

APPENDIX BB.

ANNUAL REPORT OF CAPTAIN G. J. LYDECKER, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1879.

UNITED STATES ENGINEER OFFICE,  
*Chicago, Ill., July 15, 1879.*

GENERAL: I have the honor to transmit herewith annual reports of operations for the fiscal year ending June 30, 1879, for works in my charge.

Very respectfully, your obedient servant,

G. J. LYDECKER,  
*Captain of Engineers.*

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

BB 1.

IMPROVEMENT OF THE HARBOR AT CHICAGO, ILLINOIS.

The first step taken by the United States towards the improvement of this harbor was as far back as 1833, by making a straight cut from the lower reach of the Chicago River to the lake, and constructing piers after the usual manner of lake-harbor improvements. These piers were extended from time to time, and the entrance between them deepened by dredging.

The project for constructing an outer harbor was adopted in 1870; this project contemplated the construction of an easterly breakwater 4,000 feet long, placed about 3,300 feet from the shore, and a closing pier extending from the south end of this breakwater to the shore along the dotted line on the accompanying sketch (Plate I). Dredging to obtain ample depth in this basin was a part of the project. Its total cost was estimated at \$867,095.73.

The breakwater was commenced in the fall of 1870, and finished in the fall of 1875. The detailed history of the work up to this time is published in Report of Chief of Engineers for 1876, pp. 433-438. The extension of the north pier to its present limit was completed in 1876. No work was done in 1877, except a few repairs, on account of a lack of funds.

During the past fiscal year 88,758 cubic yards were dredged in the outer harbor, giving a broad channel parallel to the breakwater; and 800 linear feet of crib work have been placed, in accordance with a modified plan, which was recently adopted, and which will be more minutely described below. The condition of the harbor on the 30th of June, 1879, is shown on Plate I, accompanying this report.

The act approved June 18, 1878, appropriated \$75,000 for continuing



the improvement of this harbor, and my project of operations was submitted July 1, as follows:

1. It is proposed to apply \$15,000, or so much thereof as can be advantageously expended, to dredging a broad channel in the outer harbor parallel to the eastern breakwater; the depth of channel to be 16 feet at mean low-water.

2. It is proposed to apply \$55,000 toward breakwater construction. In this connection attention is called to my letter of May 4, 1878, and memoranda inclosed therewith, bearing on the completion of the outer harbor and modification of the present project.

3. It is proposed to apply the remaining \$5,000 to necessary repairs of piers and breakwater.

The above amounts include the usual contingencies of engineering and superintendence for carrying on the work, office expenses, &c. They may be varied within small limits if the best interest of the work should require an increased expenditure under one head at the expense of the other.

The dredging is necessary to enable vessels of all draughts to enter the river through the outer harbor and to enlarge the space available as a roadstead. To illustrate the importance of the latter point, I would state that I have observed during severe gales prevailing at different times since assuming charge of this work, from 12 to 30 vessels riding at anchor south of the harbor unable or afraid to come up under shelter of the breakwater. There is no question that the sheltered area available as a roadstead is much greater than vessel-men suppose, and that many more vessels might be accommodated if this fact were realized; but there are shoal places, particularly towards the northerly limits of the basin, on which vessels have frequently grounded, and fearing these places the first comers rounding the south end of the breakwater drop anchor as soon as they find shelter. In this way a blockade is soon established toward the southerly limits of the basin, and the late comers are barred admission to the roadstead. On this account a number of vessels were wrecked last fall within a mile or a mile and a half south of the harbor (three of them, if I remember correctly, being total losses), accompanied in some cases with loss of life. About 100,000 cubic yards excavation, certainly not to exceed that, will give a channel at least 500 feet wide with a minimum depth of 16 feet. The deepening of this harbor, so as to procure a uniform depth (sufficient for the largest vessels), was completed in the original project, and this dredging is but the beginning of that part of the work. \* \* \*

The work of dredging as proposed having been approved, bids were solicited by advertisement, dated July 31. The contract was awarded to Fitzsimons & Connell, the lowest bidders, and signed August 28, 1878. Operations were commenced on the 3d of September with one dredge, another was added on the 12th, another on the 26th, and a fourth on the 28th of October. The contractors experienced considerable trouble at the start, on account of unfavorable weather and difficulty in procuring sufficient machinery to carry out the provisions of their contract, which required that the daily average should not be less than 1,000 cubic yards. Work was continued until December 12, when the contract was closed. The total amount excavated was 88,758 cubic yards, the number of working days 79, making the daily average 1,123.5 cubic yards. The contractors were paid 16 cents per yard, making total cost of dredging, exclusive of engineering and superintendence, \$14,201.28. The limits of the dredged channel are indicated on the accompanying sketch (Plate I).

Under date of July 16, the following instructions were given by the Chief of Engineers, bearing on the second part of the project:

In regard to the application of the sum of \$55,000 towards breakwater construction, it is deemed advisable, before entering upon the work of extending the breakwater, that the plan proposed by you in modification of that recommended by the Board of Engineers should be submitted to a Board, which will be convened at an early day at Chicago, of which you will be duly notified.

The modified plan referred to above was submitted by me, with letter of May 4, 1878 (published in Report of the Chief of Engineers for 1878, page 1184).

The Board of Engineers, to which the question was submitted, convened in Chicago on the 6th of August, and after careful consideration adjourned until the 5th of November, in order that data essential to

full study and discussion of the subject could be obtained. During this interval the time was fully occupied in making the necessary surveys and examinations, platting the results, preparing detailed estimates of cost, &c. These investigations showed very clearly the necessity of further works to afford the necessary shelter for vessels seeking this port, and for others forced by stress of weather to this end of the lake. To supply this want the construction of an exterior breakwater to the northward of the harbor, covering an anchorage in deep water, was earnestly recommended. The reasons therefor are fully set forth in my report to the Board, dated November 4, 1878. Presuming that the report of this Board, with its accompanying papers, will be published in connection herewith, it is only necessary to add that the modified plan was recommended by the Board, and that the recommendation was duly approved December 9, 1878. This plan is indicated on the accompanying sketch of the harbor (Plate I, sketch B).

Preparations for purchasing the timber, so that it could be taken out during the winter, were commenced at once, but the burning of the building in which our office was located (January 4, 1879) caused considerable delay. A contract for furnishing about 2,000,000 feet board-measure timber, and 21,000 linear feet piles, was finally entered into with George Hannahs, of South Haven, Mich., February 10, 1879, and subsequently arrangements were made for obtaining the necessary iron and stone, so as to begin work as early as possible in the spring. The first cargo of timber was delivered April 10, 1879, and the work of construction commenced April 23. Pile-driving for crib foundation was commenced May 17. The first crib (being the angle crib, 100 by 30 by 14½ feet, see Plate II) was sunk June 8, from which time the work progressed rapidly, so that by June 30 7 more cribs (each 100 by 16 by 14½ feet, see Plate III) had been sunk. The aggregate length of cribs placed during the month of June was 800 feet, and at the end of the month there were 3 more cribs framed and ready for sinking. Being on a foundation of bearing piles, the sunken cribs are all in their true positions, as to line and level, and the work for placing the superstructure has been commenced.

The cost of work to date is approximately as follows:

51, 828 feet (board measure) pine timber, at \$10.25 .....	\$531 24
858, 120 feet (board measure) hemlock, at \$9.25 .....	8, 566 67
12, 000 linear feet piles (squared timber), at 14 cents .....	1, 680 00
50, 000 pounds iron, at 2 cents .....	1, 000 00
1, 059.24 cords stone, at \$4.70; 94 cords stone, at \$4.40 .....	5, 392 03
Sundry bills (tools and machinery) .....	1, 658 96
Labor (pay-rolls for April, May, and June) .....	5, 741 33
Total .....	24, 570 23

The marked advantages and complete success of this method of construction lead me to give some of its details together with something of its history.\*

For a long time previous to assuming charge of the works in this district in the spring of 1877, I had studied with interest the various devices for pier construction on shifting bottoms, and was led to the opinion that if we could substitute a pile foundation the construction of crib-

\* This plan came up before the Board of Engineers in its consideration of Michigan City Harbor, and I take the liberty of quoting here an extract from the report thereon, as follows: "Experience has shown that the locality presents unusual difficulties for harbor construction, and the Board therefore recommends that in future the plan of sinking cribs on bearing piles, recently carried out by Captain Lydecker at Calumet Harbor, be adopted at Michigan City. This plan appears to the Board the best yet devised for crib construction on yielding bottoms."



piers would be greatly facilitated. Modifying the then existing plan of crib to adapt it to this purpose, I caused 3 cribs to be sunk on bearing-piles in extending the north pier at Calumet Harbor during the summer of 1877. The result was submitted to the Department in the following report, dated April 30, 1878:

I have the honor to transmit herewith drawings illustrating a method of constructing crib-piers, or breakwaters, for lake-harbor improvements. The difficulties of securing the stability and permanence of cribs where the natural bed is sand are so well known that they need not be repeated here. It is admitted that the first essential in overcoming these difficulties is to provide a proper foundation, one on which the crib will be truly level when it is first sunk and on which it will remain so at all times. Further, this foundation must be obtained with certainty and economy, while the time required for its construction should not delay the progress of the improvement. These conditions are not supplied by any of the plans in general use. The plan submitted herewith, a foundation of bearing piles cut off at a suitable level below the water surface, has been suggested by others,\* but, so far as I have been able to learn, they made no practical test of it. It is now presented after such a test, the results of which were most satisfactory, and which may be briefly stated as follows: The extension (150 feet) of the north pier at Calumet, Ill., in July and August, 1877, was made on this plan. Three cribs (50 by 20 feet) sunk in August are unchanged in line or level (as shown by careful instrumental measurements) after the numerous severe storms of the past fall and winter; the foundations were easily built before the cribs were ready for sinking; and finally the cost of the entire work was only 83 per cent. of previous estimates for the same extension by the usual method of construction.

The details shown on the drawings herewith must be regarded only as an adaptation of the general project to a special case, and should be modified as circumstances may require. In planning the crib its bottom should be arranged so as to present horizontal surfaces of sufficient magnitude to insure a true bearing on the piles; it should allow stone to pass freely to the lake bottom, so as to surround and support the projecting ends of the piles, while proper provisions should be made for always retaining ample weight in the crib, to insure its stability. The crib represented in the drawing meets these requirements very fully: Four horizontal surfaces, each 3 feet wide, extending the full length of crib, corresponding in position to the rows of piles, constitute the bottom, and supply the first condition; the second is provided by the side pockets, each 4 feet by 6 feet 6 inches in the clear, open at the bottom; and for the third we have the close bottom, central compartments, for holding the weight. The projecting "apron" on each side gives some spread to the foundation, and adds to the stability of the crib. It also intercepts the current along the face of the crib, and by breaking its direct action on the lake bottom prevents the formation of any deep trench close to the pier.

While the cribs are being built advantage should be taken of every suitable day when the lake is still to drive the foundation piles and cut them off at their proper level. Their number will be determined by the weight to be sustained and the nature of the material into which they are driven; their disposition will be regulated by the form of cribs used. The level at which they should be cut off depends mainly upon the depth of the water, though it is my opinion that this level should not be less than 12 feet below the water surface; hence in water of less depth I would recommend dredging to that level. On the other hand, the piles may project as much as 4 or 5 feet above the lake bottom if the water is of sufficient depth, or even more in great depths.

In the case illustrated there are 22 piles under each crib, distributed in four parallel rows, four in each exterior row and seven in each of the interior ones. With the form of crib used the interior rows sustain most of the weight, the outside piles serving mainly to steady the crib. The piles were cut off at a level of 14½ feet below the water surface, to do which a little dredging was necessary. I am now satisfied that 12 feet would have done as well, and the cost would have been correspondingly less.

For the general presentation of the subject further description is unnecessary. As a result of the test to which the method has been put, I feel justified in the belief that we can obtain with certainty a good foundation, securing thereby the stability and permanence of the structure; further, that we can do this at a less cost than by the ordinary methods. This fact may not be appreciated at first, but the following considerations help to show it: By this project the cribs are truly level and in proper alignment, when first sunk—there will be no subsequent settlement nor tilting; hence we may place the superstructure, as soon as the cribs are in position, with no expense

\* To the best of my recollection, my attention was first drawn to this method several years previously on reading a letter of Maj. D. C. Houston's, Corps of Engineers, dated December 21, 1871, and which is published in the Report of Chief of Engineers for 1872, pages 165 to 168.

for leveling up nor correcting the alignments. In this way the work is finished in all its parts; none of the stone can be washed out, and the structure is in the best condition to resist the violence of storms. On the other hand, where the cribs are sunk by the ordinary methods they are generally out of line and level from the beginning; under the action of subsequent storms these irregularities are increased, the unfinished crib settles below the water-surface, considerable stone is washed out, and frequently some of the timbers are broken and torn off. After waiting a sufficient time for settlement—generally until the season after sinking—the cribs must be refilled and the superstructure can then be placed, but to do this the crib must be "leveled up" and "built out" on one side or the other to correct the alignment—an uncertain piece of work beset with numerous difficulties, liable to frequent interruptions, and always attended with considerable expense, varying with circumstances which can be neither foreseen nor controlled.

During the summer of 1878 4 more cribs were sunk on this plan at the same harbor. During the present season, as before stated in this report, 800 linear feet of breakwater have been built on the same principle, the cribs being modified as shown in Plates II and III herewith, to adapt them to the special work in hand.

From the beginning not a crib has been misplaced, nor has one of them moved from its original position.

The unexpended balance of last year's appropriation will be applied to continuing the breakwater construction; it will probably be exhausted by the first of August. The amount appropriated by the act approved March 3, 1879, is \$75,000, and though the funds have not yet been made available the project for its application has been approved as follows:

For breakwater construction.....	\$70,000
For dredging.....	5,000

If the money becomes available in time to prevent any interruption to the work, it is believed that the entire southerly breakwater will be completed during the present season at less than its estimated cost.

When this is finished the construction of the exterior breakwater should be commenced at once, and the work of deepening the completed outer harbor should be vigorously prosecuted. When we consider the vast commercial interests centering at this port, I find the strongest reasons for urging that appropriations be made large enough to complete the work at the earliest date possible.

Where extensive works are in question, large appropriations effect not only a saving in time, but what is of equal, and in many cases of greater importance, the ultimate cost will be very much reduced. Therefore, I have the honor to urge that there be appropriated for breakwater construction during the next fiscal year the sum of \$200,000. For dredging the outer harbor, so as to enable vessels of all draughts to utilize any considerable extent of the sheltered area provided by the completed breakwater, an appropriation of not less than \$50,000 should be made. Hence, I would earnestly recommend that the total appropriation for this harbor, for fiscal year ending June 30, 1881, be not less than \$250,000.

Chicago Harbor is in the collection-district of Chicago. There is a light-house on the shore end of the north pier, a beacon light on the lake end of the same, and one at the south end of the main breakwater.

Number of vessels entered during the year.....	9,334
Number of vessels cleared during the year.....	10,124
Total tonnage of vessels entered and cleared.....	6,890,946
Amount of revenue collected.....	\$1,521,346 97

The estimated cost of the present plan of improvement is \$855,500, for which there was available at the time of its adoption the sum of \$55,500; in the execution of this plan, there had been expended to June 30, 1879, \$23,036. The act of March 3, 1879, appropriated \$75,000, but the money has not yet been made available.



Money statement.

July 1, 1878, amount available.....	\$75,304 22	
Amount appropriated by act approved March 3, 1879.....	75,000 00	
		\$150,304 22
July 1, 1879, amount expended during fiscal year.....	42,840 22	
July 1, 1879, outstanding liabilities.....	8,113 36	
		50,953 58
July 1, 1879, amount available.....		99,350 64
Amount (estimated) required for completion of existing project.....	725,000 00	
Amount that can be profitably expended in fiscal year ending June 30, 1881.....	250,000 00	

Abstract of proposals for dredging 70,000 cubic yards, received and opened August 20, 1878.

No.	Name.	Residence.	Price per cub. yd.
1	Fitzsimons & Connell.....	Chicago, Ill.....	\$0 16
2	Chicago Dredging and Dock Company.....	do.....	22
3	Harry Fox.....	do.....	23
4	O. B. Green.....	do.....	23 1/2
5	Albert Couro.....	Milwaukee, Wis.....	24

Contract awarded to Fitzsimons & Connell.

Abstract of proposals for furnishing timber and piles, received and opened January 28, 1879

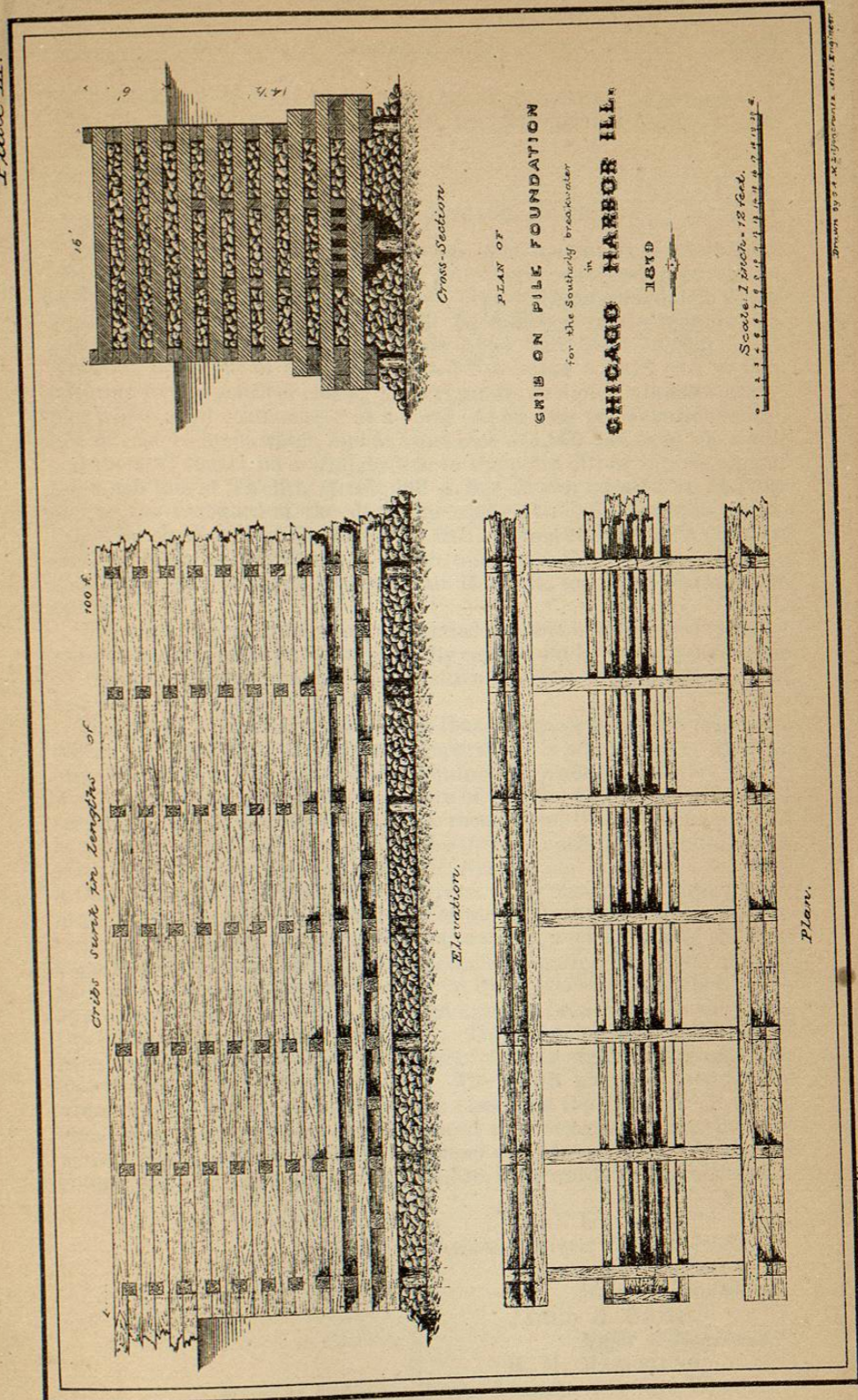
Number.	Name.	Residence.	Lot 1—1,650,000 feet hemlock timber, per M feet, board measure.	Lot 2—445,236 feet pine timber, per M feet, board measure.	Lot 3.	
					21,000 linear feet piles, per linear foot.	Or in lieu of piles, 12" by 12" square timber, per linear foot.
1	George Hannahs.....	South Haven, Mich.....	\$9 75	\$10 25	\$0 10	*\$0 14
2	Charles Mears.....	Chicago, Ill.....	10 90	12 00	11 1/2	†16
3	Street & Chatfield.....	do.....	11 50	11 50	9 1/2	16
4	Fitzsimons & Connell.....	do.....	11 90	11 90	12	
5	Lewis Sands.....	Manistee, Mich.....	12 50	11 50	12 1/2	
6	Hobert Brink.....	Pentwater, Mich.....		14 00	9 1/2	
7	Horace Butters.....	Ludington, Mich.....			9	
8	A. S. Packard §.....	Covert, Mich.....			9	14

\* Hemlock. † Pine. ‡ Pine in lieu of hemlock timber. § Informal; not in duplicate.  
Contract awarded to George Hannahs.

Abstract of contracts in force in the fiscal year ending June 30, 1879.

With—	Dated—	Expires.	Extended to—
Fitzsimons & Connell.....	Aug. 28, 1878	Dec. 1, 1878	Dec. 14, 1879.
George Hannahs.....	Feb. 10, 1879	June 30, 1879	Aug. 1, 1879.

Plate III.





EXTRACT FROM REPORT OF THE BOARD OF ENGINEER OFFICERS CONVENED BY SPECIAL ORDERS NO. 80, HEADQUARTERS CORPS OF ENGINEERS, JULY 24, 1878.

\* \* \* \* \*  
OUTER HARBOR AT CHICAGO, ILLINOIS.

The Board, after careful consideration, is of opinion that the plan of harbor recommended by the Board of Engineers, convened in pursuance of Special Orders No. 1, Headquarters Corps of Engineers, dated Washington, D. C., January 5, 1870, should be modified in the manner proposed by Capt. G. J. Lydecker, in his letter addressed to Maj. D. C. Houston, president of this Board, dated November 4, 1878, viz, by substituting for the south or closing pier originally designed a breakwater or pier which shall commence "at a point (A) on the prolongation of the line of eastern breakwater, and at a distance of 1,000 feet from the south end thereof; thence on a straight line to the point (B) of intersection of the north line of Twelfth street, and a line drawn parallel to, and 500 feet to the eastward of, the dock line along the Lake Park, as established by the Board of Engineers in 1871. From the point (A) build a 'return' to the north 200 feet in length, and more, if it be found that the opening is unnecessarily great or that it admits too much sea into the basin."

The mode of construction recommended for this breakwater is that of cribs on bearing piles, lately successfully carried out by Captain Lydecker at Calumet Harbor, making the "return" 30 feet wide and the rest of the work 16 feet wide.

The Board is further of the opinion that the importance of this harbor, where the number of arrivals and departures is much greater than at any other port on the great lakes, requires some additional work which will facilitate the arrival and departure of vessels, and afford additional security. The Board would therefore recommend the construction of a breakwater to the north and east of the present north pier, behind which vessels seeking this port can anchor in security and be enabled to select a favorable opportunity to enter the river. The reasons for these recommendations are fully set forth in the letter of Captain Lydecker, above referred to, with the accompanying letters from a committee of the Chicago Board of Trade, and Mr. R. S. Littlefield, giving the views of business men and vessel men in reference to the needs of this harbor. The approximate location of this proposed exterior breakwater is shown on the tracing accompanying this report. Its exact location and mode of construction should be made a subject of further study by the officer in charge before being finally decided. The south pier proposed for the present outer harbor, or basin, is also shown on the tracing. It is recommended that this pier be commenced next season. A statement of marine casualties in the collection-district of Chicago for the four years ending July 1, 1878, aggregating \$151,318, is forwarded with this report.

\* \* \* \* \*  
D. C. HOUSTON,  
*Major of Engineers, Brevet Colonel, U. S. A.*  
HENRY M. ROBERT,  
*Major of Engineers.*  
JARED A. SMITH,  
*Major of Engineers.*  
S. M. MANSFIELD,  
*Major of Engineers, Brevet Lieutenant-Colonel, U. S. A.*  
G. J. LYDECKER,  
*Captain of Engineers.*