The location and general plan of this work as recommended under date of October 9, 1872, by the Board of Engineers appointed for that purpose, and consisting of Col. J. N. Macomb, Col. I. C. Woodruff, Lieut. Col. J. G. Foster, Maj. C. B. Comstock, and Maj. O. M. Poe, was approved by the Chief of Engineers March 12, 1873, and by the Secretary of War March 14, 1873.

After a full and careful examination of the coast of Lake Huron from Point Aux Barques to a distance of more than 50 miles in the direction of the Saint Clair River, Sand Beach Bay was finally decided upon as the best adapted, all things considered, for the location of the harbor.

Sand Beach Bay requiring the construction of a breakwater 7,000 feet in length it was decided to build one essentially the same as is used in similar works on the lakes, consisting of cribs of timber, bolted with iron, filled with ballast stone, and planked on top, and with a sheathing of iron on the outside of breakwater so bolted to the timber that its upper edge should be one foot above the water-line to protect the timbers from cutting by ice.

The above general plan as recommended has been carried out.

On the 19th of June, 1873, a contract was signed with Dale & Davidson, of Chicago, for the beginning of the work of construction, but during the season of 1873 no work was done upon the breakwater.

In the latter part of June, 1874, the first crib at the angle was sunk, and during the season 10 cribs were completed and put in place without superstructure.

December 2, 1874, a contract was signed with H. S. Dale, of Chicago, under the appropriation of $75,000 approved June 23, 1874, for continuing the work of construction by the extension of the inshore arm.

During the season of 1875 the contract of June 19, 1873, was completed by the addition of 14 cribs to the lake arm and a superstructure over the entire 24.

Twenty-one cribs 25′ by 50′, and 9 cribs 18′ by 45′, were built and put in place, and the superstructure built over them under contract of December 2, 1874. This contract was not closed until June 16, 1876. A second contract was signed with H. S. Dale for the continuation of the work of construction under the appropriation of $100,000 approved March 3, 1875. During the season of 1876, 13 cribs 65′ by 38′, without superstructure, were added to the lake arm under that contract.

December 4, 1876, a contract was signed with Hemenway & Hayes, of Painesville, Ohio, for continuing the work of construction under the appropriation of $75,000 approved August 14, 1876. And on the 6th of December, same year, a contract for the removal of the wreck of the *City of Buffalo* and bowlders from the inside of the harbor, was signed with C. S. Barker, of Sault Ste. Marie, under the same appropriation.

During the season of 1877 the contract of December 4, 1876, was worked out by the building of a complete superstructure over the 13 cribs built and sunk in 1876, under contract of June 21, 1875, and the building and sinking in place of 5 additional 65′ by 38′ cribs on the lake arm.

The removal of the wreck and bowlders was accomplished under the contract of December 6, 1876, during the season.

In the season of 1878 a complete superstructure was built over the 5 cribs built and sunk in 1877, under the contract of December 4, 1876, by the purchase of material in open market by the government, and hired labor. A small amount of work was also done by a hired dredge, working by the day, under the appropriation approved June 18, 1878.

During the present season the work of construction is going on in the building and sinking of cribs 65′ by 38′ in extension of the lake arm, working under the balance of appropriation approved June 18, 1878. The timber and limestone are purchased under advertised contract. The plant, labor, &c., are hired, and the bowlder-stone and iron are bought in open market.

Very respectfully, your obedient servant,

C. P. GILBERT,
Assistant Engineer.

Gen. G. WEITZEL,
Corps of Engineers.

Tabulated statement of lake craft using the harbor during the year ending June 30, 1879.

Direction of wind at time of entering.

Time.	N.			N. W.			W.			S. W.			S.			S. E.			E.			N. E.			Total.
	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	Steam.	Sail.	Tow.	
1878.																									
July	7	4	4	9	4	8	.....	.....	.....	.....	.....	.....	1	.....	1	.....	3	8	.....	.....	.....	.....	.....	.....	38
August	3	3	1	2	3	3	.....	.....	.....	.....	1	1	1	8	5	.....	3	3	.....	.....	.....	.....	5	2	36
September	1	2	3	6	15	14	.....	.....	.....	.....	5	5	3	10	4	14	4	14	.....	.....	.....	.....	4	1	153
October	9	7	9	21	9	27	.....	.....	.....	.....	2	2	3	4	3	4	2	1	.....	1	1	.....	1	.....	122
November	21	12	29	28	8	27	.....	.....	.....	.....	7	7	1	2	1	4	1	.....	3	1	1	7	.....	11	164
December	.....	.....	.....	2	.....	2	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	30
1879.																									
April	5	2	3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	1	2	.....	.....	.....	.....	.....	.....	16
May	10	4	12	7	5	5	.....	.....	.....	3	6	.....	.....	.....	.....	1	5	1	.....	.....	.....	.....	.....	.....	63
June	13	5	19	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	3	2	.....	.....	.....	.....	7	.....	2	53
Total	69	39	80	75	44	86	14	12	12	39	21	37	17	22	21	29	24	8	3	1	1	22	11	15	695

Passed through north entrance: In, 43; out, 189; total, 232.

EE 3.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN.

The appended report of my assistant, Capt. A. Mackenzie, Corps of Engineers, gives the history of this work to date, and shows the progress made during the last fiscal year.

This is one of the most important works on the Northern lakes. In my annual report for the fiscal year ending June 30, 1877, I stated as follows:

> Captain Lee states that it is estimated by prominent vessel-men that 10,000,000 tons pass this point annually, and if vessels could load safely at 15 feet (as they could if the improvement were made) the annual gain to these vessels would be 500,000 tons. Now, if we only take one-half of these figures as the correct ones, or even one-fourth, it will be seen that at the very lowest rates of freight, say $1 per ton, this improvement would be of vast benefit to the great commerce of the lakes.

In my annual report for the fiscal year ending June 30, 1876, I estimated the cost of this work as—

46,660 cubic yards, at $25 ..... $1,166,500

But it has been shown by the exact methods now used in sounding that the quantities were underestimated about 38 per cent., and the total quantity to be removed will be in round numbers 64,000 cubic yards. This arose from the fact that an ordinary lead line was used in making the soundings over 18 feet on the survey, on which the estimates were based. In the strong current of the river at this point the lead gave greater depths of water than the rigid sounding apparatus we now use to measure the work done shows to exist.

But to offset this we are getting the work done much cheaper than I anticipated: 2,632 cubic yards (scow measurement) were removed under the first contract at $7.50 per yard. Under the present contract about 13,000 cubic yards will be removed at $7 per cubic yard in the prism. I believe the remainder of the work will be done for not more than $6 per cubic yard. The remainder will be 50,000 cubic yards. At $6 per yard, the cost will be $300,000.

The total cost of the work will then be $425,000, as against the original estimate of $1,166,500.

Congress at its last session appropriated $50,000 for this work. There remains then to be appropriated to complete it the sum of $250,000, which I recommend to be appropriated at once for an economical and rapid prosecution of the work.

The amounts appropriated for this work are as follows:

1874	$25,000
1878	100,000
1879	50,000
Total	175,000

The last appropriation has not yet been made available. As soon as this is done, the excavation will be continued by contract to the amount of the appropriation.

Of the amount appropriated, $43,873.65 has been expended.

This work is located in the collection-district of Detroit, Mich. The nearest port of entry is Detroit, Mich., and the nearest light Mamajuda light, in the Detroit River.

The amount of revenue collected in this district during the year was, in coin, $174,271.75; in currency, $33,114.10.

The whole commerce of the great chain of Northern and Northwestern lakes will be benefited very much by this work.

Money statement.

July 1, 1878, amount available	$100,000 00	
Amount appropriated by act approved March 3, 1879	50,000 00	
		$150,000 00
July 1, 1879, amount expended during fiscal year		18,873 65
July 1, 1879, amount available		131,126 35
Amount (estimated) required for completion of existing project		250,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881		250,000 00

Abstract of bids for improvement of the Detroit River, received and opened August 19, 1878.

Number.	Names of bidders.	Residence.	Removing solid rock.	Removing bowlders.
1	Charles F. Dunbar	Erie, Pa	$7 00	$5 00
2	Archibald McArthur and Orville J. Jennings	Chicago, Ill	7 35	2 00
3	Chicago Dredging and Dock Company	do	7 40	2 50
4	C. D. Merry	Berry Hill, Ohio	9 25	2 15
5	Julius H. Striedinger and August Doerflinger	New York, N. Y	9 80	4 00
6	Herman Clark and John B. Westbrook	do	10 00	2 00
7	Roys J. Cram	Detroit, Mich	11 50	2 00
8	Charles H. Strong	Cleveland, Ohio	11 70	8 00
9	Charles S. Barker	Sault Ste. Marie, Mich	18 00	10 00
10	George Luther Beecher and Albert Cobb	Detroit, Mich	20 00	20 00

REPORT OF CAPT. A. MACKENZIE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., June 30, 1879.

SIR: I have the honor to submit the following report on the improvement of the Detroit River for year ending June 30, 1879.

The most serious obstructions to navigation between Lakes Michigan and Huron and Lake Erie is found at a point near the mouth of the Detroit River, known as the Lime Kiln Crossing. The bed of the river at this point is of limestone, the channel winding, and the current very swift. The whole tonnage of the lakes must pass this point, and in the past many serious accidents have occurred.

The act of Congress approved June 23, 1874, made an appropriation of $25,000 for removing bowlders and rock from the Detroit River, partly in Canadian waters.

In the fall of 1874, the Canadian Government made a survey of a portion of the river near the lime kilns, and subsequently spent $5,000 for the improvement of the channel, but from the expensive way of doing the work they accomplished but little.

Their survey not being sufficiently extensive, a new survey was made in the spring of 1875 by the United States Government, based upon this survey. Estimates were made for channels 18 and 20 feet deep, entirely in American waters, and others for same depths partly in American and partly in Canadian waters. The channel, being partly in Canadian and American waters, having the least cutting was adopted for improvement, and in June, 1876, a project was submitted for expending the available balance of the $25,000 appropriated for the work, with the condition that it should be expended on that portion of the channel wholly in American waters.

Previous to this time correspondence had been carried on with the Canadian Government to obtain their co-operation in the work, but up to this time no definite action has been taken by them in the matter.

On August 4, 1876, the bids for the work included in above project were opened, and the contract was awarded to Case & Jennings, of Dunkirk, N. Y., for removing rock, at $7.50 per yard. This price was at the time considered a very low one, but it was subsequently developed that a fair profit could be made at these figures. In consequence of the low price at which it was shown the work could be done it was decided to go down to 20 feet, and in report for the year ending June 30, 1877, it was recommended that the work be continued without waiting for the co-operation of the Canadian Government.

No money for continuing this work was on hand until July 1, 1878, when $100,000, appropriated by act of Congress June 18, 1878, became available. The work was advertised and bids opened August 19, 1878. Mr. C. F. Dunbar was the lowest bidder, and the work was awarded to him at $7 per cubic yard for solid-rock excavation, and

$5 for bowlders, the work to be measured in the prism, bowlders in scows, and no payments to be made for rock removed below a depth of 20 feet. Mr. Dunbar began work as soon as his plant could be brought from Port Colborne, Lake Erie, and continued until stopped by ice, December 16, 1878.

Work was resumed March 24, 1879, but until April 7 but little was accomplished, in consequence of heavy running ice. Since that time work has been carried on day and night, and Mr. Dunbar deserves great credit as a contractor for the efficient and energetic manner in which he has carried on the work.

The work which has been thus commenced will give, when completed, a channel 300 feet in width, 2,680 in length, and 20 feet in depth. The line of channel will be a gradual curve, as shown by accompanying sketch, and will extend from deep water above to deep water below.

The plant used by the present contractor consists of 1 tug, 2 scows, 1 dredge, and 1 drilling-scow carrying 2 Ingersoll drills.

The drilling-scow is accurately located, as it takes each new position, from the ends of a base line on shore 1,000 feet in length.

A sounding float, 20 by 20 feet, with 2 hulls connected by a platform and fixed on 4 spuds, is used for sounding in advance of the drill-scow. Soundings are also taken at each position of the drill-scow. These show the accuracy of the work. A gauge is read hourly, also at times of sounding, and the reduced soundings are plotted nightly on a large map, scale 1 inch to 30 feet.

The estimates for this work are based on the survey made by Mr. H. A. Ulffers, in 1875, and in order to test the accuracy of the zero of the gauge established by him at Amherstburg it was connected with the door-sill of light-house on Bois Blanc Island, but a new sill having been put in since the survey the marks are gone. It was necessary to assume that the level of the sill had not been changed. Assuming a fall of .15 feet between Mr. Ulffers' gauge and the gauge established at the crossing near the work, the line of levels showed that in going 20 feet below the zero of the latter gauge would be giving 20 feet of water, when the water of Lake Erie is at a stage corresponding to the mean of the lowest monthly means for past 17 years.

A comparison of gauge readings taken near the mouth of the river with corresponding readings at Cleveland, Ohio, will be a check on the accuracy of the gauge established at the crossing. The soundings now being taken on the work being those on which payments are based are very accurately made, and they differ at times materially from the soundings given in survey by Mr. Ulffers; this difference will affect the estimated cost of the work.

WORK DONE TO DATE.

The drilling and blasting has been done over an area of 90,000 square feet, containing 7,134 cubic yards, prism measurement. This is 56 per cent. of the whole amount that can be done under the present appropriation of $100,000.

Total number of cubic yards dredged, 3,262. In all probability a large portion of this work will require redrilling, as the required depth, in many places, is not obtained.

These places are generally found where the cutting required is greater than the thickness of the top ledge of rock. It is found that the blasting, though breaking it, does not lift it out of place. The probability is that the resistance of the water above prevents its moving.

The appropriation of June 18, 1878, will be used in continuing the work under this contract. The appropriation of March 3, 1879, when available, will be used, after contract is made, in excavation and deepening the channel.

Accompanying this report is a map, scale $\frac{1}{4800}$, showing the line of channel, the average soundings and work of 1876 in red, and work of 1878 and 1879 in blue.

Very respectfully, your obedient servant,

A. MACKENZIE,
Captain of Engineers,

Maj. G. WEITZEL,
Corps of Engineers, U. S. A.

APPENDIX F F.

ANNUAL REPORT OF MAJOR FRANKLIN HARWOOD, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1879.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 17, 1879.

GENERAL: I have the honor to forward herewith my annual reports for the works of river and harbor improvement under my charge during the fiscal year ending June 30, 1879.

Very respectfully, your obedient servant,

F. HARWOOD,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

F F 1.

SAINT CLAIR FLATS SHIP-CANAL, MICHIGAN.

This canal was projected by Col. T. J. Cram, Corps of Engineers, in August, 1866, as the best method of improving navigation at the mouth of the Saint Clair River. He proposed to abandon the lower tortuous reach of the south channel, and make a direct cut from its mouth proper to deep water in Lake Saint Clair. His project was approved and construction begun on the 20th of August, 1867, under contract with Mr. John Brown, of Thorold, Canada.

The original plan was a straight canal 300 feet wide in the clear and 13 feet deep at low stage of water, protected by dikes 5 feet in height and 58 feet wide on top, built of the material dredged from the channel, and thrown behind a pile and timber revetment. The canal was completed in the autumn of 1871, and turned over to the charge of Maj. O. M. Poe, Corps of Engineers, on the 11th of December. As completed, the banks are 7,221 feet in length, and constructed mostly of dredged sand thrown behind and within a revetment consisting of piling in two rows driven 13 feet apart and parallel, and capped with a timber superstructure 5 feet high, the front row being supplemented with a single row of sheath-piling to prevent the sand-bank from washing back into the canal. As originally planned, the reverse faces of the embankments were to be permitted to take their natural slope, but as it was found that the banks, if left so, would be gradually washed away, they were secured eventually by a pile and plank revetment. Timbers in superstructure were carbolized to prevent rot, but the process proved a disastrous failure, owing to its imperfect application, and the timbers thus treated are, as a general rule at this date, a mere shell with a core of dry rot. The