SMALL NAVIGATION PROJECT

GREEN HARBOR

MARSHFIELD
MASSACHUSETTS

DETAILED PROJECT REPORT

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

APRIL 1965

REVISED

NEDED-R (7 Apr 65) 4th Ind
SUBJECT: Detailed Project Report for Small Navigation Project, Green Harbor, Marshfield, Massachusetts

U. S. Army Engineer Div, New England, Waltham, Mass. 22 Dec. 1965

TO: Chief of Engineers, ATTN: ENGCW-PD

1. The Governor of Massachusetts has been informed of the proposed project and his comments endorsing the project are included as part of the report. In accordance with ER 1165-2-14, paragraph 14(5), there are inclosed 10 copies of the final report.

2. Members of Congress were notified of formal adoption of the project by letters dated 15 December 1965. In accordance with paragraph 2 of the preceding indorsement, the date of final project approval for record purposes is 15 December 1965. The Governor of Massachusetts, interested State agencies and the Selectmen of the Town of Marshfield were notified of project approval on 17 December 1965.

1 Incl
wd incl 1
Added 1 incl
2. Revised DPR
Green Hbr, Mass. (10 cys)

E. J. RIBBS
Colonel, Corps of Engineers
Acting Division Engineer

ENGCW-PD (7 Apr 65) 3rd Ind
SUBJECT: Detailed Project Report for Small Navigation Project, Green Harbor, Marshfield, Massachusetts

DA, CofEngrs, Washington, D. C., 20315, 25 October 1965

TO: Division Engineer
New England Division

1. The revised report is satisfactory.

2. The Governor of Massachusetts should be informed of the project proposal and his formal endorsement obtained. After receipt of favorable comments fully endorsing the proposal, the proposed project for Green Harbor may be considered formally approved under Section 107 of the 1960 River and Harbor Act. Authority is then granted to issue simultaneous notification to the concerned Members of Congress and State Governor informing them of the formal project approval and adoption under Section 107. The notification should describe the project and local participation. For record purposes, the date of notification will be considered the date of final approval.

3. The Green Harbor project will take its place on the backlog of approved Section 107 projects. Funds for preparation of plans and specifications are being made available. The current backlog exceeds the amount appropriated for the Section 107 program for Fiscal Year 1966. Funding of construction will be dependent upon future appropriations by Congress. The following work allowance is established for project preconstruction planning:

Location	Code 902-	Amount
Green Harbor, Marshfield, Mass.	216	$8,000

4. Allotment of $8,000 under appropriation 96X3122 Construction, General will be provided by separate communication.

FOR THE CHIEF OF ENGINEERS:

for R. M. Sharp, Col. C.E.
JACKSON GRAHAM
Major General, USA
Director of Civil Works

Incl
3 cys w/d

NEDED-R(7 Apr 65) 2d Ind
SUBJECT: Detailed Project Report for Small Navigation Project, Green Harbor, Marshfield, Massachusetts

U. S. Army Engr Div, NE, Waltham, Mass. 02154. 14 October 1965

TO: Chief of Engineers, ATTN: ENGCW-PD

1. The comments in the preceding indorsement have been considered and all suggestions have been incorporated in the report.

2. In view of the changes involved, 10 copies of the complete report, as revised, have been assembled and are submitted herewith. The report reflects the pages that have been revised.

1 Incl
wd incl 1
Added 1 incl
as (10 cys)

E. J. RIBBS
Colonel, Corps of Engineers
Acting Division Engineer

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASS. 02154

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO. NEDED-R

7 April 1965

SUBJECT: Detailed Project Report for Small Navigation Project, Green Harbor, Marshfield, Massachusetts

TO: Chief of Engineers
ATTN: ENGCW-PD

1. In accordance with ER 1165-2-14, there is submitted for review and comment an advance draft of the subject report.

2. Responsible officials of the State of Massachusetts and the Town of Marshfield concur in the recommended project and have given firm indications that the requirements of local cooperation would be met. Formal assurances of participation will be obtained from the State and Town during preparation of final design for the project.

3. The plans and specifications will be prepared in accordance with the Detailed Project Report as approved. Funds in the amount of $8,000 for preparation of the plans and specifications and $175,000 for the Federal share of construction will be required. The local share will be $146,000 or 40% of the estimated project cost, plus all costs in excess of the Federal limit of $200,000, presently estimated to be $19,000.

4. Formal comments of the Governor of Massachusetts will be requested after approval of the advance draft.

Incl (12 cys)
as

E. J. RIBBS
Colonel, Corps of Engineers
Acting Division Engineer

ENGCW-PD (7 Apr 65) 1st Ind
SUBJECT: Detailed Project Report for Small Navigation Project, Green Harbor, Marshfield, Massachusetts

DA, CofEngrs, Washington, D. C. 20315, 24 June 1965

TO: Division Engineer, U. S. Army Engineer Division, New England
WALTHAM, MASSACHUSETTS 02154

1. The proposed report will be acceptable subject to the comments in the following paragraphs.

2. The project plan includes modification of the west jetty to provide recreational fishing facilities. Proposed legislation has been introduced in Congress, with Administration sponsorship, regarding development of recreation at projects. This proposal is contained in House of Representatives Bill numbered 5269, 89th Congress, cited as the "Federal Water Project Recreation Act." The Bureau of the Budget has advised that it expects the agencies concerned to implement immediately the policies and procedures set forth in the proposed Act. While small boat harbor projects, per se, are specifically excluded from these policies, it is considered that these policies would be applicable to provision of special facilities such as a walkway on a jetty for recreational fishing purposes. Accordingly, it is considered that the local cooperation for the jetty fishing feature of this project should be in accordance with the proposed Federal Water Project Recreational Act. This will mean that local assurances should include agreement to bear not less than one-half of the separable costs for project modifications, lands, and facilities allocated to recreational fishing from the jetty. In addition, local interests must agree to bear <u>all</u> costs of the operation, maintenance, and replacement of the facilities required for continued realization of such recreational fishing benefits. It may be stated in the report that nothing in this modification is intended to alter the position that improvement for navigation may be undertaken independently of the recreational fishing facilities on the jetty whenever funds for that purpose are available and the required local cooperation has been furnished.

3. The conditions of local cooperation should specify that the berths and marina facilities are to be provided outside the dredged project limits (to avoid any misunderstanding that they might be provided in the dredged 5-acre anchorage) and that they will be opposite the channel extension north of the anchorage to justify this channel extension.

4. A more efficient jetty seal could be obtained by using quarry spalls and making a 6-8 foot layer on the jetty slope. This material would tend to fill the voids and interlock. The seal should extend to near the top of the jetty.

5. The jetties will be extended to the 6-foot depth contour. The entrance channel, seaward of the ends of the jetties, is to be dredged to 8 feet below MLW. It is considered doubtful that a channel of more than 6 feet can be maintained without further extension of the jetties. It appears that a 6-foot channel depth would probably serve adequately except during severe storms. Therefore, provision should be made for change to maintenance of a 6-foot channel if maintenance experience on the 8-foot channel proves excessive.

6. The report does not contain supporting data or explanation for the derivation of the maintenance estimate for dredging in paragraph 79. No quantitative information is given regarding the present shoaling problem. Details of experience of local interests with maintaining the channel would be helpful in forming an opinion as to the adequacy of the estimate of an average annual maintenance requirement of 1,000 cu. yds. Based on the description of past experience, it is suspected that the maintenance estimate may be low.

7. The description of some of the proposed improvements as discussed in the report are not easily identifiable with the recommended project features.

a. In paragraph 38, the first sentence does not state whether the east or west jetty is being referred to and the reconstruction of the outer 250 feet of the existing jetty cannot be identified in the recommended project description.

b. Paragraph 78 mentions sealing 800 feet of the west jetty but Plates 1 and 2 mention sealing of 650 feet.

c. In paragraph 35 the concrete wall at the landward end of the east jetty is described as 170 feet long but it is shown as 196 feet long on Plate 1 and in paragraph 16.

d. The bedding stone is described as extending 3 feet beyond the toe of the slope in paragraph 40 but Plate 2 shows it as 5 feet.

8. The estimate of benefits from recreational craft appears in general to be reasonable for the number of locally based and prospective vessels cited but due to lack of detailed supporting data, it was not

ENGCW-PD (7 Apr 65) 1st Ind 24 June 1965
SUBJECT: Detailed Project Report for Small Navigation Project
Green Harbor, Marshfield, Massachusetts

possible to check the actual amounts of benefits claimed. The size of the anchorage proposed appears reasonable in view of the size of the locally based fleet but again, due to lack of detailed information, no check could be made of the size needed. Future reports should provide supporting data.

FOR THE CHIEF OF ENGINEERS:

Incl
4 cys w/d

CRAWFORD YOUNG
Colonel, Corps of Engineers
Assistant Director of Civil Works
for Atlantic Divisions

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASS. 02154

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO. NEDED-R

7 April 1965

DETAILED PROJECT REPORT
SMALL NAVIGATION PROJECT
GREEN HARBOR, MARSHFIELD, MASSACHUSETTS

PERTINENT DATA

1. Purpose. To determine the need and justification for providing channel and anchorage improvements within the harbor for the prospective recreational and fishing fleets.

2. Location. Within the Town of Marshfield about 35 miles by highway southeast of Boston and 9 miles north of Plymouth Harbor, Massachusetts.

3. Existing Project. No existing Federal project. No previous navigation study. State and Town constructed jetties and dredged channel.

4. Improvement Desired. (a) A safe entrance channel and adequate harbor channel; (b) additional anchorage; and (c) jetty repairs.

5. Recommended Improvement. (a) Dredging a 6-foot deep channel (8 feet at entrance), 100 feet wide extending 4,000 feet to a small turning basin at the head of navigation; (b) dredging a 5-acre anchorage, 6 feet deep at the Town pier; (c) sealing, rebuilding in part, and extending the west jetty 200 feet at elevation +12; with a dike to the beach berm at elevation +14; and (d) raising the east jetty to elevation +14.

6. Estimated Costs.

Navigation

Channels:

Dredging 125,000 c.y. @$1.50	$ 188,000
Contingencies @15%	28,000
Total Dredging Cost	$ 216,000

Breakwaters:

Extend west jetty at el. +12		
Armor and core stone 5,500 tons @$8	$	44,000
Blanket and seal 3,500 tons @$6		21,000
Raise east jetty to el. +14		
Armor stone 2,600 tons @$8		21,000
	$	86,000
Contingencies @ 15%		13,000
Total Jetty Cost	$	99,000
Total Construction Cost	$	315,000
Engineering & Design		25,000 (a)
Supervision & Administration		25,000
Total Cost (Corps of Engineers Funds & Non-Federal Contribution)	$	365,000
Aids to Navigation (Coast Guard)		26,000
Total Navigation Project Cost	$	391,000

(a) Includes $17,000 expended for project studies

Other Costs:

Jetty Sport Fishing (West Jetty)

On-project features:		
Safe walking surface & hand railing	$	5,000
Off-project features:		
Road access, parking area, sanitary facilities		20,000
Total	$	25,000
Total Project Cost - Navigation & Jetty Sport Fishing	$	416,000

7. Benefits

	General	Local	Total
Increased Recreational Boating	$ 16,650	$ 16,650	$ 33,300
Increased Commercial Fishing	10,000	-	10,000
Jetty Sport Fishing	3,000	3,000	6,000
Total	$ 29,650	$ 19,650	$ 49,300
	60%	40%	100%

An additional $13,500 in benefits from jetty sport fishing would result if safe walking surface, hand railing, road access, parking area, and sanitary facilities were provided at an added cost of $25,000.

8. Cost Apportionment

Navigation

Federal: Corps of Engineers - 60% of $365,000		$ 219,000*
Coast Guard		26,000
	Total Federal	$ 245,000

*Exceeds limit of $200,000 by $19,000

Non-Federal: 40% of $365,000		$ 146,000
~~Excess over $200,000~~		~~19,000~~
	Total Non-Federal	$ ~~165,000~~ 146,000

Jetty Sport Fishing

Federal: 50% of $25,000		$ 12,500*
Non-Federal: 50% of $25,000		$ 12,500
~~Excess over $200,000~~		$ ~~12,500~~
	~~Total Non-Federal~~	$ 25,000

*Exceeds limit of $200,000 by $12,500

R 10/65

9. Annual Charges

Navigation

Federal:	Interest & Amortization -(0.03979 x $226,000)*	$	9,000
	Maintenance:		
	Jetties		1,500
	Channel & Anchorage		3,000
	Navigation Aids		900
	Total	$	14,400

*Includes navigation aids -$26,000; excludes excess over $200,000 limit.

Non-Federal:	Interest & Amortization -(0.03979 x $165,000)		6,600
	Total Annual Charges	$	21,000

Jetty Sport Fishing

Federal:	Replacement & maintenance (safe walking, surface and railing)	$	300
Non-Federal:	Interest & Amortization (railing, road access, parking area & sanitary facilities)	$	1,400
	Total	$	1,700
	Total Annual Charges	$	22,700

10. Benefit-Cost Ratio

Navigation - $49,300/$21,000 = 2.3

Navigation & Jetty Sport Fishing -$62,800/$22,700 = 2.8

11. Requirements of Local Cooperation. In addition to (a) making the necessary 40% cash contribution ($146,000) and (b) assuming the excess over the Corps of Engineers' $200,000 limit ($19,000 without and $44,000 with on-site jetty sport fishing features), local interests would be required to:

(c) Agree to bear all costs of the operation, maintenance and replacement of off-site facilities required for jetty sport fishing;

(d) Provide and maintain berthing area, floats, piers, slips, and similar marina and mooring facilities outside of the Federal project limits as needed for transient and local vessels as well as necessary access

roads, parking areas and other needed public-use shore facilities open and available to all on equal terms.

(e)Continue to maintain and operate the existing Town pier with berthing depths commensurate with the Federal anchorage, open to all equally.

(f) Provide, without cost to the United States, title to the existing jetties and all necessary lands, easements, and rights-of-way required for construction and subsequent maintenance of the project, including suitable spoil disposal areas with necessary retaining dikes, bulkheads, and embankments therefor.

(g) Hold and save the United States free from damages that may result from construction and maintenance of the project.

(h) Provide adequate off-project facilities for jetty sport fishing.

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASS. 02154

ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO. NEDED-R

DETAILED PROJECT REPORT
GREEN HARBOR, MASSACHUSETTS

AUTHORITY

1. This Detailed Project Report is submitted under General Authority contained in Section 107 of the 1960 River and Harbor Act. Specific authority was provided by 1st Indorsement dated 3 April 1963 from the Chief of Engineers in reply to a letter dated 23 January 1963 from the Division Engineer, New England Division, Subject: "Small Navigation Project, Green Harbor, Massachusetts".

2. Specific Gongressional authority for a navigation survey study at Green Harbor was contained in Section 109 of the River and Harbor Act approved 14 July 1960, and funds were allocated for that study. However, because it appeared at the outset that the improvement desired might fit the criteria of the small navigation project program under Section 107, the study emphasis was changed to and continued under Section 107 authority.

PURPOSE AND EXTENT OF STUDY

3. The study was made to determine the need and justification for undertaking Federal navigation improvement for the prospective fishing and recreational fleets in Green Harbor. A public hearing was held at Marshfield in 1962 to obtain information concerning the improvement desired and to permit everyone in the locality an opportunity to present his views.

4. A hydrographic survey of the harbor was made during July and August, 1963. Data needed for the study, in addition to that presented at the public hearing, was obtained from field investigations and from information submitted by local interests. All Federal, State and local agencies known to be interested or affected by improvement of the harbor were consulted. Conferences were held with local officials to discuss considered improvements and the attendant requirements of local cooperation.

DESCRIPTION

5. Green Harbor is a small tidal estuary on the west side of Massachusetts Bay, approximately 35 miles by highway southeast of Boston, Massachusetts. It is located within the Town of Marshfield in Plymouth County and situated at the mouth of the Green Harbor River, a small stream draining marshlands to the northwest. The Green Harbor marshlands were originally fresh water or brackish marshes whose elevations were lowered due to compression of the peat and silt caused by retrograding sand bars, which enabled sea invasion through breaks in the bars.

6. Green Harbor is one of eight small boat harbors located along a 45 mile stretch of coastline between Boston Harbor and the Cape Cod Canal. Five harbors, which have been improved for navigation by the Federal Government are Cohasset, Scituate, Duxbury, Kingston and Plymouth. The latter three harbors are situated relatively close to each other within a large bight about 6 miles south of Green Harbor. Scituate and Cohasset Harbors lie approximately 9 and 14 miles to the north of Green Harbor, respectively. New Inlet, 7 miles north of Green Harbor, and Ellisville Harbor, 4 miles north of the Cape Cod Canal, have been improved by local interests. A Federal beach erosion project exists at Brant Rock Beach just north of Green Harbor in Marshfield. A cooperative beach erosion control study of the shore between Pemberton Point and Cape Cod Canal, Massachusetts, which included the shoreline at Green Harbor, was reported on in July 1957.

7. The entrance to Green Harbor is protected by two stone mound jetties having an arrowhead configuration with a navigation opening of about 250 feet at the outer ends. The east jetty is 750 feet long and the west jetty is 1,350 feet long. The jetties have a top width of about 5 feet, an elevation ranging from about 7 to 12 feet, and side slopes varying from 1 on 1 to 1 on 4. The harbor extends 3/4 mile inland from the jetty entrance northwesterly, to an earth-concrete dike equipped with tide gates. The dike marks the head of navigation and carries State Route 139 across the harbor. Approximately 1,000 feet inland from the ends of the jetties, the harbor constricts to a channel about 100 feet in width at mean high water.

8. The harbor entrance is exposed to a limited extent to winds and waves from Cape Cod Bay to the southeast. The predominant directions of wave approach are from the east and east-northeast from which ocean waves are generated over long fetches. Cape Cod limits the fetch for directions of east to south-southeast. United States Weather Bureau wind records for Boston for the 7-year period from October 1949 to September 1956 show prevailing winds to be from a westerly direction with predominant on-shore winds to be from the east to northeast. The alignment of the jetties and the shoreline configuration of the harbor entrance provide for well protected waters within the harbor proper.

9. The beach erosion report for the shore between Pemberton Point and Cape Cod Canal states that littoral materials are carried from the Scituate area along the shore by an apparent southerly drift forming continuous beach bars as far south as Brant Rock where the materials take to sea and continue south to form the Duxbury Beach tombolo. However, at some point between Green Harbor and Duxbury Beach the direction of littoral drift is reversed, i.e. in a northerly direction, resulting in accretion of materials along Green Harbor Beach, which extend southerly of the harbor entrance.

10. At mean low water most of the harbor becomes exposed mud flats. The remaining area consists of several acres of anchorage near the Town pier (dredged to a depth of 6 feet by the State of Massachusetts in 1958) and a narrow, shoal, and winding natural waterway extending from the entrance to the head of navigation. The controlling depth in the waterway is taken as 6 feet in the entrance channel and mean low water within the harbor channel. The harbor is used by 20 full-time and 12 part-time lobster boats and about 290 recreational craft.

11. The mean range of tide is 9.0 feet. The spring tide range is 10.5 feet. The locality is shown on U.S. Coast and Geodetic Chart No. 245, U.S. Geological Survey Map (Duxbury Quadrangle), and on the maps accompanying this report.

TRIBUTARY AREA

12. The area immediately tributary to Green Harbor is the community of Marshfield. The population of Marshfield in 1960

was 6,748, an increase of 107 percent over the 1950 figure. It is one of a number of small towns in Plymouth County (1960 pop. - 248,449), which utilize the boating facilities of the small coastal harbors such as Green Harbor. Recreational boating enthusiasts of the metropolitan area of Boston further increase the total summer population of the Green Harbor area. Marshfield is a shopping and commercial center for an area devoted primarily to farming, some commercial fishing, recreational boating and other vacation travel activities. There are two beaches at Green Harbor, the 2,700 foot long Brant Rock Beach laying about 1-1/2 miles north of the harbor entrance, and the 3,000 foot long Green Harbor Beach extending south of the entrance.

13. State Route No. 3, an expressway extending from the Boston perimeter Route 128 to Cape Cod, lies about 7 miles to the west of Green Harbor. State Route 139 leads from Route 3 to the harbor. Federal Route 44 carries traffic easterly from eastern Rhode Island and southern Massachusetts. Bus service is available to Marshfield from nearby cities.

BRIDGES

14. No bridges span the navigable waterway between the harbor entrance and the dike, the head of navigation.

PRIOR REPORTS

15. Green Harbor has not previously been the subject of a Federal navigation study.

OTHER IMPROVEMENTS

16. The Town of Marshfield and the State of Massachusetts have provided and maintained harbor improvements periodically for over 60 years. The stone mound jetties were constructed by the State in 1898-99 and have been repaired and reconstructed periodically since that time. Approximately the same time as jetty construction, the State built a timber bulkhead extending about 650 feet inland of the landward end of the west jetty. This bulkhead also has been maintained and extended since that time. In 1931 the State constructed 196 feet of concrete wall at the landward end of the east jetty, in an effort to prevent the loss of beach materials from Brant Rock Beach into the harbor entrance.

17. In addition to the above improvements to stabilize the entrance channel, the State has performed maintenance dredging of a channel 6 feet deep, 60 feet wide, extending about 2,000 feet into the harbor to the Town pier. The entrance channel was last dredged in December 1964. The State has provided approximately 4 acres of anchorage, 6 feet deep adjacent to the Town pier. The Town of Marshfield constructed the pier several years ago. The Town and State have appropirated funds, equally, for construction of a bulkhead on the easterly side of the harbor, extending from the dike road toward the Town pier. Construction of this bulkhead has been initiated. Replacement of the nearly inoperative old tide gates was accomplished in March 1965. The Town also appropriated and expended about $5,000 to a private engineering firm for a master plan study concerning the overall harbor needs.

TERMINAL AND TRANSFER FACILITIES

18. The major terminal facility in the harbor is the Town pier located at the end of Central Street in the village of Brant Rock. The facility is a bulkheaded, earth-filled landing and parking area about 290 feet wide and extending 210 feet into the harbor. A multiple T-head type structure of timber and wood piling extends along the concrete, gravity wall bulkhead, and presents a berth frontage of about 230 feet. The parking area was recently expanded by filling the marsh area immediately north of the Town pier with spoil materials from State maintenance dredging (Dec 1964) in the channel. The additional parking area involved is 375 feet by 200 feet, retained by an earth dike. The Town pier is used by both recreational craft and commercial lobster boats.

19. A smaller shore facility - Taylor Marine Service - is located just south of the Town pier. This facility offers boat storage, service and minor repairs and is used to a large extent as a lobster landing terminal. There is a small earth ramp adjacent to the terminal for launching and hauling boats.

20. A new terminal facility for recreational craft was developed in 1964 on the south side of the harbor near the head of navigation. Green Harbor Marina includes a boat storage building, a boat repair and service shop, and two 120-foot long finger piers with a total of about 45 wet berths. The access apron extends approximately 20 feet beyond the ends of the piers and has been dredged to 5 feet. The marina development plans call for a total of six piers with a final length of 200 feet.

IMPROVEMENTS DESIRED

21. At the public hearing held in Marshfield on 17 April 1962, the requests of local interests for navigation improvements consisted essentially of: (a) an entrance channel and a harbor channel of adequate width and depth; (b) additional anchorage, and (c) repairs to the jetties.

22. Local interests, including State and Town agencies and private individuals have shown by maps, photographs, questionnaires, local navigation studies and other data that justification exists for their requests for improvements. The improvements considered in this report are basically the same as those desired by local interests.

EXISTING AND PROSPECTIVE COMMERCE

23. Most of the commerce of the harbor results from 20 full-time and 12 part-time lobster boats. The average annual lobster landings for the years 1957-61 inclusive was 217,835 pounds valued at $108,918. The U. S. Fish and Wildlife Service has reported that the harbor improvements under consideration would permit a moderate expansion of the fishing fleet. However, they state that the inshore fishing grounds would sustain no more than about a 5 percent increase in the catch even with an increase in the number of lobster men, boats, pots or fishing time. A 5 percent increase, 10,892 pounds, would be valued at $6,600, at current prices of 60 cents per pound.

24. The U. S. Fish and Wildlife Service reports also, that channel and harbor improvement would provide an opportunity for expansion of the modest gill-net and dragger fishery which now exists. The expected increase would result from replacement of several of the existing lobster boats with larger vessels or conversion to other fishing methods during periods when not engaged in lobster fishing. The increase is estimated at 100,000 pounds valued at $10,000

25. Also, they report the possible future development of an off-shore deepwater lobster fishery - Green Harbor could provide adequate landing and anchorage facilities for off-shore lobster boats if improvements are made.

VESSEL TRAFFIC

26. Present boat traffic consists of trips by the 32 full and

part-time lobster vessels and by approximately 290 recreational craft. The loaded draft of the lobster boats and of the larger recreational power cruisers is about 4 feet. The lobster boats make daily trips over a net season of about 235 days, excluding bad weather days, boat repair days, etc. The recreational boating season is taken to be 120 days. In the event of harbor improvement, boat traffic would be greatly increased as a result of the expected large prospective recreational fleet. The increase in the size of the commercial fishing fleet is expected to be small.

DIFFICULTIES ATTENDING NAVIGATION

27. The navigation difficulties are: (1) a shifting and shoal entrance channel due primarily to the passage of littoral materials through, around, and over the west jetty, and to a lesser extent to settling out of sandy materials carried seaward from the inner harbor by tidal currents; (2) a crooked, narrow, and shoal harbor channel which limits boat access to upper harbor areas to periods of high tide; (3) insufficient anchorage and berthing space for the expanding recreational fleet; (4) an exposed entrance channel due in part to the overtopping of the damaged east jetty by waves approaching from the northeast and east; and (5) strong tidal currents at the "narrows" making for hazardous navigation conditions. There are no records of specific grounding or accidents involving vessel damages for which monetary benefits could be applied.

WATER POWER AND OTHER SPECIAL SUBJECTS

28. There are no apparent problems pertaining to water power, flood control, pollution, or related subjects involved in this report. The U. S. Fish and Wildlife Service has reported that improvement of the west jetty would result in benefits to the sport fishery.

PLAN OF IMPROVEMENT

29. A plan of improvement has been developed which represents essentially the desires of local interests. The plan of improvement selected would provide for:

a. A channel, 6 feet deep, 100 feet wide and about 4,000 feet long extending from deep water to the head of navigation with the seaward 600 feet deepened to a depth of 8 feet. A small turning basin would be included at the upstream limit of the channel.

b. An anchorage, 5 acres, 6 feet deep at the Town pier (includes the 4-acre area dredged by the State).

c. Rebuilding the outer 200 feet and sealing the outer 650 feet of the existing west jetty, and extending it 200 feet, at an elevation of +12. The extension would consist of a sand-tight core protected by armor stone. The seal would extend at an angle from Sta. 8+00 shoreward about 200 feet to the beach berm.

d. Raising and maintaining the east jetty to an elevation of +14 for its length of 650 feet.

30. One of the major navigation problems of the harbor results from shoaling within the entrance channel. There is an apparent net southerly littoral drift along the 30-mile coastal section from Pemberton Point to Gurnet Point, but with local reversals and variations. For instance, from some point several miles south of the west jetty at Green Harbor, the net littoral drift is from south to north, which has resulted in accretion of Green Harbor Beach. This reversal of littoral direction is probably due to southeasterly storms and also to refraction and diffraction of easterly storm waves around the Brant Rock Point headland and the entrance jetties, respectively. There is little or no accretion of materials along the Brant Rock headland. In fact, the public beach at Brant Rock, situated about $1\frac{1}{2}$ miles north of the Green Harbor entrance, has been subject to erosion over a long period of time. Groins have been constructed along the Brant Rock shores in an attempt to retain an adequate beach. North of Brant Rock Beach, the littoral drift is again south to north as evidenced by the accretion of the Humarock and Fourth Cliff beach extension.

31. The northerly littoral drift of materials from south of the west jetty is considered to be the major cause of shoaling in the entrance channel, as the materials pass through the existing jetty. Over the years, this passage of sand through the voids has accumulated to an extent where the sand now passes over and around the end of the jetty as well as through it. A comparison

of the mean low and mean high water lines on the map accompanying this report reveals the shoaling which takes place along the channel side of the jetty for practically its full length. This passage of the littoral materials has been substantiated by field inspection and by local information.

32. Another cause of shoaling within the harbor entrance appears to be the deposition of suspended materials carried seaward from the inner basin by the ebb tide and fresh water discharge. This deposition occurs along the northerly side of the entrance just seaward of the 'narrows' where the tidal velocity rapidly decreases from that at the 'narrows', resulting in a settling out of materials.

33. A third source of shoaling material is considered to be the sands lying landward of the timber bulkhead along the southerly side of the entrance, particularly opposite the 'narrows'. Flood tides and/or rains create a saturated condition behind this broken and porous barrier, which results in 'flotation' of the materials. The strong ebb currents at and in the vicinity of the 'narrows' then cause a 'piping' of these buoyed materials through the broken timber bulkhead and the voids of the jetty and carry them seaward.

34. A large shoal located in the center of the entrance just inland of the ends of the jetties, which is exposed at low tide, is attributed somewhat to the scouring action of the ebb and flood tides on the channel bottom. While this type of shoal is common in many coastal, jetty-stabilized inlets, the extent of the Green Harbor shoal is excessive. Therefore, most of this shoal is considered to be the result of the aforementioned causes.

35. The foregoing information indicates that a need exists for sealing and extending the west jetty. Because of the amount of littoral materials passing through or around the east jetty is comparatively small, there appears to be no need for making it sand tight or extending it. A concrete wall about 196 feet long at the landward end of the east jetty aids in trapping any littoral drift toward the channel.

36. There are several areas along the east jetty which are in substantial disrepair and are awash under mean high water conditions. Field observation and statistical records indicate that 8 to 10-foot waves from the northeast to east - the most exposed direction-break with appreciable frequency and duration on the jetty. The damaged sections are composed chiefly of 1 to 2 ton stone, which is inadequate to withstand the aforementioned wave action. The sections with stone generally in excess of 4 tons have maintained essentially stable elevations and slopes but are overtopped by some 4 to 6 feet by waves.

37. It is considered the east jetty should be raised to elevation +14 using stone sizes sufficient for slope stability and to reduce overtopping. The size of stone could be graduated from smaller to larger stone extending seaward, from the shore, because of the varying severity of wave action. The elevation +14 has been selected because it would permit placing the additional stone needed on top of the existing stone. An elevation of +12 was considered, but because the additional stone is such a relatively large size as to require reconstruction of the existing jetty stone, the higher elevation of +14 was considered incrementally more economical and much more effective as a channel protective structure.

38. The top elevation of the outer 250 feet of the existing west jetty ranges from +11.5 to +6.4. In order to provide for an effective structure, the Federal project developed in this report provides for reconstructing the outer 250 feet of the existing jetty to elevation +12, sealing the outer 650 feet of the existing jetty by means of a blanket of quarry spalls 6 to 8 feet thick on the landward slope to prevent passage of sand through the jetty; for a 200-foot extension of the west jetty; and for construction of a dike of quarry spalls to the beach berm at elevation +14 feet. Repairing the inshore 800 feet of the west jetty, including the 650 feet lying along the timber bulkhead, does not appear necessary. The amount of materials that has been lost since jetty construction, as a result of sand passage through the bulkhead and jetty, is comparatively minor. Consideration was given to providing some type of retaining wall or stone filter blanket along this jetty reach to prevent the further movement of sand into the channel. However, the cost of providing the most economical and effective retaining structure would be too high to warrant the expenditure, particularly in view of the small quantity of sand that can reach the channel over the years. Additionally, if the seaward 650 feet of the jetty is made sand tight and a dike extended from the jetty to the beach berm, it is expected that a sand fillet would develop at the juncture of the jetty with the beach, which would be concave landward and serve to reduce substantially any wave action at this point. This would permit accretion, by winds and rains, of materials along the timber bulkhead not subject to wave run-along.

39. The west jetty extension would be to the 6-foot depth contour and is considered necessary to reduce the littoral drift now passing around the end of the jetty into the entrance channel. Consideration was given to extending the jetty to the 8-foot depth contour; however, the additional impounding capacity to be obtained would not be sufficient to warrant construction of the costly additional 200 feet of extension involved. Jetty extension to the 6-foot depth contour is expected to provide adequate impoundment capacity over the project life, and would facilitate maintaining a depth of 6 feet in the entrance. In view of existing conditions at the mouth where depth in

excess of 6 feet are generally available, it is considered that an 8-foot depth could be provided more economically by dredging than by extension of the jetties to the 8-foot depth.

40. The west jetty extension would consist of a sand-tight core of 1-500 lb. stone, a secondary layer of 500 to 1,000 lb. stone, all protected by a single thickness of 5-6 ton armor stone. A bedding blanket, 2 feet in thickness and consisting of 1-50 lb. quarry spalls would be required under the jetty stone. The bedding should extend 5 feet beyond the toe of slope. A typical cross-section of the jetty extension is shown on the map accompanying this report.

41. An elevation of +12 has been selected for the proposed extension as the primary purpose of the extension is to increase the beach impoundment capacity rather than serve as protection against waves. The 5-6 ton armor stone would be adequate to stabilize the jetty against northeast storms-the worst condition - and overtopping by waves from that direction would not present a problem. The extension should line up with the seaward end of the existing jetty. The top width would be 6 feet.

42. The waterway of the harbor entrance and within the inner harbor is very shoal. A channel is needed to provide access to the Town pier and to facilities at the head of navigation. Based upon the type and size of vessels expected to use the waterway, a channel 6 feet deep and 100 feet wide extending from the harbor entrance to the head of navigation with a small turning basin in the latter area, would be adequate. However, because of the relatively exposed conditions at the entrance, an additional 2 feet of channel depth should be provided. Therefore, the improvement includes dredging the seaward 600 feet of channel, 8 feet deep.

43. The proposed channel would permit ready access to the Town pier and upper harbor facilities. However, at present the available berthing and anchorage area is very limited. The State has dredged about 4 acres of anchorage, 6 feet deep, at the Town pier. Berths or anchorage at the head of navigation having sufficient depth are inadequate. Consideration was given to providing Federal anchorage to accommodate the large prospective recreational fleet. But the cost of the required anchorage, which would involve dredging primarily exposed marshes (+2 to +8 feet above mlw) over an extensive area of the harbor, would be too high to justify construction. Provision of a smaller anchorage would not allow for full fleet expansion. Therefore, to insure that the proposed Federal channel be utilized to the full intended extent, it should be required that local interests provide any necessary berthing facilities.

44. Local interests have already indicated an awareness of the marina need. The Town of Marshfield recently expended about $5,000 to a private engineering firm for a harbor development study. The ensuing report

indicated the need for a marina. Local interests concur with the report findings. Also, a new facility, the Green Harbor Marina, has already provided two 120-foot marina piers with slips for 45 boats. The company plans to construct a total of six such piers, 200 feet long. This facility alone is expected to provide berths for that part of the existing fleet not now accommodated, the 50 immediate new boats expected shortly after improvement, and a substantial part of the gradual fleet growth as it materializes.

45. Dredging the access channels, berthing slips, and approaches needed for the marina would increase the tidal prism somewhat resulting in an increase in the tidal current at the "narrows". However, this relatively small increase would be more than offset by a reduction in tidal velocity at this point resulting from the proposed channel widening.

46. A 5-acre Federal anchorage is proposed for the vicinity of the Town pier, which represents a small increase in size over the present State anchorage, and is expected to benefit transient visiting craft to a large degree, as public shore facilities and services will be available at the Town pier.

47. The channel width at the "narrows" was about 30 feet between the mean low water contours in 1958 before it was dredged by the State. Channel dredging by the State in 1958 opened the channel width to 60 feet at this point. Hazardous navigation conditions exist at the "narrows". Widening the channel to 100 feet would alleviate the excessive currents and also reduce the velocity differential between this area and the sediment drop-out area just downstream.

48. The United States Fish and Wildlife Service has reported that an increase in benefits would accrue to the sport fishery through repair and extension of the west jetty. The plan of improvement includes reconstruction of the east jetty to an elevation of +14, i.e. about 5 feet above mean high water - considered adequate for fishing. However, restrictions concerning the road access to the jetty site, lack of sufficient land for parking, and the extent of private properties bordering the shores, are considered to be deterrents to increased sport fishing from the east jetty.

49. The U.S. Fish and Wildlife Service estimates the present average annual fisherman-use of the west jetty to be 3,000 fisherman-days. They state that the proposed jetty sealing and extension would result in an increase to 7,000 fisherman-days, without additional improvements such as a safe walking surface and parking facilities.

50. If a safe walking surface with hand railing, road access, parking and sanitary facilities are provided, sport fishing from the west jetty would amount to about 22,000 fisherman-days annually, representing a net

increase of 22,000-7,000, or 15,000 fisherman-days attributed to jetty modification for fishing. Modification of the west jetty to provide for a safe walking surface would involve chinking the surface voids having excessive vertical variation with rock or concrete, and providing a hand railing. The railing would consist of reinforced concrete or wrought iron posts with holes at the top ends to receive a chain or cable railing.

51. The above plan of improvement was selected as the one providing the most effective and economical corrective measures for the navigation difficulties of the harbor, and are generally as desired by local interests.

SHORELINE CHANGES

52. Sealing and extending the west jetty will increase its impoundment capacity and result in additional accretion of beach materials along the northerly end of Green Harbor Beach. Other than this limited beach widening, no shoreline changes are anticipated. Raising the east jetty would not affect the shoreline.

REQUIRED AIDS TO NAVIGATION

53. The U.S. Coast Guard has been consulted and has advised that three unlighted buoys and two single fixed lights would be required if Green Harbor is improved. The first cost of the additional navigation aids would be $26,000, with additional annual maintenance of $900.

ESTIMATE OF FIRST COSTS

54. The first cost is given below for the improvement recommended in this report. Federal work consists of dredging a 6 and 8-foot channel and anchorage, extending the west jetty, and raising the east jetty. The U.S. Coast Guard will provide the necessary navigation aids. Local interests will provide spoil disposal areas.

55. The stone required for the jetties can be obtained locally and trucked or barged to the job site and placed by dumping and by crane. Probings indicate the material to be dredged includes mud, clay, sand and gravel. Dredging quantities are in terms of in-place measurement and include an allowance of one-foot for overdepth and side slopes of 1 vertical and 3 horizontal. Unit prices for dredging are based on the use of hydraulic equipment with materials to be pumped to nearby spoil sites. Cost estimates are based on prices prevailing in March 1965. Contingencies are about 15 percent. The detailed cost estimate is as follows:

PROJECT COST ESTIMATE

Cost Account No.	Item	Cost Estimate (March 1965)
09	Channels:	
	6 & 8' x 100' x 4,000' channel & 5-acre anchorage 6 feet deep: 125,000 c.y. @$1.50	$ 188,000
	Contingencies @15%	28,000
	Total Dredging	$ 216,000
10	Breakwaters:	
	(a) Seal & extend west jetty at Elev. +12:	
	Armor & core stone -5,500 tons @$8	44,000
	Blanket & seal - 3,500 tons @$6	21,000
	(b) Raise east jetty to +14:	
	Armor stone-2,600 tons @$8	21,000
		$ 86,000
	Contingencies @15%	13,000
	Total Jetty Cost	$ 99,000
	Total Construction Cost	$ 315,000
30	Engineering & Design	25,000 (a)
31	Supervision & Administration	25,000
	Total Cost (Corps of Engineers & Non-Federal Contributions)	$ 365,000
	Aids to Navigation (Coast Guard)	26,000
	Total Project Cost	$ 391,000

(a) Includes $17,000 expended for project studies.

OTHER	Jetty Sport Fishing -(West Jetty)	
	On-project features:	
	Safe walking surface & handrail	$ 5,000
	Off-project features:	
	Parking area (25 cars), access road & Sanitary Facilities	20,000
	TOTAL COST	$ 25,000

ESTIMATE OF ANNUAL CHARGES

56. Annual charges for the improvement have been computed using a project life of 50 years. The Federal and non-Federal interest rates are 3-1/8%. Maintenance costs are based on experience with similar projects. Repairs to the jetties are expected to be required every 10 years involving 1,500 tons of stone. (See Section titled "Operation and Maintenance").

57. Making the west jetty sand-tight and extending it is expected to substantially reduce the major source of shoaling in the entrance channel. However, some shoaling is expected in the entrance channel as a result of inner basin sediment washing seaward and from scouring action by tides at the mouth. It is estimated that maintenance work will be needed every 10 years to restore project channel depths throughout its entire length and also in the anchorage. The maintenance will involve the removal of 25,000 cubic yards each time. Additional maintenance will be required for sport fishing facilities on the west jetty. It is estimated that the handrail chain or cable would require replacement about 5 times during the project life, at a total cost of $5,000. Reduced to an annual cost, this would average $100 per year. Maintenance of the jetty top surface and the handrail posts would involve an additional $200 per year. All maintenance costs for facilities on the jetty for sport fishing would be borne by the United States. All costs for the operation and maintenance of supporting facilities for recreational fishing would be borne by local interests. The total annual charges for the improvement are shown below.

Federal Annual Charges

NAVIGATION

Interest & Amortization (0.03979 x $226,000)*	$	9,000
Maintenance:		
Jetties	$	1,500
Channel & Anchorage		3,000
Navigation Aids		900
	$	14,400

*Corps of Engineers' limit under Section 107 is $200,000.

Aids to Navigation $26,000; Total $226,000.

Non-Federal Annual Charges

Interest & Amortization (0.03979 x $165,000)	$	6,600
Total Annual Charges (Navigation)	$	21,000

Federal Annual Charges

Interest & Amortization	$ 0
Replacement & Maintenance:	
(Safe walking surface & railing)	300
	$ 300

Non-Federal Annual Charges

Interest & Amortization (0.03979 x $25,000)	$ 1,000
Maintenance:	
(Road access, parking area & sanitary facilities)	400
Total Non-Federal	$ 1,400
Total Annual Charges (Jetty Sport Fishing)	$ 1,700
Total Annual Charges (Navigation & Jetty Sport Fishing)	$22,700

ESTIMATE OF BENEFITS

58. Improvement of the navigation facilities at Green Harbor would result in increased recreational boating and additional commercial fishing. Benefits to these interests would result from safe and ready access to the harbor and its present and proposed facilities, enlarged and improved anchorage facilities, reduced tidal delays, and increased efficiency of operation.

59. Most of the estimated benefits would accrue to recreational boating. These benefits have been computed on the basis of annual net return to the owners if the boats were "for hire". The ideal percent return is considered the maximum return that could be obtained with full unrestricted use of the harbor. Generally, the net return varies with the type and size of the boat.

60. The locally-based recreational fleet is estimated to consist of 290 craft. Nearly one-half of these boats are of the outboard-inboard class, of which many are launched in the morning and hauled out in the evening. However, a net gain in percent return was taken for these

shallow draft vessels as well as the larger cruiser, because of the zero controlling depth and the restricted mooring conditions. Benefits to the local fleet have been estimated to amount to $5,700 after a proper reduction for time on cruise.

61. The recreational boating industry is increasing steadily throughout the nation. Expansion of the fleet at Green Harbor, however, has not kept pace with the national rate of increase, or with that of its nearby small boat coastal harbors, due to an inadequate entrance channel and insufficient anchorage and berthing area. If harbor improvements were undertaken to provide for a safe entrance channel and anchorage and marina facilities, the fleet would grow rapidly with a substantial portion of the growth taking place shortly after improvement. Like many other recreational type harbors, Green Harbor has a list of boat owners awaiting berthing or mooring spaces. The early fleet growth is not expected to be such as to typify the accumulated growth curve. It appears more reasonable to consider the addition of a number of new craft immediately after improvement with the remainder of the prospective fleet considered on the basis of normal growth. The number of new craft to be added soon after improvement has been taken as 50, and the corresponding benefits estimated to be $9,000.

62. The growth of recreational boating at nearby small boat harbors, as a result of navigation improvements, has been considered in determining the probable prospective fleet for Green Harbor. In addition to the 50 new craft to be added to the existing fleet of 290 boats, a prospective fleet of 350 new boats is expected to base at or use the improved harbor facilities by the end of the 50-year project life. The additional prospective fleet represents approximately 7 boats per year and appears reasonable. Benefits for this fleet have been computed to be $47,600 at the end of 50 years. The average annual equivalent benefits are $47,600 x 0.391 or $18,600.

63. The number of boats transferring to Green Harbor from nearby harbors is expected to be small, as the latter harbors have been improved in recent years and appear to accommodate overlapping tributary areas because of their relative closeness. However, a small number of visiting craft to Green Harbor is anticipated, particularly in view of the proposed anchorage adjacent to the Town pier. But the corresponding number of equivalent locally-based craft with the contingent benefits would be relatively small and have not been included in the overall benefits.

64. The U. S. Fish and Wildlife Service has been consulted on the expected increase in lobster catch which could result from navigation improvements. They reported that the proposed improvement would permit a moderate expansion of the inshore lobster fishing fleet, presently manned by about 20 full-time and 12 part-time fishermen. However, they indicate the inshore lobster grounds would sustain no more than about a 5 percent increase in the number of lobstermen, boats, pots or fishing time.

65. The present annual average lobster landing for the years 1957-61 inclusive was 217,835 pounds valued at $108,918. A 5 percent increase in the catch, 10,892 pounds, would be valued at $6,600 at current prices of 60 cents per pound. The fishermen would be extending their productive time in existing vessels as a result of reduced tidal delays, increased efficiency and safety, and enlarged anchorage facilities. Therefore, the only additional costs incurred would be operating costs such as fuel, labor, extra traps, line, and bait. These added costs are estimated to be 40 percent of the gross value of the increased catch. Then the net benefits are $6,600 x 0.60 = $4,000.

66. The U. S. Fish & Wildlife Service reports also, that the channel and harbor improvement would provide an opportunity for expansion of the modest gill-net and dragger fishery which now exists. Nine of the present lobstermen would convert to other methods of fishing during periods when not engaged in the lobster fishery. The increase in fin-fish landings expected to result would be 100,000 pounds, valued at $10,000 annually. Net benefits are taken as 60% of the gross value, or $6,000.

67. The U. S. Fish & Wildlife Service reports that sport-fishing from the west jetty presently amounts to about 3,000 fisherman-days annually, valued at $4,500. Extension of the west jetty, without any additional modifications, would result in an increase to 7,000 fisher-men-days valued at $10,500. The net increase is $6,000 annually, attributable to navigation improvements and represents about 60 percent of the total $10,500 of sport fishing benefits.

68. If the seaward 600 feet of the existing west jetty and the 200-foot Federal extension are provided with a safe walking surface, hand railing, road access, parking area for 25 cars, and sanitary facilities, benefits from sport fishing would amount to 22,000 fisherman-days annually, valued at $33,000. This represents a net increase of 22,000-7,000 or 15,000 fisherman-days, valued at $22,500, attributable

to the jetty modification. Assuming 60% of the increase in benefits to be attributable to the Federal portion of the jetty, the benefits would be 0.60 x $22,500 = $13,500.

69. Spoil materials probably would be utilized for construction of needed marina facilities. Therefore, no benefit from land enhancement as a result of spoil disposal on nearby land areas is anticipated.

70. The benefits are summarized below:

Benefit	General	Local	Total
	NAVIGATION		
Recreational Boating:			
Locally-based	2,850	$ 2,850	$ 5,700
New	4,500	4,500	9,000
Prospective (gradual growth)	9,300	9,300	18,600
Total Recreational	$16,650	$16,650	$33,300
Commercial Fishing:			
Increased lobster catch	$ 4,000	$ -	$ 4,000
Increased finfish catch	6,000	-	6,000
Total Commercial	$10,000	$ -	$10,000
Jetty Sport Fishing:			
Extension without additional modification	$ 3,000	$ 3,000	$ 6,000
Total All Benefits	$29,650 60%	$19,650 40%	$49,300 100%

JETTY SPORT FISHING

71. If the benefits resulting from sport fishing facilities are included, the total benefit would be $49,300 + $13,500 = $62,800. The $13,500 benefits have not been utilized in computing cost apportionment as shown in above tabulation, as the cost sharing for the required jetty modification is based on different policy.

COMPARISON OF BENEFITS AND COSTS

72. A comparison of the estimated benefits of $49,300 and the annual charges of $21,000 result in a benefit-cost ratio of 2.3 based upon the project effect from navigation improvements only. If the jetty sport fishing benefits of $13,500 resulting from jetty modification are included, total benefits become $62,800. Compared to the total annual charges of $22,700, the benefit-cost ratio is 2.8.

APPORTIONMENT OF COST AMONG INTERESTS

73. Benefits resulting from navigation improvements at Green Harbor are expected to accrue primarily to recreational boating and are termed local in nature. Some benefits will accrue to the small lobster fleet. The first costs of construction have been apportioned between the Federal Government and local interests in proportion to the general and local benefits which are 60 and 40 percent, respectively. The jetty sport fishing facilities are apportioned equally between Federal and non-Federal interests. The Federal cost of the project is limited by Section 107 of the 1960 River and Harbor Act to $200,000. The cost apportionment is as follows:

NAVIGATION

Federal Investment

Corps of Engineers:

General Navigation Facilities (0.60 x $365,000)	$	219,000
Less $19,000 excess over Section 107 limit*		200,000

Coast Guard:

Navigation Aids		26,000
Total Federal Investment	$	226,000

Non-Federal Investment

Cash Contribution:

General Navigation Facilities (0.40 x $365,000)	$	146,000
Excess over Section 107 - $200,000 limit		19,000
Total Non-Federal Investment	$	165,000

* Section 107 limits Federal expenditure to $200,000

JETTY SPORT FISHING

Federal Investment

On-project features and off-project features

50% of $25,000	$	12,500
Less excess over Section 107-$200,000 limit		12,500
Total Federal Investment	$	0

Non-Federal Investment

On-project features and off-project features

50% of $25,000	$	12,500
Excess over Section 107-$200,000 limit		12,500
Total Non-Federal Investment	$	25,000

NAVIGATION & JETTY SPORT FISHING

Total Federal Investment (Including Nav. Aids)	$	226,000
Total Non-Federal Investment		190,000
Total Project Cost	$	416,000

PROPOSED LOCAL COOPERATION

74. In addition to (a) making the necessary 40% cash contribution ($146,000) and (b) assuming the excess over the Corps of Engineers' $200,000 limit ($19,000 without and $44,000 with jetty sport fishing features), local interests would be required to:

(c) Agree to bear all costs of the operation, maintenance and replacement of all off-site public access, parking and sanitary facilities required for jetty sport fishing;

(d) Provide and maintain berthing areas, floats, piers, slips and similar marina and mooring facilities outside the Federal project limits as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms;

(e) Continue to maintain and operate the existing Town pier with berthing depths commensurate with the Federal anchorage, open to all equally;

(f) Provide, without cost to the United States, title to the existing jetties constructed by local interests, all necessary lands, easements, and rights-of-way required for construction and subsequent maintenance of the project including suitable spoil disposal areas with necessary retaining dikes, bulkheads, and embankments therefor;

(g) Hold and save the United States free from damages that may result from construction and subsequent maintenance of the project;

(h) Provide adequate off-project features for jetty sport fishing.

COORDINATION WITH OTHER AGENCIES

75. All Federal, State and local agencies known to have an interest in the Green Harbor study were notified of the public hearing held in Marshfield in April 1962. All interested agencies have been consulted during the study concerning the effects of the proposed improvement on their activities. Comments of the U. S. Fish and Wildlife Service are contained in Appendix A. Comments of local interests are contained in Appendix B.

SCHEDULE FOR DESIGN AND CONSTRUCTION

76. It is estimated that preparation of contract plans and specifications will require 5 months. The estimated cost is $25,000.

77. Construction of the project can be accomplished under two contracts, one for extending the west jetty and raising the east jetty requiring about 2 months and one for dredging the channel and anchorage requiring 3 months.

a. Allocated to Date:

Reconnaissance Report	$ 4,300
Detailed Project Report	12,700

b. Required to Complete:

Plans and Specifications	$ 8,000
Construction, Engineering during construction, Supervision & Administration	357,000*
Total Cost	$ 365,000

*Including local cash contribution of $165,000

OPERATION AND MAINTENANCE

78. The west jetty will be sealed with a gravel blanket over its existing outer 650 feet and extended 200 feet. The outer 650 feet of the west jetty should be maintained to protect the channel. The east jetty will be raised to Elev. +14. Therefore, it is considered that maintenance of 650 feet of both existing jetties plus the 200-foot west jetty extension, estimated to involve replacement of about 150 tons annually at a cost of $1,500, should be assumed entirely by the Corps of Engineers.

79. During the period of 1952 through 1964, the Commonwealth of Massachusetts dredged in the harbor 3 times at intervals of two, four, and six years. Total volume removed amounted to about 160,000 cu. yds. It is estimated that the average annual volume amounts to about 13,000 cu. yds. per year. It is expected that sealing the existing jetty to prevent sand passing through it and extending the west jetty will reduce the maintenance in the channel and harbor substantially. It is estimated that maintenance after improvement will be less than 20% of that experienced under existing conditions. On this basis, it is considered that the average annual maintenance will involve removal of about 2,500 cu. yds. at a cost of about $3,000. Maintenance dredging to restore project dimensions in the channel and anchorage will be a Federal responsibility. The U. S. Coast Guard will assume maintenance of the required navigation aids, estimated at $900 annually.

CONCLUSION

80. At present, the natural entrance and harbor channel at Green Harbor is shoal, narrow, and irregular resulting in delays and unsafe navigation conditions. Most of the shoaling of the entrance channel results from beach materials passing through, over, and around the west jetty. The amount of berthing and mooring area available cannot accommodate the existing fleet of recreational and fishing craft. Therefore, the continued use and future development of Green Harbor depends on a safe, stabilized entrance and harbor channel and additional anchorage and berthing facilities. Since open anchorage would not be sufficient to economically accommodate the anticipated prospective fleet, marina facilities would be required.

81. The proposed Federal channel, jetty improvement and enlargement of the existing anchorage and berthing facilities would allow for expansion of the recreational fleet and permit increased use and efficiency of the fishing fleet. The improvement is economically justified with a benefit-cost ratio of 2.3. No objection to the improvement has been made by the interested agencies. The proportion of general and local benefits indicate a 60%-40% Federal-local apportionment, respectively. The local share including the excess over the Federal $200,000 limit, is $190,000. Local interests have

indicated that the improvement would meet their needs and that the attendant requirements of local cooperation would be met including all costs over $200,000 so that the proposed project can be accomplished under Section 107 of the 1960 River and Harbor Act.

RECOMMENDATION

82. The Division Engineer recommends Federal improvement of Green Harbor, Massachusetts be authorized under provisions of Section 107 of the 1960 River and Harbor Act, to provide for a 6-foot deep channel (8 feet at the entrance), 100 feet wide extending about 4,000 feet from deep water to the head of navigation, with a small turning basin at the upstream limit; a 5-acre, 6-foot deep anchorage near the Town pier; sealing, rebuilding in part, and a 200-foot extension of the existing west jetty at elevation +12, with a dike to the beach berm at elevation +14 ft., and raising the east jetty to an elevation of +14 all as shown on the map accompanying this report. The total project cost is estimated at $390,000 excluding $26,000 for additional aids to navigation, but including $25,000 for on-site and off-site costs for sport fishing facilities. Annual maintenance costs are estimated at $4,000 for the jetties, channel and anchorage, and $900 for the navigation aids.

83. The recommendation is made subject to the conditions that local interests:

a. Contribute 40 percent of the first cost of construction of the navigation features, and 50 percent of the cost of the jetty sport fishing features, and assume full responsibility for all project costs in excess of the $200,000 Corps of Engineers' cost limitation under Section 107 of the River and Harbor Act;

b. Agree to bear all costs of the operation, maintenance and replacement of off-site facilities required for jetty sport fishing;

c. Continue to maintain and operate the existing Town pier with berthing depths commensurate with the Federal anchorage, open to all equally;

d. Provide and maintain berthing areas, floats, piers, slips, and similar marina and mooring facilities outside of the Federal project limits as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms.

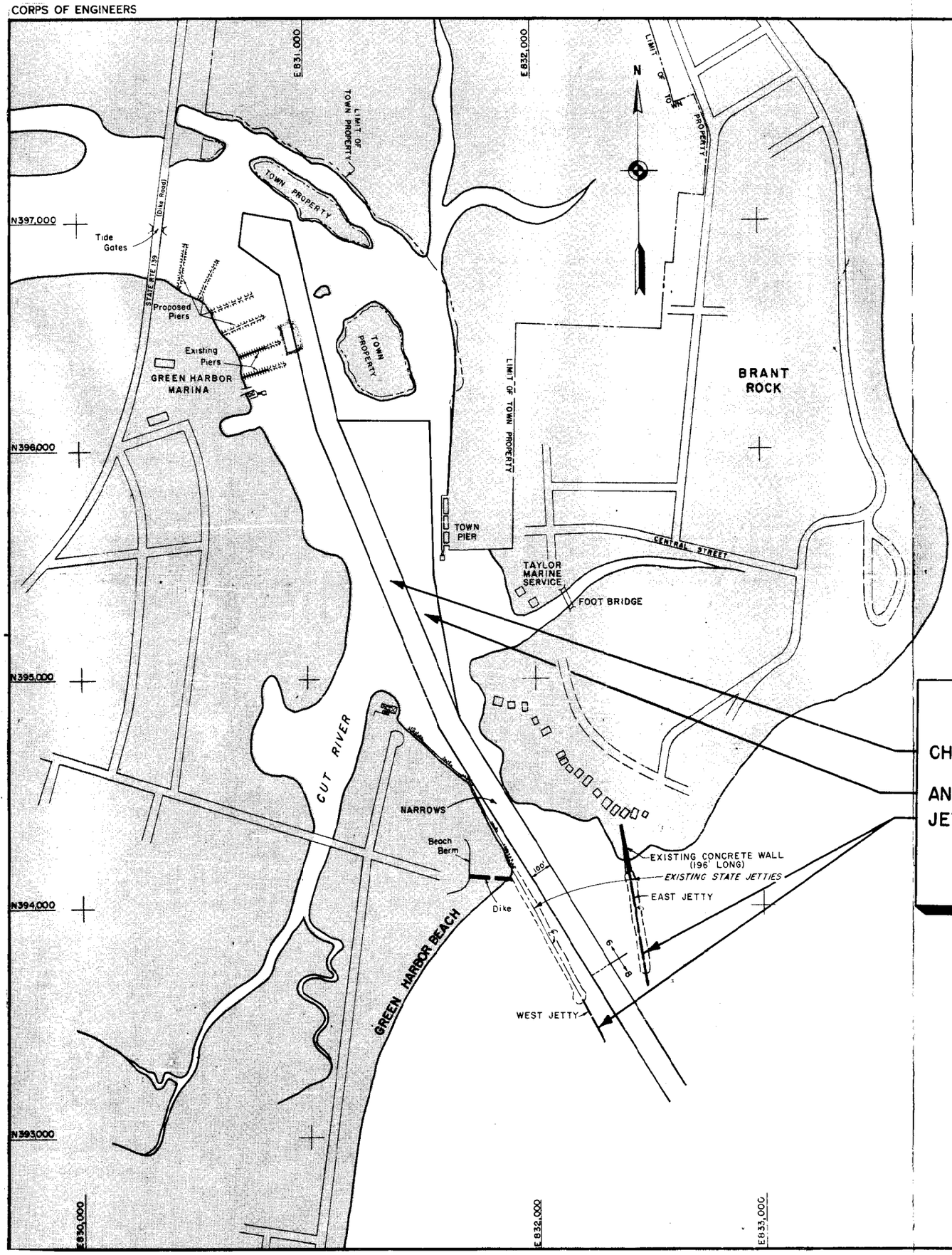
e. Provide, without cost to the United States, title to the existing jetties constructed by local interests, all necessary lands, easements and rights-of-way required for construction and subsequent maintenance of the project including suitable spoil disposal areas with necessary retaining dikes, bulkheads, and embankments therefore.

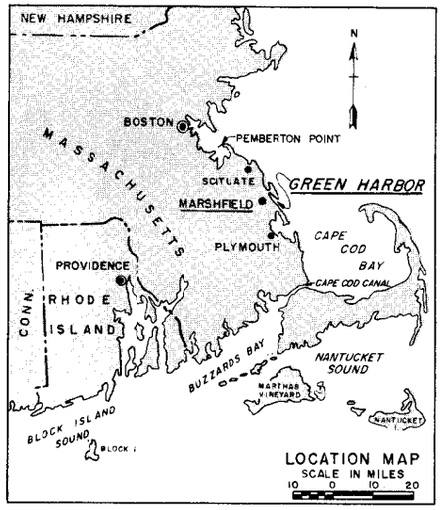
f. Hold and save the United States free from damages that may result from construction and maintenance of the project.

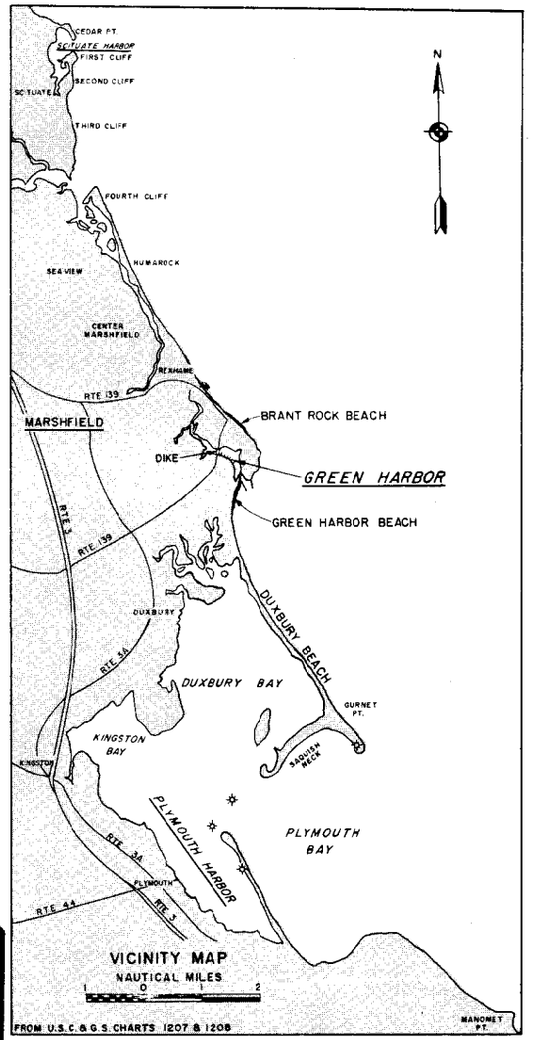
g. Provide adequate off-project facilities for jetty sport fishing.

E. J. RIBBS
Colonel, Corps of Engineers
Acting Division Engineer

3 Incls.
1. Maps - 2 Plates
2. Appendix A - U.S. Fish & Wildlife Report
3. Appendix B - Letters by Local Interests







DESIRED IMPROVEMENT RECOMMENDED

CHANNEL - 6 and 8 feet deep, 100 feet wide with turning basin of 1-acre, 6 feet deep

ANCHORAGE - 5 Acres, 6 feet deep

JETTIES - Raise east jetty to Elev. +14
Extend west jetty 200 feet - Elev. +12

Seal 650 feet of west jetty (Beach side)
Construct dike to Elev. +14

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

GREEN HARBOR MASS.

SHEET 1 OF 1 — REPORT MAP — APRIL 1964

SCALE IN FEET: 200 0 200 400 600

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECTION

PROJECT ENGINEER

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

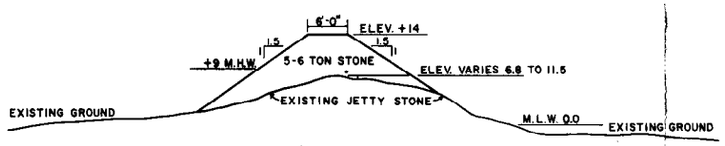
TO ACCOMPANY DETAILED PROJECT REPORT
DATED: APRIL 1965

FILE NO. 8-F-11-3

LIST OF PROBINGS

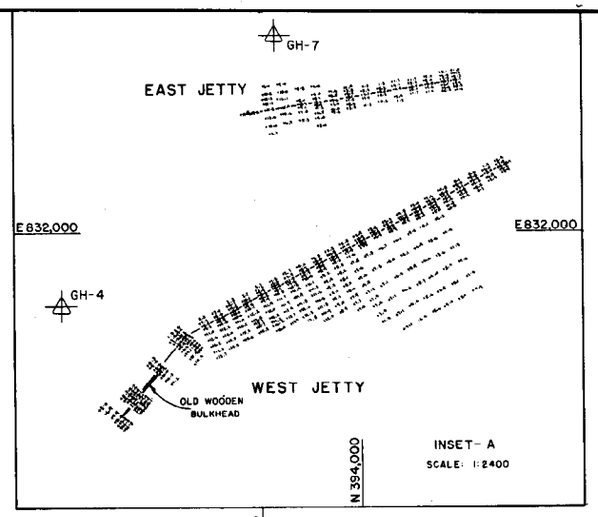
NUMBER	DEPTH OF WATER	ELEVATION BELOW M.L.W. DEPTH OF PROBE	PENETRATION	MATERIAL
1	+10.3	10.0	20.3	Gravel, sand, sandy clay
2	+9.2	10.0	19.2	" " "
3	0.8	6.8	6.0	Mud-gravel-hard clay, sand, by hand to 4.2, 60 blows to 6.0
4	+3.1	10.0	13.1	" " " by hand to 6.5, 5.2 blows to 10.0
5	+2.6	10.0	12.6	" " " by hand to 8.5, 40 blows to 10.0

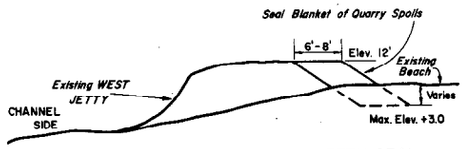
Probings were taken by hand, and 3/4" heavy duty 20 pound hammer.



TYPICAL SECTION - EAST JETTY

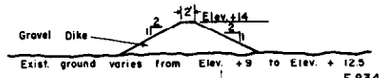
SCALE: 1" = 10'-0"



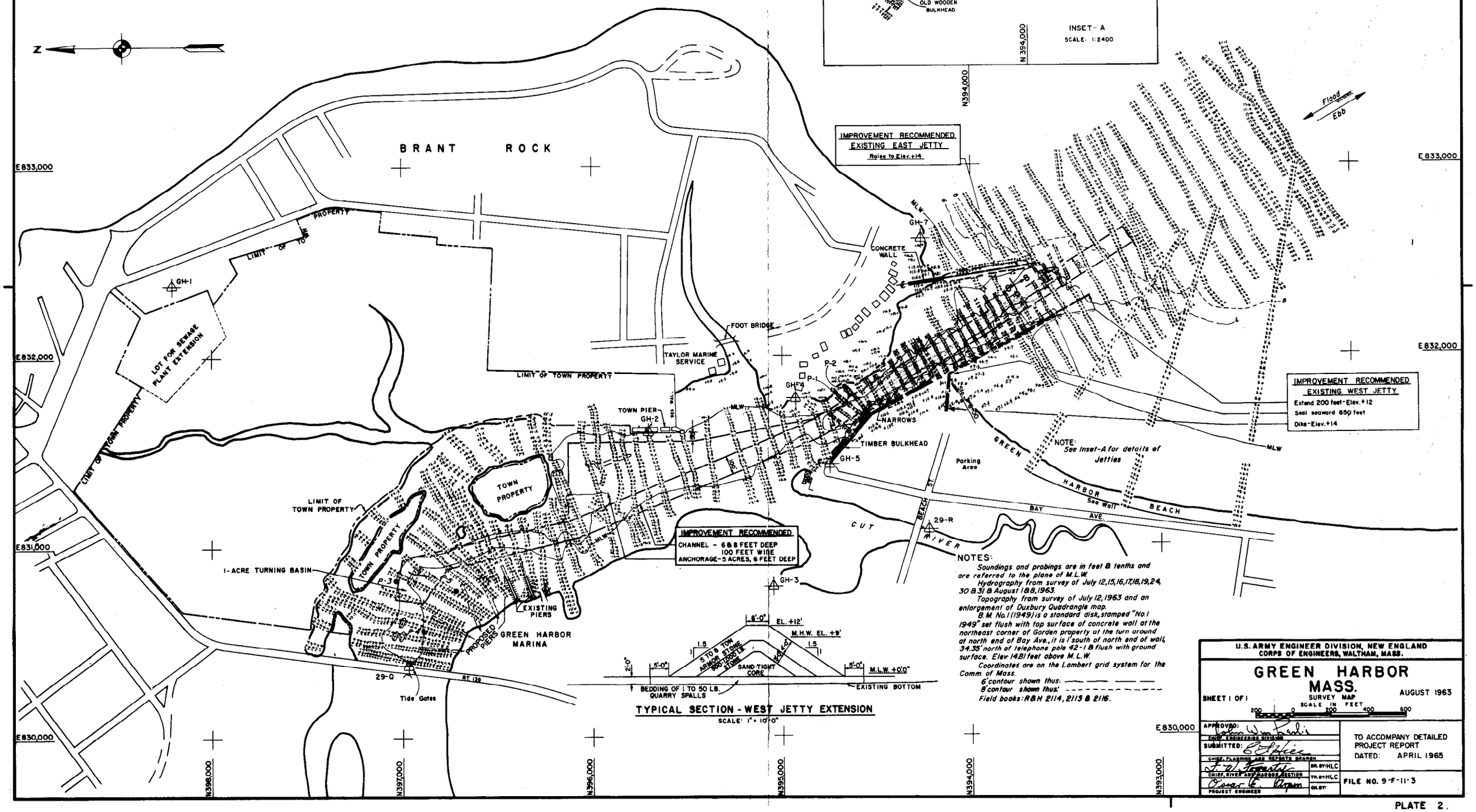


TYPICAL SECTION-WEST JETTY SEAL

STA. 8+00 to END SCALE 1" = 10'



TYPICAL SECTION-DIKE



TYPICAL SECTION - WEST JETTY EXTENSION

SCALE: 1" = 10'-0"

NOTES:

Soundings and probings are in feet & tenths and are referred to the plane of M.L.W.

Hydrography from survey of July 12, 15, 16, 17, 18, 19, 24, 30 & 31 & August 1 & 8, 1963.

Topography from survey of July 12, 1963 and an enlargement of Duxbury Quadrangle map.

B.M. No. 1 (1949) is a standard disk, stamped "No. 1 1949" set flush with top surface of concrete wall at the northeast corner of Gorden property at the turn around at north end of Bay Ave., it is 1' south of north end of wall, 34.35' north of telephone pole 42-1 & flush with ground surface. Elev. 14.81 feet above M.L.W.

Coordinates are on the Lambert grid system for the Comm. of Mass.

6' contour shown thus: — — — —

8' contour shown thus: - - - - - - - - - -

Field books: R&H 2114, 2115 & 2116.

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS, WALTHAM, MASS.

GREEN HARBOR MASS.

SURVEY MAP

AUGUST 1963

SHEET 1 OF 1

SCALE IN FEET 200 0 200 400 600

APPROVED: CHIEF, ENGINEERING DIVISION

SUBMITTED: CHIEF, PLANNING AND REPORTS BRANCH

CHIEF, RIVER AND HARBOR SECTION

PROJECT ENGINEER

DR. BY: HLC

TR. BY: HLC

CK. BY:

TO ACCOMPANY DETAILED PROJECT REPORT

DATED: APRIL 1965

FILE NO. 9-F-11-3

APPENDIX A

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
59 Temple Place
Boston, Massachusetts 02111

January 13, 1965

Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This is our conservation and development report on proposed navigation improvements at Green Harbor, Plymouth County, Massachusetts. The study is authorized under Public Law 86-645, Section 107. Our report was prepared under authority of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661-666 inc.), in cooperation with the Massachusetts Division of Fisheries and Game and Division of Marine Fisheries. Those agencies concur in the report as indicated in their letters of December 17, 1964 and December 18, 1964, respectively.

The improvements as requested for consideration by local interests include deepening the entrance to 6 and 8 feet; enlargement of the existing anchorage; construction of a new anchorage seaward of Dike Road; lengthening, raising to 14 feet at m.l.w., and sealing the west jetty; and repairing the east jetty.

We understand that local interests plan to develop Town-owned marshlands in the harbor to provide for marina and harbor facilities. The Federal navigation improvement would be dependent upon assurance by local authorities that the marina facilities would be provided under a long-range development plan. It is estimated that ultimate development would accommodate a fleet of over 900 recreational boats.

On August 13, 1964 we reported on the July 7, 1964 application by the Massachusetts Department of Public Works for permit to dredge an entrance channel 1,200 feet long, 60 feet wide, and six feet deep at m.l.w. This channel coincides with the channel included in your study of navigation improvements.

Limited soft-shell clam resources provide some recreational shellfishing and a source of seed clams for a commercial operator on Cape Cod. Wetlands in the harbor are of low value to waterfowl. We understand that there is to be an extension of sewer facilities in the area. With the construction of the sewer extension the fish and wildlife values of the marsh will be further reduced.

The present lobster fleet operating out of Green Harbor is manned by an average of 32 fishermen annually, 20 full-time and 12 part-time. The average annual lobster landing for the years 1957 through 1961 was 217,835 pounds, valued at $108,918. Sport-fishermen fish for summer flounder, American smelt, tautog, Atlantic mackerel, striped bass, and pollock in and near the inlet. Sport-fishing from the west jetty presently amounts to about 3,000 fisherman-days annually valued at $4,500. Due to the low elevation of the east jetty there appears to be no practical way to increase the fisherman use of this structure.

While we have not received specific plans for the location of the marina and harbor facilities to be constructed by local interests, the project works as planned will do minimal damage to the estuarine habitat.

The town marina which would be constructed following the Federal improvements will provide a needed harbor of refuge to this segment of the coast.

The proposed harbor improvements would also decrease tidal delays, enlarge and improve anchorage facilities, allow for added safety and increased efficiency, and permit a moderate expansion of the inshore lobster-fishing fleet. The decrease in tidal delays would shorten the working day or allow for tending more lobster pots. Our investigations indicate that the inshore lobster grounds would sustain no more than about a 5% increase in the catch, however, even with an increase in the number of lobstermen, boats, pots, or fishing time. A 5% increase in the catch, 10,892 pounds, would be valued at $6,600 at current prices of about 60 cents per pound. It is reasonable to expect that during the 50-year project life, the ex-vessel price of lobster will increase with expanding human populations and demand for more food stocks.

There is a possibility for future development of an offshore, deepwater lobster fishery on Georges Bank. The magnitude of the fishery which could be exploited here during the project life is impossible to determine at present, but it is reasonable to expect that Green Harbor could provide adequate landing and anchorage facilities for offshore lobster boats if improvements are made. Resource data are not available to permit evaluation of the potential of this fishery. In 1962, two million pounds of lobster were landed at Massachusetts ports from the offshore lobster fishery.

Channel and harbor improvement would provide an opportunity for expansion of the modest gill-net and dragger fishery which now exists. With improved facilities nine of the lobstermen would have added incentive to replace their present vessels with larger vessels or convert to other fishing methods during periods when they are not engaged in the lobster fishery. Atlantic cod, haddock, blackback flounder, and whiting are species which may be taken by trawl. The expected increase in finfish landings with navigation improvement will be about 100,000 pounds, valued at $10,000 annually. It is also expected that the marina as planned by the town will provide an additional 73,000 sportfishermen-days of boat and bottom fishing having a net recreational value of $146,000.

Sport-fishing from the west jetty amounting to about 22,000 fisherman-days annually and having a recreational value of about $33,000 would be expected to accrue if plans for the west jetty rehabilitation include facilities to accommodate land-based fishermen. Access to the jetty and parking facilities for 25 vehicles would need to be provided, and the top surface of the jetty constructed sufficiently smooth to permit safe walking. Without a safe walkway and parking facilities the expected annual fisherman use would be reduced to about one-third, or 7,000 fisherman-days valued at $10,500. The benefits accruing to parking facilities and a smooth walking surface would amount to about 15,000 fisherman-days having a net recreational value of about $22,500. We recommend that cost of construction of the safe walkway, vehicle parking, and fisherman access be made non-reimbursable project costs because the sport-fishing benefits would be widespread and general and would accrue to the public at large.

We recommend-

1. That the top surface of the west jetty be constructed so as to provide a safe walkway, and that access and parking facilities be provided for fisherman use; that costs of construction of these facilities be non-reimbursable project costs.

Sincerely yours,

Richard E. Griffith

Richard E. Griffith
Regional Director
Bureau of Sport Fisheries and Wildlife

John T. Gharrett

John T. Gharrett
Regional Director
Bureau of Commercial Fisheries

TOWN OF MARSHFIELD

COMMONWEALTH OF MASSACHUSETTS

OFFICE OF
BOARD OF SELECTMEN

MARSHFIELD, MASS.
March 24, 1965

Colonel E. J. Ribbs
Acting Division Engineer
U. S. Army Engineer Division, New England
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts

Dear Colonel Ribbs:

At a meeting held on March 9, 1965 representatives of your office outlined the proposed Federal Project for the improvement of Green Harbor.

The proposal presented received the endorsement of the Board of Selectmen at their regular meeting of March 9, 1965. We feel the plan of improvement would adequately meet the navigation needs of our fishing and recreational fleets.

It is understood that approval and construction of the project would be subject to the following requirements of local cooperation:

a. Assume full responsibility for all project costs in excess of the $200,000 Corps of Engineers cost limitation under Section 107 of the 1960 River and Harbor Act.

b. Contribute 40 percent of the first cost of construction of the navigation features, and 50 percent of the cost of the on-project jetty sport-fishing features.

c. Provide and maintain berthing areas, floats, piers, slips, and similar marina and mooring facilities as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms.

d. Continue to maintain and operate the existing Town Pier with berthing depths commensurate with the Federal anchorage, open to all equally.

e. Provide without cost to the United States all necessary lands, easements, and rights-of-way required for construction and subsequent maintenance of the project including suitable spoil disposal areas with necessary retaining dikes, bulkheads, and embankments therefor.

f. Hold and save the United States free from damages that may result from construction and maintenance of the project.

g. Provide adequate off-project facilities for jetty sport fishing.

Subject to final action by a Town Meeting, the Board of Selectmen consider that the Town of Marshfield would be willing to meet the above requirements. It is understood that a legal commitment would not be required until after an improvement is authorized and Federal Funds are available.

Very truly yours,

Harold H. Wicher

Harold H. Wicher, Chairman
Board of Selectmen

HHW:s

The Commonwealth of Massachusetts
Department of Public Works
Division of Waterways
100 Nashua Street, Boston 02114

March 26, 1965

E. J. Ribbs, Colonel
Acting District Engineer
Corps of Engineers, New England Division
424 Trapelo Road,
Waltham, Massachusetts

Dear Colonel Ribbs: Re: Green Harbor, Marshfield

The Division of Waterways is in accord with the Corps of Engineers' proposal for improvements at Green Harbor, Marshfield. Please be assured that we shall cooperate with you in every respect on this project. However, we are not in a position to forecast the decisions of the General Court, but based on past projects and policies we do not recall when the Legislature has failed to cooperate in every manner on Federal-State cooperative projects.

Very truly yours,

JOHN T. HANNON
Deputy Chief Engineer

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE DEPARTMENT
STATE HOUSE, BOSTON

JOHN A. VOLPE
GOVERNOR

December 2, 1965

Colonel E. J. Ribbs, Acting Division Engineer
U. S. Army, Corps of Engineers
New England Division
424 Trapelo Road
Waltham, Massachusetts 02154

Reference: Neded-R

Dear Colonel Ribbs:

This is a reply to your recent letter concerning local participation in the proposed Federal, State and Town Co-operative Improvement for Green Harbor, Marshfield, Massachusetts.

Our Division of Waterways Engineers of The Department of Public Works have reviewed the plans for this work and report that this is a worthwhile and needed project. In the past twenty years, the Commonwealth has expended over five hundred and fifty thousand dollars in this area and public demand for increased improvement continues to grow.

As you know, I am not in a position to forecast the deliberations of the General Court, but I feel quite certain that the Legislature will provide the required state funds and that The Department of Public Works will be able to execute the necessary agreements when the Corps is ready to proceed with construction.

Sincerely,

John A. Volpe
Governor