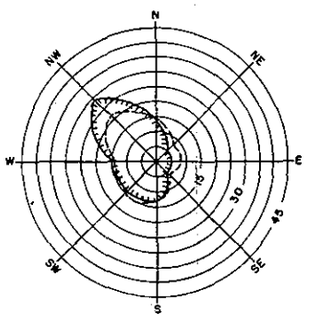

JULY



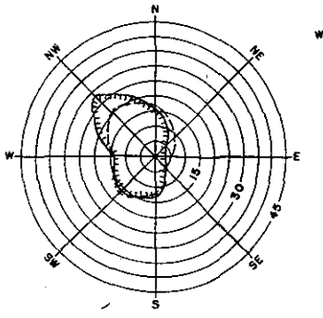

DECEMBER



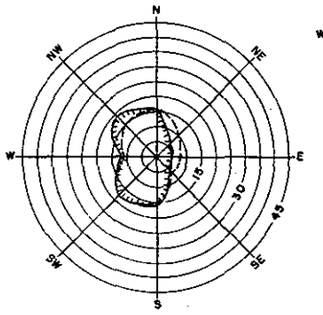

NOVEMBER



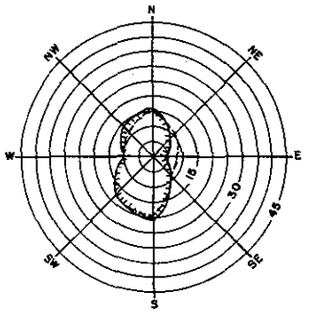

ANNUAL




OCTOBER




SEPTEMBER




AUGUST

**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

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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
Harry A. Whitcomb
CHIEF, R & H OPERATIONS DIVISION

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

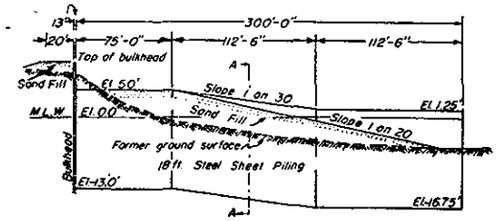
SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949.

DR. BY H.S.P.
TR. BY R.A.
CH. BY

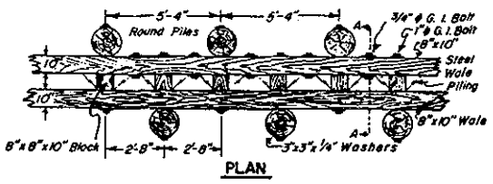
FILE NO. B.E.G1.5

PLATE 5

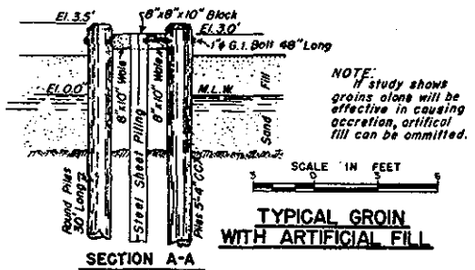



TYPICAL PROFILE

SCALE IN FEET
HOR. 50 0 50 100
VER. 10 0 10 20




PLAN

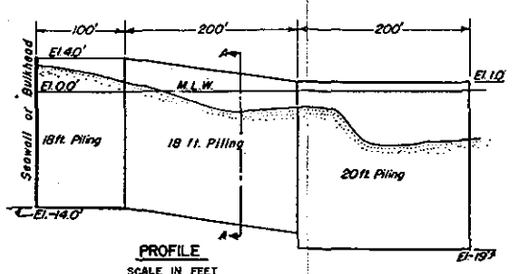



NOTE:
If study shows groins alone will be effective in causing accretion, artificial fill can be ommitted.

TYPICAL GROIN WITH ARTIFICIAL FILL

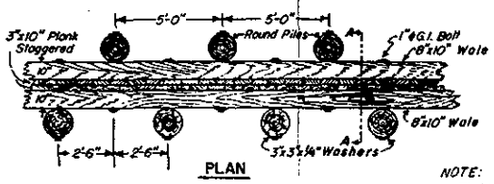
SECTION A-A

FIGURE 1



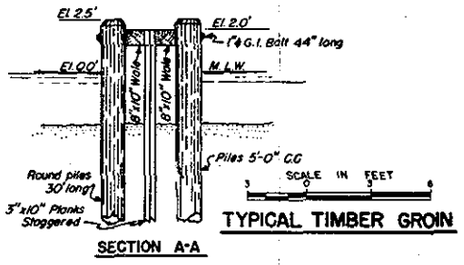

PROFILE

SCALE IN FEET
HOR. 75 0 75 150
VER. 5 0 5 10 15




PLAN

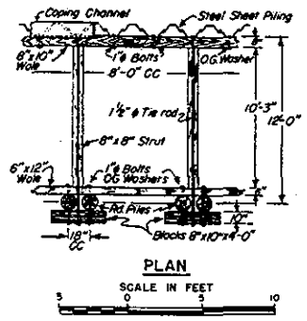
NOTE:
*Timber structures not recommended for permanent projects.*




SECTION A-A

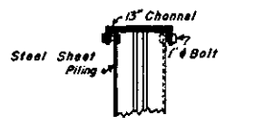
TYPICAL TIMBER GROIN

FIGURE 2



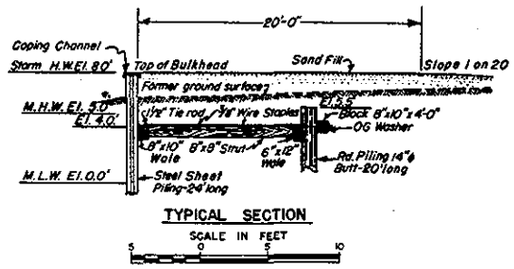

PLAN

SCALE IN FEET
5 0 5 10




DETAIL OF COPING CHANNEL

SCALE IN FEET
10 0 10 20

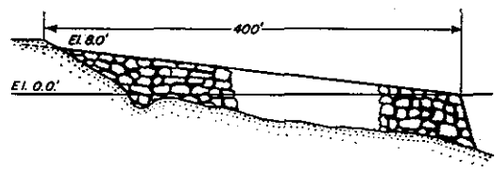



TYPICAL SECTION

SCALE IN FEET
5 0 5 10

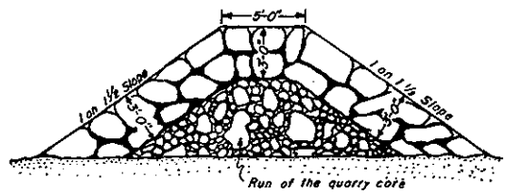
TYPICAL BULKHEAD

FIGURE 3




PROFILE

SCALE IN FEET
HOR. 60 0 60 120
VER. 10 0 10 20

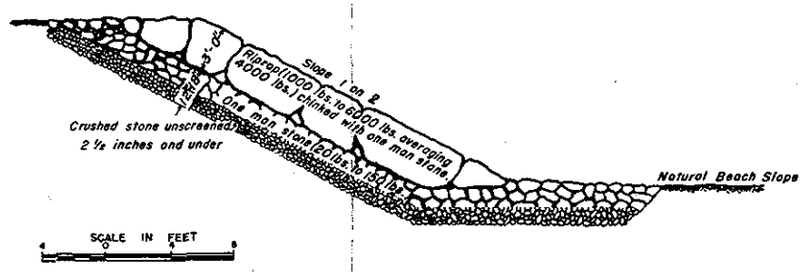



CROSS SECTION

SCALE IN FEET
5 0 5 10

TYPICAL STONE GROIN

FIGURE 4




TYPICAL SECTION OF REVETMENT

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
CHIEF, R.&H. OPERATIONS DIVISION

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

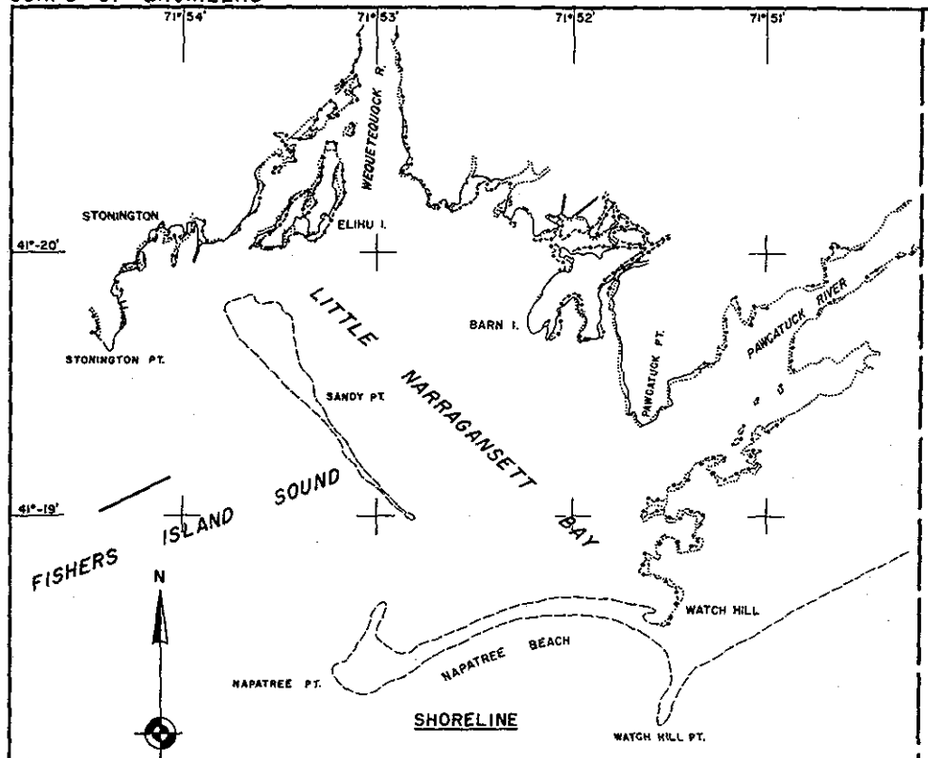
SUBMITTED
R & H PROJECTS AND REPORTS BRANCH

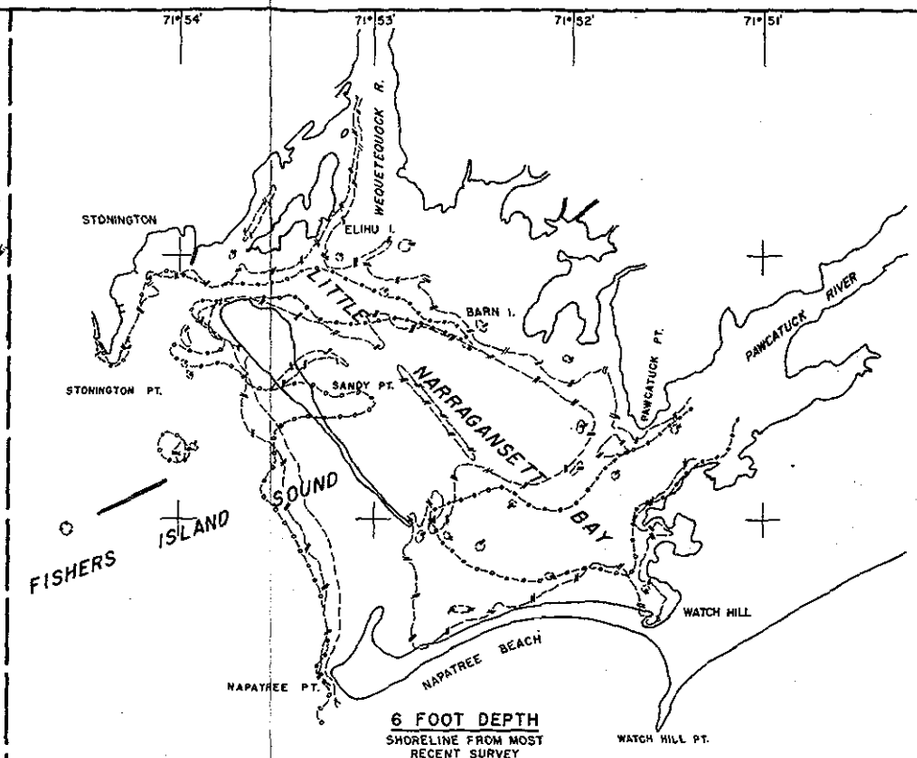
TRANSMITTED WITH REPORT DATED FEBRUARY 7, 1949.

DR. BY M.S.F.
TR. BY M.M.
CH. BY

FILE NO. B.E.C.I. 6

CORPS OF ENGINEERS — U. S. ARMY




**LEGEND**

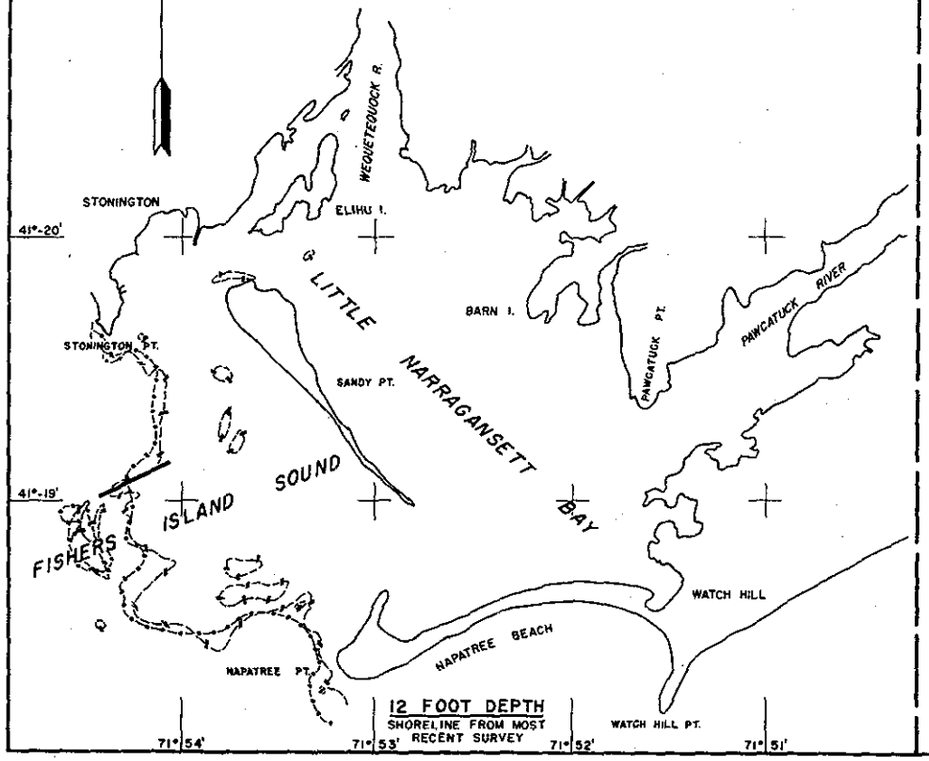
| DATE | SHORELINE | 6, 12 & 18 FOOT DEPTH |
|---|---|---|
| 1949 | ——— | ——— |
| 1946 | – – – – | – – – – |
| 1882-86 | ····· | ····· |
| 1882-84 | —//—//— | —//—//— |
| 1839 | —o—o—o— | —o—o—o— |

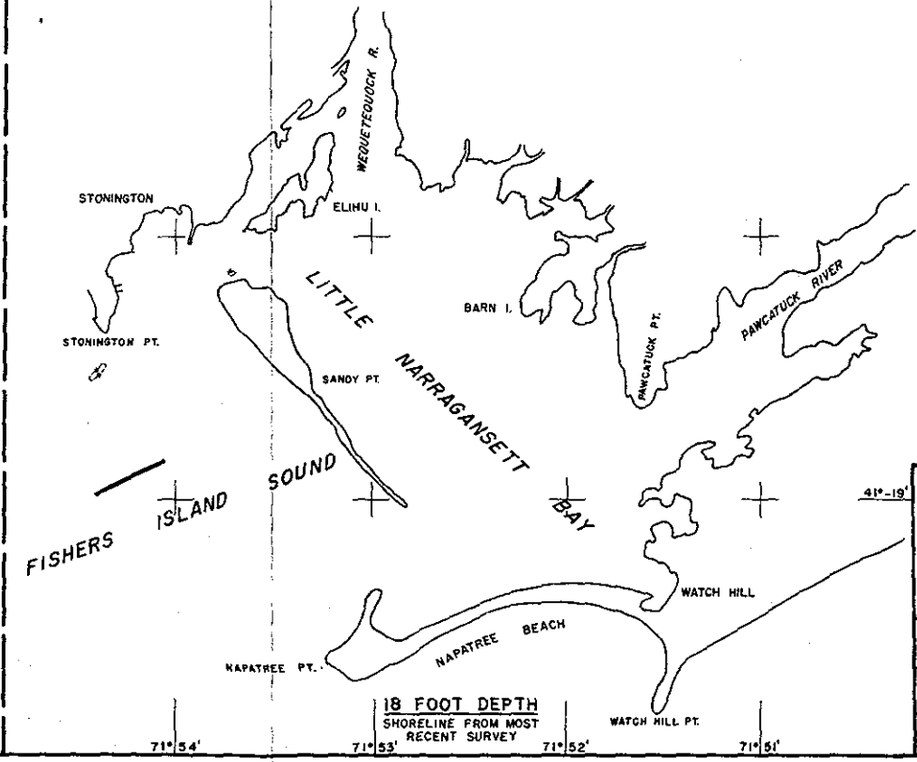
**NOTES**

*Shorelines prior to 1949 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 1949 shoreline is the Mean High Water line located for this study.*




# CONNECTICUT BEACH EROSION CONTROL STUDY
# SHORELINE AND OFFSHORE DEPTH CHANGES AREA 5
## PAWCATUCK RIVER TO THAMES RIVER

IN 3 SHEETS — SCALE IN FEET — SHEET 1

2000 0 2000 4000

NEW ENGLAND DIVISION, BOSTON, MASS. — AUG. 21, 1950

APPROVED: John E. Allen, CHIEF, ENGINEERING DIVISION

SUBMITTED: H. J. Rossin, CHIEF, PLANNING AND REPORTS BRANCH

DR. BY:
TR. BY: M.C.H.
CH. BY:

Francis H. Fraser, CHIEF, RIVER & HARBOR SECT.

APPROVED: H. J. Woodbury, COL., C.E., DIVISION ENGINEER

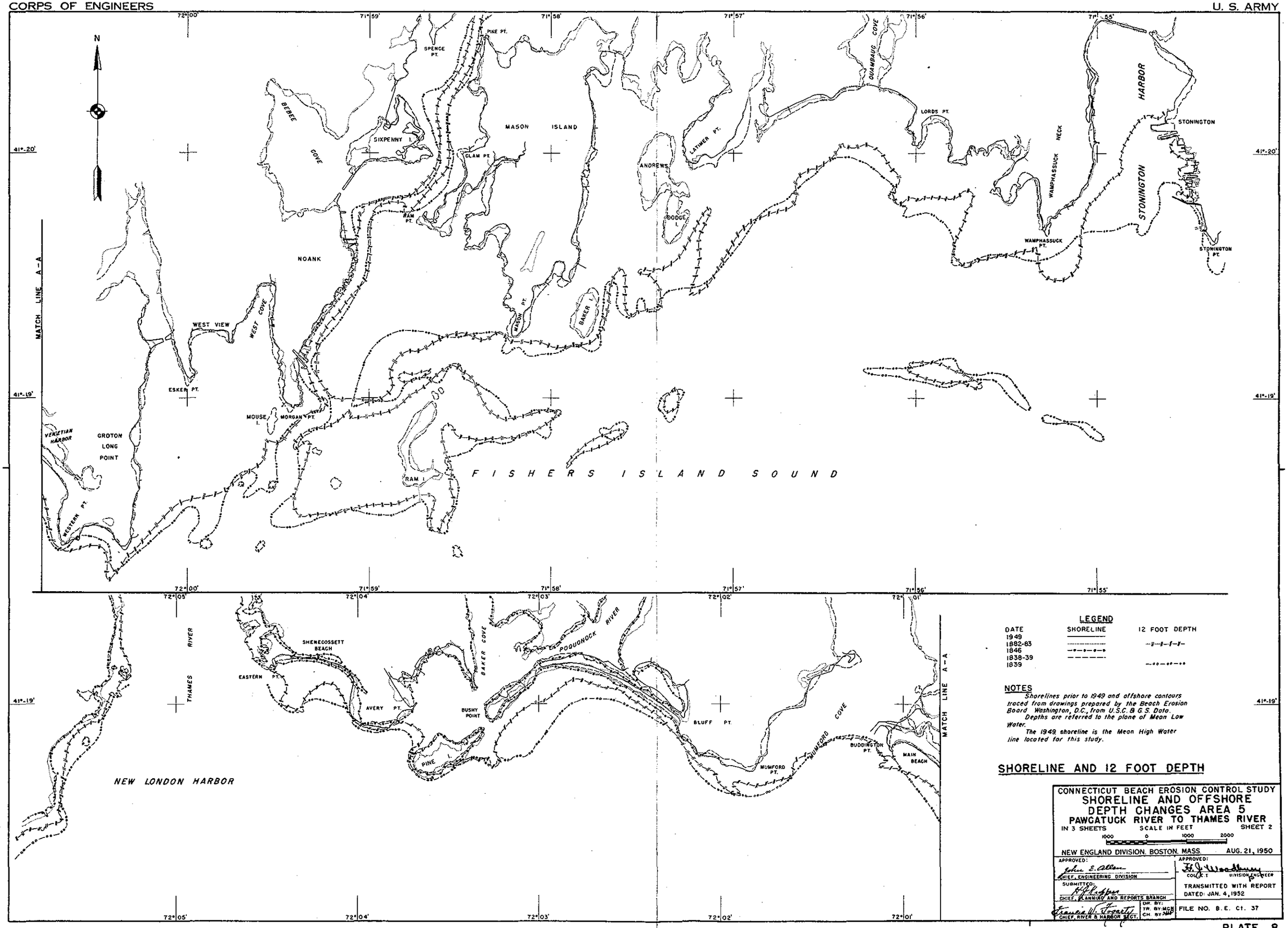
TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

FILE NO. B.E. Ct. 37

PLATE 7

CORPS OF ENGINEERS

U. S. ARMY




## LEGEND

| DATE | SHORELINE | 12 FOOT DEPTH |
|---|---|---|
| 1949 | ——— | ——— |
| 1882-83 | ..... | ——— |
| 1846 | —•—•—•— | ——— |
| 1838-39 | — — — — | ——— |
| 1839 | | —••—••—•• |

## NOTES

*Shorelines prior to 1949 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 1949 shoreline is the Mean High Water line located for this study.*

## SHORELINE AND 12 FOOT DEPTH

CONNECTICUT BEACH EROSION CONTROL STUDY

SHORELINE AND OFFSHORE DEPTH CHANGES AREA 5

PAWCATUCK RIVER TO THAMES RIVER

IN 3 SHEETS — SCALE IN FEET — SHEET 2

1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 21, 1950

APPROVED: John E. Allen, CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

Francis H. Fogarty, CHIEF, RIVER & HARBOR SECT.

DR. BY: TR. BY: MCH CH. BY:

APPROVED: H. J. Woodbury, COL. C.E. DIVISION ENGINEER

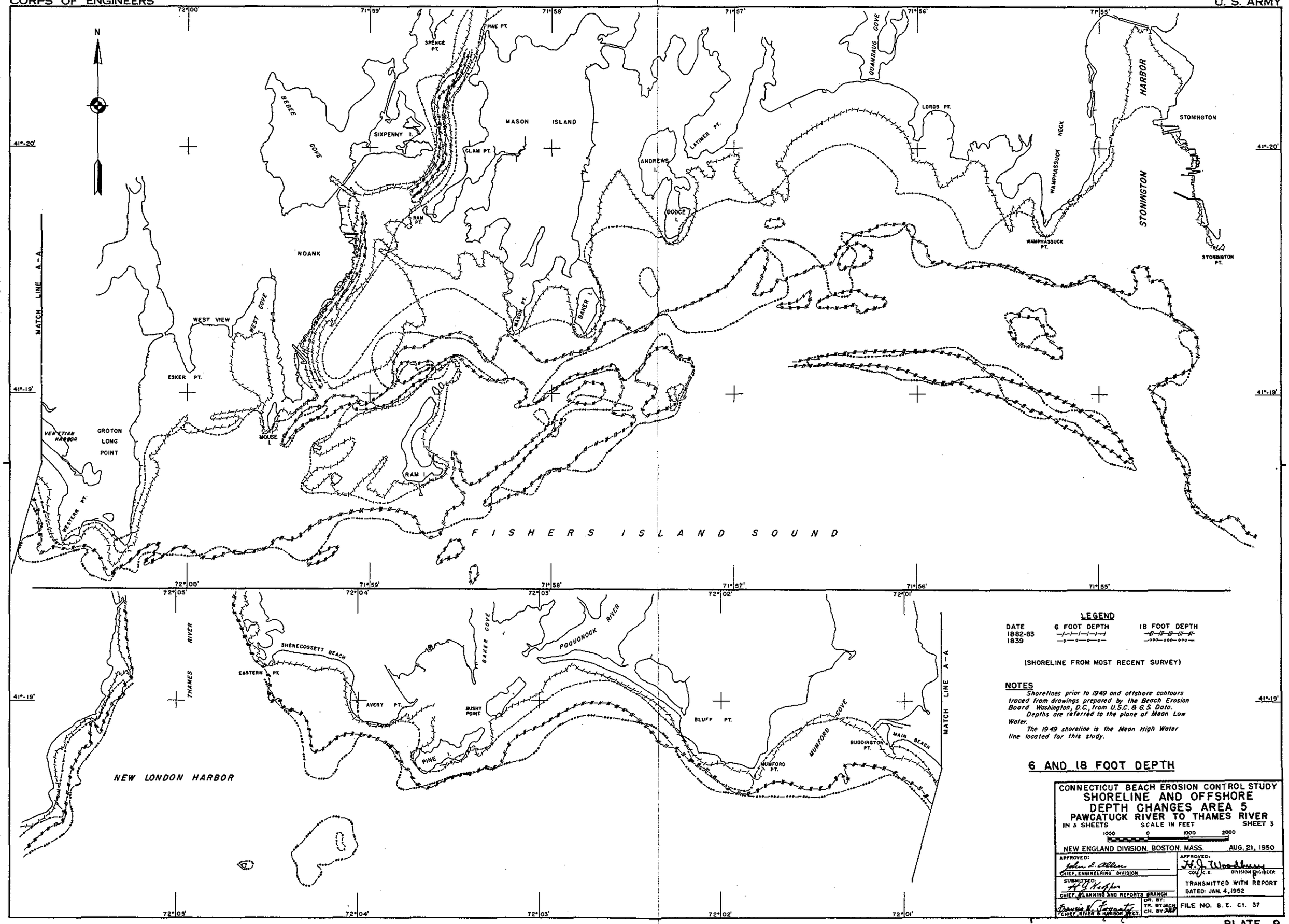
TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

FILE NO. B.E. CT. 37

PLATE 8

CORPS OF ENGINEERS

U. S. ARMY




**LEGEND**

| DATE | 6 FOOT DEPTH | 18 FOOT DEPTH |
|---|---|---|
| 1882-83 | | |
| 1839 | | |

(SHORELINE FROM MOST RECENT SURVEY)

**NOTES**

*Shorelines prior to 1949 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 1949 shoreline is the Mean High Water line located for this study.*

## 6 AND 18 FOOT DEPTH

CONNECTICUT BEACH EROSION CONTROL STUDY

# SHORELINE AND OFFSHORE DEPTH CHANGES AREA 5 PAWCATUCK RIVER TO THAMES RIVER

IN 3 SHEETS SCALE IN FEET SHEET 3

1000 0 1000 2000

NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 21, 1950

APPROVED: John S. Allen
CHIEF, ENGINEERING DIVISION

SUBMITTED: A. G. Hoffer
CHIEF, PLANNING AND REPORTS BRANCH

Francis W. Sweeney
CHIEF, RIVER & HARBOR SECT.

DR. BY:
TR. BY MCH
CH. BY JEP

APPROVED: H. J. Woodbury
COL., C.E. DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

FILE NO. B. E. Ct. 37

PLATE 9

CORPS OF ENGINEERS

U.S. ARMY

DISTANCES OUT FROM BASE LINE IN FEET

400 0 400 800 1200 1600 2000 2400 2800 3200 3600 4000 4400

DEPTHS IN FEET REFERRED TO M. L. W.

+20 +10 0 -10 -20

PROFILE NO.

2 — M.L.W. — MAY 4, 1949

7 — BOULDER AREA — M.L.W. — MAY 4, 1949

13 — M.L.W. — MAY 4, 1949

17 — M.L.W. — APRIL 29, 1949

20 — M.L.W. — APRIL 29, 1949

22 — M.L.W. — APRIL 19, 1949

27 — M.L.W. — APRIL 22, 1949

28 — M.L.W. — APRIL 22, 1949

33 — M.L.W. — APRIL 27, 1949

34 — M.L.W. — APRIL 27, 1949

36 — M.L.W. — APRIL 27, 1949

38 — M.L.W. — APRIL 27, 1949

## LEGEND

LOCATION OF 6, 12, AND 18 FOOT DEPTHS PRIOR TO 1949 SHOWN THUS:

| DATE | 1839 | 1882-83 |
|---|---|---|
| SYMBOL | ⊙ | ⊡ |

FROM SURVEYS BY U.S.C. & G.S.

**NOTE**

FOR LOCATION OF PROFILES SEE PLATES 11, 12, 13, 14 AND 15.

CONNECTICUT BEACH EROSION CONTROL STUDY

# COMPARATIVE PROFILES AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 1 SHEET — SCALES AS SHOWN

NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 21, 1950

APPROVED: John E. Allen — CHIEF, ENGINEERING DIVISION

SUBMITTED: H. Kaiser — CHIEF, PLANNING AND REPORTS BRANCH

DR. BY: N.Y. TR. BY: R.B. CK. BY: R.B.

Francis H. Fennety — CHIEF, RIVER & HARBOR SECT.

APPROVED: H. J. Woodbury — COL., C.E. DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

FILE NO. B. E. Ct. 38

PLATE 10

CORPS OF ENGINEERS

U. S. ARMY

E 836 000 E 840 000 E 842 000 E 844 000 E 846 000 E 848 000 E 850 000

71° 52' 71° 51'

N 186 000 N 184 000 N 182 000 N 180 000 N 178 000

41° - 20' 41° - 19'

71° 53' 71° 52' 71° 51'

MATCH LINE SHEET NO. 2

N. Y. N. H. & H. R. R.

GOAT I.

ELIHU ISLAND

WEQUETEQUOCK COVE

BARN ISLAND WATERFOWL AREA (STATE OF CONNECTICUT)

BARN ISLAND

HALL I.

PERCH I.

LITTLE NARRAGANSETT BAY

SANDY POINT

CONNECTICUT RHODE ISLAND

PAWCATUCK POINT

PAWCATUCK RIVER

GRAVES NECK

COLONEL WILLIE COVE

HORACE I.

RHODES POINT

POTTER COVE

P1

1

20 40

N

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 2.7 feet.

Hydrography, shoreline and shore structures determined by 1949 survey. Other topography and contours from U.S.C. & G.S. Chart No. 358.

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

LEGEND

PROBINGS ---------- ●P5

PROFILE NUMBERS ---- (7)

BEACH SAMPLE ANALYSIS

| PROFILE NUMBER | GRAIN SIZE IN MILLIMETER | | CHARACTER OF MATERIAL IN PERCENT | | | |
|---|---|---|---|---|---|---|
| | RANGE | MEDIAN DIAMETER | FINE SAND | MED. SAND | COARSE SAND | GRAVEL |
| 1 | 0.074-13.4 | 1.53 | 8 | 16 | 33 | 43 |

All samples taken at Mid Tide Elevation.

LIST OF PROBINGS

| NUMBER | DEPTH OF WATER | TOTAL DEPTH | MATERIAL AS INDICATED BY PROBINGS |
|---|---|---|---|
| P1 | 4.4 | 9.9 | 4.0' Mud, 1.5 sand. |

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

Probings were made by hand during April and May 1949.

CONNECTICUT BEACH EROSION CONTROL STUDY

# SURVEY MAP FOR AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 5 SHEETS SCALE IN FEET 500 0 500 1000 SHEET 1

NEW ENGLAND DIVISION BOSTON MASS. AUGUST 21, 1950

APPROVED: John E. Allen, CHIEF, ENGINEERING DIVISION

APPROVED: W. G. Woolbury, DIVISION ENGINEER

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

Francis H. Fogarty, CHIEF, RIVER & HARBOR SECT.

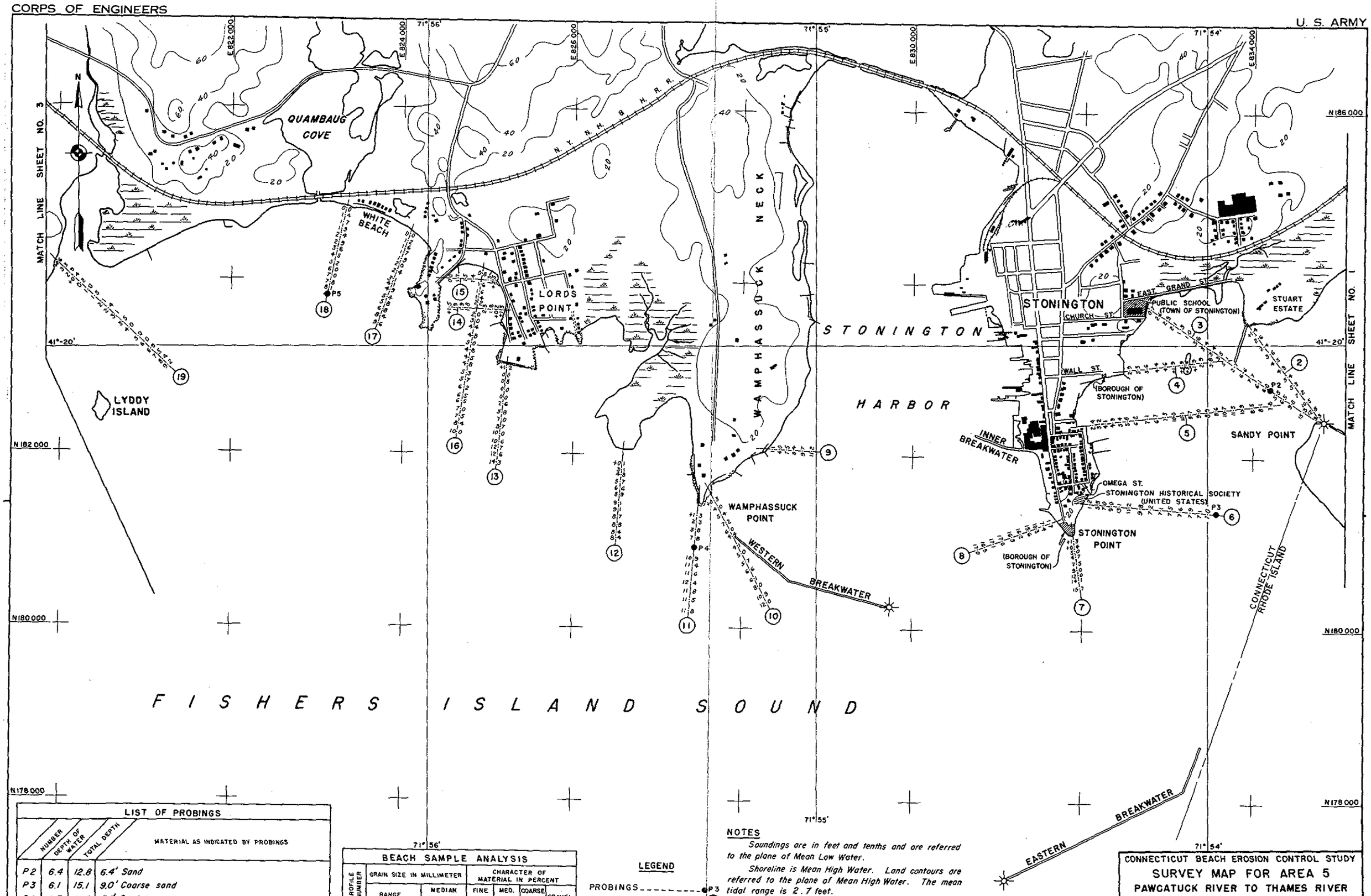
DR BY R. L. TR BY M. N. CH BY

FILE NO. B. E. CT. 39

PLATE 11

CORPS OF ENGINEERS

U. S. ARMY




## LIST OF PROBINGS

| NUMBER | DEPTH OF WATER | TOTAL DEPTH | MATERIAL AS INDICATED BY PROBINGS |
|---|---|---|---|
| P2 | 6.4 | 12.8 | 6.4' Sand |
| P3 | 6.1 | 15.1 | 9.0' Coarse sand |
| P4 | 9.7 | 11.8 | 2.1' Sand to rock |
| P5 | 9.0 | 17.0 | 4.1' Mud, 3.9' gravel |

NOTE:
Probings are in feet and tenths, and are referred to the plane of Mean Low Water.
Probings were made by hand during April and May 1949.

## BEACH SAMPLE ANALYSIS

| PROFILE NUMBER | GRAIN SIZE IN MILLIMETER | | CHARACTER OF MATERIAL IN PERCENT | | | |
|---|---|---|---|---|---|---|
| | RANGE | MEDIAN DIAMETER | FINE SAND | MED. SAND | COARSE SAND | GRAVEL |
| 14 | 0.149-19.0 | 1.00 | 1 | 18 | 52 | 29 |
| 16 | 0.074-13.4 | 0.58 | 12 | 37 | 23 | 28 |
| 17 | 0.149-9.5 | 2.00 | 1 | 6 | 43 | 50 |
| 18 | 0.149-9.5 | 0.75 | 2 | 24 | 57 | 17 |

All samples taken at Mid Tide Elevation.

LEGEND

PROBINGS ---------- P3
PROFILE NUMBERS ---- (3)
PUBLICLY-OWNED PROPERTY

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 2.7 feet.

Hydrography, shoreline and shore structures determined by 1949 survey. Other topography and contours from U.S.C. & G.S. Chart No. 358.

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

CONNECTICUT BEACH EROSION CONTROL STUDY

# SURVEY MAP FOR AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 5 SHEETS — SCALE IN FEET (500 0 500 1000) — SHEET 2

NEW ENGLAND DIVISION BOSTON MASS AUGUST 21, 1950

APPROVED: John D. Allen, CHIEF, ENGINEERING DIVISION

APPROVED: H. J. Woodbury, COL C E, DIVISION ENGINEER

SUBMITTED: N. J. Kapper, CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED JAN. 4, 1952

Francis W. Stogarti, CHIEF, RIVER & HARBOR SECT.

DR BY R.T. TR BY M.N. CH BY JWP

FILE NO. B. E. Ct. 39

PLATE 12.

CORPS OF ENGINEERS

U.S. ARMY

71°59' 71°58' 71°57'

E 812 000

41°-21'

WEST MYSTIC

MYSTIC RIVER

PEQUOTSEPOS BROOK

GROTON

STONINGTON

GROTON STONINGTON

MURPHY POINT

WILLIAMS POINT

WILLIAMS PARK (MYSTIC COMMUNITY CENTER)

N.Y.N.H.&H. R.R.

N 188 000

N

WILLOW POINT

N 186 000

SPENCE POINT

PINE POINT

MASON COVE

BEBEE COVE

SIXPENNY ISLAND

CLAM POINT

41°-20'

MATCH LINE SHEET NO. 4

MATCH LINE SHEET NO. 2

LATIMER POINT

ANDREWS ISLAND

DODGE ISLAND

P6

21

20

N 182 000

NOANK

N 180 000

RAM POINT

MASON ISLAND

BAKER ISLAND

MASON POINT

E 818 000

N 178 000

41°-19'

FISHERS ISLAND SOUND

N 176 000

RAM ISLAND

E 810 000

E 812 000

E 814 000

71°59'

71°58'

E 816 000

## LEGEND

PROBINGS ● P5

PROFILE NUMBERS (7)

PUBLICLY-OWNED PROPERTY

## 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 2.7 feet.*

*Hydrography, shoreline and shore structures determined by 1949 survey. Other topography and contours from U.S.C. & G.S. Chart No. 358.*

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

### BEACH SAMPLE ANALYSIS

| PROFILE NUMBER | GRAIN SIZE IN MILLIMETER | | CHARACTER OF MATERIAL IN PERCENT. | | | |
|---|---|---|---|---|---|---|
| | RANGE | MEDIAN DIAMETER | FINE SAND | MED. SAND | COARSE SAND | GRAVEL |
| 21 | 0.149-2.38 | 0.37 | 17 | 53 | 26 | 4 |

*All samples taken at Mid Tide Elevation.*

### LIST OF PROBINGS

| NUMBER | DEPTH OF WATER | TOTAL DEPTH | MATERIAL AS INDICATED BY PROBINGS |
|---|---|---|---|
| P6 | 8.6 | 15.5 | 6.9' Sand. |

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

*Probings were made by hand during April and May 1949.*

# CONNECTICUT BEACH EROSION CONTROL STUDY

## SURVEY MAP FOR AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 5 SHEETS SCALE IN FEET SHEET 3

500 0 500 1000

NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 21, 1950

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

APPROVED: COL., C.E. DIVISION ENGINEER

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

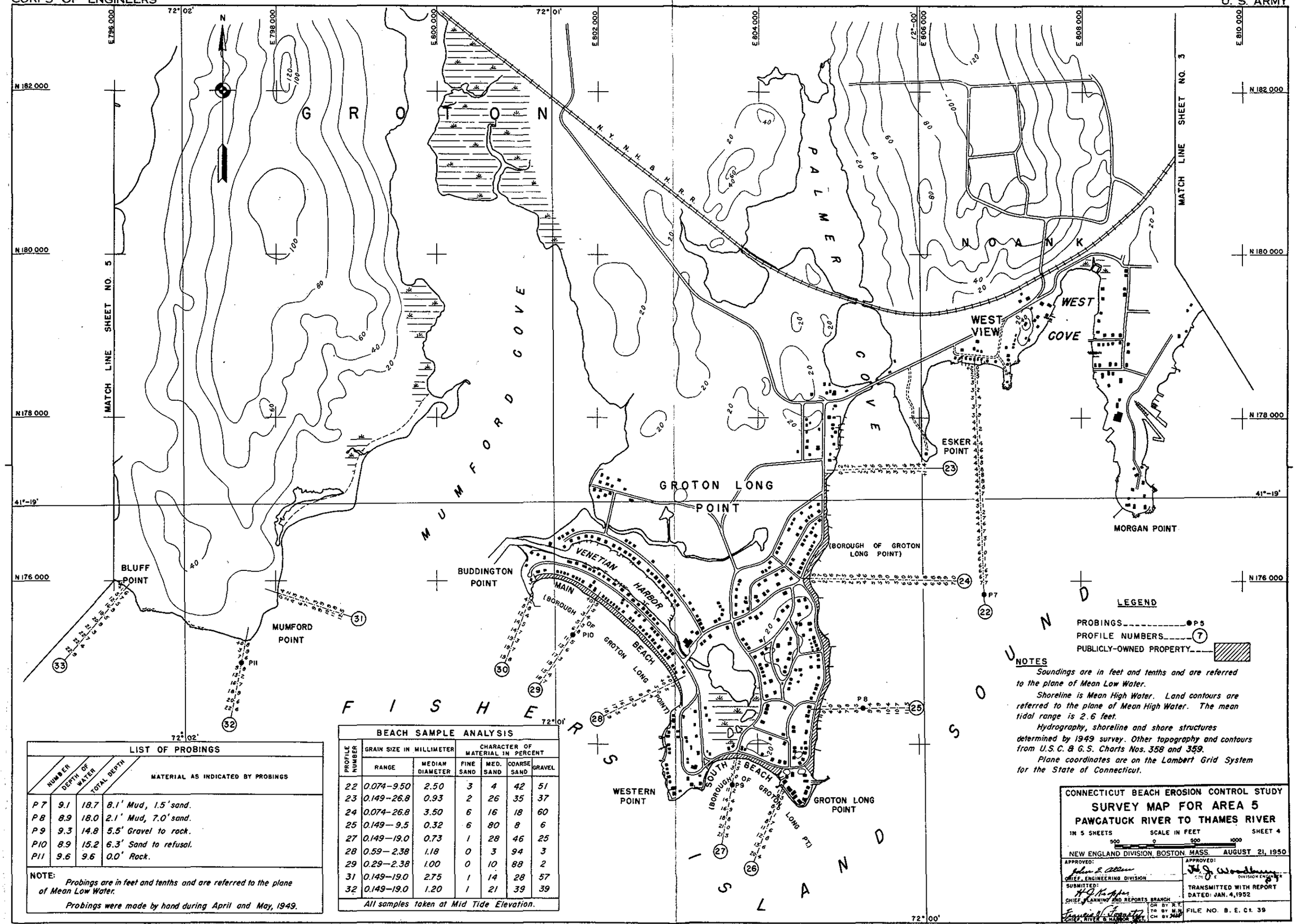
CHIEF, RIVER & HARBOR SECTION

FILE NO. B. E. Ct. 38

PLATE 13

CORPS OF ENGINEERS

U. S. ARMY




LEGEND

PROBINGS ● P5

PROFILE NUMBERS (7)

PUBLICLY-OWNED PROPERTY

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 2.6 feet.*

*Hydrography, shoreline and shore structures determined by 1949 survey. Other topography and contours from U.S.C. & G.S. Charts Nos. 358 and 359.*

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

LIST OF PROBINGS

| NUMBER | DEPTH OF WATER | TOTAL DEPTH | MATERIAL AS INDICATED BY PROBINGS |
|---|---|---|---|
| P 7 | 9.1 | 18.7 | 8.1' Mud, 1.5' sand. |
| P 8 | 8.9 | 18.0 | 2.1' Mud, 7.0' sand. |
| P 9 | 9.3 | 14.8 | 5.5' Gravel to rock. |
| P10 | 8.9 | 15.2 | 6.3' Sand to refusal. |
| P11 | 9.6 | 9.6 | 0.0' Rock. |

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

*Probings were made by hand during April and May, 1949.*

BEACH SAMPLE ANALYSIS

| PROFILE NUMBER | GRAIN SIZE IN MILLIMETER | | CHARACTER OF MATERIAL IN PERCENT | | | |
|---|---|---|---|---|---|---|
| | RANGE | MEDIAN DIAMETER | FINE SAND | MED. SAND | COARSE SAND | GRAVEL |
| 22 | 0.074–9.50 | 2.50 | 3 | 4 | 42 | 51 |
| 23 | 0.149–26.8 | 0.93 | 2 | 26 | 35 | 37 |
| 24 | 0.074–26.8 | 3.50 | 6 | 16 | 18 | 60 |
| 25 | 0.149–9.5 | 0.32 | 6 | 80 | 8 | 6 |
| 27 | 0.149–19.0 | 0.73 | 1 | 28 | 46 | 25 |
| 28 | 0.59–2.38 | 1.18 | 0 | 3 | 94 | 3 |
| 29 | 0.29–2.38 | 1.00 | 0 | 10 | 88 | 2 |
| 31 | 0.149–19.0 | 2.75 | 1 | 14 | 28 | 57 |
| 32 | 0.149–19.0 | 1.20 | 1 | 21 | 39 | 39 |

*All samples taken at Mid Tide Elevation.*

CONNECTICUT BEACH EROSION CONTROL STUDY

# SURVEY MAP FOR AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 5 SHEETS — SCALE IN FEET (500 0 500 1000) — SHEET 4

NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 21, 1950

APPROVED: John S. Allen, CHIEF, ENGINEERING DIVISION

APPROVED: J. J. Woodbury, DIVISION ENGINEER

SUBMITTED: H. G. Kaffer, CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

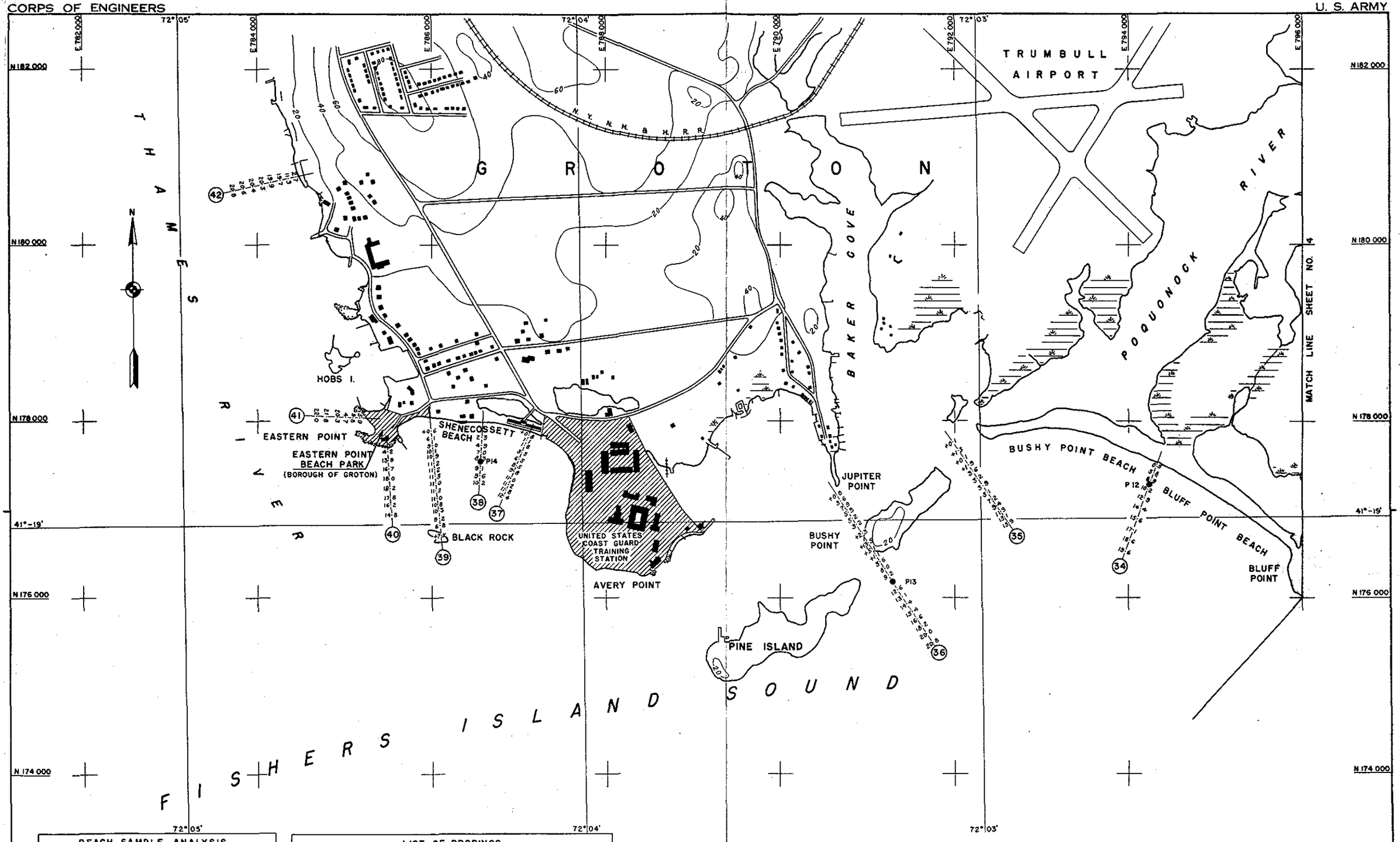
DR BY R.T. TR BY M.N. CH BY [illegible]

Francis A. Stewart, CHIEF, RIVER & HARBOR SECT.

FILE NO. B. E. Ct. 39

PLATE 14

CORPS OF ENGINEERS — U. S. ARMY




## BEACH SAMPLE ANALYSIS

| PROFILE NUMBER | GRAIN SIZE IN MILLIMETER | | CHARACTER OF MATERIAL IN PERCENT | | | |
|---|---|---|---|---|---|---|
| | RANGE | MEDIAN DIAMETER | FINE SAND | MED. SAND | COARSE SAND | GRAVEL |
| 34 | 0.074-26.8 | 11.50 | 1 | 5 | 19 | 75 |
| 35 | 0.074-26.8 | 3.40 | 3 | 22 | 20 | 55 |
| 36 | 0.074-26.8 | 4.75 | 7 | 27 | 11 | 55 |
| 37 | 0.29-9.50 | 1.25 | 1 | 4 | 60 | 35 |
| 38 | 0.149-19.0 | 1.65 | 1 | 12 | 37 | 50 |
| 39 | 0.149-26.8 | 1.10 | 1 | 34 | 20 | 45 |

*All samples taken at Mid Tide Elevation.*

## LIST OF PROBINGS

| NUMBER | DEPTH OF WATER | TOTAL DEPTH | MATERIAL AS INDICATED BY PROBINGS |
|---|---|---|---|
| P12 | 9.7 | 16.6 | 6.9' Sand to hardpan. |
| P13 | 11.0 | 17.5 | 2.9' Mud, 3.6' sand. |
| P14 | 8.7 | 18.4 | 4.1' Mud and shells, 5.6' sand. |

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

*Probings were made by hand during April and May 1949.*

LEGEND

PROBINGS ●P5

PROFILE NUMBERS (7)

PUBLICLY-OWNED PROPERTY

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 2.6 feet.*

*Hydrography, shoreline and shore structures determined by 1949 survey. Other topography and contours from U.S.C. & G.S. Chart No. 359.*

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

CONNECTICUT BEACH EROSION CONTROL STUDY

# SURVEY MAP FOR AREA 5

## PAWCATUCK RIVER TO THAMES RIVER

IN 5 SHEETS — SCALE IN FEET (500 0 500 1000) — SHEET 5

NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 21, 1950

APPROVED: John J. Allen, CHIEF, ENGINEERING DIVISION

APPROVED: [illegible], COL, C C, DIVISION ENGINEER

SUBMITTED: H. G. Kaphan, CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

Francis W. Fogarty, CHIEF, RIVER & HARBOR SECT.

DR BY R.T. TR BY M.N. CH BY [illegible]

FILE NO. B. E. CT. 39

PLATE 15

CORPS OF ENGINEERS

U. S. ARMY

G R O T O N

N O A N K

BAKER COVE

PALMER COVE

WEST COVE

FISHERS ISLAND SOUND

N180 000 N182 000 E786 000 E788 000 E790 000 E792 000 E806 000 E808 000 E810 000

N178 000 N176 000 N174 000

HOBS I.

Eastern Point

EASTERN POINT BEACH PARK (BOROUGH OF GROTON)

SHENECOSSETT BEACH

PROPOSED GROIN

PROPOSED M.H.W.

BLACK ROCK

Avery Point

PINE ISLAND

Jupiter Point

Bushy Point

LOCATION OF PROPOSED DUMPED RIPRAP WALL

LOCATION OF CONSIDERED RIPRAP DIKE

WEST VIEW

Esker Point

Morgan Point

GROTON LONG POINT

Groton Long Point

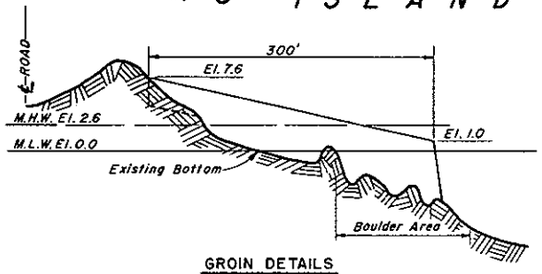
IMPROVEMENTS RECOMMENDED
WIDEN BEACH BY DIRECT PLACEMENT OF SAND FILL
GROIN 300 FEET LONG

IMPROVEMENT CONSIDERED NOT RECOMMENDED
DUMPED RIPRAP WALL 850 FEET LONG

IMPROVEMENT CONSIDERED NOT RECOMMENDED
RIPRAP DIKE 800' LONG

IMPROVEMENT CONSIDERED NOT RECOMMENDED
WIDEN BEACH BY DIRECT PLACEMENT OF SAND FILL
GROIN 340 FEET LONG

300' 850 800' 340'



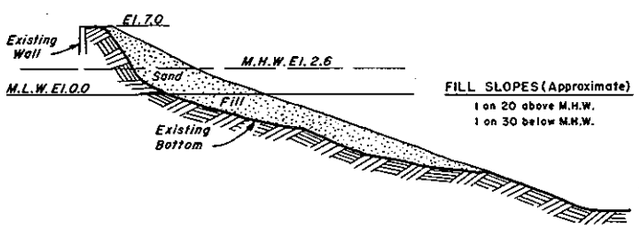

GROIN DETAILS

SECTION: Top width 5', Slopes 1 on 1.5

CORE: Quarry run stone

COVER STONES: Maximum weight 4 tons
Minimum weight 2 tons
Chinked to reduce voids

PROPOSED GROIN PROFILE

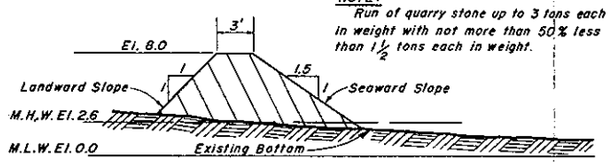



FILL SLOPES (Approximate)
1 on 20 above M.H.W.
1 on 30 below M.H.W.

TYPICAL PROFILE OF PROPOSED SAND FILL

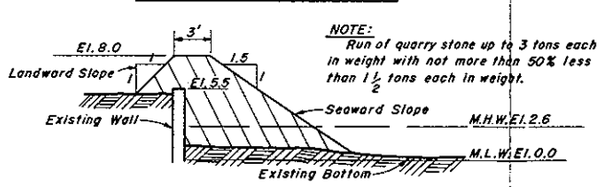
PROFILES AT EASTERN POINT BEACH PARK

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




NOTE:
Run of quarry stone up to 3 tons each in weight with not more than 50% less than 1½ tons each in weight.

PROPOSED RIPRAP WALL

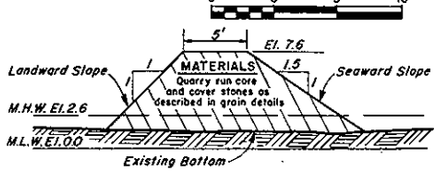



NOTE:
Run of quarry stone up to 3 tons each in weight with not more than 50% less than 1½ tons each in weight.

PROPOSED RIPRAP WALL

SECTIONS AT JUPITER POINT

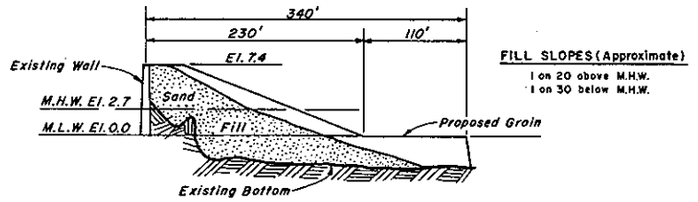
SCALE IN FEET
5 0 5 10




CONSIDERED RIPRAP DIKE

SECTION AT BUSHY POINT BEACH

SCALE IN FEET
5 0 5 10




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

GROIN DETAILS

SECTION: Top width 5', Slopes 1 on 1.5

CORE: Quarry run stone

COVER STONES: Maximum weight 4 tons
Minimum weight 2 tons
Chinked to reduce voids

PROPOSED GROIN AND SAND FILL

PROFILE AT WEST VIEW

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

NOTES

Shoreline and shore structures located by 1949 survey.

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 AREA 5

PAWCATUCK RIVER TO THAMES RIVER

IN 1 SHEET SCALE IN FEET SHEET 1

500 0 500 1000

NEW ENGLAND DIVISION, BOSTON, MASS. NOV. 1, 1951

APPROVED: John E. Allen
CHIEF, ENGINEERING DIVISION

APPROVED: H. O. Woodbury
COL., C.E. DIVISION ENGINEER

SUBMITTED: A. J. Shaffer
CHIEF, PLANNING AND REPORTS BRANCH

TRANSMITTED WITH REPORT DATED: JAN. 4, 1952

Francis W. Fogarty
CHIEF, RIVER & HARBOR SECT.

OR. BY: A.L.D.
TR. BY: A.L.D.
CH. BY: J.M.P.

FILE NO. B.E. Ct. 40

PLATE 16

FIG. 1. PAWCATUCK POINT, STONINGTON. Jan. 13, 1950. Boulder strewn west shore.

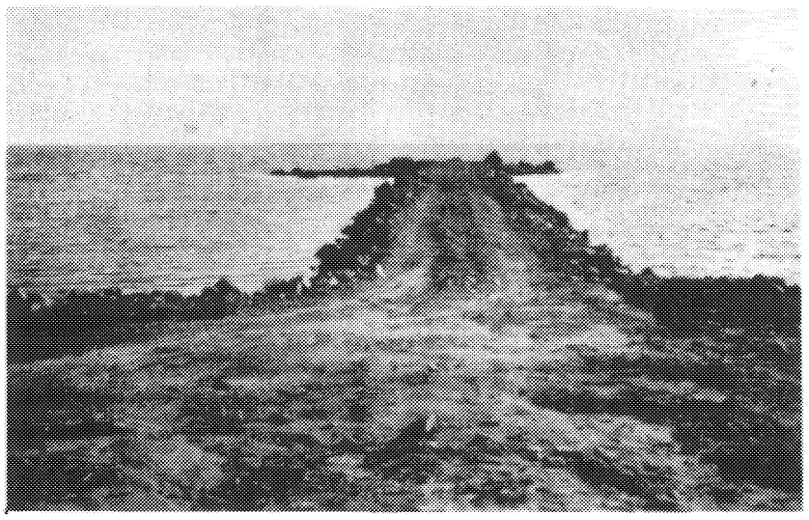


FIG. 2. STUART ESTATE, STONINGTON. Oct. 28, 1947. Newly built riprap and earth fill breakwater.

FIG. 3. BOROUGH SCHOOL, STONINGTON. Oct. 28, 1947. Coarse shore, dumped riprap revetment at sea wall.

FIG. 1. STONINGTON POINT, STONINGTON. Oct. 28, 1947. Coarse eroded east shore. Loose stone sea wall at tip of point.

FIG. 2. WAMPHASSUCK NECK, STONINGTON. Jan. 12, 1950. Sand held on south side of groins and railroad embankment.

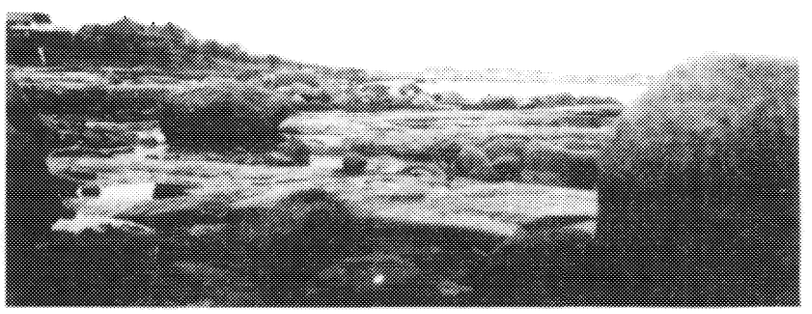


FIG. 3. WAMPHASSUCK POINT, STONINGTON. Oct. 29, 1947. Boulders and bedrock at south tip of point.

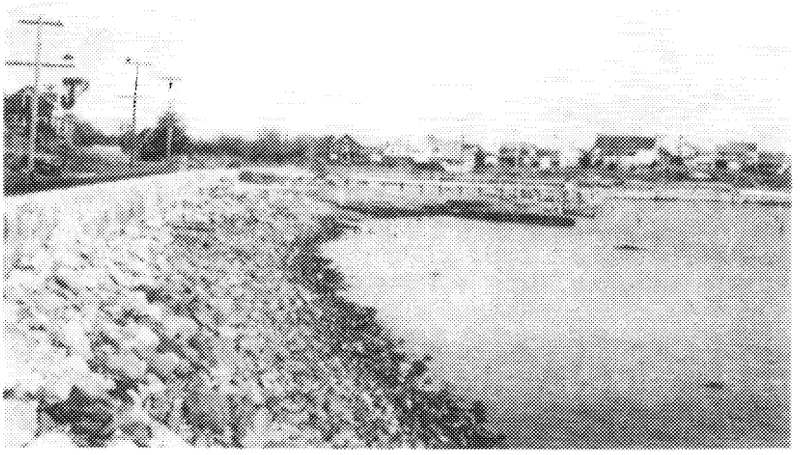


FIG. 1. LORDS POINT, STONINGTON. Oct. 28, 1947. Riprap and sea wall protect shore road along west side of cove.

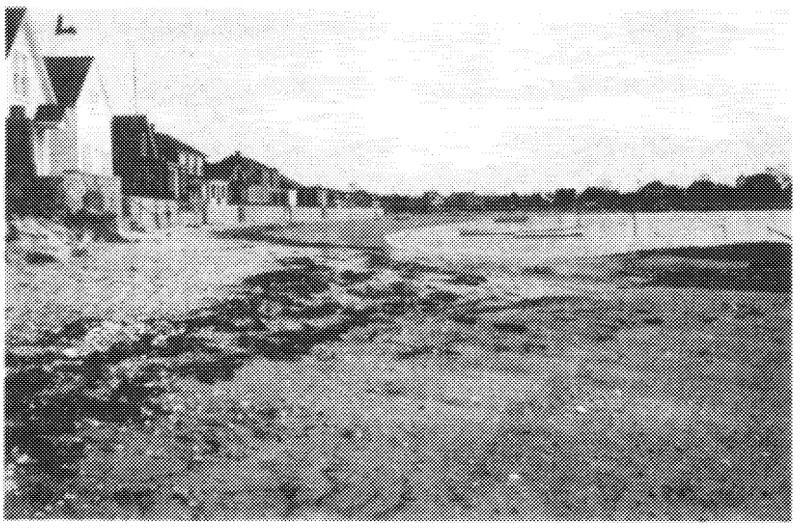


FIG. 2. WHITE BEACH, STONINGTON. Oct. 28, 1947. Sandy beach fronting sea walls.

FIG. 3. BAR WEST OF QUAMBAUG COVE. Jan. 12, 1950. Bar retreating landward over marsh.

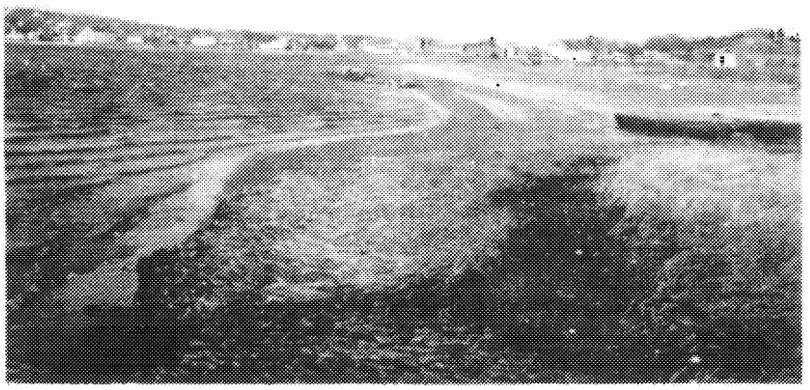


FIG. 1. WILLIAMS PARK, STONINGTON. Jan. 11, 1950. Sand bar being developed as a community recreational park.

FIG. 2. WEST VIEW, GROTON. Jan. 11, 1950. Narrow coarse beach fronting sea walls.

FIG. 3. EAST SHORE GROTON LONG POINT, GROTON. Oct. 27, 1947. Low shore area subject to flooding during storms.

FIG. 1. SOUTH BEACH, GROTON LONG POINT, GROTON. Jan. 10, 1950. Newly built sea wall protects road and low cottage area.

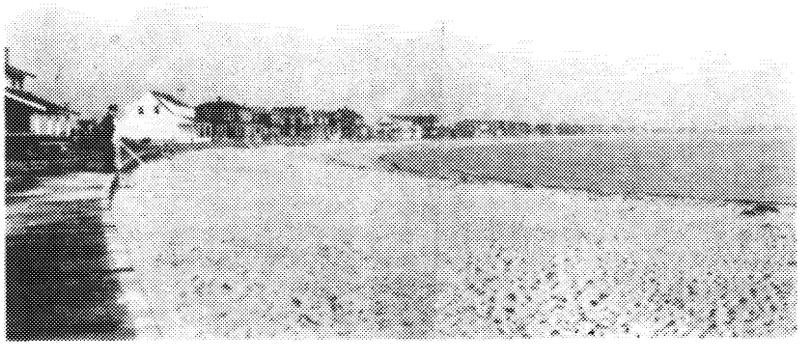


FIG. 2. MAIN BATHING BEACH, GROTON LONG POINT, GROTON. Oct. 27, 1947. Sandy bathing beach fronting wooden bulkhead and boardwalk.

FIG. 3. BLUFF POINT, GROTON. Oct. 15, 1947. Boulders left along shore from erosion of bluff.

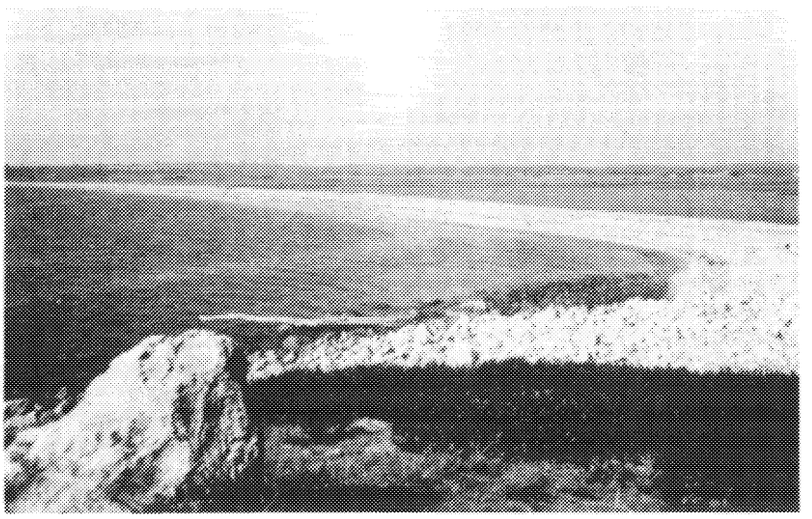


FIG. 1. BLUFF-BUSHY POINT TOMBOLO, GROTON. Oct. 15, 1947. Sandy bar connecting Bluff Point to offshore island.

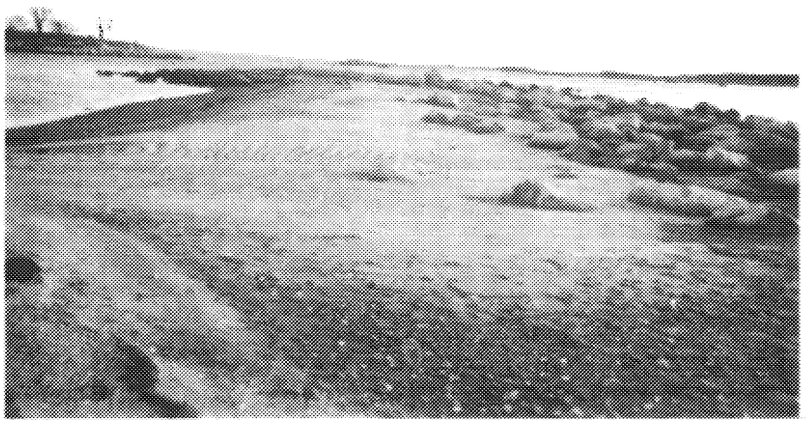


FIG. 2. JUPITER POINT, GROTON. Nov. 17, 1947. Low outer tip of point used as bathing beach.

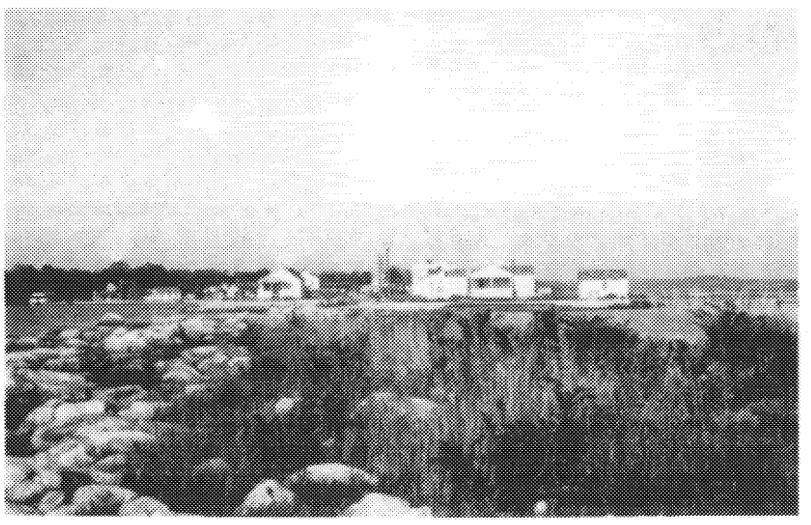


FIG. 3. JUPITER POINT, GROTON. Oct. 15, 1947. Low cottage area viewed from south tip of point.

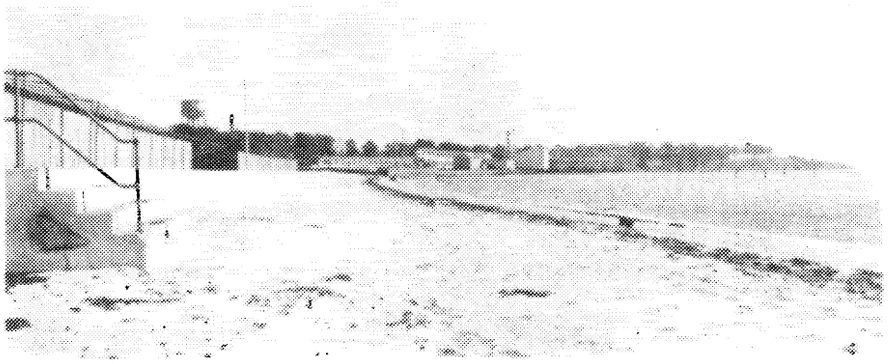


FIG. 1. SHENECOSSETT BEACH AND AVERY POINT, GROTON. Oct. 15, 1947. Sandy private bathing beach in foreground. Avery Point in background.

FIG. 2. EASTERN POINT BEACH PARK, GROTON. Jan. 9, 1950. Sandy public bathing beach at Eastern Point.

FIG. 3. EAST SHORE NEW LONDON HARBOR, GROTON. Jan. 9, 1950. Irregular bedrock shore.