The following is an estimate of the cost of this work as above projected, viz:

1. 18,200 cubic yards of dredging for the proposed channel and its side slopes, at 45 cents per cubic yard (measured *in situ*)	$8,190 00
2. 1,000 tons of rubble-stone placed in position on the breakwater, at $1 per ton	1,000 00
Adding for engineering expenses, superintendence, and other contingencies, say	810 00
Total	10,000 00

In order to ascertain from persons who are most interested, as to the commerce and navigation of this place, and others well informed in regard to it, I have addressed letters to them; and in reply have received the information contained in the accompanying letters marked A and B.

Respectfully submitted.

GEO. THOM,
Lieut. Col. of Engineers, Bvt. Brig. Gen., U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. A. C. BOTH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 14, 1878.

GENERAL: I have the honor to submit the following report on a survey of Lincolnville Harbor, Maine, made by me in pursuance of instructions contained in your letter of September 6, 1878.

A map of this survey made to a scale of 1 to 400 is also submitted.

TOPOGRAPHY.

A base line A, B, 280 feet in length (as shown on the accompanying map), was measured, and the following triangulation stations established, viz:

On easterly shore: A, B (base-line), C, D, E, and F. All these stations, excepting "Station B" (which was marked by a copper nail driven into an oak stake), were marked by holes drilled into the solid rock.

On westerly shore: I, II, III, IV, V, VI, VII, VIII, IX, and X. All these stations were marked by holes drilled into solid rock or large bowlders, excepting stations VI, VII, and X, which were marked by copper nails driven into wooden stakes. The details of the high-water lines, wharves, houses, &c., were determined by telemetric measurements.

HYDROGRAPHY.

All the soundings were taken on ranges, established on shore, were located by transit angles from suitable stations, and cover the ground from the bridge (at the head of the harbor) to the 12-foot curve outside—a distance of 2,200 feet. The soundings in the narrow entrance, and those at the head of the harbor (near the bridge), were taken 10 feet apart, and located by a marked line stretched across from point to point. The soundings, 1,846 in number, are referred to the plane of mean low-water, as determined by 28 consecutive day-observations. The tide-gauge used for these observations was nailed to the northerly face of the steamboat wharf at Lincolnville, and the following results were obtained, viz:

TIDES.

	Feet.
Mean rise and fall of tides	9.8
Rise of highest observed high-water above mean low-water	11.45
Fall of lowest observed low-water below mean low-water	2.70
Highest observed rise and fall of tides	14.15
Rise of lowest observed high-water above mean low-water	8.55
Rise of highest observed low-water above mean low-water	1.60
Lowest observed rise and fall of tides	6.95
Difference between highest and lowest high-water observed	7.20

BENCH-MARKS.

The bench-mark, to which the tide-gauge at the steamboat wharf refers, is marked by a hole drilled into a large granite bowlder lying (near the high-water line) between the store-house on the steamboat wharf and the lime-kiln shed south of same. The level part of this rock (around the drill-hole) is 13.99 feet above mean low-water.

Another bench-mark has been established at the entrance of the harbor, between triangulation stations D and E. It is marked by a hole drilled into the solid ledge, and the level part of the rock (around the hole) is 10.07 feet above the plane of mean low-water.

CHARACTER OF MATERIAL.

Six borings, marked I to VI, inclusive (shown on the map in red), were made to ascertain the character of the material, which was found to consist, throughout the extent of the survey, of coarse gravel, small rocks, and sand; the material outside being mostly sand, gravel, and mud.

PROPOSED IMPROVEMENTS.

It is proposed to improve this harbor by dredging a channel 3 feet deep at mean low-water throughout, having a width of 80 feet at its lower end, marked A, thence contracting gradually to a width of 50 feet at the entrance of the harbor, marked B, and from here to the head of the harbor, also 50 feet wide—the total length being 1,900 feet. The upper portion of this channel (near the wharves) is proposed to be dredged to an average width of 110 feet for a length of about 250 feet to enable vessels to turn around, as well as to accommodate the trade of the place.

The permanency of the channel through the entrance of the harbor depending largely upon the breakwater at this place, it is proposed to strengthen and enlarge the same; for this purpose about 1,000 tons of rubble-stone will be necessary. An estimate for this improvement is herewith submitted.

Amount of material measured *in situ* and necessary to be removed by dredging a channel from point A to the bridge at the head of the harbor, as above described (including an allowance of 2,267 cubic yards, measured *in situ*, for slopes of 30° inclination), being in all—

18,200 cubic yards, at 45 cents per cubic yard	$8,190 00
1,000 tons of rubble-stone, at $1 per ton	1,000 00
Engineering expenses and contingencies	810 00
Total	10,000 00

Very respectfully, your obedient servant,

A. C. BOTH,
Assistant Engineer.

Bvt. Brig. Gen. GEO. THOM,
Lieut. Col. of Engineers, U. S. A.

A.

LETTER FROM MR. J. P. CILLEY.

AUGUSTA, ME., *December* 4, 1878.

DEAR SIR: In reply to your communication of November 30, 1878, I would say that present importations into Lincolnville are almost nothing for want of a suitable harbor near the lime-kilns, and water-power privilege; that the coal for burning lime, and salt for fishing are entered at and as of Camden, the customs officers and warehouses being at that point.

* * * * * * * * *

2. To what extent would commerce and navigation be benefited by the improvement of the harbor?

A railroad from the interior quarries of lime-rock and lime-kilns has been built to the waters of this harbor, which kilns with the large kilns at the harbor have the producing power of 82,000 casks of lime per year, reckoning the time the kilns are run at only half time.

To ship this lime, and for other purposes of navigation, a fleet of 33 vessels are owned in Lincolnville, whose tonnage aggregates over 5,000 tons.

In addition to these a large number of wood-coasters bring wood to the kilns, and vessels from Rockland, Belfast, Camden, and along the coast are employed in carrying Lincolnville lime, and also hay, farm produce, and granite from the harbor and town.

Many of these vessels, when they haul up for the winter, are obliged to be taken across the bay to Isleboro for safe winter harbor.

While the desired improvements at Lincolnville would secure a safe and convenient winter harbor where the vessels could be cared for by their owners, instead of being removed from their oversight, it would also afford a convenient and safe harbor for all vessels passing out of Penobscot Bay when a stress of weather should compel them to make a harbor.

If it is becoming to show the further advantages of the improvement, it could be shown that a large water-power, equal to, if not superior to that of Camden, and close to the harbor, only awaits the deep water the improvement affords, to be developed and add largely to the commerce and navigation of the place.

All of which is commended to your careful consideration.

Very respectfully, yours,

J. P. CILLEY.

General GEORGE THOM, U. S. A.

B.

LETTER FROM MR. HENRY CREHORE.

LINCOLNVILLE, ME., *December* 6, 1878.

DEAR SIR: I am in receipt of your favor of 30th ultimo, and in reply would say (1) that I do not understand any revenue is collected at this port, there not being any custom-house or collector here. (2) It is a matter of judgment to say what benefit commerce and navigation would derive from the improvement of the harbor; but there is no doubt it would be very large in proportion to the outlay.

In my opinion it would do more to develop the material resources of the town (which are great) than the same or double the amount of money expended in any other way. In the first place, one of the best water-powers in the State lies at the head of navigation at this harbor. I understand this water-power will be improved if the harbor improvements are made. Probably $15,000 worth of business would then be done by this power. Again, if this mill privilege is occupied, it will afford one of the best opportunities in the State, for its size, to cut ice, and probably 10,000 tons could be cut here in a single winter. This ice being so near a shipping point, would be worth on an average $8,000 per year.

Again, some of the best lime-rock to be found in the State is quarried in this town. An excellent kiln for burning this rock is situated here, and was built at a cost of about $7,000. This company now burns about $6,000 worth of lime per year. This amount would be increased about $8,000 if the improvements are made so as to allow large vessels to load from the wharf direct.

Taking these different kinds of business, say, $15,000 for the mill privilege, $8,000 for the ice privilege, $8,000 for the lime-kilns privilege, we have $31,000 additional business which I suppose would be done at this place each year, on account, directly, of these improvements.

This is not all. Nature affords very few places adapted to the building of a patent lime-kiln; but here, all along the western bank of the harbor, is an excellent chance for these kilns. With these prospects in view, it seems to me very few appropriations will be made which will do the amount of good, according to the outlay, as this.

I am not, directly or indirectly, interested in this project; but the above statement is my judgment.

Respectfully, yours,

HENRY CREHORE.

General GEORGE THOM.

A 16.

SURVEY OF LUBEC CHANNEL, MAINE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 12, 1878.

GENERAL: I have the honor to submit the following report on the survey of Lubec Channel, Maine, called for by act of Congress approved June 18, 1878, "making appropriations for the construction, repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes."

This survey was made, under my instructions, in October and November, 1878, by Mr. A. C. Both, assistant engineer, whose report and map of the same, also prepared under my supervision, are herewith submitted.

Lubec Channel forms the eastern boundary of the State of Maine, between the town of Lubec and Campobello Island. For a length of over 2 miles (*i. e.*, from about 850 feet below the "western bar-beacon" to the head of "Lubec Narrows," as shown on the accompanying drawing) it is obstructed by bars having but 5 to 12 feet of water, at mean low-water, and for the most part only 5 feet at mean low-water, or 22 feet at mean high-water—the mean rise and fall of the tides being 17 feet; whilst at *extreme* low-water at spring tides, there is but 1 foot of water over their shoalest parts.

The condition of the channel, therefore, is such that at and near mean low-water, vessels are unable to navigate it, and are forced to take a circuitous route, 10 miles longer, from West Quoddy Head to the eastward of Campobello Island, through British waters, in order to reach Lubec, Eastport, Calais, Pembroke, and other ports in Maine, on the Saint Croix and Pembroke Rivers. Similar difficulties also occur to vessels coming down from Calais and other places on the river Saint Croix, which, leaving there at or near high-water (as they have to do), reach Lubec Channel in a low stage of the water—either to be detained there until a rise of tide, or else are forced to take the circuitous route to the eastward of Campobello Island.

With a view to the improvement of this channel, so as to make it navigable in *all* stages of the tide for steamers and other vessels that for the most part would use it, I have had it surveyed with great care and accuracy from deep water, above the head of the Narrows to the deep water below the "western bar-beacon"—a distance of about 2½ miles. In this survey 5,529 soundings have been taken and located; and numerous borings made to ascertain the character of the bottom, in which no ledges were encountered, or any other material difficult to be excavated by dredging.

The project which I have now to submit for the improvement of this channel, consists in excavating it, for a width of not less than 200 feet, to a depth of 12 feet at mean low-water, or 29 feet at ordinary high-water, which would give a depth of 9 feet at low-water of spring tides—the location of the channel to be as shown on the accompanying sketch.

The following is an estimate of the cost of this improvement based upon the results of the survey, as set forth in the accompanying report and drawing, viz:

1. 17,490 cubic yards of dredging *in situ*, in the Narrows (at points marked A, B, and C), at 50 cents per cubic yard	$8,745 00
2. 160,650 cubic yards of dredging *in situ*, below the Narrows, at 20 cents per cubic yard	32,130 00
3. Removal of Jordan's Rock, from the head of the Narrows, 10 cubic yards, at $25 per cubic yard	250 00
Adding for engineering expenses, superintendence, and other contingencies	6,875 00
Total	47,000 00

Owing to the difficulties and great expense that would attend the removal of a dredging-machine and all the necessary scows to such a distant part of the coast, as well as to the fact that the proposed channel, to be of any use, should be deepened and completed throughout its *whole* extent, it is strongly urged that an appropriation be made for the whole amount estimated for its entire completion, which could easily be accomplished in one season.

The extent to which commerce and navigation would be benefited by the improvement of Lubec Channel, as above proposed, is shown, to some extent, by the following statement furnished by the United States collector of customs of that district for the fiscal year ending June 30, 1878, viz:

Amount of revenue collected, $22,159. Number of vessels in the district is 217, having an aggregate tonnage of 29,879 tons.

Respectfully submitted.

GEO. THOM,
Lieut. Col. of Engineers, Bvt. Brig. Gen. U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

REPORT OF MR. A. C. BOTH, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 9, 1878.

GENERAL: I have the honor to submit the following report on the survey of Lubec Narrows, Maine, made by me in pursuance of instructions contained in your letter of October 9, 1878.

TOPOGRAPHY.

The field-work was commenced October 16, and completed November 19, 1878.

A base-line, 1,629.285 feet in length, was carefully measured along a level stretch of land near the so-called "sea-shore." To secure permanency to this line, granite bowlders were sunk into the sandy bottom to a depth of 3 feet, the tops of them being level with the ground. The extremities of the base-line are marked by copper bolts, set into these bowlders; each bolt having a small hole drilled in its center. The magnetic bearing of this line from its western extremity is 67° east of north.

The triangulation stations II, III, IV, V, IX, X, and XVII (all on Campobello Island), the station on the southerly end of Pope's Folly and the station on "Gun Rock" (Lubec shore) are permanently marked by holes drilled in the solid rock. The stations VI, VI$_1$, VII, XII, XII$_1$, XIV, XV, and XVI (all on Campobello Island) were also marked by holes drilled in bowlders on or near the high-water line. Stations VIII, XI, and XIII (also on Campobello Island) are marked by galvanized nails, driven into stakes. The stations A, B, C, D, E, F, G, H, I, and K (all on the Lubec shore), are marked by galvanized nails, driven into the wharf planking or into stakes. The details of the survey, high-water lines, wharves, houses, fish weirs, &c., were determined by telemetric measurements.

HYDROGRAPHY.

It had been generally supposed that the bar across the upper end of Lubec Narrows, and the one near the western bar-beacon, formed the principal obstructions to the

navigation of this channel, but this was not found to be the case, and consequently, lines of soundings were taken sufficiently close to cover the whole ground, from deep water above (Pope's Folly) to deep water below, about 2,000 feet south of western bar-beacon, or a distance altogether of about 13,000 feet along the channel. Another bar, about 950 feet north of the lower (red) buoy, nearly as shoal as the lower bar, was found, and the channel between, and above these bars, as far up as the upper (black) buoy, proved to have insufficient depth.

As the time for sounding was necessarily short, owing to the strong currents, the lines of soundings were carried no farther than deemed necessary, that is, not beyond the shoal water on either side of the present channel-way.

All the soundings (5,529 in number) were taken on ranges established on shore, and were located by transit angles from suitable stations. They are referred to the plane of mean low-water as determined by 57 consecutive observations, day and night. The tide-gauge used for these observations was nailed to the outer face of Staples wharf (the next one above △ station "B"). As all the low-waters receded from the foot of this wharf the lower portion of the tide-gauge had to be nailed to a post driven some 50 feet from this wharf.

The results obtained were as follows, viz:

TIDES.

	Feet.
Mean rise and fall of tides	17.620
Rise of highest observed high-water above mean low-water	20.702
Fall of lowest observed low-water below mean low-water	4.098
Highest observed rise and fall of tides	24.800
Rise of lowest observed high-water above mean low-water	15.002
Rise of highest observed low water above mean low-water	2.252
Lowest observed rise and fall of tides	12.750
Difference between highest and lowest high-water observed	12.050

CURRENTS.

The high and low water slacks at the Narrows occur about two hours before high and low water, and are of very short duration—from 0 to 10 minutes. The current which runs through the Narrows in both directions is very strong, especially at half ebb. The actual velocity of the current has not been ascertained, but frequent observations lead me to conclude, that its velocity varies from 6 miles per hour at neap tides to 9 miles per hour at spring tides. The current along the channel below the Narrows proper, that is, below Leadurny Point down to the western bar-beacon, probably never exceeds a velocity of 4 miles per hour.

CHARACTER OF MATERIAL.

In order to ascertain the character of the material which forms the obstructions to navigation, several borings were made.

The upper bar across Lubec Narrows, marked A on the accompanying drawing, consists mostly of sandy mud, more gravel and rocks being found nearer to Gun Rock. In mid-channel on this bar (A) is a large and dangerous bowlder, known as Jordan's Rock, which has but 4½ feet of water over it at mean low-water.

The bar off Charley's Point, marked B, consists of rocks, bowlders, gravel, and probably some clay. It appears to be the remains of an extension of Charley's Point, which is formed of the above-named materials.

The small bar off Leadurny Point, marked C, consists of very coarse gravel and small rocks.

All the bars across the channel (from D to E) and the shoal ground between them, from point D (about 700 feet north of upper (black) buoy) to point E (about 850 feet south of western bar-beacon), consists of sandy mud and a little gravel, a material supposed to be easily dredged.

In the present condition of the channel through Lubec Narrows, direct and safe communication between Quoddy Roads and Friar Roads, Passamaquoddy Bay, and Pembroke and Saint Croix Rivers (Lubec, Eastport, Calais, Dennisville, Pembroke, and numerous other ports), is only possible at or near high-water. At other stages of the tide, all vessels and steamers bound for or clearing the above-named ports have to go around East Quoddy Head, the northeastern extremity of Campobello Island, a distance of 10 miles greater than the direct route. The time lost in this way varies from 1½ hours for steamers to 24 hours for sailing-vessels. During heavy southerly and easterly weather a great many vessels make a harbor under the lee of West Quoddy Head, near Wormell's Ledges. At this latter place, large numbers of vessels, anchored there during northerly gales, have been driven on the shore and wrecked, as soon as

the wind veered more to the eastward, unless high-water at such times permitted them to escape through Lubec Narrows into a safe harbor. Another important object in having direct navigation established through Lubec Narrows, at all stages of the tide, is the fact, that vessels now cannot enter or leave the above-named ports without traversing British waters, which in case of war would be a serious obstacle. The necessity for a safe channel through Lubec Narrows, navigable at all stages of the tide, is keenly felt by the population of all the ports interested, and that such an important improvement should have been so long deferred, is to be wondered at.

PROPOSED IMPROVEMENTS.

The channel which is proposed to be excavated through the several bars having only 5 feet of water over them at mean low-water, has a width of 200 feet and a depth of 12 feet at ordinary low-water, and is believed to meet all the requirements of navigation.

I herewith submit the following estimates for this work.

ESTIMATES.

I. Opening a channel through the bar running across the head of Lubec Narrows (marked A on accompanying drawing), having a width of not less than 200 feet and a depth of 12 feet at ordinary low-water (or 9 feet at extreme low-water and 29 feet at mean high-water), for an average length of 500 feet. This will require the removal of 15,480 cubic yards of dredging as measured *in situ*, the estimated cost of which, at 50 cents per cubic yard, is $7,740.

II. Widening the channel by removing the bars off Charley's Point and Leadurny Point, marked B and C respectively, also to a depth of 12 feet at ordinary low-water and to the limits as shown on the map, will require the following amounts of dredging as measured *in situ*, viz:

Bar B, 1,290 cubic yards, at 50 cents per cubic yard	$645 00
Bar C, 720 cubic yards, at 50 cents per cubic yard	360 00

III. Opening a channel through the shoals located between the point marked D (above the upper (black) buoy) and the point marked E (below the western bar beacon), a distance of about 6,300 feet, to a depth also of 12 feet at mean low-water, and a width of 200 feet, will require the removal of 160,650 cubic yards of dredging as measured *in situ*, at an estimated cost of 20 cents per cubic yard, $32,130.

IV. Removing Jordan's Rock, from mid-channel at the Narrows, say 10 cubic yards, at $25 per cubic yard, $250.

RECAPITULATION.

Bar A, 15,480 cubic yards dredging, at 50 cents	$7,740 00
Bar B, 1,290 cubic yards dredging, at 50 cents	645 00
Bar C, 720 cubic yards dredging, at 50 cents	360 00
Bars D–E, 160,650 cubic yards dredging, at 20 cents	32,130 00
Removal of Jordan's Rock	250 00
Adding for engineering expenses, superintendence, and other contingencies	6,875 00
Total	47,000 00

Very respectfully, your obedient servant,

A. C. BOTH,
Assistant Engineer.

Bvt. Brig. Gen. GEO. THOM,
Lieut. Col. Corps of Engineers, U. S. A.

A 17.

SURVEY OF PORTSMOUTH HARBOR, NEW HAMPSHIRE.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 12, 1878.

GENERAL: I have the honor to submit the following report on the survey of Portsmouth Harbor, New Hampshire, made under my direction, in September and October last, with a view to its improvement, with an estimate of the cost of the same, as called for by the act of Congress approved June 18, 1878, "making appropriations for the construction, repair, preservation, and completion of certain public works on rivers and harbors and for other purposes."

The location and importance of this harbor are too well known to make any description of it necessary, further than to state that it is the only harbor on the coast of New Hampshire, and the only outlet of the navigable rivers along the coast of that State (viz, the Piscataqua, Cocheco, Lamprey, and Exter rivers), and is, moreover, the harbor in which the United States navy-yard at Kittery, Me., is situated. Its accessibility and depth of water give to it a special value, the only difficulties to its navigation and safety being caused by sunken ledges and [illegible] tidal currents; which tend to force vessels upon dangerous projecting points; from which causes numerous serious accidents have occurred and are still liable to occur to United States vessels and others frequenting the harbor.

A very accurate and extended survey having been made of this harbor and its approaches by the United States Engineer Department in the years 1842–'44, it has only been necessary, at this time, to make special surveys of such localities as present obstacles and difficulties to its navigation. In the selection of these points of difficulty consultation has been freely held with the board of trade and many others who are familiar with the harbor, and in whose interests and by whose instrumentality this survey has been made; and, without exception, they all concurred in the opinion that the most important and necessary work to be done for the improvement of the harbor consists of the following (as shown on the accompanying drawing), viz:

1. The closing of the channel between Great Island and Goat Island, near the "third bridge," so as to stop the very strong current that passes through that channel on the flood tide, by which vessels passing up the harbor are thrown upon Goat Island Ledge, which projects far into the channel, here very narrow, creating thereby the greatest difficulty encountered in the navigation of this harbor (see A, sketch No. 1). The most permanent and effectual way, in my opinion, to accomplish this object, would be to build a breakwater of rubble-stone across the side channel, between Great Island and Goat Island, its location and plan to be as shown on the sketch herewith, marked No. 2—its length to be 820 feet and its height $2\frac{1}{2}$ feet above mean high-water, or 1 foot above mean spring tides; and to have a width of 10 feet on top, with slopes of 45°—a work of larger dimensions not being deemed necessary in this comparatively sheltered position.

2. The removal from the channel, of Gangway Rock, lying between South Beacon Shoal and the navy-yard (marked B on sketch No. 1). The special survey of this rock (see drawing No. 3) shows that its shoalest point has but 12 feet of water over it at mean low-water, or $20\frac{1}{2}$ feet at mean high-water—the mean rise and fall of the tides being $8\frac{1}{2}$ feet; whilst at *extreme* low-water of spring tides it has but $9\frac{7}{10}$ feet of water over it. This rock has always proved to be a very dangerous obstacle, especially for United States vessels which have visited this port and the navy-yard, as well as for other vessels of large draught, in their having been forced upon it by the strong tidal currents which exist in this harbor. To prevent a recurrence of these dangers, it is recommended that this rock be removed (as shown on drawing No. 3 by the area shaded in red) to a depth of 20 feet at mean low-water or $28\frac{1}{2}$ feet at mean high-water—especially in the interests of the United States vessels—it not being, in my opinion, advisable to remove it to a greater depth on account of the greatly-increased cost that would attend it. This improvement would

increase the width of the channel, for that depth, about 370 feet up to within 250 feet of the South beacon; which beacon would thereby answer more effectually the purpose for which it was intended.

3. The removal, in part, of the ledge at the southwest point of Badger's Island (marked C on sketch No. 1). This ledge projects into the channel about 150 feet, where it has only about 4 feet of water at mean low-water, as ascertained by the recent survey of the same, and as shown on the drawing, herewith, marked No. 4. It thus presents serious difficulties to vessels coming down the harbor on the ebb tide, which, after passing Noble's Island, and in their endeavors to avoid being thrown by the powerful current upon the projecting point of Portsmouth, opposite Badger's Island, are very liable to be, and often are, thrown upon the point of ledge projecting from Badger's Island. To prevent this difficulty, it is recommended that this ledge be broken up and removed for a length of 135 feet and to a depth of 10 feet at mean low-water, or $7\frac{7}{10}$ feet at extreme low-water of spring tides, as shown on drawing No. 4, herewith, by the area shaded in red.

For the improvements projected as above the following estimates of cost are submitted, viz:

1. For the breakwater between Goat Island and Great Island, 18,000 tons of rubble-stone, delivered and placed on the work, at 70 cents per ton.	$12,600 00
2. Breaking up and removing Gangway Rock to a depth of 20 feet below the plane of mean low-water, 2,840 cubic yards, at $30 per cubic yard.	85,200 00
3. Breaking up and removing ledge projecting from the southwest point of Badger's Island, 1,190 cubic yards, at $30 per cubic yard	35,700 00
Adding for engineering expenses, superintendence, and other contingencies	16,500 00
Total	150,000 00

In regard to the extent to which commerce and navigation would be benefited by the improvement of this harbor as above projected, the following information has been furnished by A. F. Howard, Esq., the United States collector of customs at that port, viz:

Amount of revenue collected at that port for the fiscal year ending June 30, 1878, $14,612.69.

The coastwise entries for the same time were 1,041 vessels of 112,421 tons, which include vessels engaged in the fisheries also.

The foreign arrivals were 34 vessels of 5,867 tons.

The lower harbor affords a refuge during the year of near 5,000 vessels.

The necessity and importance of the proposed improvements are much enhanced by the fact of the great value of this harbor as a United States naval station.

Respectfully submitted.

GEO. THOM,
Lieut. Col. of Engineers, Brevet Brig. Gen., U. S. A.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

A 18.

SURVEY OF SCITUATE HARBOR, MASSACHUSETTS.

UNITED STATES ENGINEER OFFICE,
Portland, Me., December 6, 1878.

GENERAL: I have the honor to submit the following report on the survey of Scituate Harbor, Massachusetts, made under my direction,

by Mr. Sophus Haagensen, assistant engineer, "with a view to its adaptability as a harbor of refuge," as called for by the act of Congress approved June 18, 1878, "making appropriation for the construction, repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes."

This harbor is situated on the eastern coast of Massachusetts (on Massachusetts Bay), about midway between Boston and Cape Cod. It is 13 miles southeast of Boston light, at the outer entrance to Boston Harbor, and $5\frac{1}{2}$ miles south 30° east from Minot's Ledge light; it is north 23° west, distant 15 miles from the Gurnet lights at the outer entrance to Plymouth Harbor, and north 68° west, distant $26\frac{1}{4}$ miles from Race Point light, the northern extremity of Cape Cod, as shown on the accompanying sketch.

The coast between Scituate and the entrance to Boston Harbor is so densely studded with dangerous shoals and sunken rocks, that no vessel could find shelter there at times when most necessary, in fogs and easterly storms; so that if a vessel passing around Cape Cod, or coming elsewhere from the eastward, should fail to make Boston Harbor and fall to the leeward, it could now find no other refuge except Plymouth Harbor, the approach to which at the "Cow Yard," is difficult and dangerous, especially to strangers. To provide a harbor of refuge, under these difficulties, that shall be easy of access and afford a safe anchorage for coasters, fishermen, and other vessels that would seek it, is an object much desired by those most interested in the commerce and navigation of this coast.

In its present condition, this harbor, in its deepest part, has not more than 3 to 5 feet of water at mean low-water, or about 13 feet at ordinary high-water (and this for an area of not more than 6 acres), which is without any protection whatever from easterly storms. To adapt this harbor, therefore, to the wants of navigation it would be indispensably necessary to build for its protection a breakwater or breakwaters at its entrance, and to excavate a basin inside of them to such an extent and depth as would afford the desired shelter and anchorage.

The survey of the harbor has, therefore, been made so as to obtain all the information necessary for forming a project and an estimate of cost of such a work. It embraces the whole harbor and the approach to it for an extent of about 1 square mile, as shown on the accompanying map.

The soundings on this map have been accurately located and are all referred to mean low-water—the mean rise and fall of the tide being about $9\frac{3}{4}$ feet.

In order to afford an easy and well-marked entrance into the harbor, it is proposed to have two breakwaters, one to project from Cedar Point, near the light-house on the north side of the entrance, in a direction south 36° east for a distance of 800 feet, and the other to project from the point of the First cliffs on the south side of the entrance, in a direction north 10° west, for a distance of 730 feet. In thus locating them they shut out all easterly winds from the proposed harbor, and also occupy the shoalest and most favorable sites in regard to cost. These works are designed to be built of rubble-stone to a height of 4 feet above the plane of mean high-water, with a width of 20 feet on top, and an exterior slope of 1 : 2 and an interior slope of 1 : 1, the channel extremities to be enlarged and raised to a height of ten feet above the mean high-water, so as to afford conspicuous guides for the entrance.