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FOR THE

FISCAL YEAR ENDED JUNE 30, 1897.

REPORT OF THE

CHIEF OF ENGINEERS.

PART 4.

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REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

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2. Menominee River, Michigan and Wisconsin.
3. Oconto Harbor, Wisconsin.
4. Pensaukee Harbor, Wisconsin.
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6. Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.
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22. Operating and care of locks and dams on Fox River, Wisconsin.
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30. Kewaunee Harbor, Wisconsin.
31. Waukegan Harbor, Illinois.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 15, 1897.

GENERAL: I have the honor to transmit herewith annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

H H I.

IMPROVEMENT OF MENOMINEE HARBOR, MICHIGAN AND WISCONSIN.

The original condition at the mouth of the Menominee River, object of the improvement, projects, and present works were described in detail in Annual Report Chief of Engineers for 1896, page 2459.

Condition of the improvement.—June 30, 1896, the channel had the required dimensions of 200 feet wide and 17 feet deep. Soundings taken February 19, 1897, show that the upper end of it has been reduced in depth 0.5 to 1 foot in places, but the shoals are not of sufficient extent to seriously impede navigation.

The piers are built the full length contemplated.

Operations during the fiscal year.—By hire of labor and purchase of materials in accordance with law, 300 linear feet of the superstructure of the north pier and 100 feet of the south pier were rebuilt, openings between the pile and crib piers were closed with plank shutters to prevent the passage of sand into the channel, and minor repairs were made to the outer end of the south pier.

The work was begun July 15 and completed September 24, 1896.

The materials used and cost of same in place were as follows:

Pine timber and plank	$1,488.15
Iron bolts and spikes	24.79
Stone	255.36
Rent of scow	71.17
Tools, freight, cartage, etc	16.07
Labor, including pay of overseer	1,155.51
Total	3,011.05

Remarks.—In accordance with requirements of river and harbor act of June 3, 1896, a survey was made and report, dated November 30, 1896, submitted for "harbor at Menominee, Michigan and Wisconsin, with a view of obtaining a 20-foot depth of water."

The report, with map, is published in House Doc. No. 86, Fifty-fourth Congress, second session.

The estimated cost of the desired improvement is $18,920.

The upper course of timbers of 1,050 linear feet of the piers require renewal and new decking, and the north pierhead and 130 linear feet of the waling to the protection piling should be renewed. In other respects the piers are in good order.

For the maintenance of the channel and piers for the fiscal year ending June 30, 1899, the following estimate is submitted:

For dredging	$3,000
For repairs	2,000
For contingencies, 10 per cent	500
Total	5,500

Money statement.

July 1, 1896, balance unexpended	$7,182.80
June 30, 1897, amount expended during fiscal year	3,285.28
July 1, 1897, balance unexpended	3,897.52
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	5,500.00

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	August 3, 1882	$15,000
June 10, 1872	25,000	July 5, 1884	10,000
March 3, 1873	25,000	August 5, 1886	3,000
June 23, 1874	25,000	August 11, 1888	9,000
March 3, 1875	25,000	August 17, 1894	10,000
August 14, 1876	8,000	June 3, 1896	7,150
June 18, 1878	10,000	Miscellaneous receipts credited to appropriations	62
March 3, 1879	10,000		
June 14, 1880	10,000		
March 3, 1881	12,000	Total	229,212

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. Joseph Werner, deputy collector of customs.]

Name of harbor, Menominee, Mich.; collection district, Superior, Mich.; nearest light-house, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	400	136,326	400	138,955
Sail	367	49,704	318	40,321
Total	767	186,030	718	179,276

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Butter	½	Eggs	1⅛
Fish	39	Flour	2¼
Lath	2,498⅛	Hay	197
Lumber	259,827⅜	Lime and cement	3¾
Merchandise (general)	38,806	Lumber	357
Shingles	697⅛	Merchandise (general)	9,710
Wood	512	Mill stuffs	12
		Oats	33¾
Total	302,380⅛	Salt	105
		Shingles	7⅛
IMPORTS.		Stone	140
Apples	367	Wood	8⅛
Brick	12¼		
Butter	1	Total	15,878⅛
Coal and coke	4,616		

NOTE.—The railroad companies decline to give statement of their business, hence the statistics by all ways of transportation could not be given.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. B. H. Anderly, deputy collector of customs.]

Name of harbor, Marinette, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	326	97,410	329	97,647
Sail	243	72,183	255	72,591
Total	569	169,593	584	170,238

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	82.5	Apples	210
Flour	125	Cattle	1
Lath	500	Coal and coke	4,922
Lime and cement	108.5	Eggs	4.5
Lumber	252,752	Flour	40
Merchandise (general)	97	Hay	143
Paper	120	Lumber	202.5
Pease	20	Merchandise (general)	195
Salt	12.5	Oats	.5
Shingles	195	Salt	1,812
Soap	4.5	Wheat	.5
Wood	140		
		Total	7,535.5
Total	254,157		

H H 2.

IMPROVEMENT OF MENOMINEE RIVER, MICHIGAN AND WISCONSIN.

The original condition of the Menominee River, the object of the improvement and the projects for carrying it out, were fully described in the Annual Report Chief of Engineers for 1896, p. 2463.

Condition of the improvement.—The projects of 1890 and 1892 have been completed. Since completion a shoaling of from 1 to 2 feet has occurred in places.

Dredging under the contract now in force will form the turning basin and extend the channel to Wells Street in accordance with the project of 1896, and also admit of redredging the channel where most needed.

Operations during the fiscal year.—Under the existing contract with William A. Starke for the removal of 111,000 cubic yards of material, more or less, dredging was begun April 27, 1897, and to June 30, 1897, 60,837 cubic yards were excavated, resulting in the completion of the turning basin and dredging about 30 per cent of the amount required to extend the channel to the west side of Wells street.

Remarks.—The depth of water in the channel is reduced by materials brought down the river during heavy spring freshets rendering periodical dredging necessary to maintain the required depth.

For the maintenance of the channel an appropriation of $5,000 is recommended for the fiscal year ending June 30, 1899.

Original estimate (see House Ex. Doc. No. 34, Fifty-first Congress, first session)	$109,609.80
Revised estimate (see Report of Chief of Engineers, 1891, pp. 2529–2530).	74,500.00
Estimate for turning basin and extension of channel to Wells street, (see report of Chief of Engineers, 1896, page 2464)	13,800.00

Money statement.

July 1, 1896, balance unexpended		$15,014.47
June 30, 1897, amount expended during fiscal year		3,890.61
July 1, 1897, balance unexpended		11,123.86
July 1, 1897, outstanding liabilities	$2,620.20	
July 1, 1897, amount covered by uncompleted contracts	6,190.47	
		8,810.67
July 1, 1897, balance available		2,313.19
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

APPROPRIATIONS.

Act of—	
September 19, 1890	$54,000.00
July 13, 1892	20,500.00
August 17, 1894	6,000.00
June 3, 1896	15,000.00
Miscellaneous receipts credited to appropriations	80.03
Total	95,580.03

Abstract of proposals for dredging 70,000 cubic yards of material at Menominee River, Michigan and Wisconsin, received in response to advertisement dated September 1, 1896, and opened October 6, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.		Total for 70,000 cubic yards.
		Sand, clay, mud, etc.	Bowlders and hard pan.	
		Cents.	*Cents.*	
1	Arthur H. Vogel, Milwaukee, Wis	12.9	12.9	$9,030
2	William A. Starke, Milwaukee, Wis	9	25	*a* 7,996
3	Green's Dredging Co., Chicago, Ill	15	25	11,560
4	Racine Dredge Co., Racine, Wis	9	27	8,208

a The cost being so low, a contract was made for 111,000 cubic yards, more or less.

Amount of appropriation available for this work $13,000.

With the approval of the Chief of Engineers, a contract was entered into October 14, 1896, with William A. Starke, the lowest responsible bidder for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
William A. Starke	Dredging 111,000 cubic yards.	Oct. 22, 1896	Apr. 27, 1897	Dec. 1, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

The commercial statistics for the Menominee River are the same as for Menominee Harbor, Michigan, and Marinette, Wis.

H H 3.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

The original condition of the Oconto River, the object of its improvement, and the project for carrying it out, and present works, were fully described in the Annual Report Chief of Engineers for 1896, p. 2465.

The original project was modified in 1897 by making Spies's mill the terminus of the improved channel, instead of Section Street Bridge, thereby abandoning 3,800 linear feet of the originally projected improvement.

Condition of the improvement.—Soundings taken in April, 1897, showed the channel to have a width of 70 feet, and a depth of 9 feet from Green Bay to within about 300 feet of Spies's mill; for the latter distance the governing depth was about 8 feet.

Operations during the fiscal year.—Under contract dated August 28, 1896, with the Green Bay Dredge and Pile Driver Company for dredging 45,000 cubic yards, more or less, work was begun September 5, 1896, and completed November 12; 48,060.4 cubic yards of material were removed under this contract, resulting in an increase in depth from 7 feet to 9 feet from Green Bay to Spies's mill, and a width of 70 feet.

Remarks.—The channel should be widened 30 feet in order to obtain the required width of 100 feet. To give the north pier the length contemplated it should be extended 875 feet. Three hundred and twenty feet of the north pier (damaged by fire) and 300 feet of the south pier require repairs. The remainder of the piers are in fair condition.

The estimate to complete the work before the modification of project was adopted was $72,000; the estimate to complete it as modified was $37,610, being a reduction of $34,390. The estimate for repairs needed to the piers, $3,100, and annual dredging for maintenance of the channel, $6,000, added to $37,610 for completion, makes the aggregate estimate $46,710.

The estimate, therefore, for fiscal year ending June 30, 1899, is—

For completion of modified project	$37,610
For repairs to piers	3,100
For maintenance of channel	6,000
Total	46,710

Money statement.

July 1, 1896, balance unexpended	$4,896.77
June 30, 1897, amount expended during fiscal year	4,741.89
July 1, 1897, balance unexpended	154.88
Amount (estimated) required for completion of existing project	37,610.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	*46,710.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1881	$10,000	July 13, 1892	$3,000
August 2, 1882	15,000	August 17, 1894	3,000
July 5, 1884	15,000	June 3, 1896	4,000
August 5, 1886	8,000		
August 11, 1888	20,000	Total	78,000

Abstract of proposals for dredging 37,000 cubic yards of material at Oconto Harbor, Wisconsin, received in response to advertisement dated August 1, 1896, and opened August 20, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.	Total for 37,000† cubic yards.
		Cents.	
1	Green's Dredging Co., Chicago, Ill	20	$7,400.00
2	Racine Dredge Co., Racine, Wis	12½	4,625.00
3	Green Bay Dredge and Pile Driver Co., Green Bay, Wis	8	2,960.00
4	C. E. Mitchell & Co., Ludington, Mich	13½	4,995.00
5	George Cooper and Theodore Joesch, Manitowoc, Wis	13¾	5,085.50
6	Oconto Company, Oconto, Wis	10	3,700.00

* $9,100 for maintenance.
† The cost being so low, a contract was made for 45,000 cubic yards, more or less.

Amount of appropriation available for this work $4,000.

With the approval of the Chief of Engineers, a contract was entered into August 28, 1896, with Green Bay Dredge and Pile Driver Company, the lowest responsible bidder, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by the mayor of Oconto, Wis.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sherwood Point, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,050	52,800	1,045	51,400
Sail	230	22,620	235	24,300
Tow barge	182	72,800	182	72,800
Total	1,462	158,220	1,462	148,500

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Fish	2,800	Corn	187½
Hay	330	Eggs	1
Lath	412½	Flour	1,467½
Lumber	12,000	Furniture	27½
Oats	5,020	Hay	650
Pease	25½	Hogs	213
Poles (telegraph)	36,975	Iron and steel	700
Posts (fence)	2,280	Leather	4½
Potatoes	1,890	Lime and cement	1,083
Saw logs	12,000	Marble	16
Shingles	3,060	Merchandise (general)	9,000
Ties (railroad)	3,262	Mill stuffs	1,600
Wood	31,750	Oats	12,000
Wool	5½	Oil	474½
		Plaster (land)	110
Total	111,811	Pork and beef	720
		Provisions	900
Total approximate value	$659,480	Salt	600
		Sash, doors, and blinds	30
IMPORTS.		Saw logs	6,000
		Sheep	40
Agricultural implements	11½	Stone	3,920
Apples	90	Wagons and carriages	85
Barley	84	Wheat	1,050
Beer	373½	Wood	2,750
Brick	920	Woodenware	12½
Butter	90		
Cattle	810	Total	49,280
Chairs	3		
Cheese	36½	Total approximate value	$1,277,395
Coal and coke	2,220		

Principal articles of export and import—Continued.

[By all ways of transportation.]

Articles.	Tons.
EXPORTS.	
Bark (tan)	88,720
Beans	180
Beer	1,437½
Corn	392¾
Fish	5,000
Hay	1,450
Hides	200
Lath	8,850
Lumber	90,000
Mill stuffs	480
Oats	7,200
Peas	28¾
Poles (telegraph)	95,000
Posts (fence)	23,560
Potatoes	2,220
Saw logs	12,000
Shingles	5,250
Ties (railroad)	4,228
Wood	47,500
Wool	7½
Total	338,704¼
Total approximate value	$2,940,262
IMPORTS.	
Agricultural implements	28
Apples	225
Barley	180
Beer	1,095⅛
Brick	1,721
Butter	120
Cattle	1,880
IMPORTS—continued.	
Chairs	7⅛
Cheese	125
Coal and coke	8,600
Corn	886
Eggs	2¼
Flour	2,257⅛
Furniture	82
Hay	12,000
Hogs	530
Iron and steel	1,150
Leather	7½
Lime and cement	1,247
Marble	84
Merchandise (general)	19,700
Mill stuffs	14,200
Oats	25,600
Oil	837
Plaster (land)	240
Pork and beef	1,128
Provisions	1,850
Salt	1,050
Sash, doors, and blinds	75
Saw logs	13,800
Sheep	68
Stone	4,480
Wagons and carriages	222⅛
Wheat	2,010
Wood	8,500
Woodenware	102½
Total	119,491
Total approximate value	$1,968,840

H H 4.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

The original condition of the mouth of Pensaukee River, object of the improvement, project, and present works were described in detail in Annual Report of Chief of Engineers for 1896, page 2468.

Condition of the improvement.—The harbor pier is in about the same condition as on June 30, 1896. A survey made in 1890 showed the governing depth at that time to be 3.8 feet. Soundings taken in April, 1897, showed a depth in channel varying from 3 to 10 feet below the datum plane of harbor improvements, the average being about 5 feet.

Operations during the fiscal year.—There have been no operations by the United States at this harbor during the fiscal year.

Remarks.—Some dredging was done by private parties in 1895. No dredging has ever been done at this harbor by the United States, except 5,698 cubic yards during fiscal year ending June 30, 1884.

There appears to be no prospect of any new industries being located at this harbor, and there is no one there, except those engaged in or interested in fishing, to the number of twelve or fourteen persons, who seems to take any interest in the harbor.

It is considered that the funds available will be sufficient to make any repairs and do any dredging that may be necessary during the fiscal year ending June 30, 1899, and no further appropriation is recommended.

No arrivals and departures of vessels were reported at this harbor for the calendar year ending December 31, 1896.

Money statement.

July 1, 1896, balance unexpended	$1,000.00
July 1, 1897, balance unexpended	1,000.00

APPROPRIATIONS.

Act of—	
August 2, 1882	$10,000
July 5, 1884	5,000
June 3, 1896	1,000
Total	16,000

H H 5.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Fox River near its mouth constitutes the harbor of Green Bay. Its original condition, object of improvement, projects, and present works were described in detail in Annual Report of Chief of Engineers for 1896, pages 2469, 2470.

Projects.—1896: The modification in the project for improving "Fox River below Depere," approved July 11, 1896, provided for increasing the depth of channel to 15 feet, as wide as available funds would admit, the ultimate depth to be 17 feet.

1897: The modification in the project for improving "Green Bay Harbor," approved March 9, 1897, provided for increasing the width of entrance at the northern end of the channel 300 feet, making its total width 500 feet.

Condition of the improvement.—The revetments at Grassy Island are in fair condition. The channel, 15 feet deep, 200 feet wide, was completed in 1892. The 17-foot channel has a minimum width of 100 feet. Dredging now in progress is to give it a least width of 200 feet.

Fox River below Depere.—A channel 150 feet wide, 13 feet deep, was completed in 1894. Dredging now in progress is for increasing the depth to 15 feet and as wide as available funds will admit.

Operations during the fiscal year.—Under contract with Racine Dredge Company, dated October 14, 1896, for dredging 250,000 cubic yards, more or less, work was begun June 1, 1897, and is in progress at the close of the fiscal year.

The number of cubic yards of material removed under this contract to June 30, 1897, was 44,610.

To comply with a provision in river and harbor act of June 3, 1896, appropriating $25,000 for improving Green Bay Harbor, viz, "of which sum five thousand dollars may, in the discretion of the Secretary of War, be expended on the Fox River below Depere," a contract, dated May 14, 1897, was entered into with the lowest bidder, Mr. Arthur H. Vogel, for dredging 45,000 cubic yards, more or less. Under this contract dredging was begun June 2, 1897, and at the close of the fiscal year 17,935 cubic yards of material had been removed.

Remarks.—It is deemed worthy of record that the price paid the Racine Dredge Company for dredging under the existing contract, viz, 6⅝ cents per cubic yard, scow measure, is the lowest ever paid for work of that character in this district.

The first contract for dredging at this harbor was in 1866, and the price then paid was 50 cents per cubic yard.

Owing to the extremely low prices for dredging under the present and preceding contracts, the estimate to complete the work, as modified in 1897, was reduced from $26,915 to $2,200.

The estimate for completing the channel in Fox River below Depere to dimensions of 150 feet wide, 17 feet deep, was $35,000, of which sum $5,000 were appropriated by act of June 3, 1896.

Estimate for fiscal year ending June 30, 1899.

To complete Green Bay Harbor in accordance with modified project of 1897	$2,200
For repairs to revetments at Grassy Island	1,000
For dredging for maintenance of channel	5,000
Contingencies	600
	8,800
For completing channel in Fox River below Depere in accordance with modified project of 1896	30,000
Total	38,800

Money statement.

July 1, 1896, balance unexpended		$26,703.48
June 30, 1897, amount expended during fiscal year		1,241.10
July 1, 1897, balance unexpended		25,462.38
July 1, 1897, outstanding liabilities	$4,293.99	
July 1, 1897, amount covered by uncompleted contracts	17,306.69	
		21,600.68
July 1, 1897, balance available		3,861.70
Amount (estimated) required for completion of existing project		32,200.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		*38,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—		Act of—	
June 23, 1866	$30,500.00	August 2, 1882	$20,000.00
March 2, 1867	45,000.00	July 5, 1884	10,000.00
July 25, 1868 (allotted)	17,500.00	August 5, 1886	7,000.00
April 10, 1869 (allotted)	44,550.00	August 11, 1888	10,000.00
July 11, 1870	17,500.00	September 19, 1890	10,000.00
March 3, 1871	17,500.00	July 13, 1892	25,000.00
March 3, 1873	20,000.00	August 17, 1894	25,000.00
June 23, 1874	10,000.00	June 3, 1896	25,000.00
March 3, 1875	10,000.00	Miscellaneous receipts credited to appropriations	52.50
August 14, 1876	8,000.00		
June 18, 1878	5,000.00		
March 3, 1879	4,000.00		
June 14, 1880	6,000.00	Total	372,602.50
March 3, 1881	5,000.00		

* $6,600 for maintenance.

Abstract of proposals for dredging 200,000 cubic yards of material at Green Bay Harbor, Wisconsin, received in response to advertisement dated September 1, 1896, and opened October 6, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 200,000 [a] cubic yards.
		Cents.	
1	Arthur H. Vogel, Milwaukee, Wis	8 7/10	$17,400.00
2	Green Bay Dredge and Pile Driver Co., Green Bay, Wis	8	16,000.00
3	William A. Starke, Milwaukee, Wis	10	20,000.00
4	Green's Dredging Co., Chicago, Ill	13	26,000.00
5	A. McGillis & Co., Cleveland, Ohio	8½	17,000.00
6	Racine Dredge Co., Racine, Wis	6⅝	13,250.00

[a] The cost being so low, a contract was made for 250,000 cubic yards, more or less.

Amount of appropriation available for this work, $18,000.

With the approval of the Chief of Engineers, a contract was entered into October 14, 1896, with Racine Dredge Company, the lowest responsible bidders for this work.

Abstract of proposals for dredging 50,000 cubic yards of material at Green Bay Harbor, in Fox River, below Depere, Wis., received in response to advertisement dated April 5, 1897, and opened May 6, 1897, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 50,000 cubic yards.
		Cents.	
1	John Smith, Manistee, Mich	10	$5,000.00
2	Green Bay Dredge and Pile Driver Co., Green Bay, Wis	10	5,000.00
3	Eggers & Simono, Two Rivers, Wis	10	5,000.00
4	William A. Starke, Milwaukee, Wis	10	5,000.00
5	Chicago Dredging and Dock Co., Chicago, Ill	12¾	6,375.00
6	Arthur H. Vogel, Milwaukee, Wis	9½	4,750.00
7	Racine Dredge Co., Racine, Wis	10½	5,250.00

Amount of appropriation available for this work, $4,300.

With the approval of the Chief of Engineers, a contract was entered into May 14, 1897, with Arthur H. Vogel, the lowest responsible bidder, for this work.

List of all contracts in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Racine Dredge Co	Dredging 250,000 cubic yards	Nov. 2, 1896	June 1, 1897	Dec. 1, 1897
Arthur H. Vogel	Dredging 45,000 cubic yards in Fox River below Depere.	June 1, 1897	June 2, 1897	Nov. 1, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. M. J. McCormick, agent Lackawanna Transportation Company.]

Name of harbor, Green Bay, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	363	181,398	368	182,497
Sail	228	51,605	228	51,702
Total	591	233,003	596	234,199

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Barley	18, 200	Agricultural implements	245
Brick	507	Apples	1, 184
Butter	½	Beer	17
Cattle	87	Cattle	38½
Cheese	2, 524½	Cement	402¾
Corn	600	Cheese	27½
Fish	911¾	Coal and coke	170, 811
Flour	19, 832	Fish	1, 078½
Hay	4, 783	Furniture	13¾
Hides	25	Hay	15
Hogs	6	Iron and steel	3, 800
Malt	1, 000	Marble	120
Merchandise (general)	92, 423	Merchandise (general)	149, 276
Mill stuffs	5, 697	Oil	463½
Oats	35, 312	Plaster (land)	434
Oil	67½	Pork and beef	180
Pease	6, 000	Posts (fence)	328¾
Pork and beef	8½	Rye	173½
Potatoes	125¾	Salt	9, 180
Rye	14, 000	Shingles	99¾
Salt	53½	Wagons and carriages	18¾
Wheat	9, 000	Wood	14, 690
Wool	82	Total	352, 096½
Total	211, 195¾		

H H 6.

IMPROVEMENT OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

The original condition, object of the improvement, project, and present works were described in detail in Annual Report of Chief of Engineers for 1896, pages 2471 and 2472.

Project of 1896.—A modification of the original project, approved August 4, 1896, provides for a width of 250 feet between revetments for the westerly 1,000 feet of the canal and the dredging and maintenance of a channel 200 feet wide and 15 feet deep below the datum plane of harbor improvements from the westerly end of canal to deep water in Sturgeon Bay. It is also provided that when the old revetments are replaced in the narrow part of the canal they shall be set back so as to give a width of 160 feet between them.

Condition of the improvement.—For a distance of 6,200 feet on the north side and 4,900 feet of the south side, measuring from the east or lake end, the canal banks are protected by revetments. Work now in progress will extend the revetment on south side 1,300 feet during the present working season, making its total length 6,200 feet.

June 30, 1897, the governing depth in the channel was about 15 feet below the datum plane of harbor improvements, being the same as at the beginning of the fiscal year.

Operations during the fiscal year.—By hire of labor, the use of a Government dredge, and the purchase of materials in accordance with law the north revetment was extended 555½ linear feet and the south revetment 963 linear feet. Work on the extension of the south revetment was in progress at the close of the fiscal year. Thirty thousand four hundred and twenty cubic yards of material was excavated in widening for new revetment.

By hire of labor and purchase of materials in accordance with law 150 linear feet of guide piling was built on the north side of the harbor entrance to the canal. The fender piling consists of two parallel rows of round piles driven at 2-feet centers each way, with upper and lower outsides wales of 12 by 12 inch white oak, inner wale of 12 by 12 inch white pine, and inside binder 8 by 12 inch white pine, all securely bolted together with screw bolts. The channel face of the oak wales is protected with heavy railroad iron.

Remarks.—Since the purchase of the canal by the Government in 1893 the tonnage passing through this important waterway has increased over 50 per cent, notwithstanding the commercial depression of the past three years. This rapidly increasing commerce plainly demonstrates the importance of the early completion of the present project for widening both the canal and the channel in Sturgeon Bay.

The estimated cost of project adopted in 1894 (see Report of Chief of Engineers, 1894, p. 2057) was		$98,450
Additional estimate, modified project of 1896—		
Increasing width of westerly 1,000 feet of canal to 250 feet	$4,750	
Increasing width of channel in Sturgeon Bay to 200 feet	10,300	
Total additional estimate		15,050
Total		113,500
Total appropriations, exclusive of purchase		50,000
Amount (estimated) to complete present project		63,500

An appropriation of $63,500 is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$32,171.76
June 30, 1897, amount expended during fiscal year	16,088.26
July 1, 1897, balance unexpended	16,083.50
Amount (estimated) required for completion of existing project	63,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	63,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
July 13, 1892 (for purchase)	$81,833
August 17, 1894	20,000
June 3, 1896	30,000
Total	131,833

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. Adam N. Dier, superintendent Sturgeon Bay and Lake Michigan Ship Canal.]

Name, Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, on north pier head, entrance to harbor.

Arrivals and departures of vessels.

Class.	Bound down.		Bound up.		Total.	
	No.	Net tons.	No.	Net tons.	No.	Net tons.
Steam	1,077	441,163	986	372,448	2,063	813,611
Sail	793	153,908	689	115,204	1,482	269,112
Unrigged	232	233,425	254	242,000	486	475,425
Total	2,102	828,496	1,929	729,652	4,031	1,558,148

Navigation through the canal for the season of 1896 was resumed April 10, the date on which the car-ferry steamer *Ann Arbor No. 2* forced a passage through the ice in Green Bay, and was practically closed December 20, the active season being, therefore, two hundred and fifty-four days long.

Average number of vessels passing through the canal per day for the whole season (not including tugs)	15.92
Average number of net tons passing through the canal per day for the whole season (not including tonnage of tugs)	6,158.68
Average net tonnage of steam craft	394.33
Average net tonnage of sail craft	181.58
Average net tonnage of unrigged craft	978.24

Statement of freight and passengers carried through the canal for the calendar year ending December 31, 1896.

Articles.	Net tons.
BOUND DOWN.	
Agricultural implements	1,767
Apples	784
Beans	15
Beef and pork	388
Brick	628
Coal and coke	29,897
Fish	547
Flour and grain	2,178
Grindstones	150
Hay	280
Iron (manufactured)	9,659
Iron (pig)	699
Leather	100
Lumber (hard wood)	1,090
Merchandise (general)	37,007
Oils	1,508
Piles	75
Poles (telegraph)	10
Salt	15,785
Stone (building and crib)	259
Total cargo	102,826
Passengers ... number	5,836
BOUND UP.	
Bark	670
Brick	100
Coal	265
Dairy products	248
Fish	252
Flour and grain	17,269
Hay	992
Hides	151
Ice	300
Iron (manufactured)	750
Iron (ore)	8,100
Iron (pig)	5,826
Logs	4,400
Lumber	519,436
Merchandise (general)	6,621
Oils	214
Piles	11,301
Poles (telegraph)	14,339
Posts (fence and paving)	1,032
Potatoes	776
Stone (building and crib)	59,930
Ties (railroad)	28,421
Trees (shade and Christmas)	1,440
Wood	45,697
Wool	14
Total cargo	728,544
Passengers ... number	3,865

Statement showing amount and estimated value of freight carried through the canal for the calendar year ending December 31, 1896.

Items.	Quantity.	Price per unit.	Total valuation.
Agricultural implements........tons..	1,767	$150.00	$265,050.00
Apples........barrels..	10,450	4.00	41,800.00
Bark........cords..	609	6.00	3,654.00
Beans........bushels..	500	1.00	500.00
Beef and pork........barrels..	3,230	10.00	32,300.00
Brick........M..	364	10.00	3,640.00
Coal and coke........tons..	30,162	3.50	105,567.00
Dairy products........do....	248	150.00	37,200.00
Fish........do....	799	80.00	63,920.00
Flour........barrels..	92,350	5.00	461,750.00
Grain:			
Barley........bushels..	50,000	.50	25,000.00
Corn........do....	4,200	.50	2,100.00
Malt........do....	32,579	.55	17,918.45
Oats........do....	20,000	.35	7,000.00
Pease........do....	120,645	.90	108,580.50
Wheat........do....	145,030	.65	94,269.50
Grindstones........tons..	150	30.00	4,500.00
Hay........do....	1,272	10.00	12,720.00
Hides........do....	151	100.00	15,100.00
Ice........do....	300	3.00	900.00
Iron:			
Manufactured........do....	10,409	50.00	520,450.00
Ore........do....	8,100	3.50	28,350.00
Pig........do....	6,525	17.00	110,925.00
Leather........do....	100	150.00	15,000.00
Logs........M feet B. M..	740	12.00	8,880.00
Lumber (hard wood)........do..	545	30.00	16,350.00
Lumber (all other kinds)........do....	346,291	15.00	5,194,365.00
Merchandise (general)........tons..	43,628	150.00	6,544,200.00
Oils........barrels..	7,650	7.00	53,550.00
Piles (round)........number..	3,670	3.00	11,010.00
Poles (telegraph)........do....	84,946	1.00	84,946.00
Posts (fence and paving)........do....	57,455	.10	5,745.50
Potatoes........barrels..	10,350	2.00	20,700.00
Salt........do....	105,235	.90	94,711.00
Stone (building and crib)........tons..	60,189	.90	54,170.10
Ties (railroad)........number..	348,859	.20	69,771.80
Trees (shade and Christmas)........do....	48,000	.25	12,000.00
Wood........cords..	18,259	4.00	73,036.00
Wool........tons..	14	200.00	2,800.00
Total value of freight........	....	....	14,224,429.85

Comparative statement of principal items of commerce through the canal for the calendar years 1895 and 1896.

Items.	Year. 1895.	Year. 1896.	Increase.	Decrease.
Vessels........number..	3,349	4,031	682	....
Tonnage........tons..	1,304,815	1,558,148	253,333	....
Tonnage (freight)........do..	810,970	831,370	20,400	....
Passengers........number..	10,989	9,700	....	1,289
Agricultural implements........tons..	227	1,767	1,540	....
Apples........barrels..	11,340	10,450	....	890
Beef and pork........do..	....	3,230	3,230	....
Brick........M..	1,531	364	....	1,167
Coal and coke........tons..	29,644	30,162	518	....
Fish........do...	946	799	....	147
Flour........barrels..	93,683	92,350	....	1,333
Grain (all kinds)........bushels..	337,491	372,454	34,963	....
Hay........tons..	4,338	1,272	....	3,066
Iron:				
Manufactured........do...	5,861	10,409	4,548	....
Ore........do...	1,925	8,100	6,175	....
Pig........do...	4,855	6,525	1,670	....
Lumber........M feet B. M..	386,880	346,836	....	40,044
Merchandise (general)........tons...	30,853	43,628	12,775	....
Oils........barrels..	....	7,650	7,650	....
Piles (round)........number..	1,089	3,670	2,581	....
Poles (telegraph)........do....	10,475	84,946	74,471	....
Posts (fence and paving)........do....	92,812	57,455	....	35,357
Potatoes........barrels..	6,491	10,350	3,859	....
Salt........do....	83,964	105,235	21,271	....
Stone (building and crib)........tons..	71,212	60,189	....	11,023
Ties (railroad)........number..	163,900	348,859	184,959	....
Trees (shade and Christmas)........do....	22,000	48,000	26,000	....
Wood........cords..	12,805	18,259	5,454	....

Estimated value of freight passing through canal during the calendar year ending December 31, 1895	$12,171,903.75
Estimated value of freight passing through the canal during the calendar year ending December 31, 1896	14,224,429.85
Increase of 1896 over 1895	2,052,526.10

Statement showing number and net tonnage of tugs passing through the canal during the calendar year ending December 31, 1896, and the number of vessels and scows towed during that time.

Month.	Bound down.				Bound up.			
	Number.	Net tons.	Vessels towed.	Scows towed.	Number.	Net tons.	Vessels towed.	Scows towed.
April	39	1,092	20	9	40	1,075	24	11
May	121	3,274	56	30	126	3,407	34	31
June	146	4,149	55	38	151	4,200	72	33
July	134	3,788	64	32	145	4,162	71	38
August	104	3,117	22	28	107	3,191	46	23
September	108	3,269	38	27	116	3,651	40	34
October	156	4,544	64	26	159	4,509	60	35
November	133	4,006	44	33	150	4,411	32	38
December	14	758	6	7	22	830	3	9
Total	955	27,997	359	230	1,016	29,436	382	252

Total number of trips made through canal by tugs for whole season	1,971
Total number of net tons	57,433
Total number of vessels towed	741
Total number of scows towed	482
Total number of vessels and scows towed	1,223
Average net tonnage of tugs	29.13
Average number passing through the canal per day for the whole season	7.79
Number of tugs stationed at canal for local towing	6
Net tonnage of tugs stationed at canal for local towing	190
Length of towing route from harbor entrance to mouth of Sturgeon Bay, miles	8¼

Statement of class and tonnage of vessels coming in from the lake via the canal during the season to seek shelter in Sturgeon Bay from storms.

Month.	Steam.		Sail.		Unrigged.		Total.	
	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.	Number.	Net tons.
April	8	5,665	6	1,598	3	3,036	17	10,289
May	13	6,283	12	3,172	3	1,100	28	10,555
June	2	505	10	3,752	2	800	14	5,057
July	7	1,296	9	2,742	7	6,107	23	10,145
August	5	1,119	22	5,069	2	2,962	29	9,114
September	6	1,623	17	4,362	6	4,726	29	10,711
October	11	4,039	37	6,381	8	11,095	56	21,515
November	10	3,172	18	4,739	3	3,334	31	11,255
December	9	3,373	3	177	4	5,970	16	9,520
Total	71	27,075	134	31,992	38	39,094	243	98,161

No record was kept of those craft bound out detained at Sturgeon Bay by stormy weather, though at times during the spring and fall months the outbound fleet thus sheltered numbered from 20 to 45 craft, not including those that came in from the lake via the canal to seek a harbor of refuge in this bay.

Craft hailing from nearly every principal port on the chain of lakes could be found among those sheltered here during storms, the natural landlocked harbor of Sturgeon Bay affording ample room and perfect protection from all storms, whichever quarter the wind may blow from.

Total number of steam craft sheltered during the season (only those coming in from the lake via the canal being counted)	71
Total number of sail craft sheltered during the season (only those coming in from the lake via the canal being counted)	134
Total number of unrigged craft sheltered during the season (only those coming in from the lake via the canal being counted)	38
Average net tonnage of steam craft sheltered	381.33
Average net tonnage of sail craft sheltered	238.74
Average net tonnage of unrigged craft sheltered	1,028.78

Class, quantity, and estimated value of cargoes carried by vessels while sheltered in Sturgeon Bay, season of 1896, only those coming in from the lake via the canal being included.

Items.	Quantity.	Price per unit.	Total valuation.
Agricultural implements .... tons..	51	$150.00	$7,650.00
Apples .... barrels..	3,050	4.00	12,200.00
Bark .... cords..	420	6.00	2,520.00
Brick .... M..	100	10.00	1,000.00
Coal and coke .... tons..	4,233	3.50	14,815.50
Flour .... barrels..	5,900	5.00	29,500.00
Grain (oats) .... bushels..	2,000	.35	700.00
Hay .... tons..	288	10.00	2,880.00
Iron:			
Manufactured .... tons..	586	50.00	29,300.00
Ore .... do....	550	3.50	1,925.00
Pig .... do....	65	17.00	1,105.00
Lumber .... M feet B. M..	12,870	15.00	192,050.00
Merchandise (general) .... tons..	2,595	150.00	389,250.00
Piles (round) .... number..	100	3.00	300.00
Poles (telegraph) .... do....	4,875	1.00	4,875.00
Pork .... barrels..	1,560	10.00	15,600.00
Posts (fence and paving) .... number..	1,800	.10	180.00
Potatoes .... barrels..	2,000	2.00	4,000.00
Salt .... do....	1,640	.90	1,476.00
Stone (building and crib) .... tons..	11,354	.90	10,218.60
Ties (railroad) .... number..	51,300	.20	10,260.00
Trees (shade) .... do....	8,000	.25	2,000.00
Wood .... cords..	2,934	4.00	11,736.00
Total estimated value of cargoes	....	....	745,041.10
Total approximate value of vessels sheltered	....	....	3,709,011.00
Approximate value of vessels and cargoes	....	....	4,454,052.10

The valuation of vessel property seeking shelter in Sturgeon Bay via the canal during the past season, as given above, is based on the valuation given in Lloyd's Vessel Register, and is approximate.

Principal lines of transportation using the canal during the past year and number and net tonnage of boats comprising each line.

Name of line.	Home port.	Number of boats.	Net tonnage.
Toledo, Ann Arbor and Northern Michigan R. R., freight and passenger.	Toledo, Ohio	2	2,992
Lake Michigan Car Ferry Transportation Co., freight...	Chicago, Ill	6	6,847
Goodrich Transportation Co., freight and passenger.....	.....do	7	5,126
Manistee Transportation Co., freight and passenger	Manistee, Mich	1	467
Stephenson Transportation Co., freight	Chicago, Ill	6	2,134
Spalding Lumber Co., freight	.....do	5	1,563
Leathem & Smith Towing and Wrecking Co., freight....	Sturgeon Bay, Wis....	11	3,801
Two Rivers Manufacturing Co., freight	Two Rivers, Wis	3	677
Hamilton & Merryman Co., freight	Marinette, Wis	3	956
Total	....	44	24,653

In addition to the above regular lines of transportation a large number of steam barges, said vessels and scows engaged in the general freighting business, use the canal continually going both ways during the season of navigation, and a large local business is done by tugs engaged in assisting sail vessels, scows, etc, through the canal. During the past year the Lake Michigan Car Ferry Transportation Company added two large barges to their line, which increased the tonnage through the canal quite materially.

Among the large class of craft passing through the canal during the past season were the steamers *W. H. Wolf*, *Florida*, *Wyoming*, *Lackawanna*, *Marquette*, *Russia*, *Cuba*, the Ann Arbor car ferries, and others, whose net tonnage was 1,000 tons and more.

H H 7.

OPERATING AND CARE OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

Operations have been confined to work incident to operating and care, examinations, keeping a record of vessels and tonnage through the canal, and such dredging and repairs as were necessary for maintenance.

Mr. Adam N. Dier, superintendent of the canal, reports as follows:

The work accomplished during the year consisted principally in completing the construction of the revetment of the slip on the north side of the canal near the lake end and building about 518 linear feet of fender piling along the channel face of same; rebuilding, above the water line, about 350 linear feet of the south revetment, adjacent to the harbor front, and further strengthening this section of the works by driving an additional row of 3 by 12 inch by 16 feet white oak sheet piling in the rear of the old piling; dredging in the canal to maintain the required depth of water as the needs of navigation demanded; replacing a large number of old and unserviceable water wale, cap timbers, and tie-rods with new materials; increasing the durability of the riprap and shore protection along the harbor front by placing additional stone in the works; entire renewal of the pile driver; grading and otherwise improving the grounds adjacent to office building and dwelling house of assistant superintendent and clerk; painting the exterior of the buildings and papering the rooms in dwelling house; making a careful survey of the canal and the navigable channel in Sturgeon Bay east of the railway bridge; in collecting commercial statistics, etc.

Revetment and fender piling of slip.—By hire of labor and purchase of materials in accordance with law work on revetment of the slip on north side of the canal, near lake end, which was in progress at the beginning of the present fiscal year was continued, and the improvement completed July 23. As soon as the revetment was finished work was commenced on construction of a line of fender piling along the channel face of the new docking. Including the ends of the slip and connections with the old work, a total of 602¼ linear feet of revetment and 530 linear feet of fender piling were constructed. This fender piling consists of round piles driven on a line 3 feet out from the center of the dock piles, and at intervals of 5 feet from center to center; a 12 by 12 inch white pine lower wale bolted to the piles with 1¼-inch by 2-foot 3-inch screw bolts, a 12 by 12 inch white pine upper wale, and 8 by 12 inch white pine binder securely fastened with 1¼-inch by 2-foot 9-inch screw bolts.

Repairs of canal revetments—About 350 linear feet of the south revetment, adjacent to the harbor front, built by the canal company in 1879–80, was in such dilapidated condition as to require entire renewal above the water line and an additional row of oak sheet piling below the water. The materials for this improvement were purchased in November, 1896, after inviting proposals as required by law, and by hire of labor work on the same was commenced April 1, 1897, and completed May 20, 1897. The materials behind the revetment were removed with wheelbarrows, the old round and sheet piles cut down on a plane with the upper surface of the lower wale, new 6 by 12 inch white-pine backing sills put in between the upper ends of the round and sheet piling, and 345 white-oak sheet piles 3 by 12 inches by 16 feet driven in place and fastened at the top with 4 by 12 inch white-pine binders securely bolted to the round piles. Three hundred and fifty linear feet of new superstructure, consisting of three courses of 12 by 12 inch white-pine timber securely bolted together with 1 by 24 inch round driftbolts, with cross-ties of similar dimensions at intervals of 6 feet bolted to anchor piles 6 feet apart driven on a line 8 feet back from the face of the revetment, was put in place. The new superstructure is further strengthened with a longitudinal wale of 6 by 12 inch white pine placed over the joint between the first and second courses of timber and held in position with tie-rods fastened to the anchor piles.

Minor repairs to canal revetments during the year consisted principally in replacing broken and unserviceable water wale, cap timbers, binders, tie-rods, etc., with new materials and refastening a number of the old caps and binders with new screw bolts. By hire of labor and purchase of materials in accordance with law the following-described repair work was accomplished during the year.

North revetment.—One hundred and twenty-eight linear feet of new 12 by 12 inch white-pine water wale, 36 linear feet of new 12 by 12 inch white-pine cap timber, and 40 linear feet of new 3 by 12 inch white-pine binders were used in replacing broken and unserviceable materials between Stations 1 and 13. This timber was fastened in place with 24 iron tie-rods 1¼ inches by 17 feet and 18 new screw bolts 1¼ by 27½ inches. Seventy linear feet of the old caps and binders between Stations 22 and 25 were refastened with new screw bolts, and the corner of the works at the harbor entrance, which was damaged by collision of *Car Ferry No. 4* on the morning of October 21, 1896, was entirely rebuilt, the materials used being as follows: Twenty-two round piles 20 feet long, 6 round piles 30 feet long, 40 linear feet of 12 by 12 inch white pine, 36 linear feet of 8 by 12 inch white pine, 6 iron tie-rods 1¼ inches by 17 feet, and 12 screw bolts 1¼ by 27½ inches; also 60 linear feet of 16 by 16 inch oak timber, formerly used as spuds on the dredges.

South revetment.—Between stations 1 and 21, 1,313 linear feet of new 12 by 12 inch white pine water wale, 80 linear feet of new 12 by 12 inch white pine cap timber, and 92 linear feet of new 4 by 12 inch white pine binders were used in replacing broken and unserviceable materials. This timber was fastened in place with 237 iron tie-rods, each 17 feet long by 1¼ inches in diameter, and 47 screw bolts 1¼ by 27½ inches. One hundred and forty-seven linear feet of old caps and binders between stations 32 and 39 were refastened with 37 new screw bolts 1¼ by 27½ inches, and the cluster of protection piles near the corner of the harbor entrance further strengthened by driving 4 additional round piles and putting on two more turns of heavy binding chain.

Dredging operations.—During the fiscal year, by hire of labor and use of United States dredges Nos. 1 and 2, 28,202 cubic yards of material was removed from the canal for maintenance of channel.

Improvements along harbor front.—The usefulness of the riprap and shore protection along the north and south harbor fronts having become impaired to a considerable extent by the action of sea and drift ice, more hard stone was purchased after inviting proposals, as required by law, and deposited in the works. Forty-one and one-half cords was deposited along the north harbor front during the month of September, 1896, and 60 cords along the south harbor front during the month of June, 1897, the total cost of the additional stone in place being $363.77.

Renewal of United States pile driver.—By hire of labor and purchase of material, in accordance with law, the United States pile driver was entirely renewed during the months of January, February, and part of March, 1897. Work on renewal of the driver was commenced January 7 and completed March 5.

Improvements to grounds and buildings.—By hire of labor and purchase of material, in accordance with law, improvements were made to the grounds surrounding the office building and dwelling house, also to the buildings. The canal lands on the north side, between stations 33 and 72, were fenced in with a standard barb wire fence 5 strands high. The fence is 266 rods in length, and cost, completed, $98.42, or at the rate of 37 cents per rod. The grounds adjacent to the office building and dwelling house occupied by the assistant superintendent were graded and sodded. The terrace in front of the premises was extended westward 140 feet. The well on the grounds was enlarged and provided with a windmill, with water tank of 24 barrels capacity, at a total cost of $184. A small woodshed and outhouse, all under one roof, was constructed near the dwelling house for the convenience of the assistant superintendent's family. The office building, dwelling house, and watchhouse were painted on the outside with two coats of best prepared paint, and minor repairs made to the roof of the storage warehouse. The rooms in the dwelling house were papered at a cost of $33.10.

Surveys and soundings.—During July and August, 1896, a topographical survey was made of the lands pertaining to the canal, and the limits of the right of way on both sides of the canal were established. The survey was made under the immediate supervision of Mr. James Whelan.

During the month of December, 1896, soundings were taken in the canal. As heretofore, these soundings were taken on transverse lines 100 feet apart, at regular intervals of 20 feet. February, 1897, soundings were taken through the ice, in the navigable channel in the easterly portion of Sturgeon Bay from the westerly end of the canal to the railroad bridge, a distance of about 23,100 feet. The soundings were taken on transverse lines 100 feet apart, at regular intervals of 20 feet, there being 16 soundings on each line between the westerly end of the canal and the "Angle" in Sturgeon Bay; from the "Angle" to the railroad bridge 16 and 18 soundings were taken alternately on the transverse lines. Very shoal water was found for about 3,000 feet easterly from the bridge, but nearly the entire bottom is composed of very soft mud, through which craft could force their way without much difficulty when deeply laden and drawing more water than actually exists.

General supervision, etc.—General supervision over the works and the different improvements in progress during the year was maintained as usual. Complete and classified records of all craft passing through the canal during the year were carefully kept as usual. Also a classified record of those craft coming in from the lake, via the canal, to seek shelter in Sturgeon Bay from storms, together with a record of the class, quantity, and approximate value of the cargoes carried by them at the time they were thus sheltered. The reports of commercial statistics received were properly entered on the canal register and the necessary reporting, correspondence, and all other clerical work connected with the office attended to. During the open season the regular night service was maintained and day patrols made along the canal to see that the regulations governing the use of the same were not violated. The engineer property received for storage from various sources during the year was properly cared for.

The rules and regulations governing the use of the canal were generally observed and carefully complied with by those in charge of craft passing through the canal during the year, there being only two apparently willful violations, and these were promptly reported for prosecution by the United States district attorney. Collisions in the canal between craft in transit bound in opposite directions occurred on only two occasions, the damages in each case being nominal. The widening of the canal at the westerly end reduces the danger of collisions very materially, as it gives craft an opportunity to pass each other in comparative safety. Except in the case of the damage done the corner of the works at the harbor entrance of the canal October 21, 1896, by collision of *Car Ferry No. 4*, of the Lake Michigan Car Ferry Transportation Company, damage to the works from this source has been very light during the past year. The car-ferry boats of this line are so large and unwieldy that the utmost skill and care in towing them through the narrow portion of the canal is required to prevent them from coming in contact with and damaging the works. Since the damage done to the northeast corner of the north revetment last fall by *Car Ferry No. 4*, the men in charge of the boats have been very careful in navigating the canal, and no damage has resulted to the works since then. With the canal widened to 160 feet for its entire length the chances of colliding with and damaging the works by craft in transit would be reduced to the minimum.

No serious groundings occurred in the canal during the year on account of an insufficient depth of water, a few deeply laden craft striking bottom quite hard, however, while passing out through the canal during the fall months. The water reached its lowest stage for the year at noon of November 27, 1896, when the tide gauge showed it to be 3.6 feet below the zero mark, or 6.66 feet below high-water mark of 1838, and its highest stage at noon of June 17, 1897, when the tide gauge showed it to be 0.2 foot below the zero mark, or 3.26 feet below the high-water mark of 1838. A permanent raise of about a foot has taken place since April 1, 1897.

For commercial statistics for the calendar year ending December 31, 1896, see the statistics with report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin, for the fiscal year ending June 30, 1897.

Remarks and recommendations.—The north revetment from harbor entrance to westerly end of the new slip is in good condition and will require no repairs unless damaged by craft in transit, or from some other now unknown cause. About 350 linear feet of this section of the works was rebuilt above the water line, and another row of 3 by 12 inch by 16 foot oak sheet piling driven in the rear of the old piling during the season of 1894, while the revetment of the slip was constructed last season. Immediately westerly from the slip the revetment is in a very advanced state of decay and badly out of line, and should be entirely rebuilt for a distance of about 500 linear feet and the new work set back to conform to the line of the revetment of the slip and that at the westerly end of the canal where the canal has been widened.

Between stations 15 and 33 the old revetments on both sides of the canal are in a very advanced state of decay above the water line, and will require extensive repairs to put them in good order. The cap timbers, binders, and top ends of the round and sheet piles are badly rotted, and new caps and binders will be necessary in many places to prevent more extensive damage to the works. The lower or water wales, which were originally only 10 by 10 inch white pine timber, have been so badly worn by the action of the elements and by craft in transit chafing against them that they have been very much reduced in size, and nearly or quite 50 per cent of the old wales have thus been rendered unserviceable. This also applies to the old tie-rods, the greater portion of which have been rendered unserviceable by rust and the wearing away of the button heads on the channel face of the wales. It will therefore be necessary to take up nearly all the old water wales and tie-rods and replace them with new materials. It is very essential that the revetments be at all times provided with good water wales and tie-rods, so that the dock may be held in line and prevent that portion above the water, which has been very much weakened by progress of decay, from going to pieces.

Beyond station 33 on each side of the canal the revetments are in excellent condition and will require no repairs unless damaged by craft in transit, or by some other now unknown cause.

Of the materials required for extension of revetment of the slip on the north side, near the lake end of canal, and for repairs as above outlined, the round piles and all the iron have been purchased in accordance with the requirements of law, and the materials have been delivered on the works.

For placing a stone foundation under the office building, further improvement of the grounds, and keeping the buildings in good condition, an appropriation of $800 is recommended, as that amount can be very profitably expended for those purposes during the fiscal year ending June 30, 1898.

Navigation through the canal was maintained until December 22, 1896, when ice closed Sturgeon Bay, and was reopened for the season March 27, 1897. Between the foregoing dates the harbor and easterly portion of the canal were usually free enough from ice to admit of navigation, but Sturgeon Bay and Green Bay were entirely frozen over and the ice so thick as to make navigation impracticable. However, during the early part of February the car-ferry steamer *Ann Arbor No. 2* made an attempt to force a passage through the ice from the canal to Menominee, Mich., distant about 27 miles. The steamer encountered but little difficulty in making its way as far as the mouth of Sturgeon Bay, but when that point was reached it was found the huge windrows of ice had formed from shore to shore, making it impossible for the craft to proceed farther. Dynamite was used to raise these barriers of ice, but this too was abandoned as impracticable, and after seventy-two hours of steady bucking, the *Ann Arbor* was compelled to return to the lake, via the canal. This is the second attempt at maintaining winter navigation over the route covered by this car-ferry line, and each attempt having proved futile, it is probable that the project will be abandoned.

The expenditures during the year ending June 30, 1897, amounted to $16,280.12, from an allotment from the indefinite appropriation for "operating and care of canals and other works of navigation," provided by section 4 of river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended hereto.

Money statement.

July 1, 1896, balance unexpended	$1, 310. 88
Amount allotted for fiscal year ending June 30, 1897	17, 513. 84
	18, 824. 72
June 30, 1897, amount expended during fiscal year	16, 280. 12
July 1, 1897, balance unexpended	2, 544. 60
July 1, 1897, outstanding liabilities	1, 118. 37
July 1, 1897, balance available	1, 426. 23
Amount (estimated) for expenditure in fiscal year ending June 30, 1898	*12, 873. 77
Amount available for fiscal year ending June 30, 1898	14, 300. 00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
July 8	1	A. L. Lewis & Co	Round piles	$1, 224. 72
16	2	Raworth, Schodde & Co	Soap	6. 90
16	3	W. D. Halsted	Oil	18. 54
Aug. 4	1	Hired men	Services, July, 1896	1, 125. 46
4	2	.....do	.....do	544. 00
4	3	The Laurie Stone Co	Freight	7. 50
8	4	J. S. Hay	Paint	10. 50
8	5	A. Hanson	Wood	200. 63
8	6	Dunham Towing and Wrecking Co	Hire of tug	130. 00
8	7	Leathem & Smith	Coal, etc	320. 01
14	8	James Whelan	Traveling expenses	4. 12
31	9	Hired men	Services	305. 00
31	10	James Whelan	.....do	150. 00
31	11	Hired men	.....do	562. 24

*Amount allotted if estimate is approved.

Itemized statement of expenses made from appropriation for operation and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
Sept. 2	1	Scofield & Co	Iron straps, etc	$6.70
10	2	M. J. Schmitt	Blue prints, etc	8.58
10	3	Western Union Telegraph Co	Telegrams	.62
12	4	G. K. Kendall	Paper, etc	15.10
25	5	Chas. Crosman	Traveling expenses	15.26
30	6	Continental Bolt and Iron Works	Tie-rods, etc	238.87
Oct. 1	1	Hired men	Services, September, 1896	410.73
2	2	F. A. Hagen	Stone	165.17
2	3	Wakefield Sheet Piling Co	Royalty on sheet piling	150.66
9	4	Western Union Telegraph Co	Telegrams	1.85
10	5	H. Niedecken Co	Stationery	42.48
13	6	N. S. Washburn & Co	Pine lumber, etc	64.60
17	7	Swain & Tate Co	Books	52.00
31	8	E. A. Cannon	Services	150.00
31	9	.....do	Traveling expenses	9.25
Nov. 2	1	Hired men	Services, October, 1896	492.47
14	2	Rieboldt, Wolter & Co	Pine timber, etc	806.76
17	3	Bucyrus Steam Shovel and Dredge Co	Hoisting engine	675.00
19	4	Parkhurst & Wilkinson	Tie-rods, etc	96.10
25	5	Louis Fidler	Barb-wire fence	98.42
Dec. 2	1	Hired men	Services, November, 1896	393.33
2	2	Leathem & Smith	Coal	33.75
2	3	N. S. Washburn & Co	Wood	9.00
2	4	J. S. Hay	Storm sashes, etc	24.43
9	5	The Marsh & Bingham Co	Timber, etc	230.21
19	6	Bishop & Brooks	Round piles	126.75
31	7	A. Ross Houston	Services	200.00
31	8	Hired men	.....do	308.14
1897.				
Jan. 28	1	Manitowoc Steam Boiler Works	Steam dome	19.00
31	2	Hugh Gillen	Services	150.00
Feb. 2	1	Hired men	Services, January, 1897	344.83
2	2	J. S. Hay	Bolts, etc	31.84
2	3	Rieboldt, Wolter & Co	Pine timber, etc	57.32
11	4	Hugh Gillen	Traveling expenses	7.60
24	5	Scofield & Co	Iron bolts, etc	145.72
24	6	E. Gilien	Maple rollers, etc	179.50
28	7	Hired men	Services	540.58
Mar. 5	1	J. S. Hay	Globe valves, etc	63.42
5	2	.....do	Steel, etc	31.24
10	3	H. B. & G. B. Burger	Calking, etc	413.72
10	4	E. Gillen	Sheaves, etc	17.15
27	5	E. A. Cannon	Traveling expenses	17.27
27	6	Ives Brothers	Pump rods, etc	14.90
31	7	E. A. Cannon	Services	150.00
31	8	Hired men	.....do	218.08
Apr. 3	1	Hugh Gillen	Traveling expenses	7.47
5	2	John M. Borgman	Screw bolts, etc	104.73
9	3	M. J. Schmitt	Blue prints, etc	14.51
30	4	Chas. Crosman	Services	200.00
30	5	Hired men	.....do	732.84
May 60	1	J. S. Hay	Tallow, etc	108.24
6	2	Scofield & Co	Iron, etc	83.05
6	3	Leathem & Smith Lumber Co	Coal	189.00
11	4	M. J. Schmitt	Blue prints, etc	11.05
20	5	G. D. Greely	Letter paper	4.40
31	6	Chas. Crosman	Services	200.00
31	7	Rieboldt, Wolter & Co	Pine timber	77.83
31	8	N. S. Washburn & Co.	Pine plank	87.34
31	9	J. S. Hay	Iron, etc	17.26
31	10	E. G. Karker	Wall paper, etc	33.10
31	11	Termansen & Jensen	Stone	198.60
June 2	1	Hired men	Services, May, 1897	870.10
9	2	E. A. Cannon	Traveling expenses	10.82
9	3	Des Forges & Co	Stationery	17.85
9	4	W. D. Halsted	Oil	17.51
25	5	Continental Bolt & Iron Works	Bolts, etc	114.88
26	6	The C. Reiss Coal Co	Coal	192.50
30	7	E. A. Cannon	Services	150.00
30	8	Hired men	.....do	340.00
30	9	.....do	.....do	428.71
30	10	J. S. Hay	Hawser line, etc	21.45
30	11	E. G. Karker	Paint, etc	34.20
30	12	Scofield & Co	Enlarging well, etc	184.00
30	13	.....do	Packing, etc	27.16
30	14	The P. Hayden Saddlery Hardware Co.	Dredge chain	64.50
		Total		16,280.12

H H 8.

IMPROVEMENT OF STURGEON BAY CANAL, HARBOR OF REFUGE, WISCONSIN.

The original condition at this harbor, object of the improvement, projects, and present works, were described in detail in Annual Report Chief of Engineers for 1896, pages 2481 and 2482.

Condition of the improvement.—The main and detached piers are of the full length contemplated. Soundings taken in April, 1897, showed a channel 16 feet deep below the datum plane of harbor improvements, with a width at entrance of about 190 feet, and a minimum width at entrance to canal of about 90 feet. The dredging now in progress has restored a channel 17 feet deep and about 100 feet wide, and this width will be increased to about 180 feet during the present working season.

Operations during the fiscal year.—By hire of labor, and the use of U. S. dredge No. 1, dredging was in progress at the beginning of the fiscal year and was continued until July 9, 1896, resulting in the removal of 3,793 cubic yards since the beginning of the fiscal year. Dredging was resumed by U. S. dredge No. 2 on May 14, 1897, and was in progress at the close of the fiscal year, 10,741 cubic yards having been removed, or a total of 14,534 cubic yards during the fiscal year.

By hire of labor and purchase of materials, in accordance with law, repairs were made to the outer end of the detached south pier, which had been damaged by the action of drift ice and by collisions. The work consisted in cutting down the damaged portion of the crib to about 1 foot below the water surface and rebuilding same. The repairs have been completed with the exception of redriving a line of fender piling along the outer face of the pier, and which will be done during the present working season with the funds now available.

Remarks.—The project for the improvement of this harbor is completed, and the only expenditures now necessary are for maintenance of channel and repairs to existing works.

Annual dredging will be necessary to remove the deposit of material brought in by the canal, by waves from the lake, and by other causes, but the amount of this deposit will probably be less in the future than in the past. Much of the shoaling in the harbor has been caused by the erosion of the unrevetted portions of the canal banks, the eroded material being carried out and deposited in the harbor by currents setting through the canal to the lake. During the present working season, those portions of the canal banks from which erosion takes place, will be revetted, and it is believed the amount of shoaling in the harbor will be greatly decreased. It is impossible to estimate the exact amount of dredging required, but it is thought that the removal of 10,000 cubic yards annually will maintain the channel.

The fender piling built in 1881, that connects the main and detached piers, is in an advanced state of decay, and has been materially weakened at and near the water surface by the action of ice and by vessels colliding with it. It should be entirely rebuilt as soon as funds are provided. Repairs to the harbor piers are also necessary.

Estimate of funds required for fiscal year ending June 30, 1899.

Renewal of 330 linear feet of fender piling	$3,500
Repairs of piers	500
Dredging 10,000 cubic yards, at 10 cents	1,000
Contingencies, 10 per cent	500
Total	5,500

For the maintenance of the channel and existing works an appropriation of $5,500 is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$6,288.03
June 30, 1897, amount expended during fiscal year	2,304.73
July 1, 1897, balance unexpended	3,983.30
July 1, 1897, outstanding liabilities	35.33
July 1, 1897, balance available	3,947.97
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	5,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1873	$40,000.00	September 19, 1890	$3,000.00
March 23, 1874	10,000.00	July 13, 1892	5,000.00
June 18, 1878	30,000.00	August 17, 1894	5,000.00
March 3, 1879	30,000.00	June 3, 1896	5,000.00
June 14, 1880	10,000.00	Miscellaneous receipts credited to appropriations	182.50
March 3, 1881	10,000.00		
August 2, 1882	20,000.00		
July 5, 1884	10,000.00		
August 5, 1886	5,000.00	Total	183,182.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

See the statistics with the report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

H H 9.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

The original condition of the mouth of Wolf River, object of the improvement, projects, and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, pp. 2483, 2484.

Condition of the improvement.—To complete the original project the extension of each pier 50 feet would be required. By a modification of this project, approved March 6, 1897, further extension of the piers was abandoned, such extension not being deemed necessary for the maintenance of the projected depth.

Soundings taken in May, 1896, showed a depth of water of about 16½ feet below the datum plane of harbor improvements at the entrance between the piers, decreasing to about 11 feet at the shore end of the piers. Soundings taken in April, 1897, showed a channel between the piers 12 feet deep, with a least width of about 75 feet, the depth at entrance between the piers being about 16½ feet, and an average depth of from 10 to 11 feet in the basin immediately inside the shore line.

Operations during the fiscal year.—By hire of labor and the purchase of materials in accordance with law, repairs were made to the Government dredging plant.

Remarks.—In accordance with requirement of river and harbor act of June 3, 1896, a survey was made and report dated December 31, 1896, submitted for "Harbor of Ahnapee." The report is published in House Document No. 172, Fifty-fourth Congress, second session, and fully covers the condition and needs of the harbor.

The estimated cost of completing the project now in force is $18,000. Various plans were submitted for increasing the harbor facilities, the estimated cost of the plan that was considered to be the most desirable being $19,000 in addition to the $18,000 for completing the present project, making a total of $37,000 as the estimate for the work.

To obtain the projected depth in the harbor it is necessary to remove about 5,060 cubic yards of rock, and to dredge about 24,500 cubic yards of sand, which will cost as follows:

5,060 cubic yards of rock, at $2.75	$13,915
24,500 cubic yards of sand, at 10 cents	2,450
Contingencies, 10 per cent	1,635
Total	18,000

There has been appropriated for improving this harbor a total of $183,220, of which amount about $7,000 was on hand June 30, 1897. It is estimated that $4,000 of the funds available will be required to maintain the channel until June 30, 1899, leaving the net amount of $3,000 available for completion of present project. There will then be needed to complete the present project ($18,000 less $3,000), $15,000 in addition to the amount now available.

The original estimated cost of the present project (see Report of Chief of Engineers, 1876, Part II, pp. 346 and 359, and 1880, p. 1910), was	$175,000
Additional estimate (see Report of Chief of Engineers, 1891, p. 2539)	10,000
Additional estimate (see Report of Chief of Engineers, 1893, pp. 350 and 2722)	8,000
Total	193,000
Less total appropriations	183,220
Balance of estimate, unappropriated	9,780
Estimated amount required for completion of present project, in addition to funds now available	15,000
Less unappropriated balance of estimate	9,780
Increase in estimate	5,220
Total estimated cost of present project	198,220

The increase in the estimate is due to the cost of maintenance of channel.

An appropriation of $15,000 for completion of present project is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$8,357.59
June 30, 1897, amount expended during fiscal year	1,377.77
July 1, 1897, balance unexpended	6,979.82
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	August 5, 1886	$15,000
June 10, 1872	25,000	August 11, 1888	5,000
March 3, 1875	25,000	September 19, 1890	6,000
August 14, 1876	8,000	July 13, 1892	7,000
June 18, 1878	8,000	August 17, 1894	5,000
March 3, 1879	7,000	June 3, 1896	5,000
June 14, 1880	7,000	Miscellaneous receipts credited to appropriations	220
March 3, 1881	8,000		
August 2, 1882	12,000		
July 5, 1884	15,000	Total	183,220

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. George R. Wilbur, mayor.]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Ahnapee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	540	205,309	540	205,309
Sail	224	22,397	225	22,607
Total	764	227,706	765	227,916

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	12	Agricultural implements	615
Bark (tan)	82½	Apples	71½
Beans	4	Chairs	2½
Butter	97½	Cheese	2½
Cheese	441¾	Coal and coke	124
Eggs	146½	Fish	2½
Furniture	115½	Furniture	281½
Hay	1,360	Iron and steel	84
Hides	35	Leather	180
Lumber	60	Lime and cement	34½
Marble	20	Lumber	2,744½
Merchandise (general)	200,000	Marble	31
Oats	427	Merchandise (general)	3,000
Oil	225	Mill stuffs	68
Pease	7,542	Oil	185½
Potatoes	312	Pork and beef	21½
Rye	272¾	Provisions	300
Shingles	120	Salt	345
Ties (railroad)	1,680	Sash, doors, and blinds	19½
Wagons and carriages	26	Shingles	48
Wheat	296	Wagons and carriages	89
Wooden ware	280	Wooden ware	9½
Wool	14½	Total	8,257¾
Total	218,569¾	Total approximate value	$718,386.27
Total approximate value	$646,232		

Principal articles of export and import—Continued.

[By all ways of transportation.]

EXPORTS.		IMPORTS.	
Agricultural implements	28	Agricultural implements	975
Bark (tan)	82½	Apples	71½
Barley	318½	Bark (tan)	82½
Beans	4½	Beer and liquor	1,014½
Butter	104½	Chairs	2½
Cattle	576	Cheese	1½
Cheese	441½	Coal and coke	124
Eggs	112½	Fish	2½
Fish	106	Flour	140
Flour	48½	Furniture	281½
Furniture	130	Iron and steel	84
Hay	1,680	Lath	90
Hides	85	Leather	7½
Lumber	60	Lime and cement	34
Marble	85	Lumber	2,745
Merchandise (general)	400,000	Marble	440
Oats	422	Merchandise (general)	3,600
Oil	225	Mill stuffs	68
Pease	754	Oil	200½
Potatoes	811½	Pork and beef	21½
Rye	744½	Provisions	310
Sheep	12½	Salt	345
Shingles	890	Sash, doors, and blinds	19½
Ties (railroad)	1,680	Saw logs	240
Wagons and carriages	27	Shingles	48
Wheat	295½	Stone	1,610
Wood	810½	Wagons and carriages	98
Wooden ware	280	Wooden ware	5
Wool	14½		
Total	409,723½	Total	126,681½
Total approximate value	$846,246.00	Total approximate value	$827,380.63

H H 10.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

The original condition of the mouth of the Kewaunee River, object of the improvement, projects, and present works were described in detail in Annual Report, Chief of Engineers for 1896, page 2486.

Condition of the improvement.—Under the contract now in force the piers will be completed to their projected length. Soundings taken in May, 1897, on the completion of dredging showed a channel between the piers 15 feet deep below the datum plane of harbor improvements, with a width of 200 feet at entrance and a minimum width of about 95 feet.

Operations during the fiscal year.—Under contract, dated December 11, 1896, with Thomas J. McGrath for the construction of 425 linear feet, more or less, of pile pier for the extension of the north pier 200 feet and the south pier 225 feet, work was begun May 10, 1897, and was in progress at the close of the fiscal year. The details of construction are the same as for the extension built in 1895, except that Wakefield triple-lap sheet piling, of 2 by 12-inch pine planks, was used instead of the ordinary double-sheet piling of 3 by 12-inch planks.

By hire of labor, the use of United States dredges Nos. 1 and 2, and the purchase of materials in accordance with law, dredging was begun August 1, 1896, suspended September 15, resumed November 17, and closed for the season November 30; resumed March 25, 1897, and completed May 11, resulting in the removal of 74,825 cubic yards of material.

By hire of labor and purchase of materials in accordance with law, a frame warehouse 24 by 50 feet was built on land donated to the United States by the city of Kewaunee, and the property was partially docked, 135 linear feet of dock having been built during the fiscal year; minor repairs were also made to the piers.

Remarks.—The city of Kewaunee has donated to the United States a piece of land, 120 feet by 265 feet, to be used for laying up the Government dredging plant during the winter, and also as a yard for the storage, handling, and framing of materials required for construction and repair of piers. The location of this land. and of the warehouse built thereon by the United States, is shown on the map accompanying this report. The warehouse and dock along the front of this property were built out of the appropriations for the improvement of Kewaunee, Manitowoc, and Waukegan harbors.

The estimated cost of the project for improving Kewaunee Harbor was $200,000 (see Report of Chief of Engineers, 1881, p. 2084), and $150,014 has been appropriated for carrying it out. The funds available will complete the piers to the present 19-foot contour, which is about 200 feet in advance of this contour in 1880, when the original estimate was made, and dredge the channel and turning basin to the required depth, thereby completing the project of 1881 as modified in 1892, at a saving of nearly $50,000 over the original estimate.

The channel is subject to constant deterioration by the deposit of sediment brought in by the river, waves from the lake, and other causes. It is impossible to estimate the exact quantity deposited each year, but it is believed that about 30,000 cubic yards will have to be removed during the fiscal year ending June 30, 1899. Part of the superstructure is now in a decayed condition, and should be renewed at once. The superstructure is constantly subject to decay and requires renewal from time to time.

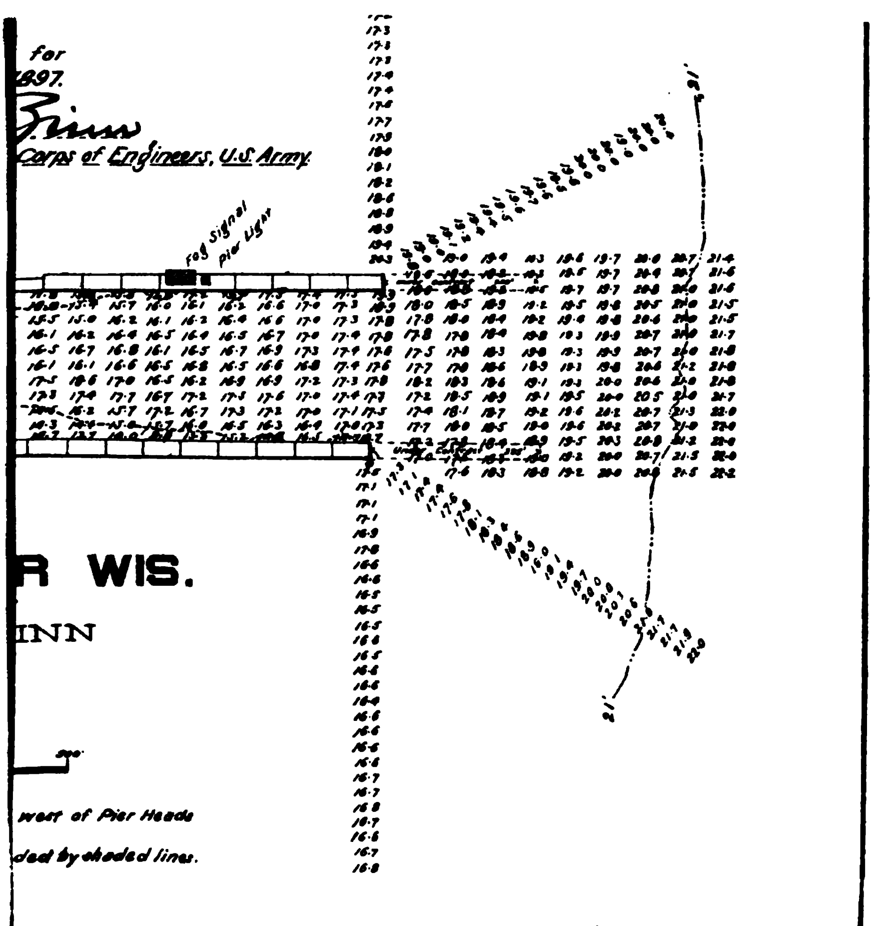
Estimate for fiscal year ending June 30, 1899.

Dredging, 30,000 cubic yards, at 10 cents	$3,000
Repairs to piers	3,000
Contingencies, 10 per cent	600
Total	6,600

An appropriation of $6,600 for maintenance of existing works is recommended for fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended		$27,970.79
June 30, 1897, amount expended during fiscal year		7,639.46
July 1, 1897, balance unexpended		20,331.33
July 1, 1897, outstanding liabilities	$295.59	
July 1, 1897, amount covered by uncompleted contracts	18,000.00	
		18,295.59
July 1, 1897, balance available		2,035.74
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance		6,600.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		


for
1897.
Corps of Engineers, U.S. Army.
Fog Signal
Pier Light
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APPROPRIATIONS.

Act of—		Act of—	
March 3, 1881	$5,000	August 17, 1894	$20,000
August 2, 1882	12,000	June 3, 1896	25,000
July 5, 1884	18,000	Miscellaneous receipts credited to appropriations	14
August 5, 1886	10,000		
August 11, 1888	10,000		
September 19, 1890	20,000	Total	150,014
July 13, 1892	30,000		

Appropriated by local authorities in 1881 and expended by the United States under the direction of the engineer officer in charge, $8,042.72.

Abstract of proposals for building 425 linear feet, more or less, of pier extension at Kewaunee Harbor, Wisconsin, received in response to advertisement dated October 27, 1896, and opened November 27, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Round piles, per linear foot (27,850 linear feet).	Wakefield sheet piling, per M (71,400 feet B. M.).	White oak timber, per M (28,800 feet B. M.).	White pine timber, per M (17,400 feet B. M.).	White pine decking plank, per M (16,700 feet B. M.).	Stone, per cord (1,400 cords).	Wrought-iron screw bolts and tie rods, per pound (17,800 pounds).	Wire iron spikes, per pound (2,000 pounds).	Total for 425 linear feet.
		Cents.						*Cents.*	*Cents.*	
1	P. W. Galloway, Racine, Wis	16½	$25.00	$35.00	$17.00	$16.00	$4.70	3	4	$15,145.25
2	McArthur Brothers Co., Chicago, Ill	20	25.00	28.00	19.50	19.00	5.00	2¾	3½	16,872.50
3	Greiling Brothers, Green Bay, Wis	22	27.25	42.50	29.00	22.00	5.25	3½	3½	18,211.65
4	Adolph Green and W. B. Anderson, Green Bay, Wis	17	24.00	38.80	26.80	21.00	5.15	3¾	3½	16,325.06
5	Jas. A. Beauvais, Charlevoix, Mich	17	28.00	30.00	21.00	15.00	6.75	4	4	18,455.60
6	James A. Eslow and John Munroe, Charlevoix, Mich	16½	25.00	33.00	23.00	18.00	5.50	3½	3½	16,305.32
7	Chicago Star Construction and Dredging Co., Chicago, Ill	19	28.00	50.00	26.00	20.00	5.50	3¾	3½	17,910.10
8	Joseph Wolter, Sheboygan, Wis	16	30.00	34.00	22.00	15.00	4.90	3	3	15,664.50
9	Hausler & Lutz Towing and Dock Co., Chicago, Ill.	17	25.00	40.00	25.00	17.00	4.75	3	4	15,654.40
10	Donald A. McLeod and William McLeod, Manistee, Mich	24	27.75	38.00	21.00	18.00	6.25	3	4	19,789.75
11	John M. Borgman, Kewaunee, Wis	17	25.00	36.00	22.00	16.00	4.65	3½	3½	15,409.30
12	Matthews & Keith, Manitowoc, Wis	16	23.50	35.00	20.00	17.00	5.50	3¾	4	16,176.30
13	George Cooper, Manitowoc, Wis	16	23.90	35.00	19.90	20.00	4.95	2$\frac{1}{10}$	2$\frac{44}{100}$	15,558.52
14	Thos. J. McGrath, Green Bay, Wis	16	23.00	38.00	24.00	20.00	4.75	2½	4	15,119.20

Amount of appropriation available for this work, $18,000.

With the approval of the Chief of Engineers, a contract was entered into December 11, 1896, with Thomas J. McGrath, the lowest responsible bidder for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Thos. J. McGrath	425 feet pile pier	Jan. 14, 1897	May 17, 1897	Nov. 30, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by the mayor of Kewaunee, Wis.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	600	451,587	600	451,587
Sail	200	13,920	200	13,920
Total	800	465,507	800	465,507

Principal articles of export and import.

[By way of harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	27.5	Apples	225
Apples	15	Barley	47
Bark (tan)	495	Beans	2.5
Barley	728.5	Beer	42
Beans	9	Cattle	9
Beer	9	Chairs	21
Brick	2,400	Cheese	1
Butter	1,400	Coal and coke	1,200
Cattle	1,500	Corn	980
Cheese	900	Furniture	17
Corn	28	Iron and steel	250
Eggs	150	Lath	37.5
Fish	40	Leather	18.5
Flour	10,212.5	Lime and cement	217.5
Furniture	5.5	Lumber	547.5
Hay	6,000	Malt	6
Hides	25	Marble	25
Hogs	100	Merchandise (general)	8,500
Lumber	1,500	Mill stuffs	300
Merchandise (general)	35,000	Oats	2,560
Mill stuffs	36,500	Oil	675
Oats	400	Plaster (land)	2,500
Peas	6,900	Pork and beef	60
Pork and beef	120	Potatoes	9
Posts (fence)	380	Provisions	70
Potatoes	81	Rye	66
Rye	1,260	Salt	1,650
Sheep	160	Sash, doors, and blinds	30
Ties (railroad)	1,400	Shingles	60
Wheat	1,050	Stone	11,200
Wood	750	Wagons and carriages	375
Wool	11	Wheat	360
		Wood	1,000
Total	109,557	Woodenware	3
Total approximate value	$4,255,650	Total	83,064.5
		Total approximate value	$3,142,640

H H 11.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

The original condition of the mouth of Twin Rivers, object of the improvement, original project, and present works were described in detail in Annual Report, Chief of Engineers, for 1896, page 2489.

The modification of the project adopted in 1897 was, in substance, that no further extension is necessary; that as now built the requirements of commerce involved are sufficiently provided for.

Condition of the improvement.—June 30, 1896, the governing depth of water in the channel was about 12 feet. The dredging that was completed June 9, 1897, restored the channel to a depth of 13 feet for a width of 150 feet.

The piers are built the full length contemplated. The crib piers are in good condition. The superstructure of the pile piers is in a dilapidated condition, being very much decayed; the sheet piling to the pile piers is very imperfect and does not prevent the passage of sand through the piers into the channel.

Operations during the fiscal year.—Under contract dated August 28, 1896, with Eggers & Simono, for dredging 40,000 cubic yards, more or less, work was begun September 10, 1896, suspended November 28, 1896, resumed April 24, 1897, and completed June 9, 1897, resulting in restoring the channel to a depth of 13 feet and width of 150 feet by the removal of 39,554.9 cubic yards of material.

The original estimate for completing this work was	$265,588.80
There has been appropriated to date	214,500.00
Difference	51,088.80

The modification of the project, approved February 27, 1897, caused a reduction in the estimate of the foregoing difference.

For the fiscal year ending June 30, 1899, the following estimate is submitted for maintenance of channel and piers:

2,000 feet of superstructure and repairs to sheet piling, at $7	14,000.00
Dredging 40,000 cubic yards, at 10 cents	4,000.00
Contingencies, 10 per cent	1,800.00
Total	19,800.00

Money statement.

July 1, 1896, balance unexpended	$5,122.43
June 30, 1897, amount expended during fiscal year	4,859.92
July 1, 1897, balance unexpended	262.51
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	19,800.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
March 3, 1871	$25,000
June 10, 1872	25,000
March 3, 1873	25,000
June 23, 1874	15,000
March 3, 1875	15,000
August 14, 1876	5,000
June 18, 1878	10,000
March 3, 1879	20,000
June 14, 1880	20,000
March 3, 1881	15,000
August 2, 1882	$15,000
July 5, 1884	8,000
August 11, 1888	2,500
September 19, 1890	3,000
July 13, 1892	3,000
August 17, 1894	3,000
June 3, 1896	5,000
Total	214,500

Abstract of proposals for dredging 30,000 cubic yards of material at Two Rivers Harbor, Wisconsin, received in response to advertisement dated August 1, 1896, and opened August 20, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 30,000 *a* cubic yards.
		Cents.	
1	Arthur H. Vogel, Milwaukee, Wis	10 7/10	$3,210.00
2	Green's Dredging Co., Chicago, Ill	17	5,100.00
3	Eggers & Simono, Two Rivers, Wis	9⅜	2,812.50
4	George Cooper and Theodore Joesch, Manitowoc, Wis	9 1/10	2,930.00

a The cost being so low, a contract was made for 40,000 cubic yards, more or less.

Amount of appropriation available for this work, $4,000.

With the approval of the Chief of Engineers, a contract was entered into August 28, 1896, with Eggers & Simono, the lowest responsible bidders, for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by the mayor of Two Rivers, Wis.]

Name of harbor, Two Rivers, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Two Rivers, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	260	208,000	260	208,000
Sail	54	10,600	54	10,600
Tugs	400	20,800	400	20,800
Total	714	239,400	714	239,400

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	5¾	Agricultural implements	20
Butter	6¼	Apples	22½
Chairs	5¼	Beer	2
Cheese	24¼	Cheese	½
Eggs	18	Furniture	11¼
Fish	18¾	Iron and steel	2½
Hay	900	Lumber	1,200
Hides	3	Merchandise (general)	2,000
Merchandise (general)	936	Oil	67½
Oats	144	Salt	180
Oil	49¼	Saw logs	45,000
Pease	369¼	Total	47,506¼
Potatoes	90		
Wagons and carriages	2½		
Wooden ware	16½		
Wool	1¼		
Total	2,592¼		

Principal articles of export and import—Continued.

[By all ways of transportation.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Butter	12¾	Apples	6
Chairs	983	Lime and cement	11,400
Cheese	64¾	Lumber	1,500
Merchandise (general)	829¾	Merchandise (general)	250
Mill stuffs	150	Total	13,150
Oil	162¼		
Sheep	6		
Wooden ware	6,567½		
Total	8,776½		

H H 12.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

The original condition of the mouth of Manitowoc River, object of the improvement, projects and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, page 2491.

The present project was approved July 9, 1896, and provides for an extension of the south pier to the 20-foot contour, a distance of 500 feet, at an estimated cost of $44,440. If it should be found necessary to extend the piers to the 22-foot contour, the cost would be $36,900 additional, or an aggregate of $81,400.

The project, with map, is published in House Document No. 300, Fifty-fourth Congress, first session.

Condition of the improvement.—The piers are in fair condition, minor repairs to the decking being the only repairs needed. The work in progress will extend the south pier 500 feet; it will then terminate in 20 feet depth of water.

June, 1896, the channel was 17 feet deep for a width of 70 feet. May, 1897, it was 18 feet deep and 110 feet wide, these depths being below the datum plane of harbor improvements, giving at the present stage of the lake an actual depth of 17 feet.

Operations during the fiscal year.—Under contract dated December 11, 1896, with the Hausler & Lutz Towing and Dock Company for the extension of the south pier 500 feet, more or less, with cribs 100 feet long, 24 feet wide, and 22½ feet high, including the superstructure, work was begun May 25, 1897, and was in progress at the close of the fiscal year. The first crib was sunk June 12, the second crib was sunk June 21, and the remainder of the work is well under way.

By hire of labor and purchase of materials in accordance with law, and the use of United States Dredge No. 2, dredging was begun July 3, 1896, and completed September 12, resulting in restoring the channel to a depth of 19 feet for a width of 130 feet, by the removal of 37,493 cubic yards of material. Repairs were also made to the dredging plant.

Remarks.—The proposed new lines of transportation between the West and the East, of which mention was made in the last annual report, to be formed by the Wisconsin Central Railroad Company, the Chicago and Northwestern Railway Company, car ferries across Lake Michigan and Eastern railroads already built are in successful operation.

Under date of May 5, 1896, the Secretary of War granted permission to the Chicago and Northwestern Railway Company to remove 320 linear feet of the shore end of the south pier to construct a car-ferry slip about 965 feet long and to construct 2,000 linear feet of protection cribs along the shore of Lake Michigan to afford protection to the ferry slip and car tracks in that vicinity. This work has been completed in accordance with the approved plans. The portion of the harbor pier that was removed affords entrance to and exit from the ferry slip.

The city of Manitowoc dredged the Manitowoc River to 20 feet depth from the inner end of the harbor piers up the river for a distance of about 5,500 feet. The mayor of the city states that 273,400 cubic yards were removed, at a cost of $25,940.46. The Manitowoc Terminal Company dredged a strip of 30 feet width alongside of its docks, removing about 60,000 cubic yards.

Owing to the extremely low prices for materials and labor under the present and preceding contracts a large saving of the original estimates was made, and it is believed, as shown by the following statement, that the funds now available will be sufficient to complete the 20-foot channel and to maintain the channel and piers until June 30, 1899; therefore no estimate for that purpose is submitted:

Funds available		$45,500
Estimated expenditures:		
Present contract	$28,000	
Dredging to complete the 20-foot channel	5,000	
Minor repairs to piers	1,000	
Contingencies	3,500	
		37,500
Estimated balance		8,000

Money statement.

July 1, 1896, balance unexpended		$51,020.11
June 30, 1897, amount expended during fiscal year		5,921.54
July 1, 1897, balance unexpended		45,098.57
July 1, 1897, outstanding liabilities	$406.08	
July 1, 1897, amount covered by uncompleted contracts	30,000.00	
		30,406.08
July 1, 1897, balance available		14,692.49

APPROPRIATIONS.

Act of—	
August 30, 1852	$8,000.00
June 23, 1866	52,000.00
March 2, 1867	45,000.00
July 25, 1868 (allotted)	17,500.00
April 10, 1869 (allotted)	17,820.00
July 11, 1870	20,000.00
March 3, 1871	11,000.00
March 3, 1873	20,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	8,000.00
June 18, 1878	15,000.00
March 3, 1879	6,500.00
June 14, 1880	7,000.00
March 3, 1881	$4,000.00
August 2, 1882	10,000.00
July 5, 1884	15,000.00
August 5, 1886	15,000.00
August 11, 1888	8,000.00
September 19, 1890	8,000.00
July 13, 1892	28,000.00
August 17, 1894	20,000.00
June 3, 1896	44,440.00
Miscellaneous receipts credited to appropriations	220.50
Total	400,480.50

Abstract of proposals for building 500 linear feet, more or less, of pier extension at Manitowoc Harbor, Wisconsin, received in response to advertisement dated October 27, 1896, and opened November 27, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Pine timber, per M (870,000 feet B. M.).	Hemlock timber, per M (334,000 feet B. M.).	Pine plank, per M (82,000 feet B. M.).	Stone, per cord (2,100 cords).	Wrought-iron drift-bolts, per pound (54,000 pounds).	Wrought-iron screw bolts, per pound (5,800 pounds).	Wire-iron spikes, per pound (1,050 pounds).	Foundation and protection piles, each (number, 328).	Total for 500 linear feet.
						Cents.	*Cents.*	*Cents.*		
1	Thos. J. McGrath, Green Bay, Wis	$20.00	$15.00	$20.00	$6.00	2½	3	4	$8.50	$30,004.00
2	McArthur Brothers Co., Chicago, Ill	20.00	17.00	19.00	5.40	2½	2¾	3½	9.88	29,810.26
3	Matthews & Keith, Manitowoc, Wis	22.00	16.00	17.50	6.00	3	3½	4	9.25	31,543.00
4	George Cooper, Manitowoc, Wis	19.90	14.00	16.00	5.45	1 78/100	3	2 85/100	8.75	27,922.62
5	Adolph Green and W. B. Anderson, Green Bay, Wis	20.84	16.09	16.20	5.40	2½	3½	3½	9.60	29,664.68
6	Donald A. McLeod and William McLeod, Manistee, Mich	21.00	18.00	18.00	6.00	2 85/100	3	4	10.25	31,299.00
7	Nelson J. Gaylord, Ludington, Mich	21.00	15.00	18.00	5.35	2½	2½	2¾	8.50	28,767.87
8	James A. Ealow and John Munroe, Charlevoix, Mich	23.00	14.75	17.00	8.00	2¾	3½	3	9.00	35,437.50
9	Chicago Star Construction and Dredging Co., Chicago, Ill	23.00	17.00	19.00	5.75	2½	3½	3½	9.00	31,412.75
10	Hausler & Lutz Towing and Dock Co., Chicago, Ill	19.50	15.00	17.00	5.00	2½	3	5	8.50	27,633.50
11	Knapp & Gillen, Racine, Wis	21.00	15.25	16.50	5.40	2½	2¾	2½	8.50	28,929.25
12	Joseph Wolter, Sheboygan, Wis	22.00	14.00	16.00	5.20	2	3	3	12.00	29,469.50

Amount of appropriation available for this work, $35,000. With the approval of the Chief of Engineers a contract was entered into December 11, 1896, with Hausler & Lutz Towing and Dock Company, the lowest responsible bidders for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Hausler & Lutz Towing and Dock Co.	500 feet crib pier	Jan. 9, 1897	May 25, 1897	Nov. 30, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. Thomas E. Torrison, mayor.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pierhead, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	791	568,123	788	567,492
Sail	313	42,128	313	42,319
Total	1,104	610,251	1,101	609,811

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	1,050	Agricultural implements	950
Apples	90	Apples	112½
Barley	96	Bark (tan)	880
Beans	30	Barley	1,680
Beer	52½	Coal and coke	220,000
Brick	660	Corn	42
Butter	250	Fish	5
Cattle	90	Furniture	7,000
Cheese	2,000	Hides	100
Coal and coke	40,000	Iron and steel	5,000
Eggs	225	Lath	1,925
Fish	5	Leather	21
Flour	22,682½	Lime and cement	665
Furniture	500	Lumber	9,000
Hay	9,000	Marble	90
Hides	5	Merchandise (general)	26,000
Hogs	4,000	Mill stuffs	200
Leather	9½	Oil	225
Malt	750	Plaster (land)	3,800
Merchandise (general)	7,000	Pork and beef	24
Mill stuffs	3,000	Salt	3,450
Oats	9,600	Shingles	600
Pease	12,000	Stone	4,900
Plaster (land)	400	Wagons and carriages	28½
Pork and beef	24	Wood	15,000
Potatoes	4,120	Total	301,697½
Rye	1,092	Total approximate value	$2,750,000
Salt	1,500		
Sheep	12		
Wagons and carriages	100		
Wheat	1,200		
Wool	35		
Total	121,578½		
Total approximate value	$2,170,000		

BY ALL WAYS OF TRANSPORTATION.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Agricultural implements	4,500	Agricultural implements	1,150
Apples	54	Apples	172½
Barley	456	Bark (tan)	1,320
Beans	36	Barley	4,480
Beer	2,625	Beans	21
Brick	3,400	Beer	35
Butter	305	Coal and coke	20,400
Cattle	660	Corn	1,680
Cheese	1,500	Fish	6½
Coal and coke	210,000	Flour	24,775
Eggs	352½	Furniture	1,237½
Fish	8½	Hides	103½
Flour	27,950	Iron and steel	6,500
Furniture	1,100	Lath	2,475
Hay	18,000	Leather	25
Hides	7½	Lime and cement	712½
Hogs	300	Lumber	15,000
Leather	150	Marble	200
Malt	650	Merchandise (general)	40,000
Merchandise (general)	13,000	Mill stuffs	4,000
Mill stuffs	4,700	Oil	742½
Oats	12,800	Plaster (land)	3,900
Pease	17,100	Pork and beef	74½
Plaster (land)	610	Poles (telegraph)	544
Pork and beef	33½	Salt	405
Potatoes	4,860	Sash, doors, and blinds	70
Rye	3,248	Shingles	765
Salt	2,550	Stone	7,700
Sheep	60	Ties (railroad)	630
Wagons and carriages	300	Wagons and carriages	150
Wheat	3,450	Wheat	960
Wool	50	Wood	16,750
Total	334,816	Total	156,984½
Total approximate value	$6,000,000	Total approximate value	$4,900,000

H H 13.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

The original condition of the mouth of Sheboygan River, object of the improvement, projects, and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, page 2495.

Condition of the improvement.—To complete the present project each pier should be extended 100 feet. Soundings taken in May, 1897, showed a channel between the piers 19 feet deep below the datum plane of harbor improvements, with a minimum width of about 70 feet, except at its inner end, where it was obstructed by a shoal lying nearly in mid-channel. This shoal has since been removed by dredging.

Operations during the fiscal year.—By hire of labor and the use of United States dredge No. 2, dredging for deepening and widening the channel, and for removal of the shore end of the original south pier, was begun September 21, 1896, suspended December 2, resumed March 25, 1897, and was in progress at the close of the fiscal year; 44,239 cubic yards of material and about 1,200 linear feet of old pier were removed during the fiscal year.

By hire of labor and purchase of material in accordance with law, work on the pile pier to connect the old pier with the new pier built in 1895 and the construction of a warehouse has been in progress during the fiscal year. Work on the pile pier was begun May 20, 1897, and at the close of the fiscal year about 100 linear feet had been finished, leaving about 229 linear feet to be built. The pile pier is of the same construction as that built in 1895.

The warehouse is a one-story frame building of outside dimensions 24 by 32 feet, located on United States land adjoining the life-saving station on the north side of the harbor under authority granted by the Secretary of the Treasury February 18, 1897. It was completed June 25, 1897.

Remarks.—The land needed for the widening of the channel was transferred by the city of Sheboygan to the United States and was dredged away in November, 1896. The owners of the adjacent property have put in an excellent revetment 935 feet long on the line of the new pier.

In accordance with requirements of river and harbor act of June 3, 1896, a survey was made and report dated January 27, 1897, submitted for harbor at "Sheboygan, with a view of obtaining 21 feet." The report, with map, is published in House Document No. 327, Fifty-fourth Congress, second session, and fully covers the condition and needs of the harbor. The estimated cost of the desired improvement is $75,000.

A revised estimate, approved March 6, 1897, for the completion of the present project was submitted February 17, 1897, and is as follows:

200 feet pier extension, at $65	$13,000
Work on south pier	10,000
1,000 feet sheet pile revetment along north pier, at $15	15,000
Dredging 60,000 cubic yards, at 10 cents	6,000
Contingencies, 10 per cent	4,400
Total	48,400
Estimated amount required to complete the present project	48,400
Funds available February 1, 1897	21,800
Estimated amount to complete	26,600
Amount (estimated) required for completion of existing project, in Annual Report for June 30, 1896, was	55,900
Revised estimate herewith submitted	26,600
Reduction	29,300

An appropriation of $26,600 for completion of present project is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$26, 393. 57
June 30, 1897, amount expended during fiscal year	13, 994. 09
July 1, 1897, balance unexpended	12, 399. 48
July 1, 1897, outstanding liabilities	168. 35
July 1, 1897, balance available	12, 231. 13
Amount (estimated) required for completion of existing project	26, 600. 00
Amount that can be profitably expended in fiscal year ending June 30, 1899	26, 600. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
August 30, 1852	$10, 000. 00
June 28, 1864 (allotted)	10, 000. 00
June 23, 1866	47, 598. 91
March 2, 1867	8, 000. 00
April 10, 1869 (allotted)	14, 850. 00
July 11, 1870	15, 000. 00
March 3, 1871	15, 000. 00
June 10, 1872	18, 000. 00
March 3, 1873	10, 000. 00
June 23, 1874	10, 000. 00
March 3, 1875	12, 000. 00
August 14, 1876	6, 000. 00
June 18, 1878	4, 000. 00
March 3, 1879	$3, 000. 00
June 14, 1880	7, 000. 00
March 3, 1881	25, 000. 00
August 2, 1882	30, 000. 00
July 5, 1884	28, 000. 00
August 5, 1886	15, 000. 00
August 11, 1888	15, 000. 00
September 19, 1890	15, 000. 00
July 13, 1892	25, 000. 00
August 17, 1894	25, 000. 00
June 3, 1896	26, 000. 00
Total	394, 448. 91

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. E. P. Ewer.]

Name of harbor, Sheboygan, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	750	568, 876	753	568, 310
Sail	292	44, 464	306	47, 266
Total	1, 042	613, 340	1, 059	615, 576

Principal articles of export and import.

[By all ways of transportation.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Agricultural implements	350	Cheese	650
Apples	90	Coal and coke	200,000
Beer	945	Corn	1,350
Chairs	49,050	Flour	645
Cheese	3,201	Furniture	1,150
Coal	155,000	Hay	350
Eggs	148½	Hides	4,950
Fish	435	Iron and steel	3,000
Furniture	8,000	Lath	1,300
Iron and steel	2,600	Leather	200
Leather	2,150	Lime and cement	180½
Lime and cement	1,159	Lumber	72,000
Malt	3,400	Malt	262½
Merchandise (general)	4,635	Marble	300
Peas	960	Merchandise (general)	16,228
Potatoes	258	Mill stuffs	325
Salt	1,650	Oats	1,120
Stone	2,400	Oil	2,407½
Woodenware	317½	Poles (telegraph)	680
		Posts (fence)	646
Total	236,749	Salt	2,175
		Sash, doors, and blinds	200
IMPORTS.		Shingles	1,500
		Stone	292½
Agricultural implements	500	Ties (railroad)	700
Apples	150	Wood	30,000
Bark (tan)	15,840		
Barley	3,720	Total	362,817

H H 14.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

The original condition of the mouth of Sauk River, object of the improvement, projects, and present works, were described in detail in Annual Report Chief of Engineers, for 1896, page 2499.

Condition of the improvement.—The piers were completed in 1893; the rebuilding of superstructure over the inshore ends of the piers, built in 1871, is now in progress. Soundings taken in May, 1896, showed that, with minor exceptions, the channel and basins had a depth of 13 feet, and that the object of the improvement had been practically obtained. The soundings taken in May, 1897, showed that shoaling had occurred in places, and that the governing depth was about 12 feet.

Operations during the fiscal year.—By hire of labor and purchase of materials in accordance with law, the rebuilding of decayed superstructure of the north and south piers was begun May 17, 1897, and is in progress at the close of the fiscal year. The funds available will probably admit of rebuilding about 670 linear feet, of which 320 linear feet are completed, and the remainder is well under way. About 33 cords of stone were transferred from the shore ends of the piers where they were no longer needed, and used as refilling and riprap to the outer ends of the piers.

Remarks.—The most urgently needed repairs to the piers are in progress, and will be continued to the extent of available funds; they will probably be completed during the month of August.

Estimate for fiscal year ending June 30, 1899.

For dredging for restoration and maintenance of channel	$3,500
For minor repairs to pier	500
Contingencies	400
Total	4,400

Money statement.

July 1, 1896, balance unexpended	$5,973.17
June 30, 1897, amount expended during fiscal year	2,814.28
July 1, 1897, balance unexpended	3,158.92
July 1, 1897, outstanding liabilities	349.77
July 1, 1897, balance available	2,809.15
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	4,400.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
July 11, 1870	$15,000.00
March 3, 1871	15,000.00
June 10, 1872	15,000.00
March 3, 1873	15,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	8,000.00
June 18, 1878	5,000.00
March 3, 1879	7,500.00
June 14, 1880	20,000.00
March 3, 1881	17,000.00
August 2, 1882	17,000.00
July 5, 1884	$10,000.00
August 5, 1886	5,000.00
September 11, 1888	5,000.00
September 19, 1890	3,000.00
July 13, 1892	6,500.00
August 17, 1894	5,000.00
June 3, 1896	5,500.00
Miscellaneous receipts credited to appropriations	36.50
Total	194,536.50

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by the mayor of Port Washington, Wis.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house on outer end of north pier, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	91	11,600	91	11,600
Fishing tugs	672	35,200	669	35,050
Sail	162	15,800	162	15,800
Total	925	62,600	922	62,450

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Apples	22½	Agricultural implements	120
Barley	4,320	Bark (tan)	1,210
Beans	36	Beer	43½
Beer	87½	Chairs	5
Brick	2,000	Coal and coke	5,200
Butter	27½	Corn	173½
Chairs	3,200	Flour	172
Cheese	115	Furniture	12½
Eggs	19½	Hides	425
Fish	450	Iron and steel	2,600
Flour	19,350	Lath	275
Furniture	1,350	Lime and cement	114
Hay	650	Lumber	17,250
Hides	12½	Malt	40
Hogs	20	Marble	200
Iron and steel	2,500	Merchandise (general)	2,200
Leather	290	Oil	810
Lime and cement	1,900	Pork and beef	12
Mill stuffs	600	Posts (fence)	95
Oats	160	Provisions	105
Pease	9	Salt	300
Potatoes	120	Shingles	300
Provisions	27½	Wheat	1,560
Sash, doors, and blinds	160	Wooden ware	9
Wood	765½		
Wool	3	Total	33,231½
Total	38,195½	Total approximate value	$1,045,000
Total approximate value	$975.000		

H H 15.

IMPROVEMENT OF HARBOR OF REFUGE AT MILWAUKEE, WISCONSIN.

The original condition of Milwaukee Bay, object of the improvement, projects, and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, page 2502.

Condition of the improvement.—The depth of water along main arm varies from 30 feet at the angle to 36 feet at southerly end. Area covered by present works, outside 13-foot contour, 228 acres; outside 19-foot contour, 147 acres; omitting the 500 feet of pier without superstructure, the area covered by completed works, outside 13-foot contour, is 191 acres; outside 19-foot contour is 119 acres.

Operations during the fiscal year.—Under contract dated January 13, 1897, with Knapp & Gillen, of Racine, Wis., for the extension of the breakwater 1,600 feet, more or less, work was commenced April 24, and is in progress at the close of the fiscal year. The extension will consist of timber cribs, each 100 feet long by 30 feet wide, and 25½ feet high, without superstructure, placed on a stone foundation. At the close of the fiscal year 2,931.9 cords of stone had been placed in the foundation and crib construction was in progress, but no cribs had yet been sunk under this contract. The contractors have built, by authority of the Secretary of War, a temporary wharf in the harbor of refuge near the shore end of the breakwater, and have made extensive preparations to complete the entire contract during the present working season.

By hire of labor and purchase of materials in accordance with law, repairs were made to the shore arm of breakwater, and the gap between the inner end of breakwater and the shore was closed.

The repairs consisted chiefly in providing 24 intervals with plank shutters, and filling them with stone, 602.7 cords being used for this purpose. This stone was furnished in the work, at the remarkably low price of $4.40 per cord.

The gap between the inner end of breakwater and the shore was closed by building a continuous plank crib, at right angles to the shore arm of the breakwater, beginning at a point about 125 feet southerly from the inner end of breakwater and extending for a distance of 275 feet. The crib is 6 feet wide, and of a height varying from 11 feet 4 inches at the breakwater to 2 feet 8 inches at its inner end, its top surface being nearly level. It was built of 2 by 6 inch pine planks, spiked together with cross walls 8 feet 6 inches apart, center to center. The crib rests on three 6 by 6 inch mud sills, has a solid plank bottom, is filled with sand, gravel, and stone, and riprapped on both sides. The location of the crib, and soundings taken May 14, 1897, are shown on the accompanying map.

The scow *Dunham* has been reengaged to serve as a light-ship at the south end of the breakwater under a new agreement with her owner.

Remarks.—At the beginning of the fiscal year there remained of the original project yet to be built 2,600 feet of breakwater and 500 feet of superstructure to be placed on work already built. The accepted bid for the construction of work authorized by the river and harbor act of June 3, 1896, was so low that it has been found possible to build 1,700 feet of breakwater without superstructure and 300 feet of superstructure. There remains, therefore, of the original project 900 feet of breakwater and 1,900 feet of superstructure. The exact cost can not be foretold and it is not safe to use the present contract price in estimating it, because this price is unusually low. It is believed that $115 per foot is a safe estimate.

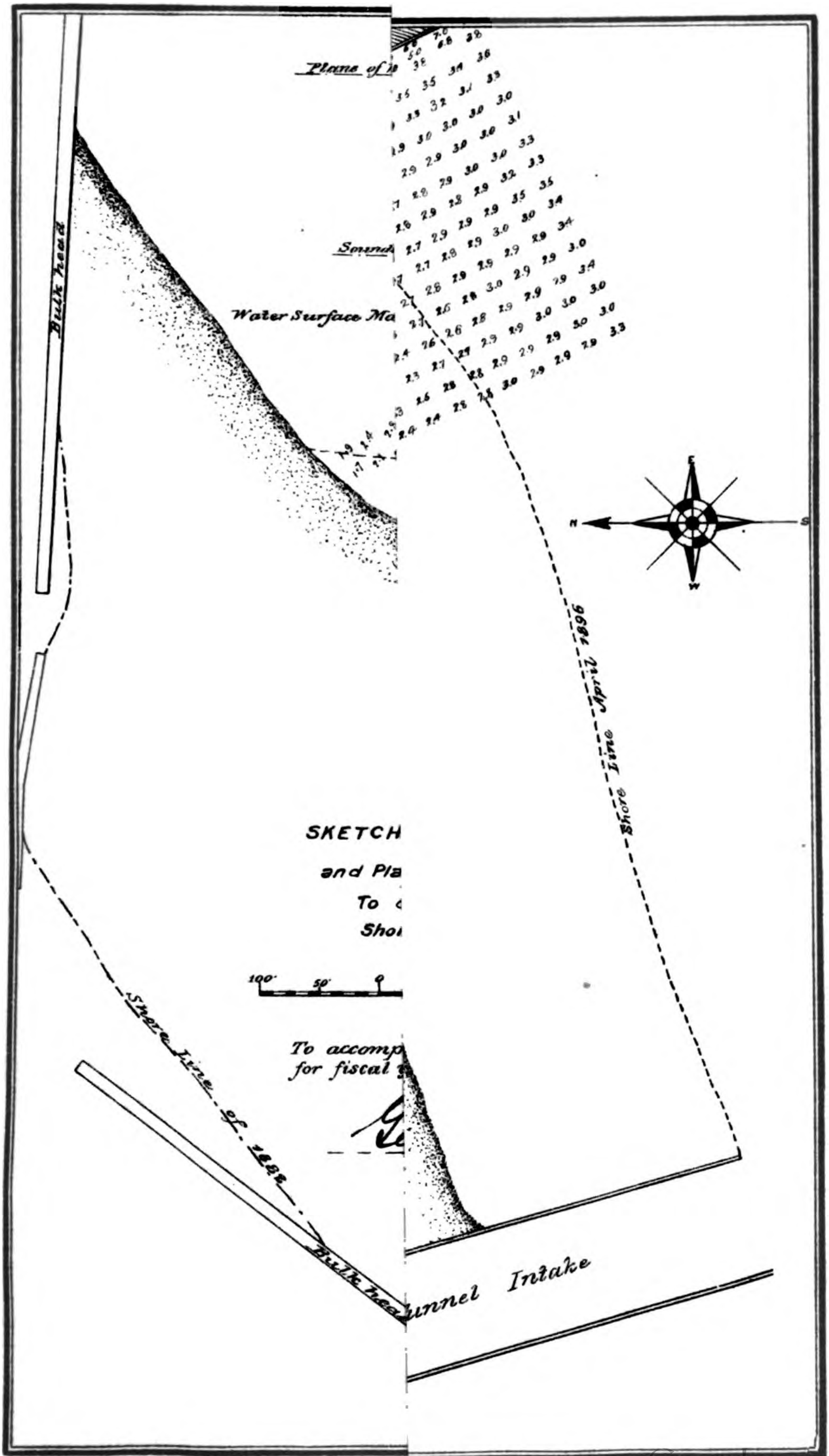
Estimate of cost of completing breakwater at Harbor of Refuge, Milwaukee, Wis.

900 feet of crib work on stone foundation, complete, at $115 per foot	$103,500
1,900 feet of superstructure, at $20	38,000
Contingencies, 10 per cent	14,150
Total	155,650

In the annual report upon this improvement for 1896 it was explained in detail why its final cost has exceeded the original estimate. The principal items not included in the original estimate and paid for from appropriations for the work, are (1) maintenance of light-ship for thirteen years (1884 to 1896, inclusive), $18,740.94, and (2) repairs to breakwater, $77,163.20, after damage by severe storms.

Money statement.

July 1, 1896, balance unexpended		$22,415.11
Amount appropriated by sundry civil act approved June 4, 1897		168,737.91
		191,153.02
June 30, 1897, amount expended during fiscal year		17,467.46
July 1, 1897, balance unexpended		173,685.56
July 1, 1897, outstanding liabilities	$4,908.55	
July 1, 1897, amount covered by uncompleted contracts	163,829.36	
		168,737.91
July 1, 1897, balance available		4,947.65
Amount (estimated) required for completion of existing project		155,650.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		155,650.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		



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APPROPRIATIONS.

Act of—		
March 3, 1881		$100,000.00
August 2, 1882		100,000.00
July 5, 1884		85,000.00
August 5, 1886	$60,000.00	
From which allotted to Milwaukee Harbor	4,737.91	
		55,262.09
August 11, 1888		70,000.00
September 19, 1890		80,000.00
July 13, 1892		75,000.00
August 17, 1894		45,000.00
June 3, 1896		20,000.00
June 4, 1897		168,737.91
Miscellaneous receipts credited to appropriations		1,000.00
Total		800,000.00

Abstract of proposals for building 1,600 linear feet of breakwater extension at Harbor of Refuge, Milwaukee Bay, Wisconsin, received in response to advertisement dated December 17, 1896, and opened January 9, 1897, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Pine timber, per M (1,735,000 feet B. M.).	Hemlock timber, per M (1,205,000 feet B. M.).	Pine plank, per M (16,000 feet B. M.).	Stone, per cord (16,000 cords).	Wrought-iron driftbolts, per pound (250,000 pounds).	Wrought-iron screw bolts, per pound (5,300 pounds).	Wrought-iron spikes, per pound (14,000 pounds).	Total for 1,600 linear feet.
						Cents.	Cents.	Cents.	
1	Chicago Star Construction and Dredging Co., Chicago, Ill	$22.00	$15.00	$18.00	$6.00	2	3	3	$158,112.00
2	McArthur Brothers Co., Chicago, Ill	24.70	16.00	18.00	5.65	2	2	2	158,208.50
3	Carkin, Stickney & Cram, Detroit, Mich	22.50	16.50	21.00	5.50	$2\frac{1}{2}$	$2\frac{3}{4}$	$2\frac{3}{4}$	154,036.75
4	Hausler & Lutz Towing and Dock Co., Chicago, Ill	21.50	15.50	21.00	6.00	$2\frac{1}{2}$	3	4	159,285.00
5	Adolph Green and W. B. Anderson, Green Bay, Wis	23.80	16.80	17.50	6.25	$2\frac{1}{2}$	3	$2\frac{1}{8}$	168,576.00
6	Knapp & Gillen, Racine, Wis	20.75	14.75	16.50	5.65	$1\frac{45}{100}$	2	$2\frac{1}{2}$	149,770.00
7	William A. Starke, Milwaukee, Wis	35.00	20.00	20.00	6.00	3	3	3	171,874.00
8	Joseph Wolter, Sheboygan, Wis	21.90	15.50	15.00	6.25	3	3	3	164,993.00

Amount of appropriation available for this work, $178,737.91.

With the approval of the Chief of Engineers, a contract was entered into January 13, 1897, with Knapp & Gillen, the lowest responsible bidders, for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Knapp & Gillen	1,600 feet breakwater	Jan. 27, 1897	Apr. 24, 1897	Dec. 31, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

Name of harbor, Harbor of Refuge, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected at nearest port of entry, $329,398.87.

(See the commercial statistics for Milwaukee Harbor, Wisconsin.)

H H 16.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

The original condition at the mouth of the Milwaukee River, the object of the improvement, projects, and present works were described in detail on page 2506, part 4, Annual Report of the Chief of Engineers, United States Army, for 1896.

Condition of the improvement.—The harbor piers were completed to their projected length in 1872. Soundings taken in April, 1897, showed a channel midway between the piers with a least width of 130 feet and 19 feet deep below plane of reference of coast survey charts of Lake Michigan, viz, 3.06 feet below high water of 1838.

Operations during the fiscal year.—Under contract with Mr. William A. Starke, dated August 28, 1896, for dredging 12,000 cubic yards, more or less, work was begun September 21 and completed October 20, 1896. The amount of material removed under this contract was 14,271.5 cubic yards, resulting in the restoration of the 19-foot channel for a width of 150 feet.

By hire of labor and purchase of materials in accordance with law, 407 linear feet of the superstructure of the south pier were rebuilt. The work was begun August 3 and completed September 20, 1896. The materials used and cost of same in place were as follows:

Pine timber and plank	$1,166.08
Iron bolts and spikes	125.26
Tools, cartage, etc	43.43
Labor, including pay of overseer	941.05
Total	2,275.82
Cost per linear foot	5.59

Tridaily observations of water levels of Lake Michigan were made and recorded.

Remarks.—In accordance with requirements of river and harbor act of June 3, 1896, a survey was made, and report, dated November 23, 1896, submitted for "harbor at Milwaukee, Wis., with a view of obtaining a channel 21 feet deep." The report is published in House Doc. No. 61, Fifty-fourth Congress, second session. The estimated cost of the desired improvement is $12,000.

About 600 linear feet of the superstructure of the south pier is in a very dilapidated condition and should be rebuilt at once. The cross-ties are entirely rotted out, and there is constant danger of that portion of the pier above the water surface caving into the channel.

A new pile protection should also be built at once along the channel face of the south pier for a distance of about 1,100 feet.

These repairs to the south pier are most urgently needed and have already been too long deferred.

Repairs to the north pier are also needed. The upper face of the stone superstructure is broken in places, and for a distance of about 390 feet should be filled with crushed stone and covered with heavy dimension stone.

Estimate for fiscal year ending June 30, 1899.

Rebuilding 600 feet superstructure (south pier), at $5.59	$3,354
Reconstructing 1,100 linear feet protection piling (south pier), at $3.50	3,850
Repairs to north pier stone superstructure	1,600
Dredging for maintenance of channel	4,000
Contingencies	1,196
Total	14,000

An appropriation of $14,000 for maintenance of existing works is urgently recommended for fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$7,052.89
June 30, 1897, amount expended during fiscal year	5,236.02
July 1, 1897, balance unexpended	1,816.87
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance	14,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Expended on former mouth of Milwaukee River.

Act of—	
July 4, 1836	$400.00
March 3, 1843	30,000.00
June 11, 1844	20,000.00

Straight cut.

Act of—	
August 30, 1852	15,000.00
March 3, 1853	163.94
June 23, 1866	48,283.51
April 10, 1869 (allotted)	35,640.00
July 11, 1870	40,000.00
March 3, 1871	38,000.00
March 3, 1873	10,000.00
March 23, 1874	10,000.00
March 3, 1875	25,000.00
August 14, 1876	26,000.00
June 18, 1878	15,000.00
March 3, 1879	7,500.00
June 14, 1880	10,000.00
March 3, 1881	8,000.00
August 2, 1882	10,000.00
August 5, 1886 (from appropriation for harbor of refuge)	4,737.91
August 11, 1888	10,000.00
March 17, 1890 (special act)	6,100.00
September 19, 1890	6,000.00
July 13, 1892	14,000.00
August 17, 1894	7,000.00
June 3, 1896	7,000.00
Total expended at old river mouth and straight cut	403,825.36
Expended at former mouth of Milwaukee River	50,400.00
Total expended at straight cut (present harbor)	353,425.36

Abstract of proposals for dredging 12,000 cubic yards of material at Milwaukee Harbor, Wisconsin, received in response to advertisement dated August 1, 1896, and opened August 20, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 12,000 cubic yards.
		Cents.	
1	Norris G. Dodge & Son, Chicago, Ill	21	$2,530
2	William A. Starke, Milwaukee, Wis	14½	1,740
3	Arthur H. Vogel, Milwaukee, Wis	18	2,160

Amount of appropriation available for this work, $2,000. With the approval of the Chief of Engineers, a contract was entered into August 28, 1896, with William A. Starke, the lowest responsible bidder for this work.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. W. J. Langson, secretary Chamber of Commerce.]

Name of harbor, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected during the year, $329,398.87.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	4,109	3,523,987	4,305	3,764,220
Sail	1,372	342,897	1,378	332,408
Total	5,481	3,866,884	5,683	a 4,096,628

a Registered tonnage of the vessels. Tonnage of freight carried was approximately 3,446,492 tons.

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.
EXPORTS.	
Barley	115,394
Beans	177
Beer	381
Butter	6
Cement	12,633
Chair stock	75
Cheese	218
Coal	306
Corn	8,380
Eggs	102
Flour	444,962
Hay	3,928
Hides	145
Iron	7,788
Leather	5,205
Lime	51
Lumber	45,000
Malt	36,976
Mill stuffs	136,917
Oats	156,660
Peas	10,506
Pork, beef, and lard	41,465
Provisions	621
Rye	32,306
Wheat	35,047
Wool	486
Wisconsin tobacco	615
Total	1,096,350
IMPORTS.	
Bark (tan)	30,942
IMPORTS—continued.	
Barley	96
Beans	1,330
Brick	1,372
Butter	48
Cement	4,046
Cheese	8
Coal	1,487,483
Eggs	144
Flour	431
Fruit	354
Hay	39
Hides	1,037
Iron	119,829
Lath	2,605
Leather	215
Lumber	178,538
Oil	206
Peas	10,001
Plaster (land)	3,965
Posts (fence)	2,119
Potatoes	1,649
Rye	846
Salt	94,089
Shingles	2,032
Stone	5,489
Sugar	2,926
Ties (railroad)	1,116
Wheat	3,325
Wood	157,327
Wool	251
Total	2,122,878

Principal articles of export and import—Continued.

[By all ways of transportation.]

EXPORTS.	
Barley	150,741
Beans	386.5
Beer	7,895
Brick	1,176
Butter	181.5
Cattle	484
Chair stock	1,155
Cheese	669
Coal	446,683
Corn	11,917.5
Eggs	45
Flour	491,061.5
Hay	5,053
Hides	736
Hogs	30,609
Iron	124,441
Lath	82
Lime and cement	28,076.5
Lumber	31,056
Malt	69,068.5
Mill stuffs	150,250
Oats	209,763.5
Peas	10,422
Pork, beef, and lard	16,400
Potatoes	159
Provisions	44,695.5
Rye	35,495.5
Salt	92,660.5
Sheep	849
Shingles	690
Wheat	76,115
Wooden ware	825
Wool	66
Wisconsin tobacco	1,108.5
Total	2,041,025.5

IMPORTS.	
Bark (tan)	48,338
Barley	279,145.5
Beans	1,605
Brick	17,122
Butter	2,424
Cattle	16,879
Cement	37,343
Chair stock	1,290
Cheese	1,919
Coal	1,587,795
Corn	58,033
Eggs	3,197
Flour	343,672
Fruit	355
Hay	22,264
Hides	8,866
Hogs	75,323.5
Iron	218,183
Lath	3,255
Leather	2,043
Lime	12,604
Lumber	245,253
Malt	28,249
Mill stuffs	31,049
Oats	222,048
Oil	42,509
Peas	10,918
Plaster (land)	4,347
Posts (fence)	2,153
Potatoes	70,579
Rye	49,881
Salt	95,267
Sheep	2,487
Shingles	2,243
Sugar	335,333
Stone	202,057
Ties (railroad)	1,722
Wheat	280,081
Wood	172,088
Wooden ware	2,040
Wool	1,253
Wisconsin tobacco	2,382
Total	4,545,595

The railroads decline to furnish tonnage of freight carried.

Comparative statement of commercial statistics from 1890 to 1896.

Year.	In freight.	Out freight.	Total.
1896	6,668,473	3,137,375.5	9,805,848.5
1895	2,238,404	828,651	3,096,055
1894	2,160,706	718,899	2,879,605
1893	1,926,604	735,233	2,661,827
1892	2,181,730	838,741	3,020,471
1891	2,155,311	761,167	2,916,478
1890	1,706,973	655,149	2,362,052

H H 17.

IMPROVEMENT OF SOUTH MILWAUKEE HARBOR, WISCONSIN.

The original condition of the mouth of Oak Creek, object of the improvement, project, and present works, were described in detail in Annual Report, Chief of Engineers, for 1896, pp. 2509, 2510.

Condition of the improvement.—There has been no change in the condition of the improvement, other than a shoaling between the piers, since the survey of October, 1894, a report of which survey, accompanied by a map of the harbor, was published in Annual Report, Chief of Engineers, for 1895, pp. 2642, 2643.

The present piers, built by private parties, are of such inferior construction as to be unfit to form any portion of the permanent improvement.

Soundings taken April 28, 1897, showed a depth of channel between the piers varying from about 9 feet at the end of north pier to nearly absolute closure at the mouth of Oak Creek at the inner end of the piers.

Operations during the fiscal year.—There have been no operations at this harbor.

Remarks.—A contract, entered into December 9, 1896, with Mr. P. W. Galloway, of Racine, Wis., for the extension of the north pier 180 linear feet, more or less, provided that the work on the extension should commence on or before May 1, 1897. The work, however, has not yet been commenced, as the contractor has been engaged on repairs to the harbor piers at Kenosha and Racine, these repairs being urgently needed, and their early completion considered to be of more importance than the pier extension at South Milwaukee.

With the present depth of water, and length and condition of piers, the harbor of South Milwaukee is of no benefit whatever to general commerce. It is not considered advisable to do any dredging until the piers shall have been rebuilt and extended. Considerable dredging between the piers has been done by private parties, and a depth of about 12 feet was secured. This depth has now decreased to an average of about 6 feet, with but 9 feet depth at entrance, thus plainly demonstrating the utter futility of attempting to maintain a navigable channel between piers of their present length.

The estimated cost of completion of present project (see Report of Chief of Engineers, 1895, p. 2643) is $133,000.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	35.89
July 1, 1897, balance unexpended	4,964.11
July 1, 1897, amount covered by uncompleted contracts	4,500.00
July 1, 1897, balance available	464.11
Amount (estimated) required for completion of existing project	133,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

APPROPRIATIONS.

Act of June 3, 1896	$5,000.00

Abstract of proposals for building 180 linear feet, more or less, of pier extension at South Milwaukee Harbor, Wisconsin, received in response to advertisement dated October 27, 1896, and opened November 27, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Names and residence of bidders.	Round piles, per linear foot (6,532 linear feet).	Wakefield sheet piling, per M, 2 by 12 inches by 24 feet (25,920 feet B. M.).	White-pine decking plank, per M (2,016 feet B. M.).	White-oak timber, per M (11,376 feet B. M.).	White-pine timber, per M (6,168 feet B. M.).	Stone per cord (320 cords).	Wrought-iron screw bolts and tie-rods, per lb. (5,000 pounds).	Wire iron spikes, per lb. (600 pounds).	Total for 180 linear feet.
		Cents.						*Cents.*	*Cents.*	
1	P. W. Galloway, Racine, Wis	20	$27.00	$18.00	$36.00	$20.00	$5.50	3	4	$4,509.43
2	James Cape & Sons, Racine, Wis	21	30.00	30.00	40.00	30.00	8.00	2½	5	5,564.88
3	P. F. Kelly, Milwaukee, Wis	20	26.00	17.50	40.00	23.00	5.50	2½	2½	4,512.50
4	Knapp & Gillen, Racine, Wis	21	24.50	16.50	42.00	21.00	7.50	4	3½	5,268.34
5	James A. Eslow and John Monroe, Charlevoix, Mich	23	27.00	19.00	35.00	23.00	7.25	3¾	3¾	5,310.52
6	Chicago Star Construction & Dredging Co., Chicago, Ill	19	30.00	22.00	50.00	28.00	6.75	3½	3½	5,160.53
7	John M. Borgman, Kewaunee, Wis	20	36.00	16.00	38.00	24.00	6.25	3½	3½	4,788.90

Amount of appropriation available for this work, $4,500.

With the approval of the Chief of Engineers a contract was entered into, December 9, 1896, with P. W. Galloway, the lowest responsible bidder for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
P. W. Galloway	180 feet pile pier	Dec. 16, 1896	Will probably begin in July.	Aug. 31, 1897.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. Fred. W. Rogers, secretary South Milwaukee Company.]

Name of harbor, South Milwaukee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, north pier, Milwaukee, Wis.

Principal articles of export and import.

[By all ways of transportation.]

Articles.	Tons.
EXPORTS.	
Cattle	180
Iron and steel	13,500
Merchandise (general)	11,738.5
Mineral wool	1,200
Total	26,618.5
Total approximate value	$1,689,100
IMPORTS.	
Agricultural implements	29
Beer	1,022
Brick	3,400
Cattle	180
Coal and coke	15,595
Corn	5,850
Flour	522½
Furniture	33
Hay	700
Horses	60
Iron and steel	16,050
Lath	51
IMPORTS—continued.	
Lime and cement	799
Lumber	2,410
Malt	130
Merchandise (general)	27,805
Mill stuffs	120
Oats	771
Oil, petroleum	8,212½
Pork and beef	55
Poles (telegraph)	204
Posts (fence)	52
Rye	268¾
Salt	240
Sash, doors, and blinds	12½
Sewer pipe and drain tile	400
Shingles	90
Ties (railroad)	21,000
Wood	3,000
Total	109,062½
Total approximate value	$1,138,228

H H 18.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

The original condition of the mouth of Root River, object of the improvement, projects, and present works were described in detail in Annual Report, Chief of Engineers, for 1896, pages 2511 and 2512.

A modification of project approved March 9, 1897, provides for the construction of 900 linear feet of sheet piling and dredging for maintenance of channel.

Condition of the improvement.—Both piers are now of the full length contemplated under the revised project of 1889.

Soundings taken in December, 1896, on the completion of dredging, showed a channel 17 feet deep, having a width at entrance of about 140 feet and a least width of about 60 feet. An extensive bar, with a least depth of about 13½ feet on it, had formed around the outer end of the south pier south of the navigable channel.

Operations during the fiscal year.—Under contract dated August 28, 1896, with the Racine Dredge Company for dredging 30,000 cubic yards, more or less, work was begun September 9, 1896, and completed December 4, 1896. The amount of material removed under this contract was 29,639 cubic yards, resulting in the restoration of a channel of navigable width and with a least depth of 17 feet.

Under contract dated December 11, 1896, with Knapp & Gillen, of Racine, Wis., for the extension of the south pier 250 linear feet, work was begun April 12, 1897.

The extension consists of two cribs, each 100 feet long, and one crib 50 feet long, the width of all the cribs being 20 feet and their height 18½ feet, including the superstructure. The cribs were placed upon a pile foundation and were filled with stone and riprapped. A row of protection piles was driven at the end of the pier. The 50-foot crib and one 100-foot crib were made continuous above the eleventh course of timber and sunk as one crib.

The work was completed June 26, 1897.

List of materials and cost of same in place for building 250 linear feet of crib pier at Racine, Wis., under contract with Knapp & Gillen.

Materials.	Quantity.	Unit price.	Amount.
Pine timber .... feet B. M..	152,006	$20.00	$3,040.12
Hemlock timber .... do....	120,408	15.00	1,806.12
Pine plank .... do....	13,269	16.50	218.94
Stone .... cords..	693.7	6.00	4,162.20
Foundation and protection piles .... number..	114	8.00	912.00
Wrought-iron drift bolts .... pounds..	22,732	.02½	568.30
Wrought-iron screw bolts .... do....	3,712	.03	111.36
Wrought-iron spikes .... do....	810	.02½	20.25
Total	....	....	10,839.29

South pier extension, 250 by 20 feet; cost per running foot, $43.36.

By hire of labor and purchase of materials in accordance with law 281 linear feet of Wakefield triple-lap sheet pile revetment, to prevent the passage of sand through the north pier, was constructed along the channel face of the pier. A total length of 550 feet of this revetment is to be constructed. Of the remaining 269 linear feet the materials are all purchased and the work partially done, the round piles having been driven for the entire distance. An agreement was entered into April 17, 1897, with Mr. P. W. Galloway, of Racine, Wis., to furnish all machinery, tools, and labor necessary for the completion of the revetment, the work to be completed on or before August 1, 1897. Sixty-two cords of stone have been used in refilling the piers and for riprap where undue settlements had occurred.

Remarks.—In accordance with requirement of river and harbor act of June 3, 1896, a survey was made and report, dated January, 27, 1897, submitted for "Harbor at Racine, with a view to obtaining a channel 21 feet deep." The report is published in House Doc. No. 326, Fifty-fourth Congress, second session, and fully covers the condition and needs of the harbor. The estimated cost of the desired improvement is $51,650.

Estimate for fiscal year ending June 30, 1899.

900 linear feet sheet piling, at $15	$13,500.00
Dredging for maintenance of channel	6,000.00
Rebuilding superstructure, 300 by 30 feet, north pier	2,400.00
Contingencies	2,100.00
Total	24,000.00

An appropriation of $24,000 for completion of existing project and maintenance of existing works for the fiscal year ending June 30, 1899, is recommended.

Money statement.

July 1, 1896, balance unexpended	$27,418.20
June 30, 1897, amount expended during fiscal year	12,447.21
July 1, 1897, balance unexpended	14,970.99
July 1, 1897, outstanding liabilities	11,211.29
July 1, 1897, balance available	3,759.70
Amount (estimated) required for completion of existing project	13,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	*24,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

* $10,500 for maintenance.

APPROPRIATIONS.

Act of—		Act of—	
June 15, 1844	$12,500	March 3, 1879	$6,000
August 30, 1852	10,000	June 14, 1880	6,000
June 28, 1864	3,600	March 3, 1881	6,000
June 23, 1866	23,910	August 2, 1882	7,000
March 2, 1867	45,000	July 5, 1884	7,000
April 10, 1869 (allotted)	22,275	August 5, 1886	10,000
July 11, 1870	10,000	August 11, 1888	10,000
March 3, 1871	10,000	September 19, 1890	17,500
March 3, 1873	20,000	July 13, 1892	25,000
June 23, 1874	10,000	August 17, 1894	20,000
March 3, 1875	10,000	June 3, 1896	27,000
August 14, 1876	8,000		
June 18, 1878	10,000	Total	336,785

Abstract of proposals for dredging 25,000 cubic yards of material at Racine Harbor, Wisconsin, received in response to advertisement dated August 1, 1896, and opened August 20, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 25,000 *a* cubic yards.
		Cents.	
1	Arthur H. Vogel, Milwaukee, Wis	$15\frac{9}{10}$	$3,973.00
2	Racine Dredge Co., Racine, Wis	$11\frac{1}{4}$	2,812.50
3	Edward Gillen, Racine, Wis	$11\frac{7}{8}$	2,967.50
4	Green's Dredging Co., Chicago, Ill	$12\frac{1}{2}$	3,125.00
5	Norris G. Dodge & Son, Chicago, Ill	$14\frac{1}{2}$	3,625.00
6	George Cooper and Theodore Joesch, Manitowoc, Wis	17	4,250.00

a The cost being so low, a contract was made for 30,000 cubic yards, more or less.

Amount of appropriation available for this work, $3,500.

With the approval of the Chief of Engineers, a contract was entered into August 28, 1896, with Racine Dredge Company, the lowest responsible bidders for this work.

Abstract of proposals for building 250 linear feet, more or less, of pier extension at Racine Harbor, Wisconsin, received in response to advertisement dated October 27, 1896, and opened November 27, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Pine timber, per M (152,000 feet B. M.).	Hemlock timber, per M (120,000 feet B. M.).	Pine plank, per M (12,800 feet B. M.).	Stone, per cord (800 cords).	Foundation and protection piles, each (Number, 113).	Wrought-iron drift bolts, per pound (22,000 pounds).	Wrought-iron screw bolts, per pound. (3,800 pounds).	Wrought-iron spikes per pound (600 pounds).	Total for 250 linear feet.
							Cents.	*Cents.*	*Cents.*	
1	P. W. Galloway, Racine, Wis	$20.00	$16.00	$16.00	$5.60	$10.00	3	3	3	$11,566.80
2	Jas. Cape & Sons, Racine, Wis	30.00	25.00	20.00	6.00	8.40	$2\frac{1}{2}$	$2\frac{1}{2}$	5	14,240.20
3	Knapp & Gillen, Racine, Wis	20.00	15.00	16.50	6.00	8.00	$2\frac{1}{2}$	3	$2\frac{1}{2}$	11,434.20
4	McArthur Bros. Co., Chicago, Ill	20.00	17.00	19.00	5.65	9.00	$2\frac{1}{2}$	$2\frac{3}{4}$	3	11,532.70
5	George Cooper, Manitowoc, Wis	21.00	14.75	17.00	6.75	8.50	2	2	$2\frac{1}{2}$	12,069.60
6	Chicago Star Construction and Dredging Co., Chicago, Ill	23.00	17.00	19.00	6.75	9.00	$2\frac{1}{2}$	$3\frac{1}{2}$	$3\frac{1}{2}$	12,900.20
7	Hausler & Lutz Towing and Dock Co., Chicago, Ill	20.50	16.00	18.00	6.00	9.50	$2\frac{1}{2}$	3	5	11,833.90

Amount of appropriation available for this work, $12,000.

With the approval of the Chief of Engineers, a contract was entered into December 11, 1896, with Knapp & Gillen, the lowest responsible bidders for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Knapp & Gillen	250 feet crib pier	Dec. 22, 1896	May 5, 1897	Nov. 30, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by the mayor of Racine, Wis.]

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,214	1,733,792	1,214	1,735,945
Sail	256	39,003	265	41,737
Total	1,470	1,772,795	1,479	1,777,682

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Agricultural implements	815	Cheese	⅛
Beer	19½	Coal and coke	64,140
Fish	16⅛	Furniture	52½
Flour	92⅛	Hay	30
Hides	66	Hides	193
Iron and steel	8,925½	Iron and steel	362½
Leather	293	Lath	550
Lumber	15,540	Leather	192
Marble	15	Lime and cement	36
Merchandise (general)	29,408	Lumber	108,402
Mill stuffs	75	Merchandise (general)	78,925
Oats	28¾	Mill stuffs	68
Posts (fence)	266	Oil	153
Shingles	5,250	Posts (fence)	5,092
Wagons and carriages	610	Potatoes	54
Wool	28½	Provisions	820
		Rye	36½
Total	56,418	Salt	240
		Sawlogs	174
Total approximate value	$4,280,460	Shingles	2,611½
		Stone	9,100
IMPORTS.		Ties (railroad)	476
		Wagons and carriages	36
Agricultural implements	16	Wheat	30
Apples	188	Wood	35,800
Bark (tan)	704	Wooden ware	1½
Barley	120	Wool	61
Beans	4½		
Beer	262½	Total	308,400¾
Butter	5⅞		
Cattle	12	Total approximate value	$8,410,208
Chairs	1½		

Principal articles of export and import—Continued.

[By all ways of transportation.]

EXPORTS.	
Agricultural implements	48,123
Beer	287
Brick	1,560
Coal and coke	8,400
Fish	790
Flour	132
Furniture	1,626
Hides	19
Iron and steel	5,420¼
Leather	293
Lime and cement	807½
Lumber	25,230
Marble	15
Merchandise (general)	79,657
Mill stuffs	175
Oats	44¾
Oil	618¾
Posts (fence)	342
Provisions	555¼
Sash, doors, and blinds	108
Shingles	525
Wagons and carriages	5,900
Wool	25
Total	180,653½
Total approximate value	$32,260,140
IMPORTS.	
Agricultural implements	51½
Apples	138
Bark (tan)	2,178
Barley	144
Beans	4½
Beer	1,624
Brick	174
Butter	105

IMPORTS—continued.	
Cattle	12
Chairs	1½
Cheese	½
Coal and coke	165,840
Corn	60
Flour	1,182½
Furniture	200
Hay	75
Hides	850
Iron and steel	69,000
Lath	550
Leather	192
Lime and cement	190
Lumber	117,000
Merchandise (general)	156,445
Mill stuffs	2,240
Oats	70¼
Oil	2,025
Pork and beef	846
Posts (fence)	2,470
Potatoes	54
Provisions	1,702½
Rye	5½
Salt	570
Saw logs	192
Shingles	2,611½
Stone	9,100
Ties (railroad)	826
Wagons and carriages	50
Wheat	600
Wood	30,000
Wooden ware	1
Wool	50
Total	570,065
Total approximate value	$36,240,102

H H 19.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

The original condition of the mouth of Pike Creek, object of the improvement, projects, and present works, were described in detail in Annual Report Chief of Engineers, for 1896, page 2516.

Condition of the improvement.—Under the present project the north pier is to be extended 150 feet. The pier extension now in progress will complete the south pier to the full length contemplated under the existing project. Soundings taken on the completion of dredging in April, 1897, showed a channel between the piers 16 feet deep with a width of entrance of about 140 feet, and a least width of about 100 feet. There was a depth of 15 feet over an area of about 3 acres in the basin.

Operations during the fiscal year.—Under contract dated August 28, 1896, with the Racine Dredge Company, for dredging 50,000 cubic yards, more or less, work was begun September 24, 1896, suspended December 5, resumed April 5, 1897, and completed April 21. The amount of material removed under this contract was 68,350 cubic yards, of which 32,700 cubic yards were from the channel and 35,650 cubic yards were from the basin.

The river and harbor act of June 3, 1896, required that "four thousand dollars, or so much thereof as may be necessary, shall be expended in dredging in the harbor basin, and removing wreck therefrom."

In accordance with these requirements, proposals were invited for the removal of the wreck of schooner *Horace Greeley* and of a small flat scow from the basin. The bid of the Racine Dredge Company, amounting to $547, it being the only proposal received, was accepted, and the wrecks were entirely removed, the work being completed November 14, 1896.

Under contract dated December 11, 1896, with McArthur Brothers Company, of Chicago, Ill., for extension of south pier 250 linear feet, more or less, work was begun June 3, 1897, and was in progress at the close of the fiscal year. The extension consists of two cribs, each 100 feet long, and 1 crib 50 feet long; the width of all the cribs being 20 feet, and their height 20½ feet, including the superstructure.

Under special agreement, dated May 8, 1897, with Mr. P. W. Galloway, of Racine, Wis., 300 linear feet of Wakefield triple-lap sheet pile revetment were constructed along the channel face of the south pier, and near the inner end of same, to prevent the passage of sand through the pier.

The work consists, first, of a row of close, round piling, driven as near the face of pier as possible. Outside of the round piles, Wakefield sheet piling was driven, each sheet pile being made of three 2 by 12 inch pine planks, spiked together with ten or twelve 7-inch wire spikes clinched in the rear side, and so as to form a 4-inch tongue and groove. The sheet piles and round piles are held together by white oak wales, and secured to the pier by 1¼-inch round screw bolts. Before driving the piles all the riprap along that portion of the pier to be revetted was removed by dredging done by the Racine Dredge Company under a special agreement. The entire work was completed June 30, 1897.

Cost of materials and labor for 300 linear feet of sheet pile revetment.

Materials.	Quantity.	Unit price.	Amount.
Dredging			$393.75
Round piles, linear feet	6,360	$0.20	1,272.00
Wakefield sheet piling, feet B. M.	47,008	27.00	1,269.22
White oak timber, do	5,536	36.00	199.30
White pine timber, do	3,948	20.00	78.96
Wrought-iron screw bolts, pounds	3,335	.05	166.75
Wire spikes, do	600	.04	24.00
Total			3,403.98

Cost per linear foot of revetment, $11.34.

Remarks.—In accordance with requirements of river and harbor act of June 3, 1896, a survey was made, and report, dated January 26, 1897, submitted, for "harbor at Kenosha, with a view of obtaining a channel 21 feet deep, and basin 20 feet deep." The report is published in House Doc No. 328, Fifty-fourth Congress, second session, and fully covers the condition and needs of the harbor. The estimated cost of the desired improvement is $125,000.

To complete the present project requires that the north pier should be extended 150 feet beyond its present length. On the completion of the contract now in force the south pier will be of its full projected length. Extensive repairs to the older portions of the piers are greatly needed. The west end of the north pier is in an extremely dilapidated condition, the extreme 60 feet of it having been carried away in 1885, and never having been restored. Erosion of the adjacent bank commenced at once and has continued ever since; large quantities of material are thus washed into the channel by the action of every storm. The inner portions of both the harbor piers are in such condition as to readily permit the passage of sand through them. It is believed that 1,500 feet of sheet piling will remedy this defect.

Estimate for fiscal year ending June 30, 1899.

To extend the north pier to the full length contemplated by the modified project of 1889—150 feet, at $65	$9,750
Making old piers sand tight—1,500 linear feet of sheet piling, at $10	15,000
Protecting shore at inner end of north pier—140 linear feet sheet piling, at $8	1,120
Dredging for maintenance of channel	5,000
Contingencies	3,130
Total	34,000

An appropriation of $34,000 for completion of project and maintenance of existing works for the fiscal year ending June 30, 1899, is recommended.

Money statement.

July 1, 1896, balance unexpended	$26,597.91
June 30, 1897, amount expended during fiscal year	8,307.40
July 1, 1897, balance unexpended	18,290.51
July 1, 1897, amount covered by uncompleted contracts	13,000.00
July 1, 1897, balance available	5,290.51
Amount (estimated) required for completion of existing project	9,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	*34,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Act of—		Act of—	
March 15, 1844	$12,500.00	June 14, 1880	$5,000.00
March 3, 1845	15,000.00	March 3, 1881	5,000.00
August 13, 1852	10,000.00	August 2, 1882	6,000.00
June 23, 1866	75,461.41	July 5, 1884	5,000.00
April 10, 1869 (allotted)	5,346.00	August 5, 1886	5,000.00
July 11, 1870	10,000.00	August 11, 1888	7,500.00
March 3, 1871	10,000.00	September 19, 1890	17,500.00
June 10, 1872	10,000.00	July 13, 1892	15,000.00
June 23, 1874	10,000.00	August 17, 1894	15,000.00
March 3, 1875	15,000.00	June 3, 1896	24,000.00
August 14, 1876	8,000.00		
June 18, 1878	8,000.00	Total	299,307.41
March 3, 1879	5,000.00		

Abstract of proposals for dredging 45,000 cubic yards of material at Kenosha Harbor, Wisconsin, received in response to advertisement dated August 1, 1896, and opened August 20, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 45,000 † cubic yards.
		Cents.	
1	Arthur H. Vogel, Milwaukee, Wis	$11\frac{7}{10}$	$5,265.00
2	William A. Starke, Milwaukee, Wis	11	4,950.00
3	Green's Dredging Co., Chicago, Ill	10	4,500.00
4	Racine Dredge Co., Racine, Wis	$8\frac{7}{8}$	3,915.00
5	Edward Gillen, Racine, Wis	11	4,950.00
6	Norris G. Dodge & Son, Chicago, Ill	$11\frac{1}{2}$	5,175.00
7	Lydon & Drews Co., Chicago, Ill	19	8,550.00
8	George Cooper and Theodore Joesch, Manitowoc, Wis	17	7,650.00

* $24,250 for maintenance.
† The cost being so low, a contract was made for 50,000 cubic yards, more or less.

Amount of appropriation available for this work, $5,000. With the approval of the Chief of Engineers, a contract was entered into August 28, 1896, with Racine Dredge Company, the lowest responsible bidders for this work.

Abstract of proposals for building 250 linear feet, more or less, of pier extension at Kenosha Harbor, Wisconsin, received in response to advertisement dated October 27, 1896, and opened November 27, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Pine timber, per M (157,000 feet B. M.).	Hemlock timber, per M (140,000 feet B. M.).	Pine plank, per M (13,000 feet B. M.).	Stone, per cord (800 cords).	Foundation and protection piles, each (number, 119).	Wrought-iron drift-bolts, per pound (24,500 pounds).	Wrought-iron screw bolts, per pound (4,000 pounds).	Wrought-iron spikes, per pound (500 pounds).	Total for 250 linear feet.
							Cents.	*Cents.*	*Cents.*	
1	P. W. Galloway, Racine, Wis	$21.00	$16.00	$17.00	$7.00	$10.00	3	3	3	$13,418.00
2	Jas. Cape & Sons, Racine, Wis	30.00	25.00	20.00	6.00	8.40	2½	2½	5	15,007.10
3	McArthur Brothers Co., Chicago, Ill	20.00	17.00	19.00	6.00	9.00	2½	2¾	3	12,375.50
4	Knapp & Gillen, Racine, Wis	21.00	15.50	16.50	6.15	9.00	2½	3	2½	12,417.50
5	George Cooper, Manitowoc, Wis	22.70	14.90	17.00	6.35	8.50	$1\frac{70}{100}$	$1\frac{95}{100}$	$2\frac{25}{100}$	12,468.15
6	James A. Eslow and John Munroe, Charlevoix, Mich	23.00	15.00	17.00	6.75	9.00	2¾	3¼	3	13,221.75
7	Chicago Star Construction and Dredging Co., Chicago, Ill	23.00	17.00	19.00	6.75	9.00	2½	3½	3½	13,479.00
8	Hausler & Lutz Towing and Dock Co., Chicago, Ill	20.50	16.00	18.00	6.00	9.50	2½	3	5	13,380.50

Amount of appropriation available for this work $13,000.

With the approval of the Chief of Engineers, a contract was entered into December 11, 1896, with McArthur Brothers Company, the lowest responsible bidders for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
McArthur Brothers Co	250 feet crib pier	Dec. 31, 1896	June 1, 1897	Nov. 30, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. H. S. Van Ingen.]

Name of harbor, Kenosha, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.; nearest light-house, Kenosha, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	72	10,911	72	10,911
Sail	149	27,356	148	27,335
Total	221	38,267	220	38,246

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Coal and coke	150	Lath	120
Furniture	1	Lumber	15,975
Sand and gravel	21,000	Merchandise (general)	1,000
		Posts (fence)	114
Total	21,151	Potatoes	30
		Shingles	600
Total approximate value	$125,000	Wood	3,000
IMPORTS.		Total	50,546½
Apples	7½	Total approximate value	$800,000
Bark (tan)	18,700		
Coal and coke	11,000		

[By all ways of transportation.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Brass	625	Eggs	12½
Coal and coke	150	Fish	700
Copper	750	Flour	967½
Merchandise (general)	16,212	Furniture	56½
Provisions	250	Hides	9,250
Sand and gravel	25,000	Iron and steel	5,500
Wagons and carriages	2,750	Lath	275
Woodenware	374¾	Lime and cement	950
		Lumber	24,000
Total	47,111¾	Merchandise (general)	50,341½
		Mill stuffs	700
Total approximate value	$12,000,000	Oil	2,025
		Pork and beef	360
IMPORTS.		Poles (telegraph)	17
		Posts (fence)	114
Agricultural implements	55	Potatoes	120
Apples	60	Provisions	150
Bark (tan)	18,700	Salt	225
Barley	600	Sash, doors, and blinds	15
Beans	8¾	Shingles	600
Beer	1,050	Stone	7,000
Brick	6,000	Wagons and carriages	25
Butter	15	Wood	5,000
Cattle	90		
Chairs	5	Total	169,995½
Cheese	7½		
Coal and coke	34,000	Total approximate value	$8,000,000
Copper	1,000		

H H 20.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

The original condition at Waukegan Harbor, object of the improvement, projects, and present works were described in detail in Annual Report, Chief of Engineers, for 1896, pages 2519, 2520.

Project of 1896.—The modification of original projects of 1880 and 1882, as approved July 28, 1896, is as follows: The north-and-south arm of the north pier to be connected by a revetment with the American Mortar Company's revetment; the entrance to the harbor to be dredged to a depth of 13 feet below the plane of reference of the coast charts of Lake Michigan, viz, 3.06 feet below high water of 1838, with a width of 200 feet, and the harbor itself to be dredged to the same depth, and with a width of 300 feet, beginning at the northern boundary line of the Government land; and the new shore line in the harbor to be riprapped with heavy blocks of stone for a length of about 400 feet, beginning at the south pier.

Condition of the improvement.—Both piers are now of the full projected length. Under the project of 1896, a section of about 35 linear feet of revetment is to be built to connect the north-and-south arm of north pier with the American Mortar Company's revetment. It is expected to construct this revetment during the present season.

Soundings taken April, 1897, showed a channel between the piers 13 feet deep and with a least width of about 160 feet, and the same depth in the harbor or basin over about three-fourths of its area.

Operations during the fiscal year.—Under contract dated September 23, 1896, with Illinois Dredging Company, for dredging 122,000 cubic yards, more or less, from the entrance channel and basin, work was begun October 5, 1896, suspended December 23, and resumed June 18, 1897. At the close of the fiscal year 128,862 cubic yards had been removed. By agreement with the contractors the amount to be dredged was increased 47,000 cubic yards, making a total amount to be dredged of 169,000 cubic yards, of which amount 40,138 cubic yards are yet to be removed.

By hire of labor and purchase of materials in accordance with law, repairs to the north-and-south arm of the north pier were begun June 1, 1897, and are in progress at the close of the fiscal year. The work consists chiefly in cutting down the old pile pier to the water surface, and in building on the remaining portion a superstructure of 12 by 12 inch white-pine timbers to a height of about 6 feet. At the close of the fiscal year 100 linear feet of this superstructure had been built two courses in height; the remainder is well under way, and it is expected will be completed about August 15, 1897.

Remarks.—On August 24, 1880, a strip of land about 100 feet wide and 2,294 feet long was donated to the United States by the city of Waukegan for harbor purposes. The advance of the shore, especially to the north of the harbor entrance, has greatly added to this land until at the present time there is a tract about 350 by 580 feet lying to the east of the harbor basin and to the north of the harbor entrance. This tract and also a narrow strip of land 50 feet wide inclosing the shore end of the south pier and extending from the shore line westward to the boundary of the Government land will always be useful to the United States. Under the modified project of 1896, the rest of the Government land is no longer of use for harbor purposes. It has therefore been recommended that the same be transferred to the city of Waukegan, under the following conditions:

First. The right to be reserved to the United States to maintain a suitable riprap slope along the southern 400 feet of the westerly harbor line, the foot of the slope to be on the harbor line and at the depth called for in the project of 1896, and the slope to be such as can be maintained with riprap; and if any structure is set over this riprap, it shall rest upon piles and be of such form as may be approved by the War Department.

Second. The city of Waukegan shall build and maintain a dock revetment of the usual construction along the westerly harbor line, the revetment to begin at the northern boundary of the Government land and extend southerly about 567 feet until it reaches the riprap revetment to be put in by the United States as provided for in the project.

It is understood that, in accordance with these recommendations, a bill has been introduced in Congress to authorize the Secretary of War to make the transfer to the city of Waukegan, and that a favorable report on said bill has been made by the Chief of Engineers.

The present contract for dredging, the repairs now in progress and to be made, and the riprapping of the harbor front will be finished this season, thus completing the modified project of 1896. No further extension of either pier is considered necessary. Dredging will, however, be required from time to time to maintain the projected depth in channel and basin, and occasional repairs to piers will be necessary.

An appropriation of $3,000, for maintenance of channel and existing works, is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended		$30,497.28
June 30, 1897, amount expended during fiscal year		14,021.52
July 1, 1897, balance unexpended		16,475.76
July 1, 1897, outstanding liabilities	$1,045.65	
July 1, 1897, amount covered by uncompleted contracts	5,721.88	
		6,767.53
July 1, 1897, balance available		9,708.23
Amount that can be profitably expended in fiscal year ending June 30, 1899, for maintenance		3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

APPROPRIATIONS.

Act of—	
August 30, 1852, for breakwater (outer)	$15,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	20,000
July 5, 1884	20,000
August 15, 1886	20,000
August 11, 1888	25,000
September 19, 1890	35,000
July 13, 1892	25,000
August 17, 1894	20,000
June 3, 1896	20,000
Total appropriation for harbor	230,000
Appropriation for outer breakwater (1852)	15,000
Total for present harbor	215,000

Abstract of proposals for dredging 122,000 cubic yards of materials at Waukegan Harbor, Illinois, received in response to advertisement dated August 17, 1896, and opened September 16, 1896, by Capt. George A. Zinn, Corps of Engineers.

No.	Name and residence of bidder.	Price per cubic yard.	Total for 122,000 cubic yards.
		Cents.	
1	Green's Dredging Co., Chicago, Ill	9	$10,980.00
2	Charles Berner, Green Bay, Wis	$10\frac{1}{2}$	12,810.00
3	William A. Starke, Milwaukee Wis	9	10,980.00
4	Racine Dredge Co., Racine, Wis	$9\frac{1}{2}$	11,590.00
5	Illinois Dredging Co., Chicago, Ill	8	9,760.00
6	Arthur H. Vogel, Milwaukee, Wis	$8\frac{6}{10}$	10,492.00

Amount of appropriation available for this work, $15,000.

With the approval of the Chief of Engineers, a contract was entered into September 23, 1896, with Illinois Dredging Company, the lowest responsible bidders for this work.

Contract in force.

Name of contractor.	Work.	Approved.	Work commenced.	Work to be completed.
Illinois Dredging Co.........	Dredging 122,000 cubic yards	Oct. 31, 1896	Oct. 5, 1896	Oct. 31, 1897

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

[Furnished by Mr. W. W. Pearce, mayor.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest lighthouse, Waukegan, Ill.

Principal articles of export and import.

[By way of the harbor only.]

Articles.	Tons.
IMPORTS.	
Lath........	110
Lumber........	1,125
Shingles........	450
Total........	1,685

[By all ways of transportation.]

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS—continued.	
Beer........	1,400	Eggs........	5½
Brick........	10	Fish........	12½
Cattle........	128¼	Flour........	1,447½
Eggs........	11½	Furniture........	562½
Fish........	18	Hay........	350
Hay........	10	Hides........	240
Hides........	10	Iron and steel........	61,779
Iron and steel........	53,000	Leather........	10
Leather........	225	Lime and cement........	1,936
Merchandise (general)........	33,810	Lumber........	15,406½
Oil........	675	Malt........	270
Sash, doors, and blinds........	500	Marble........	100
Sheep........	60	Merchandise (general)........	66,295
Stone........	840	Mill stuffs........	1,000
Wood........	8,750	Oats........	400
		Oil........	1,715½
Total........	99,447¾	Pork and beef........	240
		Poles (telegraph)........	323
IMPORTS.		Posts (fence)........	50
Agricultural implements........	25	Potatoes........	900
Bark (tan)........	825	Salt........	150
Barley........	240	Sash, doors, and blinds........	200
Beans........	1,880	Sheep........	60
Brick........	1,320	Stone........	14,805
Butter........	10	Ties (railroad)........	7,000
Cattle........	210	Wagons and carriages........	125
Chairs........	50	Wheat........	30
Cheese........	10	Wood........	600
Coal and coke........	99,224		
Corn........	150	Total........	279,957

H H 21.

IMPROVEMENT OF FOX RIVER, WISCONSIN.

Original condition.—The Fox River rises in Columbia County, Wis., and flows generally westward. Near Portage City it turns northward, then eastward into Lake Winnebago, the latter being about 28 miles long and 10 to 12 miles wide. From Lake Winnebago the Fox flows northward into Green Bay, an arm of Lake Michigan.

The Fox and Wisconsin rivers, separated at Portage City by a distance of only 2 miles, were the early means of communication between the Great Lakes and the Mississippi.

The fall in the river from Portage City to Lake Winnebago, 110 miles, is about 30 feet, and from Lake Winnebago to Green Bay, 35 miles, is about 170 feet. From mouth of Fox River (Oshkosh) to Menasha is 18 miles.

The upper Fox has a small discharge and flows through extensive marshes and lakes; near Lake Butte des Morts it unites with the Wolf River, the latter having a much larger discharge than the Fox. The lower Fox carries off all the water brought down by the upper Fox, the Wolf, and other small streams; a discharge of 900,000 cubic feet per minute having been known. The average low and high water discharges have not been accurately determined. A low-water discharge of 2,320 cubic feet per minute is given.

From Lake Winnebago to De Pere the river was obstructed by rapids, and at places portages had to be made.

In 1846 Congress granted to the State of Wisconsin, on its admission to the Union, a quantity of land for the purpose of improving the navigation of the Fox and Wisconsin rivers in the Territory of Wisconsin, and of constructing the canal to unite the said rivers at or near the portage.

To carry out the object of this act, the State of Wisconsin established in 1848, by act of legislature, a board of public works, which began the work of improvement and carried it on until 1853, when all the property and franchises were transferred to the Fox and Wisconsin Improvement Company. After various vicissitudes, financial and otherwise, the entire property was sold in 1866 to the Green Bay and Mississippi Canal Company, and finally by this company in 1872 to the United States for $145,000, with the exception of personal property, water-power privileges, and the lots or parcels of land belonging to the water powers. The deed of transfer was indefinite in its terms, and so many questions have arisen concerning property and franchises that it is impossible to tell at this time without considerable research what the deed actually conveyed.

At the time of transfer in 1872, there were on the upper Fox 4 locks, 4 dams, 1 canal; on the lower Fox 18 locks, 9 dams, 8 canals. The project of the board of public works, State of Wisconsin, recommended the construction of canals, 40 feet wide at bottom, with 4 feet depth at usual low water, and locks 125 feet long between gates and 30 feet wide in the chamber.

The plan to be carried out by the Fox and Wisconsin Improvement Company was to make the lower Fox of sufficient capacity to allow the free passage of boats drawing 4 feet of water, and the upper Fox of boats drawing 2 feet at ordinary low water. This plan required the enlargement of the locks to 160 feet long, 35 feet wide, with 5 feet depth on the miter sills.

Object.—The improvement of the Wisconsin River having been abandoned, the present object is to obtain a navigable channel from Portage on the Wisconsin River, to the harbor of Green Bay, 160 miles.

Project.—The original project of 1872 was a continuation of the project to be carried out by the Fox and Wisconsin Improvement Company. The present project is that recommended by the Board of Engineers of May 14, 1886, and is to deepen the Fox River by rock excavation and dredging from Portage to Montello to 4 feet depth, and from Montello to Green Bay to 6 feet depth; to widen the river channels to 100 feet throughout; to dredge the channel in the Neenah River, and to remove the bar at the mouth of the Fond du Lac River.

Present works.—The present works are as follows:

	Upper Fox.	Lower Fox.	Total.
Locks	9	18	27
Dams	7	9	16
Canals	4	8	12
Total	20	35	55

Of the locks, 15 are of stone; 14 built by the United States and 1 by the canal company, but repaired by the United States in 1878. The remaining 12 are wooden locks, which have been rebuilt and repaired from time to time.

Of the dams, 1 is of masonry, 11 of cribs, 1 of piles and cribs with movable weir, and 2 of brush and stone.

Of the canals, the one at Portage, 2 miles long, is revetted its entire length on both sides with a timber revetment. At Appleton, above the first lock, there is a cement-laid stone revetment wall about 800 feet long and from 16 to 20 feet high. It was built by the United States in 1879–80. Below the guard gate Kaukauna is a dry-stone revetment wall about 1,200 feet long. It was built by the canal company and may have to be rebuilt in places, as it shows signs of yielding. Also, in the left bank of the fourth level at Kaukauna there is a core wall of cement masonry 77 feet long, built in 1893–94; in the right bank of the same level, two core walls, one 600 feet long, built in 1892–93, and one 143 feet long, built in 1893–94; and in the right bank of the fifth level, one 376 feet long, built in 1893–94.

Dry masonry retaining walls were built along right bank of canal above the "combined locks," 521 feet long, 11 feet high, built in 1895 and 1896, and below Kaukauna first lock, 123 feet long, 12 to 14 feet high, built in 1897.

Masonry waste weirs in the second, third, and fourth levels at Kaukauna were built in 1894–95 to regulate the water in the Kaukauna system.

Depth of water.—The fall from Menasha to Green Bay is about 170 feet, and on the upper Fox, from Portage to Lake Winnebago, about 30 feet. Previous to any improvements the river was obstructed by rapids and at places portages had to be made.

As stated above, the project contemplates a channel 6 feet deep from Green Bay to Montello and 4 feet deep from Montello to Portage; these channels to have a minimum width of 100 feet.

On the lower Fox, which is thoroughly canalized, the crests of the dams are uniformly 6 feet above the breast walls of the locks immediately below, and where rapids are passed by means of several locks the breast wall of any one is about the same elevation as the lower miter sill of the lock above. The exception is the lower miter sill of the Menasha Lock, which is 1.5 feet higher than the breast wall of the next lock below, the Appleton First Lock. This condition gives only 4.6 feet of water at the lower miter sill, Menasha Lock, when the river is at a low stage. When the river is at a high stage, with a surplus of 1 foot or more flowing over the Appleton Dam, there is 6 feet over the sill. It is impossible to raise the crest of the Appleton Dam, so that it will be necessary to lower this sill when the Menasha Lock is rebuilt.

During the last year the water in the lower Fox and Lake Winnebago has been well maintained at the crest of the dams throughout the year, with few exceptions. This is the first full year this has occurred, and was brought about by the enforcement of Rule 12. The rule was not strictly enforced against the water users at Neenah and Menasha, but they were allowed certain privileges by the authority of the Secretary of War. For the exceptions thus made attention is invited to the history in the report of Mr. L. M. Mann, assistant engineer, appended to report upon Operating and Care of Locks and Dams on Fox River, Wisconsin; also accompanying hydrographs, etc., showing stages of water, etc.

The violators of Rule 12, Rules and Regulations for the Navigation and Use of Locks and Canals on Fox River, were prosecuted by the United States attorney, Mr. M. C. Phillips, in whose report, herewith appended, further details are given.

During the fiscal year ending June 30, 1897, navigation closed November 14, 1896, on the Fox and Wolf rivers, and was again opened April 10, 1897, excepting at Depere, on the 16th, and in Portage Canal, on the 23d of April, 1897.

Operations during the fiscal year.—The work done during the year consisted principally in rebuilding the outlet of the wasteweir at Kaukauna Second Lock, the construction of a roadway upon United States property from the warehouse at the Appleton First Lock to Lake street, the construction of fishways in the Eureka, Berlin, and White River dams, a small amount of dredging on the lower Fox near Appleton and Menasha. A survey and plan for harbor of refuge at Stockbridge Landing, on the east shore of Lake Winnebago, and an examination of the Wolf River were also made. The timber shed at Appleton First Lock, under construction at the date of the last annual report, was completed.

Preparations have been made to build a new crib dam with masonry abutments and to remove the old brush and stone dam at Princeton.

The dredging along the lower Fox consisted (1) in removing about 540 cubic yards of rock from a cut 1,830 feet long, varying from 20 to 40 feet in width and from 3 inches to 2 feet in depth, between Appleton First Lock and the Chicago, Milwaukee and St. Paul Railroad Bridge and (2) in widening the Menasha Canal between the Wisconsin Central and Tayce Street bridges.

The river and harbor act of June 3, 1896, provided for a "harbor of refuge on the east shore of Lake Winnebago, at one of the several landings on said shore, the location of which harbor of refuge shall be determined by the Government engineer." In accordance with this provision, surveys were made at three places, Stockbridge Landing, Mud Creek, and Calumet Harbor (Pike Creek), the first of which was selected as the best location for the harbor. The citizens of Stockbridge have donated to the United States 3.09 acres of land for the harbor and set aside a strip of land for public use as a highway from the harbor to the existing highway leading to Stockbridge. It is expected to begin the dredging at this harbor as soon as the land has been accepted by the War Department.

The river and harbor act of June 3, 1896, appropriated $1,500 for removing bars and snags from the Wolf River below Shawano, Wis. An examination was made in August and project submitted for doing the work called for between Lake Poygan and New London, 47 miles—

all that the funds would permit. It is expected to commence this work during July, 1897. Further details will be found in the appended report of Mr. L. M. Mann, assistant engineer.

Remarks and recommendations.—The river and harbor act of June 3, 1896, appropriated $3,000 for a thorough investigation of the character, limitations, and description of the property and rights of the United States in connection with the improvement of the Fox and Wisconsin rivers. This investigation was intrusted by the Secretary of War to the Hon. Edward S. Bragg, of Fond du Lac, Wis., and the information when obtained will be of great value.

No action has yet been taken upon the matter of the use of flush boards or other means of making avail of all the natural flow of water and preventing the waste thereof to the height to which the right of the United States to hold the same has been established and without interfering with private rights, as directed by the river and harbor act of June 3, 1896. It appears from an investigation of the subject that the United States can not legally place flush boards upon the Government dams without interfering with private rights. A special report was made upon this subject, dated July 7, 1896.

By the courtesy of water-power owners a table has been made by Mr. L. M. Mann, assistant engineer, of all water powers on the lower Fox, which shows clearly the great value of this improvement.

The repairs to boats and dredges belonging to the Fox River improvement are now made at a private shipyard in Oshkosh, Wis. The cost of hauling these boats out of the water is so large as to justify the construction of a dry dock on Government land along the lower Fox.

The rebuilding of the Princeton and Grand River dams, for which the necessary funds are now on hand, will complete the replacement of all temporary structures in the improvement by permanent ones. The only work left, therefore, to complete the existing project is to dredge the upper Fox to the required depth and to rebuild the Menasha Lock so as to give 6 feet of water over the lower miter sill at all stages of water in the river. This is a wooden lock nine years old, and will require rebuilding within two years in order to be absolutely safe. To give the required depth and to make a better structure than the present one slightly increases the estimate for rebuilding. It can be rebuilt properly for $16,000.

Soundings taken last winter upon the ice from Oshkosh to Fort Winnebago Lock show that there remains 2,060,831 cubic yards of material to be removed to give the required depth, which will cost $164,866.48. The banks of the river are eroded by floods and rains and the channels gradually obliterated. The quantity of material brought into the channels can not be accurately estimated at this time. After the projected depth has been secured, proper observations will give this amount. At the worst places the banks have been revetted, and this revetment may have to be continued, not only to protect the banks against freshets, but also in the narrow parts against the wash of passing vessels. The dredges in present use can not cast material very far from the channel, so that it has to be rehandled. By means of another kind of dredge the material could be deposited at such distance that it would not need rehandling and would not be brought back into the channel by wave wash, etc. It will be more economical to obtain such a dredge at once, not only for the purpose of completing the project, but also for future use in maintaining the channel depth, than to continue using the present dipper dredges. The material to be removed could not well be handled by a rotary pump dredge. A chain bucket dredge is well suited to the work to be done and can be bought for about $35,000.

Estimate of cost of completing project for improving Fox River.

Rebuilding Menasha Lock	$16,000.00
Dredging 2,060,831 cubic yards in upper Fox, at 8 cents	164,866.48
Total	180,866.48

Money statement.

July 1, 1896, balance unexpended	$41,770.90
June 30, 1897, amount expended during fiscal year	6,174.47
July 1, 1897, balance unexpended	35,596.43
July 1, 1897, outstanding liabilities	1,799.59
July 1, 1897, balance available	33,796.84
Amount (estimated) required for completion of existing project	180,866.48
Amount that can be profitably expended in fiscal year ending June 30, 1899	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

List of appropriations made by Congress for the improvement of the Fox and Wisconsin rivers, Wisconsin.

Act of—

March 2, 1867, for snag boat on Wisconsin River	$40,000
July 10, 1870, for improving Wisconsin River	100,000
June 10, 1872, for purchase of works on Fox River from Green Bay and Mississippi Canal Company	145,000
March 3, 1873, for improving Fox and Wisconsin rivers	300,000
June 23, 1874	300,000
March 3, 1875	500,000
August 14, 1876	270,000
June 18, 1878	250,000
March 3, 1879	150,000
June 14, 1880	125,000
March 3, 1881	125,000
August 2, 1882	200,000
July 5, 1884	160,000
August 5, 1886, for improving Fox River	56,250
August 11, 1888, for improving Fox River	100,000
September 19, 1890, for improving Fox River	100,000
July 13, 1892, for improving Fox River	75,000
August 17, 1894, for improving Fox River	37,500
June 3, 1896, for improving Fox River	37,500
Total	3,071,250

REPORT OF MR. M. C. PHILLIPS, UNITED STATES ATTORNEY.

OSHKOSH, WIS., *July 13, 1897.*

CAPTAIN: The suits referred to in the report of my predecessor, under date of June 30, 1896, relating to the Fox and Wisconsin rivers, are still pending in the United States circuit court, and none of them have been moved since the date of his report. No new civil cases have been commenced relating to the same subject during theyear. There have been several criminal cases brought during the year for drawing water from the Government canal below the level established by the Secretary of War, in which indictments have been found by the grand jury.

My term of office covering only two months, viz, May and June of the year, no action in any of these matters was taken during that time. They are all pending for trial, and will be brought on for hearing at the October term, 1897.

Yours, truly,

M. C. PHILLIPS,
United States District Attorney, Eastern District of Wisconsin.

Capt. GEORGE A. ZINN,
Milwaukee, Wis.

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER, FOX RIVER IMPROVEMENT.

UNITED STATES ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1897.

CAPTAIN: I have the honor to submit the following report of operations on "Improving Fox River, Wisconsin," from Portage to Green Bay, for the fiscal year ending June 30, 1897:

The work done during the year consisted principally in rebuilding outlet to waste weir at Kaukauna Second Lock; construction of roadway at Appleton First Lock; construction of fishways in Eureka, Berlin, and White River dams; commencing construction of Princeton Crib Dam; dredging rock channel below Chicago, Milwaukee and St. Paul Railroad Bridge, Appleton; widening canal above Menasha Lock; making survey and plan for harbor at Stockbridge Landing, and making examination of Wolf River.

CONSTRUCTION OF LOCKS, ETC.

Waste weir at Kaukauna Second Lock. (Rebuilding outlet of weir.)—The work of rebuilding this outlet of the waste weir was commenced October 9, 1896. The vitrified pipe was replaced by a stone culvert laid in cement, 3½ by 4 feet in cross section, connected with the weir wall in a stone arch. It runs 282 feet from weir to below draw bridge along left side of lock, emptying into third level.

One thousand three hundred cubic yards of earth was excavated from the trench and all the serviceable sewer pipe was removed from the old outlet. Two hundred and sixty-nine cubic yards of cement masonry was laid for the sides and bottom and 56½ cubic yards of flag stone was placed in cement for the top. One thousand two hundred and fifty cubic yards of earth excavated from the trench was replaced, and material left over was hauled by team to Kaukauna warehouse and stored, completing the rebuilding of the outlet November 20, 1896.

Timber shed at Appleton First Lock.—This shed, which was under construction at the close of last fiscal year, was given three coats of No. 20 paint on the outside, completing the construction of same.

Roadway at Appleton First Lock.—For the purpose of giving access by team from Lake street to the United States buildings at the lock, this roadway was built on United States property. The construction was commenced May 20 and completed June 5, 1897.

One thousand two hundred and sixty-five cubic yards of earth was excavated by plow and scraper from cut side of roadway and placed in fill side. Three lines of 24-inch old sewer pipe were placed for culverts under roadway.

This roadway is 1,080 feet long and 15 feet wide, and runs along hillside on right side of canal from Lake street to warehouse. The road was well ditched on the inside.

Fishways on Eureka, Berlin, and White River dams.—In accordance with the requirements of the State law, fishways were placed in these dams last fall. They are all of the same construction, and consist of a riffle trough 4 feet 10 inches by 24 inches and 24 feet long, covered. Riffles are 14 inches apart and openings are 10 inches wide. The trough is fastened at the crest of the dam and runs to low water, with a gate at the upper end to regulate the water or shut it off.

The construction of fishways on these dams was commenced on October 6 in the order named. The material was transported from Oshkosh to the dams in conjunction with the trip of inspection on the Upper Fox.

Fishway on Eureka Dam.—One thousand five hundred and seventy-nine feet B. M. pine lumber was framed and secured in place, forming the trough, gate, supports, etc. The trough was connected with the navigable pass between the third and fourth valves. Nine pieces 12 by 12 inches by 6 feet to 8 feet were driftbolted to the apron timbers of dam for supports of lower end of the trough, to which it was securely fastened.

The best opening of the head gate was determined by experiment to be 12 by 18 inches, which fills the trough with water completely, and but little water passes through the openings in top.

Fishway on Berlin Dam.—One 30-foot rock-elm pile was driven for support of lower end of trough, and 5 22-foot piles were driven at upper end above the dam to protect it from ice and drift. A pine bent was securely placed to support middle of trough. Experiments determined that opening the gate 18 inches the trough is completely filled with water with a minimum current and without forcing the water through the openings on the top.

Fishway on White River Dam.—The upper end of this fishway was let into the crest of the dam 12 inches. Experiment determined that when the gate is raised 18 inches and flushboards are removed from the crest the trough fills within 2 inches of the top. The construction of this fishway was completed on November 10, 1896.

The pile driver which was used in driving the piles was towed to Berlin by the steam tug *Fox* and her machinery laid up for the winter.

Princeton Dam.—The old brush and stone dam at this place is worn, and is to be replaced by a timber-crib dam with masonry abutments. Land is about to be purchased for the right abutment, the left abutment resting on United States property. Material is being purchased and received and all preparations are being made to commence construction this month (June, 1897).

DREDGING LOWER FOX.

Canal below Chicago, Milwaukee and St. Paul Railroad Bridge, Appleton, Wis.—On May 21, 1897, dredge No. 2 was towed by steam tug *Boscobel* from Cedars to Appleton, and cleaned the channel between the bridge and Appleton First Lock. Cuts were made in rock, 1,830 feet by 20 feet to 40 feet by 3 inches to 2 feet, and 540 cubic yards of large flat stones excavated, which were of such size and shape that they could not be lifted by the dipper but were shoved sidewise, making the work slow and expensive. The work was completed June 7, 1897.

Total amount dredged, 540 cubic yards; total amount rehandled, 184 cubic yards.

Widening canal above Menasha Lock.—June 8, 1897, dredge No. 2 was towed by steam tug *Boscobel* from Appleton to Menasha Canal, where cuts 310 feet by 20 feet by 3 feet to 4 feet were made, excavating 774 cubic yards of hardpan, which was banked on the left. The intention is to widen the canal about 20 feet between the Wisconsin Central Railroad and Tayco Street bridges.

SURVEYS.

For a harbor of refuge, east shore of Lake Winnebago.—In accordance with your authority of July 20, 1896, surveys were made at Stockbridge Landing, Mud Creek, and Calumet Harbor (Pike Creek), on the east shore of Lake Winnebago, to determine the best location for a harbor of refuge, as provided for in the river and harbor act of June 3, 1896. * * *

A project was submitted, and approved by the Secretary of War November 4, 1896, as follows: "That the harbor be located at Stockbridge Landing, on land donated by citizens of the town of Stockbridge." The plan contemplates an entrance channel 6 feet deep and 100 feet wide, extending from the 6-foot contour in Lake Winnebago to a point 100 feet inside the shore line, protected on the south side by a single pier 250 feet long and an interior basin about 2½ acres in area. As the appropriation available is not sufficient to do the entire work, it is proposed to excavate the entrance channel and basin and drive a few guide piles at the entrance, omitting the protection pier for the present.

The citizens of Stockbridge have transferred to the United States, free of cost, 3.09 acres of land for the harbor, and also a strip of land for public use as a roadway connecting the harbor with the present highway leading to Stockbridge. As soon as this land is accepted the work of making the harbor can commence.

Examination of Wolf River.—In compliance with the authority of July 22, 1896, a preliminary examination was made of the Wolf River, Wisconsin, August 11 to 13, inclusive, on the steam tug *Fox* for the purpose of determining a project for the expenditure of the amount appropriated by the river and harbor act of June 3, 1896, viz, "$1,500 appropriated for removing bars and snags from the Wolf River below Shawano." * * *

A project was submitted and approved by the Secretary of War, November 5, 1896, to the effect, to remove all snags and leaning trees obstructing navigation between New London and Lake Poygan, a distance of 47 miles, and to dredge a channel 80 feet wide and 4½ feet deep at medium stage through the following bars: New London Bar, 600 feet long with 2½ feet of water; Little Wolf Bar, 400 feet long with 3½ feet of water; Upper Muckwa Bar, 300 feet long with 3½ feet of water; Lower Muckwa Bar, 400 feet long with 3½ feet of water; Tom Wall Bar, 300 feet long with 3 feet of water; and removal of wreck of steamer *Tom Wall*.

The dredging is estimated at 11,000 cubic yards and 477 snags and deadheads and 225 leaning trees to be removed. It is expected to commence this work during the month of July.

For Princeton Dam.—As the United States does not own any land on the right bank of the Fox River adjacent to the site of the proposed new dam at Princeton Lock, a survey was made to determine the land needed for the right abutment of the new dam. A map and tracing of the survey were made, showing the land needed to be 1 acre, situated in Lot 2, Sec. 35, T. 16 N., R. 11 E., and belonging to Mr. Franz Zülke, with whom negotiations have been entered upon for its transfer.

General remarks.—The dredges on the Upper Fox, for the fiscal year ending June 30, 1897, completed between Berlin and Eureka locks a navigable channel 100 feet wide and 6 feet deep, and removed bars from other portions of the Upper River.

Data in tabular form accompanies this report, showing the amount of work and cost, in different relations, of dredging done by all of the dredges on Fox River during the year 1896.

As the result of last winter's survey of the Upper Fox, a complete estimate of the amount of dredging necessary to complete the project is herewith given in tabular form.

Milepost 12 to Eureka Lock.		Berlin to White River Lock.		White River to Princeton Lock.	
Mileposts.	Cubic yards.	Mileposts.	Cubic yards.	Mileposts.	Cubic yards.
12 to 13	2,664	Berlin Lock to 33	....	White River to 43	4,647
13 to 14	2,334	33 to 34	28,380	43 to 44	28,193
14 to 15	2,540	34 to 35	22,624	44 to 45	29,823
15 to 16	8,936	35 to 36	24,608	45 to 46	30,901
16 to 17	13,941	36 to 37	36,781	46 to 47	39,430
17 to 18	21,464	37 to 38	27,532	47 to 48	37,151
18 to 19	18,464	38 to 39	32,906	48 to 49	27,843
19 to 20	20,181	39 to 40	26,995	49 to 50	33,789
20 to 21	18,806	40 to 41	32,189	50 to 51	31,454
21 to 22	14,187	41 to 42	25,017	51 to 52	37,643
22 to 23	17,284	42 to White River Lock	21,541	52 to Princeton Lock	16,295
23 to 24	29,075				
24 to Eureka Lock	16,743				
Total	186,619		278,573		317,169

Princeton to Grand River Lock.		Grand River to Montello Lock.	
Mileposts.	Cubic yards.	Mileposts.	Cubic yards.
Princeton Lock to 53	24,269	Grand River Lock to 74	29,213
53 to 54	33,270	74 to 75	27,452
54 to 55	45,828	75 to 76	80,692
55 to 56	21,959	76 to Montello Lock	25,422
56 to 57	500		
57 to 58	....		
58 to 59	6,160		
59 to 60	5,618		
60 to 61	10,913		
61 to 62	17,804		
62 to 63	42,682		
63 to 64	58,081		
64 to 65	47,436		
65 to 66	34,850		
66 to 67	35,275		
67 to 68	123		
68 to 69	963		
69 to 70	40,170		
70 to 71	46,949		
71 to 72	31,300		
72 to 73=Grand River Lock	37,325		
Total	541,481		162,780

Montello to Governor Bend Lock.		Governor Bend to Fort Winnebago Lock.	
Mileposts.	Cubic yards.	Mileposts.	Cubic yards.
83 to 84	791	Governor Bend Lock to 101	24,972
84 to 85	261	101 to 102	51,209
85 to 86	....	102 to 103	70,162
86 to 87	....	103 to 104	73,554
87 to 88	4,948	104 to Fort Winnebago Lock	50,706
88 to 89	2,647		
89 to 90	3,154		
90 to 91	17,215		
91 to 92	24,205		
92 to 93	38,081		
93 to 94	23,944		
94 to 95	17,884		
95 to 96	12,519		
96 to 97	29,865		
97 to 98	31,820		
98 to 99	22,372		
99 to 100	44,608		
100 to Governor Bend Lock	29,292		
Total	303,606		270,603

	Cubic yards.
Total between Oshkosh and Montello Lock	1,486,622
Total between Montello Lock and Fort Winnebago Lock	574,209
Total between Oshkosh and Fort Winnebago Lock	2,060,831

This can be reduced 296,515 cubic yards by leaving channel 75 feet wide between high banks, from Section Post 90 to Fort Winnebago Lock.

No dredging required between Oshkosh and Section Post 12, between Eureka and Berlin Locks, and between Montello and Section Post 83.

This estimate is based on 6-feet dredging to Montello and 4 feet from Montello to Fort Winnebago Lock below mean low water, a grade having been established in each section between locks. From Lake Butte des Morts to Eureka Lock, the grade was taken from the crest of the Menasha dam to mean low-water mark on lower Eureka gauge. An allowance of 33⅓ per cent was made for dipper measurement.

Estimate of cost.

1,486,622 cubic yards, at 8 cents	$118,929.76
574,209 cubic yards, at 8 cents	45,936.72
2,060,831 cubic yards, at 8 cents	164,866.48

In estimating the cost it is based on 6 cents per cubic yard, and if the old method of dredging is used, another 33⅓ per cent must be added for rehandling, which practically makes the cost 8 cents per cubic yard.

As the principal work remaining to complete the project of the Fox River improvement is the dredging on the Upper Fox, I would again respectfully draw attention to my special report of October 30, 1896, in regard to the improvement of the dredging plant on the Fox River. As stated therein, I believe a plant can be built for $35,000 (a liberal estimate), adaptable to the conditions on the Upper Fox, that could handle 250 cubic yards per hour, or as much as the four present dredges. Such a dredge would avoid rehandling the material, place it where wanted, and generally eliminate the cost of dumping privileges, and remove it from the attack of high water and channel currents. Such a plant should dredge for one-quarter the cost or less, say 2 cents per yard. If only one-half the amount estimated to be dredged, or 1,000,000 cubic yards were handled by the new plant, a saving of $60,000 would be gained or about double the cost of the plant aside from the general advantages of the method before enumerated.

Very respectfully, your obedient servant,

L. M. MANN, *Assistant Engineer.*

Capt. GEORGE A. ZINN,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of articles transported on Fox River, Wisconsin, during season of 1896.

Articles.	Quantity in tons.	Articles.	Quantity in tons.
Beer	249.5	Lumber	5,572.5
Brick	7,424	Merchandise (general)	3,473
Cedar posts	150	Oil	113.5
Coal	25,531.5	Paper	52.5
Cord wood	15,772	Pulp wood	2,908
Drain tile	100	Salt	2,181
Flour	56.5	Sand	7,845
Gravel	2,940	Sewer pipe	400
Grain, flour, and mill stuffs	5,696	Shingles	689
Land plaster	75	Slabs	30
Lath	326	Stone	8,108
Lime	259		
Logs	58,159	Total	148,110

Passengers, 22,576.

List of boats navigating Fox River between Portage and Green Bay, Wis., 1896.

Name of boat.	Kind.	Draft in feet.	Tonnage.	Class.
Evalyn		3	150	Steam.
J. H. Crawford		2	100	Do.
B. F. Carter		4½	210	Do.
Ossian Cook		4½	210	Do.
Fashion		3	50	Do.
J. H. Marston		5	75.25	Do.
John Lynch		3	50	Do.
D. A. Cady	Tug	1⅝	50	Do.
M. D. Moore	do	3	50	Do.
Hustler	do	2	50	Do.
John Denessen	do	5½	15	Do.
Nettie Denessen	do	5½	22	Do.
Agnes C	do	5⅝	15.64	Do.
Volunteer	do	5½	17	Do.
D. L. Libbey	do	5	17	Do.
Morning Bell	do	5½	9	Do.
Eclipse	Scow	2⅝	70	Sail.
Venture	do	6	91	Do.
Georgia	do	5½	78	Do.
Emma	do	4½	45	Do.
J. Porter	do	7½	142	Do.
Nellie Church	do	7½	123	Do.
Long Tom	Barge	5	145	Tow.
Jumbo	do	5½	97	Do.
Hustler	do	3½	90	Do.
Hustler	do	3½	80	Do.
Sandy	Scow	4	150	Do.
Anna M	Pleasure yacht	2½		Steam.
Theresa	do	3½		Do.
Cambria	do	4		Do.
Gazelle	do	3½		Do.
Irma	do	3½		Do.
Nia	do	3½		Do.
Swallow	do	3½		Do.

NOTE.—There are quite a number of small pleasure yachts besides those mentioned.

Number of lockages on Fox River, Wisconsin, for the calendar year 1896.

No.	Lock.	Lockages.	No.	Lock.	Lockages.
1	Depere	301	16	Appleton, second	296
2	Little Kaukauna	308	17	Appleton, first	384
3	Rapide Croche	220	18	Menasha	402
4	Kaukauna, fifth	303	19	Eureka	424
5	Kaukauna, fourth	300	20	Berlin	376
6	Kaukauna, third	302	21	White River	123
7	Kaukauna, second	302	22	Princeton	141
8	Kaukauna, first	302	23	Grand River	105
9	Little Chute, fourth*	285	24	Montello	80
10	Little Chute, third*	285	25	Governor Bend	61
11	Little Chute, second	297	26	Fort Winnebago	95
12	Little Chute, first	294	27	Portage	71
13	Cedars	280			
14	Appleton, fourth	307		Total	6,963
15	Appleton, third	319			

* Combined.

H H 22.

OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

The expenditures for maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams and lock houses, and for lock tenders' services, have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation," provided for by section 4 of river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended hereto.

The work during the fiscal year has consisted principally in dredging the channels of the river and canals and in making repairs of locks, dams, canal banks, lock houses, dredges, and boats.

For details of work done during the year see the report of Mr. L. M. Mann, assistant engineer, appended to this report. His report is accompanied by: 1 tracing, hydrograph Lake Winnebago, discharge of Fox River, and rainfall; 1 tracing, statistics, etc., of water powers on Government dams, Lower Fox; 1 tracing, statistics, etc., of water powers on private dams, Lower Fox, and 1 blue print, dredging data for year 1896.

It is particularly to be noted that this is the first year in the history of this improvement that the water in the Lower Fox and Lake Winnebago has been maintained at or near the crests of the dams, a condition brought about by the enforcement of the rules and regulations for the navigation and use of the locks and canals on Fox River, approved by the Secretary of War February 15, 1895, under the river and harbor act of August 17, 1894.

Money statement.

July 1, 1896, balance unexpended	$11,426.96
Amount allotted for fiscal year ending June 30, 1897	62,665.03
	74,091.99
June 30, 1897, amount expended during fiscal year	66,317.49
July 1, 1897, balance unexpended	7,774.50
July 1, 1897, outstanding liabilities	2,687.12
July 1, 1897, balance available	5,087.38
Amount (estimated) for expenditure in fiscal year ending June 30, 1898	*60,009.62
Amount available for fiscal year ending June 30, 1898	65,097.00

REPORT OF MR. L. M. MANN, ASSISTANT ENGINEER.

OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1897.

CAPTAIN: I have the honor to submit the following report of operations upon "operating and care of canals and other works of navigation on Fox River, Wisconsin," from Portage to Greenbay, for the fiscal year ending June 30, 1897.

The work done during the year consisted, principally, in rebuilding the Depere Lock; repairing and reenforcing Little Kaukauna Dam; building retaining wall below right abutment of Depere Dam; building retaining wall below Kaukauna First Lock; building protection above and below Kaukauna Guard Lock; repairs of Little Chute Combined Locks; building retaining wall above Combined Locks; repairs of Appleton Second Lock and Menasha sluice gates; building shore protection below Eureka Dam; repairs to Eureka Lock, Dam, lock house, and roadway; repairs to Montello Lock; repairs to boats and dredges; removing bars of Upper Fox River by dredging, and making incidental repairs to locks, dams, and canal banks.

*Amount allotted if estimate is approved.

MAINTENANCE OF NAVIGATION.

Navigation was closed formally November 14, 1896, on the Fox River and Wolf River. Flushboards at Berlin and White River dams were removed and valves in the navigable pass of Eureka Dam opened. Water was drawn from the Kaukauna and Little Chute canal systems preparatory for the winter. Navigation was again opened April 10, excepting at Depere, on the 16th, and in Portage Canal on the 23d.

The water in the Lower Fox and Lake Winnebago has been well maintained at the crest of the dams throughout the year with few exceptions. This is the first full year this has occurred, and was brought about by the enforcement of Rule 12. The stages of Lake Winnebago are shown on hydrograph accompanying this report, with discharges as observed at Rapide Croche Dam and precipitation of the upper valleys. Hydrograph shows—

Water below crest of dam	days..	154
Water above crest of dam	do....	211
Maximum height of water April 17, 1897	feet..	+3.19
Lowest point reached, August 26, 1897	feet below crest..	.7

Of the one hundred and fifty-four days below crest, water was less than one-tenth foot below crest during twenty-four days.

Maximum discharge, April 23, 1897, 523,703 cubic feet per minute.

Mean monthly discharges at Rapide Croche for year are as follows:

1896:	Cubic feet per minute.	1897:	Cubic feet per minute.
July	167,244	January	165,795
August	87,177	February	165,913
September	8,431	March	162,506
October	63,833	April	367,891
November	120,428	May	240,756
December	142,071	June (1 to 27)	195,752

Mean for year, 157,316.

In comparing the three curves of last year with this it will be noticed that, although the rainfall was far greater in 1896, the discharges in 1897 are much the greater. This was due to the fact that during the winter and spring of 1896 the lakes and adjoining marshes were very low and took up much of the surplus water, while this spring they were nearly full, having been kept so by the enforcement of Rule 12. The lake also, although its maximum stage was slightly higher than last year, did not go as high as the discharge curve might indicate, because the water was sluiced at Menasha.

In continuance of the history of the water regulation, I would state that the Oshkosh gauge reached its maximum June 8, 1896, at +2.92, after which the waters commenced to recede rapidly, due to heavy evaporation and a meager supply. Contrary to all warning to the mill men, the water continued to go down, and on August 21 all the mills were obliged to close down. The water continued to fall, and at this time it was apparent that the flow of the river but slightly exceeded the evaporation of the lakes. The mills on the Lower Fox ran by steam with few exceptions. All leakages were repaired as much as possible and the water husbanded, although some water had to be sluiced at Menasha Lock to keep the lower levels full for navigation. The water commenced to rise, and the mean for the month of September was +1.42, the highest for this month in eleven years.

On September 30 the Secretary of War rescinded the order of August 21, and issued a new order permitting the mills at Neenah and Menasha to gradually draw the level of Lake Winnebago down 6 inches below the crest of the Menasha Dam.

A new company, called the Neenah and Menasha Water Power Company, was organized, which comprises all the water powers on Fox River from Neenah and Menasha to Depere. Its committee controls and divides the water within certain limits, thereby giving a more uniform and just distribution. Many of the contentions have been done away with, and during last fall, when water was generally low, it was kept up beyond expectations. In accordance with the last order the mills continued to slowly draw the lake down until it reached a point below the level prescribed by the Secretary of War, between the 8th and 10th of March, and the mills were verbally requested on the 10th to stop drawing water. This order was, however, suspended on the same day awaiting further orders from the Secretary of War. On March 11, by order of the Secretary of War, the mills were permitted to draw the water in Lake Winnebago to 12 inches below the crest. The mills did not take advantage of this order until the 19th, when the committee allowed all "first water" to be drawn, and on the 31st they commenced drawing "second water." The lake continued to rise until it reached its flood height, April 17, 1897.

The very high water was kept down by sluicing at the Menasha Dam, but the heavy sluicing at one side only caused backwater in the Menasha River and reduced the head of the mills on that side very materially. Although the regulation has been successful in many respects, it is again apparent that the United States should have absolute control, so that all can be treated alike.

By order of the Secretary of War, March 17, 1897, the authority given the mills at Neenah and Menasha to draw the water below the crest of the Menasha Dam was to cease upon the opening of navigation (April 10, 1897).

The means of all gauge readings were calculated and tabulated for nineteen years. Daily discharge computations were made, tabulated, and plotted.

In order to show the importance of the great water power in the Lower Fox Valley, I have taken great pains to obtain an accurate and complete tabulation of these powers, which is appended hereto. The data to base calculations on was kindly furnished by the mill men themselves and is therefore supposed to be correct.

A recapitulation below gives the horsepower for each dam individually, and also the steam power, as follows:

GOVERNMENT DAMS.

Dams.	Horsepower of wheels.		Amount of water required for the wheels (cubic feet per minute).	Horsepower of dams, computed for a flowage of 170,000 cubic feet per minute.		Steam power (horsepower).
	Theoretical, computed from discharges of the wheels.	Practical wheel capacity.		Theoretical.	Practical (75 per cent of theoretical).	
Neenah (private)	5,163	4,176	342,398	....	....	1,732
Menasha	2,797	2,234	248,806	2,646	1,984	3,005
Appleton, upper	7,329	5,903	298,809	4,508	3,381	975
Appleton, lower	1,877	1,528	144,475	2,721	2,041	200
Cedars	5,227	4,217	250,888	3,142	2,356	150
Little Chute	3,950	3,152	172,624	3,864	2,898	....
Kaukauna	6,402	5,144	239,514	4,508	3,381	1,445
Rapide Croche	....	....	....	2,746	2,059	....
Little Kaukauna	....	....	....	2,548	1,911	....
Depere	2,672	2,130	201,539	2,694	2,021	1,833
Total	35,417	28,484	....	29,377	22,032	8,840

PRIVATE DAMS.

Dams.	Theoretical	Practical wheel capacity	Amount of water	Theoretical	Practical	Steam power
Appleton	5,715	4,597	304,556	2,367	1,775	2,205
Combined locks	5,336	4,438	152,287	5,957	4,468	....
Kaukauna	2,169	1,735	76,199	4,830	3,623	....
Total	13,220	10,770	....	13,154	9,866	2,205
Totals for Government and private dams	48,637	39,254	....	42,531	31,898	11,045

The power of the dams is based on a mean flowage of the river of 170,000 cubic feet per minute, which was about the mean flowage as observed for the past year and as has been estimated in previous years. The above table shows that the practical wheel capacity at Neenah and Menasha is 6,410 horsepower, with a possible consumption of 591,204 cubic feet of water per minute, or about three times the mean flowage of 170,000 cubic feet per minute, with an estimated practical power of 1,984 horsepower.

The total practical power offered by Government dams is estimated at 22,032 horsepower, of which 3,970 horsepower at Rapide Croche and Little Kaukauna is not now and little of it ever has been utilized. The reason is because the water rights and the adjoining property rights belong to different parties and they can not be harmonized, causing a very large yearly loss. The total practical horsepower of the Fox, from Neenah and Menasha to Depere, is estimated at 31,898 horsepower and an additional steam power connected with the different manufactories of 11,045 horsepower.

The following table shows the water power owned by the Green Bay and Mississippi Canal Company, on the Lower Fox, as estimated from data given by Mr. A. L. Smith.

GOVERNMENT DAMS.

	Practical horsepower, wheel capacity.	Practical horsepower due to flow of 170,000 cubic feet per minute (75 per cent of theoretical horsepower).	Per cent of flow of river entitled to.	Remarks.
Appleton, upper	2,600	1,183	35.00	Owned jointly by Green Bay and Mississippi Canal Company and Kaukauna Water Power Company.
Appleton, lower	1,371	624	18.45	
Little Chute	3,152	2,837	100.00	
Kaukauna	2,307	1,516	44.85	
Do	2,837	1,865	55.15	
Rapide Croche		2,059	100.00	
Little Kaukauna		1,911	100.00	
Total		11,995		

PRIVATE DAMS.

Kaukauna	567	1,184	32.68	Owned jointly by Green Bay and Mississippi Canal Company and Patton Company.
Do	352	735	20.29	
Do	Small power.			Owned jointly by Green Bay and Mississippi Canal Company and Edwards.
Combined locks	4,488	4,468	100.00	

The average cost of steam power per horsepower per year I would place between $50 and $75, or $62.50 per horsepower.

The cost of water power per horsepower per year, including 10 per cent for interest on original cost of dams, canals, etc., and sinking fund, repairs, taxes, etc., or water rent in lieu thereof, at the rate of $5 to $7 per horsepower, and 75 cents for oil and attendance, would average $10 per horsepower per year. The gain, therefore, of water power over steam is at least $52.50. On the Fox River, however, the dams, etc., are maintained by the United States, excepting the Neenah Dam, and the water users have only to pay for the water wheels, pits, foundation, head gates, and wasteweirs, which would amount to about $20 per horsepower. The annual cost per horsepower does probably not exceed $3, and $50 per year per horsepower would therefore be a low estimate for the gain of water over steam power. This can be considered an income, and amounts for the total horsepower furnished by Government dams from Menasha to Depere, equal to 22,032 practical horsepower, at $50, to $1,101,600. This includes Rapide Croche and Little Kaukauna, not now utilized, as stated above.

REPAIRS OF LOCKS, ETC.

Depere Lock.—This lock, which was found in a very weak and leaky condition, was entirely rebuilt during the last winter. It was last (partly) rebuilt in the year 1886–87, but the lower part of the lock was not renewed at that time and it was left in bad condition.

With several improvements this lock is now the best wooden lock on the river. The lock was lengthened from 166 to 170 feet to make it conform to other locks. Rock was blasted from under the lock walls along both sides, and the mud sills placed on the bottom in cement. The space between the breast wall and upper gates was also blasted to a level with bottom of the lock, and a platform with a new system of valves constructed. The upper gates were cut off and the old valve openings closed. The head walls and upper wing walls were built up in good cement masonry; the lower wing crib walls were also reconstructed. The entire lock walls of dry masonry were relaid. As these walls were composed principally of small rubblestone, many large ones were added, and good walls built up. Middle girts were placed so as to permit repairs of the upper work without disturbing the lower part under water. The old crib breast wall was removed and a good cement masonry wall built in its place.

The work of rebuilding the lock was commenced November 2, 1896. Old cribs, pump engine, timber, and tools were towed by steam tug *Boscobel* and *Dredge No. 2* from Appleton, Kaukauna, and Little Kaukauna to this lock.

Five hundred and sixty-six cubic yards of gravel were excavated for shore connections of coffer dams above and below the lock, 8,725 feet B. M. of pine timber were used in constructing 4 cribs, which were floated to place and filled with 15 cords of stone. Eleven thousand and eighty-six feet B. M. new and old plank were used for planking. One thousand and ninety-four cubic yards of clay were excavated from the bed of the river, and 616 cubic yards were purchased in bank, loaded, scowed, and placed on back of the coffer dams. One hundred and fifty cubic yards of earth were also placed for strengthening the same. *Dredge No. 2* was employed in dredging and sinking cribs, and steam tug *Boscobel* in towing dredged material.

Ninety-three thousand three hundred feet B. M. of old girts, posts, mud and miter sills, hollow quoins, miter sill platform, plank, and timber in coping, breast wall, and in wing walls were removed; 2,564 cubic yards of stone were removed from the lock and wing walls and from the wing-wall cribs—this stone was used in rebuilding the lock; 1,694 cubic yards of earth, gravel, and stone was excavated for the foundation of the cross, breast, wing, head, and lock walls and wing-wall cribs and for site of pumping engine; 315 cubic yards of stone was quarried from the site of the new valve platform and from the sides—this stone was used in the construction and was profitable; 1,644 cubic yards of dry masonry was laid in the cross wing, head, and lock walls; 947 cubic yards of concrete masonry was laid in the cross, breast, wing, and lock walls, pier under platform, behind mud sills, and between chord and cheek pieces of lower miter sill; 20 cubic yards of concrete was placed between front and back coping timbers of lock walls; 1¼ cords of stone was placed for a riprap wall at upper end of right wing wall; 1,676 square feet of head, breast, lock, and wing walls was pointed with cement; 16 holes were drilled in coping of head and breast walls, and 16 iron dowels were placed for securing coping. The solid rock along the sides was dressed to receive the mud sills and lower miter sill, which were framed, bedded in cement, and bolted with 1½-inch bolts to the solid rock. New framework of oak, consisting of posts and girts, were built and secured in place with 1½-inch anchor bolts through the walls. Two thicknesses of 2-inch pine plank, dressed and jointed, were spiked to the framework. Hollow quoins and recess corner posts were framed and bolted in position. New coping timbers were framed and placed.

A new valve platform was built, having for its supports a cement masonry pier in the middle and 31 gas-pipe supports properly distributed. The base plates of the pipes were secured by means of split bolts to the solid rock, which was dressed to receive them, and the top plates were fastened to the timber with lag screws. The upper miter sill was framed and securely bolted to the new platform. Six oak snubbing posts were framed and secured by anchor rods to the lock walls. New platforms were built and the maneuvering system overhauled.

The gates were removed; top timbers placed on them to raise them to the necessary height; the valves in upper gates removed and openings closed; gate posts were repaired and gates replaced; 4 new heel-post caps with yokes and back straps and 4 galvanized caps for hollow quoin posts were fitted and secured in place. The valves and valve-maneuvering gear for lower gates were repaired.

Two hundred and thirty-four cubic yards of earth, stone spalls, and ice was removed from the recesses and chamber of the lock; 26 cords of stone, the cribs, and 4,129 cubic yards of earth and clay were removed from the cofferdams and from the bank where earth had been placed from the excavations of the lock walls, of which 3,416 cubic yards was excavated and 680 cubic yards was rehandled by *Dredge No. 2*, completing the removal of the cofferdams on the 22d of April, 1897. The lock was filled with water on the 15th of April.

Three hundred and six cubic yards of earth were wheeled and placed for filling in back of lock walls.

In connection with this lock a masonry cross wall was built 9 feet 4 inches high, 3 feet on top and 4 feet on the bottom, extending from the upper left head wall of lock about 43 feet up to the left canal bank and reaching to a point beyond the entrance of the old lock. This makes the bank on this side permanently safe. It was on an old fill, composed principally of mill refuse.

Retaining wall above Depere Lock.—A cross wall 3 feet wide on top, 4 feet wide at bottom, 9 feet 1 inch high, and 54 feet long was built, extending from the upper end of the head wall on the right bank of the canal above the lock to the wall of the electric-light flume. Twenty-six and one-third cubic yards of cement masonry was laid in constructing the same. Twelve cubic yards of earth was placed, filling over this cross wall.

The joints in 826 square feet of the retaining wall were raked out and repointed with cement.

The wall permanently stops all leakage through the embankment and prevents further washouts.

Depere Dam—Retaining wall below right abutment.—A wall 3 feet wide on top, 6.5 feet wide at bottom, 14 feet high, and 18.5 feet long was built, connecting the right abutment of the dam with pier of highway bridge. A low cofferdam was necessary to keep out the water while the foundation was laid. The old crib was removed and part of the stone used in the wall. Forty-nine cubic yards of cement masonry and 25 cubic yards of dry masonry were laid in the construction of the wall. Forty-six cubic yards of clay was placed in back of wall for filling.

The joints and seams in 1,100 square feet of the abutments were raked out and repointed with cement.

This wall was also required to insure the safety of the canal bank, which was always leaking and in danger of washing out.

Little Kaukauna Dam.—The work of building the submerged cribs 16 feet wide and 4 feet high for the total length of the dam and sinking same below the apron was continued.

Twenty-seven thousand three hundred and twelve feet B. M. pine timber was framed and bolted for seven cribs. These, with the six cribs built last year, were towed to foundation prepared for them below apron of dam and sunk with 211¼ cords of stone. Two thousand four hundred feet B. M. pine timber for stringers and 11,812 feet B. M. oak plank for decking were placed and secured on top of the submerged cribs opposite the sluiceway.

Fifty-nine piles, for keeping the cribs in place, were driven on lower side from 13 feet to 19 feet into the ground.

New abutments and horses were built and replaced the old ones in the sluiceway. New needles were framed and placed and the walk over the sluiceway was repaired. For these repairs in the sluiceway 3,738 feet B. M. pine and 11,480 feet B. M. oak timber and plank were used.

One hundred and five linear feet of old apron plank and 373 linear feet of old crest timbers were removed. The tops of 123 piles were reframed and 9,906 feet B. M. pine timber and 880 feet B. M. oak plank were framed and bolted for the new crest.

The apron plank on the crib at the right abutment of the dam was removed; 860 feet B. M. of pine and oak timber and plank was framed and placed for leveling the top stringers of this crib for apron plank and for sheer timbers, to prevent the river from undermining the abutment. One hundred and sixty-eight and thirty-three one hundred and twenty-eighths cords was filled between the piles of the dam in place of that washed out.

Dredge No. 2 was employed in preparing the foundation for the submerged cribs, for which purpose there were removed 1 pile, 5 snags, 43 large stones, and 190 cubic yards of small stone, and excavated 4,890 cubic yards of material, of which 610 cubic yards, not being suitable, was dumped on the bank and in deep water; 4,280 cubic yards was placed for the foundation. The dredge was also employed in excavating 2,555 cubic yards of clay and gravel for the backing of the dam, which was loaded in dump scows and towed by the steam-tug *Boscobel* to the dam and dumped in place.

Rapide Croche Lock.—The joints and seams in 3,000 square feet of the lock walls were raked out and repointed with cement.

Kaukauna Fifth Lock.—Six large dimension stones were towed from Rapide Croche and Kaukauna Third Lock to this lock, where 205 cubic yards of cement masonry in the head walls was removed and relaid. Five stones were also cut and placed in repairing the upper slope walls of the lock.

Kaukauna Fifth Lock House.—Seven storm windows were placed for use on the lock house. Under agreement with Peter Feller 106 linear feet of galvanized-iron eaves trough and 35 linear feet of galvanized conductor pipe were furnished and placed on lock house.

Kaukauna First, Second, Third, and Fourth Locks.—Joints and seams were raked out and repointed with cement.

Kaukauna Second Lock House.—Sixty linear feet of 6-inch sewer pipe was laid from the rear of the house to the outlet of the waste weir.

Retaining wall below Kaukauna First Lock.—A wall resting on bed rock, and extending in a straight line from the end of the lower left wing wall of Kaukauna First Lock a distance of 123 feet, was constructed of dry rubble masonry. The wall is 14 feet high at upper and 12 feet at lower end and 5 feet in width at the bottom and 3 feet on top. At lower end a wall 11 feet long extends into canal bank at right angles, but rests on the canal bank.

Three hundred and ninety cubic yards of earth was excavated for the foundation, 240$\frac{8}{9}$ cubic yards of dry masonry wall was laid, and 471 cubic yards of earth was wheeled from canal bed and bank and placed for filling back of same.

Kaukauna Dam.—The joints and seams in 930 square feet of the abutments were raked out and repointed with cement.

Kaukauna Guard Lock.—Sixteen protection piles were driven above and below the guard lock. One thousand five hundred and ninety-nine feet B. M. of pine timber was towed from Appleton to the lock, framed, and bolted for waling timbers to the piles.

The joints and seams in 400 square feet of the walls were raked out and repointed with cement.

Little Chute Combined Locks.—The upper gates were rebuilt; 1,600 feet B. M. of old pine was removed from the old gates; 6,734 feet B. M. pine and 136 feet B. M. oak lumber was hauled by team from Kaukauna, framed, and bolted for the new gates, and hand rails for the same; one steel T bar and 5 steel plates were bolted to each gate. New heel-post caps were fitted to place, straps and yokes were repaired and placed, and the gates hung with 12 weight irons.

The old valve system in the upper platform, which was worn out and had become troublesome, was removed and the new system put in; 1,488 feet B. M. old pine plank and timber was removed; 5,236 feet B. M. pine timber and plank was framed and secured for stringers, posts, bed timbers for valve seats, plank on platforms, covering for miter gears, hand-wheel frames, and for closing old valve openings; 94 feet B. M. oak plank was placed for valve stops. Checks were cut in recess walls for the miter gears; the valves, miter gears, shafts, and purchase gearing were secured in place.

Two thousand one hundred and thirty-six feet B. M. pine timber and plank was framed and placed for the upper tripod platform, and the middle and lower tripod platforms were rebuilt, and all platforms placed on a level with the lock walls. Two tripods, complete, for maneuvering the upper gates, replaced the old system, which had become obsolete and worn out.

Two spars were framed and the rack irons were moved from the old spar and secured on the new ones, which were placed in position.

Checks and holes were drilled in the lock walls and 12 new cast-iron snubbing posts were bolted in place. Seventy-five cubic yards of earth was excavated from back of lock walls for securing anchor rods and then replaced. Seventy-one cubic yards of earth was excavated, wheeled, and placed for filling behind lock walls.

Waste weir at Little Chute Combined Locks.—Twenty-four cubic yards of earth was excavated from the upper sides of the waste weir and 19.3 cubic yards of dry masonry were laid in constructing the wing walls of the waste weir.

Retaining wall above Combined Locks—The old wall at this place was a riprap wall, which had been pushed into the canal by the adjacent hill.

The work of replacing this wall with one of dry masonry was commenced November 14, 1896; 25 cords of stone were removed from the old wall; 320 cubic yards of dry masonry wall were laid; 1,301 cubic yards of earth were excavated from the site, wheeled to, and placed behind the lock walls and on both sides of the retaining wall. This wall connects the head wall of the lock with the retaining wall built last year and is in extension of the latter. It has a 5-foot base, 3 feet on top, 11½ feet high, and 192 feet long. This work was completed in April, 1897.

Little Chute Second Lock.—The joints and seams in 2,300 square feet of the lock walls were raked out and repointed with cement.

Cedars Dam.—This dam having settled unevenly and crest worn by ice and water, 642 linear feet of the crest was leveled and dressed to receive new crest timber. Two thousand nine hundred and seventy-three feet B. M. oak timber was framed, bolted, and then dressed to a level 6 feet above breast wall at Cedars Lock. This work was commenced November 16 and completed December 8, 1896.

Appleton Fourth Lock.—The 4 tripod platforms were rebuilt on a level with the top of the lock and the snubbing posts were sawed off to a height of 12 inches above the top of the lock. A leak through the fill back of upper wing wall of the lock was stopped by driving sheet piling. The hole washed out by the leak was filled with 23 cubic yards of earth, puddled.

Appleton Lower Dam.—Eighteen feet B. M. oak timber and 3 wrought-iron plates were used in replacing the lost and broken struts of the truss beams of the sluice gates. Material is also being purchased for new truss beams, saddles, and trunnions for the sluice gates, the work to be commenced this month (June).

Appleton Third Lock.—Two thousand six hundred and forty-one feet B. M. of new and old timber and plank were framed and fastened in place for a diamond block, 3 snubbing posts, in repairing the upper left capstan platform, in replacing a part of the walk on the right lock wall and the coping timbers, which were damaged last year by fire communicated from the burning of the adjacent mill. One hundred and thirty linear feet of the back coping of the lock walls was leveled.

Appleton Third Lock House.—Two hundred and thirty feet B. M. pine lumber was framed and fastened in place for a storm house on the front of the lock house.

Appleton Second Lock.—The wing-wall cribs below the lock and the 4 tripod platforms were rebuilt. For this purpose, 7,947 feet B. M. pine timber which was on hand at Appleton First Lock and Kaukauna was transported by steam tug *Boscobel* to this lock. The old timber and stone were removed. Ten thousand five hundred and seventy-one feet B. M. of old and new pine timber and plank was framed and secured in place for the cribs and platforms. The platforms were lowered to the level of the top of the lock. Seven cubic yards of stone was laid in dry foundation wall of the right crib, and 986 cubic yards was placed in the cribs. New spar rollers were placed for the upper and lower right gate spars. Fifteen cubic yards of earth was placed in back of left crib.

Appleton First Lock.—The upper timbers and planking on the protection crib above the upper left-hand wall of the lock being rotten were removed, and 1,656 feet B. M.

of old pine timber was framed and bolted in replacing same. The upper left tripod platform was rebuilt on a level with the top of the lock. Five hundred and sixteen feet B. M. of timber was used for posts, braces, and plank for same.

Menasha lock house.—One 35-barrel 4-hoop pine cistern was set up in the cellar of the lock house under agreement with John Lenz, sr. The eaves trough was changed and conductor pipe lengthened and connected with cistern; new gutter and iron cistern pump were put in place under agreement with Mr. George Loescher.

Menasha Dam (sluice gates).—The truss beam of one of the sluice gates being decayed and unsafe, a cofferdam was built of 984 feet B. M. of timber, shutting off the water from this part of the dam, in October, 1896. On account of the delay of arrival of oak timber, the repairs to the sluice gates were not commenced until March 21, 1897. All the old truss beams, trunnions, struts, and some of the gate arms were replaced with new, using for this purpose 4,099 feet B. M. of pine and oak timber. The ends of the trunnions were turned to fit the bands. The old serviceable iron was used again in the repairs, which were completed March 26, 1897.

Eureka lock.—The 4 tripod platforms were rebuilt and replaced on a level with the top of the lock, and 8 spar-plates were fastened to the bottom of the spars. To prevent the valve rods from being broken by boats during high water, blocks were framed and bolted on top of the upper gates.

Eureka lock house.—The front, side, and back steps were rebuilt; 7 windows and a door of the old lock house, used as a tool shed, were boarded up; 1,404 square feet of tin roof of the lock house was painted two coats, and 3,774 square feet of the sides of the lock house, shed, and fountain house, one coat of No. 20 asphaltum paint.

Eureka Dam.—One hundred and seven cubic yards of gravel was towed by steam tug *Fox* from section post 28 to the dam. Ninety-eight cubic yards was placed on the backing level with the crest, and 9 cubic yards was placed in back of navigable pass by the crew. For the purpose of lowering the water so the gravel could be placed, the valves in the navigable pass were removed and then replaced. The superstructure of the navigable pass was painted one coat by the lock tender and crew. Repairs to the woodwork of this dam were commenced October 7, 1896. Five thousand five hundred and twenty feet B. M. pine plank was transported from Oshkosh by the steam tug *Fox*, framed and spiked for replacing the planking on lower apron and on rear of dam. One thousand five hundred feet B. M. of oak timber and plank was hauled by team from Berlin for building a float for use in making the repairs.

Shore protection below Eureka Dam.—October 12, 1896, the building of the shore protection just below the left abutment of the dam was commenced. Twenty rock-elm piles were driven 10 feet apart. Brush and 2,000 mat poles were cut, and 2,300 fascines were made and hauled to the river. Four hundred brush mats were scowed to the site of the shore protection, and weighted down by 27¼ cords of stone, completing the building of a shore protection 200 feet long. The pile driver was towed from Berlin Lock by the steam tug *Fox*, the machinery put together, and piles driven by the crew.

Eureka lock cut.—In conjunction with building the shore protection below the left abutment of the dam, 60 brush mats were sunk with 8 cords of stone around the point of land at head of lock cut to prevent the water from cutting away the point.

Roadway at Eureka Lock.—The roadway from the highway to the lock having become in bad repair, the old bridge was removed and a new one built 10 feet wide by 10 feet long in place; also two culverts 8 by 12 inches by 14 feet were constructed in place. The material used was surplus and old timber on hand taken from Berlin and Eureka locks. Two hundred and eighty cubic yards of earth was placed on the roadway, building it 6 feet wide and raising it 1 foot for 1,175 feet.

White River Lock.—The upper and lower gates were removed by the crew of the steam tug *Fox*, and 2 inches from bottom of toe post were sawed off to prevent it from striking the bottom of the lock. The gates were replaced. Eight spar plates and hard-wood strips were fastened to the spars.

Shore protection below White River Dam.—Brush and mat poles were cut, 725 fascines and 145 brush mats were made, placed, and weighted down with 8 cords of stone, which had been scowed by the steam tug *Fox* from Section Post 42 and from the lock, raising the shore protection 3 feet on right side below the dam.

Montello Lock.—Repairs to this lock were commenced August 8, 1896. Material for the repairs was transported from Oshkosh and Berlin Lock by the steam tugs *Fox* and *Boscobel* and the crews, together with one carpenter, were employed in making the repairs. Eighteen thousand five hundred and fifty-six feet B. M. of old plank and coping timbers and 3 diamond blocks were removed; 20,539 feet B. M. of pine plank and timber was framed and secured in place for posts, wall plank, coping, and diamond blocks; hand rails were framed and placed on all gates; 7,850 square feet of the lock walls and gates was painted one coat and 948 square feet two coats with No. 20 asphaltum paint; the tripods and other ironwork with one coat No. 31 asphaltum paint.

Montello Dam.—On account of high water the brush and stone backing next to left abutment and back of old waste wier had settled 2 feet, causing a leak, which was stopped with a cord of rubblestone and 15 cubic yards of gravel.

MISCELLANEOUS.

Painting.—Two hundred and eleven gallons of No. 20 asphaltum paint and 25 gallons of No 31 asphaltum paint were purchased and distributed among the lock tenders, etc., for painting wood and iron work of locks, sluiceways of dams, lock houses, warehouses, tool houses, etc., for the purpose of preserving and improving their appearance.

Different kinds of grass seed were purchased and distributed for use of the lock tenders in improving United States property around the locks, lock houses, etc.

REPAIRS OF BOATS AND DREDGES.

Steam tug General G. K. Warren.—This tug was laid up all last year at Appleton, where she was repaired this spring by the crew of the steam tug *Boscobel*. A new floor was placed in the boiler room. A new injector was purchased and connected. The machinery was adjusted and tested. The vessel was painted inside and outside, fitted out, and went into commission June 11, 1897.

Steam tug Boscobel.—This tug was laid up at Depere last fall where a new grouser was built and put in place of the old one which had become unserviceable; the machinery was overhauled and tested. The boat went into commission April 16, 1897. May 1, 1897, the repairs were resumed at Appleton. Eighty-six linear feet of new guard frame was built on the starboard bow and around the stern and new decking was laid on the same. The paddle wheels, paddle boxes, and cabin windows were repaired and the deck calked. The boat was fitted out and painted. The repairs were made by the crew and hired labor.

Steam tug Fox.—This tug was hauled out and blocked up last fall in Oshkosh boat yard for general repairs, which were commenced January 18, 1897. This work was done by hired labor and under agreement with J. A. Barnes, Oshkosh. Both ends of the hull and part of one side were replanked with oak plank; a steam boiler was used for steaming the plank. The stem, fenders, plank-sheer, chocks, anchor chocks, facia, jackstaff, and part of the deck plank were replaced. A truss beam was made of oak and two 1-inch hog rods and placed to support rear end of boiler which was raised to the right height. Two strips of galvanized iron were nailed to bow of hull to protect same against ice. Both ends of the boiler deck were extended 4 feet aft and 7 feet forward and the cabin was cut across 7 feet from the rear end, the rear end moved back 8 feet, and the intervening space closed in for another stateroom. Under agreement with Williams & Williams the new tin roofing and scupper pipes were placed and secured on boiler deck and cabin. The hull and deck were calked and pitched. The machinery was overhauled and tested. The boat was cleaned, fitted out, and painted inside and outside. She was launched April 16 and went into commission May 4, 1897.

Quarter boat No. 1.—The outside of this boat was painted.

Dredge No. 2.—Last fall two new forward grousers were made and put in place of the old ones which had become unserviceable. The old purchase-sheave shaft, being broken, was replaced by a new one. The dredge was laid up for the winter at Depere, where the general repairs were made by the crew and under agreement with C. A. Lawton & Co. A new leader-sheave frame was made. The dipper handle and turntable were repaired. The machinery was generally overhauled and tested. The cabin was cleaned and painted. The dredge went into commission April 13, 1897.

Dredge No. 4.—After minor repairs were made the dredge was put in commission April 27, 1897. With the new crane and hoisting engines of No. 3 this dredge is in excellent condition, better than she has ever been.

Dredge No. 7.—This dredge was laid up last fall at Oshkosh boat yard, where she was hauled out and blocked up. The repairs were done by hired labor and under agreement with H. C. Doman. The repairs were commenced January 18, 1897. The old material was removed and all the gunwales were built of new timber and thoroughly bolted in place, the bolts running through the gunwales and riveted at both ends. New grouser frames were built of oak timber and connected transversely to strengthen the forward part of the dredge and take up the transverse strains. Two new forward grousers and a new dipper handle were also built of oak timber and put in place. The A-frame was reenforced at its base under the deck. New stanchion braces, chocks, deadwood, fenders, cleats, deck plank, etc., were framed and secured in place. A new floor was put in the kitchen and dining room. All the old iron that was removed and was serviceable was used again in the repairs.

On account of weak teeth in the hoisting gear, the hoisting and backing gears were exchanged. The boiler and machinery were generally overhauled and tested. The grouser frame was oiled, and the new work, the boom and A-frame, were painted. The hull and deck were calked and pitched. The dredge was launched May 30 and went into commission June 11, 1897.

The hull of this dredge was too weak for its machinery and caused much trouble and expense during the past two years. It is supposed to be greatly strengthened now, and that the dredge will show far better service this year.

Barge Princeton.—Minor repairs were made.

Ninety-foot (drill) scow.—This scow, having been sunk at Cedars for the past two years, was siphoned out by the crew of steam tug *Boscobel.* The seams were calked enough for towing, the small building was removed, and the scow was towed by steam tug *Boscobel* to Oshkosh boat yard, where she was hauled out and blocked up October 14, 1896, by George Ryan under verbal agreement. She was repaired by hired labor. February 6, 1897, the repairs were commenced. The old material was removed. New rake plank for bow and stern, bumper, plank-sheer, and fender were framed of oak and fastened in place. New pine plank was placed for decking. The scow was calked and pitched, and launched May 21, 1897.

Wood scow for dredge No. 7.—A new wood scow, 5½ by 18 feet, was built at Oshkosh for use of dredge No. 7. She was calked and painted, and launched May 7, 1897.

General remarks.—The cost of hauling out boats for repairs and launching at Oshkosh boat yard is considered very expensive, aside from the rent paid for the yard, and it is proposed to recommend the construction of a suitable dry dock on Government property, probably at Kaukauna. Such a dock would cost less to construct than the expense of hauling and launching the boats during the past year amounted to. The docks could be emptied by gravity and the expense of handling boats would be very slight.

DREDGING LOWER FOX.

By dredge No. 2, channel below Kaukauna Fifth Lock.—Dredge No. 2 was towed to Kaukauna Fifth Lock, after completing work at Depere Lock. Dredging was commenced April 26, 1897. Cuts were made 320 by 25 by 4 to 9 feet, excavating 1,731 cubic yards of earth, which was banked on the left, completing the cleaning of the channel. The dredge was towed April 28, 1897, to—

Channel below Cedars Lock.—Cuts were made, 1,580 by 5 to 21 by 2 to 6 feet, excavating 3,415 cubic yards of stone, hardpan, and gravel, of which 3,120 cubic yards was banked on the left and 295 cubic yards on the right, completing the work. The dredge was towed May 21, 1897, to—

Channel below Chicago, Milwaukee and St. Paul Railroad Bridge.—(See improvement report.)

DREDGING UPPER FOX.

The work of dredging Upper Fox River was continued by dredges Nos. 2, 4, 5, and 7, for the purpose of providing a navigable channel 100 feet wide and 6 feet deep.

By dredge No. 2, between Section Posts 33 and 30.—Work was continued after July 1, 1896. Cuts were made 8,179 by 15 to 35 by 1.5 to 8 feet, excavating 34,548 cubic yards of sand, clay, gravel, and stone, which was dumped to the left and right. Fifteen thousand seven hundred and thirty-three cubic yards was rehandled and 17,703 cubic yards is to be rehandled. The dredge stopped work September 4, 1896, and was towed to Little Kaukauna Dam.

By dredge No. 4, between Section Posts 32 and 26.—Work was continued in this section. Cuts were made 1,466 by 45 to 70 by 1 to 3 feet, excavating 8,580 cubic yards of sand, gravel, and stone, which was dumped to the left and right. One thousand and eighty-six cubic yards is to be rehandled.

Between Section Posts 41 and 40.—July 22, 1896, the dredge was towed to 1,540 feet above Section Post 40. Cuts were made 2,303 by 36 to 70 by 1.5 to 7.5 feet, excavating 21,151 cubic yards of clay, which was dumped to the left and on land owned by Frank Hopp, from whom free dumping privileges were obtained. Nine thousand three hundred and forty-five cubic yards was rehandled and 10,003 cubic yards is to be rehandled.

Between Section Posts 34 and 32.—September 3, 1896, the dredge was towed below Berlin Lock. Cuts were made 2,550 by 12 to 75 by 2 to 2.5 feet, excavating 12,174 cubic yards of sand and clay, which was dumped to the left and right. Ten thousand six hundred and eighty cubic yards was rehandled.

Between Section Posts 28 and 27.—October 1, 1896, the dredge was towed to 1,660 feet below Section Post 28. Cuts were made 2,215 by 70 to 75 by 1.5 to 2 feet, excavating 11,970 cubic yards of sand and gravel, which was dumped to the left.

Between Section Post 26 and 25.—October 27, 1896, the dredge was towed above Eureka Lock. Cuts were made 1,820 by 15 to 75 by 1 to 2.5 feet, excavating 7,890 cubic yards of sand, which was dumped to the left and right. One thousand five hundred and thirty cubic yards was rehandled and 1,725 cubic yards is to be rehandled. November 10, 1896, work was suspended for the season and the dredge was towed to Berlin Lock.

Between Section Posts 26 and 24.—April 27, 1897, the dredge went into commission and commenced dredging 3,700 feet below Section Post 26, where work had been discontinued last season. Cuts were made 3,720 by 36 to 75 by 1 to 6 feet, excavating 21,162 cubic yards of sand, which was dumped to the left and right and on land owned by Mr. Hart and Mr. Ehrlich, from whom free dumping privileges were obtained. Eight thousand and forty cubic yards was rehandled and 6,096 cubic yards is to be rehandled.

By dredge No. 7, between section posts 33 and 26.—Work was continued. Cuts were made 17,350 by 15 to 37 by 2 to 7 feet, excavating 77,181 cubic yards of sand, clay, gravel, and hardpan, which was dumped to the left and right and on land owned by L. C. Bassett, Rupers Hodgkins, D. C. Palmeter, H. G. Pierce, H. Stedman, and William Stewart, from whom free dumping privileges were obtained, and also on land owned by Dayton R. Burr and D. C. Palmeter. Thirty-eight thousand and fifty-two cubic yards was rehandled and 4,094 cubic yards is to be rehandled. November 3, 1896, work was suspended for the season and the dredge was towed to Oshkosh boat yard for repairs.

Between section posts 27 and 25.—May 11, 1897, the dredge went into commission and commenced dredging 4,600 feet below section post 27. Cuts 3,201 by 30 to 40 by 1.5 to 4.5 feet were made, excavating 14,512 cubic yards of sand, which was dumped to the left and right and on land owned by Mr. Ehrlich, from whom free dumping privileges were obtained. Five thousand six hundred and twenty-seven cubic yards was rehandled.

Between section posts 31 and 30.—June 3, 1897, the dredge was towed to 1,600 feet below section post 31, where she excavated 406 cubic yards of clay and stone from combings, which were dumped to the right on dredge bank.

Between section posts 48 and 46.—June 6, 1897, the dredge was towed to 70 feet below section post 47. A cut 789 by 42 by 2 to 3 feet was made, excavating 2,662 cubic yards of sand, which was dumped on Government land.

Care of works and property—Property at Appleton First Lock.—The timber stored in the old material sheds was transferred to the new timber shed and the old material sheds were taken down. The coal bin at the upper end of the lock was removed and rebuilt back of the lower right wing wall of the lock, and a shed 24 feet long was built of old lumber next the coal bin for the purpose of storing old material and scrap iron. One hundred and sixty cubic yards of earth was excavated from the bank above the lock house, wheeled, and placed for filling holes in the ground where the old material sheds stood.

Two scow loads of old iron, old and new timber, and plank, cribs, engine, pump, derrick, winch, and tools left over from the repairs of Depere Lock were towed by steam tug *Boscobel* to Kaukauna, where the tools and old material were stored, and the old iron and new timber and plank were towed to Appleton and stored in the warehouse.

The portable material was removed from dredge No. 3 and transported by steam tug *Boscobel* from Kaukauna to Appleton warehouse, where the material was stored.

Signboards, as a warning to trespassers, were made and placed as follows: One at Depere Dam, one at Eureka Dam, one at Berlin Dam, one at White River Dam, and 5 at intervals along Portage Levee.

SURVEYS.

A survey of Combined Locks and vicinity, to determine the location of wasteweir and outflow of same, and one of Kaukauna Canal and vicinity from First Lock to Guard Lock, were made. Maps and tracings of surveys and of Kaukauna Canal system were also made.

The boundary lines of the United States property at Appleton First Lock were run out and the roadway from Lake Street Bridge to the lock was cross-sectioned. A map of the United States property at the lock was commenced.

A survey was made of the property adjacent to Main Street Bridge, Oshkosh, and measurements were taken of the bridge of the Wisconsin Central and Chicago, Milwaukee and St. Paul railways at Oshkosh, and sketches made showing location of same.

The east boundary line between the United States and George Zuhl's property at White River Lock was run out. The fence line was found to be about 10 feet too far east and about parallel to the correct line; the fence will be moved to the correct line.

A complete survey was made of the United States property near Fort Winnebago Lock, October 12 to 15, 1896. A map and tracing of the survey were also made.

Survey of Upper Fox.—A survey was made of the Upper Fox River from Oshkosh to Fort Winnebago Lock and soundings taken through the ice to determine the correct location of mile posts and the amount of dredging necessary to complete the project. The party consisted of Mr. Grover, in charge; Mr. Woodworth, transitman, and five men with team. The work was commenced January 27, 1897, at West Algoma Street Bridge, Oshkosh, and a transit line, with zero of distance at center of

Main Street Bridge, was run along the steamboat channel. Soundings were taken as follows: On Lakes Butte des Morts, Apuckawa, and Buffalo one sounding was taken every 100 feet on transit line, and at intervals of 500 feet on transit line cross soundings 25 feet apart on Lake Butte des Morts, and 20 feet apart on Lakes Apuckawa and Buffalo, and covering a channel from 200 to 300 feet in width, were also taken. In the river proper one sounding was taken every 100 feet on transit line, and at intervals of 200 feet on transit line cross soundings 20 feet apart and extending far enough on either side to fully cover the channel, were also taken. Where bars were encountered, cross soundings were taken at intervals of 100 feet on transit line; 104.62 miles were chained and 85.32 miles sounded. In various parts of the river were found unsafe ice and open water, in all about 10¼ miles, where no soundings were taken, nor were any soundings taken in that portion of the river sounded after dredging last year.

Holes were made with a boring machine through ice varying from 3 to 20 inches in thickness, and through these 18,983 soundings were taken. The boring machine was of the same pattern as the one used by Col. O. M. Poe, Corps of Engineers, and described by him in Annual Report of 1893, part 4, page 2964.

During the progress of the work the following changes were made in the equipment of the machines. A small windlass was attached to the frame, and a wire cable, three-eighths inch diameter, substituted for the manila rope fastened to top of auger, thus making the feed more uniform and greatly facilitating the withdrawal of the auger from the ice. Narrow and high, instead of wide and low, runners were added to make the passage through deep and wet snow easier. A short wooden platform, provided with small steel dogs to prevent machine from sliding on smooth ice when auger was being used, was attached to frame with strap hinges under the crank, in order to give the operator more power. Lastly, and perhaps, the greatest improvement, was the placing of an iron balance wheel, 125 pounds in weight, on the crank shaft, this insuring a steady, regular motion to the auger.

Together with the work of sounding, measurements were taken from transit line to shore lines, generally with chain or stadia; otherwise, with transit, by intersection. Also good substantial stakes were driven on shore at the end of each mile, to be replaced later by regular mileposts.

On March 15, 1897, Fort Winnebago Lock was reached, where survey was ended and party disbanded. The work of platting the soundings and making maps of the survey is nearly completed.

MISCELLANEOUS.

In conjunction with inspection trips, permanent bench marks were set at all the locks or at the head and foot of a system. These consist of heavy flat stones with a copper bolt let in the center, and the stone buried 4 feet below the surface of the ground with a 3-inch gas pipe placed over the bolt, projecting just above the surface, a cast-iron cap marked "U. S. B. M." was placed on the top end.

New gauges were placed and old ones readjusted in accordance with breast walls and miter sills, and levels taken to the new permanent bench marks.

Measurements were taken of all the locks, dams, and buildings for tabulation. Experiments were also made at most of the locks to determine the time, etc., in filling and emptying them and tabulated.

A map of Lake Winnebago and one of Lake Poygan and vicinity were compiled, and tracings made of same. A chart of the present and proposed lighting of bridges on Fox River and tabulations of water power on lower Fox River, United States buildings, locks, dams and other works were made and discharges of different locks were computed. Plans, bills of material, and estimates for proposed works were made.

Sounding for progress map of upper Fox dredging, gauge readings, and discharges of dams were platted.

The steam tug *Fox* was employed in towing dredges Nos 2, 4, 5, and 7 on the upper Fox from place to place, in supplying them with fuel, etc., in towing scow loads of material for repairs of locks, dams, etc., in taking soundings and ou inspection trips. The crew assisted on repairs and other construction when not otherwise engaged.

The steam tug *Boscobel* was employed in towing dredge No. 2 on the lower Fox from place to place, in supplying her with fuel, etc., in towing scow loads of material for repairs of locks, dams, etc., in taking soundings and on inspection trips. The crew assisted on repairs and other construction when not otherwise engaged.

All the boats and dredges, excepting dredge No. 3 and steam tug *General G. K. Warren* were inspected by the United States inspectors, and found to be in good condition.

Very respectfully, your obedient servant,

L. M. MANN, *Assistant Engineer.*

Capt. GEORGE A. ZINN,
Corps of Engineers, U. S. A.

Statistics of water power on

FURNISHED BY

Place.	Manufacturers.	Amount of water power entitled to.	Present capacity.
Neenah	Robert Jamison	294 square inches first-class water, 221 square inches second-class water.	
Do	Kimberly & Clark Co		
Do	Kreuger & Lachmann	Original ownership, 2,340 square inches.	
Do	Neenah Boot & Shoe Manufacturing Co.	118 square inches first-class water.	
Do	Neenah & Menasha Gas and Electric Light Plant.	470 square inches first-class water.	1,180 square inches.
Do	Neenah Paper Co		
Do	Winnebago Paper Mills	2,646 square inches first-class water, 1,308 second class.	4,532 square inches.
Do	Wulff, Clauson & Co	470 square inches first-class water, 355 second class.	815 square inches
Menasha	Banner Flouring Mills	500 square inches	200 square inches
Do	Gilbert Paper Co	4,484 square inches	
Do	W. P. Hewitt & Co	475 square inches	536 square inches
Do	Howard Paper Co	2,217 square inches	
Do	MacKinnon Excelsior Co	1,500 square inches	
Do	MacKinnon Pulley Co	300 square inches	
Do	Menasha Wooden Ware Co	2,500 square inches	2,500 square inches
Do	John Schneider	1,000 square inches	
Do	Chas. R. Smith		
Do	John Strange Paper Co		
Do	Geo. A. Whiting	2,217 square inches first-class water.	
Menasha Dam			
Appleton	Appleton Boot and Shoe Co., upper dam.	10 horsepower	
Do	Appleton Chair Co., upper dam.	25 horsepower	
Do	Appleton Electric Light and Power Co., upper dam.	300 horsepower or 9,500 cubic feet per minute.	

Lower Fox River, Wisconsin.

GOVERNMENT DAMS.

Number, size, and name of wheels.	Total number of wheels.	Average head.	Total ventage.	Theoretical horse-power.	Practical horse-power.	Steam power, horse-power.	Remarks.
		Feet.	*Sq. in.*				
Two 45-inch Houston	2	8	......	117	94	10	
Two 66-inch Old American; two 65-inch, four 60-inch, one 40-inch Houston; one 66-inch, one 56-inch, one 44-inch Leffel; six 55-inch, two 48-inch Victor.	20	7½	......	1,916	1,560	550	
One 54-inch, two 66-inch American Turbine (old style); one 72-inch Johnson.	4	8	......	588	469	125 to 150	
One 40-inch Houston	1	8	......	48	39	12	Use steam only when water is cut off.
One 60-inch and one 66-inch Eclipse.	2	7½	......	249	199	125	
One 42-inch Hercules, one 61-inch Leffel, one 45-inch, one 50-inch, one 60-inch, one 65-inch, and one 70-inch Page, and six 48-inch Victor.	13	8	7,275	1,034	838	375	
One 72-inch Elmer, two 36-inch Hercules, one 50-inch and four 60-inch Houston, and one 48-inch Victor.	9	9	......	1,069	854	450	
One 44-inch and one 66-inch Leffel.	2	8	......	142	123	60	
One 48-inch and one 60-inch, name not given.	2	5	......	91	72	50	T. W. Orbison's report of February 27, 1896, gives two 48-inch Leffel.
Four 66-inch New American	4	5	......	304	243	800 to 1,000	
One 60-inch Blackstone	1	5	......	59	47	50	T. W. Orbison's report of February 27, 1896, gives one 60-inch Page.
One 54-inch, one 56-inch, three 66-inch Alcott; one 35-inch Beloit; one 48-inch Leffel.	7	5	......	411	331	200	
Two 60-inch Monitor	2	6	......	156	124	225	
One 40-inch American	1	6	......	31	25	25	T. W. Orbison's report of February 27, 1896, gives one 48-inch Old American.
Two 55-inch Beloit; 4 others have not been used for years.	6	5	......	519	414	1,090	T. W. Orbison's report of February 27, 1896, gives two 55-inch, two 65-inch Houston; one 60-inch Page; one 72-inch Elmer Special.
Two 60-inch Johnson, reported as one 66-inch and one 72-inch by T. W. Orbison February 27, 1896.	2	6	......	156	124	......	Using about 500 inches.
Two 72-inch Johnson	2	6	......	244	195	......	Transferred to Menasha Wooden Ware Co. two years ago.
One 54-inch and three 66-inch Elmer (Berlin, Wis).	4	4	......	195	156	300	
Three 65-inch, one 45-inch, and one 50-inch Houston, and one 42-inch New American.	6	8	2,495	631	503	265	The combined book measurements of the wheels is 2,495 inches, which is 278 inches more than the lease calls for.
......	....	8.218	......	2,646	1,984	......	For a flow of 170,000 cubic feet per minute.
......	....	....	......	......	......	......	Leased from Green Bay and Mississippi Canal Co. To be leased by the Appleton Electric Light and Power Co.
One 36-inch New American	1	7½	......	33	26	35	Leased from Green Bay and Mississippi Canal Co.
One 45-inch Elmer, one double 25-inch horizontal Humphrey, one 48-inch Leffel, one 45-inch Victor.	4	14		468	383	......	

Statistics of water power on Lower

FURNISHED BY GOV

Place.	Manufacturers.	Amount of water power entitled to.	Present capacity.
Appleton	Appleton Electric Light and Power Co., lower dam.	200 horsepower	
Do	Appleton Knitting Mill, lower dam.	10 horsepower	
Do	Appleton Paper and Pulp Co., upper dam.	800 to 1,000 horsepower	
Do	Appleton Water Works Co., upper dam.	50 horsepower	
Do	Atlas Paper Co., upper dam.	500 horsepower	
Do	Baum Flouring Mill, lower dam.	100 horsepower	
Do	Kimberly & Clark Co., upper dam.	All of one-half of the flow of Fox River on the upper Government dam, except 500 horsepower to the Atlas Paper Co. and an unknown quantity, claimed to be 600 to 800 horsepower, of Appleton Paper and Pulp Co.	
Do	Manufacturing Investment Co., lower dam.	950 horsepower	900 horsepower
Do	Pettibone, Mulliken & Co., lower dam.	83,966 cubic feet per minute, 700 horsepower.	60,000 to 70,000 cubic feet per minute.
Do	Union Toy and Furniture Co., upper dam.	25 horsepower	
Do	Upper Atlas Pulp Mill, upper dam.		
Do	Lower Atlas Pulp Mill, upper dam.		
Menasha, upper dam.			
Menasha, lower dam.			
Cedars	Kimberly & Clark Co	All the power developed, less the amount needed for purposes of navigation.	
Cedars dam			
Little Chute	Little Chute Pulp Co	Total flow Fox River, less 100 horsepower.	
Do	Arnold Verstegen	100 horsepower	
Little Chute dam			
Kaukauna	Badger Paper Co	Power leased from Kaukauna Water Power Co.	
Do	Brokaw Pulp Co	do	
Do	C. & N. W. Rwy. shops	75 horsepower. Power leased from Kaukauna Water Power Co.	55 horsepower
Do	Kaukauna Electric Light Co.	100 horsepower	130 horsepower
Do	Kaukauna Fiber Co	100 horsepower. Power leased from Kaukauna Water Power Co.	

Fox River, Wisconsin—Continued.

ERNMENT DAMS—Continued.

Number, size, and name of wheels.	Total number of wheels.	Average head.	Total ventage.	Theoretical horse-power.	Practical horse-power.	Steam power, horse-power.	Remarks.
		Feet.	*Sq. in.*				
Two 60-inch Humphrey	....	7	......	197	157	200	Appleton Electric Street Railway.
One 34-inch Elmer	1	7	......	27	22	......	Leased from Green Bay and Mississippi Canal Co.
One 48-inch, two 66-inch American, and two 74-inch Leffel.	5	8½	......	671	552	......	
One 25-inch and one 30-inch Victor turbine.	2	10	......	82	69	160	
Two 66-inch, one 42-inch, and three 25-inch New American.	6	14	......	959	766	250	
Two 30-inch, one 40-inch Elmer and one 40-inch Leffel.	4	6	......	84	69	......	Do.
Vulcan Mill, one 40-inch, two 66-inch New American, one 39-inch Hercules, one 35-inch Victor.	5	12½	......	881	711	500	
Tioga Mill, two 66-inch New American, one 60-inch, one 45-inch, one 35-inch Houston.	5	12	......	958	772		
Nine 66-inch New American, one 44-inch, and one 66-inch Old Style Leffel.	11	7	......	1,251	1,006	......	Do.
Four 68-inch Sampson (Leffel).	4	6½	......	313	274	......	Do.
One 48-inch Elmer.	1	8	......	63	50	30	
Three 66-inch New American, one 66-inch Old American, one 40-inch Beloit.	5	15	......	1,710	1,362	......	Do.
One 66-inch New American, two 66-inch Old American, two 25-inch Beloit, one 61-inch Leffel.	6	15	......	1,504	1,212	......	Do.
....	....	14	......	4,508	3,381	......	For a flow of 170,000 cubic feet per minute.
....	....	8.451	......	2,721	2,041	......	Do.
One 55-inch Leffel; seventeen 55-inch, two 48-inch, four 44-inch, five 60-inch, three 40-inch, one 35-inch Victor.	33	11	......	5,227	4,217	150	
....	....	9.758	......	3,142	2,356	......	Do.
One 27-inch, three 48-inch, and twenty 54-inch McCormick.	24	12	......	3,780	3,016	......	Leased from Green Bay and Mississippi Canal Co.
One 35-inch Elmer; one 30-inch, and four 48-inch old wooden paddle wheels.	6	9.8	......	170	136	......	Do.
....	....	1.2	......	3,864	2,898	......	For a flow of 170,000 cubic feet per minute.
Seventeen 20-inch and four 45-inch Elmer; one 25-inch Humphrey; two 18-inch and one 33-inch S. Morgan Smith.	25	16	......	1,544	1,230	450	Owned jointly by Green Bay and Mississippi Canal Co. and Kaukauna Water Power Co.
Two 66-inch American Turbine and one 36-inch Special American Turbine.	3	14	......	862	687	......	Do.
One 50-inch Improved Elmer.	1	7	......	59	47	110	Do.
One 45-inch Leffel and one 46-inch, name not given.	2	14	......	233	194	160	Leased from Green Bay and Mississippi Canal Co.
One 15-inch and one 45-inch New American Turbine.	2	14	......	238	190	200	Owned jointly by Green Bay and Mississippi Canal Co. and Kaukauna Water Power Co.

Statistics of water power on Lower

FURNISHED BY GOV

Place.	Manufacturers.	Amount of water power entitled to.	Present capacity.
Kaukauna	Kaukauna Lumber and Manufacturing Co.	50 horsepower	200 to 250 horsepower.
Do	Kaukauna Machine Co	75 horsepower. Power leased from Kaukauna Water Power Co.	
Do	Kaukauna Water Power Co.	6,500	2,500
Do	Kleins Mill	Power leased from Kaukauna Water Power Co.	
Do	Russell Bros	60 horsepower	54 horsepower
Do	Thilmany Pulp and Paper Co.	275 horsepower	
Do	Western Paper Bag Co	400 horsepower	1,400 horsepower
Kaukauna dam			
Rapide Croche dam			
Little Kaukauna dam.			
Depere	Depere Electric Light and Power Co.	100 horsepower	60 horsepower
Do	The John P. Donsman Milling Co.	200 horsepower	
Do	Dunham & Smith		
Do	Shattuck & Babcock Co	Total flow of Fox River, less 290 horsepower.	
Depere dam			

Fox River, Wisconsin—Continued.

ERNMENT DAMS—Continued.

Number, size, and name of wheels.	Total number of wheels.	Average head.	Total ventage.	Theoretical horsepower.	Practical horsepower.	Steam power, horsepower.	Remarks.
		Feet.	*Sq. in.*				
One 61-inch Special Leffel...	1	16	......	252	217	25	Leased from Green Bay and Mississippi Canal Co. Use only 50 horsepower of water.
One 48-inch and one 50-inch, name not given.	2	14	......	314	250	15	Owned jointly by Green Bay and Mississippi Canal Co. and Kaukauna Water Power Co.
....	....	......	......	......	......	......	Owned jointly by Green Bay and Mississippi Canal Co. and Kaukauna Water Power Co. Canal closed during last 18 months by order of court.
Four 45-inch Elmer.........	4	14	......	543	433	......	Owned jointly by Green Bay and Mississippi Canal Co. and Kaukauna Water Power Co.
One 36-inch and one 40-inch Elmer.	2	11	......	136	108	......	Leased from Green Bay and Mississippi Canal Co.
Two 30-inch and two 35-inch Elmer; one 30-inch and one 44-inch New American.	6	14	......	487	389	175	Do.
One 25-inch American; one 36-inch New American; one 40-inch Elmer; two 27-inch Hercules; one 66-inch Leffel.	8	15	......	1,734	1,399	310	Do.
....	....	14	......	4,508	3,381	......	For a flow of 170,000 cubic feet per minute.
....	....	8.529	......	2,746	2,059	......	Owned by Green Bay and Mississippi Canal Co. For a flow of 170,000 cubic feet per minute. Not used.
....	....	7.915	......	2,548	1,911	......	For a flow of 170,000 cubic feet per minute. Owned by Green Bay and Mississippi Canal Co.
One 66-inch New American.	1	7	......	126	101	......	
One 66-inch American Turbine and two 44-inch Elmer.	3	7	......	220	175	......	
Two 84-inch Johnson.......	2	7	......	364	289	......	Mill burned October, 1896, and wheels not in use.
Two 60-inch and fourteen 66-inch New American.	16	7	......	1,962	1,565	1,333	Shattuck and Babcock estimate that Depere Dam, at an ordinary flow, is equivalent to 2,500 horsepower.
....	....	8.360	......	2,694	2,021	......	For a flow of 170,000 cubic feet per minute.

Compiled and computed from data received from the mill owners, to accompany my report of June 30, 1897.

L. M. MANN, *Assistant Engineer.*

Statistics of water power on Lower

FURNISHED BY

Place.	Manufacturers.	Amount of water power entitled to.	Present capacity.
Appleton	Appleton Machine Co	500 square inches	35 horsepower
Do	Appleton Woolen Mill	90 horsepower	67.62 horsepower
Do	Fairbanks & Swallow	6 horsepower	
Do	Fourth Ward Plaining Mill.	30 horsepower	
Do	Fox River Paper Co	⅛ flow Fox River, less 25 horsepower.	
Do	Manser, Renner & Co		
Do	Marston & Beveridge	75 horsepower	
Do	Patten Paper Co	1,250 horsepower	
Do	A. Spiering	None	
Do	Telulah Paper Co	3,000 square inches *a*	
Do	The Eagle Manufacturing Co	25 horsepower	
Do	Valley Iron Works Manufacturing Co.	40 horsepower	40 horsepower
Appleton dam			
Combined locks	Combined Locks Paper Co	5,000 horsepower	With an 18-foot head, 151,392 cubic feet per minute.
Combined dam			
Kaukauna	Outagamie Paper Co	1,500 horsepower	
Do	Robert Pride		
Do	Reese Pulp Co	300 horsepower	300 horsepower
Do	Thilmany Pulp and Paper Co.	475 horsepower	
Kaukauna dam			

a Also control all surplus obtained after the other deeds and leases are filled.

Fox River, Wisconsin—Continued.

PRIVATE DAMS.

Number, size, and number of wheels.	Total number of wheels.	Average head.	Total ventage.	Theoretical horsepower.	Practical horsepower.	Steam power, horsepower.	Remarks.
		Feet.	*Sq. in.*				
One 35-inch Taylor..........	1	5	228	17	14	....	One 25-horsepower electric motor.
One 60-inch American Turbine.	1	5	....	59	47	60	Consumes 52.52 horsepower under ordinary running.
....	.	.....	....	....	....	....	Included in report of Patten Paper Co.
One 35-inch Elmer..........	1	8	....	35	28	....	
Ravine Mill—One 66-inch, two 61-inch, one 40-inch Leffel; one 35-inch and one 55-inch Victor. Lincoln Mill—Four 55-inch, one 20-inch Victor; one 36-inch, one 42-inch New American; one 20-inch Elmer. Fox River Mill—Three 61-inch, one 66-inch, one 44-inch Special Leffel; one 30-inch, one 66-inch, one 26½-inch, two 48-inch Standard Leffel.	24	11	....	2,623	2,126	1,050	
One 35-inch New Elmer.....	1	9	....	41	33	75	
One 55-inch Beloit..........	1	8	....	96	77	....	
One 30-inch and one 33-inch Hercules, three 44-inch and ten 48-inch Victor.	15	7½	....	1,018	814	500	
One 42-inch..................	....	5	....	27	21	20	
Paper Mill—Two 66-inch, three 42-inch New American; one 25-inch Elmer.	6	14	....	1,130	903	500	
Telulah Paper Mill—One 66-inch, three 60-inch New American; one 25-inch Elmer.	5	8½	....	582	465	....	
One 30-inch Turbine........	....	8	....	28	22	....	
One 50-inch American	1	7	....	59	47	....	
....	....	7.35	....	2,367	1,775	....	For a flow of 170,000 cubic feet per minute.
One 25-inch, one 30-inch, four 36-inch, and one 48-inch American; thirty 25-inch, one 27-inch, four 30-inch, two 32-inch, four 35-inch, and one 48-inch Victor.	49	18½	....	5,336	4,438	....	Leased from Green Bay and Mississippi Canal Co.
....	....	18½	....	5,957	4,468	....	For a flow of 170,000 cubic feet per minute.
Two 18-inch, one 27-inch, two 36-inch Hercules; one 20-inch New American; one 25-inch, two 35-inch Victor.	9	21	....	1,020	816	....	
....	....	.....	....	....	....	....	Small power leased from Green Bay and Mississippi Canal Co. and Edwards.
Two 60-inch Elmer..........	2	12	....	440	352	....	Leased from Green Bay and Mississippi Canal Co. and Patten Co.
One 60-inch American and three 42-inch Victor.	4	12	....	709	567	....	Leases the Fox River Pulp Mill from the Patten Paper Co.
....	....	15	....	4,830	3,623	....	For a flow of 170,000 cubic feet per minute.

Compiled and computed from data received from the mill owners, to accompany my report of June 30, 1897.

L. M. MANN, *Assistant Engineer.*

Data respecting dredging done on Fox River, Wisconsin, for the year 1896.

Dredge.	Location of dredging.	Material handled.	Material rehandled.	Per cent of material rehandled.	Depth of material dredged.	Character of material dredged.	Days employed.	Hours worked.	Hours lost.	Cost of running repairs.
		Cu. yds.	*C. yds.*		*Feet.*					
No. 2...	Lower Fox *a*..	4,158	......	......	1½ to 6	Clay, gravel, and bowlders.	21	131	13	......
No. 2...	Upper Fox *b* ..	*c*47,378	15,733	33.21	1 to 7	Loam, sand, clay, gravel, and stone.	103	601	95	$39.49
No. 4...	Upper Fox *a*..	92,680	18,357	19.81	1 to 3	Sand, clay, gravel, and stone.	158	1,004½	51½	54.48
No. 5...	Upper Fox *a*..	71,030	20,035	28.20	1 to 7.5	Loam, sand, clay, gravel, and stone.	158	1,004	52	6.72
No. 7...	Upper Fox *a*..	93,112	47.221	50.72	2 to 7	Sand, clay, gravel, and hardpan.	150	967	37	28.39
	Total ...	308,358	101,346	......	....	....	....	3,707½	248½	129.08

Dredge.	Location of dredging.	Cost of general repairs.	Cost of fuel.	Cost of sundries.	Cost of crew.	Cost of towing.	Cost of superintendence.	Total cost.	Material handled per day of eight hours.
									Cu. yds.
No. 2...	Lower Fox *a*..	$132.70	$58.20	$2.62	$233.33	$87.73	$48.34	$562.92	253.9
No. 2...	Upper Fox *b*..	*d*2,270.82	263.74	12.02	1,178.31	773.11	97.73	4,635.22	630.5
No. 4...	Upper Fox *a*..	606.81	705.25	20.00	1,822.32	352.56	159.24	3,720.66	738.1
No. 5...	Upper Fox *a*..	*e*1,624.82	437.94	22.64	1,524.15	284.26	155.17	4,055.70	566
No. 7 ..	Upper Fox *a*..	1,162.77	920.56	43.18	1,741.15	375.83	165.63	4,437.51	770.3
	Total...	5,797.92	2,385.69	100.46	6,499.26	1,873.49	626.11	17,412.01	....

Dredge.	Location of dredging.	Cost per cubic yard.							
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.
No. 2...	Lower Fox *a*..	....	$0.0319	$0.0140	$0.0006	$0.0562	$0.0211	$0.0116	$0.1354
No. 2...	Upper Fox *b*..	$0.0008	.0479	.0056	.0003	.0249	.0163	.0020	.0978
No. 4...	Upper Fox *a*..	.0006	.0065	.0076	.0002	.0196	.0038	.0017	.0400
No. 5...	Upper Fox *a*..	.0001	.0229	.0062	.0003	.0214	.0040	.0022	.0571
No. 7...	Upper Fox *a*..	.0003	.0125	.0099	.0005	.0187	.0040	.0017	.0476
	Averages.	.0004	.0188	.0078	.0003	.0211	.0061	.0020	.0565

a Appropriation for operating and care.
b Appropriation for improvement, operating, and care.
c 9,035 cubic yards of this quantity was dredging done in Fond du Lac Harbor.
d $1,662.28 of this amount includes cost of repairs of dump scows Nos. 3 and 4.
e $592.11 of this amount includes cost of constructing pontoon and wood scow.

The following data are not included in the above:

Dredge.	Location of dredging.	Material handled.	Material rehandled.	Per cent of material rehandled.	Depth of material dredged.	Character of material dredged.	Days employed.	Hours worked.	Hours lost.	Cost of running repairs.
		Cu. yds.	*C. yds.*		*Feet.*					
No. 2...	Little Kaukauna.*a b*	10,119	1,913	18.90	1 to 14	Clay, gravel, and stone.	65	353	79	$23.30
No. 2...	Depere lock *a c*	2,675	1,189	44.45	14	Clay and gravel.........	12	76	4	4.99
	Total ...	12,794	3,102	......	....	....	....	429	83	28.29

Dredge.	Location of dredging.	Cost of general repairs.	Cost of fuel.	Cost of sundries.	Cost of crew.	Cost of towing.	Cost of superintendence.	Total cost.	Material handled per day of eight hours.
									Cu. yds.
No. 2...	Little Kaukauna.*a b*	$357.59	$160.20	$7.06	$701.63	$132.74	$152.18	$1,534.70	229.3
No. 2...	Depere lock *a c*	76.99	33.80	1.51	163.33	97.60	27.61	405.83	281.6
	Total...	434.58	194.00	8.57	864.96	230.34	179.79	1,940.53	....

Dredge.	Location of dredging.	Cost per cubic yard.							
		Running repairs.	General repairs.	Fuel.	Sundries.	Crew.	Towing.	Superintendence.	Total.
No. 2...	Little Kaukauna.*a b*	$0.0022	$0.0354	$0.0158	$0.0007	$0.0693	$0.0132	$0.0150	$0.1516
No. 2...	Depere lock *a c*	.0019	.0288	.0128	.0005	.0610	.0364	.0103	.1517
	Averages.	.0021	.0339	.0152	.0006	.0676	.0180	.0141	.1516

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION, APPLIED TO FOX RIVER, WISCONSIN, SECTION 4 OF RIVER AND HARBOR ACT OF JULY 5, 1884.

Detailed statement of expenditures for fiscal year ending June 30, 1897, with itemized statement of expenses attached, as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Depere lock........................	Materials	$4,115.47	
Do	Labor and transportation......	9,679.93	
			$13,795.40
Repairs of retaining wall above Depere lock.....	Materials	110.75	
Do	Labor	10.25	
			121.00
Repairs of Depere dam	Materials	13.40	
Do	Labor	204.97	
			218.37
Repairs of Little Kaukauna dam	Materials	4,444.39	
Do	Labor and transportation......	2,929.12	
			7,373.51
Repairs of Rapide Croche lock..................	Labor	....	126.09
Repairs of Rapide Croche dam..................	Materials	....	2.17
Repairs of Kaukauna fifth lock..................	.....do	25.44	
Do	Labor	36.66	
			62.10
Repairs of lock house at Kaukauna fifth lock....	Materials	....	14.86
Repairs of Kaukauna fourth lock..................	.....do	11.80	
Do	Labor	140.07	
			151.87

a Appropriation for operating and care.
b Work at Little Kaukauna consisted of removing cofferdams, excavating and placing material for submerged cribs, and for backing of dam.
c Work at Depere lock consisted of excavating and placing material for cofferdams.

Detailed statement of expenditures for fiscal year ending June 30, 1897, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of Kaukauna third lock	Labor		106.00
Repairs of Kaukauna second lock	....do		3.00
Repairs of lock house, Kaukauna second lock	Materials		20.86
Repairs of Kaukauna first lock	....do	263.60	
Do	Labor	540.49	
			804.09
Repairs of Kaukauna guard lock	Materials	55.07	
Do	Labor	64.12	
			119.19
Repairs of Kaukauna dam	....do		21.66
Repairs of Little Chute combined locks	Materials	785.75	
Do	Labor	860.35	
			1,646.10
Retaining wall above Little Chute combined locks	Materials	214.50	
Do	Labor	804.44	
			1,018.94
Waste weirs at Little Chute combined locks	....do		41.50
Repairs of Little Chute second lock	....do		30.66
Cross wall at head of Little Chute first lock	Materials		47.50
Repairs of Little Chute dam	....do		2.17
Repairs of Cedars dam	....do	92.14	
Do	Labor	128.79	
			220.93
Repairs of Appleton fourth lock	....do		23.46
Repairs of Appleton third lock	Materials	9.16	
Do	Labor	36.68	
			45.84
Repairs of lock house, Appleton third lock	Materials	7.22	
Do	Labor	6.25	
			13.47
Repairs of Appleton second lock	Materials	15.40	
Do	Labor	135.35	
			150.75
Repairs of Appleton first lock	....do		13.41
Repairs of warehouse, Appleton first lock	....do		6.75
Repairs of Appleton upper dam	....do		5.63
Repairs of Appleton lower dam	....do		7.00
Repairs of Menasha dam	Materials	196.41	
Do	Labor	283.53	
			479.94
Repairs of lock house at Menasha lock	Materials		18.31
Repairs of Eureka lock	Labor		86.83
Repairs of lock house, Eureka lock	Materials	9.63	
Do	Labor	53.37	
			63.00
Repairs of roadway at Eureka lock	....do		12.33
Eureka lock cut	Materials	56.00	
Do	Labor	16.33	
			72.33
Shore protection below Eureka dam	Materials	269.71	
Do	Labor and transportation	257.74	
			527.45
Repairs of Eureka dam	Materials	110.73	
Do	Labor and transportation	173.45	
			284.18
Repairs of White River lock	Labor		136.08
Repairs of White River dam	Materials		4.40
Repairs of lock house at Princeton lock	....do		11.64
Repairs of Montello lock	....do	416.40	
Do	Labor and transportation	505.17	
			921.57
Repairs of Montello dam	Materials	16.25	
Do	Labor	6.00	
			22.25
Repairs of Portage Canal	Materials	1.75	
Do	Labor	13.16	
			14.91
General repairs of locks, dams, and canal banks	Materials	686.21	
Do	Labor	2,688.72	
			3,374.93
Dredging bars, Lower Fox	Fuel, supplies, etc	287.31	
Do	Labor	405.48	
			692.79
Dredging bars, Upper Fox	Fuel, supplies, etc	3,913.28	
Do	Labor	9,076.38	
			12,989.66
Repairs of boats and dredges	Rent of boat yard at Oshkosh	100.00	
Do	Repairs of dredge No. 2	627.28	
Do	Repairs of dredge No. 3	56.50	
Do	Repairs of dredge No. 4	1,171.71	
Do	Repairs of dredge No. 5	248.47	
Do	Repairs of dredge No. 7	3,149.79	

Detailed statement of expenditures for fiscal year ending June 30, 1897, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of boats and dredges	Repairs of steamer Fox	$1,424.54	
Do	Repairs of steamer Boscobel	467.65	
Do	Repairs of steamer Gen. G. K. Warren.	93.34	
Do	Repairs of barge Princeton	361.62	
Do	Repairs of quarter boat	15.50	
Do	Repairs of drill scow (90 feet)	587.73	
Do	Repairs of scow (48 feet)	99.55	
			$8,403.68
Maintenance of navigation	Lock tenders' services	6,930.00	
Do	Gate keepers' services	170.00	
Do	Watchmen, labor, etc	607.18	
Do	Buoying channel opposite Gruenhagens Point, Lake Winnebago.	110.34	
			7,817.52
Care of works and property	Watchmen, labor, and transportation.	915.89	
Do	Traveling expenses of assistant engineers, overseers, etc.	378.46	
			1,294.35
Contingencies	Salaries of assistant engineer, clerks, etc.	2,150.00	
Do	Rent of office at Oshkosh, Wis.	298.47	
Do	Mileage	57.79	
Do	Stationery	167.96	
Do	Rent of telephone, etc	208.83	
Do	Job printing	19.50	
Do	Rent of post-office box at Oshkosh, Wis.	8.00	
Do	Telegrams	4.42	
Do	Map case	15.00	
			2,924.97
Total			66,317.49

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
July 8	1	Priest & Gorrow	Wood and coal	$493.11
8	2	H. C. Doman	Bronze pinion, etc	37.24
16	3	M. J. Rounds	Services	12.00
16	4	James E. Patton Co	Oil, etc	31.40
Aug. 4	1	L. M. Mann	Services	175.00
4	2	John M. Paige	do	35.00
4	3	Alexander Sims	do	35.00
4	4	John Baeten	do	25.00
4	5	George T. Allanson	do	30.00
4	6	George Gifford	do	25.00
4	7	Gabriel Wick	do	25.00
4	8	Gottlieb Jahnke	do	25.00
4	9	Jerry Parkinson	do	25.00
4	10	John Lewis	do	25.00
4	11	Richard E. Rice	do	25.00
4	12	James Clear	do	30.00
4	13	A. H. Pape	do	5.00
4	14	Keuffel & Esser Co	Tracing cloth	7.88
4	15	Henry A. Foster	Glass	1.80
4	16	Hay Hardware Co	Water gauge, glasses, etc	1.91
4	17	H. C. Doman	Screws, etc	3.56
4	18	Stroud & Thomson	Paint brushes	4.20
4	19	The Cook & Brown Lime Co	Coal	5.85
4	20	Robert Brand & Sons	Pigeonhole cabinet, etc	15.65
4	21	William Diehmann	Rent of office	24.83
4	22	Battis Bros	Patch bolts, etc	26.84
4	23	Campbell & Cameron Co	Lumber	25.44
4	24	do	Oak lumber, etc	733.12
4	25	do	Pine lumber	1,745.42
4	26	Niels Johnson	Iron, etc	17.50
4	27	Chas. S. Morris	Coal	41.46
4	28	Priest & Gorrow	Wood and coal	823.15
4	29	Wisconsin Telephone Co	Rent of telephones	10.50
4	30	do	Telephone messages	10.98

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
Aug. 4	31	National Paint Works	Paint	$50.00
4	32	Frank B. Fargo	Calcimining, etc	9.00
4	33	National Paint Works	Paint	242.50
4	34	John A. Banker	Services	25.00
5–8	35	Hired men	Services, July, 1896	3,699.21
8	36	Frank Smith	Services	1.25
8	37	G. L. & D. W. Thomas	Brooms, etc	1.94
8	38	Des Forges & Co	Stationery	21.55
8	39	Elwin Bauter	Traveling expenses	2.68
8	40	John C. Beye	.....do	7.30
8	41	Charles M. Cole	.....do	2.52
8	42	L. M. Mann	.....do	7.48
14	43	Dayton R. Burr	Depositing dredged material	11.28
31	44	Fred. J. Anger	Services	60.00
31	45	L. M. Mann	.....do	175.00
31	46	John M. Paige	.....do	35.00
31	47	Alexander Sims	.....do	35.00
31	48	John Baeten	.....do	25.00
31	49	George T. Allanson	.....do	30.00
31	50	George Gifford	.....do	25.00
31	51	John A. Banker	.....do	25.00
31	52	Gabriel Wick	.....do	25.00
31	53	Gottlieb Jahnke	.....do	25.00
31	54	Jerry Parkinson	.....do	25.00
31	55	John Lewis	.....do	25.00
31	56	Richard E. Rice	.....do	25.00
31	57	James Clear	.....do	30.00
31	58	A. H. Pape	.....do	5.00
31	59	Keuffel & Esser Co	Notebooks	9.00
31	60	F. Cortez Wilson & Co	Tank	10.00
31	61	H. C. Doman	Globe valve	1.60
31	62	James Gillingham & Son	Iron bands	5.00
31	63	.....do	Driftbolts	6.42
31	64	Hay Hardware Co	Chain, etc	6.39
31	65	William Dichmann	Rent of office	24.83
31	66	Orville Beach	Rent of land	25.00
31	67	Conlee Lumber Co	Pine lumber	24.00
31	68	.....do	.....do	193.71
31	69	The Cook & Brown Lime Co	Coal	35.10
31	70	Campbell & Cameron Co	Oak timber	66.24
31	71	.....do	Pinelumber	224.38
31	72	Wisconsin Telephone Co	Rent of telephones	7.50
31	73	.....do	Telephone messages	8.25
31	74	Chas. S. Morris	Coal	40.50
31	75	Priest & Gorrow	Wood and coal	564.73
Sept. 2	1	L. M. Mann	Traveling expenses	5.06
4	2	Hired men	Services, August, 1896	3,401.13
10	3	John Arft	Services	9.00
10	4	Charles M. Cole	Traveling expenses	2.92
10	5	Elwin Bauter	.....do	2.68
25	6	John Yuenger	Services	6.09
30	7	Fred. J. Anger	.....do	60.00
30	8	Burdick, Armitage & Allen	Job printing	13.50
30	9	L. M. Mann	Services	175.00
30	10	John M. Paige	.....do	35.00
30	11	Alexander Sims	.....do	35.00
30	12	John Baeten	.....do	25.00
30	13	George T. Allanson	.....do	30.00
30	14	George Gifford	.....do	25.00
30	15	John A. Banker	.....do	25.00
30	16	Gabriel Wick	.....do	25.00
30	17	Gottlieb Jahnke	.....do	25.00
30	18	Jerry Parkinson	.....do	25.00
30	19	John Lewis	.....do	25.00
30	20	Richard E. Rice	.....do	25.00
30	21	James Clear	.....do	30.00
30	22	A. H. Pape	.....do	5.00
30	23	Schlafer & Barrett	Scythe, etc	1.48
30	24	Joseph Kloeckner, postmaster	Rent of post-office box	.75
30	25	Stroud & Thomson	Glass, etc	3.61
30	26	Wisconsin Telephone Co	Rent of telephones	7.50
30	27	.....do	Telephone messages	9.60
30	28	William Dichmann	Meat, etc	2.91
30	29	.....do	Flour, butter, etc	15.37
30	30	.....do	Rent of office	24.83
30	31	H. C. Doman	Gas pipe, etc	29.57
30	32	Campbell & Cameron Co	Pine lumber	31.20
30	33	Hay Hardware Co	Spikes, etc	48.26
30	34	John H. Crawford	Coal	50.40

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
Sept. 30	35	The Cook & Brown Lime Co	Coal	$53.38
30	36	G. L. & D. W. Thomas	Lye, etc	5.43
30	37	Niels Johnson	Boiler rivets, etc	10.98
30	38	Chas. S. Morris	Coal	46.79
30	39	Priest & Gorrow	Wool and coal	452.67
Oct. 2	1	L. M. Mann	Traveling expenses	10.28
2	2	Thomas Malone	Stone	184.43
2	3	Gerry Lumber Co	Lumber	12.32
2	4	Western Union Telegraph Co	Telegrams	1.53
2	5	Western Lime and Cement Co	Cement	10.80
3	6	Badger Typewriter and Stationery Co	Stationery	9.87
3	7	The Chas. Baumbach Co	Oil	4.76
5	8	Hired Men	Services, September, 1896	3,247.41
5	9	Elwin Bauter	Traveling expenses	2.81
7	10	Charles M. Cole	.....do	7.05
9	11	John Arft	Services	45.00
9	12	M. J. Schmitt	Blueprints, etc	5.06
9	13	Bucyrus Steam Shovel and Dredge Co	Dipper lips	82.98
9	14	Western Union Telegraph Co	Telegrams	1.21
10	15	Albert Belz	Services	3.12
14	16	Wenzel Brouchek	.....do	10.00
31	17	C. A. Lawton & Co	Steel, etc	5.55
31	18	L. Lindauer	Stone	297.91
31	19	Thomas Malone	.....do	485.87
31	20	Gerry Lumber Co	Lumber	12.78
31	21	J. C. Koelsch	Shovel, etc	1.85
31	22	Stroud & Thomson	Oakum	4.25
31	23	Western Union Telegraph Co	Telegrams	.20
31	24	Wisconsin Telephone Co	Rent of telephones	7.50
31	25	.....do	Telephone messages	12.47
31	26	Hay Hardware Co	Spikes, etc	11.35
31	27	The Cook & Brown Lime Co	Coal	19.50
31	28	William Dichmann	Rent of office	24.83
31	29	George Ryan	Hauling out drill scow	50.00
31	30	Campbell & Cameron Co	Lumber and piles	181.24
31	31	Conlee Lumber Co	Pine lumber	198.52
31	32	J. H. Crawford	Coal and wood	345.00
31	33	G. L. & D. W. Thomas	Soap	.60
31	34	C. A. Peck	Iron	1.41
31	35	Priest & Gorrow	Coal and wood	410.14
31	36	A. J. Wier	Coal	11.00
31	37	L. M. Mann	Services	175.00
31	38	John M. Paige	.....do	35.00
31	39	Alexander Sims	.....do	35.00
31	40	John Baeten	.....do	25.00
31	41	George T. Allanson	.....do	30.00
31	42	George Gifford	.....do	25.00
31	43	Gabriel Wick	.....do	25.00
31	44	Gottlieb Jahnke	.....do	25.00
31	45	Jerry Parkinson	.....do	25.00
31	46	John Lewis	.....do	25.00
31	47	Richard E. Rice	.....do	25.00
31	48	James Clear	.....do	30.00
31	49	A. H. Pape	.....do	5.00
31	50	John A. Banker	.....do	25.00
Nov. 5	1	Hired men	Services, October, 1896	3,427.83
6	2	J. Wm. Worm	Lumber, etc	11.64
6	3	Chas. S. Morris	Coal	43.60
6	4	MacKinnon Excelsior Co	Excelsior waste	1.05
6	5	Keuffel & Esser	Tracing cloth	7.88
6	6	William Dichmann	Flour, sugar, etc	19.37
6	7	Charles M. Cole	Traveling expenses	9.31
6	8	Elwin Bauter	.....do	2.81
6	9	John C. Beye	.....do	2.94
10	10	John Arft	Services	28.50
13	11	William Biggs	.....do	1.87
16	12	R. Booth	Driving piles	209.00
17	13	Clarence L. Neff	Services	6.00
19	14	Badger Typewriter and Stationery Co	Paper	6.48
30	15	Fred. J. Anger	Services	60.00
30	16	L. M. Mann	.....do	175.00
30	17	John M. Paige	.....do	35.00
30	18	Alexander Sims	.....do	35.00
30	19	John Baeten	.....do	25.00
30	20	George T. Allanson	.....do	30.00
30	21	George Gifford	.....do	25.00
30	22	John A. Banker	.....do	25.00
30	23	Gabriel Wick	.....do	25.00
30	24	Gottlieb Jahnke	.....do	25.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1896.				
Nov. 30	25	Jerry Parkinson	Services	$25.00
30	26	John Lewis	do	25.00
30	27	James Clear	do	30.00
30	28	A. H. Pape	do	5.00
30	29	Richard E. Rice	do	25.00
30	30	The Marsh & Bingham Co	Oak lumber	138.24
30	31	do	do	189.25
30	32	Kaukauna Lumber and Mfg. Co	Pine lumber	6.46
30	33	Thomas Malone	Stone	159.65
30	34	Gerry Lumber Co	Pine lumber	23.07
30	35	Valley Iron Works Manufacturing Co	Pinions, etc	23.52
30	36	Schlafer & Barrett	Nails and bolts	29.36
30	37	do	Spikes and bolts	9.79
30	38	Western Union Telegraph Co	Telegrams	.60
30	39	M. A. Searl	Ice	6.00
30	40	Wisconsin Telephone Co	Rent of telephones	7.50
30	41	do	Telephone messages	6.90
30	42	Stroud & Thompson	Axle grease	4.00
30	43	Hay Hardware Co	Spikes, etc	4.08
30	44	The Cook & Brown Lime Co	Coal	11.70
30	45	Banderob-Chase Co	Oak lumber	12.00
30	46	William Dichmann	Rent of office	24.83
30	47	Orville Beach	Rent of land	25.00
30	48	Chas. S. Morris	Coal	71.51
30	49	Priest & Gorrow	Wood	160.87
30	50	do	Stone	245.87
Dec. 1	1	L. M. Mann	Traveling expenses	4.21
2	2	John C. Beye	do	3.31
5	3	Hired men	Services, November, 1896	3,361.99
7	4	Eugene Dietzgen Co	Transit books, etc	9.20
7	5	Elwin Bauter	Traveling expenses	2.22
9	6	Charles M. Cole	do	9.69
12	7	Mathias Helf	Services	12.18
14	8	Des Forges & Co	Stationery	4.10
17	9	G. K. Kendall	Paper	1.88
31	10	John Smith	Clay	30.80
31	11	L. Lindauer	Stone	214.50
31	12	Schlafer Hardware Co	Stone wheelbarrows, etc	47.11
31	13	Joseph Kloeckner, postmaster	Rent of post-office box	.75
31	14	The Morgan Co	Storm sash	5.95
31	15	Wisconsin Telephone Co	Rent of telephones	7.50
31	16	do	Telephone messages	6.95
31	17	Robert Brand & Sons	Map case	15.00
31	18	William Dichmann	Rent of office	24.83
31	19	George Ryan	Oak lumber, etc	66.80
31	20	Mann Bros	do	82.35
31	21	The Marsh & Bingham Co	Lumber	158.37
31	22	L. M. Mann	Services	175.00
31	23	John M. Paige	do	35.00
31	24	Alexander Sims	do	35.00
31	25	John Baeten	do	25.00
31	26	George T. Allanson	do	30.00
31	27	George Gifford	do	25.00
31	28	John A. Bauker	do	25.00
31	29	Gabriel Wick	do	25.00
31	30	Gottlieb Jahnke	do	25.00
31	31	Jerry Parkinson	do	25.00
31	32	John Lewis	do	25.00
31	33	Richard E. Rice	do	25.00
31	34	James Clear	do	30.00
31	35	A. H. Pape	do	5.00
31	36	Badger Typewriter and Stationery Co	Stationery	7.04
31	37	do	do	10.60
1897.				
Jan. 5	1	L. M. Mann	Traveling expenses	6.33
5	2	John C. Beye	do	3.07
5	3	Butler Bros	Nails, etc	1.70
5	4	Jones & Laughlins, Limited	Tie rods, etc	41.02
5	5	Hired men	Services, December, 1896	3,045.79
16	6	Burdick, Armitage & Allen	Job printing	6.00
16	7	Charles M. Cole	Traveling expenses	13.31
16	8	Fulton Iron and Engine Works	Ice-boring machines	121.64
16	9	J. W. Black	Stone	260.00
16	10	Mann Bros	Oak lumber	353.11
16	11	do	do	701.10
26	12	Capt. George A. Zinn	Mileage	16.79
28	13	Charles W. Day	Pine lumber	700.22
28	14	Jones & Laughlins, Limited	Boat spikes, etc	116.85
28	15	Bailey Grover	Traveling expenses	13.11

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
Jan. 30	16	Ben Jacobsen	Tamarack knees	$24.00
30	17	John Van Vonderen	Sand	33.96
30	18	Ramsay & Jones	Pine lumber	3.22
30	19	Appleton Machine Co	Heel post caps, etc	22.02
30	20	.....do	Anchor rods, etc	112.72
30	21	American Express Co	Express charges	.35
30	22	H. C. Doman	Labor	1.70
30	23	Hay Hardware Co	Rope, etc	2.45
30	24	William Dichmann	Rent of office	24.83
30	25	The A. G. Wells Co	Blacksmith coal	8.00
31	26	Fred. J. Anger	Services	60.00
31	27	L. M. Mann	.....do	175.00
31	28	John M. Paige	.....do	35.00
31	29	Alexander Sims	.....do	35.00
31	30	John Baeten	.....do	25.00
31	31	George T. Allanson	.....do	30.00
31	32	George Gifford	.....do	25.00
31	33	John A. Banker	.....do	25.00
31	34	Gabriel Wick	.....do	25.00
31	35	Gottlieb Jahnke	.....do	25.00
31	36	Jerry Parkinson	.....do	25.00
31	37	John Lewis	.....do	25.00
31	38	Richard E. Rice	.....do	25.00
31	39	James Clear	.....do	30.00
31	40	A. H. Pape	.....do	5.00
31	41	L. M. Mann	Traveling expenses	11.66
Feb. 2	1	Western Lime and Cement Co	Cement	285.00
4	2	Hired men	Services, January, 1897	3,006.68
6	3	Elwin Bauter	Traveling expenses	2.23
6	4	Des Forges & Co	Stationery	5.55
11	5	Wisconsin Telephone Co	Rent of telephones	7.50
11	6	.....do	Telephone messages	8.50
11	7	Charles M. Cole	Traveling expenses	21.61
13	8	Joseph Rabedieu	Services	6.25
13	9	Henry Hahner	.....do	15.00
15	10	Capt. George A. Zinn	Mileage	11.24
20	11	William Doberstein	Services	14.21
20	12	John Van Vonderen	Sand	65.32
28	13	C. A. Lawton & Co	Bolts, etc	74.17
28	14	Charles W. Day	Pine lumber	264.21
28	15	Western Union Telegraph Co	Telegrams	.84
28	16	Wisconsin Telephone Co	Telephone messages	6.00
28	17	.....do	Rent of telephones	7.50
28	18	H. C. Doman	Bolts, etc	15.27
28	19	William Dichmann	Rent of office	24.83
28	20	Orville Beach	Rent of land	25.00
28	21	Hay Hardware Co	Spikes, bolts, etc	126.54
28	22	L. M. Mann	Services	175.00
28	23	John M. Paige	.....do	35.00
28	24	Alexander Sims	.....do	35.00
28	25	John Baeten	.....do	25.00
28	26	George T. Allanson	.....do	30.00
28	27	George Gifford	.....do	25.00
28	28	Gabriel Wick	.....do	25.00
28	29	Gottlieb Jahnke	.....do	25.00
28	30	Jerry Parkinson	.....do	25.00
28	31	John Lewis	.....do	25.00
28	32	Richard E. Rice	.....do	25.00
28	33	James Clear	.....do	30.00
28	34	A. H. Pape	.....do	5.00
28	35	John A. Banker	.....do	25.00
28	36	L. M. Mann	Traveling expenses	5.46
Mar. 4	1	Joys Bros. & Co	Oakum, etc	70.75
4	2	Western Lime and Cement Co	Cement	190.00
4	3	Keuffel & Esser Co	Drawing paper, etc	11.78
4	4	H. Channon Co	Chain block, etc	62.85
4	5	Depere Lumber & Fuel Co	Lumber	1.56
4	6	I. H. Battin	Boiler oil, etc	13.52
4	7	Appleton Machine Co	Iron castings, etc	2.72
4	8	Hired men	Services, February, 1897	3,698.38
5	9	Charles M. Cole	Traveling expenses	22.01
5	10	Elwin Bauter	.....do	2.10
10	11	Bailey Grover	.....do	13.47
15	12	Capt. George A. Zinn	Mileage	17.71
19	13	W. S. Woodworth	Traveling expenses	25.22
31	14	Fred. J. Anger	Services	60.00
31	15	L. M. Mann	.....do	175.00
31	16	John M. Paige	.....do	35.00
31	17	Alexander Sims	.....do	35.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

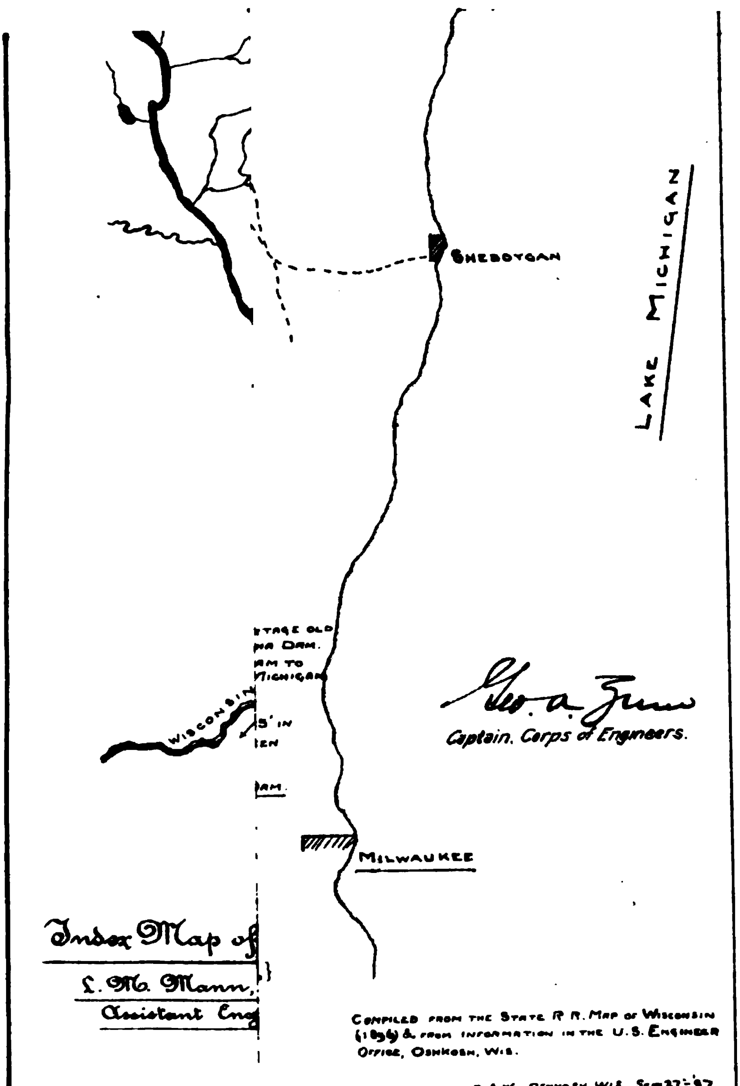
Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
Mar. 31	18	John Baeten	Services	$25.00
31	19	George T. Allanson	....do	30.00
31	20	George Gifford	....do	25.00
31	21	John A. Banker	....do	25.00
31	22	Gabriel Wick	....do	25.00
31	23	Gottlieb Jahnke	....do	25.00
31	24	Jerry Parkinson	....do	25.00
31	25	John Lewis	....do	25.00
31	26	Richard E. Rice	....do	25.00
31	27	James Clear	....do	30.00
31	28	A. H. Pape	....do	5.00
31	29	Keuffel & Esser Co	Paragon leads	.53
31	30	....do	Blue-print paper	.90
31	31	The Marsh & Bingham Co	Oak lumber	119.90
31	32	Mann Bros	....do	156.83
31	33	Frederick C. Peslin	Stone	25.50
31	34	John Van Vonderen	Sand	58.17
31	35	Thiele & Handeyside	Stone	68.62
31	36	Gerry Lumber Co	Pine lumber	67.98
31	37	Appleton Machine Co	Iron castings, etc	68.44
31	38	....do	Tripods, etc	83.65
31	39	Hay Hardware Co	Tin funnel	.40
31	40	Joseph Kloeckner, postmaster	Rent of post-office box	.75
31	41	Stroud & Thomson	Glass, etc	1.14
31	42	H. C. Doman	Washers, etc	4.11
31	43	Western Union Telegraph Co	Telegrams	.40
31	44	Wisconsin Telephone Co	Rent of telephones	7.50
31	45	....do	Telephone messages	9.45
31	46	J. A. Barnes	Rent of engine and boiler	14.50
31	47	The Medberry-Bemis Co	Index books, etc	14.60
31	48	William Dichmann	Rent of office	24.83
31	49	C. A. Peck	Spikes and iron	19.84
31	50	D. W. Thomas	Services	9.00
31	51	Mann Bros	Pine lumber	14.50
31	52	....do	....do	272.04
31	53	....do	Oak lumber	415.21
Apr. 3	1	....do	Pine lumber	82.59
3	2	Western Lime and Cement Co	Cement	90.00
3	3	Elwin Bauter	Traveling expenses	2.10
5	4	Hired men	Services, March, 1897	4,051.01
5	5	W. S. Woodworth	Traveling expenses	17.02
5	6	Western Union Telegraph Co	Telegrams	.92
9	7	Bailey Grover	Traveling expenses	26.29
9	8	L. M. Mann	....do	18.87
15	9	Charles M. Cole	....do	19.37
22	10	H. H. West Co	Figuring blocks, etc	18.16
22	11	David O'Malley	Services	10.00
24	12	John H. Crawford & Co	Blacksmith coal	1.57
30	13	L. M. Mann	Services	175.00
30	14	John M. Paige	....do	85.00
30	15	Alexander Sims	....do	35.00
30	16	John Baeten	....do	25.00
30	17	George T. Allanson	....do	30.00
30	18	George Gifford	....do	25.00
30	19	John A. Banker	....do	25.00
30	20	Gabriel Wick	....do	25.00
30	21	Gottlieb Jahnke	....do	25.00
30	22	Jerry Parkinson	....do	25.00
30	23	John Lewis	....do	25.00
30	24	Richard E. Rice	....do	25.00
30	25	James Clear	....do	30.00
30	26	A. H. Pape	....do	5.00
30	27	Keuffel & Esser Co	Drawing paper	2.70
30	28	Lee & Diebels Co	Blacksmith coal, etc	15.30
30	29	C. A. Lawton & Co	Grate bars	14.75
30	30	....do	Valve boxes, etc	35.06
30	31	....do	Steel sprocket, etc	57.26
30	32	....do	Steel gear, etc	242.75
30	33	....do	Valves, etc	316.95
30	34	James R. Shepard	Stone	63.25
30	35	Gerry Lumber Co	Lumber	25.18
30	36	Schlafer Hardware Co	Linseed oil, etc	38.60
30	37	MacKinnon Pulley Co	Steel, iron, etc	37.60
30	38	American Express Co	Express charges	.80
30	39	Western Union Telegraph Co	Telegrams	.89
30	40	Wisconsin Telephone Co	Rent of telephones	7.50
30	41	....do	Telephone messages	16.79
30	42	The Cook & Brown Lime Co	Coal	3.60

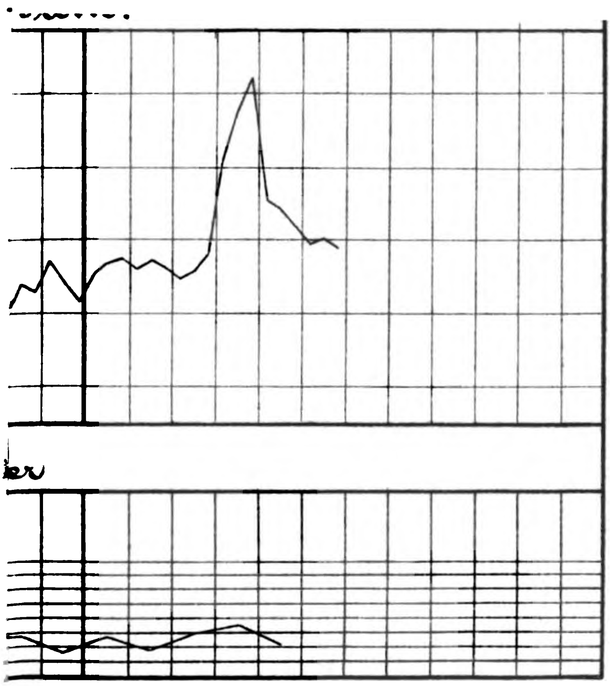
Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
Apr. 30	43	Frank Leach Hardware Co	Wire nails, etc	$4.06
30	44	The Morgan Co	Pine lumber, etc	48.55
30	45	Stroud & Thomson	Axle grease, etc	11.44
30	46	C. E. Angell & Co	Seeds	15.55
30	47	Battis Bros	Hand-hole plates, etc	10.98
30	48	William Dichmann	Rent of office	25.00
30	49	H. C. Doman	Iron, etc	5.13
30	50	.....do	Iron rods, etc	62.33
30	51	.....do	Carrying sheaves, etc	118.06
30	52	.....do	Chain, etc	128.99
30	53	John W. Slater	Linseed oil	3.42
30	54	Niels Johnson	Gas pipe, etc	8.25
30	55	Ernest Eastman	Gravel, etc	16.25
30	56	Valley Iron Works Manufacturing Co.	Snubbing posts, etc	78.20
30	57	.....do	Valves, shafts, etc	343.47
30	58	Hay Hardware Co	Deck plugs, etc	6.47
30	59	J. George Mueller	Soil pipe	.55
May 6	1	Hired men	Services, April, 1897	3,946.14
6	2	Des Forges & Co	Stationery	3.35
6	3	Rundle-Spence Manufacturing Co	Injector	14.85
6	4	Joys Bros. & Co	Hawsing beetle	2.50
6	5	.....do	Oakum, etc	51.75
6	6	L. M. Mann	Traveling expenses	10.87
6	7	Bailey Grover	.....do	9.62
7	8	Capt. George A. Zinn	Mileage	12.05
8	9	Western Lime and Cement Co	Cement	14.40
14	10	Elwin Bauter	Traveling expenses	2.68
14	11	Charles M. Cole	.....do	9.80
14	12	George H. Jenkins	Services	24.75
20	13	Des Forges & Co	Stationery	8.15
31	14	Fred. J. Anger	Services	60.00
31	15	L. M. Mann	.....do	200.00
31	16	John M. Paige	.....do	35.00
31	17	Alexander Sims	.....do	35.00
31	18	John Baeten	.....do	25.00
31	19	George T. Allanson	.....do	30.00
31	20	George Gifford	.....do	25.00
31	21	John A. Banker	.....do	25.00
31	22	Gabriel Wick	.....do	25.00
31	23	Gottlieb Jahnke	.....do	25.00
31	24	Jerry Parkinson	.....do	25.00
31	25	John Lewis	.....do	25.00
31	26	Richard E. Rice	.....do	25.00
31	27	James Clear	.....do	30.00
31	28	A. H. Pape	.....do	5.00
31	29	Charles Rogers	.....do	25.00
31	30	Axel Fahlstrom	.....do	25.00
31	31	John Kilawee	.....do	30.00
31	32	Alexander G. Grignon	.....do	30.00
31	33	Cornelius Romsom	.....do	30.00
31	34	Henry G. Bongers	.....do	25.00
31	35	National Paint Works	Asphaltum paint	198.50
31	36	Charles Schroeder	Wood	26.00
31	37	F. H. Blood	Sewer pipe	4.20
31	38	Schlafer Hardware Co	Iron, etc	3.30
31	39	.....do	Rope, etc	16.73
31	40	Gerry Lumber Co	Lumber	72.89
31	41	G. A. Loescher	Iron pipe, etc	7.31
31	42	John Lenz, sr	Cistern	11.00
31	43	Western Union Telegraph Co	Telegram	.20
31	44	American Express Co	Express charges	.25
31	45	Gillen Bros	Laundry	1.22
31	46	H. C. Johnson & Co	Storing awnings, etc	1.75
31	47	H. C. Doman	Brass, etc	2.22
31	48	.....do	Steam cocks, etc	7.74
31	49	.....do	Dredge chain, etc	256.97
31	50	Wm. R. Williams	Chimney hood	3.00
31	51	.....do	Tin roofing, etc	32.00
31	52	Hay Hardware Co	Iron, etc	3.60
31	53	.....do	Rope, etc	163.19
31	54	Wisconsin Telephone Co	Telephone messages	5.15
31	55	.....do	Rent of telephones	7.50
31	56	The Morgan Co	Pine lumber, etc	6.40
31	57	Conlee Lumber Co	Lumber, etc	6.63
31	58	.....do	.....do	24.56
31	59	H. M. Harmon	Labor	8.10
31	60	Stroud & Thomson	Tallow, etc	8.12
31	61	S. E. McPartlin	Asbestus covering	19.88
31	62	Orville Beach	Rent of land	25.00
31	63	William Dichmann	Rent of office	25.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1897.				
May 31	64	William Dichmann	Soap, etc	$60.13
31	65	I. H. Battin	Oil	41.88
31	66	O. McCorison	Linoleum, etc	58.74
31	67	The Cook & Brown Lime Co	Coal	57.60
31	68	John H. Crawford & Co	Coal and wood	143.77
31	69	Hiram Stedman	Coal	22.44
31	70	Priest & Gorrow	Wood	280.85
31	71	A. J. Weir	Lumber	1.15
June 4	1	Hired men	Services, May, 1897	8,393.14
5	2	Joys Bros. & Co	Oakum, etc	12.50
5	3	Western Lime and Cement Co	Cement	95.00
5	4	Rundle-Spence Manufacturing Co	Cutter block, etc	.48
5	5	J. A. Barnes	Steel castings, etc	64.48
5	6	Peter Feller	Galvanized iron	8.46
5	7	John C. Beye	Traveling expenses	9.35
9	8	James E. Patton Co	White lead, etc	38.03
9	9	Charles M. Cole	Traveling expenses	8.95
9	10	L. M. Mann	do	9.14
12	11	Racine Yacht and Boat Works	Rowboat	39.00
16	12	Abraham Hibbard	Services	1.25
16	13	Rolla Fuller	do	1.25
16	14	Wenzel Steidl	do	13.90
16	15	G. D. Greely	Paper	6.60
30	16	L. M. Mann	Services	200.00
30	17	John M. Paige	do	35.00
30	18	Alexander Sims	do	35.00
30	19	John Baeten	do	25.00
30	20	George T. Allanson	do	30.00
30	21	George Gifford	do	25.00
30	22	John A. Banker	do	25.00
30	23	Gabriel Wick	do	25.00
30	24	Gottlieb Jahnke	do	25.00
30	25	Jerry Parkinson	do	25.00
30	26	John Lewis	do	25.00
30	27	Richard E. Rice	do	25.00
30	28	James Clear	do	30.00
30	29	A. H. Pape	do	5.00
30	30	Charles Rogers	do	25.00
30	31	Axel Fahlstrom	do	25.00
30	32	John Kilawee	do	30.00
30	33	Alexander G. Grignon	do	30.00
30	34	Cornelius Romsom	do	30.00
30	35	Henry C. Bongers	do	25.00
30	36	Keuffel & Esser Co	Blue-print paper	.90
30	37	do	Tracing cloth	7.88
30	38	F. Cortez Wilson & Co	Oil tank	5.60
30	39	John Van Vonderen	Sand	6.50
30	40	John Shea	Clay	6.90
30	41	do	Gravel	18.50
30	42	Stark & Tesch	Nails, etc	8.34
30	43	Schlafer Hardware Co	Cotton waste, etc	3.15
30	44	do	Quilts, etc	8.50
30	45	do	Manila rope, etc	14.80
30	46	do	Cotton waste, etc	26.47
30	47	Joseph Kloeckner, postmaster	Rent of post-office box	.75
30	48	The Casket Hardware Co	Use of jackscrews	.90
30	49	Battis Bros	Labor	1.00
30	50	Gillingham & Son	Cold chisels, etc	3.15
30	51	William Dichmann	Pillowcases	1.50
30	52	do	Flour, etc	4.52
30	53	do	Rent of office	25.00
30	54	H. C. Johnson & Son	Canvas	4.00
30	55	August Schroeder	Use of jackscrews	7.20
30	56	Wisconsin Telephone Co	Rent of telephones	7.50
30	57	do	Telephone messages	12.43
30	58	Conlee Lumber Co	Lumber	8.71
30	59	I. H. Battin	Oil	18.36
30	60	The Cook and Brown Lime Co	Coal	26.10
30	61	Hay Hardware Co	Scales, etc	29.64
30	62	H. C. Doman	Chain, etc	96.59
30	63	John H. Crawford & Co	Wood and coal	168.01
30	64	Hiram Stedman	Coal	48.43
30	65	Priest & Gorrow	Wood and coal	292.73
30	66	A. J. Weir	Coal	7.50
30	67	L. M. Mann	Traveling expenses	9.55
		Total		66,317.49


Sheboygan
Lake Michigan
Wisconsin
Milwaukee
Captain, Corps of Engineers.
Index Map of
L. M. Mann,
Assistant Eng
Compiled from the State R R. Map of Wisconsin
& from information in the U.S. Engineer
Office, Oshkosh, Wis.
D.A.W. Oshkosh, Wis. Sep 27 '97



M. Mann, Asst. Engr.

W. S. Woodworth, Draftsman

Oshkosh, Wis. June 30-1897.

H H 23.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck of barge Sumatra in Milwaukee Bay.—The barge *Sumatra*, loaded with railroad rails, in tow of the steam barge *Arnold*, foundered in 33 feet depth of water September 30, 1896, about three-fourths of a mile east by south of the entrance to Milwaukee Harbor, Wisconsin, and formed a dangerous obstruction to navigation. All of the cargo except 40 rails was removed by December 10, 1896, and the wreck abandoned by the wreckers and owners.

A recommendation dated December 26, 1896, that an allotment of $500 from the permanent indefinite appropriation for removing sunken vessels, etc., act of June 14, 1880, was approved January 4, 1897, for the removal of the remaining portions of the wreck, which consisted chiefly of the bow, bowsprit, centerboard box, and one pair of sheet posts, over which the depth of water was from 18 to 22 feet, so that there should be a clear depth of 28 feet over all parts of the wreck.

An examination of the wreck was made by a diver and proposals invited for the removal of the obstruction.

Proposals were received January 29, 1897, from the Milwaukee Tug Company and the Independent Tug Company, each being for the sum of $300. The latter company undertook to do the work and to furnish all necessary appliances.

The removal was accomplished February 18, 1897, the site of the wreck swept by an iron bar suspended at a depth of 28 feet, and no obstruction encountered.

Dynamite was used for blowing up the wreck. The bowsprit, which was afloat, was towed into the Milwaukee River.

The cost of removal was as follows:

Examination by diver	$50.00
Removal of wreck	300.00
Total	350.00

H H 24.

SURVEY OF HARBOR AT MENOMINEE, MICHIGAN AND WISCONSIN, WITH A VIEW OF OBTAINING A 20-FOOT DEPTH OF WATER.

[Printed in House Doc. No. 86, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 7, 1896.

SIR: I have the honor to submit the accompanying copy of report of November 30, 1896, with map,* by Capt. George A. Zinn, Corps of Engineers, of results of a survey of harbor at Menominee, Michigan and Wisconsin, with a view of obtaining a 20-foot depth of water, made to comply with requirements of the river and harbor act of June 3, 1896.

Two plans of improvement are presented by Captain Zinn, one by

*Not reprinted. Printed in House Doc. No. 86, Fifty-fourth Congress, second session.

pier extension and dredging, and the other by dredging only. But he is of opinion that the better method of obtaining a 20-foot channel at Menominee Harbor is to dredge the channel to that depth from the river to the 20-foot contour in Green Bay without extension of the piers. He further states that in case this plan should be adopted the open channel should be widened, requiring for the entire work the removal of 172,000 cubic yards of material at an estimated cost, including contingencies, of $18,920.

Col. H. M. Robert, Corps of Engineers, the division engineer, in forwarding this report says:

I concur with Captain Zinn in recommending the adoption of the second, or dredging, plan for the further improvement of this harbor, at a cost of about $19,000. Only about $7,000 of this will be expended outside the present pierheads. After the 20-foot channel has been obtained it will probably cost about $3,000 annually to maintain it. Should it be found to much exceed this amount then this cost should be compared with that of constructing and maintaining piers, and if the latter method is proven to be cheaper it could at any time be adopted. At present I think dredging should be tried.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 30, 1896.

GENERAL: I have the honor to submit, in compliance with instructions contained in printed letter from office of the Chief of Engineers, United States Army, dated Washington, D. C., September 5, 1896, the following report upon a survey of harbor at Menominee, Michigan and Wisconsin, and an estimate of the cost of improvement, with a view to obtaining a channel 20 feet deep.

The harbor of Menominee is situated at the mouth of the river of the same name on the western shore of Green Bay, and has already been successfully improved by the construction of two approximately parallel piers, from 370 to 400 feet apart, and by dredging between them under a project whose object is to maintain a channel 200 feet wide and 17 feet deep below a plane which is 3.06 feet below the plane of reference of the Lake Survey, from Green Bay into the Menominee River. These piers project about 1,000 feet on the north side and 1,400 feet on the south side beyond the present shore line, and terminate in 18 feet of water on the north side of the channel and 13 feet on the south side. The south pier projects about 100 feet beyond the north pier.

Inasmuch as separate appropriations have been made for the improvement of the Menominee River and of Menominee Harbor, and since the word "harbor" has heretofore been interpreted in this district to mean the channel connecting deep water in the lake with deep water in the river to which it usually gives entrance, the project proposed herein for obtaining a 20-foot depth of water under the act of June 3, 1896, will be limited to the entrance channel, as indicated by red lines upon the inclosed tracing.

The Menominee River is one of the largest streams emptying into Lake Michigan, the area of its watershed being about 4,400 square miles. It is subject to severe annual freshets, and, as a large portion of the banks of the river proper between its mouth and the dam situated about 3 miles back from the shore, as well as the banks of the numerous artificial channels dredged to the various log pockets, are unprotected by docks, large quantities of material eroded from these unprotected banks are brought down and deposited in Green Bay, thus tending to form a bar opposite the mouth of the river.

An examination of the Lake Survey chart shows that to the northward of the mouth of the Menominee River the 18-foot contour is about one-half mile from the shore, leaving a narrow strip of shoal water; while commencing immediately at the mouth of the river and continuing southwardly to the head of Green Bay, the 18-foot contour recedes from the shore to a distance of about a mile and a half, forming an extensive shoal area. This recession of the 18-foot contour is undoubtedly caused by the material brought down and deposited by the Menominee River and other rivers to the south of it emptying into Green Bay.

The littoral currents set to the southward along the western shore of Green Bay. At the mouth of the Menominee the river current heavily charged at times of freshet with sand is encountered. The river current is deflected to the southward and checked, and a deposit of sand commences.

No deposits of sand occur to the north of Menominee Harbor; they occur exclusively to the southward. A bar is thus formed to the southward of the harbor entrance, and unless removed by dredging will gradually extend across the harbor entrance.

Such a bar existed in 1892, as is shown by a plat of soundings taken through the ice in January of that year. It was removed during the following summer, and has not yet re-formed to such an extent as to be an obstruction to navigation. The formation of this bar between July, 1889, and January, 1892, a period of two and one-half years, was rapid, over 52,000 cubic yards being deposited in the channel in that time. (See Annual Report Chief of Engineers for 1892, part 3, p. 2174.) The improvement of Menominee River was commenced in 1891. The consequent disturbance of the river bed undoubtedly contributed largely to these deposits.

The present condition of the harbor of Menominee permits the choice of one of two plans of improvement:

First. The extension of the present harbor piers to the depth sought and dredging between them to the same depth.

Second. Dredging to the required depth between the present piers and beyond them to the 20-foot contour in Green Bay without extending the piers.

In the first plan the channel will be maintained at the proper depth by the protecting effect of the piers and by a certain amount of annual dredging. In the second plan the channel will be maintained entirely by dredging. In order to compare the value of the two plans it is only necessary to compare the annual dredging required by the first plan plus the annual interest on the cost of the pier extension with the annual dredging required by the second plan, because the dredging originally required to obtain the proposed depth will be about the same in both plans.

The distance from the present end of the south pier to the 20-foot contour is about 850 feet; at the north pier this distance is 150 feet.

To extend the piers will cost—

South pier:	
350 linear feet crib pier, 20 by 18¼ feet, at $42	$14,700
300 linear feet crib pier, 20 by 20¼ feet, at $45	13,500
200 linear feet crib pier, 24 by 22¼ feet, at $59	11,800
850 linear feet crib pier	40,000
North pier:	
150 linear feet crib pier, 24 by 22¼ feet, at $59	8,850
Total cost	48,850

But this would leave the south pier 800 feet in advance of the north pier. It is considered necessary in the case of piers of unequal length that the pierhead light shall be upon the longer pier. While the present south pier is 100 feet longer than the north pier, the width of opening being 400 feet, this difference in length is not material. Were the difference in length, however, 800 feet, it would be very objectionable to maintain the light on the shorter pier. And further, at all harbors on the west shore of Lake Michigan, without exception, the pierhead light is carried by the north pier. That Menominee Harbor may form no exception to this general rule, it would therefore be necessary to extend the north pier an additional 800 feet, or a total extension of 950 feet. This additional extension would cost, at $59 per linear foot, $47,200. The interest on this amount at 3½ per cent would be $1,652. To maintain an additional light on the south pier would cost probably about $1,000 annually. Considering the question of lights then alone, it would be more economical to maintain two pier lights than to extend the pier.

But it is believed that if the south pier were to be extended 800 feet in advance of the north pier the tendency would be to arrest the river current, and thereby cause a large deposit in the channel that would otherwise be deflected to the southward and away from the harbor entrance. Experience shows that, generally speaking, piers should be of approximately equal length.

The estimate for pier extension will then stand as follows:

850 feet south pier extension	$40,000
950 feet north pier extension	56,050
Total	96,050

At 3½ per cent per annum, the interest on $96,050 is $3,361.75.

It is impossible to calculate from the available data the exact amount of annual dredging required after the piers are extended.

It is equally impossible to determine the amount of dredging required to maintain the proposed depth if the piers are not extended under the second plan, but on the basis of the 52,000 cubic yards removed from in front of the piers in two years and a half, between July 1889, and January, 1892, it would cost about $3,300, or about as much as the annual cost of the first plan without the dredging.

I am therefore of the opinion that the best method of obtaining a 20-foot channel at Menominee Harbor is to dredge the channel to that depth from the river to the 20-foot contour in Green Bay without extension of the piers.

The present channel is somewhat narrow for large vessels, and especially at the angles near the inner ends of the piers, where numerous cases of grounding have occurred. A project for a deeper channel should, therefore, also provide for a wider one.

To obtain a channel 300 feet wide and 20 feet deep, extending from the 20-foot contour in Green Bay to the second angle in the channel as indicated on the map, a distance of 3,145 feet, will require the removal of about 98,000 cubic yards of material. To dredge the triangular area indicated will require the removal of about 37,000 cubic yards of material, or a total of 135,000 cubic yards, which at 10 cents will cost $13,500. The material to be removed is believed to be all sand, and about 30,000 cubic yards are outside the present pierheads.

In case the second plan is adopted, the open channel should be widened to about 600 feet in order to guard against an early formation of a bar across the entrance, requiring the removal of about 37,000 cubic yards of material in addition to the 135,000 cubic yards above mentioned, making in all 172,000 cubic yards, which at 10 cents per cubic yard will cost $17,200, or adding 10 per cent for contingencies, $18,920.

I am of the opinion that the proposed improvement is a worthy one and justified by the interests of commerce involved.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, December 3, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army. I concur with Captain Zinn in recommending the adoption of the second, or dredging, plan for the further improvement of this harbor, at a cost of about $19,000. Only about $7,000 of this will be expended outside the present pierheads. After the 20-foot channel has been obtained, it will probably cost about $3,000 annually to maintain it. Should it be found to much exceed this amount, then this cost should be compared with that of constructing and maintaining piers, and if the latter method is proven to be cheaper it could at any time be adopted. At present I think dredging should be tried.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

H H 25.

SURVEY OF HARBOR AT AHNAPEE, WIS.

[Printed in House Doc. No. 172, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 8, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated December 31, 1896, with map,* by Capt. George A. Zinn, Corps of Engineers, concerning survey of harbor at Ahnapee, Wis., provided for by terms of the river and harbor act of June 3, 1896.

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* Not reprinted. Printed in House Doc. No. 172, Fifty-fourth Congress, second session.

Captain Zinn states that the harbor facilities at Ahnapee may be increased at three places, indicated on map, in the following manner, viz:

A. Extending the 13-foot channel above the bridge, but reducing its width to 50 feet. This work involves drilling, blasting, and dredging, and is estimated to cost $19,266.

B. Dredging between the piers, removing 260 linear feet of dock, and excavating a basin 200 by 250 feet and 13 feet deep. Two sides of the basin will be available for shipping purposes, and should therefore be revetted by the owner of the property. The title to the site for the basin should be obtained without cost to the United States and conveyed to the Government before work is commenced. The cost of the basin is estimated at $11,594.

C. Constructing a basin in the lake, having an area of about 6½ acres, south of the present harbor entrance, by pier construction, dredging, and the removal of a portion of the south pier. The estimated cost of this basin is $33,203. This plan contemplates that 600 linear feet of dock, to connect the present south pier with the proposed pier, should be built by the owners of the adjacent property.

Captain Zinn states that the property at the sites of plans B and C is probably owned by a single individual, and that these plans would, therefore, afford no relief to the public or destroy the owner's monopoly.

Captain Zinn is of opinion, after considering the benefit to be derived by the public from the plans above proposed, together with the cost of maintenance, which can not be estimated with exactness, that plan A, although the most expensive, involving as it does completion of the present project estimated to cost $18,000, is preferable to the others; would be the least expensive to maintain, and, besides, would permit a greater number of landowners to use their property for shipping purposes.

For the reasons mentioned in his report he is of the opinion that nothing more than the completion of the present project and its maintenance should be undertaken by the United States, as this, when completed, will, in his judgment, fulfill all the requirements of a harbor at Ahnapee.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., December 31, 1896.

GENERAL: I have the honor to submit the following report and estimate for a harbor at Ahnapee, Wis., as required by section 9 of the river and harbor act of June 3, 1896. The tracing herewith shows the condition of this harbor in 1870 before any improvement was made by the United States Government, its condition above the drawbridge in November, 1875, and below the drawbridge in May, 1896.

The natural features of this harbor are such that it is unnecessary to make more extended or elaborate surveys than those above mentioned in order to determine the cost of improvement. The bed of the river is shown by the survey of 1875 to be rock overlaid with sand and mud for a distance of 2,800 feet from its mouth, and, inasmuch as but little work of improvement has been done since that date above the bridge, its condition may be assumed as unchanged.

The act of June 3, 1896, is indefinite in regard to this harbor, because it requires only that the cost of improvement shall be estimated at "harbor at Ahnapee" without stating what sort of harbor shall be provided. On account of this indefiniteness it may therefore not be out of place, before discussing the general question of the proper kind of harbor, to give an account of what has already been done at this place by the United States Government.

The present harbor of Ahnapee is situated at the mouth of the Wolf or Ahnapee River on the Lake Michigan or eastern side of the peninsula that projects between the waters of Green Bay and Lake Michigan, and is about 120 miles northward of Milwaukee. Its present relation to the nearest harbors north and south of it is quite different from that when its improvement was begun, and consequently the conditions governing its improvement are changed.

By direction of the Chief of Engineers, in 1870, an examination and survey was made of the mouth of Wolf River, with a view to a harbor at that point; in fact, the chief incentive to the undertaking was the desire to establish a harbor of refuge, because at that date the nearest available shelter for vessels was at Baileys Harbor, 40 miles north, and at Manitowoc, 43 miles south of Ahnapee.

It was found by this survey that at a distance of about 450 feet inside the mouth of the river an outcropping of limestone existed, with only about 4 feet of water over it at low stages of the lake. It was estimated that an excavation of more than 30,000 cubic yards of this rock would be necessary, in order to provide a channel 12 feet in depth, 150 feet in width, and 700 feet in length. Since this obstruction precluded the practicability of constructing a harbor of refuge inside the river, a project was formed for the construction of an outer harbor by means of a breakwater parallel to, and piers at right angles to, the shore, at an estimated cost of $370,000.

On the 3d of March, 1871, an appropriation of $25,000 was made for the improvement of Ahnapee Harbor, and on the 10th of June, 1872, another appropriation of $25,000, both of which were expended in constructing two parallel piers 230 feet apart at the river mouth, with a view to making a small harbor preparatory to the construction of the outer harbor. In 1873 and 1874 no appropriations were made for this harbor. In 1874 the citizens of Ahnapee, by permission of the Government authority, constructed a temporary pier between the piers proper to confine the river current within the limits of a channel but 50 feet in width, with a view to its assistance in removing the accumulation of sand forming the bar at the mouth by an anticipated acceleration in its velocity.

The act of Congress approved March 3, 1875, appropriated $25,000 for this harbor. At this date the north pier was 353 feet long, the south pier 620 feet long, and 15,390 cubic yards of material had been removed from the entrance channel by dredging, at a cost of $1,621.80.

Maj. D. C. Houston submitted a project, dated March 25, 1875, for the expenditure of the funds last appropriated, in which he recommended the modification of the project then in force by substituting for the outer harbor an inner harbor, which would be adequate to all local wants. He proposed to extend the south pier 50 feet and the north pier 300 feet, and to dredge a channel into the river. He states that "the existence of a ledge of rock in the river bed precludes the improvement of the river for any except local needs." A contract was made June 1, 1875, for the construction of the proposed pier extension. The United States dredge excavated 30,403 cubic yards of material from the channel between June and November, 1875.

On July 31, 1875, Maj. Henry M. Robert proposed a change in the plan of improving this harbor, in which he contemplated blasting a channel in the river through the rocky ledge. He says:

If a channel 50 feet wide and 12 feet deep were cut through this rock for a distance of about 700 or 800 feet vessels could run into the river, which forms a deep, large basin, the water being about 18 feet deep a half mile above, I understand. * * * If this ledge is cut through there will be a larger harbor available than there is any use for.

A Board of Engineers was convened by Special Orders, No. 131, Headquarters Corps of Engineers, October 7, 1875, to consider and report thereon. The Board met at Milwaukee, October 13, and directed Major Robert to make such a survey and examination by drilling, blasting, and dredging, as would afford data for an estimate of the cost of removing the rock.

This examination was carried on during October and November, and on the reassembling of the Board, December 15, the result was placed before it, accompanied by a project and estimate for the completion of an inner harbor by excavating the rock to 12 feet at low water for a length of about 750 feet, and extending the piers to 18 feet of water, with a breakwater across the widest part between the piers to within 90 feet of the south pier. This plan was reported upon favorably by the Board in its report of December 16, 1875. The Board states that—

The project submitted by Major Robert is entirely for local purposes. * * * But if Congress should continue to make small appropriations for this work, as heretofore, it would indicate an intention to improve the harbor for local purposes.

Major Robert states in his report to the Board, dated December 15, 1875:

The survey extends above the bridge to a distance of nearly a mile above the mouth of the harbor. The depth of water in the upper part is less than I was led to believe by common report.

The survey above mentioned is shown on the accompanying tracing.

Work was begun under this new project in the spring of 1876 and continued with some slight modifications to the present time.

In 1879 the citizens of Ahnapee raised by subscription an amount necessary to drill, blast, and dredge a channel from the channel below the bridge to deep water above the bridge.

Major Robert states in his annual report for 1882:

The accompanying letter from the mayor of Ahnapee shows that the Government is expected not only to construct a harbor, but also to preserve it against the results of local neglect and even direct local injury. In my reply * * * I declined to admit this theory. * * * In the above-mentioned case the work was finally done by the local authorities.

Captain Davis states in his annual report for 1887:

From the commencement much trouble has been experienced in carrying on the work at this place, owing to the fact that a private party claims to own the entire site of the harbor from the piers up to the highway bridge. This man was the owner of a landing pier, from which he derived a handsome revenue before the Government undertook the improvement of the harbor. He has built a warehouse just in rear of the south pier and has continued to make his own charges for all goods shipped by the steamer which stops there three times a week. As Ahnapee has no railroad communication, and as this man claims to own the land on both sides of the river, no one can reach the piers except as he may direct.

This has been the subject of various official reports (see House Ex. Doc. No. 259, Forty-eighth Congress, second session; also Annual Report of Chief of Engineers for 1877, 1878, and 1885).

It was doubtless due to those reports that the river and harbor act of August 5, 1886, appropriating $15,000 for continuing the improvement of Ahnapee Harbor, contained a proviso that none of the money as appropriated should be expended until wharfage over the Government piers should be made free.

The effort of the citizens for free wharfage has been unsuccessful, and consequently there have been no operations carried on at this harbor during the past fiscal year.

It is very desirable that work at this harbor should be resumed, and it is recommended that the proviso about free wharfage be omitted from future appropriations, as, after the channel has been excavated above the present site of the bridge, steamers can land above the limits of the land now claimed by the owner of the warehouse, and his monopoly will then be ended.

The present project is for the removal of rock up to the bridge only. The citizens have continued rock excavation some 200 feet farther up the river, making a channel about 30 feet wide and 7 feet deep.

Whenever work is resumed at this harbor, a modification of the project is recommended, with a view of making the channel above the bridge 50 feet wide and 12 feet deep, and that drilling and blasting at first be confined to the improvement of the channel begun by the citizens.

The condition above outlined continues to the present time, although the property in question has changed owners. The present owner has built a railroad from Ahnapee to connect with the railroad from Green Bay to Kewaunee.

The following appropriations have been made for this harbor:

1871	$25,000	1884	$15,000
1872	25,000	1886	15,000
1875	25,000	1888	5,000
1876	8,000	1890	6,000
1878	8,000	1892	7,000
1879	7,000	1894	5,000
1880	7,000	1896	5,000
1881	8,000		
1882	12,000	Total	183,000

by the expenditure of which 2,227 linear feet of pier has been built, 30,528 cubic yards of rock excavated, and 147,773 cubic yards of other material removed from the channel, both for original work and maintenance.

The present condition of the harbor, as shown by the survey of 1896, is as follows: The north pier is 1,102 feet long and projects 1,070 feet beyond the present shore line; the south pier, 1,125 feet long and projects 980 feet beyond the shore line. To complete the original project requires the extension of each pier an additional distance of 50 feet. The distance between the piers at entrance to harbor is 205 feet, and the minimum distance between them is 125 feet. The depth of water at the outer end of the piers is about 17 feet, which gradually diminishes, going inward, to 12 feet at the place where the rock excavation begins. Over the site of the rock excavation the depth varies from 15.6 feet to 2.9 feet. The rock excavation as proposed was not entirely completed. About 5,060 cubic yards in place remains to be removed, out of the original total of 18,000 cubic yards.

It was stated above that the present relation of this harbor to others in the vicinity had changed since the improvement was begun. The nearest harbor to Ahnapee on the north is the Sturgeon Bay harbor of refuge and Sturgeon Bay Canal, 15 miles distant; on the south is Kewaunee, 11 miles distant. Green Bay Harbor is 30 miles to the southwest, in Green Bay. These harbors are all better than Ahnapee, and give through transportation facilities, while the harbor at Ahnapee will never be used except to supply the local needs of an area of about 170 square miles of territory immediately in its vicinity. The existence of the rock bottom in Ahnapee Harbor will require an undue expenditure to provide it with harbor facilities even equal to those of neighboring cities. It would seem, therefore, that the Government has already provided a harbor amply large enough for the present trade of Ahnapee, provided the present project is completed by removing the sand overlying the rock and by removing the 5,060 cubic yards of rock referred to, for it is unnecessary to further extend the piers, now terminating in 17 feet of water, in order to maintain a depth of 12 feet in the entrance channel. To complete the present project will cost for drilling, blasting, and dredging—

5,060 cubic yards of rock, at $2.75	$13,915
For dredging 24,500 cubic yards of sand, at 10 cents	2,450
10 per cent for contingencies	1,635
Total	18,000

The harbor facilities at Ahnapee may be increased at three places indicated on the tracing by the letters A, B, and C, the cost at each being as follows:

A. By extending the 13-foot channel above the bridge, but reducing its width to 50 feet—

For drilling, blasting, and dredging 6,140 cubic yards of rock, at $2.75	$16,885
For dredging 6,300 cubic yards of mud, etc., at 10 cents	630
10 per cent for contingencies	1,751
Total	19,266

B. By dredging between the piers, removing 260 linear feet of the dock built by the city in 1889, and excavating a basin 200 feet by 250 feet and 13 feet deep. Two sides of the basin will be available for shipping purposes, and should therefore be revetted by the owner of the property. The title to the site for the basin should be obtained without cost to the United States and conveyed to the Government before the work is commenced. The cost of the basin will be as follows:

200 linear feet of pile pier, at $15	$3,000
Removing 260 linear feet of city dock, at $4	1,040
Dredging 65,000 cubic yards of sand, etc., at 10 cents	6,500
10 per cent for contingencies	1,054
Total	11,594

C. By constructing a basin in the lake, having an area of about 6½ acres, south of the present harbor entrance, by pier construction, dredging, and the removal of a portion of the south pier. The estimate for this basin is as follows:

For taking up 350 feet of south pier and resetting the seven cribs on the easterly side of the proposed basin, at $15	$5,250
For 625 linear feet of pile pier, at $25	15,625
For 350 feet pile revetment, at $7	2,450
For removing 200 feet of pile pier, at $4	800
For dredging 60,600 cubic yards, at 10 cents	6,060
10 per cent for contingencies	3,018
Total	33,203

The 600 linear feet of dock to connect the present south pier with the proposed pier should be built by the owners of the adjacent property, and would, with the proper filling between it and the shore line, afford dock facilities during fair weather.

It is believed that the property to be occupied by plans B and C is owned by a single individual, and these plans would therefore afford neither relief to the public nor destroy the owner's monopoly.

Plan B will give but little additional wharf space; plan C is open to the objection that it will be more expensive to maintain the depth by dredging and the longer piers in good repair; plan A is the most expensive, because it involves also the completion of the present project, but will be less expensive to maintain, and will permit other landowners to use their property for shipping purposes.

The exact cost of maintenance can not be estimated for any of these plans, and it may occur that the rock can be removed for less than the estimate given above.

Taking into consideration the benefit to be derived by the public from the plans above proposed, and the cost of maintenance, it appears that plan A is the best of the three. Considering only the local character of the commerce of this harbor, its natural disadvantages and close proximity to other harbors, it appears that nothing more than the completion of the present project and its maintenance should be undertaken by the United States, and I am of the opinion that the present project when completed will fulfill all the requirements of a harbor at Ahnapee.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

H H 26.

SURVEY OF SHEBOYGAN HARBOR, WISCONSIN, WITH A VIEW OF OBTAINING 21 FEET.

[Printed in House Doc. No. 327, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 26, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 27, 1897, with two maps,* by Capt. George A. Zinn, Corps of Engineers, giving the results of survey of harbor at Sheboygan, Wis., with a view of obtaining 21 feet, provided for by the river and harbor act of June 3, 1896.

The harbor of Sheboygan has been under improvement by the United States since 1852, the present project providing for securing and maintaining a channel depth of 19 feet. The plan of improvement presented by Captain Zinn for securing a depth of 21 feet includes the completion of the present project and a continuation of the means of improvement heretofore employed at this place, i. e., pier construction and dredging. The estimated cost of the work required is $75,000 in addition to the funds now available.

Captain Zinn, for reasons stated, is inclined to believe that the interests of commerce justify the proposed improvement at Sheboygan, and his views are concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

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* Not reprinted. Printed in House Doc. No. 327, Fifty-fourth Congress, second session.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 27, 1897.

GENERAL: I have the honor to submit the following report of a survey and estimate of the cost of improvement of "Sheboygan, with a view of obtaining twenty-one feet," in accordance with the requirements of section 9, river and harbor act of June 3, 1896.

The harbor of Sheboygan is situated at the mouth of the river of the same name, on the western shore of Lake Michigan. The present project for its improvement provides for securing and maintaining a channel 19 feet deep below the plane of reference of coast charts of Lake Michigan, which plane is 3.06 feet below the high water of 1838, extending from deep water in Lake Michigan to deep water in Sheboygan River. In furtherance of this project there have been built two approximately parallel pile and crib piers, the distance between them varying from a minimum of 238 feet to a maximum of 275 feet at entrance.

The north pier is 2,370 feet long and projects about 1,600 feet beyond the present shore line; and the south pier, when the gap of about 260 feet is closed between the old and the new work now in process of construction, as indicated on the map, will be 2,160 feet long, and will project the same distance beyond the present shore line. From 1880 to 1896, inclusive, 256,984 cubic yards of material have been removed from the channel between and beyond the piers in furtherance of the project and for maintenance of depth.

From August 30, 1852, to June 3, 1896, inclusive, there has been appropriated for this harbor $394,448.91, and there remained on hand July 1, 1896, $26,393.57, which is to be expended in removing the old south pier, in connecting the old and new work, and in dredging.

A survey required to determine the cost of improvement to obtain a channel 21 feet deep was made October 7 to 12, 1896, at the close of the dredging for the season, and consisted in taking soundings between and around the piers.

The depth at the outer end of the north pier was about 18 feet, and at the outer end of the south pier about 17 feet. The depth between the piers varies from 10 to 21½ feet, there being a 19-foot channel with a least width of 90 feet, and a 15-foot channel with a least width of 135 feet.

The rebuilding of a portion of the south pier, on the rectified line, will undoubtedly make that pier practically sand tight. Large quantities of sand pass through the older portion of the north pier. The most effective way of making this pier sand tight will be the construction of a sheet-pile revetment close to the pier on the channel side. About 1,000 feet of revetment will be required, the cost of which may be estimated at about $15 per linear foot, as determined by experience at Racine Harbor.

To complete the present project, therefore, requires the extension of the north pier 100 feet; the extension of the south pier 100 feet; the completion of the work now in progress at the south pier; 1,000 feet of sheet-pile revetment along the north pier, and about 60,000 cubic yards of dredging in the channel.

Annual dredging will be required to maintain the channel, and repairs from time to time will be required to maintain the piers.

The estimate for the completion of the present project is as follows:

Extending north pier 100 feet	$6,500
Extending south pier 100 feet	6,500
Work now in progress at south pier	10,000
1,000 feet of sheet-pile revetment along north pier	15,000
Dredging in channel, 60,000 cubic yards	6,000
Contingencies, 10 per cent	4,400
Total	48,400

There was on hand January 15, 1897, for this work, $21,500.

In order to study the changes which have taken place in the lake bottom in and around this harbor from year to year, to determine what effect pier construction has upon the forces at work along the lake shore, I have had a sketch prepared (copy herewith) showing the dates of pier extension and the contours from 1880 to 1896, inclusive, as determined by the surveys of July, 1880, June, 1885, July, 1889, April, 1891, March, 1893, April, 1895, and May, 1896. This sketch exhibits, as well as the incomplete data permit, the character of these changes.

It is unfortunate that so few of the surveys cover the territory beyond the influence of the piers.

These surveys show that as the piers were extended the contours advanced until 1890, at which time the 17-foot contour had retreated to the north pier head, and has since advanced with it; the 19-foot contour was in advance of the pier until 1892, since which time it has followed the pier head; the 21-foot curve has fluctuated, touching the pier head in 1894 and advancing afterwards.

This harbor is subject to constant deterioration, the forms and causes of which are discussed in my report* of January 26, 1897, on the survey of harbor at Kenosha.

A channel 21 feet deep may be obtained either by (1) dredging to the required depth an open, unprotected channel from the present pier heads to the 21-foot curve, or (2) extending the piers to the 21-foot curve or other points found to be necessary, and dredging between them to the required depth.

The average amount dredged annually for maintenance of channel from 1891 to 1896, inclusive, was about 27,000 cubic yards, which includes dredging done beyond as well as between the piers. The channel has been fairly but not thoroughly maintained during the period mentioned. It may be assumed that a 21-foot channel will require much more annual dredging than a 16-foot channel; it would be impossible to predict the amount.

Major Robert stated in his annual report for 1881:

> Until the piers are pushed out to deep water annual dredging will be required to maintain a channel, as the cut opened one season is nearly obliterated by the effects of the succeeding winter and spring storms.

It is certain that a 21-foot unprotected channel at this place would have to be redredged every spring. It is possible that it would be obliterated by a single storm, and could therefore not be depended upon for safe navigation.

On the other hand, it is not certain that the amount of annual dredging in the channel will be materially reduced by a mere extension of the piers, but on account of the uncertainty attending an open channel at this place it is necessary to extend the piers.

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* Printed in House Doc. No. 328, Fifty-fourth Congress, second session.

Adopting the plan proposed at Kenosha for the improvement of Sheboygan Harbor, there will be required (1) the completion of the present project; (2) the further extension of the north pier 100 feet to reach the 21-foot contour; (3) the further extension of the south pier 500 feet; (4) dredging in channel, 23,000 cubic yards; the estimate of cost being as follows:

(1) Completion of present project, over and above the funds on hand	$26,900
(2) Extension of north pier 100 feet	6,500
(3) Extension of south pier 500 feet	32,500
(4) Dredging 23,000 cubic yards, at 10 cents	2,300
Contingencies	6,800
Total	75,000

The interest upon the amount required to extend the piers, at 3½ per cent, is $1,365, which is much less than the annual dredging would cost if the channel were unprotected, as in the first plan mentioned.

The south pier should be extended first, in order to determine the effect upon the bar and the proper final length of the two piers.

Sheboygan Harbor is situated 50 miles north of Milwaukee. The nearest harbor on the north, at a distance of 25 miles, is Manitowoc, with a projected depth of 20 feet, which will be available during the latter part of the season of 1897; on the south, at a distance of 25 miles, is Port Washington, a very small harbor with little trade and a projected depth of 13 feet.

The population of Sheboygan is about 22,000, of Manitowoc about 10,000. Sheboygan, as well as Manitowoc, has rail communication to the north, south, and west.

The commerce of Sheboygan in 1895 placed it fourth in the list of harbors north of Chicago, and it was somewhat greater than that of Manitowoc, although the building of car ferry ships and an elevator in 1896 at the latter place will stimulate navigation to a great extent. One of the principal imports at Sheboygan is coal carried in deep-draft vessels and forwarded west by rail. An increase in depth will be of value to the commerce at this place.

It may seem unnecessary to have two deep lake harbors so near together as the two places mentioned, but it is impossible to predict the line which commerce will follow in future, so that while it could not be said that commerce absolutely requires 21 feet at Sheboygan, I am inclined to believe that the interests of commerce justify the proposed improvement.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers U. S. A.
(Through the Divison Engineer.)

[First Indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, February 20, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with Captain Zinn in the view that the harbor of Sheboygan, Wis., is worthy of the proposed improvement by the United States Government.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

H H 27.

SURVEY OF MILWAUKEE HARBOR, WISCONSIN.

[Printed in House Doc. No. 61, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated November 23, 1896, by Capt. Geo. A. Zinn, Corps of Engineers, giving the results of a survey of harbor at Milwaukee, Wis., "with a view to obtaining a channel twenty-one feet deep," made to comply with provisions of the river and harbor act of June 3, 1896.

The proposed method for obtaining a 21-foot channel at the harbor of Milwaukee is to dredge the present channel to the width of 225 feet between the piers and 600 feet wide from the pierheads to the 21-foot contour in Lake Michigan.

It is estimated that this plan of improvement will cost $12,000 for original work and about $3,000 per year for maintenance.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., November 23, 1896.

GENERAL: I have the honor to submit, in compliance with instructions contained in printed letter from office of the Chief of Engineers, United States Army, dated Washington, D. C., September 5, 1896, the following report upon a survey of harbor at Milwaukee, Wis., and an estimate of the cost of improvement with a view to obtaining a channel 21 feet deep:

The Milwaukee River empties into Milwaukee Bay through an artificial channel cut through the point which overlapped the original river mouth. Milwaukee Bay is an indentation of the western shore of Lake Michigan, about 2 miles deep and 7½ miles long between headlands.

The entrance is protected by approximately parallel piers 1,720 feet long, 284 feet apart at the outer end and 258 feet at the inner ends, projecting about 1,600 feet beyond the present shore line. The present southerly end of the breakwater inclosing the Milwaukee harbor of refuge is now distant in a north-northeasterly direction about 6,400 feet from the outer ends of the piers, and when completed to its projected length its southerly end will be 4,200 feet from the pierheads. Measuring on a line in the direction of the harbor piers, the distance to a line in prolongation of the breakwater is about 2,700 feet.

The meaning of the word "harbor" in the acts of Congress is not defined, but it has been assumed in this district to be the artificial channel, together with the piers built for its protection, extending from deep water in the lake to deep water in the river, to which the artificial channel gives entrance.

The harbor of Milwaukee is naturally sheltered by the headlands, and the breakwater affords additional shelter from northeasterly storms, which are the most severe in this part of the lake.

A survey was made September 14–22, 1896, of the harbor, the results of which are shown on the inclosed tracing,* the figures representing depths below a plane 3.06 feet below the plane of reference of the United States Lake Survey. It is to be noted that just before the date of the survey a dredging contract had been completed, restoring the channel to a depth of 19 feet for a width of about 160 feet, from the river to the lake.

The present project calls for a channel 19 feet deep below the above-mentioned plane. The piers have been completed to their projected length, and now terminate in 18 feet of water.

The material of the bottom, to a depth of 21 feet, is believed to be chiefly clay overlaid with from 1 to 2 feet of sand.

There is no appreciable littoral drift at Milwaukee Harbor, judging from the facts (1) that there is no bar formation at the outer end of either pier, and (2) that there are no shore accretions on either side of the harbor to any great extent. The Milwaukee River is not of great extent and the discharge is not large. The city sewers empty into it, however, and there is always more or less sediment brought down and deposited in the channel.

From 1890 to 1896, inclusive, a period of seven years, and characterized by being a period of the lowest water in the history of this harbor, there has been dredged from the channel, in maintaining the above project, 95,800 cubic yards, an average of about 13,700 cubic yards per annum. This amount covers the dredging both within and beyond the pierheads, but the necessary data is lacking to determine just how much of this was removed from either place. It is also impossible to determine the source from which these deposits have come, although storms from the northeast, east, and southeast, the littoral current, and the river sediment all contribute a certain amount.

In order to obtain a permanent channel 21 feet deep at the harbor of Milwaukee, it will be necessary, first, to dredge to that depth in the present channel from the river to the 21-foot contour in the lake; second, to maintain this channel either by annual dredging, by protecting it on both sides by piers, or by both these means. It is estimated that to obtain a channel 21 feet deep and 225 feet wide will require the removal of 58,000 cubic yards of material, of which 10,000 cubic yards are beyond the present pierheads. Six hundred feet of this channel will be unprotected by the present piers, and therefore subject to destruction by littoral drift and wave action along the bottom. To prevent this by extending the present piers will require an addition of 600 feet to each pier, at an estimated cost of $78,000, being at the rate of $65 per foot.

It is impossible to determine without a series of annual observations the rate at which the channel would shoal if unprotected by piers, but it would not be much greater than the average annual amount given above, of 13,700 cubic yards. To determine, therefore, which method should be adopted, it seems only necessary to compare the cost of building the piers and maintaining them and that of the annual dredging required.

The interest on the cost of pier extension—$78,000, at 3½ per cent per annum—would be $2,730. An annual expenditure of this amount,

* Not printed.

based upon the last contract price of 14½ cents per cubic yard, would pay for the removal of about 18,800 cubic yards of material, or 5,100 cubic yards more than the above-mentioned average amount removed to maintain the channel from 1890 to 1896, inclusive. In case this improvement is undertaken it is therefore advisable to maintain the channel for a few years by dredging rather than to extend the piers, at least until the rate of channel obliteration can be reasonably well determined by proper observations. If the rate is greater than has been assumed, then another comparison may be made in which the annual deterioration of the piers should also be taken into account. Even if the piers should be extended, a certain amount of shoaling between them would still take place, and the cost of its removal would have to be added to the above.

If the channel should be deepened to 21 feet without extending the piers another fact must be taken into consideration. Washing in from the sides of the dredged channel would undoubtedly occur immediately and continue until the slope became quite flat, perhaps equal to the natural slope of the lake bottom, and consequently the channel would be injured to some extent. To provide against this immediate danger the channel beyond the pierheads should be made much wider than between the piers; an exact calculation would be useless, but a width of 600 feet will be ample. The extra dredging required by this increased width will be about 30,000 cubic yards, in addition to the 58,000 cubic yards previously mentioned, or a total of 88,000 cubic yards for the entire channel, which, at 12 cents per cubic yard, with contingent expenses added, will cost $12,000. The reduced price of 12 cents is assumed, as it is believed the larger amount of dredging will invite competition that can not be expected for the smaller amount of annual dredging. I am therefore of the opinion that the proper method to obtain a 21-foot channel at the harbor of Milwaukee is to dredge the present channel to the width of 225 feet between the piers and 600 feet wide from the pierheads to the 21-foot contour, a distance of about 600 feet.

It is estimated that this plan will cost $12,000 for original work and about $3,000 per year for maintenance.

The commerce of the harbor of Milwaukee is large and second on Lake Michigan in importance to Chicago alone. The interests of commerce involved justify the proposed improvement, and it is my opinion that it is a worthy one.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, November 27, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

H H 28.

SURVEY OF HARBOR AT RACINE, WISCONSIN, WITH A VIEW TO OBTAINING A CHANNEL 21 FEET DEEP.

[Printed in House Doc. No. 326, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 26, 1897.

SIR: I have the honor to submit the accompanying copy of report dated January 27, 1897, with two maps,* by Capt. George A. Zinn, Corps of Engineers, of the results of a survey of harbor at Racine, Wis., with a view to obtaining a channel 21 feet deep, made to comply with the requirements of the river and harbor act of June 3, 1896.

The harbor of Racine is now being improved by the United States under a project providing for securing and maintaining a channel 17 feet deep. To complete this project requires that the piers shall be made sand tight, that 3,500 cubic yards of material shall be removed from the channel, and that the south pier be extended 250 feet. The last item is now under contract.

The plan of improvement now proposed by Captain Zinn under the act of 1896 contemplates securing a depth of 21 feet, and its estimated cost is as follows:

Completion of present project over and above the funds now on hand	$13,435
Extension of south pier 300 feet	16,300
Dredging	10,600
Contingencies	4,165
Total	44,500

In connection with the further improvement of the harbor at Racine, Captain Zinn suggests the removal of a part of the present north pier and of the docks adjacent thereto, building new docks, and dredging the area outside this new line. This additional work, exclusive of building new docks, which should be done by private individuals or by the city, will, it is estimated, cost $7,150, and this amount should be added to the estimate given above, making a total of $51,650 for securing a 21-foot channel in the manner proposed.

Captain Zinn states that the commerce of Racine is large, and justifies, in his opinion, the proposed improvement. This opinion is concurred in by Col. Henry M. Robert, Corps of Engineers, division engineer.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 27, 1897.

GENERAL: I have the honor to submit the following report of a survey and estimate of the cost of improvement of "harbor at Racine with view to obtaining a channel 21 feet deep," in accordance with

* Not reprinted. Printed in House Doc. No. 326, Fifty-fourth Congress, second session.

the requirements of section 9, river and harbor act, approved June 3, 1896:

The harbor at Racine is situated at the mouth of the Root River, on the western shore of Lake Michigan, and is understood to mean the channel leading from deep water in the lake to deep water in the river.

The present project for the improvement of this harbor provides for securing and maintaining a channel 17 feet deep below the plane of reference of the United States lake survey coast charts, which plane is 3.06 feet below the high water of 1838. In furtherance of this project there have been built two approximately parallel crib piers. The distance between the piers at the entrance is 250 feet; at a point 600 feet west of the outer end of the north pier it is 270 feet, and at the inner end of the harbor it is 160 feet. The north pier is 1,760 feet long and projects about 1,150 feet beyond the present shore line. The south pier, when the extension of 250 feet now under contract shall have been completed, will be 1,720 feet long and will project about 1,600 feet beyond the present shore line.

From 1880 to 1896, inclusive, 184,249 cubic yards of material were removed from the channel between and beyond the piers in furtherance of the project and for maintenance.

From June 15, 1844, to June 3, 1896, there has been appropriated for this harbor $336,785, of which there remained on hand unexpended July 1, 1896, $27,418.20, which is to be used for extending the south pier by contract, for dredging in the channel, and for repairs to piers.

The survey required to determine the cost of improvement to obtain a channel 21 feet deep was made September 24 to October 2, 1896, at the close of the dredging for the season, and consisted in taking soundings between and around the piers. The results are shown on the tracing herewith.

The depth of water at the outer end of the north pier is about 19 feet, and at the outer end of the south pier is about 14 feet. When the extension now under contract is completed the outer end will rest in a depth of about 15½ feet.

The depth between the piers varies from 9 feet to 21.3 feet, there being a 17-foot channel, with a least width of 60 feet, and a 15-foot channel, with a least width of 110 feet.

The older portions of both piers are in a dilapidated condition, and have permitted the almost unobstructed passage of sand through the intervals between the cribs and even through holes in the cribs themselves. It is thought that the repairs now in progress on the north pier will render it practically sand tight. Similar repairs should be made to about 900 feet of the south pier, and from experience with the north pier the cost is estimated at about $15 per linear foot.

In 1888 the original 13-foot channel was deepened to 17 feet for the full width of channel. (See Annual Report Chief of Engineers, 1889, Part III, p. 2076.) The following shows the amounts dredged annually since 1889 for maintenance of this channel, and also the condition of the channel.

1889.—No dredging done during year. In May there was a channel 16 feet deep with a minimum width of 85 feet.

1890.—In April there was a channel 14 feet deep with a minimum width of 70 feet. Later in the year 9,627 cubic yards were dredged, forming a channel 17 feet deep and 50 feet wide.

1891.—In April, channel 14 feet deep, minimum width 46 feet; 14,273 cubic yards of material dredged during year, forming channel 16 feet deep and 80 feet wide.

1892.—In April, channel 14 feet deep, minimum width 60 feet. Entrance about one-half closed by a bar with a maximum depth of 15 feet over it. No dredging done in 1892.

1893.—In April, channel 13 feet deep, minimum width of 60 feet; 15,047 cubic yards dredged, forming a channel 16 feet deep and 80 feet wide.

1894.—In March, channel 14 feet deep, minimum width of 55 feet. Entrance two-thirds closed by a bar with a maximum depth of 15 feet over it; 8,964 cubic yards dredged, forming a channel 15½ feet deep and 60 feet wide.

1895.—In April, channel 14 feet deep, minimum width 45 feet. Entrance two-thirds closed by a bar with a maximum depth of 15 feet over it; 21,372 cubic yards dredged, and in August, on completion of dredging, a channel 14 feet deep, minimum width of 100 feet, and a channel 17 feet deep and a minimum width of 35 feet. In October the minimum widths of channels were as follows:

	Feet.
14-foot channel	100
15-foot channel	95
16-foot channel	55
17-foot channel	18

1896.—In April the 15-foot channel had a minimum width of 20 feet and the 14-foot channel had a minimum width of 50 feet; entrance about one-third closed by the bar, with a maximum depth of 15 feet over it; 29,639 cubic yards dredged, and at close of dredging there was a channel 17 feet deep with a minimum width of 60 feet.

To complete the present project requires that the piers shall be made sand tight, that 3,500 cubic yards of material shall be removed from the channel, and that the south pier shall be extended 250 feet. The last item is now under contract.

To maintain the depth will require annual dredging, and the piers will need repairs from time to time.

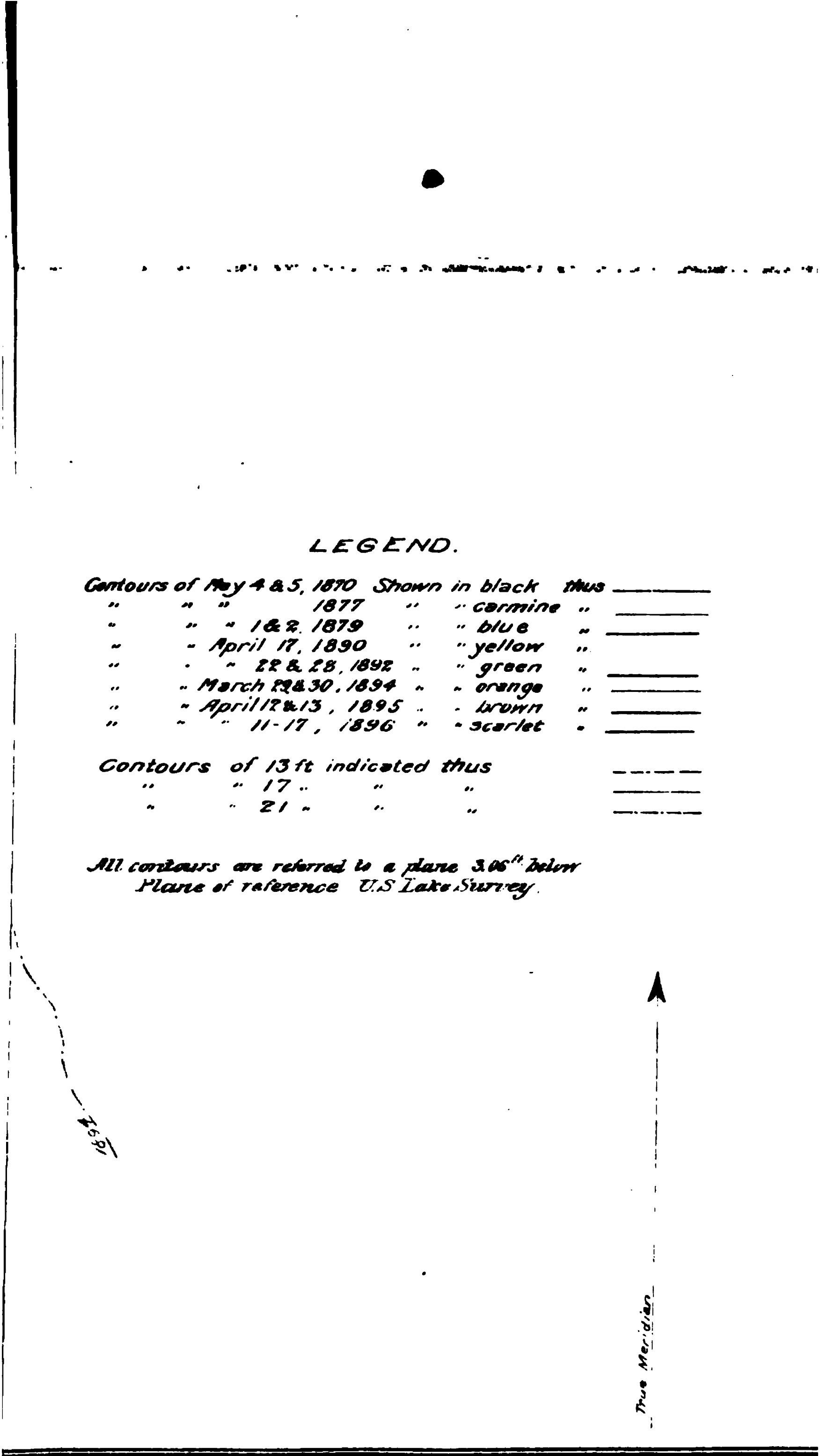
The estimated cost of completing the present project is as follows:

(1) 900 feet of sheet piling, at $15	$13,500
(2) Extending south pier 250 feet	12,000
(3) Dredging 3,500 cubic yards, at 10 cents	350
Contingencies, 10 per cent	2,585
Total	28,435

There was on hand January 15, 1897, for this work, $15,000.

In order to study the changes which have taken place in the lake bottom in and around this harbor from year to year, and thus determine, if possible, the effect of pier construction upon the forces at work along the shore in this vicinity, I have had a sketch prepared (copy herewith) showing the dates of pier extension and the contours from 1870 to 1896, inclusive, as determined by the surveys of May, 1870, May, 1877, May, 1879, April, 1890, April, 1892, March, 1894, April, 1895, April, 1896; and inasmuch as these surveys give as much information as those of other dates, the sketch exhibits, as well as the incomplete data permits, the character of the movement of the lake bottom.

These surveys show that the contours advanced with the piers, the 13-foot contour being always in rear of the north pierhead. In 1893 the 17-foot contour is in rear of it, and in 1895 the 21-foot contour is also in its rear. The total advance of the shore line on the north side of the harbor since the work of improvement was begun in 1845 is about 725 feet. To the south of the harbor erosion takes place, and which it has been necessary to prevent by the construction of protection works put in by the city of Racine.


LEGEND.
Contours of May 4 & 5, 1870 Shown in black thus
" " " 1877 " " carmine "
" " " 1 & 2, 1879 " " blue "
" " April 17, 1890 " " yellow "
" " " 22 & 28, 1892 " " green "
" " March 29th & 30, 1894 " " orange "
" " April 12th & 13, 1895 " " brown "
" " " 11-17, 1896 " " scarlet "
Contours of 13 ft indicated thus
" " 17 " "
" " 21 " "
All contours are referred to a plane 3.06 ft. below
Plane of reference U.S. Lake Survey.
1894
True Meridian

Deterioration at this harbor consists in (1) the advance of the foreshore, (2) the formation of a bar in front of the entrance, (3) shoaling between the piers, the causes of which are discussed in my report* of January 26, 1897, on the survey of harbor at Kenosho.

Two plans of improvement are possible: (1) Dredging and maintaining an open unprotected channel from the river to the 21-foot contour in the lake; (2) extending the piers to the proper point and dredging between them to the required depth.

The dredging at this harbor from 1880 to 1896, inclusive, was 184,249 cubic yards removed from the channel between and beyond the piers. The channel has been insufficiently maintained, and at numerous times vessels have been prevented from entering the harbor on this account. The bar at the outer end forms rapidly and unless removed annually forms an obstruction which at times reduces the width of entrance two-thirds. It would be unsafe for vessels to use a channel which might be obliterated by a single storm, and it is therefore necessary to extend the piers.

Adopting the plan of improvement proposed for Kenosha Harbor, it will be necessary in order to obtain a channel 21 feet deep, (1) to complete the present project, (2) to extend the south pier 300 feet, (3) to dredge to 21 feet between the piers. The estimate of cost is as follows:

(1) To complete present project over and above the funds on hand	$13,435
(2) To extend south pier 300 feet	16,300
(3) To dredge 106,000 cubic yards, at 10 cents	10,600
Contingencies	4,165
Total	44,500

The funnel-shaped entrance to this harbor has always been a serious defect, and its correction should be included in any plan for further improvement. This correction may be accomplished, as shown on the accompanying tracing, by removing a portion of the present north pier and of the docks adjacent thereto, rebuilding new docks on a line commencing at a point on the channel face of the pier, about 100 feet west of the west face of the light-house crib, and extending westward to a point on face of dock about 50 feet west of the west line of North Michigan street extended to the face of the present dock, and dredging the area left outside of this line to 21 feet. The land to be removed should be given to the United States by the city of Racine, and the new dock should be built by private individuals or the city, as the city of Sheboygan has recently done at that harbor. The dredging and removal of the old pier should be done by the United States.

The estimated cost of this improvement is as follows:

Tearing out old pier and dock	$2,000
Dredging 45,000 cubic yards, at 10 cents	4,500
Contingencies, 10 per cent	650
Total	7,150

This amount should be added to the estimate above, $44,500, making a total of $51,650 for obtaining a 21-foot channel.

The harbor of Racine is situated 62 miles north of Chicago and 23 miles south of Milwaukee. The nearest harbor on the north is Milwaukee and on the south Kenosha. Racine has a population of 22,000, and is quite a manufacturing place. In commerce by all ways of transportation it ranks next to Menominee or next but one to Milwaukee, and is connected by rail with the North, South, and West. Situated as it is, between Milwaukee and Chicago, each having much greater facilities

* Printed in House Doc. No. 328, Fifty-fourth Congress, second session.

for transacting through business, it may not be so important to have a deep-water harbor at this place, yet its present commerce is large, and justifies, in my opinion, the proposed improvement.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, February 20, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the views of Captain Zinn, that the harbor of Racine, Wis., is worthy of improvement by the United States Government as proposed.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

H H 29.

SURVEY OF HARBOR AT KENOSHA, WIS., WITH A VIEW TO OBTAINING A CHANNEL 21 FEET DEEP AND BASIN 20 FEET DEEP.

[Printed in House Doc. No. 328, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 26, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 26, 1897, with two maps,* by Capt. Geo. A. Zinn, Corps of Engineers, giving the results of a survey of harbor at Kenosha, Wis., with a view to obtaining a channel 21 feet deep and basin 20 feet deep, made to comply with the provisions of the river and harbor act of June 3, 1896.

The harbor at Kenosha is now in course of improvement by the United States under a project which provides for securing and maintaining a channel depth of 16 feet. Captain Zinn states that the simplest plan for obtaining the increased channel depths contemplated in the act of 1896 would consist in completing the present project, in extending north and south piers, and in dredging. The cost of the work, in addition to the funds already on hand (about $20,000), is estimated at $87,000. Under this plan, however, the distance between the piers would be entirely inadequate, and Captain Zinn expresses the opinion that should a plan for a 21-foot channel depth be adopted the present project should be abandoned, so as to avoid further extension of the existing piers on the present lines, and to apply the funds thus saved to rebuilding the north pier in its proper position, as shown upon map.

In conformity with these views there is presented an alternate plan of improvement, which contemplates the completion of the present project (omitting repairs and extension of north pier), extension of south

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* Not reprinted. Printed in House Doc. No. 328, Fifty-fourth Congress, second session.

pier, removal and rebuilding of north pier, and dredging. The cost is estimated at $125,000. The work of dredging in the channel includes the removal of a strip of land for the purpose of widening the channel west of the shore line. This land is private property, and should be donated to the United States. After its removal the work of revetment thereat should be done by the city authorities or by property owners.

Captain Zinn, in closing his report, states as follows:

The area of the interior harbor at Kenosha is small, and any enlargement of it would be expensive. The present harbor facilities are by no means all in use, and it appears that a depth of 16 feet at the entrance will be ample for some years. It would be more advisable, consequently, for the General Government to complete the present project, and then wait for several years to see whether commerce will make use of the present facilities or demand a greater depth before entering upon a new project which is not now clearly seen to be necessary.

I am of the opinion that the present interests of the commerce involved do not justify the proposed improvement.

This opinion is concurred in by the division engineer, Col. Henry M. Robert, Corps of Engineers.

Very respectfully, your obedient servant.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., January 26, 1897.

GENERAL: I have the honor to submit the following report of a survey and estimate of the cost of improvement of "harbor at Kenosha, with a view to obtaining a channel 21 feet deep and basin 20 feet deep," in accordance with the requirements of section 9, river and harbor act approved June 3, 1896.

The harbor at Kenosha is situated at the mouth of Pike Creek, on the western shore of Lake Michigan, and is understood to be the channel leading from deep water in the lake to deep water in the creek, or, to speak more accurately, to deep water in the basin, which is the southern section of an extensive bayou, separated from the lake by a point of sand and into which the creek discharges.

The present project for the improvement of this harbor provides for securing and maintaining a channel 16 feet deep below the plane of reference of coast charts of Lake Michigan, and which plane is 3.06 feet below the high water of 1838, and for dredging in the basin to provide a turn around for vessels about 4 acres in area. In furtherance of this project there have been built two approximately parallel crib piers, the distance between them varying from 142 feet to 165 feet. The north pier is 1,750 feet long and projects about 800 feet beyond the present shore line; the south pier will be 1,366 feet long when the extension of 250 feet now under contract shall have been completed, and will then project about 1,170 feet beyond the present shore line. From 1880 to 1896, inclusive, 111,256 cubic yards of material were removed from the channel and 40,848 cubic yards from the basin in furtherance of the project and for maintenance of depth.

From March 15, 1844, to June 3, 1896, there has been appropriated for this harbor $299,307.41, and there remained on hand June 30, 1896, a balance of $26,597.91, which is to be expended for extending the south pier under the present contract, for dredging, and for repairs to piers.

The survey required to determine the cost of improvement to obtain the depths of 21 and 20 feet was made December 7–8, 1896 after the dredging in progress during the season of 1896 was completed, and consisted mainly in taking soundings to determine the depth in the entrance channel and the basin and in making five test holes to a depth of 23 feet to determine the character of the material to be dredged in the basin. The location of the holes is shown on the map. The material found in them was all mud, and it is a fair assumption that such will be the material to be removed from the basin to give 20 feet in depth. The material in the channel between the piers is chiefly sand, and it is therefore expected that no hard material will be encountered in dredging to a depth of 21 feet either in channel or basin. The depth between the piers varies from 8½ to 20½ feet, there being a 16-foot channel with a least width of 90 feet and a 15-foot channel with a least width of 110 feet. The depth of water at the outer end of the north pier is about 20 feet and at the south pier about 15 feet, but the outer end of the extension now under contract will rest in a depth of 16 feet.

The depth in the basin over an area of 4 acres, inclosed by the broken red lines, will be not less than 16 feet after the completion of the existing dredging contract.

The inner portions of both piers are in such condition as to readily permit the passage of sand through them, and to this cause may be ascribed in a large measure the constant shoaling in the channel. The cribs composing this portion of the piers have no foundation of stone or piles, but rest upon the original bottom. The piers at this point are less than 150 feet apart.

On December 8, 1885, a section of the westerly end of the north pier about 60 feet long was carried away during a severe storm and has never been restored. Erosion of the adjacent bank commenced immediately and has continued until in April, 1896, the bank had been washed away for a distance of 75 feet back from the shore line of 1885, the eroded material settling in the basin and channel. This bank is clay and rises from 8 to 10 feet above datum.

From the inner end of the north pier as originally constructed there is a line of sheet piling extending in a northwesterly direction for a distance of about 350 feet, built for the protection of the adjacent bank, now in an extremely dilapidated state and utterly worthless for its original purpose.

To complete the present project requires that the piers should be made sand tight; that the shore line at the inner end of the north pier should be protected, and that the north pier should be extended 150 feet, in addition to the extension of the south pier 250 feet and a small amount of dredging, both of the latter being now under contract. The estimate for this work is as follows: Making the old piers sand tight, 1,800 feet of sheet piling, at a total estimated cost of $18,000; protecting the shore line at the inner end of the north pier, 140 feet of sheet piling, at a total estimated cost of $1,120; extending the north pier 150 feet, at $9,750; extending the south pier 250 feet, at $13,000; dredging, $2,000; office expenses, $2,000; making a total of $45,870. There is on hand, January 15, 1897, for this work $20,800, and a contract has been made for the south pier extension.

Besides keeping the piers in good repair, annual dredging will be required to maintain the projected depth between them and in the basin, the exact amount of which can not be estimated, although from 1887 to 1896 the removal of 111,256 cubic yards (11,126 cubic yards per annum) resulted in the maintenance of a fairly good channel.

In order to form a project for further improvement at this harbor or for obtaining an increased depth in the entrance channel, it is necessary to know what forces are at work in this vicinity upon the lake bottom and to understand how they act. For the purpose of making a study of this question I have had a sketch prepared from surveys of this harbor showing the shore line and the contours, representing 13, 17, and 21 foot depths in the years 1870, 1877, 1879, 1890, 1892, 1894, 1895, and 1896, these years having been selected because the surveys are more complete than those of other years. It will be seen from this drawing how imperfect and incomplete even this data is for the formulation of a clear theory and a simple project of improvement. The surveys were limited to the immediate vicinity of the piers, and show, therefore, the characteristics of the bottom at that place and not its relation to the general shore line to the north, south, or east of the harbor. No observations have ever been taken by the Engineer Department to determine the presence of lake currents, the general direction of the wind, the amount of material carried in suspension, or any other physical data except the changes in level of the lake surface. Some of this information has been obtained by the Weather Bureau, affording a means, in connection with the surveys by the Engineer Department at all the harbors on the west shore of Lake Michigan, of forming a theory which I desire to give for what it is worth, leaving to future observations its overthrow or establishment. The importance of securing better and deeper channels at all lake harbors amply justifies the cost of observations required to verify this theory.

The first surveys of harbors in this district were made in 1836 at Milwaukee, Sheboygan, Manitowoc, and Kewaunee by Lieutenants Center and Rose, Corps of Engineers. The mouths of these harbors were shown to be obstructed by bars having in general a direction parallel to the shore line, or protruding outward very slightly. No further surveys were made until after improvements had been begun, so that it is impossible to say positively whether the configuration above described was permanent or not. It is known, however, that the river currents were and are very weak at all times except occasionally during a freshet or storm, and that the river mouths were at times almost closed by the bars. Another fact which may be of importance is that at several harbors the peninsula which separates the river in the last part of its course from the lake is attached to the main land at its southern end, except at Milwaukee, where the case is reversed. While the evidence is seen to be very scant, I believe that those conditions were more or less permanent, and indicate the presence of forces constant in direction, but variable in force. The shape of the bars indicates that these forces are almost solely the waves and currents in the lake.

The plan of improvement adopted at all the harbors, and begun in nearly every instance at a very early date, consisted in constructing two approximately parallel piers of equal length from the shore line at or near the river mouth to deep water in the lake, usually also on the shortest line between the two, and dredging a channel to the proper depth between them. By comparing surveys of different dates the effects of pier construction are readily seen, and consist in general (1) of an advance of the foreshore in the vicinity of the piers, (2) of a decided change in the shape of the contours about the ends of the piers, and (3) of the formation of a bar at their outer ends. There is also a constant shoaling in the channel between the piers. The same forces are still at work, changed slightly in direction and energy, though still more or less constant, a condition which should have been expected. The problem of improvement, which in the beginning appeared to be simply the maintenance of a channel from the river to the lake, consists now in preventing (1) a further advance of the foreshore, (2) the formation of the bar at the outer end of the piers, and (3) the shoaling between the piers. We are prepared, therefore, to question both the proper direction and relative positions of the piers.

It is easily seen that an open channel through the bar from the river to the lake would soon be obliterated by the waves and currents; that the next step is to construct piers for its protection, and that inasmuch as the contours are approximately parallel to the shore line, the shortest piers will be at right angles to the shore line and of equal length. The custom has been followed, however, of making additions to the north pier first, so it has happened for many years that the north pier was considerably longer than the south pier. In fact, at only a few periods have they been of equal length, and only once has the south pier been the longer one.

The adopted plan has never been entirely successful, for the reasons previously given, and whether a more successful plan can be devised is a question which can not be definitely decided until our knowledge of the forces at work is much more complete.

The Weather Bureau made an investigation of the currents of the Great Lakes in 1892, 1893, and 1894, the results of which were published in 1895. The observations established conclusively the existence of constant currents in Lake Michigan, varying only in velocity and occasionally in direction. The main current passes south along the western shore and north along the eastern shore, with secondary currents across the lake and in reverse directions at various places. An eddy near Manitowoc is of interest in this connection. The following quotations from the report mentioned will show the opinions of the Weather Bureau in regard to the currents and their causes:

> The prevalence of westerly and especially southwesterly winds would also favor the persistence of the currents, and also the body current would favor it. When the surface of water is set in motion by a current of air, this motion is gradually communicated to the strata below, if the wind persists. Having been communicated to the strata below, a change of wind of briefer duration would not easily check the motion below the surface.
>
> It appears probable, therefore, that while the primary currents have good persistence in direction, they do not have very much constancy in velocity, while the secondary may fluctuate greatly in velocity and some in direction. * * *
>
> It appears, therefore, that here, as in so many other places in the northern hemisphere, the deflection toward the right hand, due to the earth's rotation, gives form to the current system.

I am inclined to believe, however, that these currents are directly due to winds accompanying storms of low or high barometer. The Great Lakes are of sufficient area to be acted upon by different parts of a storm at the same time, and it is therefore possible to set up the whirls directly in them, the motion of which might be temporarily checked by contrary winds, but would again be renewed by succeeding storms or cyclonic motions of the atmosphere. The relation of storm centers or points of lowest atmospheric pressure to the direction of the winds would also result in the same currents in the lake.

The average storm track as given in the Special Notice to Mariners, published monthly by the Hydrographic Office for September, 1896, passes across Lake Michigan just north of Sturgeon Bay. Storms approaching at Kenosha, or in fact any harbor on the west shore, therefore, generally begin with a southwest wind, changing to west and then to northwest. None of these winds would produce much sea on that shore. When a storm approaches with its center nearer to the middle part of the lake, the west shore would feel the effect of the southeast, east, and then the northeast winds. Now, the last wind adds its intensity to that of the current already in existence, and has in addition a greater reach across the lake at the southernmost harbors, so that the greatest disturbance may be expected from that direction. In other words, the beach around the harbor entrance will conform to the influence of northeast storms, and will show a more or less constant configuration. The comparison of surveys shows this to be actually the case. The only exception being at Manitowoc and Two Rivers, where the eddy previously mentioned exerts a contrary influence.

We may therefore expect sand to be brought from the north by both waves and currents, or rather by both combined, for it can hardly be believed that the general currents are sufficiently rapid to carry much material in suspension.

The surface of Lake Michigan, in whole or in part, is subject to fluctuations in surface level, arising from a variety of causes, such as variation in rainfall, and surface evaporation, in atmospheric pressure, and the direction and velocity of the wind. From 1880 to 1886 the general surface rose from 3.98 feet below the datum plane to 1.16 feet below, and fell after that to 5.39 feet below the datum plane in December, 1896, with minor fluctuations every year according to season and rainfall. Variations of from 3 to 7 feet have been known to occur at various places from changes in atmospheric pressure and direction of wind. These changes of depth along the shore modify the effect of waves and currents upon the bottom.

The relative effect upon the surface of the lake or its waters produced by winds and by atmospheric pressure has not been determined. The effect upon the surface level of changes in pressure alone are enormous, reaching in some cases as much as 6 feet. The currents produced by these changes probably permeate the entire mass. The changes of level produced by winds are great in extent, and are the direct result of the motion of surface particles gradually carried downward until a well-defined current results.

There is another factor in this problem which may be of greater importance than is now realized; that is, the river current during or immediately after a storm. The river discharge is small throughout the year, except for a short period in the freshet season. It has been noted that easterly storms cause a rapid rise in the river at some distance from its mouth. The river acts as a reservoir for water carried in by the rise in the lake. Now, whether an undercurrent is produced immediately or upon the cessation of the storm is not known. It is certain that this water is loaded with sand or has brought material with it which would as readily be carried out with a slight current, and it may be expected that when the lake falls a current arises in the river which, in meeting the general lake current, produces quieter water at the harbor entrance and creates a deposit at that point, or, at least, a modification of the form of the bar.

The forces acting upon the entrance to a lake harbor are, therefore, the constant current to the southward, the waves and currents produced by storms, and the river current. For harbor-improvement purposes observations should be taken in the vicinity of each harbor during calm and stormy weather to determine their direction, exact location, and velocity. The depth to which these forces disturb the bottom has not been accurately determined, although certain observations made at

Milwaukee by the city engineer in connection with recent waterworks construction in 1895 show that it is at least 42 feet. We may assume without question that the bottom in 21 feet of water will be readily moved by a heavy storm, and any obstruction like a pier in that depth will produce a modification of the forces and of the bottom around its outer end. This modification is shown by all the surveys made at the harbor of Kenosha.

The material of the lake bottom in 21 feet and lesser depths on the western shore of the lake is sand and silt, with some gravel, and is readily rolled or carried in suspension from one place to another. Great quantities of sand are transported—in fact, are in constant motion. Accessions are also constantly being made by erosion along the bluffs, which in some places recede at the rate of from 12 feet to 16 feet per year.

At—	Feet.
Kenosha	12
Racine Point	16
Racine	6
Oak Creek	2
Milwaukee	6.25
Port Washington	2.90
Sheboygan	6.25
Manitowoc	5

The surveys of the harbor entrances show where this material has a tendency to deposit, although the exact action of the waves and currents or obstructions in producing it are undetermined.

An examination of the tracing shows the following facts: In 1870 the south pier was longer than the north pier; in 1871, 1872, 1874, 1875, 1878, 1879, 1880, and 1881 additions were made to the north pier, making it longer than the south pier, and this condition has continued to the present time. The shore line north of the piers has advanced from 1860 to 1875 and but little since; south of the piers it advanced in the same way, but not to so great an extent. The 13-foot contour advanced from 1871 to 1880 and since that time has fluctuated forward and backward. From 1870 to 1890 the 17 and 21 foot contours gradually advanced, and have fluctuated since. There has been a bar across the entrance projecting northward from 1875 to 1896, its position varying from year to year, always in the lee of the north pier, having less than 13 feet of water over it and in advance of the south pier. There has generally been deeper water about the ends of both piers, always a recession of the contours behind the north pier, and generally behind both. There has always been deeper water close to the north pier on its north side than at a little distance from it. The general direction of the contours at some distance north of the piers is northwest and southeast, and to the eastward it is approximately parallel to the general shore line, and the latter contours are nearly straight, showing that the influence of the piers does not extend more than 500 or 600 feet beyond their outer ends. It may be stated in this connection that nearly all the harbors on the western shore of Lake Michigan present the same peculiarities.

In 1889 Major Davis reported as follows:

A plat of soundings taken at this harbor on May 3, 1889, shows that the bar to the westward of the extremities of the piers which was removed by the dredge to the depth of 15 feet in October and November, 1888, has re-formed across the entire front of the harbor entrance, the depth of the water upon it being from 9.8 feet to 13 feet. Between the piers the deposit has not been as large during the past winter as it has been in some former years. * * * The shore line now extends beyond the extremity of the north pier as it was built under the original project for improvement. [See Annual Report Chief of Engineers, 1889, Part III, p. 2080.]

Since that report was made a channel has been cut through the bar several times, but in the spring is not to be found. The constant shoaling between the piers has previously been mentioned.

The forces at work produce three forms of deterioration: (1) Shoaling between the piers, (2) a general advance of the foreshore to and beyond the ends of the piers, and (3) a bar across the entrance.

The problem of lake harbor improvement is therefore to maintain a uniform depth at the channel entrance and a uniform depth in the channel.

The material producing the first form of deterioration comes from several sources: (1) Sediment brought down by the river, (2) sand brought over the piers by wind, (3) sand carried through the piers by waves, and (4) sand carried in suspension from the lake through the entrance by winds and currents. The current of the river is so gentle that the scour on the bottom is comparatively little; in fact, the sediment carried by the river finds a resting place at that point where still water is created by the meeting of the river and the lake. There is no practicable method of preventing this deposit. The material brought in from the lake through the entrance also finds a resting place at the same point as that just mentioned. A further extension of the piers may diminish the amount of material brought in, but to prevent it altogether would require their extension beyond the reach of sand-bearing currents, and be far more expensive than to remove the deposit by dredging. By making the piers tight another source of deterioration is cut off, and the only practicable method of preventing sand from coming over the piers is the erection of sand fences, which are, after all, only temporary expedients. It is easily seen, therefore, that dredging between the piers will be required annually to maintain the channel. It is impossible to say from the data on hand what the amount will be, and it will vary considerably from year to year on account of changing weather conditions.

The advance of the foreshore and the formation of the bar in front of the entrance are much more difficult to deal with. In fact, it can not be shown from the imperfect data just why they take place or just what methods should be employed to prevent their occurrence. I am of the opinion that they are connected by being the results of the same cause acting at different places. In order to determine the proper direction, length, and relative position of the piers it is necessary that this information should be at hand, and it can only be supplied by extended surveys and observations upon winds, waves, and currents. While the north pier has constantly been in advance of the south pier, it can not be stated positively that the bar would not be formed if the conditions had been reversed. In extending the piers the additions have been made to the north pier first, probably in order to afford shelter for vessels entering the harbor during northeast gales. Whether the harbor would be as easy of entrance with a longer south pier, I can not say, but it seems that if the object of pier construction be to provide and maintain a navigable channel it should not be made to include the additional purpose of providing shelter, especially when it may be true that both objects can not be fulfilled at the same time.

The questions to be solved in order to decide how to maintain a constant depth at the entrance are the following: What causes the advance of the foreshore? Can a point ever be reached by extending the north pier where no further accumulations will take place about its outer end, or will there be a constant advance? What causes the formation of the bar in front of the entrance? Can it be prevented by extension of the piers, or must the piers be arranged in a different manner from the present system, i. e., parallel and of equal length?

There are almost no facts at hand to assist in the solution of these questions, beyond a knowledge of the existence of the before-mentioned general currents, the meteorological data, and the few and very incomplete surveys.

Inasmuch as the heaviest seas and strongest currents come from the north we may expect to find a deposit of material, rolled or pushed along the bottom, on the north side of the piers, and this accumulation will continue, not only as long as the piers remain of a constant length, but while they are being extended. In fact, it may be expected to continue forever unless there should be such a current at all times around the ends of the piers, and even to the north of them, as will prevent the deposit of sand in that vicinity. An advance of the foreshore will push the currents farther and farther from the original shore line, and it would appear as if the process would not stop. If the general currents in the lake increase in velocity as the distance from the shore increases and if they are so persistent in direction as not to be affected by an advance of the piers, we would in time reach the desired point and further advance be prevented. Even if the currents created by storms showed the same characteristics, we should expect this result. Unfortunately the observations of the Weather Bureau and the surveys of the Engineer Department have not determined these points positively. We have only the very general knowledge, as previously stated, of the directions of the main currents and form of the lake bottom near the piers at one epoch in each year to guide us in this study. Nor are the general surveys of the lake made by that branch of the War Department known as the Lake Survey detailed enough to show the effect of the advancement of the shore into the lake upon the form of the bottom. I am inclined to believe, however, that a constant depth can be obtained at the outer ends of the piers by extending them to the proper distance from the original shore line, judging from the shape and position of the contours.

At Sheboygan Harbor, as the piers were extended, the contours advanced until 1890, at which time the 17-foot contour had retreated to the north pierhead and since has advanced with it. The 19-foot contour was in advance of the pier until 1892, since which time it has followed the pierhead. The 21-foot contour has fluctuated, touching the pierhead in 1894 and advancing afterwards. It would seem, therefore, that we may expect a constant depth of 19 feet at that place, and that if the same process continued we might expect a constant depth of 21 feet by the proper extension of the pier.

At Kenosha the contours advanced until 1890, when the 13-foot contour is found in rear of the north pierhead, and in 1895 the 17-foot contour is in rear, while since 1892 the 21-foot curve has fluctuated. Equilibrium seems, therefore, to have been reached for the 13 and 17 foot depths.

At Racine the contours advanced with the pier, the 13-foot contour being always in rear of the north pierhead. In 1893 the 17-foot contour is in rear of it, and in 1895 the 21-foot contour is also in its rear. Equilibrium seems to have been reached for the 17-foot curve and perhaps for the 21-foot curve.

It would be unsafe to say positively, however, that no further advance may be expected of the curves now at or behind the pierheads, for the reason that there was an actual recession at each period when the curves are first found in rear of the pier, and we may expect them to regain what they lost; but the fluctuations backward and forward since 1890 and 1892, with almost no general advance on the line of the north pier, lend support to the idea that we may hope to secure the desired constant depth at the outer end.

These facts may be given in another way—although the data are quite insufficient for a positive statement—as follows: Since the rate of advance of the contours has constantly diminished, we may hope, if this effect continues, to finally reach a point where it will stop for every contour.

The original data are also too meager to determine what the original depths were at the places in which the pierheads stood at the times when the contours are first found in rear of them; and even if we knew those depths it would be impossible to predict the depths to which the piers should be extended to maintain 21 feet. This point can be found by gradual extension of the pier accompanied by careful surveys and other observations.

Another argument in this direction is the following: As the minimum depth on the bar is much greater than originally, and as each extension of the piers has pushed the bar into deeper water with a consequent greater minimum depth, it is probable that at some point a minimum depth over the bar may be obtained which will never be less than the depth sought, and the bar will then cease to be an obstruction.

While it appears quite certain that the bars originally obstructing the mouths of lake rivers are formed by the combined action of waves and currents, with very little modification by the river currents, it is not quite so clear how the bars existing at the present harbor entrances are formed, although undoubtedly the result of the same forces, changed by the restraint imposed upon them by the piers projecting out from the shore and nearly at right angles to it.

Again, these bars are neither so constant in position nor in shape as to show the action of forces constant either in direction or velocity. The surveys have only in a few instances been so extended as to cover their whole extent or to pass beyond the evident influence of the piers, and it is difficult to determine the exact shape. It appears, however, that they are in general V-shaped, with the point to the north, and extending, occasionally, north of the line of the north pier. They are separated from the piers by deeper water, and the depth at the north pier is always greater than at the south pier. The depth over the bar is greater at its north end than at its south end, and its axis if extended southward would meet the shore line. It can not be stated whether the bar is connected with the shore to the southward or separated from it by deeper water.

The shape of the contours to the south of each pier is to be noted. Many of the surveys show that the deep water around the pierheads extends back along the south sides of the piers; in other words, there is a deep pocket to the south of each pierhead. It is also to be noted that, with very few exceptions, a portion of the bar is west of the east end of the north pier, and that the exceptions occur at times when the north pier was not longer than the south pier.

Out of 10 harbors on the west shore of Lake Michigan, 8 have piers of equal length and 2 have the north pier longer than the south. At 3 of them, Ahnapee, Manitowoc, and Milwaukee, there is an absence of bar formation; at all the others are bars, partially or entirely across the channel, extending from the southward in every case with the exception of Two Rivers.

The effect of building the piers is simply to put the river mouth that much farther out into the lake, and the forces that caused closure or bar formation before pier construction was begun are still in operation, but with decreased effect, owing to increased depth of water. The waves and currents will roll heavy material along the bottom until it comes under the shelter of the piers or into a place where there is a less degree of motion in the water. The material carried in suspension will seek still quieter places, their location being shown by the contours of the bottom. Absolutely still water is found only in the river or where the river body brings the waves to rest, which will be in the channel approximately at the inner ends of the piers. There appears to be no tendency to a bar formation just within the outer ends of the piers.

Now, it is evident that some condition of affairs brings about a quieter condition of the water to the eastward of the piers and just south of the north pier when it happens to be longer than the south pier, and it appears to me that this can only be due to the deflection of the current by the north pier. It is certain that nothing exists to check the incoming waves at that point, and whether waves of translation or of oscillation, they would keep up the same motion at this place as at any other place situated at the same distance from shore, unless it be modified or prevented by the existence of a cross current, the presence of which is also shown by the deeper water along the north side of the north pier. The resultant of the primary southerly current and the secondary easterly current would lie toward the southeast, leaving quieter water to the south of it, where a portion of the moving material will be deposited. The deflection of the current at the end of the pier and the deflection of the waves will maintain the pocket at that place.

If this be the true explanation of the movements of the water about the pierheads, then to prevent the formation of the bar we must conform the piers to this condition—that is to say, so arrange them that the resultant current will sweep directly across the opening. The way to do this is simply to extend the south pier beyond the north pier to the proper point, the position of which can be found, however, only by experiment. A permanent depth should, then, always be found at the entrance.

It is probable that a greater deposit would occur in the channel under this new condition than now takes place, but we must choose this as a lesser evil than the danger to entering vessels created by the existence of a bar.

An extension of both piers equally to the proper point will undoubtedly accomplish the same result; but if it is probable that it can be brought about by the extension of only one, it is certainly worthy of a trial.

It may be mentioned, incidentally, that the theory above set forth requires that the material deposited in the channel should be lighter and finer than that found on the bar. It is known that the material in the channel is extremely fine, but no notice seems to have been taken of the quality of material dredged from the bar, although no very heavy gravel has been found.

A project for obtaining a 21-foot entrance channel involves primarily the completion of the present project.

The simplest method of obtaining an increased depth in the channel is to dredge to that depth from the basin to the lake. Part of the channel would be beyond the protection of the piers, and therefore subject to obliteration; in fact, it might be obliterated in a single storm. Experience has shown that it would be unsafe to depend upon such a channel, and it is therefore necessary to extend the piers for its protection. The exact point to which the north pier should be extended can not be accurately determined, but it must be extended at the least to the 21-foot contour of 1896, requiring the addition of 225 feet to the present pier, or 75 feet more than the present project calls for. The south pier will have to be extended somewhat farther than the north, in order to prevent the formation of the bar, if the reasoning above outlined is correct. Its outer end should be on a line following approximately the contour of the bar, which will be at a distance of about 775 feet from the present end of the pier, or 525 feet from where the end will be when the work now under contract is completed.

The south pier should also be extended first in sections and proper observations taken after each extension to determine the exact effect upon the bar and the ultimate length required; also whether there is any greater difficulty in entering the harbor than when the north pier is the longer.

To provide 21 feet in depth between the piers will require the removal of about 46,000 cubic yards. To obtain a depth of 20 feet in the basin over an area of about 4 acres will require the removal of 105,000 cubic yards of material.

The following is, then, the estimate for obtaining a channel 21 feet deep and basin 20 feet deep, by the simplest possible plan:

To complete present project, in addition to the funds now on hand	$25,870
To extend north pier 75 feet	4,875
To extend south pier 525 feet	34,125
Dredging in channel, 46,000 cubic yards, at 10 cents	4,600
Dredging in basin, 105,000 cubic yards, at 10 cents	10,500
Contingencies	7,030
Total	87,000

The distance between the piers at the entrance is only 165 feet—entirely inadequate for the safe entrance of the larger class of lake vessels. Therefore a complete plan for a 21-foot channel should include the widening of the entrance at least, but preferably the whole channel. The entrance could be widened by extending the present piers on divergent lines, producing, however, a very objectionable funnel shape; or by building two detached piers, parallel or convergent, beyond the present piers; or by extending the south pier and building a detached pier on the north side parallel to it and at the proper distance; or by taking up the entire north pier and rebuilding it parallel to the south pier and at the proper distance from it. The latter method is the proper one.

If a project should be adopted for a 21-foot channel the present project should be abandoned, so as to avoid any further extension of the piers on the present lines and to apply the funds thus saved to rebuilding the north pier in its proper position, as shown upon the inclosed tracing.

The following is the estimated cost, based upon the removal of the present north pier, of a channel 21 feet deep and a basin 20 feet deep:

Completing present project, omitting repairs and extension of north pier		$3,700
Extending south pier 525 feet, at $65		34,125
Removing and rebuilding north pier from shore to 21-foot contour, moving 3 cribs, each 50 by 24 by 22¼ feet on pile foundation, driving new foundation piles, and refilling and riprapping cribs with stone	$6,500	
Tearing out 1,550 linear feet old pier, at $6 per linear foot	9,300	
450 linear feet 18-foot pile pier, at $36	16,200	
475 linear feet 14-foot pile pier, at $26	12,350	
		44,350
	Cubic yards.	
Dredging in channel, including removal of strip of land	211,000	
Dredging in basin	105,000	
	316,000, at 10 cents,	31,600
Contingencies		11,225
Total		125,000

The land to be removed in widening the channel west of the shore line is private property and should be donated to the United States, and after being removed should be revetted by the city authorities or property owners.

If this plan is carried out the south pier should be kept ahead of the north, and careful observations taken in order to determine the effect upon the bar and the ultimate length of piers required.

It is difficult to estimate the importance to commerce of providing a 21-foot channel at Kenosha. Kenosha is a city of about 8,500 inhabitants, situated on the western shore of Lake Michigan, 52 miles north of Chicago, 10 miles south of Racine, with 25,000 inhabitants, and 33 miles south of Milwaukee, 280,000 inhabitants. Chicago and Milwaukee have excellent harbors, as well as harbors of refuge. A branch of the Chicago and Northwestern Railway runs directly west from Kenosha, and the main line of the same railway runs through it north and south, furnishing facilities for through shipments west, north, and south. It would certainly, therefore, be of great advantage to commerce to have as great a depth at Kenosha as at other points on the lake, but it is doubtful in my mind whether commerce would make use of these facilities when better ones exist at points so near as Chicago and Milwaukee. The commercial statistics for the calendar year ending December 31, 1895, show the arrival and departure of 185 vessels from this port, the approximate value of exports and imports by way of the harbor $1,131,000, and approximate value of same by all ways of transportation $31,200,000. This commerce is probably entirely local or confined to the immediate vicinity.

While but little reliance can be placed upon the commercial statistics of the various lake harbors, they form the means of obtaining a conception of their relative amounts of business. The commercial statistics for the year ending December 31, 1895, place Kenosha at number thirteen in the list of harbors along the west shore of Lake Michigan.

The area of the interior harbor at Kenosha is small, and any enlargement of it would be expensive. The present harbor facilities are by no means all in use, and it appears that a depth of 16 feet at the entrance will be ample for some years. It would be more advisable, consequently, for the General Government to complete the present project, and then wait for several years to see whether commerce will make use of the present facilities or demand a greater depth, before entering upon a new project which is not now clearly seen to be necessary.

I am of the opinion that the present interests of the commerce involved do not justify the proposed improvement.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

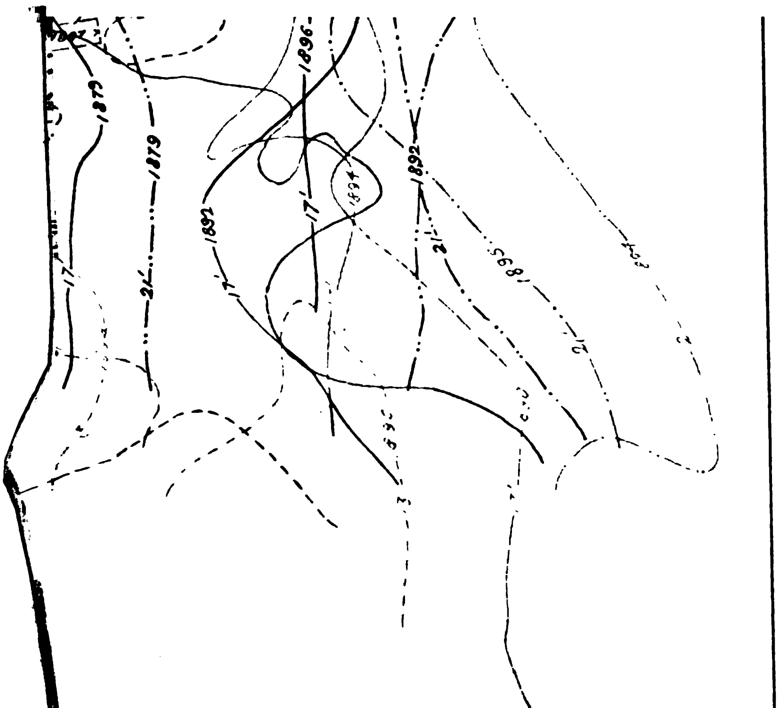
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, February 20, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the views of Captain Zinn, that the present interests of



ary 26, 1897

Geo. A. Zinn,
Captain, Corps of Engineers U.S. Army.

commerce involved do not justify the proposed improvement to give a 21-foot channel and 20-foot basin to the harbor of Kenosha, Wis.

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HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

H H 30.

ESTABLISHMENT OF HARBOR LINES AT KEWAUNEE, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., March 2, 1897.

GENERAL: I have the honor to forward herewith map of harbor at Kewaunee, Wis., made by George M. Mashek, city engineer, and showing dock lines as established by the city council of Kewaunee on December 21, 1896.

I would respectfully recommend that the dock lines as laid down be made the harbor lines at Kewaunee, Wis., under the approval of the Secretary of War.

The description of the proposed harbor lines is as follows:

Beginning at the westerly end of the south harbor pier, and on the channel face thereof; thence north 67° 36′ west, 156 feet; thence north 72° 11′ 30″ west, 394.1 feet; thence north 80° 56′ 30″ west, 39.8 feet to a point on the section line between secs. 17 and 18, T. 23 N., R. 25 E., said point being 511.3 feet north of the southwest corner of said sec. 17; thence north 80° 56′ 30″ west, 233.7 feet; thence north 37° 12′ west, 265 feet; thence north 1° 46′ west, 709.6 feet; thence north 34° 23′ west, 219.5 feet; thence north 75° 59′ west, 810 feet; thence north 60° 00′ west, 307 feet; thence north 25° 02′ west, 497.2 feet; thence north 0° 07′ west, 195 feet to a point on the north boundary line of the S. E. ¼ of sec. 18 aforesaid, said point being 1,795 feet west of the northeast corner of said S. E. ¼ of sec. 18.

Beginning at the westerly end of the north harbor pier, and on the channel face thereof; thence north 67° 36′ west, 250 feet; thence north 5° 40′ 15″ west, 230.3 feet; thence north 17° 46′ east, 1,065.2 feet; thence north 40° 04′ 30″ east, 595.6 feet; thence north 0° 07′ west, 235 feet; thence south 89° 53′ west, 750 feet; thence south 0° 07′ east, 425 feet; thence north 89° 53′ east, 170 feet; thence south 0° 07′ east, 265 feet; thence south 17° 46′ west, 1,153.3 feet; thence north 85° 08′ west, 161.6 feet to a point on the section line between secs. 17 and 18 aforesaid, said point being 760.4 feet north of the southwest corner of said sec. 17; thence north 85° 08′ west, 100.8 feet; thence north 36° 50′ west, 80 feet; thence north 2° 32′ west, 692.4 feet; thence north 34° 23′ west, 389.5 feet; thence north 75° 59′ west, 864 feet; thence north 60° 00′ west, 204.8 feet; thence north 25° 02′ west, 376.8 feet; thence north 0° 07′ west, 145.3 feet to a point on the north boundary line of the S. E. ¼ of sec. 18 aforesaid, said point being 1,570 feet west of the northeast corner of said S. E. ¼ of sec. 18.

All courses are referred to the true meridian.

A tracing and two black prints of the map are inclosed.*

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. Army.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 6, 1897.

Respectfully referred to Col. Henry M. Robert, Corps of Engineers,

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* Not printed.

Division Engineer, Northwest Division, for his views and recommendations.

To be returned.

By command of Brig. Gen. Wilson:

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, March 9, 1897.

Respectfully returned to the Chief of Engineers, U. S. Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 13, 1897.

Respectfully submitted to the Secretary of War.

Captain Zinn forwards the accompanying map of the harbor at Kewaunee, Wis., showing harbor lines established by the city council of Kewaunee on December 21, 1896, and recommends that the lines as laid down upon the map be approved.

Concurring in the views of Captain Zinn, I recommend that the lines selected be approved, and that the Secretary place his approval both upon the tracing, which has been prepared for his signature, and upon this paper.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

[Sixth indorsement.]

WAR DEPARTMENT, *April 8, 1897.*

Approved as recommended by the Chief of Engineers in the third indorsement hereon.

R. A. ALGER,
Secretary of War.

H H 31.

ESTABLISHMENT OF HARBOR LINES AT WAUKEGAN HARBOR, ILLINOIS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., December 11, 1896.

GENERAL: I have the honor to recommend that harbor lines be established as follows at the harbor of Waukegan, Ill. They conform exactly to the boundaries of the harbor as proposed by the present project for improvement, approved July 28, 1896 (E. D. $\frac{7823}{1}$):

Beginning at the point where the north boundary line of United States property intersects the channel face of the present revetment on east side of harbor basin; thence west along said north boundary line, 302 feet, more or less; thence southerly parallel to and 300 feet distant from the north and south arm of the north harbor pier, 962 feet, more or less, to the channel face of the south harbor pier.

Very respectfully, your obedient servant,

GEO. A. ZINN,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 16, 1896.

Respectfully referred to Col. Henry M. Robert, Corps of Engineers, Division Engineer, Northwest Division, for his views and recommendations.

To be returned.

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, December 17, 1896.

Respectfully returned to the Chief of Engineers, U. S. Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 19, 1896.

Respectfully submitted to the Secretary of War with recommendation that the harbor lines described within, and shown in red on the accompanying map, be approved, and that the Secretary place his approval both upon this paper and upon the map.

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

[Fourth indorsement.]

WAR DEPARTMENT, *December 21, 1896.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX I I.

IMPROVEMENT OF CHICAGO AND CALUMET HARBORS AND CHICAGO AND ILLINOIS RIVERS, ILLINOIS, AND CALUMET RIVER, ILLINOIS AND INDIANA; ILLINOIS AND MISSISSIPPI CANAL.

REPORT OF MAJ. W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chicago Harbor, Illinois.
2. Chicago River, Illinois.
3. Calumet Harbor, Illinois.
4. Calumet River, Illinois and Indiana.
5. Illinois River, Illinois.
6. Operating and care of Lagrange and Kampsville locks and dams, Illinois River.
7. Illinois and Mississippi Canal.
8. Operating and care of Illinois and Mississippi Canal. (Canal around lower rapids of Rock River, Illinois.)
9. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

10. Upper Illinois River and Lower Des Plaines River, Illinois.

SURVEY.

11. Wolf Lake and River, Illinois and Indiana.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 16, 1897.

GENERAL: I have the honor to transmit herewith annual reports upon the works in my charge for the fiscal year ending June 30, 1897, as follows:

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Very respectfully, your obedient servant,

W. L. MARSHALL,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

I I 1.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

The project for this harbor was adopted in 1870, and modified in 1878. By act of July 3, 1896, the project was again modified to include dredging Chicago River, or the inner harbor, to admit passage by vessels drawing 16 feet of water.

The project of 1870 as modified in 1878 contemplated—

(a) The formation of an outer harbor or basin by inclosing a portion of Lake Michigan, just south of and adjoining the entrance to the river for the purpose of increasing the harbor facilities of Chicago, and to give relief to the overcrowded river.

(b) The construction of an exterior breakwater of crib work filled with stone, in deep water in Lake Michigan and wholly detached from the shore, north of the entrance to Chicago River, to shelter the entrance to the river, and the outer harbor from northerly storms, and to form a harbor of refuge at the southern end of Lake Michigan. The project also included the maintenance, by dredging, of the channel at the entrance to Chicago River as far west as to Pine street, and the piers so far as they project beyond the existing shore line. All of this project has been completed, except dredging the outer harbor.

(c) Under the river and harbor act of June 3, 1896, the Chicago River, which is the inner harbor, has been directed improved for vessels drawing 16 feet of water. This work is reported upon separately as "Improving Chicago River, Illinois."

CONDITION OF THE WORK JUNE 30, 1897.

Outer Basin.—This basin originally covered 455 acres of the area of Lake Michigan, of which 270 acres lie seaward of the dock line established by the Secretary of War September 22, 1890, and 185 acres west of this dock line. The dock line is about 1,300 feet east of the right of way of the Illinois Central Railroad and 2,000 feet distant from, and parallel to, the easterly breakwater of the basin.

A portion of the outer basin was dredged prior to 1887 to a depth of 16 feet, by the United States, but work was suspended due the litigation over the ownership of the submerged lands, and because the harbor was not and could not be used for its intended purposes.

The basin beyond the dock line is gradually filling up with sand and sediment, until its available depth does not exceed from 12 to 13 feet.

The litigation is now practically ended as far as the ownership of lands is concerned, and it would be well to dredge this basin to 20 feet depth.

Under authority granted by the Secretary of War July 24, 1895, a bulkhead has been constructed along the dock line, and the area shoreward of the dock line is now being filled in for a public park.

At the northern end of the basin are several slips and docks now in possession of the Illinois Central Railroad Company, but title is in litigation. In view of the restricted capacity of Chicago River, these outer slips and docks become more important to the commerce of the city, and the wisdom of dredging the outer basin to 20 feet depth becomes apparent. The northern part is now in use for commercial purposes, and the entire basin would be useful as a safe roadstead for large vessels if dredged. The cost of this dredging is estimated at $509,960.

The piers of this basin are now in good condition.

No work has been done during the year by the United States Government in this basin nor on the breakwater limiting it.

EXTERIOR BREAKWATER.

This work is situated about 1 mile north of the entrance to Chicago River, which it shelters against northerly storms. The breakwater is 5,413 feet in length, 30 feet wide, and constructed in water varying from 18 to 32 feet in depth. All of it, except 1,200 linear feet, which is on a foundation of riprap stone, has been built upon the natural sand and clay bottom.

This work has been successful and well subserves its object. It was begun in 1880 and completed in 1890. This breakwater has been slightly damaged by a vessel running into it, but otherwise is in good condition.

No work has been done upon it during the year, and probably none will be required for several years.

ENTRANCE TO CHICAGO RIVER.

It has been customary for the United States to maintain the channel between the piers and docks at the entrance of Chicago River by dredging to the extent required by vessels of the dimensions navigating Chicago River as far as to Rush Street Bridge, and the improvement of Chicago Harbor has been limited inshore by this bridge.

During the past fiscal year no work has been done at the entrance to Chicago River, and none will probably be necessary during the year ending June 30, 1898.

PROPOSED APPLICATION OF FUNDS NOW ON HAND.

It is proposed to apply the funds on hand to the maintenance of existing work.

APPROPRIATIONS.

By act of—		By act of—	
July 11, 1870	$100,000.00	September 19, 1890	$100,000.00
March 3, 1871	100,000.00	July 13, 1892	72,000.00
June 10, 1872	90,000.00	August 17, 1894	80,000.00
March 3, 1873	90,000.00		
June 23, 1874	75,000.00	Total appropriated	*1,810,000.00
March 3, 1875	78,000.00	Received from all other sources since 1870 (transfer of tug, sales, etc.)	630.16
August 3, 1876	5,000.00		
June 18, 1878	75,000.00		
March 3, 1879	75,000.00		
June 14, 1880	145,000.00	Total	1,810,630.16
March 3, 1881	150,000.00	Expenditures to June 30, 1897	1,800,571.77
August 2, 1882	200,000.00		
July 5, 1884	100,000.00		
August 5, 1886	75,000.00	Balance unexpended June 30, 1897	10,058.39
August 11, 1888	200,000.00		

*$50,000 appropriated by act June 3, 1896, for "improving Chicago River," and which was included in statement for Chicago Harbor in last annual report, has been deducted from amounts reported June 30, 1896.

Money statement.

July 1, 1896, balance unexpended	* $33,602.52
June 30, 1897, amount expended during fiscal year	23,544.13
July 1, 1897, balance unexpended	10,058.39

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 1, 1897.

MAJOR: I have the honor to submit herewith a report on operations in Chicago Harbor, Illinois, during the fiscal year ending June 30, 1897.

At the beginning of the year there was no contract in force for any work to be done in improving this harbor. No work was done, and none is contemplated for the ensuing year.

PRESENT CONDITION OF THE HARBOR.

The harbor entrance was dredged in the spring of 1896 to a depth of 18 feet below low water of 1847, and is now in good condition.

The north and south piers and the exterior breakwater are in very good condition. The easterly and southerly breakwaters are also in very good repair, except that the stone filling has settled considerably in some places, especially in the westerly part of the latter, where it is below the water surface, and in case of a severe southeasterly storm might endanger the overturning of a portion of this very narrow breakwater, as happened to a part of its outer or easterly portion in 1888. An estimate of the cost, amounting to $1,907.40, of the needed repairs, including three clumps of piles, was submitted on the 13th of June, 1896, but no work has so far been authorized.

The rough element, fishermen and disreputable characters, that have for years past infested the piers and breakwaters in this harbor, erecting shanties and derricks thereon, particularly on the north pier, as has been complained of in former reports, were finally removed on the 10th of May, this year, by the United States revenue cutter *Calumet*, Capt. W. H. Cushing commanding, printed notices having been posted ten days previously at several places on each of the piers.

The United States life-saving station, located at the outer end of the South Pier, has heretofore had a communication with the city by a road running across the Illinois Central Railroad Company's land, which adjoins this pier. This was of much importance, partly for the transportation of the life boat to some point along the lake shore and partly for transportation of supplies, but new warehouses were planned for during the year, which would entirely shut off this communication. Application for authority to construct a road on and along the South Pier was then made to the Secretary of War. The owners of the warehouses offered to build the said road, free of any cost to the Government, if they should be allowed to use it for the passage of fire engines in case of fire on their property. This advantage being equally applicable to the life-saving station, under like circumstances, a revocable license was granted by the Secretary of War on the 24th of April, 1897, with provisions that the road should be built under the supervision of the engineer officer in charge of this district, and that it shall not be used by any private parties, except in case of fire. The road has been constructed.

With last year's report was submitted certain diagrams, designed to facilitate the preparation of estimates for proposed pier work. I have since noticed that, unless the formulæ contained therein are used frequently, so as to insure familiarity, there are chances for making errors, and also that it becomes cumbersome to pick out the proper constants for use in the different formulæ, and more especially in the "composite formula." I have therefore arranged all the formulæ in tabular form, which is respectfully submitted herewith. With the aid of this I believe that an estimate with close approximation to accuracy can be obtained, with but slight familiarity with the diagrams, with very little work, in a very short time, and with but minimum chances for errors. The strictest attention should, however, be given to the note concerning the value given to X, as this is about the only place where an error is liable to occur, in case proper care is not exercised.

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* $50,000 appropriated by act June 3, 1896, for "improving Chicago River," and which was included in statement for Chicago Harbor in last annual report, has been deducted from amounts reported June 30, 1896.

A table, showing the means of tridaily readings on the water gauge, is also submitted herewith.

I am, major, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Means of (tridaily) readings of the gauge at Chicago Harbor, Illinois, 1896.

[Plane of reference: Low water of 1847.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	—1.30	—0.93	—0.63	—0.93	—0.50	—0.23	—0.33	—0.13	—0.37	—0.07	—0.60	—1,07
2	—1.23	—1.10	—0.93	—1.00	—0.77	—0.10	—0.20	—0.07	—0.67	—0.07	—0.60	—0.63
3	—1.00	—0.17	—0.87	—1.00	—0.80	—0.17	—0.23	—0.40	—0.40	—0.17	—0.30	—0.87
4	—1.37	—0.90	—0.80	—1.17	—0.70	—0.13	±0.00	—0.70	—0.40	—0.10	—0.57	—1.07
5	—0.60	—1.07	—1.00	—1.10	—0.47	—0.43	—0.30	—0.53	—0.30	—0.20	—0.03	—0.80
6	—1.23	—1.07	—1.03	—1.13	—0.60	—0.33	+0.01	—0.23	—0.33	—0.17	—0.53	—0.57
7	—0.63	—1.06	—1.30	—1.03	—0.57	+0.07	—0.03	—0.20	—0.53	—0.30	—0.83	—0.77
8	—1.47	—1.03	—0.83	—1.10	—0.53	—0.30	—0.07	—0.27	—0.43	—0.23	—0.80	—0.80
9	—1.30	—1.13	—1.10	—0.97	—0.57	—0.23	±0.00	+0.17	—0.40	—0.27	—0.90	—1.10
10	—0.87	—1.70	—0.50	—0.83	—0.63	—0.10	—0.23	+0.17	—0.37	—0.37	—0.80	—1.00
11	—1.27	—1.33	—0.53	—0.57	—0.50	—0.17	—0.43	—0.30	—0.27	—0.23	—0.73	—0.90
12	—1.40	—1.13	—0.70	—0.67	—0.53	—0.20	—0.43	—0.10	+0.23	—0.17	—0.73	—0.77
13	—1.27	—0.57	—1.03	—1.13	—0.30	—0.13	—0.23	+0.13	—0.07	—0.37	—0.67	—0.47
14	—1.17	—0.70	—1.04	—1.03	—0.33	—0.10	—0.13	—0.27	—0.30	—0.37	—0.67	—0.47
15	—1.20	—0.50	—0.97	—1.13	—0.43	—0.03	+0.20	—0.27	±0.00	—0.30	—0.93	—0.30
16	—1.13	—0.53	—1.00	—1.03	—0.50	—0.10	—0.10	+0.27	—0.13	—0.57	—0.87	—0.63
17	—1.13	—1.20	—1.20	—0.80	—1.43	±0.00	—0.23	—0.17	—0.20	—0.27	—0.57	—1.07
18	—1.30	—1.40	—1.13	—0.77	—0.77	—0.13	—0.43	+0.03	—0.30	—0.40	—0.50	—0.63
19	—1.03	—0.53	—0.30	—0.70	—0.23	—0.30	—0.10	—0.03	—0.03	—0.87	—0.50	—1.03
20	—1.50	—0.97	—1.20	—0.70	—0.37	—0.10	—0.23	—0.03	—0.43	—0.57	—0.57	—0.67
21	—1.00	—0.97	—1.77	—0.73	—0.47	+0.10	—0.17	—0.20	—0.53	—0.70	—0.70	—0.70
22	—0.70	—1.53	—1.23	—0.83	—0.43	—0.13	—0.23	—0.13	—0.20	—0.87	—0.67	—0.60
23	—0.40	—1.23	—0.93	—0.70	—0.23	±0.00	—0.40	—0.20	—0.57	—0.80	—1.07	—0.37
24	—0.60	—1.07	—1.57	—0.73	—0.50	—0.13	—0.37	—0.23	—0.80	—0.70	—0.53	—0.77
25	—0.90	—1.23	—1.93	—0.90	—0.27	—0.20	—0.17	—0.53	—0.87	—0.93	—0.63	—1.57
26	—0.63	—1.17	—0.87	—0.80	—0.20	—0.27	—0.50	—0.27	—0.43	—0.77	—0.77	—0.97
27	—0.87	—1.00	—1.20	—0.53	—0.40	—0.43	—0.10	—0.37	—0.17	—0.57	—0.27	—0.93
28	—1.23	—0.80	—0.93	—0.47	—0.07	—0.07	—0.07	—0.43	—0.40	—0.50	—1.17	—1.27
29	—1.13	—0.30	—1.00	—0.60	—0.67	—0.30	—0.30	—0.83	—0.30	—0.83	—0.80	—1.20
30	—0.90	....	—1.20	—0.47	—0.37	—0.37	—0.07	—0.63	+0.50	—1.10	—0.87	—1.10
31	—0.70	....	—0.70	....	—0.40	....	—0.17	—0.37	....	—0.93	....	—0.87
Means	—1.05	—0.98	—1.01	—0.85	—0.50	—0.17	—0.19	—0.23	—0.31	—0.48	—0.67	—0.84

I I 2.

IMPROVEMENT OF CHICAGO RIVER, ILLINOIS.

The Chicago River constitutes the inner harbor of Chicago. In its natural condition it was navigable for such vessels as could pass the bar at its mouth. It has been improved, docked, dredged, and bridged by the city of Chicago and by the riparian owners, as the city grew to keep pace with their requirements for commerce primarily and for sewage disposed for convenience incidentally, without aid from the Federal Government, until it has grown to be a great artificial waterway, without public landings or docks, defiled and putrescent with sewage and filth, but one of the most important waterways (measured by its commerce) on the globe. The adoption by Congress of the project for a comparatively deep waterway, 20 to 21 feet, to replace the 15-foot channel between Duluth, Chicago, and Buffalo, has been followed by such a revolution in the lake marine as to make the Chicago River, as limited by docks, by bridges, and by tunnels, utterly inadequate in capacity to accommodate the great vessels of to-day, and at once make necessary either (1) a complete remodeling of the river, (2) a new harbor at Chicago for largest vessels, or (3) a loss of commerce as far as may relate to heavy commodities "in transit" at Chicago, which require the lowest rates of transportation and, therefore, the most capacious vessels and commodious channels.

Prior to 1892 it had been the custom of Congress in the construction of lake harbors to confine the work done by the United States Government under river and harbor acts to piers, breakwaters, and dredging, or to work required lying lakeward or beyond the natural shore lines of the lake, and to such works as were found to be necessary to protect the jetties or piers at the shore ends thereof against cutting out by the waves in storms.

The act of July 13, 1892, contained a provision directing the officer in charge at Chicago to report "what, if any, improvement should be made by the General Government in Chicago River," which report was submitted under date August 9, 1893, and will be found in the Annual Report of the Chief of Engineers for 1893, page 2974 and following.

In accord with long-established precedents, the opinion of the officer in charge was adverse to the expenditure of money by the General Government on the river within the old shore line of the lake as long as it may be used as a dumping ground for filth and sewage, and therefore involving scavenger work for the city, but certain work of dredging and rectification was suggested for the information of Congress, as in the interest of commerce and navigation. The limit in depth of the suggested improvement, 16 feet, was determined by the depths over the Washington Street and La Salle Street tunnels, and the improvement suggested is to the limit of the present capacity of Chicago River, without embarking in a scheme of indefinite cost, in remodeling or rebuilding an artificial waterway, with all its bridges, tunnels, wharves, and accessories, which are owned, built, and controlled by municipal, corporate, or private parties.

This suggestion as to the capacity of the river for improvement seems to have been accepted as just and proper. Congress, which in the river and harbor act of August 17, 1894, in making provision for Chicago Harbor authorized the Secretary of War to expend not exceeding $25,000 out of the $80,000 appropriated "in the improvement of Chicago River up to the forks of said river," and later, in the river and harbor act of June 3, 1896, wherein it is provided—

For improving Chicago River in Illinois, from its mouth to the Stock Yards on the South Branch and to Belmont avenue on the North Branch, as far as may be permitted by existing docks and wharves, to be dredged to admit passage by vessels drawing sixteen feet of water, according to the recommendation of Capt. W. L. Marshall, of the Corps of Engineers of the United States Army, in his report under date of August ninth, eighteen hundred and ninety-three: Continuing improvement, fifty thousand dollars: *Provided*, That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the said project of improvement, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate six hundred and fifty thousand dollars, exclusive of the amount herein and heretofore appropriated.

And again, in the sundry civil act of June 4, 1897, it is provided—

Improving Chicago River, Illinois: For continuing improvement from its mouth to the Stock Yards on the South Branch and to Belmont avenue on the North Branch, one hundred and thirteen thousand dollars, in pursuance of the provisions of an act making appropriations for the construction, repair, and improvement of certain public works on rivers and harbors and for other purposes, approved June third, eighteen hundred and ninety-six; and it is hereby declared to be the true intent and meaning of the said provisions of said act relating to the improvement of said Chicago River that all of the work in the improvement of said river which was recommended or suggested to be done in the interest of commerce by Captain William L. Marshall, of the Corps of Engineers of the United States Army, in his report of

August ninth, eighteen hundred and ninety-three, may be done: *Provided*, That the total cost of such improvement or work shall not exceed the limit provided for in said act.

The conclusion was also accepted by local bodies interested in the improvement of the river, as shown by their actions in pressing upon Congress the necessity of adopting the suggestions made in this report of August 9, 1893, and by their failure in any manner to controvert either the statement of facts or conclusions deduced therefrom.

In accord with the act of June 3, 1896, a project for dredging was submitted by the officer in charge, and approved by the Chief of Engineers and Secretary of War. The work was advertised under date September 25, 1896; proposals received October 24, 1896, and with the approval of the Chief of Engineers contracts were entered into November 5, 1896, with the lowest responsible bidders, viz, Green's Dredging Company, for dredging 458,427 cubic yards of material from the main river and South Branch at 10.9 cents per cubic yard, measured in scows, and with The Lydon & Drews Company for dredging 848,704 cubic yards of material from the North Branch at 9.7 cents per cubic yard, and in each case for certain unimportant and contingent work of small extent.

The contractors began work promptly, and up to the close of the fiscal year had removed from the main river and South Branch 258,966 cubic yards and from the North Branch 248,610 cubic yards of material. The dredging of the North Branch was suspended in June, 1897, awaiting further appropriations, but will be resumed in July and continued to completion.

It is expected that the work of dredging as far as may be done under the existing contracts will be completed by the close of the calendar year 1898.

The sundry civil act of June 4, 1897, permits the slight work of rectification and widening suggested in the report of August 9, 1893, to be done, and a project is now being prepared to be submitted to the Secretary of War for action at as early a date as practicable.

The fact that Chicago River can accommodate vessels of 16 feet draft only, and for but a small part of its length can admit vessels not exceeding 325 feet length and 42 feet beam, when large modern vessels now being rapidly added to the fleets of the Great Lakes are 432 feet in length, 48 feet beam, and designed for a draft of water of 19 to 20 feet, is disquieting and hampering to all interests at Chicago dependent upon commerce by water, and the demand for better accommodations in Chicago River is growing in intensity.

No practical method of procedure to remove the obstructions to navigation has been proposed. The authorities of the sanitary district have contracted for dredging the main river and South Branch from Lake Michigan to the connection with the drainage canal to a depth of 20 feet (or more in places), and propose some increase in the capacity of the channel for discharge by widening between docks at a few narrow points, and some more important aids to navigation in widening at a few bridge draws; but these changes, as well as those proposed in the Report of 1893, and allowed to be made by the sundry civil act of June 4, 1897, are not in accord with the radical improvements demanded for the accommodation of the largest modern vessels.

The tunnels absolutely limit the draft of vessels; the bridge draws, docks, and bends absolutely limit the length and beam.

If the tunnels could be lowered to allow a draft of 20 feet, and the river dredged to that depth, vessels of the same horizontal dimensions as now navigate the river could load 4 feet deeper, or their carrying capacity be increased from 33 to 75 per cent. A vessel 325 feet long, 42 feet beam, deducting 20 feet in length for run or model, would have its capacity increased about 400 tons for each foot of additional draft, or 1,600 tons, an increase of 50 per cent over 16 feet draft.

The tunnels alone, however, represent some $2,500,000, and are used for the cable lines of street railway connecting the north and west sides with the business center of the city. No practical method has been proposed for removing or altering these tunnels, nor any suggestion made as to the source of the necessary money to pay the cost of modification in tunnels, bridges, and other artificial obstructions, which are costly and much used property.

I submit herewith a series of maps showing the profiles of the crowns of the La Salle Street and Washington Street tunnels as ascertained by sounding, and of all bridges over Chicago River which prohibit passage by the largest lake vessels; also of such short bends in the river as may be impassable by such vessels.

The most obvious fact shown by these maps is that while the river, even without bridges, is too narrow for such boats to tie to the docks while similar boats are passing each other in the channel, yet it would be navigable by such vessels even with its present shore lines were the bridges above the forks of the river removed or constructed with central draws of from 110 to 120 feet span.

The bridges and tunnels therefore may be said to be the obstructions to navigation by large vessels, although the stream itself is too narrow for easy navigation by such vessels, were such obstructions removed.

A list of steam vessels of the larger class navigating Chicago River, to a greater or less extent of its course, is submitted.

List, dimensions, and tonnage of the average steamers, navigating the Chicago River (not including small-sized lumber vessels).

Steamer.	Gross tonnage.	Net tonnage.	Length.	Width.
			Feet.	*Feet.*
Susquehanna	2,781	2,347	327	40
Codorus	2,165	1,802	295	40
Mahoning	2,189	1,744	292	40
Schuylkill	2,205	1,819	292	40
Clarion	1,711	1,513	258	36
Lehigh	1,704	1,503	256	36
Conestoga	1,726	1,562	270	36
Wissahickon	1,619	1,423	256	35
Delaware	1,731	1,526	271	36
Juniata	1,708	1,474	270	35
Conemaugh	1,609	1,423	269	36
Lycoming	1,609	1,423	269	36
Manitou	2,944	2,391	292	42
Christopher Columbus	1,511	945	390	42
Mohawk	2,857	1,616	312	41
Harlem	2,299	1,858	306	41
Hudson	2,294	1,853	306	41
Syracuse	1,917	1,677	295	38
Commodore	2,082	1,927	283	42
Boston	1,829	1,669	281	36
Buffalo	1,762	1,662	276	35
Chicago	1,847	1,721	283	36
Milwaukee	1,770	1,571	282	36
Tioga	2,085	1,744	303	38
Owego	2,611	1,940	343	41
Ramapo	3,045	2,484	338	44
H. J. Jewett	1,953	1,722	263	39
Chemung	2,615	1,943	345	41
New York	1,921	1,751	286	36
Rochester	2,220	2,046	284	40
Gov. Smith	2,044	1,547	258	42
H. R. James	2,048	1,552	258	42
A. McVittie	2,046	1,552	258	42
J. R. Langdon	2,044	1,550	258	42

List, dimensions, and tonnage of the average steamers, navigating the Chicago River (not including the small-sized lumber vessels)—Continued.

Steamer.	Gross tonnage.	Net tonnage.	Length.	Width.
			Feet.	*Feet.*
F. H. Prince	2,047	1,547	258	42
W. A. Haskell	1,530	1,440	260	37
W. J. Averill	1,603	1,425	260	37
E. P. Wilbur	2,633	1,902	308	40
Sarinac	2,669	1,939	308	40
Seneca	2,669	1,939	308	40
Tuscarora	2,669	1,939	308	40
Tacoma	1,879	1,609	278	38
Oceanica	1,490	1,241	280	37
Clyde	1,306	1,158	274	36
H. E. Packer	1,142	962	243	35
Fred Mercur	1,224	966	250	35
Lackawanna	2,015	1,595	278	39
Scranton	2,015	1,595	278	39
Wyoming	1,952	1,739	260	39
Florida	2,103	1,834	288	40
J. W. Moore	1,961	1,689	274	40
Brasil	2,186	1,655	294	40
Arthur Orr	2,329	1,972	304	41
Average	2,014	1,653	287	39

An examination of the elaborate and accurate maps of Chicago River made under direction of the trustees of the sanitary district at Chicago, which embody results from the only careful survey that has been made of the river, show the navigable capacity of the river (irrespective of draft of vessels) as determined by the limiting docks or bulkheads, and by the piers, abutments, and guards of the bridges. In preparing the table below a paper model of the horizontal dimensions stated cut to the same scale as the maps was applied, and if it was found that such model, without apparent wedging or binding, could be passed through the representation of the bridge, the bridge has been denominated as passable by a vessel of such horizontal dimensions. The results given in the table are considered extreme—or in favor of the navigability of the river.

The table follows:

Table showing how far vessels of dimensions given can navigate Chicago River and its branches.

Dimensions of vessels.	Limits which can be reached by vessels.		
	In South Branch.	In North Branch.	In North Branch Canal.
Feet.			
48 by 432	Might possibly squeeze through Madison Street Bridge if it can pass over La Salle street tunnel; then to Taylor street.	Only to the first, the Chicago and Northwestern Rwy. Bridge.	Can not reach the canal.
42 by 340	To Eighteenth street	To Division street	To Halsted street.
42 by 325	do	do	do
42 by 305	Might possibly squeeze through Eighteenth street and Fuller street. If so, can go to Indiana State Line Rwy. Bridge, west arm of South Fork.	do	do
40 by 305	To Indiana State Line Rwy. Bridge in west arm of South Fork of South Branch.	To Chicago, Milwaukee and St. Paul Rwy. Bridge. (North of North ave.)	To Chicago, Milwaukee and St. Paul Rwy. Bridge.
38 by 300	To Indiana State Line Rwy. Bridge in west arm of South Fork of South Branch.	do	Might possibly squeeze through St. Paul Rwy. Bridge and go to the main channel in the North Branch.

Boats 325 feet length, 42 feet beam, can navigate Chicago River to the elevators, drawing, after dredging is completed, barely 16 feet at present stage of water (0.5 foot above Chicago city datum).

The crown of Washington Street Tunnel now limits the draft, as stated.

Over La Salle Street Tunnel 17 feet is now barely possible over central part.

Over Van Buren Street Tunnel 18 feet is practicable at present stage.

(1) Each foot additional draft in vessels of the dimensions named (allowing 20 feet off for run or mold at bow and stern, or of rectangular horizontal dimensions, 305 feet by 42 feet), corresponds in round numbers to 400 tons cargo, or about 13,300 bushels of wheat.

(2) If available draft were 20 feet, then cargoes carried by same vessels could be increased 1,600 tons, or about 53,000 bushels of wheat.

This would result, simply, by the removal of tunnels and deepening of the river channel, and minor changes in docks, now contemplated, or the capacity of boats of same beam and length could be increased from 33 to 50 per cent.

(3) To adapt Chicago River for boats 432 feet length, 48 feet beam, 20 feet draft, will require not only removal of tunnels and strengthening of bulkheads or docks, but also the reconstruction or remodeling of bridges, as shown herewith; the cutting away of much wharf property to straighten the river; and, in general, a complete remodeling of Chicago River, if such boats are to load at wharves and pass each other in channels.

These facts and maps are submitted as data bearing upon the question of the improvement of Chicago River, for the information of Congress.

PROPOSED APPLICATION OF FUNDS NOW ON HAND AND AVAILABLE.

It is proposed to apply these funds to the completion of the dredging now contracted for.

PROPOSED APPLICATION OF FUNDS ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1899.

It is proposed to apply the funds asked for, contingent upon the adoption of a project for minor widening of the river or rectification of the dock line, to describing the necessary lands and acquiring title thereto, and to dredging and removing the necessary material, and reconstructing the docks or bulkheads along the changed sections.

Since the Chicago River constitutes the inner harbor at Chicago, reference is made to the report on Chicago Harbor for commercial statistics.

APPROPRIATIONS.

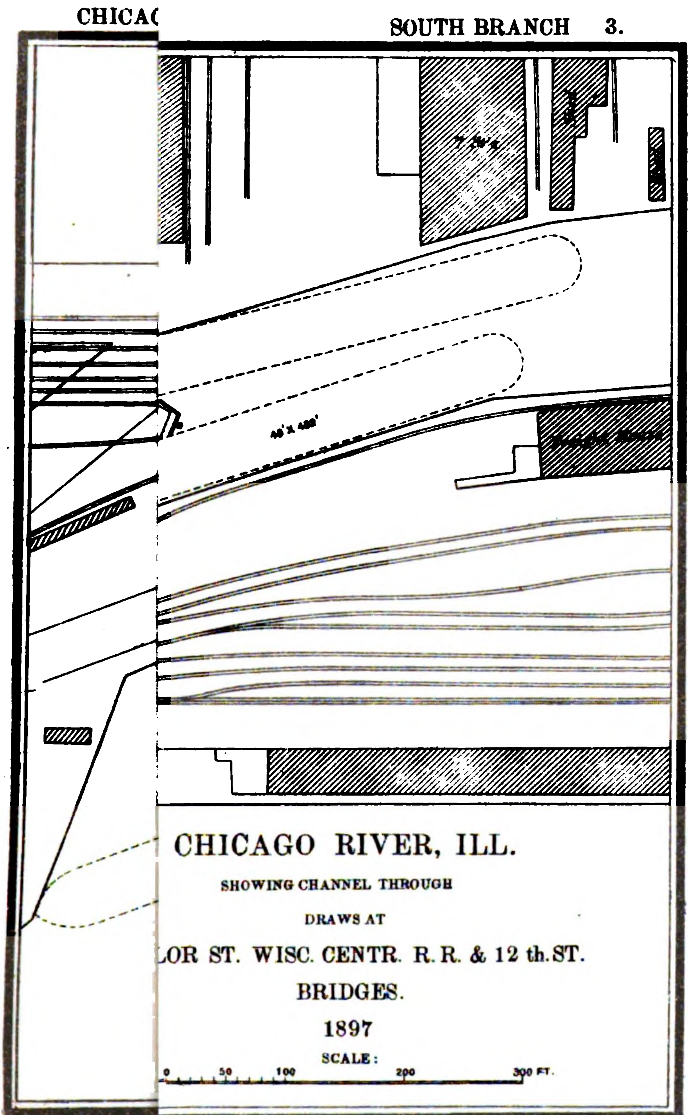
Act June 3, 1896	$50,000.00
Sundry civil act, June 4, 1897	113,000.00
Total	163,000.00
Expenditures to June 30, 1897 (exclusive of $25,000 allotted from appropriation for Chicago Harbor of August 17, 1894)	24,475.21
Balance unexpended June 30, 1897	138,524.79

Money statement.

July 1, 1896, balance unexpended (act June 3, 1896)		$50,000.00
Amount appropriated by sundry civil act approved June 4, 1897		113,000.00
		163,000.00
June 30, 1897, amount expended during fiscal year		24,475.21
July 1, 1897, balance unexpended		138,524.79
July 1, 1897, outstanding liabilities	$100.00	
July 1, 1897, amount covered by uncompleted contracts	118,598.49	
		118,698.49
July 1, 1897, balance available		19,826.30
Amount (estimated) required for completion of existing project		537,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		400,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

3


CHICAC
SOUTH BRANCH 3.
40' x 482'
CHICAGO RIVER, ILL.
SHOWING CHANNEL THROUGH
DRAWS AT
LOR ST. WISC. CENTR. R. R. & 12 th. ST.
BRIDGES.
1897
SCALE:
0 50 100 200 300 FT.

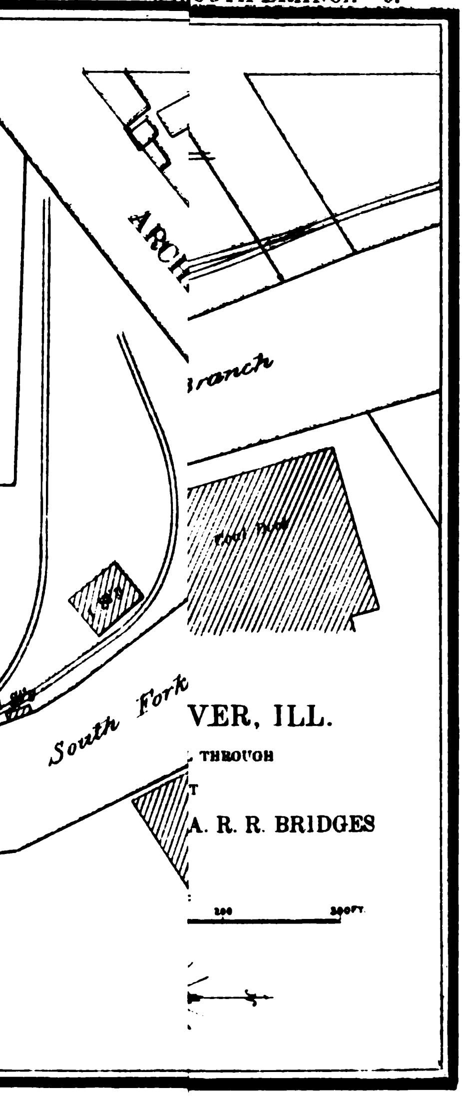
6

7

8

9

RIVER OBSTRUC OUTH BRANCH 9.



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Abstract of proposals for removing wreck of steam canal barge China, received in response to advertisement of November 23, 1896, and opened December 23, 1896, by Maj. W. L. Marshall, Corps of Engineers.

No.	Name of bidder.	Address.	Price.	Manner in which work is to be done.	Remarks.
1	Dunham Towing and Wrecking Co.	210 South Water street, Chicago, Ill.	$495.00	Remove boiler and parts of engine to make wreck lighter and then tow it out in lake and sink in deep water. Failing in this will tear wreck to pieces with dredge and put pieces on scows and sink them in lake.	Lowest bid.
2	Lydon & Drews Co.	Unity Building, Chicago, Ill.	500.00	By means of steam dredge and drivers.	

Abstract of proposals for dredging Chicago River, Illinois, received in response to advertisement of September 25, 1896, and opened at 12 m. October 24, 1896, by Maj. W. L. Marshall, Corps of Engineers.

No.	Name and address of bidder.	Main river and South Branch.						
		Dredging 458,427 cubic yards (per cubic yard).	Cost.	Removing 100 old piles (each).	Cost.	Removing old dock, etc., 250 cubic yards (per cubic yard).	Cost.	Total main river and South Branch.
		Cents.						
1	S. O. Dixon, Racine, Wis	......	....	......	....	......	....	....
2	Carkin, Stickney & Cram, Detroit, Mich	15¾	$72,202.25	$2.50	$250.00	$3.00	$750.00	$73,202.25
4	Chicago Dredging and Dock Co., Chicago, Ill	14	64,179.78	1 50	150.00	.25	62.50	64,392.28
5	Green's Dredging Co., Chicago, Ill.*a*	10.9	49,968.54	1.00	100.00	.50	125.00	50,193.54
6	Lydon & Drews Co., Chicago, Ill	12¼	56,157.31	1.00	100.00	.13	32.50	56,289.81
7	FitzSimons & Connell Co., Chicago, Ill	15½	71,056.18	1.75	175.00	.30	75.00	71,306.18

No.	Name and address of bidder.	North Branch.						
		Dredging 848,515 cubic yards (per cubic yard).	Cost.	Removing 100 old piles (each).	Cost.	Removing old docks, 250 cubic yards (per cubic yard).	Cost.	Total North Branch.
		Cents.						
1	S. O. Dixon, Racine, Wis	12¼	$103,943.09	$2.50	$250.00	$3.00	$750.00	$104,943.09
2	Carkin, Stickney & Cram, Detroit, Mich	13¾	116,670.81	2.50	250.00	3.00	750.00	117,670.81
3	Chicago Dredging and Dock Co., Chicago, Ill	12	101,821.80	1.50	150.00	.25	62.50	102,034.30
5	Green's Dredging Co., Chicago, Ill	9.9	84,002.99	1.00	100.00	.50	125.00	84,227.99
6	Lydon & Drews Co., Chicago, Ill.*b*	9.7	82,305.95	1.00	100.00	.13	32.50	82,438.45
7	FitzSimons & Connell Co., Chicago, Ill	14	118,792.10	1.75	175.00	.30	75.00	119,042.10

a Lowest bid for main river and South Branch.

b Lowest bid for North Branch.

List of contracts for improving Chicago River, Illinois, in force during fiscal year ending June 30, 1897.

Name and address of contractor.	Nature of contract.	Date.	To expire.
Green's Dredging Co., Chicago, Ill ...	Dredging main river and South Branch.	Nov. 5, 1896	Nov. 30, 1898
Lydon & Drews Co., Chicago, Ill.....	Dredging North Branch	.....do	Do.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 2, 1897.

MAJOR: I have the honor to submit herewith a report on operations in Chicago River, Illinois, during the fiscal year ending June 30, 1897.

There was no contract in force for the improvement of this river at the beginning of the year. Money having been appropriated under act of Congress of June 3, 1896, to wit, $50,000, bids for dredging according to project approved were advertised for and opened on the 24th of October, 1896. The said act authorized contracts to be entered into for the whole work of improving the main river and its branches between certain specified limits, but made only the above-mentioned amount available for immediate use. The specifications, used as a basis for bids, and designed to govern work under the contract, provided for separate bids if desired for work in the Main and South branches and for work in the North Branch, respectively, three-fifths of the available funds to be applied to the former and the other two-fifths to the latter, and also gave the contractors the option of suspending operations when available funds were exhausted or of continuing the work in anticipation of additional appropriation, before which no further payments could be made.

Contracts were entered into on the 5th of November, 1896, with the Green's Dredging Company for work in the Main and South branches to the stock yards, and with the Lydon & Drews Company for work in the North Branch to Belmont avenue. The terms of the former contract were for the removal of 458,427 cubic yards, more or less, of dredged material, at the rate of 10.9 cents per cubic yard; of 100 piles, more or less, at $1 each, and of 250 cubic yards, more or less, of old docks and piers, at 50 cents per cubic yard. Those of the latter were for the removal of 848,704 cubic yards, more or less, by dredging, at the rate of 9.7 cents per cubic yard; of 100 piles, more or less, at $1 each, and of 250 cubic yards, more or less, of old docks and piers, at 13 cents per cubic yard. Both firms are of Chicago, Ill.

WORK DONE DURING THE YEAR.

(A) In the Main and South branches:

Work in the Main Branch was commenced west of Rush Street Bridge on the 12th of November, 1896. On the 13th of January, 1897, work was closed for the season on account of the inclemency of the weather. At that time the channel was completed through the Main Branch and to the Twenty-second Street Bridge in the South Branch, with the exception of a number of bridge draws. Work was resumed on the 21st of March, 1897. All the bridge draws, heretofore omitted, were deepened, and at the close of the fiscal year the channel was completed to Ashland avenue, in the west fork of the South Branch (the terminal point in that fork), and to opposite Thirty-third street extended, in the south fork of the South Branch, a total distance of about 5¼ miles, by the removal of 258,966.7 cubic yards of dredged material and 11 piles. The last portion of the dredging has been in exceptionally hard material, which has considerably delayed the progress. A number of accidents have also been met with, the most remarkable of which was the explosion of a loaded dump scow near the mouth of the river, while on its way to the dumping ground, and which was accompanied by extensive damages to numerous adjacent buildings. No convincing theory has been offered in explanation of the cause. From and after the 28th of March, 1897, the work has been carried on continuously by day and by night, which was found necessary to comply with the clause in the contract requiring the removal of not less than 60,000 cubic yards per calendar month.

(B) In the North Branch:

Work in the North Branch was begun at the junction of the two branches near Lake Street Bridge on the 19th of November, 1896, and was suspended for the season on the 24th of December, at which time the channel had been improved to Chicago ce of about seven-eighths of a mile. Work for the season of 1897 the 15th of March and continued until the 9th of June, when the iling themselves of the privilege contained in paragraph 49 of the ected to suspend operations until additional funds should become portion of the available funds ($20,000) allotted to this contract d on the 19th of May, when the contractors were paid for the work ncluding that day. Work was, however, continued until the 9th of stated, with the understanding, in writing, that further payments upon a subsequent appropriation.

nt of work done up to the end of the fiscal year consisted in deepen-nnel to North avenue and about three-quarters of the length of the anal, which is about 1 mile in length, a total distance of, approxi-, by the removal of 248,610.3 cubic yards of dredged material and 2 ractors have generally worked from 14 to 16 hours per day. This ge is an exceptionally powerful machine, with a 4½-yard dipper and ving about 200 cubic yards per hour.

as dredged, under both contracts, to a depth of 17 feet below low d to 15 feet from existing docks. No old docks have been removed so far under either of the contracts.

rge *China*, which sank in the North Branch near Chicago Avenue h of November, 1896, and was abandoned by the owner, was removed ith the Dunham Towing and Wrecking Company in January, 1897, icles saved that were of any appreciable value, a tubular boiler and , were sold at public auction.

WORK PROPOSED FOR THE ENSUING YEAR.

to continue during the ensuing year and complete all the work under ging Company's contract to the established limits in the south fork anch at the stock yards. The Lydon & Drews Company have been ne work under their contract on the 2d of July. It is proposed to rk northward, and it is confidently expected that the channel will Belmont avenue, the northerly limit of the work contracted for, by 98, and under especially favorable circumstances it might be done he ensuing fiscal year.

of straightening and widening the river in the most obstructive ovisions in the act of Congress of June 4, 1897, will be taken up for d action during the year. Maps have been prepared and are sub-showing the most obstructive places in both branches of the river. e selection of these places those were chosen where a vessel of 48 2 feet in length could not pass, and this is illustrated on the maps at of said dimensions in a position where further progress would be

r, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

ARSHALL,
ngineers, U. S. A.

II 3.

PROVEMENT OF CALUMET HARBOR, ILLINOIS.

f the work is to provide a deep entrance to the Calumet e port at South Chicago, which object is effected in the by first protecting the proposed channel against drift by of jetties—in this case 300 feet apart, projecting into the shore at the river's mouth—and by dredging between roper depth.

CONDITION OF THE WORK JUNE 30, 1896.

begun on this harbor in 1870, and prior to June 30, 1896, eet of the south pier, and 3,640 linear feet of the north pier had been completed, and a channel 16 feet in depth between the piers had been secured and maintained, which completed the old project for this improvement.

CONDITION OF THE WORK JUNE 30, 1897.

The river and harbor act of June 3, 1896, adopted for this harbor a project submitted June 30, 1895, which provided for a channel depth of 20 feet, a prolongation of the south pier 1,200 linear feet and the north pier 500 linear feet.

Prior to the adoption of this project by Congress, by authority of the Chief of Engineers, a narrow channel, 20 feet in depth, barely practicable, had been begun under contract, leading from deep water in Lake Michigan as far as to the Illinois Steel Company's slip. Work under this contract was under way at the beginning of the fiscal year and was completed soon thereafter.

In February, 1896, a project supplementary to that of June 30, 1895, was submitted and published as House Executive Document No. 277 (see also Report of Chief of Engineers, U. S. A., 1896, p. 2584), which covered not only the requirements of the entrance to Calumet River, or the present harbor, but all the present needs of this locality. This extended project contemplated an outer breakwater, in continuation of the north pier of the Illinois Steel Company's harbor, to shelter the entrance to Calumet River and the Steel Company's harbor, and to form a sheltered roadstead to be dredged to 20 feet deep; the extension of the south pier 800 linear feet, and dredging the entrance to the river, and the river itself for a distance of two miles, for a width of 200 feet and to a depth of 20 feet.

Congress in making appropriations for Calumet Harbor adopted the project of June 30, 1895, but in appropriating for the river adopted that part of the later project relating to the 20-foot channel in Calumet River.

The outer breakwater is an urgent necessity, and if it be built the north pier of Calumet Harbor should not be extended, and the extension of 800 feet is sufficient for the south pier.

From the movement of sands in this vicinity it is very apparent that one of these projects should be more definitely adopted. The drift into the channel can only be stopped by the intervention of a solid obstruction or pier, and it is apparent that any material extension of the piers of the United States harbor will result in closing the approaches to the Illinois Steel Company's harbor by the sand caught and held against the United States piers.

Such a result should be avoided, and the harbors can both be protected by extending the north pier of the Illinois Steel Company's pier, as proposed in the report of February 26, 1896, while at the same time such a construction would make access to the docks at South Chicago possible at all conditions of weather. At present the entrance to the harbor can not be safely made by vessels during high winds or gales, and continuous dredging will soon be required to keep the channels navigable.

By authority of the Chief of Engineers the appropriation made by the act of June 3, 1896, has been applied to the execution of the work common to both projects named above, i. e., to the extension of the south pier 800 linear feet, and to dredging the channel between the piers and to a similar depth in Lake Michigan, to 20 feet depth below the low water of 1847. This work has been done during the year by contract with the lowest responsible bidders, after public advertisement, under which contracts (including the contract with Norris G. Dodge & Son, in effect at the beginning of the year) 223,006 cubic yards of material was dredged from the 20-foot channel, 808,966.6 feet B. M. hemlock timber, 281,688 feet pine timber, 20,917 feet oak plank, 320 pine piles, 13 white-oak piles, 82,056 pounds driftbolts, 64,804 pounds screw bolts, 2,205 pounds spikes, 222 pounds chain, 819 pounds boiler-plate iron, 2,326.12 cords of stone, and 4,219.1 cubic yards dredging for foundations of cribs were placed in the work or done in extending the south pier 800 linear feet.

This work was accomplished at considerably less cost than estimated and by authority of the Chief of Engineers a contract with the lowest responsible bidder, Mr. George Cooper, Manitowoc, Wis., was entered into June 14, 1897, for rebuilding superstructure over 500 linear feet of the north pier near its outer extremity. Work under this contract has begun, and about 80 feet of the old superstructure had been removed on June 30, 1897.

At present, then, there is a channel 20 feet in depth between the piers, but storms have somewhat filled in the channel seaward of the piers. On the completion of the present contract for rebuilding superstructure the work will be in good condition, except the revetment west of the Illinois Steel Company's slip, which is very much broken up, and needs rebuilding.

The Illinois Steel Company from time to time has done some dredging, especially outside of the piers of the two harbors.

The expenditure of the appropriation made for this harbor in the act of June 3, 1896, in connection with the 20-foot channel in Calumet River, now approaching completion, has provided Chicago with the finest harbor on Lake Michigan, capable of receiving and accommodating the largest vessels yet afloat on the Great Lakes, as long as the bar at the mouth of the river can be kept dredged. With an exterior breakwater to prevent formation of this bar there could be little to be desired at the present stage of development of wharfage at South Chicago.

The freights here consist almost entirely of heavy, bulky articles, such as iron ore, salt, coal, grain, and timber, which require the largest vessels, the cheapest freight rates, and the most commodious channels. The iron ore in great part comes from natural harbors of great depth, and cargoes have been limited by the depth of water at South Chicago, consequently the increased channels have been at once availed of; also in the grain, coal, and salt trade the value of this harbor has become apparent, and is evidenced by the doubling of the output from the elevators at South Chicago in one year. The steamer *Queen City* took out in 1896 a cargo of 208,000 bushels of corn from this port to Buffalo, or 5,800 tons of 2,000 pounds that established a new record in size of cargoes that can now be carried between Chicago and Buffalo.

The arrivals and departures of steam vessels at South Chicago during the past year were 1,454, the registered tonnage 2,116,482 tons, showing the average steam vessel to be of 1,456 tons register.

At Chicago the average registered tonnage of steam vessels arriving and departing was 790 tons.

The average steam vessel trading at South Chicago is larger than at any port on the globe, the reason for which, however, is seen in what has been stated above, i. e., the trade is almost entirely in the bulky, heavy freights, the more valuable freights, merchandise, package freight, etc., as well as pleasure, passenger, and excursion traffic go to Chicago River and Harbor, and the smaller vessels are in sufficient number to reduce the average tonnage.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE.

It is proposed to apply these funds to the prosecution of the work under contract, of rebuilding 500 linear feet superstructure over the north pier, and to such work of maintenance as may seem necessary from time to time.

PROPOSED APPLICATION OF FUNDS ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1899.

The fact that there are two projects for this locality, parts of each of which have been adopted by Congress, make it necessary to state the facts again explicitly. There remains to be done under the project of June 30, 1895, 400 linear feet in extension of the south pier and 500 linear feet in extension of the north pier, and some minor work, at an estimated cost of $79,550.

Under the supplementary project of February 21, 1896, there remains to be done the construction of the outer harbor, and if this latter project be adopted the 900 linear feet of pier extension in the former project is entirely unnecessary. The outer harbor sooner or later must be built as a necessity, and it would result in a saving of $79,550 if future appropriations went toward the construction of the works demanded by the later projects and no further work be done under the project of June 30, 1895.

The estimate submitted is therefore to be considered as for the construction of the outer harbor under the project or report of February 21, 1896.

It is proposed to apply such funds as may be granted under this project to extending the outer breakwater on the same line as the shore end of the north pier of the Illinois Steel Company's harbor, and to dredging the bar at the mouth of Calumet Harbor.

APPROPRIATIONS.

By act of—	
July 11, 1870	$50,000.00
March 3, 1871	50,000.00
June 10, 1872	40,000.00
March 3, 1873	40,000.00
June 23, 1874	25,000.00
March 3, 1875	25,000.00
August 3, 1876	20,000.00
June 18, 1878	15,000.00
March 3, 1879	12,000.00
June 14, 1880	20,000.00
March 3, 1881	30,000.00
August 2, 1882	35,000.00
July 5, 1884	20,000.00
By act of—	
August 5, 1886	$10,000.00
August 11, 1888	20,000.00
September 19, 1890	20,000.00
July 13, 1892	15,000.00
August 17, 1894	15,000.00
June 3, 1896	75,000.00
Total	537,400.00
Expended to June 30, 1897	512,731.28
Balance unexpended June 30, 1897	24,668.72

Money statement.

balance unexpended		$82, 911. 47
, amount expended during fiscal year		58, 242. 75
balance unexpended		24, 668. 72
outstanding liabilities	$56. 81	
amount covered by uncompleted contracts	9, 153. 93	
		9, 210. 74
balance available		15, 457. 98
timated) required for completion of existing project, Feb- 1896		1, 009, 830. 00
timated) required for completion of existing project, June		79, 550. 00
at can be profitably expended in fiscal year ending June		300, 000. 00

in compliance with requirements of sections 2 of river and
cts of 1866 and 1867 and of sundry civil act of June 4, 1897.

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roposals for dredging in Calumet Harbor, Illinois (160,000 cubic yards,), received in response to advertisement of August 3, 1896, and opened at 12 24, 1896, by Maj. W. L. Marshall, Corps of Engineers.

e of bidder.	Address.	Price per cubic yard.	Amount.	Remarks.
		Cents.		
nell & Co	Ludington, Mich	$9\frac{7}{10}$	$15, 520	Plant with which they propose to commence work not specified.
Vogel	Milwaukee, Wis	13	20, 800	Do.
Lutz Towing and .	Chicago, Ill	17	27, 200	Do.
Gillis & Co	do	$13\frac{4}{10}$	21, 440	Do.
ickney & Cram	Detroit, Mich	$10\frac{1}{2}$	16, 640	Plant with which they propose to commence work not specified. Justification of guarantors irregular.
redging and Dock	Chicago, Ill	23	36, 800	Plant with which they propose to commence work not specified.
Drews Co	do	9	14, 400	Plant with which they propose to commence work not specified. Lowest bid.
edging Co	Racine, Wis	14	22, 400	
redging Co	Chicago, Ill	12	19, 200	Plant with which they propose to commence work not specified.

roposals for pier extension, Calumet Harbor, Illinois (800 linear feet, more ceived in response to advertisement of August 3, 1896, and opened at 12 m., 1896, by Maj. W. L. Marshall, Corps of Engineers.

ne and address of bidder.	Hemlock timber (788,448 feet B. M.).		Pine timber (278,080 feet B. M.).		Pine piles (13).	
	Per M feet B. M.	Amount.	Per M feet B. M.	Amount.	Each.	Amount.
Leod and Donald A. McLeod, e, Mich	$16.00	$12, 615. 17	$21.50	$5, 978. 72	$11.00	$143.00
n & Young, Chicago, Ill	18. 50	14, 586. 29	24. 50	6, 812. 96	8. 25	107. 25
tar Construction and Dredging cago, Ill	15. 50	12, 220. 94	20. 00	5, 561. 60	7. 50	97. 50
Luts Towing and Dock Co., , Ill.*	15. 25	12, 023. 83	19. 50	5, 422. 56	8. 50	110. 50
ns & Connell Co., Chicago, Ill	19. 00	14, 980. 51	26. 00	7, 230. 08	7. 50	97. 50
Monroe, Charlevoix, Mich	15. 00	11, 826. 72	21. 00	5, 839. 68	9. 00	117. 00
Drews Co., Chicago, Ill	16. 25	12, 812. 28	21. 00	5, 839. 68	6. 00	78. 00
redging Co., Chicago, Ill	15. 00	11, 826. 72	19. 50	5, 422. 56	9. 10	118. 30

Abstract of proposals for pier extension, Calumet Harbor, Illinois, etc.—**Continued.**

No.	Name and address of bidder.	Oak piles (320).		Oak planks (16,280 feet B.M.).		Driftbolts (81,504 pounds).	
		Each.	Amount.	Per M feet B. M.	Amount.	Per pound.	Amount.
						Cents.	
1	Wm. McLeod and Donald A. McLeod, Manistee, Mich	$14.00	$4,480.00	$30.00	$488.40	2½	$2,037.60
2	Richardson & Young, Chicago, Ill	10.40	3,328.00	26.80	436.30	2¼	1,833.84
3	Chicago Star Construction and Dredging Co., Chicago, Ill	8.85	2,832.00	26.75	435.49	2.5	2,037.60
4	Hausler & Lutz Towing and Dock Co., Chicago, Ill.*a*	8.50	2,720.00	28.00	455.84	2.5	2,037.60
5	Fitz Simons & Connell Co., Chicago, Ill	9.50	3,040.00	35.00	569.80	3	2,445.12
6	Eslow & Monroe, Charlevoix, Mich	10.50	3,360.00	31.00	504.68	4	3,260.16
7	Lydon & Drews Co., Chicago, Ill	8.00	2,560.00	30.00	488.40	2	1,630.08
8	Green's Dredging Co., Chicago, Ill	9.10	2,912.00	30.00	488.40	2.5	2,037.60

No.	Name and address of bidder.	Spikes (2,000 pounds).		Screw bolts (5,500 pounds).		Ulster chain (130 pounds).		Stone (2,416 cords).	
		Per pound.	Amt.	Per pound.	Amt.	Per pound.	Amt.	Per cord.	Amount.
		Cents.		*Cents.*		*Cents.*			
1	Wm. McLeod and Donald A. McLeod, Manistee, Mich	3	$60.00	2.8	$154.00	50	$65.00	$6.00	$14,496.00
2	Richardson & Young, Chicago, Ill	2½	50.00	2½	137.50	7	9.10	5.68	13,722.88
3	Chicago Star Construction and Dredging Co., Chicago, Ill	4	80.00	3	165.00	6	7.80	5.60	13,529.60
4	Hausler & Lutz Towing and Dock Co., Chicago, Ill.*a*	4	80.00	3	165.00	10	13.00	5.00	12,080.00
5	Fitz Simons & Connell Co., Chicago, Ill	3	60.00	4	220.00	5	6.50	6.00	14,496.00
6	Eslow & Monroe, Charlevoix, Mich	4	80.00	5½	302.50	10	13.00	6.00	14,496.00
7	Lydon & Drews Co., Chicago, Ill	3	60.00	3	165.00	7	9.10	6.10	14,737.60
8	Green's Dredging Co., Chicago, Ill	3	60.00	3	165.00	10	13.00	5.50	13,288.00

No.	Name and address of bidder.	Boiler iron (920 pounds).		Dredging (6,880 cubic yards).		Total.
		Per pound.	Amount.	Per cubic yard.	Amount.	
		Cents.		*Cents.*		
1	Wm. McLeod and Donald A. McLeod, Manistee, Mich	30	$276.00	35	$2,408.00	$43,201.89
2	Richardson & Young, Chicago, Ill	3.5	32.20	12	825.60	41,881.92
3	Chicago Star Construction and Dredging Co., Chicago, Ill	3	27.60	15	1,032.00	38,027.13
4	Hausler & Lutz Towing and Dock Co., Chicago, Ill.*	10	92.00	18	1,238.40	36,438.73
5	Fitz Simons & Connell Co., Chicago, Ill	5	46.00	20	1,376.00	44,567.51
6	Eslow & Monroe, Charlevoix, Mich	5	46.00	20	1,376.00	41,221.74
7	Lydon & Drews Co., Chicago, Ill	3	27.60	12	825.60	39,233.34
8	Green's Dredging Co., Chicago, Ill	6	55.20	9	619.20	37,005.98

a Lowest bid. Irregular. Proposal not signed in corporation's name; guarantee made in corporation's name.

...proposals for rebuilding superstructure over north pier, Calumet Harbor, Illi-...red in response to advertisement of May 18, 1897, and opened at 12 m., June 8, ...Maj. W. L. Marshall, Corps of Engineers.

...d address ...dder.	White-pine timber, framed and secured in work (146,400 feet B. M.).		Wrought-iron drift-bolts in work (16,896 pounds).		Stone in work (30 cords of 128 cubic feet each).		White-oak piles, driven, sawed off, and secured in place (13).		Dredge chain, secured in place (130 pounds).		Total.
	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	Price.	Amount.	
...aier & ... Chicago, ...	$38.50	$5,636.40	Cts. 3	$506.88	$8.00	$240.00	$15.00	$195.00	Cts. 20	$26.00	$6,604.28
... & Lutz ...g and ...Co., Chi- ...Ill	23.00	3,367.20	2½	422.40	6.00	180.00	14.00	182.00	10	13.00	4,164.60
... J. Gay- ... Lnding- ...Iich.*a*	28.00	4,099.20	2½	422.40	6.00	180.00	13.00	169.00	7	9.10	4,879.70
... Cooper, ...itowoc, ...	23.00	3,367.20	2½	422.40	6.00	180.00	11.00	143.00	12	15.60	4,128.20
... & Peter ...son, Chi- ...Ill	24.75	3,623.40	2¾	464.64	6.50	195.00	13.50	175.50	8½	11.05	4,469.59
... Dredg- ...o., Chi- ...Ill	25.00	3,660.00	2.8	473.09	7.00	210.00	10.80	140.40	10	13.00	4,496.49
...Star Con- ...ion and ...ing Co., ...go, Ill	26.50	3,879.60	2	337.92	6.00	180.00	12.60	163.80	7	9.10	4,570.42
...& Drews ... Chicago, ...	24.50	3,586.80	2½	422.40	6.00	180.00	9.00	117.00	6	7.80	4,314.00

a Justification before notary public. *b* Lowest bid.

...ontracts for improving Calumet Harbor, Illinois, in force during fiscal year ending June 30, 1897.

...ddress of con-...ractor.	Nature of contract.	Date.	To expire—	Remarks.
...dge & Son, Chi-...	Dredging at entrance to harbor.	June 12, 1896	July 31, 1896	Extended to and completed Aug. 20, 1896.
...itz Towing and ...Chicago, Ill.	Pier extension	Sept. 1, 1896	June 30, 1897	Completed.
...rews Co., Chi-...	Dredging	......do	July 31, 1897	Completed Nov. 21, 1896.
...er, Manitowoc, ...	Rebuilding superstructure.	June 14, 1897	Aug. 31, 1897	

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 1, 1897.

... I have the honor to submit herewith a report on operations in Calumet ...inois, during the fiscal year ending June 30, 1897.

...eginning of the year there was one contract in force with Messrs. Norris G. ... Son, of Chicago, Ill., dated June 12, 1896, for deepening the channel ...e piers and through the bar at the harbor entrance, to a width consistent ...vailable amount of funds and the price bid, and to a depth of 20 feet ...water of 1847, by the removal of 27,500 cubic yards, more or less, of material, ... of 17½ cents per cubic yard. Work under this contract commenced during ...us year, on the 18th of June, 1896, and at the end of that month (the end ...al year) 5,200 cubic yards had been removed. The Illinois Steel Company ...o the beginning of the work under this contract, dredged a channel from the ...ir slip. This was 100 feet in width, with its northerly limit 70 feet south ...th pier. Work under the contract was therefore done north and south of ...el, until the slip was reached, after which the channel was dredged to within 50 feet of each of the piers. This work was done under a special authority, and with funds from an unexpended balance of the appropriation of August 17, 1894.

In the act of Congress of June 3, 1896, an appropriation of $75,000 was made for the improvement of this harbor. Bids were accordingly advertised for, and opened on the 24th of August, 1896, for, first, completing the dredging of the channel farther up the river, and to within 25 feet of the piers, and to a depth of 20 feet below low water of 1847; and second, the extension of the south pier 800 linear feet.

These contracts were awarded to the lowest bidders, respectively, viz: The first to the Lydon & Drews Company, of Chicago, Ill., for dredging 160,000 cubic yards, more or less, of material, at the rate of 9 cents per cubic yard—the lowest price ever received in this harbor. The second to the Hausler & Lutz Towing and Dock Company, of South Chicago, Ill., for pier extension, 800 linear feet, at the rates for work done and materials secured in place, as given hereafter in the copy of the last estimate.

Both these contracts were entered into on the 1st of September, 1896.

On the 8th of June, 1897, bids were opened for the rebuilding of the superstructure, six courses high, over the outer 500 linear feet of the North Pier, and for a clump of piles at the end thereof. A contract for this work was awarded on the 14th of the same month to Mr. George Cooper, of Manitowoc, Wis., the lowest bidder, at the following rates, viz: For pine timber, $23 per M feet B. M.; for wrought-iron driftbolts, 2¼ cents per pound; for stone, $6 per cord of 128 cubic feet; for white-oak piles, $11 each; and for Ulster iron chain, 12 cents per pound.

The prices bid were for all materials secured in place, and included also the removal of the old work and the replacing of the old stone, and the elevated walk, if required.

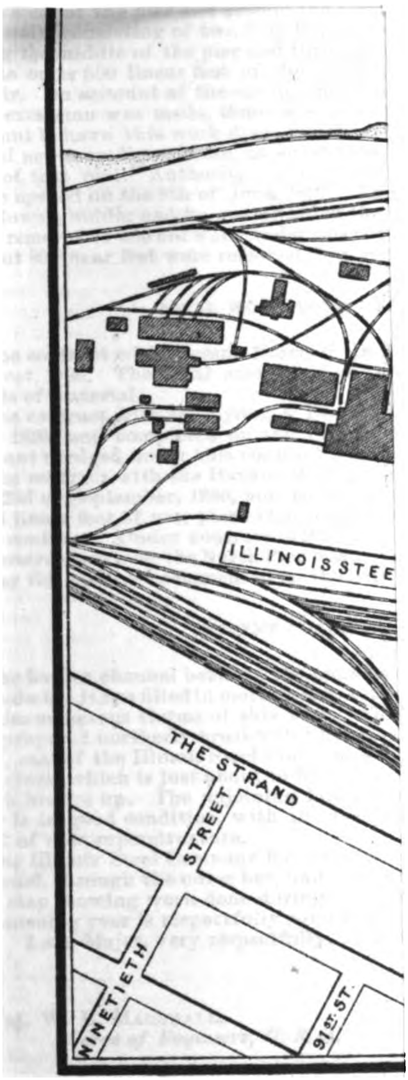
WORK DONE DURING THE YEAR.

Work under contract with Messrs. Norris G. Dodge & Son was completed on the 26th of August, 1896, after a total of 27,537.2 cubic yards of material had been removed (including the amount dredged during the previous fiscal year, 5,200 cubic yards). The time originally fixed for the expiration of the contract was July 31, but, owing to the very unfavorable weather prevailing during that season, an extension of time was granted to the 20th of August. Owing further to some special, necessary work in the draws of the Ninety-second Street bridge, done under a special written agreement, the completion of the contract was delayed until the date given above. The contractors received the final payment and the contract was closed.

Dredging operations under contract with The Lydon & Drews Company commenced on the 7th of September, with three dredges and eight dump scows. In consideration of the very low price for this work, the contractors were allowed to extend their operations some distance beyond what has been considered as the boundary between the river and the harbor (the intersection with the original shore line), and thus the material removed exceeded that contracted for by 40,669.4 cubic yards, amounting in all to 200,669.4 cubic yards. The contract was completed on the 18th of November, 1896; the contractors received the final payment on the 20th of that month, and the contract was closed. The channel dredged under this contract extended from deep water in the lake to the Car Ferry Company's slip.

The work of extending the south pier 800 linear feet, under contract with the Hausler & Lutz Towing and Dock Company, was commenced on the 23d of September, 1896, and completed on the 30th of June, 1897. The contractors deserve special mention for the class of work done under this contract. The alignment and level of the work are exceptionally good, and the materials used were of exceptionally good quality. The last estimate was submitted for payment and the contract closed, and as this estimate gives a full account of all the materials used under the contract, and also the prices paid, it is submitted herewith. It is as follows:

808,966.6 feet B. M. hemlock timber, at $15.25	$12,336.74
281,686 feet B. M. pine timber, at $19.50	5,492.88
20,917 feet B. M. oak plank, at $28	585.68
320 pine piles, at $8.50 each	2,720.00
13 white-oak piles, at $8.50 each	110.50
82,056 pounds wrought-iron driftbolts, at 2½ cents	2,051.40
6,480.4 pounds wrought-iron screw bolts, at 3 cents	194.41
2,205 pounds wrought-iron spikes, at 4 cents	88.20
222 pounds Ulster iron chain, at 10 cents	22.10
819 pounds boiler iron, at 10 cents	81.90
2,326.12 cords of stone, at $5 per cord	11,630.60
4,219.1 cubic yards of dredging, at 18 cents per cubic yard	759.44
Total	36,073.95
The payments previously made aggregated	31,048.22
And the contractors were paid	5,025.73


ILLINOIS STEE
THE STRAND
STREET
NINETIETH
91st. ST.

The cribs in this work were 8 in number, 100 feet each in length, 20 feet in width, and 16 courses (16¼ feet) in height.

The first crib was sunk on the 22d of October, 1896, the last on the 11th of May, 1897. They were covered by a superstructure 6 feet high, similar in construction to that of the crib. Some new innovations were adopted for this work. Experience has shown that in pier work of this kind the courses at or near the water level become in time very seriously affected by the action of ice, which in many cases has worn away the otherwise sound timbers to almost half of their width, leaving a very poor support for a new superstructure, when needed. To protect these timbers an ice guard was constructed along the new work. This consists of 2 by 12 inch oak plank, 5 feet in length, spiked on to the work perpendicularly, so that the bottom would reach 2 feet below low water and the top 3 feet above. A 3 by 12 inch oak wale was afterwards bolted on to bind the whole together. Another deviation from the usual modes of construction was the strengthening of the corners at the end of the pier by surrounding them with a covering of boiler iron, in a similar manner to that used in Chicago Harbor a few years ago. For further protection of the end of the pier, a clump of 13 oak piles was placed there, with its center about 15 feet therefrom and in line with the channel-side longitudinals. Riprap was placed along both sides of the pier and around the clump.

A walk, consisting of two 3 by 12 inch hemlock plank laid side by side, was laid along the middle of the pier and throughout its whole length.

The outer 500 linear feet of the north pier have for some time been in need of repair. On account of the exceptionally low prices at which the work of the south pier extension was made, there was an unexpended balance available, sufficient in amount to have this work done, which was the more needed on account of a proposed new iron light-house, as substitute for the old frame beacon located at the end of that pier. Authority was obtained for rebuilding the superstructure. Bids were opened on the 8th of June, 1897. Mr. George Cooper, of Manitowoc, Wis., was the lowest bidder and he was awarded the contract on the 14th of the same month. The removal of the old work under this contract was commenced on the 25th of June. About 80 linear feet were removed, but no new work was done.

TOTAL WORK DONE UNDER THE CONTRACTS.

The contract with Messrs. Norris G. Dodge & Son was completed on the 26th of August, 1896. The total amount of work done was the removal of 27,537.2 cubic yards of material.

The contract with the Lydon & Drews Company was begun on the 7th of September, 1896, and completed on the 18th of November of the same year. The total amount dredged under this contract was 200,669.4 cubic yards.

The contract with the Hausler & Lutz Towing and Dock Company was begun on the 23d of September, 1896, and completed on the 30th of June, 1897. Eight hundred linear feet of new pier extension was completed, and one clump of piles, under this contract. Under contract with Mr. George Cooper, 80 linear feet of the old superstructure over the North Pier was removed, but no new work was done. Work under this contract commenced on the 25th of June, 1897.

PRESENT CONDITION OF THE HARBOR.

The harbor channel between the piers has now a depth of 20 feet, but through the outside bar it has filled in more or less, since the dredging operations were completed, by the numerous storms of this year. This will undoubtedly recur regularly until the proposed northerly breakwater has been built to protect this area. The North Pier, east of the Illinois Steel Company's Slip, is in good condition, except the superstructure, which is just about to be rebuilt. The revetment west of the slip is very much broken up. The adjoining land belongs to the Steel Company. The South Pier is in good condition, with the exception of about 500 linear feet, which is in need of new superstructure.

The Illinois Steel Company has done some dredging at their own expense in the channel, through the outer bar, and in their own harbor during the past year.

A map showing work done during the year and work proposed to be done during the ensuing year is respectfully submitted herewith.

I am, Major, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

I I 4.

IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this work as originally projected was to secure a channel 16 feet in depth, 200 feet wide, from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the commerce of this region and to give relief to the overcrowded port of Chicago.

The history of the work, especially as regards the conditions imposed by various river and harbor acts of Congress, may be found in the Annual Reports of the Chief of Engineers prior to 1890, especial attention being invited to the Report of 1889, page 2142.

The United States have acquired the right of way and releases from claims for damages by reason of the improvement of Calumet River over the stretch from the mouth of the river to the outlet from Lake Calumet, the limits of the improved channel to be dock lines 200 feet apart, which have been established by authority of the Secretary of War.

The improvement above the forks, or from the forks to one-half mile east of Hammond, Ind., can not be made of the full width of 200 feet until the right of way and releases from damages have been acquired by the United States. In view of this fact, under provisions of various acts of Congress, the work has been subdivided into two sections—

(1) From the mouth of the river to the forks of the Calumet ("Below the Forks").

(2) From the forks to one-half mile east of Hammond, Ind.

No steps have been authorized by Congress or undertaken by parties interested to secure rights of way and releases from damage claims for the improvement above the forks, and consequently work has been carried on in desultory fashion over that section in an attempt to secure a channel 60 feet wide and 10 feet deep. This section is part of an old river, now dead, or without current to carry off the filth cast into it from slaughter houses and manufactories near Hammond and from the sewers of the town. The dredged channels were filled up with filthy deposits as fast as excavated, and after repeated attempts to secure the depths sought the work was abandoned in 1895, for reasons more fully given in the Report of the Chief of Engineers, United States Army, for that year.

On the lower section of the river, or from its mouth to the forks of the Calumet—this section lies wholly within the State of Illinois—systematic work has been carried on since 1888 up to the close of the fiscal year 1896 to secure a channel 200 feet wide and 16 feet deep, and prior to that date the work had been extended as far as to One hundred and eighteenth street crossing, a distance of 3¾ miles, with the exception of a short stretch of rock and hardpan, involving the future excavation of about 9,000 cubic yards of rock in place, over which stretch the full-depth channel is only 80 feet wide. The work deteriorated rapidly in depth near the upstream limit and much of it had been dredged the second time.

In view of the rapid increase in size and draft of vessels on the Great Lakes, due the near completion of an enlarged channel between Duluth, Chicago, and Buffalo, and of the impracticability of speedily providing elsewhere at Chicago a channel of sufficient capacity for such large vessels, Congress provided in the river and harbor act of June 3, 1896, that the Calumet River may be dredged to a depth of 20 feet for 2 miles southward from the mouth. The elevators, coal and salt docks, and principal establishments along the river are within this 2-mile limit.

CONDITION OF THE WORK JUNE 30, 1897.

There have been removed by dredging between the mouth of the river and One hundred and eighteenth street, in making the 16-foot channel, 1,436,358 cubic yards, and in maintaining this channel by redredging 330,862 cubic yards, or in all on this 16-foot project 1,767,220 cubic yards.

In dredging the 20-foot channel, about 1¼ miles have been completed to full dimensions, from which 222,400 cubic yards have been removed.

In the attempt to make and maintain a channel 60 feet wide and 10 feet deep from the forks to one-half mile east of Hammond, Ind., there has been done in primary dredging to make the channel 150,094 cubic yards, and in redredging 98,422 cubic yards. The channel is now in much worse condition than when the work begun.

The channel below the forks fills in at the rate of about 22,340 cubic yards per mile per annum, and there remains about 240,000 cubic yards of redredging to restore the channel to its full depth between the end of the 20-foot channel, near One hundred and sixth street, and the end of the dredged 16-foot channel, at One hundred and eighteenth street. Above One hundred and eighteenth street boats carrying more than 7 feet can not pass, and in the vicinity of Hammond, Ind., it will be difficult for boats to navigate drawing as much as 5 feet.

WORK DONE DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

The river and harbor act of June 3, 1896, appropriated $50,000, and therein Congress adopted the project contained in the report of February 21, 1896, as far as to authorize the Calumet River to be dredged to a depth of 20 feet from the mouth of the river a distance of 2 miles southward therefrom. With the approval of the Chief of Engineers, United States Army, a contract was entered into with C. E. Mitchell & Co., Ludington, Mich., the lowest responsible bidders for the work, September 1, 1896, for dredging 320,000 cubic yards, more or less, at 13¾ cents per cubic yard, measured in place. Work began under the contract September 15, 1896, and at the close of the year, June 30, 1896, there had been removed 222,400 cubic yards, carrying the 20-foot channel from the mouth of the river, at Calumet Harbor, a distance of 1¼ miles southward.

The estimate for the work was $51,700, and the amount appropriated will barely accomplish it.

The want of a turning or winding basin in Calumet River was so evident and urgent that one was laid out in the old channel at the cut-off, opposite the Counselman Elevators slip, giving sufficient room for turning or winding the largest vessels trading on the Great Lakes. Similar basins should be constructed at intervals of 1 mile in any waters under control of the United States for purposes of navigation. Such places exist in the old beds of the river where cut-offs have been made in straightening the channel, and the dock lines should be changed to pre-empt such basins.

Now that a sufficient channel has been made in the lower part of the Calumet River, this harbor is one of the best on Lake Michigan. Large vessels can enter and reach their berths with little or no aid from tugs, and the bridges, with the exception of the three bridges nearly in contact of the Baltimore and Ohio, Pennsylvania, and Lake Shore railroads, are not obstructive for the largest vessels. The three bridges named require removal or material modification.

PROPOSED USES OF FUNDS NOW ON HAND AND THOSE ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1899.

It is proposed to expend the funds now on hand in carrying on and completing the work on the 20-foot channel.

It is proposed to apply the funds asked for to redredging the 16-foot channel from One hundred and sixth street to One hundred and eighteenth street and to extending this channel southward from One hundred and eighteenth street.

APPROPRIATIONS.

By act of—		By act of—	
July 5, 1884	$50,000.00	June 3, 1896	$50,000.00
August 5, 1886	30,000.00		
August 11, 1888	50,000.00	Total	350,000.00
September 19, 1890	50,000.00	Expended to June 30, 1896	317,336.28
July 13, 1892	75,000.00		
August 17, 1894	45,000.00	Balance unexpended June 30, 1896	32,663.72

Money statement.

July 1, 1896, balance unexpended		$58,157.93
June 30, 1897, amount expended during fiscal year		25,494.21
July 1, 1897, balance unexpended		32,663.72
July 1, 1897, outstanding liabilities	$100.00	
July 1, 1897, amount covered by uncompleted contracts	22,433.03	
		22,533.03
July 1, 1897, balance available		10,130.69
Amount (estimated) required for completion of existing project		700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for dredging in Calumet River, Illinois (320,000 cubic yards, more or less), received in response to advertisement of August 3, 1896, and opened at 12 m., August 24, 1896, by Maj. W. L. Marshall, Corps of Engineers.

No.	Name of bidder.	Address.	Price per cubic yard.	Amount.
			Cents.	
1	C. E. Mitchell & Co.[a]	Ludington, Mich	$13\frac{1}{4}$	$42,400.00
2	Arthur H. Vogel	Milwaukee, Wis	$14\frac{3}{8}$	46,000.00
3	W. A. McGillis & Co	Chicago, Ill	$16\frac{2}{5}$	52,480.00
4	Carkin, Stickney & Cram[b]	Detroit, Mich	$13\frac{3}{8}$	42,800.00
5	Chicago Dredging and Dock Co	Chicago, Ill	16	51,200.00
6	Racine Dredge Co	Racine, Wis	24	76,800.00
7	Lydon & Drews Co	Chicago, Ill	17	54,400.00
8	Green's Dredging Co	do	14	44,800.00

[a] Lowest bid. [b] Justification of guarantors irregular.

Contract for improving Calumet River, Illinois, in force during fiscal year ending June 30, 1897.

Name and address of contractor.	Nature of contract.	Date.	To expire.
C. E. Mitchell & Co., Ludington, Mich	Dredging	Sept. 1, 1896	Sept. 1, 1897

EPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 3, 1897.

have the honor to submit herewith a report on operations in Calumet ois and Indiana, for the fiscal year ending June 30, 1897.

ginning of the year there was no contract in force for any work to be done rovement of this river, but, money having been appropriated for this the act of Congress of June 3, 1896, bids were advertised for and opened of August following. A contract was entered into with the lowest bid- . C. E. Mitchell & Co., of Ludington, Mich., on the 1st of September of ar for dredging the channel from the mouth of the river to One hundred treet Bridge, a distance of 2 miles, to a depth of 20 feet below low-water the removal of 320,000 cubic yards, more or less, of material, at the rate per cubic yard

WORK DONE DURING THE YEAR.

der the contract commenced on the 15th of September, 1896, with one nging to Messrs. Norris G. Dodge & Son. Later the plant was increased he contractors' own dredges, which had been delayed on their way to this e prevailing severe storms of the season. The progress was quite slow ne. On the 30th of November the channel was completed for a distance t, or up to the Counselman Elevators slip.

of a basin for large vessels to turn around in had been apparent for some he old channel opposite the just-mentioned slip offering a favorable ch a basin, it was then decided to construct one at that place with the as that given to the river, and this was done. It was completed on the ember, 1896, after which operations were closed for the season. Work d on the 30th of March, 1897, but, the progress continuing slow and below ments of the contract (60,000 cubic yards per month), the contractors ned that no payments would be made until the terms of the contract were ith, and accordingly no payment was made in the month of April. The secured then, on the 8th of May following, the services of an additional onging to the Sheboygan Dredging and Dock Company, and the results ially improved.

t amount of material removed up to the end of the fiscal year can not be he payments are made according to measurement in place, and the work g the month of June, though practically completed, has not yet been The channel completed prior to June 1, and paid for, was 4,726 feet in contained, including the turning basin, 167,438 cubic yards. The chan- was about completed at the close of the month of June, is 2,060 feet in will contain about 55,000 cubic yards of material. On this basis there moved up to the end of the year about 222,400 cubic yards, completing l for a distance of 6,786 feet, or slightly in excess of 1¼ miles. Large ave occasionally been found in the channel. On the 30th of June last l of one of these occupied four and three-fourths hours.

was done during the year in the river above the forks.

PRESENT CONDITION OF THE RIVER.

at present a 20-foot channel from deep water in the lake to the Chicago ing Company's dry dock. Thence to One hundred and sixth street there ge depth of from 16 to 17 feet, which, however, is to be increased to 20 the present working season. No soundings have been taken above One d sixth Street Bridge since the writing of last year's report.

PROGRESS OF THE RIVER IMPROVEMENT.

howing the total amount of work done in this river since the beginning rovement is respectfully submitted herewith. This shows the various nder which work has been done with results and details pertaining to

WORK PROPOSED FOR THE ENSUING YEAR.

osed to continue and complete the work provided for under the existing o wit, the deepening of the channel to 20 feet below low water of 1847 One hundred and sixth Street Bridge. The available funds will be suf- this work but not for any work beyond this place, wherefore the redredg- channel between One hundred and seventh and One hundred and eleventh ovided for in the specifications in case the available funds should permit, done under this contract.

According to the terms of the contract the work must be completed on or before the 1st of September, 1897. It probably will if the plant in use at present is maintained at work.

I am, Major, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

ACCOUNT OF IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

A.—*Below the forks; channel 200 feet wide.*

[Contracts 1 to 5, 16 feet deep; contract 6, 20 feet deep.]

Contract. No.	Contract. Date.	Contractor.	Period of work. Beginning.	Period of work. Ending.	Amount dredged. New channel.	Amount dredged. Redredging.	Total.
					Cubic yds.	*Cu. yds.*	*Cubic yds.*
1	Nov. 5, 1888	W. A. McGillis & Co	May 4, 1889	Dec. 21, 1890	771, 737	....	771, 737
2	Dec. 10, 1890	Wheeler & Purcell	Apr. 6, 1891	June 30, 1892	365, 719	....	365, 719
3	Oct. 28, 1892	Sheboygan Dredge and Dock Co.	May 30, 1893	May 9, 1894	298, 902	101, 632	400, 534
4	*a* May, 1894	W. A. McGillis & Co	May 24, 1894	Aug. 22, 1894	....	50, 035	50, 035
5	Oct. 1, 1894	.....do	Oct. 1, 1894	Aug. 20, 1895	....	179, 195	179, 195
6	Sept. 1, 1896	C. E. Mitchell & Co	Sept. 15, 1896	In force	*b* 222, 400	....	222, 400
		Total to end of fiscal year.	....	....	1, 658, 758	330, 862	1, 989, 620

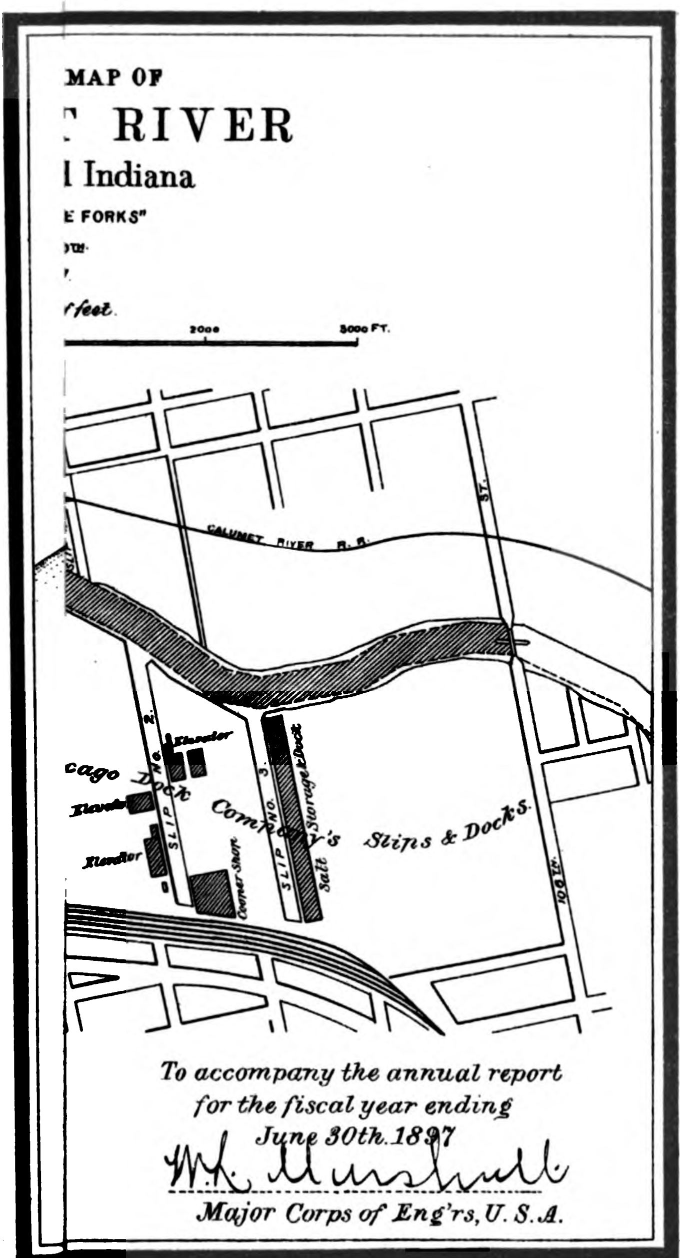
No.	Contractor.	Price per cubic yard.	Cost of— New channel.	Cost of— Redredging.	Length of channel improved. New.	Length of channel improved. Redredged.
		Cents.			*Feet.*	*Feet.*
1	W. A. McGillis & Co	11.75	$90, 679. 10	....	12, 165	....
2	Wheeler & Purcell	12.25	44, 800. 58	....	4, 020	....
3	Sheboygan Dredge and Dock Co	10.7	31, 982. 52	$10, 874. 62	3, 333	2, 300
4	W. A. Gillis & Co	10.7	....	5, 353. 74	....	*c* 8, 700
5	.....do	16.5	....	29, 567. 16	....	11, 826
6	C. E. Mitchell & Co	13.25	29, 468. 00	....	*d* 6, 786	....
	Total to end of fiscal year	....	196, 930. 20	45, 795. 52	26, 304	14, 126

a A special agreement.
b Approximately.
c This amount being only for "half width" and other half being done under following contract, is not included in total length dredged.
d New as a 20-foot channel but where dredging had been previously done to 16 feet.

B.—*Above the forks; channel 60 to 70 feet wide, 10 feet deep.*

Contract. No.	Contract. Date.	Contractor.	Period of work. Beginning.	Period of work. Ending.	Amounts dredged. New channel.	Amounts dredged. Redredging.	Total.
					Cubic yds.	*Cu. yds.*	*Cubic yds.*
1	Aug. 11, 1887	S. O. Dixon	Sept., 1887	May 5, 1888	76, 804	......	76, 804
2	Oct. 31, 1888	Burdick & McMahon	May 7, 1889	Aug. 12, 1889	54, 100	10, 726	64, 826
3	Oct. 28, 1892	Wisconsin Dredge and Dock Co.	May 15, 1893	June 5, 1894	19, 190	72, 772	91, 962
4	Oct. 1, 1894	McMahon & Montgomery Co.	Oct. 11, 1894	*a* Dec. 6, 1894	....	14, 924	14, 924
		Total to end of fiscal year.	....	....	150, 094	98, 422	248, 516

a The contract was canceled at the request of contractors March 18, 1895.


MAP OF
RIVER
Indiana
E FORKS"
feet.
2000
3000 FT.
ST.
CALUMET RIVER R. R.
SLIP NO. 2.
Elevator
Elevator
Elevator
cago Dock Company's Slips & Docks
SLIP NO. 3.
Salt Storage Dock
Cooper Shop
100 Ft.
To accompany the annual report
for the fiscal year ending
June 30th. 1897
Major Corps of Eng'rs, U. S. A.

B.—*Above the forks; channel 60 to 70 feet wide, 10 feet deep*—Continued.

No.	Contractor.	Price per cubic yard.	Cost of—		Length of channel improved.	
			New channel.	Redredging.	New.	Redredged.
		Cents.			*Feet.*	*Feet.*
1	S. O. Dixon	11	$8,448.44		4,900	
2	Burdick & McMahon	22	11,902.00	$2,359.72	5,600	2,200
3	Wisconsin Dredg and Dock Co	13.7	2,629.03	9,969.76	2,900	4,900
4	McMahon & Montgomery Co	12.9		1,925.20		1,500
	Total to end of fiscal year		22,979.47	14,254.68	13,400	8,600

I I 5.

IMPROVEMENT OF ILLINOIS RIVER, ILLINOIS.

The object of this improvement is to secure ultimately, in connection with an enlargement of the Illinois and Mississippi Canal, or an equivalent enlarged channel, a waterway from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for large-sized Mississippi River steamboats, and for military and naval purposes.

The present project was adopted in 1880, and contemplates the extension of the slack-water improvement begun by the State of Illinois, from the mouth of Copperas Creek to the Mississippi River at Grafton, Ill., a distance of 135 miles. The project includes the construction of two locks, each 350 feet in length of chamber, 75 feet in width, and with 7 feet depth at low water over sills, and dredging the channel where necessary to secure that depth of water at low water throughout the pools created by the dams.

The locks and dams have been completed and have been in use since 1889 and 1893, respectively. One is situated at Lagrange, 79 miles above the mouth of the Illinois, the other at Kampsville, 31 miles from the Mississippi.

The State of Illinois, aided by the United States, has executed part of the general project by the construction of locks and dams at Henry and Copperas Creek, completing, except dredging, that part of the project between Lasalle and the mouth of Copperas Creek, a distance of about 90 miles, over which section the State of Illinois collects tolls.

In executing this work the United States has expended prior to June 30, 1897, $1,344,090.62, including $25,000 from appropriation of August 11, 1888, for surveys, and exclusive of $62,359.80 expended upon a foundation for Copperas Creek Lock, afterwards completed by the State of Illinois.

An additional amount of $747,747 was expended by the State of Illinois at Henry and Copperas Creek.

CONDITION OF THE WORK JUNE 30, 1897.

During the fiscal year ending June 30, 1897, the following work was done:

The condition of the dredging plant as reported in the last annual report was such that it was necessary to practically rebuild the dredges and tenders. Consequently, two new dredge tenders were constructed by hired labor at the United States yards at Keokuk, Iowa. A new hull was constructed for dredge No. 1 and new cranes for both dredges, a new hull for a quarter-boat for the dredge crews was constructed, and a general overhauling and repair of the other plant made.

On account of the litigation over the Moline Bridge across Rock River, the dredging plant constructed the preceding year for the Illinois and Mississippi Canal could not be used and was transferred to the Illinois River, awaiting the removal of that obstruction.

The repairs and renewals were not completed until the spring of 1897, and work was further delayed awaiting the subsidence of the flood in the Illinois River.

Work began May 17, 1897, and at the close of the year 51,631 cubic yards of material had been dredged from the bars at Devils Elbow, Grand Island, Sugar Creek, and Macoupin Creek. Work was still in progress at the close of the year at Macoupin Creek Bar. The bars are being dredged to allow the full depth to be attained at low water over a practicable width of channel.

With few exceptions the dredged channels are reasonably permanent, the exceptions being at mouths of certain creeks and tributaries which bring in detritus from the bluffs. Such places will require redredging at intervals of from two to three years.

The expenditures during the year were mainly for renovating the plant. There are now available in good working order on the Illinois River 3 dredges, 3 steam tenders, 2 quarter boats, 6 dump scows, and several coal barges, and good progress may be expected.

The shallow water outside of channels at low water limits the capacity of scow loads and restricts the output of the dredges. It would be economy to construct one powerful hydraulic dredge, with means for transporting the spoil through pipes, to supplement the dipper dredges now employed.

The annual report of the Chief of Engineers for 1896, page 2597, contains a concise résumé of this improvement and remarks to which attention is again invited.

During the past fiscal year a good stage of water existed in the Illinois River throughout the season of navigation. Low water was not reached in any of the pools, or below the Kampsville Dam. The tonnage passing Lagrange and Kampsville locks increased from 294,983 to 342,265 tons. No report has been received from the State works at Henry and Copperas Creek, but the United States records show an increase of about 15 per cent over the preceding year, although one of the most important boats making triweekly trips from St. Louis to Kampsville, destroyed by the cyclone at St. Louis, was not replaced. The year marked a diminution of lockages at Kampsville lock and a considerable increase at Lagrange lock. This has arisen from the fact that local traffic is directed to Peoria and is carried on in large part by small steamers with barges carrying farm produce.

The clearing and use of bottom lands and the leveeing of the same to protect them against overflow is rapidly increasing, and the wisdom of improving this natural waterway will become more and more apparent by the uses made of it as the channel is improved.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE AND THOSE ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1899.

It is proposed to apply the funds now available to continuing the dredging in the pools to attain the full depth over a practicable width

el, to be afterwards widened, and to the care and preservation
operty pertaining to the improvement.
roposed to apply the funds asked for to the purchase of an
l dredge and outfit and to the completion of the channel
ut from Copperas Creek to the Mississippi.

Disbursements, fiscal year 1897.

	$200.01
	2,992.57
dence and office	5,242.46
nd plant	13,494.05
epair of property and plant	1,914.06
l	23,843.15

APPROPRIATIONS.

80, available from previous appropriations	$38,337.81
4, 1880	110,000.00
3, 1881	250,000.00
2, 1882	175,000.00
1884	100,000.00
5, 1886	112,500.00
11, 1888	200,000.00
29, 1890, joint resolution	200,000.00
3, 1892	100,000.00
t 17, 1894	35,000.00
, 1896	40,000.00
	1,360,837.81
rom all other sources	535.40
l	1,361,373.21
to June 30, 1897	1,344,096.62
nce unexpended June 30, 1897	17,282.59

Money statement.

6, balance unexpended	$41,125.74
97, amount expended during fiscal year	23,843.15
7, balance unexpended	17,282.59
7, outstanding liabilities	3,101.58
7, balance available	14,181.01
(estimated) required for completion of existing project	357,000.00
that can be profitably expended in fiscal year ending June 30, 1899	357,000.00

ed in compliance with requirements of sections 2 of river and
acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *June 30, 1897.*

I have the honor to submit the following report of operations upon
Illinois River for the fiscal year ending June 30, 1897:
k done during the year consisted in building a new hull for dredge No. 1,
inor repairs to the other floating property, and dredging the channel of

the river at the following points: Devils Elbow, head of Grand Island, mouth of Sugar Creek, and at mouth of Macoupin Creek. Two steam tenders were built at the Des Moines Rapids Canal dry dock by Mr. M. Meigs, U. S. C. E.

REPAIRS TO PLANT.

Dredge No. 1.—A new hull was built for this dredge, using the iron truss for supporting the crane from the old hull. The hull is 80 feet long by 30 feet wide and 7 feet 4 inches deep. The timber used was principally Oregon fir, of such lengths as to need no splices, even in the gunwales or fore-and-aft keelsons. The machinery of this dredge being good, it was used on the new hull, only a new boiler being purchased. The woodwork of the crane was renewed, new spuds and new dipper arms provided, the dippers were changed, a 2¼-cubic-yard dipper being put on in place of the 1½-cubic-yard dipper formerly used, the friction blocks of the hoisting drum were set out, and a new cone for backing friction put in.

Dredge No. 2.—This dredge was furnished with six new spuds, a new pair of dipper arms, and the friction of the backing drum was set out.

Dredge Apache.—This dredge was furnished with a new set of dipper arms, new brass bushing put in spider frame, one of the spider-frame arms welded, a switch for turning the exhaust steam into the smokestack was connected with the exhaust pipe, and friction of both hoisting and backing drums was set out.

Steam-tender Marion.—The hog chains were adjusted, the engines lined up, the buckets on the wheel made larger by increasing their depth 4 inches, and a new 6-inch lap-welded flue put in for a heater in place of the riveted-joint heater which came with the boat.

Office boat.—A lot of pigeonholes for stationery were made, a few plank put in the deck and guards, and new combing made for the hatches.

Launch W. M. Childs.—This boat was painted during the winter after it was hauled out on the bank and housed.

Dump scows.—New nosing was put around three of the scows, five rake plank and two rake timbers being put in one scow.

Skiffs.—Made six skiffs.

DREDGING.

Work began at Devils Elbow, 5 miles below Havana, May 17. This bar was 1,800 feet long, with about 3 feet of water at low water in the shoalest place. A channel 155 feet wide was dug through the bar, making 7 feet of water at low water, with flashboards on the Lagrange Dam. The channel was completed June 1 by the removal of 17,740 cubic yards of sand.

Head of Grand Island.—A bar about 7 miles below Havana, below the head of Grand Island in the West Point Chute, which was a slight obstruction, was dredged, giving a channel 105 feet wide and 7 feet deep at low water, with flashboards on the Lagrange Dam. The channel through this bar was completed June 3 by the removal of 3,219 cubic yards of sand.

Sugar Creek.—At this point, which is 25 miles below Havana, there are two channels, one on each side of Sugar Island. The one on the east side is used by small boats only. When the west channel was dredged in former years a dike was built across the east channel. This dike was removed for one-half of the width of the channel and the west channel dredged, a total of 4,211 cubic yards being removed from both channels. Work here began June 4 and was completed June 8. The dredges and outfit were then towed to the mouth of Macoupin Creek, arriving there June 10, in the evening.

Macoupin Creek.—Work began at this bar, 12½ miles below Kampsville Lock, June 11. A cut 2,200 feet long, 130 feet wide, with from 7 feet to 7½ feet at low water, was made to June 30. There were 26,761 cubic yards of sand removed and dumped on the east side of the river, with a view of contracting the channel and forcing the water through the dredged channel. This bar was dredged in the fall of 1894, but heavy rains about the head of Macoupin Creek, when the water in the river was at a comparatively low stage, caused a shoaling until there was less than 3 feet of water in parts of the dredged channel.

Very respectfully, your obedient servant,

C. V. BRAINARD, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers.

Means of (tridaily) readings of the upper gauge at Copperas Creek Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.40	14.07	15.63	13.60	13.50	14.47	12.17	14.57	13.17	12.93	12.80	13.40
2	18.30	14.17	15.83	13.60	13.47	14.57	12.03	14.63	13.07	13.10	12.90	13.40
3	18.20	14.36	16.00	13.50	13.37	14.47	12.00	14.80	13.00	13.30	12.90	13.40
4	17.90	14.40	16.07	13.50	13.30	14.40	12.33	14.80	13.00	13.60	13.00	13.30
5	17.70	14.40	16.00	13.47	13.27	14.40	12.37	14.80	12.90	13.90	13.03	13.30
6	17.60	14.50	15.97	13.33	13.20	14.30	12.03	14.70	12.87	14.03	13.10	13.30
7	17.47	14.50	15.90	13.33	13.03	14.20	11.97	14.70	12.80	14.10	13.20	13.30
8	17.30	14.53	15.77	13.23	12.93	14.07	11.80	14.70	12.80	14.13	13.23	13.30
9	17.13	14.73	15.70	13.23	12.80	14.00	11.70	14.70	12.80	14.20	13.40	13.20
10	16.97	14.80	15.63	13.60	12.73	13.80	11.60	14.70	12.70	14.20	13.30	13.20
11	16.87	14.80	15.60	13.50	12.63	13.67	11.60	14.60	12.70	14.20	13.40	13.20
12	16.80	14.80	15.60	13.43	12.47	13.60	11.60	14.50	12.67	14.17	13.50	13.20
13	16.70	14.80	15.47	13.37	12.40	13.60	11.50	14.37	12.67	14.10	13.50	13.20
14	16.60	14.70	15.40	13.30	12.30	13.57	11.47	14.27	12.77	14.07	13.50	13.20
15	16.30	14.60	15.40	13.30	12.20	13.43	11.40	14.06	12.80	13.90	13.50	13.20
16	16.13	14.60	15.33	13.27	12.13	13.30	11.27	13.97	12.80	13.80	13.50	13.20
17	15.80	14.60	15.23	13.20	12.17	13.17	11.20	14.00	12.90	13.70	13.60	13.20
18	15.47	14.50	15.17	13.17	12.30	13.10	11.23	13.90	13.03	13.70	13.63	13.13
19	15.33	14.40	15.03	13.17	12.77	13.10	11.43	13.90	12.97	13.60	13.70	13.10
20	15.03	14.40	14.93	13.17	12.97	13.00	11.74	13.80	12.90	13.60	13.80	13.10
21	14.77	14.40	14.77	13.00	13.30	13.00	12.07	13.77	12.90	13.50	13.97	13.10
22	14.57	14.30	14.63	13.00	13.57	12.93	12.30	13.70	12.90	13.40	13.97	13.00
23	14.40	14.40	14.57	13.00	13.73	12.90	12.43	13.70	12.90	13.40	13.83	12.93
24	14.30	14.53	14.43	13.00	13.87	12.77	12.63	13.63	12.90	13.30	13.73	12.90
25	14.20	14.80	14.27	13.10	13.80	12.57	12.84	13.60	12.90	13.27	13.70	12.90
26	14.13	14.93	14.07	13.10	13.80	12.40	13.10	13.60	12.90	13.13	13.67	12.90
27	14.03	15.07	14.00	13.10	13.90	12.33	13.50	13.50	12.90	12.97	13.60	12.90
28	13.90	15.30	13.93	13.43	14.07	12.30	13.83	13.50	12.90	12.90	13.50	12.90
29	13.80	15.47	13.90	13.50	14.23	12.30	14.03	13.40	12.90	12.83	13.50	12.80
30	13.80	......	13.77	13.43	14.43	12.30	14.23	13.40	12.80	12.77	13.50	12.80
31	13.93	......	13.63	......	14.47	......	14.43	13.30	......	12.70	......	12.80
Means	15.93	14.64	15.08	13.30	13.20	13.40	12.25	14.11	12.87	13.56	13.45	13.12

Means of (tridaily) readings of the lower gauge at Copperas Creek Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.10	13.53	15.47	13.30	12.50	14.00	10.27	12.97	10.73	9.63	10.03	11.50
2	18.00	13.70	15.63	13.20	12.50	14.10	10.07	13.23	10.57	9.90	10.07	11.43
3	17.90	13.90	15.67	13.13	12.43	14.07	10.00	13.70	10.47	10.40	10.13	11.27
4	17.60	14.00	15.60	13.07	12.37	14.00	10.13	13.67	10.27	10.80	10.23	11.10
5	17.40	14.00	15.53	13.00	12.30	14.00	9.90	13.67	10.07	11.40	10.40	11.10
6	17.30	14.03	15.50	12.90	12.23	14.07	9.63	13.57	9.87	11.70	10.50	11.00
7	17.20	14.13	15.50	12.90	12.07	13.87	9.43	13.67	9.80	12.00	10.60	11.00
8	17.10	14.20	15.40	12.80	11.97	13.60	9.27	13.67	9.70	12.13	10.57	11.00
9	16.97	14.30	15.30	12.80	11.80	13.60	9.07	13.80	9.57	12.27	10.50	11.00
10	16.87	14.30	15.30	13.07	11.50	13.47	8.80	13.73	9.33	12.43	10.50	11.00
11	16.73	14.40	15.30	12.63	11.23	13.40	8.73	13.70	9.17	12.50	10.50	11.00
12	16.60	14.40	15.30	12.83	11.07	13.27	8.50	13.60	9.03	12.57	10.53	11.00
13	16.50	14.40	15.23	12.83	10.93	13.06	8.10	13.47	9.03	12.57	10.77	11.00
14	16.30	14.30	15.20	12.83	10.70	13.00	7.83	13.27	9.13	12.47	10.97	11.00
15	16.10	14.20	15.17	12.83	10.30	12.90	7.63	13.03	9.17	12.37	11.20	10.90
16	15.87	14.20	15.07	12.74	10.07	12.80	7.40	12.87	9.00	12.20	11.43	10.90
17	15.60	14.20	14.90	12.74	9.97	12.77	7.23	12.70	9.23	12.10	11.57	10.87
18	15.20	14.10	14.77	12.63	10.10	12.70	7.47	12.60	9.50	12.03	11.70	10.80
19	15.03	14.00	14.70	12.67	10.93	12.53	7.67	12.53	9.63	11.87	11.80	10.70
20	14.80	14.00	14.57	12.67	11.43	12.37	7.93	12.40	9.87	11.60	11.90	10.67
21	14.47	14.00	14.47	12.80	11.93	12.17	8.30	12.30	10.03	11.47	12.00	10.57
22	14.27	14.00	14.37	12.00	12.20	12.03	8.60	12.13	10.07	11.30	12.00	10.50
23	14.10	14.10	14.23	12.00	12.77	11.93	8.77	11.97	9.90	11.07	11.90	10.40
24	14.00	14.23	14.20	12.00	13.10	11.83	9.27	11.83	9.77	10.93	11.83	10.27
25	13.90	14.47	14.07	12.10	13.13	11.67	10.57	11.70	9.63	10.80	11.70	10.07
26	13.83	14.57	14.00	12.10	13.10	11.47	10.83	11.60	9.57	10.67	11.60	9.90
27	13.67	14.73	13.87	12.10	13.23	11.26	11.07	11.50	9.50	10.47	11.53	9.80
28	13.53	15.00	13.73	12.33	13.47	11.00	11.53	11.50	9.40	10.37	11.47	9.70
29	13.40	15.20	13.63	12.50	13.63	10.70	12.00	11.37	9.40	10.23	11.43	9.60
30	13.40	......	13.47	12.43	13.87	10.47	12.30	11.17	9.50	10.17	11.50	9.50
31	13.50	......	13.33	......	13.90	......	12.63	10.93	......	10.10	......	9.40
Means	15.65	14.28	14.79	12.66	12.35	12.73	9.38	12.70	9.66	11.87	11.10	10.64

Means of (tridaily) readings of the upper gauge at Lagrange Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.87	17.58	18.00	17.18	16.78	17.35	16.25	18.12	16.43	15.92	16.15	16.45
2	20.02	17.55	18.03	17.08	16.75	17.35	16.25	18.32	16.40	15.97	16.10	16.40
3	19.95	17.52	18.05	17.00	16.75	17.48	16.25	18.47	16.33	16.05	16.12	16.40
4	19.75	17.50	18.10	17.00	16.73	17.45	16.20	18.35	16.28	16.25	16.27	16.40
5	19.60	17.45	18.10	17.00	16.70	17.40	16.13	18.20	16.23	16.38	16.28	16.38
6	19.33	17.45	18.10	16.98	16.70	17.35	16.08	17.97	16.23	16.30	16.25	16.35
7	19.07	17.50	18.10	16.95	16.72	17.30	16.05	17.88	16.13	16.50	16.25	16.40
8	18.93	17.50	18.10	16.95	16.60	17.42	16.00	17.72	16.02	16.48	16.25	16.38
9	18.80	17.50	18.10	16.98	16.50	17.52	15.95	17.65	15.97	16.57	16.25	16.35
10	18.72	17.55	18.10	17.05	16.45	17.35	15.88	17.60	15.90	16.67	16.25	16.35
11	18.68	17.60	18.10	17.05	16.40	17.30	15.83	17.47	15.90	16.77	16.25	16.35
12	18.70	17.67	18.05	17.03	16.35	17.23	15.75	17.38	15.87	16.80	16.25	16.35
13	18.70	17.78	18.03	17.00	16.28	17.20	15.70	17.32	15.85	16.80	16.25	16.35
14	18.53	17.85	18.00	17.02	16.18	17.20	15.63	17.28	15.88	16.80	16.28	16.35
15	18.43	17.83	18.00	16.98	16.10	17.20	15.60	17.22	15.90	16.75	16.37	16.30
16	18.34	17.85	17.95	16.95	16.05	17.13	15.52	17.13	15.90	16.73	16.48	16.30
17	18.20	17.80	17.90	16.95	16.08	17.13	15.45	17.10	16.37	16.68	16.55	16.30
18	18.13	17.75	17.88	16.95	16.10	17.15	15.35	17.12	16.47	16.65	16.57	16.25
19	17.98	17.68	17.85	16.93	16.33	17.12	15.65	17.13	16.50	16.62	16.55	16.25
20	17.95	17.40	17.78	16.90	16.50	17.03	16.82	17.10	16.52	16.57	16.55	16.20
21	17.85	17.22	17.69	16.90	16.78	16.97	16.92	17.00	16.40	16.55	16.55	16.20
22	17.75	17.20	17.62	16.85	16.90	16.90	16.82	16.97	16.25	16.50	16.55	16.18
23	17.75	17.35	17.58	16.80	16.95	16.83	16.58	16.95	16.15	16.48	16.55	16.15
24	17.70	17.60	17.55	16.80	16.95	16.75	17.48	16.90	16.12	16.43	16.53	16.13
25	17.57	17.88	17.50	16.77	16.95	16.68	17.68	16.83	16.08	16.32	16.52	16.08
26	17.47	17.97	17.45	16.73	17.00	16.62	17.60	16.78	16.02	16.27	16.50	16.05
27	17.40	17.95	17.40	16.70	17.02	16.52	17.43	16.73	16.00	16.22	16.47	16.00
28	17.33	17.97	17.30	16.75	17.12	16.48	17.42	16.68	15.93	16.15	16.42	15.95
29	17.30	18.00	17.20	16.75	17.15	16.40	17.52	16.58	15.90	16.07	16.47	15.90
30	17.30	......	17.20	16.80	17.20	16.35	17.60	16.53	15.90	16.10	16.47	15.95
31	17.43	......	17.18	......	17.27	......	17.68	16.45	......	16.10	......	15.95
Means	18.40	17.63	17.81	16.92	16.65	17.07	16.42	17.32	16.13	16.43	16.38	16.24

Means of (tridaily) readings of the lower gauge at Lagrange Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	19.10	15.33	16.40	14.85	13.15	15.13	11.65	15.37	12.25	10.82	11.53	12.40
2	19.28	15.35	16.38	14.08	13.03	15.03	11.50	16.20	12.05	10.93	11.50	12.35
3	19.30	15.35	16.43	13.95	12.95	15.43	11.35	16.77	11.98	11.19	11.63	12.35
4	19.22	15.23	16.55	13.90	12.93	15.35	11.22	16.95	11.85	11.50	12.23	12.30
5	18.98	15.27	16.60	13.85	12.88	15.22	11.10	16.73	11.63	11.82	12.07	12.28
6	18.60	15.30	16.60	13.77	12.82	15.17	10.97	16.42	11.40	12.12	11.98	12.20
7	18.35	15.25	16.58	13.67	12.68	15.02	10.90	16.15	11.17	12.35	11.90	12.25
8	18.15	15.32	16.60	13.70	12.58	15.33	10.85	15.88	11.10	12.53	11.83	12.22
9	17.97	15.35	16.60	13.78	12.48	15.50	10.75	15.65	10.95	12.70	11.73	12.20
10	17.87	15.42	16.58	13.96	12.25	15.12	10.55	15.45	10.75	12.90	11.70	12.20
11	17.75	15.58	16.50	14.00	12.10	15.03	10.37	15.20	10.53	13.02	11.73	12.20
12	17.70	15.72	16.45	13.95	12.00	14.73	10.15	14.95	10.52	13.20	11.75	12.20
13	17.67	15.92	16.40	13.87	11.75	14.50	9.95	14.78	10.47	13.20	11.80	12.20
14	17.50	16.13	16.35	13.85	11.52	14.30	9.70	14.62	10.48	13.20	11.95	12.13
15	17.38	16.20	16.35	13.80	11.38	14.20	9.55	14.42	10.62	13.18	12.15	12.03
16	17.15	16.20	16.27	13.72	11.19	14.10	9.45	14.32	10.45	13.12	12.30	12.00
17	16.92	16.05	16.17	13.70	11.07	14.10	9.28	14.25	11.83	13.03	12.42	11.97
18	16.77	15.95	16.10	13.65	11.30	14.08	8.97	14.30	12.50	12.97	12.50	11.90
19	16.55	15.75	16.05	13.60	11.70	14.05	9.90	14.28	12.52	12.85	12.55	11.85
20	16.35	15.33	15.85	13.58	12.27	13.95	12.95	14.05	12.40	12.73	12.60	11.80
21	16.20	15.02	15.73	13.43	12.95	13.70	13.23	13.95	12.07	12.62	12.63	11.73
22	16.05	14.92	15.62	13.30	13.48	13.48	12.67	13.85	11.65	12.53	12.67	11.70
23	16.00	14.97	15.37	13.20	13.72	13.25	12.18	13.65	11.45	12.35	12.70	11.63
24	15.95	15.37	15.30	13.17	13.96	13.05	14.00	13.58	11.25	12.23	12.67	11.53
25	15.55	16.05	15.18	13.07	14.12	12.85	15.30	13.45	11.15	12.10	12.70	11.48
26	15.37	16.22	15.05	13.08	14.28	12.60	15.22	13.30	11.05	11.95	12.68	11.28
27	15.20	16.25	14.90	13.05	14.32	12.37	14.53	13.10	11.03	11.78	12.60	11.18
28	15.05	16.30	14.82	13.00	14.45	12.18	14.12	12.95	10.93	11.55	12.53	11.10
29	14.95	16.38	14.58	13.08	14.65	12.00	14.00	12.73	10.87	11.37	12.50	10.95
30	14.90	......	14.58	13.17	14.90	11.80	14.13	12.58	10.80	11.37	12.50	10.82
31	15.18	......	14.48	......	15.05	......	14.32	12.45	......	11.42	......	10.83
Means	17.06	15.64	15.92	13.61	12.90	14.09	11.77	14.59	11.32	12.28	12.20	11.85

Means of (tridaily) readings of the upper gauge at Kampsville Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.48	17.37	17.70	17.00	16.70	19.93	16.25	17.90	16.50	16.00	16.20	16.40
2	18.60	17.40	17.65	16.95	16.70	19.65	16.25	17.90	16.40	16.00	16.20	16.40
3	18.58	17.40	17.65	16.90	16.70	19.75	16.30	17.92	16.40	16.00	16.20	16.40
4	18.47	17.38	17.65	16.85	16.65	19.87	16.30	17.95	16.40	16.12	16.32	16.40
5	18.38	17.35	17.65	16.85	16.63	19.83	16.23	17.95	16.33	16.25	16.40	16.40
6	18.30	17.35	17.75	16.80	16.60	19.68	16.10	17.90	16.25	16.32	16.45	16.40
7	18.30	17.35	17.70	16.80	16.60	19.55	16.00	17.78	16.18	16.35	16.35	16.40
8	18.25	17.35	17.70	16.82	16.55	19.82	16.00	17.68	16.10	16.42	16.20	16.40
9	18.20	17.35	17.65	16.90	16.50	19.95	16.00	17.58	16.08	16.47	16.20	16.40
10	18.15	17.30	17.65	16.90	16.47	20.05	15.93	17.48	16.00	16.52	16.27	16.40
11	18.10	17.35	17.60	16.95	16.40	19.85	15.88	17.40	16.00	16.57	16.28	16.35
12	18.10	17.43	17.60	16.90	16.35	19.08	15.85	17.35	16.00	16.70	16.25	16.35
13	18.05	17.67	17.55	16.90	16.28	18.10	15.85	17.30	15.95	16.70	16.28	16.35
14	18.03	17.70	17.60	16.90	16.23	17.30	15.80	17.25	15.95	16.70	16.22	16.35
15	17.93	17.75	17.60	16.90	16.15	17.08	15.78	17.15	16.00	16.70	16.33	16.35
16	17.90	17.75	17.60	16.85	16.10	17.00	15.80	17.10	15.93	16.68	16.35	16.35
17	17.85	17.70	17.55	16.85	16.03	17.22	15.77	17.05	16.67	16.60	16.40	16.35
18	17.80	17.55	17.55	16.85	16.10	17.17	15.68	17.00	16.88	16.55	16.35	16.30
19	17.75	17.40	17.50	16.83	16.68	17.05	16.25	17.00	16.75	16.52	16.35	16.30
20	17.68	17.20	17.50	16.70	16.85	17.00	17.27	17.02	16.63	16.50	16.40	16.30
21	17.58	17.00	17.40	16.80	17.88	16.92	17.38	17.03	16.55	16.50	16.50	16.30
22	17.50	17.30	17.40	16.73	18.77	16.90	17.10	16.93	16.45	16.48	16.45	16.25
23	17.50	17.25	17.40	16.70	19.25	16.82	16.82	16.85	16.28	16.40	16.45	16.25
24	17.50	17.32	17.35	16.65	19.70	16.65	17.00	16.85	16.18	16.37	16.50	16.25
25	17.48	17.52	17.30	16.60	20.00	16.60	17.85	16.83	16.08	16.30	16.45	16.18
26	17.38	17.60	17.28	16.60	19.93	16.55	17.85	16.78	16.00	16.30	16.45	16.10
27	17.30	17.61	17.15	16.60	19.52	16.55	17.55	16.72	16.00	16.28	16.58	16.05
28	17.28	17.65	17.10	16.60	19.90	16.45	17.25	16.70	16.00	16.20	16.45	16.00
29	17.25	17.70	17.12	16.65	20.45	16.40	17.08	16.65	16.00	16.20	16.45	16.00
30	17.25	....	17.05	16.75	20.63	16.35	17.00	16.58	16.00	16.20	16.40	15.95
31	17.27	....	17.00	....	20.25	....	17.20	16.50	....	16.20	....	15.90
Means	17.88	17.45	17.48	16.80	17.60	17.71	16.50	17.23	16.23	16.39	16.35	16.28

Means of (tridaily) readings of the lower gauge at Kampsville Lock, 1896.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.82	13.85	15.05	13.00	12.85	19.77	12.15	15.25	11.33	10.17	10.60	11.30
2	16.90	13.95	15.05	12.87	12.90	19.45	12.15	15.55	11.15	10.20	10.60	11.30
3	16.87	14.00	15.05	12.68	13.05	19.57	12.23	15.75	11.10	10.27	10.55	11.25
4	16.80	14.00	15.03	12.63	13.37	19.66	12.75	15.95	10.95	10.45	10.95	11.20
5	16.80	14.00	15.00	12.58	13.67	19.60	12.95	16.10	10.83	10.72	11.30	11.15
6	16.75	14.00	15.00	12.50	13.95	19.53	12.65	15.95	10.53	10.98	11.60	11.15
7	16.55	14.00	15.00	12.50	14.07	19.38	12.15	15.60	10.40	11.12	11.30	11.15
8	16.25	13.95	15.00	12.50	14.27	19.62	11.80	15.22	10.22	11.35	11.00	11.15
9	16.05	13.90	14.95	12.52	14.38	19.85	11.45	14.80	10.15	11.47	10.90	11.07
10	15.85	13.92	14.90	12.70	14.45	19.95	11.15	14.40	10.10	11.55	10.95	11.05
11	15.80	13.95	14.85	12.80	14.45	19.68	10.90	14.10	9.93	11.75	10.88	11.00
12	15.78	14.12	14.77	12.80	14.43	18.87	10.55	13.83	9.85	11.90	10.85	11.00
13	15.70	14.78	14.70	12.80	14.33	17.75	10.28	13.60	9.70	11.98	10.85	11.08
14	15.60	15.07	14.70	12.90	14.13	16.65	9.90	13.50	9.67	11.98	10.87	11.05
15	15.50	15.30	14.68	12.85	13.85	15.85	9.72	13.43	9.62	12.00	11.05	11.00
16	15.43	15.28	14.58	12.80	13.60	15.25	9.55	13.28	9.78	11.98	11.10	11.05
17	15.32	14.98	14.50	12.73	13.60	15.18	9.30	13.05	11.48	11.90	11.15	11.12
18	15.15	14.70	14.44	12.63	13.65	15.07	9.13	12.95	12.48	11.83	11.22	11.25
19	14.98	14.35	14.33	12.58	14.80	14.75	10.28	12.95	12.43	11.77	11.30	11.28
20	14.82	13.85	14.25	12.50	16.65	14.55	13.25	13.17	12.15	11.70	11.35	11.30
21	14.58	13.50	14.00	12.45	17.77	14.35	14.97	13.30	11.98	11.62	11.55	11.25
22	14.50	14.10	14.00	12.35	18.67	14.15	15.93	13.23	11.83	11.50	11.55	11.17
23	14.50	13.82	13.98	12.25	19.15	13.82	15.45	13.05	11.53	11.32	11.55	11.08
24	14.50	13.88	13.85	12.23	19.60	13.53	15.22	12.77	11.20	11.23	11.63	10.93
25	14.35	14.27	13.68	12.13	19.90	13.28	15.70	12.47	10.85	11.05	11.55	10.75
26	14.05	14.45	13.63	12.10	19.83	13.08	15.65	12.32	10.70	10.90	11.50	10.58
27	13.80	14.65	13.43	12.00	19.42	13.05	15.10	12.10	10.78	10.92	11.60	10.47
28	13.60	14.80	13.35	12.00	19.80	13.05	14.30	11.98	10.59	10.80	11.47	10.42
29	13.58	14.97	13.37	12.28	20.38	12.75	13.87	11.80	10.35	10.75	11.40	10.35
30	13.50	....	13.15	12.70	20.57	12.37	13.60	11.65	10.20	10.70	11.35	10.30
31	13.62	....	13.00	....	20.15	....	13.67	11.50	....	10.65	....	10.10
Means	15.30	14.29	14.36	12.55	15.99	16.45	12.51	13.70	10.80	11.24	11.18	10.97

I 16.

OPERATING AND CARE OF LAGRANGE AND KAMPSVILLE LOCKS, ILLINOIS RIVER, AND APPROACHES THERETO.

These locks and dams have been operated and maintained under the indefinite appropriation provided for in section 4 of the river and harbor act of July 5, 1884.

Lagrange Lock and Dam.—These works were operated and maintained in good order during the year. The drift was kept cleared from the dam, the pointing of lock walls completed, 1,117 cubic yards mud were dredged from the approach above the lock and 19,814 cubic yards from Meredosia Bar below the lock, a small warehouse was constructed, and a new hull was built for the cabin of an old quarter boat pertaining to the work.

The hull of Dredge No. 2, begun during preceding fiscal year, was completed.

Kampsville Lock and Dam.—A small amount of dredging was done at the approaches to the lock, 3,720 cubic yards of earth filling was put upon the grounds. Three of the barges pertaining to the operating and care plant were calked and repaired, and the house for the lock hands that was wrecked by the storm of July 31, 1896, was rebuilt by the lock hands.

The lockages of boats through the Lagrange Lock increased from 504 in 1896 to 640 in 1897, and the tonnage from 129,297 in 1896 to 167,641 in 1897. The average tonnage of the boats passing increased from 236 tons in 1896 to 262 tons in 1897.

At Kampsville Lock the lockages decreased from 592 in 1896 to 426 in 1897, but the tonnage increased from 165,686 tons in 1896 to 174,624 in 1897, and the average tonnage of boats and barges increased from 279 tons in 1896 to 409 tons in 1897.

There was an increase of tonnage passing the two locks of about 15 per cent over the preceding year.

Disbursements fiscal year 1897.

Lagrange Lock, Illinois River:		
Operating and caring for lock	$4,884.41	
Dredging	1,528.44	
Property and plant	2,758.91	
Care and repair of property and plant	630.57	
		9,802.33
Kampsville Lock, Illinois River:		
Operating and caring for lock	4,165.93	
Dredging	48.00	
Property and plant	4,102.97	
Care and repair of property and plant	1,888.51	
		10,205.41
		20,007.74

Money statements.

LAGRANGE LOCK.

July 1, 1896, balance unexpended (outstanding)	$1,292.71
July 1, 1896, allotment for fiscal year	13,000.00
	14,292.71
June 30, 1897, amount expended during fiscal year	9,802.33
July 1, 1897, balance unexpended	4,490.38
July 1, 1897, outstanding liabilities	496.10
July 1, 1897, balance available	3,994.28

KAMPSVILLE LOCK.

July 1, 1896, balance unexpended (outstanding)	$3,132.72
July 1, 1896, allotment for fiscal year	10,000.00
	13,123.72
June 30, 1897, amount expended during fiscal year	10,205.41
July 1, 1897, balance unexpended	2,927.31
July 1, 1897, outstanding liabilities	480.60
July 1, 1897, balance available	2,446.71

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *June 30, 1897.*

MAJOR: I have the honor to submit the following report of operating and care of lock and dams, Illinois River, for the fiscal year ending June 30, 1897.

LAGRANGE LOCK.

The remainder of the joints of both walls were painted with Portland cement (the coping having been pointed the previous year). The grounds were kept in order and the drift was removed from the dam as fast as it accumulated. Eighteen inches of dirt was filled in the ice house to bring the bottom above the level of the ground, the drain to it repaired, and 100 tons of ice put up during the winter. A warehouse 12 by 14 feet was built of old material; built 150 feet of 4-foot cement walk; cemented cellar of superintendent's house; painted ironwork of lock gates; put in a few cubic yards of stone at east abutment of dam where caving had begun. Owing to the good stage of water prevailing during the year no flashboards were required on the dam.

Dredging.—In October and November the bar at Meredosia was dredged out; a channel 155 feet wide and 7 feet deep at low water (with flashboards on the Kampsville Dam) being made. There were removed from this bar, which was 1,200 feet long, 19,814 cubic yards of sand, scow measurement. The work was completed November 20, and the dredge and other boats were moved to Kampsville Lock into winter quarters. This work was done by Dredge *Apache* and steam tender *Marion* of the Illinois and Mississippi Canal, which were sent to this river the last of September.

In June the upper entrance to Lagrange Lock was dredged for a distance of 400 feet above the upper gates, 417 cubic yards of mud being scowed away, and 700 cubic yards cast on the bank to be used as filling.

Repairs to plant.—A new hull was built for the cabin of the old quarter boat that had been on the bank at this lock for a number of years, a new canvass roof was put on the cabin, the cabin divided into rooms, and bunks put in. Tho boat is used for quarters for the dredge crews.

Dredge No. 2.—At the beginning of the fiscal year the material for a new hull for this dredge had been received and a small amount of framing done. The hull was completed, the machinery and iron truss from the old hull were put on this hull, the old crane was put on, the only new part being a boiler. The dredge was ready for work November 3. The new hull is 80 feet long by 30 feet wide and 8 feet deep. Oregon fir was used mainly in the construction of the hull, the gunwales and keelsons being furnished in lengths of 80 feet, thus doing away with any splices in the hull. During the winter the woodwork of this crane was rebuilt, roof of cabin recanvassed, a 2¼ cubic yard dipper, new hoisting and backing chains, and a new spider frame and sheave were put on.

KAMPSVILLE LOCK.

Sixty cubic yards of mud were removed from above the upper gates, a deposit left by the high water; 12 cubic yards of rock were placed above the dam, where the break occurred in the fall of 1895, to fill up a settlement. The force at this lock, aside from their regular duties of locking boats and keeping the lock and grounds in order, rebuilt the lock-hands' house that was wrecked by the wind July 31, 1896, and were employed upon the two new dredge hulls built during the year.

Dredging.—During the high water of April 3,270 cubic yards of dirt was scowed on the grounds, to be used for filling.

Repairs to plant.—Three of the coal barges were hauled out, caulked with 1 thread of oakum, and launched.

There is herewith a statement showing boats and tonnage passing both Kampsville and Lagrange locks, and one showing boats navigating this river.

Very respectfully, your obedient servant,

C. V. BRAINARD, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers.

Tonnage passing Lagrange Lock.

	Fiscal year ending June 30—							
	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.
Steamboats ....number..	142	280	265	291	296	374	340	416
Barges ....do....	68	147	168	176	213	251	164	224
Steamboats ....tonnage..	41,915	63,967	68,236	80,181	59,730	60,814	79,495	91,550
Barges ....do....	12,386	45,711	79,211	162,118	91,361	76,530	49,802	76,091
Ice ....tons..	(a)	20,575	39,400	46,600	31,900	11,950	11,150	19,425
Wheat ....bushels..	5,082	9,800	14,536	12,700	6,750	22,017	30,142	21,477
Corn ....do....	....	18,176	33,800	29,691	45,900	87,563	67,179	161,767
General merchandise....tons..	(a)	(a)	1,651	4,675	3,734	1,976	6,455	4,508
Passengers ....number..	(a)	(a)	1,334	2,382	2,179	4,682	6,391	4,774
Coal......................tons..	100	650	729	225	1,087	640	80	320
Stock ....head..	(a)	(a)	219	298	2,307	1,323	1,925	1,657
Wood ....cords..	....	70	250	....	60	28	....	35
Logs ....feet B. M..	....	45,000	....	181,000	200,000	....	....	70,000
Lumber ....do....	....	....	10,000	15,000	50,000	....	10,000	70,000
Apples ....barrels..	....	....	....	....	....	....	9,670	158

a No record kept.

Tonnage passing Kampsville Lock.

	Fiscal year ending June 30—			
	1894.	1895.	1896.	1897.
Steamboats ....number..	177	440	436	320
Barges ....do....	120	192	156	106
Steamboats ....tonnage..	57,149	99,315	111,382	107,855
Barges ....do....	51,295	81,597	54,304	66,769
Ice ....tons..	31,900	11,950	10,950	19,425
Wheat ....bushels..	63,600	178,025	158,795	130,081
Corn ....do....	86,267	164,000	178,188	72,047
Oats ....do....	....	1,284	395	1,097
Rye ....do....	....	....	2,172	471
Apples ....barrels..	....	2,359	6,396	1,231
General merchandise....tons..	4,692	3,454	8,169	7,899
Passengers ....number..	1,197	5,017	7,049	4,796
Stock ....head..	3,760	8,735	12,358	14,003
Logs ....feet B. M..	....	....	....	30,000
Bran ....bushels..	....	....	....	305

List of steamboats navigating the Illinois River.

Name.	Registered tons.	Name.	Registered tons.
Iowa	73	Joliet	76
D. H. Pike	465	U. S. Lily	206
City of Brunswick	77	Leo	36
Cherokee	631	Jack Frost	350
Polar Wave	150	Charlotte Boeckeler	143
Ouatoga	15	Glad Tidings	5
Claribel	29	G. M. Sivley	99
Carrie Currens	7	Josie Sivley	46
Henry W. Longfellow	47	La Tosca	16
Benton	394	Belle of Ottawa	10
Ruth	60	Lotus	22
Virginia	5	New Idlewild	692
Echo	16	R. G. Schmoldt	15
Thomas Parker	57	Edith K	25
Viva	30	Peoria	5
Eileen	35	City of Pekin	5
Spread Eagle	530	Defender	7
Diana	8	Pilot	5
Elsa	33	Grey Hound	9
Edna	30	Flora	5

I I 7.

CONSTRUCTION OF ILLINOIS AND MISSISSIPPI CANAL.

The object of this improvement is to furnish a navigable waterway from Lake Michigan at or near Chicago, Ill., to the Missisippi River at the mouth of Rock River, near Rock Island, Ill., in connection with the Upper Illinois River and the proposed enlarged waterway along the present line of the Illinois and Michigan Canal.

Various surveys of different routes from the great bend of the Illinois, near Hennepin, Ill., to the Mississippi River, at or above the mouth of Rock River, have been made, viz: In 1871 (Report Chief of Engineers, 1871, p. 303), in 1882 (Report Chief of Engineers, 1883, p. 1757), and in 1885 (Report Chief of Engineers, 1886, p. 1707).

There was also a report upon the canal by a board of engineers in 1887 under the provisions of the river and harbor act of August, 1886 (Report Chief of Engineers, 1887, p. 2145).

After much discussion the present or Rock Island route was adopted.

Detailed plans and estimates, based upon preliminary surveys and under the river and harbor act of August 11, 1888, were prepared in this office and submitted to Congress June 21, 1890, the report of which plans and estimates was published as House Ex. Doc. No. 316, Fifty-first Congress first session. This report was the basis of subsequent appropriations.

The plans submitted in 1890 were subsequently modified (reports Chief of Engineers, 1891, 1892, 1896, and in papers herewith) and contemplate the construction of a canal at least 80 feet wide at the water surface, 7 feet deep, with locks 170 feet long between quoins, 35 feet wide, admitting barges carrying 600 short tons of freight, if we allow 240 short tons for weight of vessel, and 140 feet length, 34 feet beam, and 6 feet draft of vessel that may easily navigate the canal.

The canal to begin at the Great Bend of the Illinois River, thence via the valleys of Bureau and Cowcatcher creeks to the summit level near the eighteenth mile, ascending 196 feet through 21 locks, with lifts varying from 7 to 11 feet each; thence to the Feeder Junction near the twenty-eighth mile; thence to Rock River just above the mouth of Green River; thence down Rock River to its mouth. The length of the canal is about 75 miles, having been shortened about 2 miles by the adoption of the Green River route instead of the Penny Slough route. The descent from the summit level to the low-water level of the Mississippi River is 93 feet, effected by 10 lift locks of from 6 to 14 feet lift, with 1 guard lock. The number of lift locks has been reduced from 37 to 31, and the summit level has been cut down 9 feet in the changes since the 1890 report by subsequent surveys, and the length of the main line of the canal has been reduced from 77 to 75 miles.

The feeder as now located is 29 miles in length instead of 34¾ miles as proposed in 1890, and 37½ miles as proposed in 1871 and 1883.

The entire line of the canal and feeder has now been definitely located by authority of the Secretary of War, as required by river and harbor act of August 11, 1888, and subsequent acts of Congress. The estimated cost of the canal has not been increased by the changes in location, but the lockage has been reduced by 18 feet, the length of the canal and feeder by from 7 to 9 miles, the number of locks by six, and the resulting time of passage between the Illinois and Mississippi Rivers due to these changes about three hours, or about 10 per cent, and the probable cost of maintenance and operation has been correspondingly reduced.

CONDITION OF THE WORK JUNE 30, 1897.

Work began under the conditions imposed by the river and harbor act of September 19, 1890, upon the Rock River end of the canal in 1892 by the construction of a canal around the Lower Rapids of Rock River 4½ miles long, with 3 locks, 3 swing bridges, 2 dams, 3 lock houses, 7 sluiceways, and 1 arch culvert, which canal was formally opened for navigation April 17, 1895, and has since that date been in operation.

Further prosecution of work on the Rock River section has been prevented by the Moline wagon bridge across Rock River a short distance above the head of the canal, which prevents the passage of all craft requiring 11 feet headroom or more. Proceedings have been instituted in the United States district court to compel the removal of this obstruction, the authority of the Secretary of War in the matter being denied by the city of Moline.

All appropriations made subsequent to the act of September 19, 1890, have, therefore, been expended in locating the canal, acquiring its right of way, and in constructing the eastern section, beginning at the Illinois River and proceeding westward.

At the date of this report 8 miles of canal trunk on the eastern section is completed (with the exception of dredging entrance to Lock 1 and some minor filling); also the foundations and masonry of 7 locks and 1 aqueduct, 5 arch culverts and 4 pipe culverts, and the masonry and superstructure of 1 highway bridge. The earthwork, foundations for 11 locks and 2 aqueducts, diversions of creek channels, and the masonry of 2 arch and 6 pipe culverts along the next 8 miles, from mile 9 to mile 16, inclusive, have been awarded to contractors and the work is just beginning.

The right of way for the canal has been acquired and paid for over the 16 miles named. Awards have been made for more than a year, but not yet reported for right of way from miles 17 to 24, inclusive. All lands have been described, abstracts of title secured, and agreements made as far as practicable for the right of way for the Sterling Feeder and for the right to flow lands affected by the Sterling Dam, and all these papers, except a few relating to tracts of land in the vicinity of the Feeder Junction, have been forwarded to Washington for the action of the Department of Justice in acquiring title. The western section, from mile 24 to Rock River at the mouth of Green River, has been located on the ground, and the necessary legal descriptions, plats, etc., preparatory to proceedings to acquire title to the right of way are now in course of preparation.

PROGRESS OF THE WORK DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

The funds available during the fiscal year admitted no work of construction of magnitude.

Eastern section.—The contract for earthwork over the sixth mile, in progress at the close of the preceding fiscal year, was completed; 31,768 cubic yards of earthwork were placed. The force was reduced to one assistant engineer, one inspector, and two watchmen, and employed in caring for property and preparing maps, plans, and estimates for the work to be done on this section, and necessary papers for acquiring right of way from mile 24 to feeder junction near mile 28.

Since the passage of the sundry civil act of June 3, 1897, contracts have been awarded to the lowest responsible bidders under proposals opened June 3, 1897, for constructing 8 miles of earthwork, at 8¾ cents per cubic yard, to Katz, Crandall & Callahan, of Omaha, Nebr.; for the foundation of 11 locks and 2 aqueducts, to Cogan & Pound, Chicago, Ill., and for the construction of 2 arch culverts and 6 pipe culverts, to McArthur Bros. & Co., Chicago, Ill. The formal contracts had not been approved at the close of the fiscal year, but it is expected work will be begun early in July, 1897.

Reference is made to report of Assistant Long, herewith, for detailed statements of his work.

Western section.—The definite location of that part of this section from mile 24 to Rock River at the mouth of Green River was approved by the Secretary of War February 1, 1897. The canal has been definitely located on the ground by Assistant L. L. Wheeler and party, and all necessary field work has been done for completing the work of describing lands, etc., which office work is now in progress. The report upon the final location of the western section is hereto attached.

The entrance to the Milan Canal from the Mississippi River was dredged, 18,628 cubic yards of material having been removed. The approaches to the landing at Blossomburg were also dredged by contract, and 2,860 cubic yards were removed. To aid in scouring away the sand bar near the Mississippi terminus of the canal, wing dams were constructed in Rock River at its mouth, to concentrate and direct its current near to the lock. The situation is now much improved, and but little difficulty is anticipated in keeping the mouth of the canal open and clear.

Feeder line.—All necessary surveys, maps, plans, and descriptions of lands necessary for acquiring title to lands taken or damaged, and for constructing the feeder were completed during the year, and, as far as now practicable, have been forwarded for the action of the Department of Justice. The acreage required for the feeder is 1,111.71 acres and for overflow outside of the United States meandered line 1,271.31 acres, a total of 2,383.02 acres, titles to which are to be acquired.

PROPOSED APPLICATION OF FUNDS NOW AVAILABLE.

It is proposed to apply the funds now available to securing additional right of way for the canal; to carrying on work under contracts already awarded over miles 9 to 16, inclusive; to the completion by hired labor of the earthwork and lining of the canal from Lock 1 to end of mile 7, eastern section, and to paving the approaches to the locks and culverts; to the contracting for earthwork over miles 17 to 24, inclusive.

It is estimated that to complete the eastern section as far as to the Feeder Junction near end of mile 28 will require in all to complete, exclusive of amounts already expended, $2,391,964, as shown on the accompanying table of estimates.

PROPOSED APPLICATION OF FUNDS ASKED FOR FOR THE FISCAL YEAR ENDING JUNE 30, 1899.

It is proposed to apply these funds to prosecuting toward completion under contracts and by hired labor, in accordance with the act of June 3, 1896, the work on the canal as rapidly as the necessary right of way be acquired, and in prosecuting the proceedings and meeting the awards, or agreed-upon costs, for right of way.

APPROPRIATIONS.

July 1, 1890, balance unexpended from previous appropriations		$786.46
Act of—		
September 19, 1890		500,000.00
July 13, 1892		500,000.00
August 17, 1894		190,000.00
June 3, 1896		45,000.00
Sundry civil act, June 4, 1897		875,000.00
Total		2,110,786.46
Expended to June 30, 1897		1,203,887.55
Balance unexpended June 30, 1897		906,898.91

Money statement.

July 1, 1896, balance unexpended		$64,811.28
Amount appropriated by sundry civil act approved June 4, 1897		875,000.00
		939,811 28
June 30, 1897, amount expended during fiscal year		32,912.37
July 1, 1897, balance unexpended		906,898.91
July 1, 1897, outstanding liabilities	$4,100.55	
July 1, 1897, amount covered by uncompleted contracts	241,026.75	
		245,127.30
July 1, 1897, balance available		661,771.61
Amount (estimated) required for completion of existing project		4,815,960.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		1,427,740.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

ILLINOIS AND MISSISSIPPI CANAL—WESTERN SECTION AND FEEDER.

Annual statement, fiscal year 1897.

Surveys, feeder to Rock River	$1,676.54
Wing dams at mouth of Rock River	3,398.79
Superintendence and office	1,114.04
Survey of feeder line	7,416.43
Right of way, feeder line	2,140.50
Property, feeder line	5.70
Total	15,752.00

Distribution of contingent expenses, fiscal year 1897.

	Construction and right of way.	Superintendence and office.	One-fifth cost of property.	Total.
Surveys, feeder to Rock River	$1,676.54	$127.64		$1,804.18
Wing dams at mouth Rock River	3,398.79	258.77		3,657.56
Survey of feeder line	7,416.48	564.66	$1.14	7,982.28
Right of way, feeder line	2,140.50	162.97		2,303.47
Property (value of, four-fifths cost)	4.56			4.56
Total	14,636.82	1,114.04	1.14	15,752.00

Total cost to close of fiscal year 1897.

	At close of 1896.	Fiscal year 1897.	Total.
Surveys	$29,936.49	$1,804.18	$31,740.67
Right of way	26,851.14		26,851.14
Canal trunk:			
Mile 1	24,154.91		24,154.91
Mile 2	18,985.64		18,985.64
Mile 3	18,680.01		18,680.01
Miles 4 and 5	126,716.52		126,716.52
Lock No. 37	89,542.31		89,542.31
Lock No. 36	39,532.19		39,532.19
Guard lock	72,696.97		72,696.97
Dams	31,428.57	3,657.56	35,086.13
Bridges	39,437.89		39,437.89
Property	32,607.30	4.56	32,611.86
Survey of feeder line	17,530.71	7,982.23	25,512.94
Right of way, feeder line	543.00	2,303.47	2,846.47
Total	568,643.65	15,752.00	584,395.65

ILLINOIS AND MISSISSIPPI CANAL—EASTERN SECTION.

Annual statement, fiscal year 1897.

Surveys	$1,980.04
Right of way	293.55
Canal trunk:	
Mile 1	54.00
Mile 2	20.44
Mile 3	2.25
Mile 4	6.08
Mile 5	71.00
Mile 6	2,632.90
Mile 9	9.37
Mile 10	18.01
Mile 11	9.37
Mile 12	9.38
Mile 13	212.83
Mile 14	196.56
Mile 15	208.19
Mile 16	226.51
Lock No. 1	5.13
Lock No. 2	$5.13
Lock No. 3	5.13
Lock No. 4	5.13
Arch culverts:	
No. 1	5.14
No. 2	5.14
General construction	380.85
Superintendence and office	10,299.87
Care and repair of property and plant	689.20
Property	18.76
Material (stock on hand)	16,120.32
Total	33,490.30
Less material on hand June 30, 1896	16,329.93
Total for fiscal year 1897	17,160.37

Total cost to close of fiscal year 1897.

	At close of 1896.	Fiscal year 1897.	Deterioration of property.	Equitable part of general construction.	Equitable part of superintendence and office.	Equitable part of care and repair.	Total.
Surveys	$27,664.54	$1,980.04					$29,644.58
Right of way	67,514.03	293.55					67,807.58
Canal trunk:							
Mile 1	14,341.52	54.00	$100.39	$27.59	$322.54	$21.58	14,867.62
Mile 2	14,037.54	20.44	98.04	26.94	314.98	21.07	14,519.01
Mile 3	13,708.76	2.25	95.62	26.28	307.21	20.55	14,160.67
Mile 4	33,389.26	6.08	232.90	63.79	748.25	50.08	34,490.56
Mile 5	21,664.04	71.00	151.58	41.65	486.99	32.59	22,447.85
Mile 6	7,846.09	2,632.90	73.08	20.09	234.79	15.71	10,822.66
Mile 7	12,206.56		85.12	23.40	273.50	18.30	12,606.88
Mile 8	10,120.78		70.58	19.40	226.76	15.17	10,452.69
Mile 9	437.20	9.37	3.11	.85	10.00	.66	461.19
Mile 10	423.27	18.01	3.07	.84	9.89	.66	455.74
Mile 11	423.29	9.37	3.01	.81	9.69	.64	446.81
Mile 12	423.32	9.38	3.02	.82	9.69	.64	446.87
Mile 13		212.85	1.48	.41	4.76	.31	219.81
Mile 14		196.56	1.37	.38	4.40	.29	203.00
Mile 15		208.19	1.45	.40	4.66	.31	215.01
Mile 16		226.51	1.57	.43	5.07	.33	233.91
Lock No. 1	36,279.07	5.13	253.04	69.53	812.97	54.41	37,474.15
Lock No. 2	38,037.39	5.13	265.30	72.89	852.37	57.05	39,290.13
Lock No. 3	34,228.15	5.13	238.74	65.60	767.02	51.34	35,355.98
Lock No. 4	34,737.52	5.13	242.29	66.57	778.44	52.10	35,882.05
Lock No. 5	36,600.65		255.25	70.13	820.07	54.89	37,800.99
Lock No. 6	37,852.12		263.98	72.53	848.11	56.76	39,093.50
Lock No. 7	31,976.29		223.00	61.27	716.46	47.95	33,024.97
Pipe culverts:							
No. 1	3,190.91		22.25	6.11	71.52	4.78	3,295.57
No. 2	195.46		1.36	.37	4.38	.29	201.86
No. 3	7,015.68		48.92	13.44	157.19	10.51	7,245.74
No. 4	5,870.08		40.93	11.25	131.52	8.80	6,062.58
Arch culverts:							
No. 1	8,615.48	5.14	60.12	16.52	193.15	12.92	8,903.33
No. 2	6,203.22	5.14	43.29	11.90	139.10	9.31	6,411.96
No. 3	10,186.72		71.04	19.52	228.24	15.27	10,520.79
No. 4	12,498.06		87.16	23.95	280.04	18.73	12,907.94
No. 5	6,924.95		48.29	13.27	155.18	10.38	7,152.07
Aqueduct No. 1	13,474.07		93.96	25.82	301.90	20.20	13,915.95
Highway bridge	3,081.17		21.48	5.90	69.03	4.62	3,182.20
Lock forming	5,324.20						5,324.20
General construction	13,500.00	880.85					13,000.00
Property	16,010.21	18.76					12,823.18
Material (stock on hand)	16,329.93	16,120.32					16,120.32
Superintendence and office		10,299.87					
Care and repair of property and plant		689.20					
		33,490.30					
Less material on hand June 30, 1896		16,329.93					
Total	602,331.53	17,160.37	3,205.79	880.85	10,299.87	689.20	619,491.90

Expenditures Illinois and Mississippi Canal for fiscal year 1897.

Eastern section	$17,160.37
Western section and feeder line	15,752.00
Total	32,912.37

Total expenditures Illinois and Mississippi Canal to end of fiscal year 1897.

Eastern section	$619,491.90
Western section and feeder line	584,395.65
Total	1,203,887.55

***Cost of completing eastern section Illinois and Mississippi Canal, from Illinois River to Feeder Junction.** (Estimated June 30, 1897.)*

Mile number.	Fencing.	Revetment and trunk lining.	Earthwork.	Lock and aqueduct foundations.	Masonry and maneuvering gear of locks.	Masonry and superstructure of aqueducts.	Arch culverts.	Pipe culverts.	Highway and farm bridges.	Railroad bridges.	Spillways and inflows.	Lock houses.	Total.
1	......	......	$17,000	......	$5,000	......	......	......	......	......	......	$2,500	$24,500.00
2	......	......	2,500	......	10,000	......	......	......	$7,000	$32,000	......	5,000	56,500.00
3	......	$14,500	2,200	......	......	......	......	......	......	......	......	......	16,700.00
4	......	14,500	1,900	......	5,000	$50,000	......	......	......	......	......	2,500	73,900.00
5	......	......	1,900	......	5,000	......	......	......	7,000	......	......	2,500	16,400.00
6	......	14,500	......	......	......	......	......	......	......	......	......	......	14,500.00
7	......	......	1,500	......	5,000	......	......	......	9,000	38,000	......	2,500	56,000.00
8	......	14,500	2,000	......	5,000	......	......	......	7,000	......	......	2,500	31,000.00
	......	58,000	29,000	......	35,000	50,000	......	......	30,000	70,000	......	17,500	289,500.00
	Contingencies, 10 per cent												28,950.00
	Total												318,450.00
9	......	45,000	19,200	$24,000	70,000	......	......	$4,000	......	......	......	5,000	167,200.00
10	......	18,000	19,600	......	......	......	......	......	7,000	......	......	......	44,600.00
11	......	32,500	29,300	12,000	35,000	......	$4,000	......	7,000	......	......	2,500	122,800.00
12	......	21,000	14,000	32,000	70,000	66,000	......	......	......	......	......	5,000	208,000.00
13	......	......	18,300	12,000	35,000	......	......	4,000	7,000	......	......	2,500	78,800.00
14	......	......	14,600	36,000	105,000	......	8,000	......	7,000	......	$5,000	7,500	183,100.00
15	......	......	36,900	20,000	35,000	69,000	......	4,000	7,000	......	......	2,500	174,400.00
16	......	......	39,200	12,000	35,000	......	......	12,000	7,000	......	......	2,500	107,700.00
	......	116,500	191,100	148,000	385,000	135,000	12,000	24,000	42,000	......	5,000	27,500	1,086,100.00
	Contingencies, 10 per cent												108,610.00
	Total												1,194,710.00
17	$500	......	23,300	12,000	35,000	......	......	......	17,000	30,000	11,000	2,500	131,300.00
18	500	......	20,200	24,000	70,000	......	......	......	14,000	......	500	5,000	134,200.00
19	500	......	28,100	......	......	......	......	......	7,000	......	7,500	......	43,100.00
20	500	......	69,300	......	......	......	......	......	7,000	......	1,000	......	77,800.00
21	500	......	57,800	......	......	......	......	......	7,000	......	1,000	......	66,300.00
22	500	......	76,000	......	......	......	......	......	......	......	500	......	77,000.00
23	500	......	34,500	......	......	......	......	......	......	......	500	......	35,500.00
24	500	14,500	15,100	......	......	......	6,000	......	7,000	......	......	......	43,100.00
	4,000	14,500	324,300	36,000	105,000	......	6,000	......	59,000	30,000	22,000	7,500	608,300.00
	Contingencies, 10 per cent												60,830.00
	Due for right of way, miles 17-24, upon approval of title												42,054.00
	Total												711,184.00
25	500	......	25,200	......	......	......	......	......	......	......	......	......	25,700.00
26	500	......	21,800	......	......	......	6,000	......	7,000	......	......	......	35,300.00
27	500	......	24,000	......	......	......	6,000	......	7,000	......	......	......	37,500.00
28[1]	500	......	19,200	......	......	......	......	9,000	7,000	......	......	......	35,700.00
	2,000	......	90,200	......	......	......	12,000	9,000	21,000	......	......	......	134,200.00
	Contingencies, 10 per cent												13,420.00
	Estimated cost of right of way												20,000.00
	Total												167,620.00
	Total cost of completing eastern section												2,391,964.00
	Expended on eastern section to June 30, 1897												619,491.90
	Total probable cost of eastern section												3,011,455.90

[1] Fractional.

List of contracts for construction of Illinois and Mississippi Canal in force during fiscal year ending June 30, 1897.

Name and address of contractor.	Nature of contract.	Date.	To expire.	Remarks.
James Carroll, St. Louis, Mo.	Earthwork, mile 6	Oct. 10, 1894	Sept. 30, 1895	Extended to and completed Aug. 1, 1896.
Katz, Crandall & Callahan, Omaha, Nebr. a	Earthwork, miles 9-16 (inclusive).	June 19, 1897	July 1, 1898	
Cogan & Pound, Chicago, Ill. a	Pits and foundations for 11 locks and 2 aqueducts.	do	do	
McArthur Bros. Co., Chicago, Ill. a	2 concrete arch culverts, 6 cast-iron pipe culverts.	do	do	

a Contracts awarded, but had not been approved by the Chief of Engineers June 30, 1897.

Abstract of proposals for canal trunk earthwork, lock-pit excavations, preparing foundations for locks and aqueducts, and constructing cast-iron pipe culverts and concrete arch culverts for Illinois and Mississippi Canal, between mile 8 and mile 16, received in response to advertisement of April 8, 1897, and opened at 12 m., central time, June 3, 1897, by Maj. W. L. Marshall, Corps of Engineers.

Number of proposal.	Name and address of bidder.	Earthwork, mile 9 to mile 16, inclusive.					
		Mile 9 (134,000 cubic yards).		Miles 10 and 11 (307,000 cubic yards).		Mile 12 (103,000 cubic yards).	
		Per cubic yard.	Amount.	Per cubic yard.	Amount.	Per cubic yard.	Amount.
		Cents.		Cents.		Cents.	
1	Crescent Stone Co., Peoria, Ill.					10.9	$11,227.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	9	$12,060.00	7.25	$22,257.50	8.5	8,755.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	14	18,760.00	10	30,700.00	12	12,360.00
8	Monroe & Bryan, Portsmouth, Ohio			9.35	28,704.50		
17	McArthur Bros. Co., Chicago, Ill.			8.4	25,788.00		
18	R. C. Cushing & Co., Chicago, Ill.	11.8	15,812.00	9.75	29,932.50	9.8	10,094.00
20	Herbert Ripley, Chicago, Ill.	9.81	13,145.40	8.5	26,095.00		

Number of proposal.	Name and address of bidder.	Earthwork, mile 9 to mile 16, inclusive—Continued.					
		Mile 13 (144,000 cubic yards).		Mile 14 (129,000 cubic yards).		Mile 15 (258,000 cubic yards).	
		Per cubic yard.	Amount.	Per cubic yard.	Amount.	Per cubic yard.	Amount.
		Cents.		Cents.		Cents.	
1	Crescent Stone Co., Peoria, Ill.	11.3	$16,272.00	9.9	$12,771.00		
4	Winston Bros. & Co., Minneapolis, Minn.	12	17,280.00	13.5	17,415.00	15	$38,700.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	9.25	13,320.00	9	11,610.00	8.5	21,930.00
6	John J. Shea, Chicago, Ill					14.5	37,410.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	13.5	19,440.00	11.5	14,835.00	15	38,700.00
11	Griffiths & McDermott Construction Co., Chicago, Ill			14.5	18,705.00	16.25	41,925.00
13	H. A. Boedker & Co., Chicago, Ill.					14.25	36,765.00
18	R. C. Cushing & Co., Chicago, Ill.	8.9	12,816.00	10	12,900.00	12.4	31,992.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

Number of proposal.	Name and address of bidder.	Earthwork, mile 9 to mile 16, inclusive—Continued. Mile 16 (305,000 cubic yards). Per cubic yard.	Amount.	The entire 8 miles (1,380,000 cubic yards). Per cubic yard.	Amount.	Slope paving, miles 10 and 11 (4,500 square yards). Per square yard.	Amount.
		Cents.		*Cents.*			
4	Winston Bros. & Co., Minneapolis, Minn.	14	$42,700.00	......	....	......	....
5	Katz, Crandall & Callahan, Omaha, Nebr.	8.5	25,925.00	8.25	$113,850.00	$1.25	$5,625.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	15	45,750.00	13	179,400.00	1.75	7,875.00
8	Monroe & Bryan, Portsmouth, Ohio	......	....	......	....	1.10	4,950.00
11	Griffiths & McDermott Construction Co., Chicago, Ill.	14	42,700.00	......	....	......	....
14	Heldmaier & New, Chicago, Ill.	......	....	11.67	161,046.00	1.65	7,425.00
16	John Scott & Sons, St. Louis, Mo.	......	....	5.74	79,212.00	1.35	6,075.00
17	McArthur Bros. Co., Chicago, Ill.	......	....	11.2	154,560.00	1.40	6.300.00
18	R. C. Cushing & Co., Chicago, Ill.	9.8	29,890.00	9	124,200.00	1.00	4,500.00
19	Barnett & Record Co., Minneapolis, Minn.	......	....	16	220,800.00	1.95	8,775.00
20	Herbert Ripley, Chicago, Ill.	......	....	......	....	1.47	6,615.00

FOUNDATION FOR LOCK NO. 8.

Number of proposal.	Name and address of bidder.	Earth excavation (6,600 cubic yards). Price.	Amount.	Piles (363). Price.	Amount.	Pine timber (50,000 feet B.M.). Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$0.20	$1,320.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.30	1,980.00	4.00	1,452.00	22.50	1,125.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	2,640.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill.	.40	2,640.00	3.50	1,270.50	21.00	1,050.00
12	Cogan & Pound, Chicago, Ill.	.15	990.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill.	.20	1,320.00	3.80	1,379.40	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn.	.24	1,584.00	4.00	1,452.00	22.00	1,100.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B.M.). Price.	Amount.	Oak plank (13,000 feet B.M.). Price.	Amount.	Spikes, bolts, and nails (5,500 pounds). Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	21.00	315.00	49.00	637.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill.	21.00	315.00	45.00	585.00	.03	165.00
12	Cogan & Pound, Chicago, Ill.	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill.	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn.	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete. Natural cement (925 cubic yards). Price.	Amount.	Portland cement with pebbles (50 cubic yards). Price.	Amount.	Portland cement with broken stone (50 cubic yards). Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.75	3,468.75	5.25	262.50	6.00	300.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill.	2.95	2,728.75	5.20	260.00	7.20	360.00
12	Cogan & Pound, Chicago, Ill.	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill.	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn.	3.00	2,775.00	5.00	250.00	7.00	350.00

Abstract of proposals for canal trunk earthwork, etc.—**Continued.**

FOUNDATION FOR LOCK NO. 8—Continued.

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$8,671.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.30	63.00	.35	196.00	9,998.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	14,552.00
9	Doan & Tolman, Aurora, Ill	1.10	330.00	.15	31.50	.18	100.80	9,476.55
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	7,854.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	8,327.90
19	Barnett & Record Co., Minneapolis, Minn.	.65	195.00	.30	63.00	.35	196.00	8,702.50

FOUNDATION FOR LOCK NO. 9.

Number of proposal.	Name and address of bidder.	Earth excavation (3,200 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$0.20	$640.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	384.00	3.97	1,441.11	21.00	1,050.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	1,280.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.20	640.00	3.50	1,270.50	21.00	1,050.00
10	Wm. McIvor, Marseilles, Ill	.145	464.00	4.25	1,542.75	21.50	1,075.00
12	Cogan & Pound, Chicago, Ill	.15	480.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.17	544.00	3.80	1,379.40	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.19	608.00	4.00	1,452.00	22.00	1,100.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr	20.00	300.00	47.00	611.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	.03	165.00
10	Wm. McIvor, Marseilles, Ill	20.00	300.00	50.00	650.00	.0275	151.25
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.40	3,145.00	4.90	245.00	6.15	307.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	2.95	2,728.75	5.20	260.00	7.20	360.00
10	Wm. McIvor, Marseilles, Ill	3.25	3,006.25	4.60	230.00	5.25	262.50
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	3.00	2,775.00	5.00	250.00	7.00	350.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 9—Continued.

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill.	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$7,901.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.25	52.50	.30	168.00	7,895.36
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	13,192.00
9	Doan & Tolman, Aurora, Ill.	1.10	330.00	.15	31.50	.18	100.80	7,476.55
10	Wm. McIvor, Marseilles, Ill.	.75	225.00	.14	29.40	.17	95.20	7,768.85
12	Cogan & Pound, Chicago, Ill.	.60	180.00	.10	21.00	.15	84.00	7,344.88
13	H. A. Boedker & Co., Chicago, Ill.	.60	180.00	.30	63.00	.40	224.00	7,551.90
19	Barnett & Record Co., Minneapolis, Minn.	.65	195.00	.30	63.00	.35	196.00	7,726.50

FOUNDATION FOR LOCK NO. 10.

Number of proposal.	Name and address of bidder.	Earth excavation (3,900 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$0.20	$780.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.35	1,365.00	4.10	1,488.13	22.50	1,125.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	1,560.00	8.00	2,904.00	40.00	2,000.00
10	Wm. McIvor, Marseilles, Ill.	.145	565.50	4.25	1,542.75	21.50	1,075.00
12	Cogan & Pound, Chicago, Ill.	.15	585.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill.	.20	780.00	3.90	1,415.70	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn.	.23	897.00	4.00	1,452.00	22.00	1,100.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	21.00	315.00	50.00	650.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
10	Wm. McIvor, Marseilles, Ill.	20.00	300.00	50.00	650.00	.0275	151.25
12	Cogan & Pound, Chicago, Ill.	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill.	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn.	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	4.00	3,700.00	5.00	250.00	6.15	307.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
10	Wm. McIvor, Marseilles, Ill.	3.25	3,006.25	4.60	230.00	5.25	262.50
12	Cogan & Pound, Chicago, Ill.	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill.	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn.	3.00	2,775.00	5.00	250.00	7.00	350.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 10—Continued.

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$8,131.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.30	63.00	.35	196.00	9,651.05
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	13,472.00
10	Wm. McIvor, Marseilles, Ill	.75	225.00	.14	29.40	.17	95.20	7,870.35
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	7,449.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	7,824.20
19	Barnett & Record Co., Minneapolis, Minn	.65	195.00	.30	63.00	.35	196.00	8,015.50

FOUNDATION FOR LOCK NO. 11.

Number of proposal.	Name and address of bidder.	Earth excavation (11,600 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Pearce, Marseilles, Ill	$0.20	$2,320.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.15	1,740.00	3.95	1,433.85	21.50	1,075.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	4,640.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.22	2,552.00	3.50	1,270.50	21.00	1,050.00
10	Wm. McIvor, Marseilles, Ill	.155	1,798.00	4.25	1,542.75	21.50	1,075.00
12	Cogan & Pound, Chicago, Ill	.15	1,740.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.22	2,552.00	3.80	1,379.40	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.16	1,856.00	4.00	1,452.00	22.00	1.100.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	19.50	292.50	47.00	611.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	.03	165.00
10	Wm. McIvor, Marseilles, Ill	20.00	300.00	50.00	650.00	.0275	151.25
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.40	3,145.00	4.90	245.00	6.05	302.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	2.95	2,728.75	5.20	260.00	7.20	360.00
10	Wm. McIvor, Marseilles, Ill	3.25	3,006.25	4.60	230.00	5.25	262.50
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker, Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	3.00	2,775.00	5.00	250.00	7.00	350.00

Abstract of proposals for canal trunk earthwork, etc.—Continued

FOUNDATION FOR LOCK NO. 11—Continued.

Number of proposal.	Name and address of bidder.	Gravel (800 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$9,671.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.25	52.50	.30	168.00	9,261.60
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	16,552.00
9	Doan & Tolman, Aurora, Ill	1.10	330.00	.15	31.50	.18	100.80	9,388.53
10	Wm. McIvor, Marseilles, Ill	.75	225.00	.14	29.40	.17	95.20	9,102.85
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	8,604.88
13	H. A. Boedeker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	9,559.90
19	Barnett & Record Co., Minneapolis, Minn	.65	195.00	.30	63.00	.35	196.00	8,974.50

FOUNDATIONS FOR LOCK NO. 12 AND AQUEDUCT NO. 2.

Number of proposal.	Name and address of bidder.	Earth excavation (9,200 cubic yards).		Piles (977).		Pine timber (100,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$0.35	$3,220.00	$4.04	$3,947.08	$23.50	$2,350.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.50	4,600.00	8.00	7,816.00	40.00	4,000.00
8	Monroe & Bryan, Portsmouth, Ohio	.39	3,588.00	4.00	3,908.00	22.00	2,200.00
12	Cogan & Pound, Chicago, Ill	.15	1,380.00	3.36	3,282.72	23.04	2,304.00
13	H. A. Boedker & Co., Chicago, Ill	.24	2,208.00	4.10	4,005.70	23.00	2,300.00
19	Barnett & Record Co., Minneapolis, Minn	.23	2,116.00	4.00	3,908.00	22.00	2,200.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (18,000 feet B. M.).		Spikes, bolts, and nails (11,200 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$22.00	$330.00	$50.00	$900.00	$0.0225	$252.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	900.00	.05	560.00
8	Monroe & Bryan, Portsmouth, Ohio	21.50	322.50	49.00	882.00	.0225	252.00
12	Cogan & Pound. Chicago, Ill	21.60	324.00	29.40	529.20	.02	224.00
13	H. A. Boedker & Co., Chicago, Ill	21.00	315.00	50.00	900.00	.03	336.00
19	Barnett & Record Co., Minneapolis, Minn	20.00	300.00	50.00	900.00	.025	280.00

Number of proposal.	Name and address of bidder.	Concrete.						Total.
		Natural cement (1,125 cubic yards).		Portland cement with pebbles (480 cubic yards).		Portland cement with broken stone (480 cubic yards).		
		Price.	Amount.	Price.	Amount.	Price.	Amount.	
5	Katz, Crandall & Callahan, Omaha, Nebr	$4.00	$4,500.00	$6.50	$3,120.00	$7.65	$3,672.00	$18,619.08
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	5,625.00	6.75	3,240.00	7.75	3,720.00	27,191.00
8	Monroe & Bryan, Portsmouth, Ohio	2.25	2,531.25	7.25	3,480.00	8.25	3,960.00	17,163.75
12	Cogan & Pound, Chicago, Ill	3.28	3,690.00	6.72	3,225.60	7.35	3,528.00	14,959.52
13	H. A. Boedker & Co., Chicago, Ill	3.00	3,375.00	4.50	2,160.00	5.75	2,760.00	15,599.70
19	Barnett & Record Co., Minneapolis, Minn	3.00	3,375.00	7.00	3,360.00	9.00	4,320.00	16,439.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 13.

Number of proposal.	Name and address of bidder.	Earth excavation (3,000 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$0.20	$600.00	$4.00	$1,452.00	$20.00	$1,000.00
4	Winston Bros. & Co., Minneapolis, Minn.	.215	645.00	3.60	1,306.80	21.50	1,075.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	360.00	3.97	1,441.11	21.00	1,050.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	1,200.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill.	.18	540.00	3.50	1,270.50	21.00	1,050.00
12	Cogan & Pound, Chicago, Ill.	.15	450.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill.	.15	450.00	3.80	1,379.40	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn.	.17	510.00	4.00	1,452.00	22.00	1,100.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
4	Winston Bros. & Co., Minneapolis, Minn.	21.25	318.75	48.00	624.00	.025	137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	19.00	285.00	47.00	611.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill.	21.00	315.00	45.00	585.00	.03	165.00
12	Cogan & Pound, Chicago, Ill.	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill.	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn.	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill.	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
4	Winston Bros. & Co., Minneapolis, Minn.	3.40	3,145.00	6.25	312.50	9.00	450.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.40	3,145.00	4.90	245.00	6.05	302.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill.	2.95	2,728.75	5.20	260.00	7.20	360.00
12	Cogan & Pound, Chicago, Ill.	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill.	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn.	3.00	2,775.00	5.00	250.00	7.00	350.00

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain-pipe (210 linear feet).		10-inch drain-pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill.	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$7,951.15
4	Winston Bros. & Co., Minneapolis, Minn.	.75	225.00	.20	42.00	.25	140.00	7,971.55
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.30	63.00	.35	196.00	7,894.86
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	13,112.00
9	Doan & Tolman, Aurora, Ill.	1.10	330.00	.15	31.50	.18	100.80	7,376.55
12	Cogan & Pound, Chicago, Ill.	.60	180.00	.10	21.00	.15	84.00	7,314.88
13	H. A. Boedker & Co., Chicago, Ill.	.60	180.00	.30	63.00	.40	224.00	7,457.90
19	Barnett & Record Co, Minneapolis, Minn.	.65	195.00	.30	63.00	.35	196.00	7,628.50

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 14.

Number of proposal.	Name and address of bidder.	Earth excavation (9,100 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$0.20	$1,820.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	1,092.00	3.97	1,441.11	21.00	1,050.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	3,640.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.22	2,002.00	3.50	1,270.50	21.00	1,050.00
12	Cogan & Pound, Chicago, Ill	.15	1,365.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.21	1,911.00	3.90	1,415.70	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.154	1,401.40	3.90	1,415.70	21.50	1,075.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,000 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	19.00	285.00	47.00	611.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	.03	165.00
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	19.00	285.00	48.00	624.00	.0225	123.75

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.60	3,330.00	4.95	247.50	6.10	305.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	3.10	2,867.50	5.35	267.50	7.45	372.50
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	2.90	2,682.50	4.95	247.50	6.95	347.50

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain-pipe (210 linear feet).		10-inch drain-pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$9,171.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.30	63.00	.35	196.00	8,814.36
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	15,552.00
9	Doan & Tolman, Aurora, Ill	1.10	330.00	.15	31.50	.18	100.80	8,984.80
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	8,229.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	8,955.20
19	Barnett & Record Co., Minneapolis, Minn	.60	180.00	.25	52.50	.30	168.00	8,255.35

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 15.

Number of proposal.	Name and address of bidder.	Earth excavation (5,600 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$0.20	$1,120.00	$4.00	$1,452.00	$20.00	$1,000.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	672.00	4.00	1,452.00	23.00	1,150.00
7	N. S. Young and Wm. Steyh, Burlington, Iowa	.40	2,240.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.25	1,400.00	3.50	1,270.50	21.00	1,050.00
12	Cogan & Pound, Chicago, Ill	.15	840.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.18	1,008.00	3.90	1,415.70	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.154	862.40	3.90	1,415.70	21.50	1,075.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	21.00	315.00	49.00	637.00	0.0225	123.75
7	N. S. Young and Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	0.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	0.03	165.00
12	Cogan & Pond, Chicago, Ill	21.60	324.00	29.40	382.20	0.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	0.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	19.00	285.00	48.00	624.00	0.0225	123.75

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement, with pebbles (50 cubic yards).		Portland cement, with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	4.00	3,700.00	5.25	262.50	6.10	305.00
7	N. S. Young and Wm. Steyh, Burlington, Iowa.	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	3.20	2,960.00	5.45	272.50	7.45	372.50
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	2.90	2,682.50	4.95	247.50	6.95	347.50

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards.)		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$8,471.15
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.30	63.00	.35	196.00	8,946.25
7	N. S. Young and Wm. Steyh, Burlington, Iowa.	1.50	450.00	.25	52.50	.30	168.00	14,152.00
9	Doan & Tolman, Aurora, Ill	1.25	375.00	.15	31.50	.18	100.80	8,525.30
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	7,701.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	8,052.20
19	Barnett & Record Co., Minneapolis, Minn.	.60	180.00	.25	52.50	.30	168.00	7,716.35

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK No. 16.

Number of proposal.	Name and address of bidder.	Earth excavation (1,800 cubic yards).		Piles (363).		Pine timber (50.000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$0.20	$360.00	$4.00	$1,452.00	$20.00	$1,000.00
4	Winston Bros. & Co., Minneapolis, Minn.	.215	387.00	3.60	1,306.80	21.25	1,062.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	216.00	3.97	1,441.11	21.50	1,075.00
7	N. S. Young and Wm. Steyh, Burlington, Iowa	.40	720.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.18	324.00	3.50	1,270.50	21.00	1,050.00
11	Griffith & McDormott Construction Co., Chicago, Ill	.20	360.00	5.00	1,815.00	30.00	1,500.00
12	Cogan & Pound, Chicago, Ill	.15	270.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.15	270.00	3.80	1,379.40	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.154	277.20	3.90	1,415.70	21.50	1,075.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
4	Winston Bros. & Co., Minneapolis, Minn.	21.25	318.75	48.00	624.00	.025	137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	19.00	285.00	47.00	611.00	.0225	123.75
7	N. S. Young and Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	.03	165.00
11	Griffith & McDormott Construction Co., Chicago, Ill	30.00	450.00	60.00	780.00	.03	165.00
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	19.00	285.00	48.00	624.00	.0225	123.75

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement, with pebbles (50 cubic yards).		Portland cement, with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	$3,376.25	$5.72	$286.00	$7.00	$350.00
4	Winston Bros. & Co., Minneapolis, Minn.	3.40	3,145.00	6.25	312.50	9.00	450.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.60	3,330.00	5.00	250.00	5.95	297.50
7	N. S. Young and Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	3.20	2,960.00	5.45	272.50	7.45	372.50
11	Griffith & McDormott Construction Co., Chicago, Ill	6.00	5,550.00	8.00	400.00	8.00	400.00
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	2.90	2,682.50	4.95	247.50	6.95	347.50

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$7,711.15
4	Winston Bros. & Co., Minneapolis, Minn.	.75	225.00	.20	42.00	.25	140.00	7,701.05
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.25	375.00	.25	52.50	.30	168.00	7,927.36
7	N. S. Young and Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	12,632.00
9	Doan & Tolman, Aurora, Ill	1.45	435.00	.15	31.50	.18	100.80	7,509.30
11	Griffith & McDormott Construction Co., Chicago, Ill	1.50	450.00	.26	54.60	.28	156.80	11,681.40
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	7,134.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	7,277.90
19	Barnett & Record Co., Minneapolis, Minn	.60	180.00	.25	52.50	.30	168.00	7,131.15

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 17.

Number of proposal.	Name and address of bidder.	Earth excavation (5,800 cubic yards).		Piles (363).		Pine timber (50,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$0.20	$1,160.00	$4.00	$1,452.00	$20.00	$1,000.00
4	Winston Bros. & Co., Minneapolis, Minn.	.215	1,247.00	3.60	1,306.80	21.25	1,062.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	.17	986.00	4.05	1,470.15	23.00	1,150.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	2,320.00	8.00	2,904.00	40.00	2,000.00
9	Doan & Tolman, Aurora, Ill	.22	1,276.00	3.50	1,270.50	21.00	1,050.00
11	Griffith & McDormott Construction Co., Chicago, Ill	.20	1,160.00	5.00	1,815.00	30.00	1,500.00
12	Cogan & Pound, Chicago, Ill	.15	870.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill	.20	1,160.00	3.90	1,415.70	22.00	1,100.00
19	Barnett & Record Co., Minneapolis, Minn	.154	893.20	3.90	1,415.70	21.50	1,075.00

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$20.00	$300.00	$40.00	$520.00	$0.025	$137.50
4	Winston Bros. & Co., Minneapolis, Minn.	21.25	318.75	48.00	624.00	.025	137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	21.00	315.00	49.00	637.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.05	275.00
9	Doan & Tolman, Aurora, Ill	21.00	315.00	45.00	585.00	.03	165.00
11	Griffith & McDormott Construction Co., Chicago, Ill	30.00	450.00	60.00	780.00	.03	165.00
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.02	110.00
13	H. A. Boedker & Co., Chicago, Ill	20.00	300.00	48.00	624.00	.025	137.50
19	Barnett & Record Co., Minneapolis, Minn	19.00	285.00	48.00	624.00	.0225	123.75

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
3	Barron & Peace, Marseilles, Ill	$3.65	3,376.25	$5.72	$286.00	$7.00	$350.00
4	Winston Bros. & Co., Minneapolis, Minn.	3.40	3,145.00	6.25	312.50	9.00	450.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.95	3,653.75	4.95	247.50	6.10	305.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
9	Doan & Tolman, Aurora, Ill	3.20	2,960.00	5.45	272.50	7.45	372.50
11	Griffith & McDormott Construction Co., Chicago, Ill	6.00	5,550.00	8.00	400.00	8.00	400.00
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	2.90	2,682.50	4.95	247.50	6.95	347.50

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
3	Barron & Peace, Marseilles, Ill	$0.60	$180.00	$0.10	$21.00	$0.14	$78.40	$8,511.15
4	Winston Bros. & Co., Minneapolis, Minn.	.75	225.00	.20	42.00	.25	140.00	8,561.05
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.15	345.00	.25	52.50	.30	168.00	9,148.65
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	450.00	.25	52.50	.30	168.00	14,232.00
9	Doan & Tolman, Aurora, Ill	1.25	375.00	.15	31.50	.18	100.80	8,401.30
11	Griffith & McDormott Construction Co., Chicago, Ill	1.50	450.00	.26	54.60	.28	156.80	12,481.40
12	Cogan & Pond, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	7,734.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	8,204.20
19	Barnett & Record Co., Minneapolis, Minn	.60	180.00	.25	52.50	.30	168.00	7,747.15

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR AQUEDUCT NO. 3.

Number of proposal.	Name and address of bidder.	Earth excavation (4,200 cubic yards).		Piles (450).	
		Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$0.50	$2,100.00	$4.15	$1,867.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.50	2,100.00	8.00	3,600.00
11	Griffith & McDermott Construction Co., Chicago, Ill.	.50	2,100.00	5.00	2,250.00
12	Cogan & Pound, Chicago, Ill.	.15	630.00	3.36	1,512.00
13	H. A. Boedker & Co., Chicago, Ill.	.40	1,680.00	4.50	2,025.00
19	Barnett & Record Co., Minneapolis, Minn.	.28	1,176.00	4.00	1,800.00

Number of proposal.	Name and address of bidder.	Pine lumber (48,000 feet B. M.).		Oak plank (9,500 feet B. M.).		Spikes, bolts, and nails (4,800 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$23.50	$1,128.00	$53.00	$503.50	$0.0225	$108.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	40.00	1,920.00	50.00	475.00	.05	240.00
11	Griffith & McDermott Construction Co., Chicago, Ill	30.00	1,440.00	60.00	570.00	.03	144.00
12	Cogan & Pound, Chicago, Ill.	22.90	1,099.20	29.40	279.30	.02	96.00
13	H. A. Boedker & Co., Chicago, Ill.	24.00	1,152.00	50.00	475.00	.03	144.00
19	Barnett & Record Co., Minneapolis, Minn.	22.00	1,056.00	50.00	475.00	.0225	108.00

Number of proposal.	Name and address of bidder.	Concrete. Natural cement (240 cubic yards).		Concrete. Portland cement with pebbles (220 cubic yards).		Concrete. Portland cement with broken stone (220 cubic yards).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
5	Katz, Crandall & Callahan, Omaha, Nebr.	$4.50	$1,080.00	$6.80	$1,496.00	$7.65	$1,683.00	$8,283.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	1,200.00	6.75	1,485.00	7.75	1,705.00	11,020.00
11	Griffith & McDermott Construction Co., Chicago, Ill.	6.00	1,440.00	8.00	1,760.00	8.00	1,760.00	9,704.00
12	Cogan & Pound, Chicago, Ill.	3.28	787.20	6.72	1,478.40	7.35	1,617.00	5,882.10
13	H. A. Boedker & Co., Chicago, Ill.	3.50	840.00	5.00	1,100.00	6.25	1,375.00	7,416.00
19	Barnett & Record Co., Minneapolis, Minn	3.25	780.00	7.25	1,595.00	9.25	2,035.00	6,990.00

FOUNDATION FOR LOCK NO. 18.

Number of proposal.	Name and address of bidder.	Earth excavation (19,500 cubic yards).		Piles (363).		Pine timber (50,000 feet, B.M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
4	Winston Bros. & Co., Minneapolis, Minn.	$0.215	$4,192.50	$3.60	$1,306.80	$21.25	$1,062.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	.12	2,340.00	3.97	1,441.11	21.50	1,075.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.40	7,800.00	8.00	2,904.00	40.00	2,000.00
11	Griffith & McDermott Construction Co., Chicago, Ill.	.20	3,900.00	5.00	1,815.00	30.00	1,500.00
12	Cogan & Pound, Chicago, Ill.	.20	3,900.00	3.36	1,219.68	23.48	1,174.00
13	H. A. Boedker & Co., Chicago, Ill.	.22	4,290.00	4.00	1,452.00	24.00	1,200.00
19	Barnett & Record Co., Minneapolis, Minn.	.20	3,900.00	4.00	1,452.00	22.00	1,100.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATION FOR LOCK NO. 18—Continued.

Number of proposal.	Name and address of bidder.	Pine plank (15,000 feet B. M.).		Oak plank (13,000 feet B. M.).		Spikes, bolts, and nails (5,500 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
4	Winston Bros. & Co., Minneapolis, Minn.	$21.25	$318.75	$48.00	$624.00	$0.025	$137.50
5	Katz, Crandall & Callahan, Omaha, Nebr.	19.00	285.00	47.00	611.00	.0225	123.75
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	450.00	50.00	650.00	.050	275.00
11	Griffith & McDermott Construction Co., Chicago, Ill.	30.00	450.00	60.00	780.00	.030	165.00
12	Cogan & Pound, Chicago, Ill	21.60	324.00	29.40	382.20	.020	110 00
13	H. A. Boedker & Co., Chicago, Ill	22.00	330.00	55.00	715.00	.025	137 50
19	Barnett & Record Co., Minneapolis, Minn	20.00	300.00	50.00	650.00	.025	137.50

Number of proposal.	Name and address of bidder.	Concrete. Natural cement (925 cubic yards).		Portland cement with pebbles (50 cubic yards).		Portland cement with broken stone (50 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
4	Winston Bros. & Co., Minneapolis, Minn.	$3.40	$3,145.00	$6.25	$312.50	$9.00	$450.00
5	Katz, Crandall & Callahan, Omaha, Nebr.	3.60	3,330.00	4.90	245.00	6.00	300.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	4,625.00	6.75	337.50	7.75	387.50
11	Griffith & McDermott Construction Co., Chicago, Ill	6.00	5,550.00	8.00	400.00	8.00	400.00
12	Cogan & Pound, Chicago, Ill	3.28	3,034.00	6.72	336.00	7.35	367.50
13	H. A. Boedker & Co., Chicago, Ill	3.00	2,775.00	4.50	225.00	5.75	287.50
19	Barnett & Record Co., Minneapolis, Minn	3.00	2,775.00	5.00	250.00	7.00	350.00

Number of proposal.	Name and address of bidder.	Gravel (300 cubic yards).		8-inch drain pipe (210 linear feet).		10-inch drain pipe (560 linear feet.)		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
4	Winston Bros. & Co., Minneapolis, Minn.	$0.75	$225.00	$0.20	$42.00	$0.25	$140.00	$11,506.55
5	Katz, Crandall & Callahan, Omaha, Nebr.	1.00	300.00	.25	52.50	.30	168.00	9,971.36
7	N. S. Young & Wm. Steyh, Burlington., Iowa	1.50	450.00	.25	52.50	.30	168.00	19,712.00
11	Griffith & McDermott Construction Co., Chicago, Ill	1.50	450.00	.26	54.60	.28	156.80	15,221.40
12	Cogan & Pound, Chicago, Ill	.60	180.00	.10	21.00	.15	84.00	10,764.88
13	H. A. Boedker & Co., Chicago, Ill	.60	180.00	.30	63.00	.40	224.00	11,591.50
19	Barnett & Record Co., Minneapolis, Minn	.65	195.00	.30	63.00	.35	196.00	11,018.50

FOUNDATIONS FOR ELEVEN LOCKS AND TWO AQUEDUCTS.

Number of proposal.	Name and address of bidder.	Earth excavation (83,500 cubic yards).		Piles (5,057).		Pine timber (648,000 feet B. M.).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$0.199	$16,616.50	$3.97	$20,076.29	$21.90	$14,191.20
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.4175	34,861.25	8.00	40,456.00	40.00	25,920.00
12	Cogan & Pound, Chicago, Ill	.15	12,525.00	3.25	16,435.25	22.20	14,385.60
13	H. A. Boedker & Co., Chicago, Ill	.216	18,036.00	3.96	20,025.72	22.40	14,515.20
14	Heldmaier & New, Chicago, Ill	.175	14,612.50	3.50	17,699.50	22.75	14,742.00
15	Chicago Star Construction and Dredging Co., Chicago, Ill	.21	17,535.00	4.00	20,228.00	24.00	15,552.00
17	McArthur Bros. Co., Chicago, Ill	.20	16,700.00	3.70	18,710.90	23.00	14,904.00
19	Barnett & Record Co., Minneapolis, Minn	.1775	14,821.25	3.90	19,722.30	21.40	13,867.20
21	Lydon & Drews Co., Chicago, Ill	.17	14,195.00	4.00	20,228.00	22.00	14,256.00

***Abstract of proposals for canal trunk earthwork, etc.*—Continued.**

FOUNDATION FOR LOCK NO. 18—Continued.

No. of proposal.	Name and address of bidder.	Pine plank (165,000 feet B. M.).		Oak plank (157,500 feet B. M.).		Spikes, bolts, and nails (71,000 pounds).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$18.75	$3,093.75	$45.90	$7,229.25	$0.0225	$1,597.50
7	N. S. Young & Wm. Steyh, Burlington, Iowa	30.00	4,950.00	50.00	7,875.00	.05	3,550.00
12	Cogan & Pound, Chicago, Ill	22.20	3,663.00	29.40	4,630.50	.02	1,420.00
13	H. A. Boedker & Co., Chicago, Ill.	20.25	3,341.25	48.50	7,638.75	.025	1,775.00
14	Heldmaier & New, Chicago, Ill.	20.30	3,349.50	41.50	6,536.25	.03	2,130.00
15	Chicago Star Construction and Dredging Co., Chicago, Ill	19.00	3,135.00	50.00	7,875.00	.03	2,130.00
17	McArthur Bros. Co., Chicago, Ill	23.00	3,795.00	48.00	7,560.00	.0225	1,597.50
19	Barnett & Record Co., Minneapolis, Minn	18.90	3,118.50	47.00	7,402.50	.0225	1,597.50
21	Lydon & Drews Co., Chicago, Ill.	22.00	3,630.00	45.00	7,087.50	.025	1,775.00

Number of proposal.	Name and address of bidder.	Concrete.					
		Natural cement (10,615 cubic yards).		Portland cement with pebbles (1,200 cubic yards).		Portland cement with broken stone (1,200 cubic yards).	
		Price.	Amount.	Price.	Amount.	Price.	Amount.
5	Katz, Crandall & Callahan, Omaha, Nebr.	$3.65	$38,744.75	$4.90	$5,880.00	$5.90	$7,080.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	5.00	53,075.00	6.75	8,100.00	7.75	9,300.00
12	Cogan & Pound, Chicago, Ill	3.10	32,906.50	6.60	7,920.00	7.35	8,820.00
13	H. A. Boedker & Co., Chicago, Ill.	3.05	32,375.75	4.50	5,400.00	5.80	6,960.00
14	Heldmaier & New, Chicago, Ill	3.70	39,275.50	6.20	7,440.00	8.20	9,840.00
15	Chicago Star Construction and Dredging Co., Chicago, Ill	2.75	29,191.25	4.55	5,460.00	......	....
17	McArthur Bros. Co., Chicago, Ill.	2.72	28,872.80	5.00	6,000.00	6.75	8,100.00
19	Barnett & Record Co., Minneapolis, Minn	2.85	30,252.75	5.70	6,840.00	7.70	9,240.00
21	Lydon & Drews Co., Chicago, Ill.	3.00	31,845.00	5.25	6,300.00	6.60	7,920.00

No. of proposal.	Name and address of bidder.	Gravel (3,000 cubic yards).		8-inch drain pipe (2,100 linear feet).		10-inch drain pipe (5,600 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	
5	Katz, Crandall & Callahan, Omaha, Nebr	$1.15	$3,450.00	$0.24	$504.00	$0.29	$1,624.00	$113,007.24
7	N. S. Young & Wm. Steyh, Burlington, Iowa	1.50	4,500.00	.25	525.00	.30	1,680.00	185,492.25
12	Cogan & Pound, Chicago, Ill	.60	1,800.00	.10	210.00	.15	840.00	96,735.85
13	H. A. Boedker & Co., Chicago, Ill	.60	1,800.00	.30	630.00	.40	2,240.00	107,777.67
14	Heldmaier & New, Chicago, Ill	1.00	3,000.00	.12	252.00	.18	1,008.00	110,045.25
15	Chicago Star Construction and Dredging Co., Chicago, Ill	.50	1,500.00	.15	315.00	.20	1,120.00	104,041.25
17	McArthur Bros. Co., Chicago, Ill	.20	600.00	.20	420.00	.26	1,456.00	100,616.20
19	Barnett & Record Co., Minneapolis, Minn	.55	1,650.00	.25	525.00	.30	1,680.00	101,477.00
21	Lydon & Drews Co., Chicago, Ill	1.00	3,000.00	.20	420.00	.30	1,680.00	104,416.50

TWO CONCRETE ARCH CULVERTS, AND SIX CAST-IRON PIPE CULVERTS.

No. of proposal.	Name and address of bidder.	Earthwork (17,000 cubic yards).		Piles (352).		Pine timber (37,000 feet B. M.).		Pine plank (14,000 feet B. M.).	
		Price.	Am't.	Price.	Am't.	Price.	Am't.	Price.	Am't.
4	Winston Bros. & Co., Minneapolis, Minn	$0.30	$5,100.00	$3.90	$1,372.80	$24.00	$888.00	$24.00	$336.00
5	Katz, Crandall & Callahan, Omaha, Nebr	.75	12,750.00	4.50	1,584.00	24.00	888.00	23.00	322.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	.50	8,500.00	8.00	2,816.00	40.00	1,480.00	30.00	420.00
8	Monroe & Bryan, Portsmouth, Ohio.	.295	5,015.00	4.25	1,496.00	23.00	851.00	22.50	315.00
11	Griffith & McDermott Construction Co., Chicago, Ill.	.40	6,800.00	5.00	1,760.00	30.00	1,110.00	30.00	420.00
12	Cogan & Pound, Chicago, Ill.	.20	3,400.00	3.50	1,232.00	24.00	888.00	23.00	322.00
14	Heldmaier & New, Chicago, Ill.	.225	3,825.00	3.75	1,320.00	22.75	841.75	22.25	311.50
17	McArthur Bros. Co., Chicago, Ill	.34	5,780.00	3.90	1,372.80	25.00	925.00	23.00	322.00
19	Barnett & Record Co., Minneapolis, Minn	.22	3,740.00	4.00	1,408.00	22.00	814.00	20.00	280.00
21	Lydon & Drews Co., Chicago, Ill.	.20	3,400.00	4.50	1,584.00	24.00	888.00	24.00	336.00

Abstract of proposals for canal trunk earthwork, etc.—Continued.

FOUNDATIONS FOR ELEVEN LOCKS AND TWO AQUEDUCTS—Continued.

Number of proposal.	Name and address of bidder.	Oak plank (3,000 feet B. M.).		Driftbolts, etc. (4,300 pounds).		Concrete.			
						Natural cement (755 cubic yards).		Portland cement with pebbles (900 cubic yards).	
		Price.	Am't.	Price.	Am't.	Price.	Am't.	Price.	Am't.
4	Winston Bros. & Co., Minneapolis, Minn	$55.00	$165.00	$0.025	$107.50	$3.90	$2,944.50	$9.00	$8,100.00
5	Katz, Crandall & Callahan, Omaha, Nebr	60.00	180.00	.0225	96.75	4.60	3,473.00	6.90	6,210.00
7	N. S. Young & Wm. Steyh, Burlington, Iowa	50.00	150.00	.05	215.00	5.00	3,775.00	6.75	6,075.00
8	Monroe & Bryan, Portsmouth, Ohio	50.00	150.00	.02	86.00	2.50	1,887.50	7.50	6,750.00
11	Griffith & McDermott Construction Co., Chicago, Ill	60.00	180.00	.03	129.00	6.00	4,530.00	8.00	7,200.00
12	Cogan & Pound, Chicago, Ill	31.00	93.00	.02	86.00	3.50	2,642.50	8.00	7,200.00
14	Heldmaier & New, Chicago, Ill	42.50	127.50	.03	129.00	4.00	3,020.00	8.05	7,245.00
17	McArthur Bros. Co., Chicago, Ill	50.00	150.00	.025	107.50	3.00	2,265.00	6.85	6,165.00
19	Barnett & Record Co., Minneapolis, Minn	50.00	150.00	.025	107.50	3.00	2,265.00	6.75	6,075.00
21	Lydon & Drews Co., Chicago, Ill	50.00	150.00	.025	107.50	3.25	2,453.75	5.50	4,950.00

Number of proposal.	Name and address of bidder.	Rubble masonry (105 cubic yards).		Rubble paving stone (950 square yards).		48-inch cast-iron pipe (720 linear feet).		36-inch cast-iron pipe (288 linear feet).		Total.
		Price.	Am't.	Price.	Am't.	Price.	Am't.	Price.	Am't.	
4	Winston Bros. & Co., Minneapolis, Minn	$6.50	$682.50	$1.80	$1,710.00	$6.44	$4,636.80	$4.30	$1,238.40	$27,281.50
5	Katz, Crandlla & Callahan, Omaha, Nebr	7.75	813.75	2.75	2,612.50	7.48	5,385.60	5.53	1,592.64	35,908.24
7	N. S. Young & Wm. Steyh, Burlington, Iowa	6.00	630.00	1.75	1,662.50	30.00	21,600.00	25.00	7,200.00	54,523.50
8	Monroe & Bryan, Portsmouth, Ohio	4.70	493.50	1.20	1,140.00	8.45	6,084.00	5.45	1,569.60	25,837.60
11	Griffith & McDermott Construction Co., Chicago, Ill	6.00	630.00	2.50	2,375.00	8.00	5,760.00	6.00	1,728.00	32,622.00
12	Cogan & Pound, Chicago, Ill	5.00	525.00	1.75	1,662.50	8.36	6,019.20	7.53	2,168.64	26,238.84
14	Heldmaier & New, Chicago. Ill	6.80	714.00	1.80	1,710.00	6.20	4,464.00	4.00	1,152.00	24,859.75
17	McArthur Bros. Co., Chicago, Ill	6.00	630.00	1.50	1,425.00	6.20	4,464.00	4.20	1,209.60	24,815.90
19	Barnett & Record Co., Minneapolis, Minn	12.75	1,338.75	2.00	1,900.00	7.50	5,400.00	5.00	1,440.00	24,918.25
21	Lydon & Drews Co., Chicago, Ill	6.00	630.00	4.50	4,275.00	16.00	11,520.00	11.00	3,168.00	33,462.25

RECAPITULATION.

Lowest bidder on each mile earthwork:	
Mile 9, proposal No. 5, Katz, Crandall & Callahan	$12,060.00
Miles 10 and 11 and slope paving, proposal No. 5, Katz, Crandall & Callahan	27,882.50
Mile 12, proposal No. 5, Katz, Crandall & Callahan	8,755.00
Mile 13, proposal No. 18, R. C. Cushing & Co	12,816.00
Mile 14, proposal No. 5, Katz, Crandall & Callahan	11,610.00
Mile 15, proposal No. 5, Katz, Crandall & Callahan	21,930.00
Mile 16, proposal No. 5, Katz, Crandall & Callahan	25,925.00
Total	120,978.50
Lowest bidder on entire 8 miles earthwork: Proposal No. 16, John Scott & Sons	85,287.00
Second lowest bidder entire 8 miles: Proposal No. 5, Katz, Crandall & Callahan	119,475.00

(See recommendations.)

LOCK AND AQUEDUCT FOUNDATIONS.

Lowest bidder each lock and aqueduct:	
Lock No. 8, proposal No. 12, Cogan & Pound	$7,854.88
Lock No. 9, proposal No. 12, Cogan & Pound	7,344.88
Lock No. 10, proposal No. 12, Cogan & Pound	7,449.88
Lock No. 11, proposal No. 12, Cogan & Pound	8,604.88
Lock No. 12 and aqueduct 2, No. 12, Cogan & Pound	14,959.52
Lock No. 13, proposal No. 12, Cogan & Pound	7,314.88
Lock No. 14, proposal No. 12, Cogan & Pound	8,229.88
Lock No. 15, proposal No. 12, Cogan & Pound	7,704.88
Lock No. 16, proposal No. 19, Barnett & Record Company	7,131.15
Lock No. 17, proposal No. 12, Cogan & Pound	7,734.88
Aqueduct No. 3, proposal No. 12, Cogan & Pound	5,882.10
Lock No. 18, proposal No. 5, Katz, Crandall & Callahan	9,971.36
Total	100,183.17
Lowest bidder for total 11 locks and 2 aqueducts: Proposal No. 12, Cogan & Pound	96,735.85
Culverts: Lowest bidder, McArthur Bros. Co	24,815.90

REMARKS.

The price of Portland cement concrete with broken stone not included in total cost of lock and aqueduct foundations or culverts.

Proposal No. 5. Bond signed by a surety company by agents and attorneys in fact. No authority filed in this office for signature of agents and attorneys. No justification of guarantor.

Proposal No. 7. Amount of bond insufficient.

Proposal No. 9. No justification of guarantor (surety company).

Proposal No. 10. Amount of bond insufficient. Work bid on not inserted in guaranty.

Proposal No. 12. Work bid on not inserted in guaranty. No justification of guarantor (surety company).

Proposal No. 16. Proposal signed John Scott & Sons; guaranty as to Edward J. Scott, one member of firm only.

Proposal No. 17. Guaranty signed by a surety company by agents and attorneys in fact. No authority filed in this office for signature of agents and attorneys. No justification of guarantor.

Proposal No. 21. Not in triplicate. No bid for spikes, bolts, and nails in lock and aqueduct foundations. Price bid by this company on similar materials in culverts used in arriving at total amount of bid.

RECOMMENDATIONS.

(1.) That bid of John Scott & Sons (proposal No. 16), the lowest bidder for 8 miles earthwork and slope paving miles 10 and 11 be rejected, on account of their unwillingness to enter into contract and the probability that on account of irregularity in bond no penalty can be enforced, and that the contract be either awarded to Katz, Crandall & Callahan (proposal No. 5), the next lowest bidder (if above alleged irregularity in their bid may be waived), or that the 8 miles earthwork be readvertised.

(2.) That bid of Cogan & Pound (proposal No. 12), the lowest responsible bidder for lock and aqueduct foundations be accepted, waiving slight informality.

(3.) That bid of McArthur Bros'. Co. (proposal No. 17), the lowest responsible bidder for the 8 culverts, be accepted, if alleged irregularity in their bid may be waived.

REPORT OF FIRST LIEUT. HENRY JERVEY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1897.

MAJOR: I have the honor to submit the following report of hydraulic cement tested under the direction of this office during the fiscal year ending June 30, 1897. Very little new matter is presented, as sickness during the past summer and autumn prevented me from making up any briquets and from continuing the experiments with mixed cements and cement mortar exposed under varying conditions. About 350 briquets that were in stock for long-term tests were broken during the year and the resulting tensile strength is recorded in the tables that follow, which are reprinted as far as seems necessary for intelligent comparison from the last Annual Report, page 2618 et seq., where will be found also the descriptions of all samples not described herein.

Referring to the tables, it will be seen that briquets as old as two years have been broken and that, as a rule, the tensile strength is very nearly the same as that given by one-year tests, some brands showing a slight, but unimportant decrease. It may be worth while to call attention to the two samples of vulcanite tested as perhaps giving some indication as to the effects of sulphate of calcium when added to a Portland cement. The sample "V" (reported free from SO_4Ca) in 1 to 3 mortar, exhibited a moderate strength and a moderate increase up to three months, and then remained practically stationary at nine and fifteen months. The sample "VS" (said to be treated with SO_4Ca), showed high tensile strength at seven days, increased very rapidly to its maximum at seven weeks, after which it decreased about 25 per cent at the end of fifteen months, but it was even then a little stronger than the sample "V" at the same age.

The mortar of mixed cements, one-half part Utica, one-half part Portland, and three parts of sand gives a good showing at the end of one year, its tensile strength being about three-fourths of the usual one-to-three mortar of the corresponding Portland. Such a tensile strength would be ample for concrete forming the lower and back parts of lock walls where not exposed to frost nor to blows from vessels, and a saving in cost of from $1 to $1.50 per cubic yard of concrete could be effected by a mixture of the cements as above.

To the table exhibiting the comparison of natural and standard sand in Portland-cement mortar is annexed a note in regard to the relative increase in strength of the natural-sand mortar.

About 200 briquets remain on hand to be broken, and we expect to make a number of tests this summer in connection with the foundation work on the Illinois and Mississippi Canal.

ALPHA PORTLAND CEMENT.

Tensile strength in pounds per square inch.

	Neat cement (average per cent of water, 21.5).						Mortar, 1 cement to 3 sand (average per cent of water, 12.5).					
	7 days.	28 days.	3 months.	6 months.	1 year.	2 years.	7 days.	28 days.	3 months.	6 months.	1 year.	2 years.
Alpha—barrel N, first series.	574	734	......	......	805	754	188	294	......	......	278	273
	637	738	......	......	......	793	211	289	......	......	259	279
	......	......	......	......	......	768	211	299	......	......	260	278
	550	690	......	......	......	774	191	318	......	......	276	......
	596	735	......	......	......	780	192	339	......	......	271	......
	597	......	......	......	......	803	190	......	......	......	270	......
	695	......	......	......	......	......	197	......	......	......	......	......
	703	......	......	......	......	......	217	......	......	......	......	......
	756	......	......	......	......	......	217	......	......	......	......	......
Average	639	724	......	......	805	779	202	308	......	......	269	277
Alpha—barrel N, second series.	518	727	666	635	616	......	145	284	306	290	314	......
	462	760	595	665	671	......	165	256	311	287	270	......
	470	688	694	750	650	......	181	214	307	326	232	......
	590	695	612	......	626	......	179	262	284	......	295	......
	664	807	816	......	666	......	188	240	348	......	385	......
	678	......	752	......	642	......	230	241	328	......	310	......
	520	......	553	......	......	......	147	......	321	......	......	......
	594	......	559	......	......	......	147	......	289	......	......	......
	......	......	588	......	......	......	......	......	304	......	......	......
	......	......	785	......	......	......	......	......	282	......	......	......
Average...........	562	735	662	683	645	......	173	250	308	301	301	......

	Neat cement (average per cent of water, 21.9).				Mortar, 1 cement to 3 sand (average per cent of water, 11).							
	7 days.	28 days.	3 months.	2 years.	7 days.	28 days.	37 days.	3 months.	6 months.	9 months.	1 year.	2 years.
Alpha—barrel O........	601	772	805	887	162	237	324	312	395	385	358	333
	628	721	......	......	168	262	330	326	418	421	330	......
	......	......	......	......	164	262	326	396	433	411	352	......
	......	......	......	......	215	261	331	413	343	386	348	......
	......	......	......	......	208	262	370	382	386	353	372	......
	......	......	......	......	218	267	331	353	383	421	305	......
	......	......	......	......	237	269	......	343	375	......	......	......
	......	......	......	......	217	265	......	355	426	......	......	......
	......	......	......	......	170	263	......	373	410	......	......	......
	......	......	......	......	228	254	......	353	396	......	......	......
	......	......	......	......	210	272	......	345	386	......	......	......
	......	......	......	......	236	260	......	315	383	......	......	......
	......	......	......	......	232	253	......	347	......	......	......	......
	......	......	......	......	254	256	......	413	......	......	......	......
	......	......	......	......	251	296	......	......	......	......	......	......
	......	......	......	......	......	316	......	......	......	......	......	......
	......	......	......	......	......	277	......	......	......	......	......	......
	......	......	......	......	......	256	......	......	......	......	......	......
	......	......	......	......	......	297	......	......	......	......	......	......
	......	......	......	......	......	289	......	......	......	......	......	......
	......	......	......	......	......	290	......	......	......	......	......	......
	......	......	......	......	......	280	......	......	......	......	......	......
Average...........	615	747	805	887	211	270	335	359	395	396	353	333

ATLAS PORTLAND CEMENT.

Tensile strength in pounds per square inch.

	Neat cement (average per cent of water, 19.7).			Mortar, 1 cement to 3 sand (average per cent of water, 10.7).							
	7 days.	28 days.	3 months.	6 days.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.	2 years.
Atlas—Barrel S	771	782	964		176	304	280		372		358
	731	847	949		170	299	340				
					172	331					
					174	297					
						277					
						287					
						312					
						271					
						294					
						286					
						302					
Average	751	814	957		173	296	310		372		358
Atlas—Series T	660			155	144	282	229	389	377	393	
				135	161	287	274	333	396	344	
				160	160	277	250	365	380	400	
				176	185	255	274	361	366	333	
				165	150	235	256	344	400	310	
				130	156	270	270	366	378	379	
					180	258	243	308			
					196	276	215	280			
					187	270	284	409			
					190	261	338	395			
					181	268	230	306			
					209	274		267			
					196	297					
					186	261					
					191						
					204						
					197						
					187						
					199						
					199						
					197						
					197						
					184						
					197						
					185						
					180						
					187						
					169						
					237						
Average	660			154	186	269	260	344	383	360	
Grand average	721	814	957	154	184	281	268	344	381	360	358

[Series TB of Atlas cement. Tests made at Bureau, Ill.]

	Neat cement (per cent of water, 22.5).				Mortar, 1 cement to 3 sand (per cent of water, 12.1).				
	7 days.	28 days.	3 months.	6 months.	7 days.	28 days.	3 months.	6 months.	1 year.
Number of tests	84	78	5	3	85	78	3	4	3
Average tensile strength	584	680	759	750	140	228	320	344	302

SAYLOR'S AMERICAN PORTLAND CEMENT.

Tensile strength in pounds per square inch.

	Neat cement (per cent of water, 20.5).			Mortar, 1 cement to 3 sand (per cent of water, 10.9).					
	7 days.	28 days.	6 months.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.
Barrel R submitted with bid, June, 1895	391	456	750	185	151	248	316	321	336
	310	674	735	121	175	286	318	327	374
	487	705	791	185	198	280	272	357	326
	561	614	694	124	193	277	270	337	337
	453	616	739	134	200	241	300	321	309
	500	642		124	194	266	296	309	372
	444	620		135	189	273	360	371	378
	480			130	186	294	350	408	
	504			133	210	306	325		
	461			125	214	296	276		
	460			111	173	324	273		
	443			110	180		312		
	427			134	193		233		
	473			113	181		280		
	445			148	222		324		
				144	242		299		
				148	204		319		
				129	215		349		
					222				
					196				
					226				
					208				
					215				
Average	456	618	742	129	199	281	304	344	347

UTICA (NATURAL) CEMENT.

[Continuation of tests commenced in the spring of 1895.]

Barrel X was a sample sack received from Messrs. Meacham & Wright, agents at Chicago, in October, 1894. This sack was stored in the office barn all winter.

Series Y consisted of samples taken from contract shipments to Bureau, Ill., in the fall of 1894. The cement had remained in sacks all winter in the Bureau warehouse before the tests were made.

Series Z consisted of samples from contract shipments to Bureau in February, 1895.

Tensile strength in pounds per square inch.

	Utica neat cement (per cent of water, 33.2).										Mortar, 1 cement to 1 sand (per cent of water, 17.5).					
	24 hours.	3 days.	5 days.	7 days.	10 days.	28 days.	6 months.	3 months.	1 year.	2 years.	3 days.	7 days.	28 days.	3 months.	1 year.	2 years.
Barrel X	60	54	130	157	128	256										
	60	78	100	135	137	224										
	48		95	114	130	220										
					132	239										
Series Y	70	45		70		193	332		370		46	67	195			
				78		210						71	209			
				73		198						63	215			
				126								77				
				76												
Series Z	61	50		86		237		360	388	427	37	65	177	320	338	337
	62			79		223		377	373	390	64	49	229	316	328	328
				135		220		324	425	349		105		297	294	319
				84		202	465		404	363		97			300	303
									323	286					312	
Average	60	57	108	101	144	220	389	354	361	363	49	78	205	311	314	322

VULCANITE—AMERICAN PORTLAND CEMENT.

Barrel V consisted of a small package received in January, 1896, from the manufacturers of this brand and reported by them to contain no sulphate of lime (SO_4Ca), this being omitted from the sample by an oversight.

Barrel VS consisted of a package received in February, 1896, from the same company to be tested instead of the former sample. The latter sample VS is stated to contain SO_4Ca, and is supposed to represent the ordinary product of the factory.

Tensile strength in pounds per square inch.

	Neat cement (per cent of water, 22.5).				Mortar, 1 cement to 3 sand (per cent of water, 13).					
	7 days.	28 days.	3 months.	9 months.	7 days.	28 days.	7 weeks.	3 months.	9 months.	15 months.
	......	......	......	......	157	315	......	322	312	335
	......	......	......	......	145	209	......	244	280	318
	......	......	......	......	......	......	......	......	268	273
	......	......	......	......	151	194	......	275	332	279
	......	......	......	......	138	......	......	278	301	291
	......	......	......	......	146	340	......	289	300	288
	......	......	......	......	......	......	......	......	343	......
	......	......	......	......	152	317	......	299	309	302
	......	......	......	......	147	202	......	251	318	295
	......	......	......	......	120	230	......	274	287	293
	......	......	......	......	......	......	......	......	287	......
	......	......	......	......	144	227	......	268	268	306
Vulcanite—Barrel V without SO_4Ca..	......	......	......	......	144	249	......	323	269	285
	......	......	......	......	151	283	......	279	278	290
	......	......	......	......	158	285	......	295	265	278
	......	......	......	......	......	......	......	......	306	......
	......	......	......	......	169	229	......	327	314	317
	......	......	......	......	146	261	......	333	307	......
	......	......	......	......	145	303	......	310	305	......
	......	......	......	......	......	......	......	......	290	......
	......	......	......	......	154	271	......	300	326	......
	......	......	......	......	148	287	......	367	294	......
	......	......	......	......	158	275	......	390	244	......
	......	......	......	......	......	......	......	......	319	......
	......	......	......	......	100	221	......	326	283	......
	......	......	......	......	122	235	......	......	306	......
Average	......	......	......	......	144	257	......	305	297	293
	680	708	721	761	203	......	426	418	376	334
	685	831	705+	789	253	......	461	414	381	340
	625+	682	756	769	246	......	387	418	353	306
Barrel VS with SO_4Ca..............	......	......	......	684	......	......	......	......	......	......
	665	747	......	758	209	......	365	......	......	......
	682	730	......	708	190	......	409	......	......	......
	......	781	......	......	212	......	485	......	......	......
Average	657+	747	727+	737	219	......	422	415	353	327

WAYLAND PORTLAND CEMENT.

Barrel W is an original barrel received with proposal for furnishing American Portland cement in June, 1895; only the tests required for a selection of a brand under the specifications were made on this barrel.

Barrel WF is an original barrel submitted for testing in May, 1896. It is about 10 per cent more finely ground than the previous sample, and shows considerably higher tensile strength in sand briquets. I am informed by the agent for this brand in Chicago that this barrel represents the present product of the Wayland mills.

A few briquets remain on hand to be broken when two years old.

Tensile strength, in pounds, per square inch.

	Neat cement (per cent of water, 21.3 to 25).				Mortar, 1 cement to 3 sand (average per cent of water, 11.4).				
	7 days.	28 days.	3 months.	1 year.	7 days.	28 days.	3 months.	6 months.	1 year.
Barrel W—81.5 per cent fine	640	705			114	242			
	660				135	230			
					127	231			
						252			
						238			
						219			
						227			
						229			
						216			
						226			
						223			
Average	650	705			125	230			
Barrel WF—90 per cent fine	574		747	625	185	290	372	348	382
	645		723	668	230	300	371	377	393
	638			633	222	278	375	376	393
	586				175	273	371	392	379
	624				177	312	360	390	342
	695				201	286	304	390	370
					177	270		410	400
					193	259		429	391
					204	292		400	398
					236	275		409	376
					236	338		415	365
					220	310		405	344
					256	288		366	389
					233			410	407
					204			402	387
					222			382	
								426	
								395	
								431	
								431	
								425	
								419	
								459	
								441	
								396	
								464	
								425	
								435	
								405	
								444	
								440	
Average	627		735	642	211	290	359	411	381

ALSEN'S WHITE LABEL PORTLAND CEMENT.

Barrel D was an original barrel received with proposals for furnishing cement April 15, 1895, from Sinclair & Babson, New York City.

Barrel E was a 25-pound package received by express from Baltimore July 3, 1895.

Barrels F consisted of samples from contract shipments to Bureau, Ill., July, 1895, and is representative of 3,000 barrels.

Barrel FA is an original barrel specially ground (89 per cent fine) and sent for testing in the winter of 1895–96.

Tensile strength, in pounds, per square inch.

	Alsen neat cement (per cent of water, 22.8).		Mortar, 1 cement to 3 sand (per cent of water, 11.3).						
	7 days.	28 days.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.	2 years.
Barrel D	653	656	191	274	310			354	315
	650	712	232	276	322			350	312
	587	725	186	286	367			339	
		670	197	255	355				
		771		295	362				
		653		284	357				
Average	630	698	202	278	346			348	314
Barrel E		657	212			341	372	323	
		624	205			320	312	320	
		603	180			331	346		
			198			262	302		
						311			
Average		628	199			313	333	322	
Barrels F			226	278		344	349		297
			223	280		352	359		325
			193	274		365	344		337
			211	266		343	345		312
			265	335		365	311		323
			258	325		315	338		
			193	332		358			301
			250	317		337			
			235	299		356			
			222	305		344			
			235	364		305			
			195	338		355			
						332			
						311			
						301			
						329			
						311			
						328			
						319			
						280			
						304			
						301			
						265			
						285			
Average			225	309		325	340		316
Grand average	630	675	215	299	346	323	337	337	315

Tensile strength, in pounds, per square inch—Continued.

	Neat cement.				Mortar, 1 cement to 3 sand (11.3 to 15 per cent water).						
	28 days.	3 months.	6 months.	9 months.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.	16 months.
Barrel F A	600	674	716	720	212	319	347	401	373	391	333
	687	691	706		188	311	380	373	365	350	351
	690	743	626		259	306	356	359	345		323
			675		238	288	331	368	346		336
					221	303	367	384	377		353
					211	290	342	398	352		363
					219	270	376	340	337		383
					226	279	353	379	355		382
					234	305	322	378	305		
					226	286	260	318	365		381
					236	257	272	353	320		344
					231	272	343	392	417		
					240	315	388	400	421		
					263		412	393	370		
					215		344		415		
					220		376		393		
							360		407		
							364		404		
							331		400		
							328				
Average	659	703	681	720	227	292	348	374	372	371	355

[Tests of 3,000 barrels of Alsen's White Label received under contract at Bureau, Ill., July, 1895. Tests made by Mr. W. H. Ferguson.]

	Alsen's White Label neat cement (per cent of water, 22.5).				Mortar, 1 cement to 3 sand (per cent of water, 12.5).				
	7 days.	28 days.	3 months.	1 year.	7 days.	28 days.	3 months.	6 months.	1 year.
Number of tests	22	25	2	1	26	27	2	1	1
Average tensile strength	518	595	646	868	174	228	270	372	340

CONDOR PORTLAND CEMENT.

Tensile strength in pounds per square inch.

	Neat cement (per cent of water, 21.5).				Mortar, 1 cement to 3 sand (per cent of water, 12.5).							
	7 days.	6 weeks.	3 months.	9 months.	7 days.	28 days.	6 weeks.	3 months.	6 months.	9 months.	1 year.	15 months.
Barrel CR	449	734	625	745	172	235	323	332	303	371	350	318
	472	788	698	641	171	......	287	321	330	331	357	336
	508	806	822	877	131	......	267	307	......	346	......	324
	473	829	......	886	136	......	259	......	......	......	......	......
	495	748	......	816	118	......	307	......	......	......	......	......
	......	715	......	775	138	......	262	......	......	......	......	......
Average	479	770	715	790	144	235	284	320	317	349	354	326

GERMANIA PORTLAND CEMENT.

Tensile strength in pounds per square inch.

	Germania neat cement (per cent of water, 22.4).				Mortar, 1 cement to 3 sand (per cent of water, 11.4).					
	7 days.	28 days.	3 months.	1 year.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.
Barrel L	467	560	686	801	155	243	330	......	......	311
	435	564	720	......	160	229	336	......	......	312
	462	594	......	......	145	220	322	......	......	311
Average	455	573	703	801	153	231	329	......	......	311
Barrel M	600	717	......	......	158	301	301	301	349	365
	687	731	......	......	171	281	316	348	357	336
	......	......	......	......	178	262	315	354	350	314
	......	......	......	......	191	284	373	367	385	......
	......	......	......	......	......	245	328	362	......	......
	......	......	......	......	......	267	300	352	......	......
	......	......	......	......	......	262	......	359	......	......
	......	......	......	......	......	250	......	326	......	......
	......	......	......	......	......	280	......	......	......	......
	......	......	......	......	......	265	......	......	......	......
	......	......	......	......	......	266	......	......	......	......
	......	......	......	......	......	262	......	......	......	......
Average	644	724	......	......	178	269	322	346	360	338
Barrel LL	457	......	......	......	174	261	......	......	......	......
	478	......	......	......	182	263	......	......	......	......
	......	......	......	......	169	253	......	......	......	......
	......	......	......	......	190	239	......	......	......	......
	......	......	......	......	149	241	......	......	......	......
	......	......	......	......	179	255	......	......	......	......
Average	468	......	......	......	174	252	......	......	......	......
Grand average	512	633	703	801	169	259	325	346	360	325

STAR STETTIN PORTLAND CEMENT.

Barrel A was received about April 15, 1895, with proposals for furnishing German Portland cement, from E. Thiele, New York City. About 20,000 barrels were purchased on the results of tests obtained from this barrel.

Barrels B were samples from contract shipments to Bureau, Ill., in the summer of 1895.

Tensile strength in pounds per square inch.

	Star Stettin neat cement (per cent of water, 22.2).						Mortar, 1 cement to 3 sand (per cent of water, 11.7).						
	7 days.	28 days.	3 months.	9 months.	1 year.	2 years.	7 days.	28 days.	3 months.	6 months.	9 months.	1 year.	2 years.
Barrel A	602	662	797	.....	798	644	192	276	298	.....	.....	333	336
	595	628	.....	.....	703	790	220	281	342	.....	.....	338	320
	582	678	705	.....	836	682	240	296	351	.....	.....	343	325
	.....	.....	.....	.....	.....	.....	.....	312	292	.....	.....	355	.....
	.....	.....	.....	.....	.....	.....	.....	280	324	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	309	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	270	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	310	.....	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	330	.....	.....	.....	.....
Average	593	656	751	.....	780	705	217	289	314	.....	.....	342	327
Barrels B	.....	.....	714	746	.....	.....	201	229	383	383	355	.....	361
	.....	.....	690	852	.....	.....	197	275	321	289	377	.....	351
	.....	.....	.....	.....	.....	.....	167	311	350	347	379	.....	378
	.....	.....	.....	.....	.....	.....	172	246	.....	315	332	.....	.....
	.....	.....	.....	.....	.....	.....	184	283	.....	336	367	.....	.....
	.....	.....	.....	.....	.....	.....	162	241	.....	349	398	.....	.....
	.....	.....	.....	.....	.....	.....	185	226	.....	335	.....	.....	.....
	.....	.....	.....	.....	.....	.....	183	192	.....	338	.....	.....	.....
	.....	.....	.....	.....	.....	.....	193	244	.....	363	.....	.....	.....
	.....	.....	.....	.....	.....	.....	187	293	.....	372	.....	.....	.....
	.....	.....	.....	.....	.....	.....	185	246	.....	329	.....	.....	.....
	.....	.....	.....	.....	.....	.....	175	285	.....	366	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	356	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	355	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	355	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	369	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	345	.....	.....	.....
	.....	.....	.....	.....	.....	.....	.....	.....	.....	346	.....	.....	.....
Average	.....	.....	702	.....	.....	.....	183	256	351	347	368	.....	363
Grand average	593	656	727	799	780	705	190	266	323	347	368	342	345

TESTS OF 12,000 BARRELS OF STAR STETTIN RECEIVED UNDER CONTRACT ON ILLINOIS AND MISSISSIPPI CANAL IN THE SUMMER OF 1895

Tensile strength in pounds per square inch.

[Tests made by Mr. W. H. Ferguson at Bureau, Ill.]

	Star Stettin neat cement (per cent of water, 22.5).						Mortar, 1 cement to 3 sand (per cent of water, 12.5).					
	7 days.	28 days.	3 months.	4 months.	6 months.	1 year.	7 days.	28 days.	3 months.	4 months.	6 months.	1 year.
Number of tests	207	207	7	3	3	5	205	215	3	4	6	5
Average tensile strength	540	623	721	822	828	783	167	242	285	309	306	323

MIXED CEMENTS.

I have commenced a series of experiments to determine the characteristics of mortar made with Portland and natural cement. In the few briquets thus far prepared equal parts of Portland and Utica were used and the usual proportions by weight of 3 parts of quartz sand to 1 of cement. Other briquets of the mixtures given in the following table are in the immersion trays awaiting longer term tests. The mixture of cements sets much more rapidly than the Portland alone and about as quickly as the Utica. The tensile strength of the mortar at 7 and 28 days is about two-thirds the strength of mortar of the same age made with the component Portland and 3 parts sand.

Tensile strength.

Component cements.	Water, per cent.	Sand, parts.	Age of mortar.			
			7 days.	28 days.	6 months.	1 year.
Wayland and Utica	12.5	3	127	177	287	299
			110	215	287	262
			136	195	311	333
			147		293	276
			123		280	289
			123		274	295
			121		248	264
					289	
Average			127	196	284	288
Alsen's White Label and Utica	12.5	3	121	172	284	314
			136	165	224	304
			114		267	285
			118			225
Average			122	169	258	282
Condor and Utica	12.0	3	95	134	225	252
			87		241	239
					250	268
	12.5	3	92	122	241	260
Average			91	128	239	255

SUMMARY OF TENSILE TESTS ON HYDRAULIC CEMENTS.

Ultimate tensile strength in pounds per square inch.

1. NEAT CEMENT.—TESTS AT CHICAGO OFFICE.

Brand of cement.	Sample.	Water, per cent.	Approximate age of mortar when broken.						
			7 days.	28 days.	3 months.	6 months.	9 months.	1 year.	2 years.
Alpha	N.	21.5	689	724				805	779
Do	O.	21.9	615	747	805				887
Atlas		19.7	721	814	957				
Empire		22.4	487	578		679		741	
Saylor's		20.5	456	618		742			
Vulcanite	VS.	22.5	657	747	727+		737		
Wayland		21.3	650	705					
Do	WF.	23.9	627		735			642	
Utica		33.2	101	220		389		361	363
Alsen's W. L		22.5	680	675					
Do	FA.	23.2		659	703	681	720		
Condor		21.5	479		715		790		
Dyckerhoff		20.9	505	606	652			829	
Germania		22.4	512	683	703			801	
Hemmoor		21.3	454	600	576			853	
Lagerdorfer		22	503	633	631			774	
Mannheimer		22.5	417	494	639			670	
Star Stettin		22.2	593	656	727		799	780	705
Stettin Gristower		22.5	390	448					

Ultimate tensile strength in pounds per square inch—Continued.

2. SAND MORTAR.—TESTS AT CHICAGO OFFICE.

[Mortar, 1 to 3 for Portlands; 1 to 1 for Utica.]

Alpha	N.	12.5	202	308	....	....	....	269	277
Do	O.	11	211	270	359	395	396	358	333
Atlas	....	10.7	184	281	268	344	381	360	358
Empire	....	12.1	178	262	359	....	....	406	....
Saylor's	....	10.9	129	199	281	304	344	347	....
Vulcanite	VS.	11.9	219	....	415	....	358	327	....
Wayland	....	11.3	125	230	....	....	....	....	....
Do	WF.	11.4	211	290	359	411	....	381	....
Utica	....	17.5	78	205	....	....	....	314	322
Alsen's W. L	....	11.8	215	299	346	328	337	337	315
Do	FA.	11.8	227	292	348	374	372	371	....
Condor	....	10.7	144	235	320	317	349	354	....
Dyckerhoff	....	12.5	167	218	287	....	....	283	....
Germania	....	11.4	169	259	325	346	360	325	....
Hemmoor	....	11.9	148	231	272	....	....	316	....
Lagerdorfer	....	12	151	230	313	318	337	291	....
Mannheimer	....	11.8	173	254	312	288	340	305	....
Star Stettin	....	11.7	190	266	323	347	368	342	345
Stettin Gristower	....	11.3	170	258	....	....	....	....	....

3. NEAT CEMENT.—TESTS AT BUREAU, ILL., BY MR. W. H. FERGUSON.

Alpha	N.	21.5	562	735	662	683	....	645	....
Atlas	....	22.5	584	630	759	750	....	....	....
Empire	....	22.5	550	683	786	720	....	688	....
Alsen's W. L	....	22.5	513	595	646	....	....	868	....
Utica	....	35	88	183	282	286	....	255	....
Star Stettin	....	22.5	540	623	721	828	....	783	....

4. SAND MORTAR.—TESTS AT BUREAU, ILL., BY MR. W. H. FERGUSON.

[Mortar, 1 to 3 for Portlands; 1 to 1 for Utica.]

Alpha	N.	12.5	173	250	308	301	....	301	....
Atlas	....	12.1	140	228	320	344	....	302	....
Empire	....	12.5	118	203	284	308	....	328	....
Utica	....	18.9	77	181	255	310	....	304	....
Alsen's W. L	....	12.5	174	228	270	372	....	340	....
Star Stettin	....	12.5	167	242	285	306	....	323	....

COMPARISON OF NATURAL AND STANDARD QUARTZ SAND IN PORTLAND CEMENT MORTAR.

Tensile strength in pounds per square inch.

	Mortar, 1 cement to 3 quartz sand (water, 12.5 per cent).					
	Natural.			Standard.		
	3 months.	1 year.	2 years.	3 months.	1 year.	2 years.
Star Stettin cement	282 271 278	352 318 306	346 339 341	308 290 320	338 343 355	336 320 325
Average	277	325	342	306	345	327
Alsen's White Label cement	249 295 259	302 331 301	311 335 295	316 361 360	354 350 339	315 312 ....
Average	268	311	314	346	348	314

From the results of the two-year tests reported above it seems necessary to modify the statement made in the last annual report, as shown by the shorter-term tests, that standard sand showed an undoubted superiority to natural sand. An examination of the above record shows that mortar made with standard sand has retrograded in tensile strength at the end of two years, while that with natural sand has increased until the two are very close together, with a slight advantage in favor of the natural sand. This may possibly be explained by the greater density of the natural sand mortar, due to the graded particles, preventing or retarding the dissolving action of the water in which the briquets were immersed.

Summary of briquets for tensile tests made and broken during the year ending June 30, 1897.

1. IN CHICAGO OFFICE.

Brand of cement.	On hand June 30, 1896.	Made during the year.	Tested.	Lost.	Left on hand.
Natural Utica	10		10		
Foreign Portland:					
Alsen's White Label	102		66		36
Condor	23		16		7
Germania	10		3		7
Lagerdorfer	18		16	1	1
Mannheimer	2			1	1
Star Stettin	21		12		9
American Portland:					
Alpha	28		17		11
Atlas	20		8		12
Saylor's	24		8		16
Vulcanite	79		52		27
Wayland	102		75		27
Slag cement	36	24	30		30
Mixed Utica and Portland	40		31		9
Total	515	24	344	2	193

At the office of the eastern section Illinois and Mississippi Canal the few briquets remaining on hand at last report were broken and no new ones made during the year.

Very respectfully, your obedient servant,

HENRY JERVEY,
First Lieutenant, Engineers.

MAJ. W. L. MARSHALL,
Corps of Engineers, U. S. A.

REPORTS OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

ILLINOIS AND MISSISSIPPI CANAL,
OFFICE OF ASSISTANT ENGINEER,
Sterling, Ill., June 30, 1897.

MAJOR: I have the honor to submit the following report on the work on the Illinois and Mississippi Canal under my supervision during the fiscal year ending June 30, 1897.

FEEDER.

At the date of my last annual report the maps, plats, descriptions, title abstracts, and agreements for lands required for right of way in Whiteside County were completed, and those relating to lands in Bureau County were in course of preparation. These maps and papers were completed and agreements made with property owners for sale of required lands wherever price demanded was considered reasonable.

The lands in Whiteside and Lee counties which will be overflowed by the construction of the dam at head of feeder were measured, maps and plats made, descriptions, agreements, and title abstracts prepared, and agreements entered into with property owners wherever price demanded was considered reasonable. The agreements recommended for acceptance were approved by the Secretary of War, with one exception, and the property owners notified of that fact.

The total area required for right of way for feeder is 1,111.71 acres, and the total area damaged by overflowing is 1,439.22 acres, of which 167.91 acres lie between the United States meander line and the shore line of Rock River, leaving 1,271.31 acres net.

The total amount of earthwork on the feeder, except that in the bridge approaches, was computed and tabulated by miles. A map was made of the site of the head works and amounts of earth and rock excavation computed. The grades of all sipe and drainage ditches were established, profiles plotted, and earthwork computed.

WESTERN SECTION, MAIN LINE.

Since my last annual report the Secretary of War has approved the location of the western section as laid out by myself in 1895. As soon as notice of that approval was received preparations were made for placing parties in the field for making the necessary measurements for describing the required lands. The force in this office had been "furloughed without pay" in November, on account of lack of funds, and some time elapsed before the party could be organized.

A party with Mr. A. O. Rowse in charge was sent to Sheffield May 11 with instructions to commence work at the feeder junction, joining with the work of Assistant Engineer J. C. Long from the east and the feeder from the north. Previous to sending the parties into the field I had carefully gone over the entire project for the western section, and had made many minor changes in the locations of locks, bridges, etc., and had established the grades of sipe and drainage ditches as far westward as Mile 47. It was also decided to lower the grades about 3 feet on several of the levels.

There were several objections to the line as laid out in the vicinity of Colona, and it was decided to improve that location if possible. With a small party, with Mr. J. W. Woermann in charge, I went to Colona May 19, and the following day made a thorough reconnaissance of the vicinity.

The new line was approved by yourself June 1, and has been followed in the right-of-way work.

The weather proved favorable for field work, and good progress was made. All the necessary measurements for describing right of way and for making all maps and computing earthwork were completed June 29, and the parties returned to this office.

All plats of subdivisions in Henry County crossed by the line, and descriptions of land survey corners were copied from the county records. Proposals were sent out inviting bids for preparing title abstracts.

The landing at Blossomburg, on Rock River, was obstructed by sand so that when the pool was at the normal level there was an available depth of but 3 feet for a short distance. The steamer *Hattie Darling* was employed to remove the sand, and removed by pumping 2,860.4 cubic yards, at a total cost of $371.85. The work was completed on June 29.

The wagon bridge over Rock River, owned by the city of Moline, still continues to be a serious obstruction to navigation. Aside from small pleasure yachts, there are but 3 steamers in that vicinity that can pass under it at all, and these only by removing their pilot houses and smokestacks. When the surface of water in the pool above the Milan dams is more than 1 foot above the normal stage these steamers can not pass under. When the water is down to the normal level then the bars above the bridge limit the depth to which the barges can be loaded to 3½ feet. As no dredge can be taken above the bridge at any stage no improvement can be made in the depths until the bridge is in some way modified. The owners of the coal mines are expending considerable money developing the mines, with the expectation of bringing the coal to market through the canal, and it seems that some modification, if even of a temporary character, should be made in the bridge to permit their carrying on their business during the season of navigation without interruption. The coal finds a ready market at Davenport and practically controls the market there.

The entrance to the canal from the Mississippi River has been somewhat obstructed by a bar in the mouth of Rock River. The low stage that has prevailed in Rock River since 1892 has been favorable to the formation of this bar. The dredge *Apache* was put at work dredging out the entrance, and in the months of August and September removed 14,219 cubic yards. The entire dredging plant was then transferred to the Illinois River. The high water last spring in Rock River has removed some of the bar at the mouth, but the dredge channel was filled for a short distance by the sand. Proposals were invited for removing this sand and the contract let to the Builders' Sand and Gravel Company of Davenport, Iowa, at 10½ cents per cubic yard, scow measurement. Under this contract they commenced work May 21, removed 4,209 cubic yards, and stopped work June 19, a good channel having been excavated.

Four wing dams were constructed on the north side of Rock River to throw the current closer to the lock. The improvement of the Mississippi River in that locality has thrown the channel in that river nearer the lock, so that less difficulty may be expected there in future.

A map on the scale 1 inch equals 2 miles, showing the locations of the main line and feeder as formally approved by the Secretary of War, was prepared to accompany the Annual Report.

Very respectfully, your obedient servant,

L. L. WHEELER, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

ILLINOIS AND MISSISSIPPI CANAL,
OFFICE OF ASSISTANT ENGINEER,
Sterling, Ill., June 7, 1897.

MAJOR: I have the honor to submit the following report upon a survey made by myself in May, 1897, to find, if possible, a better location for the main line of the canal in the vicinity of Colona, Ill.

With a small party I went to Colona May 19, and the following day made a thorough reconnaissance of the vicinity. I concluded that it was impossible, without great expense, to bring both railroads to one crossing, but decided to run an entirely new line that would improve the alignment and make an estimate of cost. This new line crosses the Chicago, Rock Island and Pacific Railroad at an angle of 70°, the Chicago, Burlington and Quincy Railroad at an angle of 67°, and from the latter railroad follows a tangent line to Rock River at the mouth of Green River.

The field work was completed on the 22d, and the party reported to Mr. A. O. Rowse at Annawan the following day. The notes have been reduced and plotted, and an estimate of cost made. Herewith are submitted detailed estimates of the cost of the new line, a table showing comparative estimates of cost of the lines surveyed in 1895 and 1897, and two blue prints showing the location and profile.

The new line is estimated to cost $21,601 less than the line surveyed in 1895, and has in addition the following advantages over it:

(1) The oblique crossing of the Chicago, Burlington and Quincy Railroad, as laid out in 1895, is avoided.

(2) Five 48-inch pipe culverts are dispensed with.

(3) The total lift of the locks is better divided.

(4) The length is shortened 2,610 feet between common points, requiring less right of way and fencing.

(5) The line is removed from Green River and the danger resulting from being in close proximity to a rapid stream avoided.

(6) Two, and possibly three, curves are avoided, and the total amount of curvature largely reduced.

The disadvantages of the new line are that two swing bridges instead of one will have to be operated, that some surface drainage will be taken into the canal, and that the amount of earthwork will be increased.

It is respectfully recommended that the new line as shown on the blue print accompanying be adopted, except that the location of Lock No. 29 be not definitely fixed until a survey of Rock River in that vicinity is made.

Very respectfully, your obedient servant,

L. L. WHEELER, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Comparative estimate of cost of alternate lines for Illinois and Mississippi Canal in the vicinity of Colona, Ill.

[Surveyed in 1895 and 1897.]

	1895.		1897.	
	Quantity.	Cost.	Quantity.	Cost.
Excavation	277,712	$41,656.80	285,108	$42,766.20
Embankment	131,310	19,696.50	149,978	22,496.70
48-inch pipe culverts	7	31,500.00	2	9,000.00
Railway bridges	2	50,000.00	2	50,000.00
Lock No. 28	7-foot lift.	40,800.00	10-foot lift.	48,600.00
Lock No. 29	14-foot lift.	76,000.00	11-foot lift.	70,000.00
Lock keepers' dwellings	2	5,000.00	2	5,000.00
Waste weir	1	5,000.00	1	5,000.00
Highway bridge	1	5,800.00	1	5,800.00
Raising grades:				
Chicago, Burlington and Quincy	....	2,000.00	....	....
Chicago, Rock Island and Pacific	....	....	....	2,000.00
Right of way	152.36 acres.	15,236.00	125.81 acres.	12,581.00
Fencing	8.8 miles.	2,112.00	8 miles.	1,920.00
Contingencies	10 per cent.	29,480.18	10 per cent.	27,516.39
Totals	....	324,281.43 302,680.29	....	302,680.29
Difference	....	21,601.14		

The line surveyed in 1897 is 2,610 feet shorter than the 1895 line between common points.

Detailed estimate of cost of the western section from mile 59 to mouth of Green River, following line surveyed in May, 1897.

Mile 60:

98,921 cubic yards excavation, at 15 cents	$14,838.15
22,234 cubic yards embankment, at 15 cents	3,335.10
1 48-inch pipe culvert	4,500.00
1 double-track railway bridge	30,000.00
1 single-track railway bridge	20,000.00
40 acres right of way, at $100	4,000.00
Fencing	640.00
Raising grade of Chicago, Rock Island and Pacific Railroad 4.2 feet	2,000.00
1 waste weir	5,000.00
Total	84,313.25

Mile 61:

149,411 cubic yards excavation, at 15 cents	22,411.65
45,004 cubic yards embankment, at 15 cents	6,750.60
1 highway bridge	5,800.00
1 lock, No. 28, 10-foot lift	48,600.00
1 48-inch pipe culvert	4,500.00
Lock keeper's dwelling	2,500.00
41.81 acres right of way, at $100	4,181.00
Fencing	640.00
Total	95,383.25

Mile 62:

36,776 cubic yards excavation, at 15 cents	5,516.40
82,740 cubic yards embankment, at 15 cents	12,411.00
Lock No. 29, 11-foot lift	70,000.00
Lock keeper's dwelling	2,500.00
44 acres right of way, at $100	4,400.00
Fencing	640.00
Total	75,467.40

REPORT OF MR. JAMES C. LONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Tiskilwa, Ill., June 30, 1897.

MAJOR: I have the honor to submit the following report upon the work on the eastern section of the Illinois and Mississippi Canal under my supervision during the fiscal year ending June 30, 1897:

CONTRACT WORK.

All the work under contract was completed during the previous fiscal year except the canal trunk on mile 6, under contract to James Carroll, St. Louis, Mo.; date of contract, October 10, 1894; expired September 30, 1895, and extended to August 1, 1896. At the beginning of the fiscal year he had done 93,931 cubic yards of earthwork, at 6 cents, amounting to $5,635.86, and there was yet to be done to complete his contract 31,768 cubic yards, at 6 cents, amounting to $1,906.08. On August 5, 1897, he completed the whole of the work, a final estimate was rendered, and the contract closed.

OFFICE WORK.

Revised the location of embankments and structures, and made changes where improvements could be made, notably in lessening the number of pipe culverts by concentrating the drainage through the seep ditches, enlarged, to the lower end of each level of the canal, where the grade of the bottom of the canal would be above the natural surface of the ground, thence under the canal, thereby saving any deep excavations for culvert foundations, with costly quicksand excavation and pumping. Revised all earthwork calculations, made necessary by improvements and changes, such as changing lifts and locations of locks, changing alignment of embankments to give room for drainage ditches and roadways, and changes of cross section of canal prism in cuts to make a wider towpath, and tabulated same, together with earthwork in highway approaches, excavation of foundation pits, site and length of culverts, site and length of locks, revetment of creek channels, and approaches to locks and culverts.

Made a plat and blue-print copy of a strip of land on the Joseph Booher estate, upon which to locate a protection levee on mile 8 of the canal.

Made maps and blue-print copies of revised location of embankments and structures in 4-mile sections, miles 8 to 24.

Made profiles, with tables of quantities of excavation and embankment, on same sheets, and blue-print copies of same in 4-mile sections, miles 8 to 24.

Prepared blue-print copies of all index maps of canal right of way in 4-mile sections for record at Chicago office.

Maps and profiles were prepared in the month of September of the sites of Aqueducts Nos. 2 and 3, showing the vicinity in detail, profiles of the ground on the exact location of the aqueducts, borings showing character of foundations, and high-water levels. Blue-print copies of same were made and forwarded to the Chicago office.

Areas in square miles of basins drained by Main Bureau and West Bureau creeks were determined for use in designing Aqueducts Nos. 2 and 3.

Excavation and embankment tables were calculated for making approximate estimates of earthwork.

Made map of land in section traversed by the different lines from miles 24 to Feeder Junction, for use in making the land-line connections with the located lines and a list of owners of said lands.

Made a report as to the method used in building the walls and arches of concrete culverts 1 to 5 inclusive, in order to secure a continuous monolithic structure, and the manner in which the outside of the arches was plastered. The report is as follows:

After the form for the arch culvert was erected, the bulkhead was put in directly under the center of each embankment, thus dividing the culvert into three sections, the head walls and that portion of the arch from the head walls to the center of the embankment forming two of the sections and the third extending from the center of one embankment across the prism of the canal to the center of the other embankment. The head wall sections were erected first, the work being carried on continuously until the head walls and that portion of the arch in the head wall section was completed. After both head-wall sections were completed, the bulkheads were removed and work on the walls of the middle section commenced. This portion of the work was completed to the height of the walls, which were finished in skew back fashion and allowed to set or to stand until the walls were completed. Then the work of putting on the arch was commenced at the end of the walls first completed. By doing the work in this manner no bond was formed between the arch and walls, thus allowing an opportunity for contraction and expansion without so much danger of cracking. After the arch was completed far enough ahead to allow a mason to work continuously, the work of plastering over the arch was commenced. This plaster was of the proportions of 1 cement to 2 sand and mixed to about the consistency of this mortar. The walls were carried up on a slope of 1 in about 5 or 6, thus allowing the tampers to use their tools in a perpendicular manner, and no part of the work would set before new material could be deposited. The finished work was covered immediately with either plank or tent flies, and after twenty-four hours was thoroughly wet and kept so for about three days. The proportions in the walls were 1 cement, 4 gravel in natural state, and 4 screened pebbles. The proportions in the arch were 1 cement, 4 gravel in natural state, and 3 screened pebbles. The forming for the head walls was allowed to remain in place about six days and the arch forming about ten days after completion.

The foregoing method was used in building arch culverts 1 and 2, each of 10-foot openings, and they were not strictly monolithic, as they were built in three sections, the joints coming under each canal embankment. Arch culverts 3, 4, and 5 are nearer monolithic structures, as they were not built in sections. This method of carrying forward the work of placing the concrete without joints (except where the arch rests on the skew back of the walls) was as follows: The concrete was conveyed from the mixing platform to place of deposit in wheelbarrows after being well mixed by hand. One head wall was first built projecting from it enough of the side walls (about 20 feet), to allow about 6 feet of the arch to be built at same time, then the side walls were carried through on a slope of about 1 in 5 to the other head wall, then the second head wall was built up with the side walls. After the side walls were built and finished with skew backs, the arch was brought forward from the first to the second head wall and was also carried through on a slope of about 1 in 5.

Made a tabular statement showing quantities of cast-iron pipe necessary to complete all of the pipe culverts from the Illinois River to mile 24, and the quantity of cast-iron pipe now on hand.

Made a profile of the Chicago, Burlington and Quincy Railroad where it crosses the Illinois and Mississippi Canal on mile 17, near Wyanet.

On January 8 to 11, inclusive, attended United States court at Chicago with C. A. Browne, inspector, in the matter of suits for the condemnation of land required for right of way, miles 20 to 24.

Prepared cross sections of canal and natural surface of ground on canal right of way at proposed sites of culverts, miles 8 to 16.

Made changes on the profile of the lift of Locks 15 and 16 and grades of the levels in the canal adjacent thereto.

Prepared profiles of 8 highway crossings, from miles 1 to 16, showing grades and other information necessary to obtain quantities of masonry in the highway bridges.

Made large-scale contour maps and blue-print copies of highway bridge sites on miles 11, 13, 14, and 15 for use in locating the bridges.

Made a map of the Carlson gravel pit, showing areas of waste bank, land upon which stripping may yet be wasted, exhausted gravel pit, and land upon which gravel may yet be obtained; also land adjoining, upon which gravel may be obtained, with cross section and quantities of gravel and stripping.

Made a report on the effect of spring freshets on canal embankments and culverts and high-water levels at various points on the canal between miles 1 and 8, as follows:

Lock No. 2.

	Feet.
High-water level, 1897, Illinois River, elevation	22.50
High-water level, extreme, Illinois River, elevation	29.85
Top of south embankment below Lock 2, elevation	21.50
Top of north embankment below Lock 2, elevation	30.50

Lock No. 3.

High-water level, 1897, Bureau Creek, elevation	30.50
High-water level, 1893, elevation	31.60
Top of canal embankment below Lock 3, elevation	33.00

East Bureau Creek and Lock No. 4.

High-water level, 1897, East Bureau Creek, elevation	38.60
High-water level, 1893, East Bureau Creek, elevation	39.30
Top of canal embankment below Lock 4, elevation	41.00
Bottom grade of canal above Lock 4, elevation	39.00
Bottom of chord of railroad bridge, north side, elevation	39.67
Bottom of chord of railroad bridge, south side, elevation	39.31

Lock No. 5.

High-water level, 1897, Bureau Creek, elevation	43.82
High-water level, 1893, Bureau Creek, elevation	45.50
Top of canal embankment below Lock 5, elevation	48.50

Lock No. 6.

High-water level, 1897, Bureau Creek, elevation	60.62
High-water level, 1893, Bureau Creek, elevation	61.30
Top of canal embankment below Lock 6, elevation	62.00

Lock No. 7.

High-water level, 1897, Bureau Creek, elevation	64.76
High-water level, 1893, Bureau Creek, elevation	65.50
Top of canal embankment below Lock 7, elevation	66.50

It will be seen from the foregoing that the Illinois River lacked, near Lock 2, 7.35 feet of reaching its highest stage. East Bureau Creek at Lock 4 lacked 0.7 foot, and Bureau Creek at Locks 5, 6, and 7 about 1 foot of reaching the high-water level of 1893, which is considered the highest known.

The canal embankment below Lock 6 is only 0.6 foot below high-water level, but it is now as high as the Chicago, Rock Island and Pacific Railway embankment, which it is useless to exceed. When their track is raised the canal embankment at that point can also be raised.

While Bureau Creek was at its highest stage this spring I observed that its waters flowed inward through culverts, thence behind the canal embankments and through culverts below outward to Bureau Creek again at the following points, viz: Double-pipe culvert at Station 411, on mile 5; 10-foot arch culvert at Station 383, on mile 8; 48-inch pipe culvert at Station 300, on mile 6; 10-foot arch culvert at Station 144, on mile 3.

Some water also from East Bureau Creek flowed behind Lock 4 and discharged through arch culverts below.

This flow of water behind the canal can be prevented by building protection levees below culverts as follows, viz:

Ten-foot arch culvert at Station 383, on mile 8, levee 8 feet wide on top, 4 feet high, and 300 feet long, cubic yards earthwork	622
Forty-eight-inch pipe culvert at Station 411, on mile 8, levee 6 feet wide on top, 4.5 feet high, and 200 feet long, cubic yards earthwork	492
Ten-foot arch culvert at Station 144, on mile 3, levee 8 feet wide on top, 4 feet high, and 60 feet long, cubic yards earthwork	125
At the head of Lock 4, north side, levee 8 feet wide on top, 5 feet high, and 60 feet long, cubic yards earthwork	172
Total cubic yards of earthwork in levees	1,411

At the 48-inch pipe culvert at Station 300, on mile 6, no levee will be required, for there is a 10-foot arch culvert below through which the water can flow outward, and which is amply able to accommodate it.

At East Bureau Creek the opening spanned by the railway bridge was not taxed to its full capacity to discharge the water during the freshet of this year, but it would be taxed to its full extent with a freshet like that of 1893. It is well to add, though, that the capacity of this bridge to pass the water might be increased at least 25 per cent by removing the earth, gravel, and other débris that has accummulated between the piers.

In the month of May brought up to date and forwarded to the Chicago office (after making blue-print copies for use here) the following maps:

Topographical maps, miles 8 to 12 and 12 to 16; maps showing location of banks and structures, miles 8 to 12 and 12 to 16; profiles showing borings at one-eighth mile intervals and at lock sites, miles 8 to 12 and 12 to 16.

Made tracing of map of location, main line from mile 24 to Feeder Junction, near mile 28, and sent blue-print copies of it to Chicago office and Assistant Engineer L. L. Wheeler, Sterling, Ill.

Overhauled and brought up to date cross sections showing borings at sites of locks from Nos. 8 to 21, inclusive; made blue-print copies of them for use here and sent the tracings to Chicago office.

Made investigations of abstracts of titles to land adjoining canal right of way, miles 14, 15, and 16, owned by Chicago, Rock Island and Pacific Railway, and made various measurements in connection with their claim that we have encroached on their right of way, and made a report in regard thereto.

Made a design with bills of material and estimated cost of a dwelling to be erected at Lock No. 11.

During the month of May kept prospective contractors supplied with information in regard to the work to be let by contract June 3, 1897, from miles 8 to 16.

On June 4 made and submitted for approval plans for reorganization of inspecting and office force, and made application for the reemployment of such men as were needed for continuing the work on the Illinois and Mississippi Canal under the contracts to be let on June 3, 1897. Also submitted an estimate of the force required to complete the unfinished work, miles 0 to 8, Illinois and Mississippi Canal.

Reemployed on the 21st of June, 1897, a part of my office and inspecting force—J. D. Truss, jr., inspector; C. F. Scott, clerk; Henry Fox and George P. Hawley, rodmen.

PLATS AND DESCRIPTION AND TITLE ABSTRACTS OF LAND.

Had plat and description No. 104 and abstracts Nos. 80 and 81 brought up to date for use in condemnation suits.

Made plat and description of Lot 35 A on mile 8, being the land required on which to locate a protection levee, and had title abstract No. 25, covering said Lot 35 A, brought up to date.

Prepared abstracts of title to each tract of land required for right of way from mile 24 to Feeder Junction, near mile 28.

CARE AND REPAIR.

One watchman, assisted by 1 laborer, was kept at the bureau warehouses and storage yards to look after the plant and material stored there, and to pass over the line of canal from time to time between miles 0 and 8 to see that fences were kept in order and repaired where damaged by freshets, and since warm weather to cut the growth of weeds from the canal embankments, additional laborers being employed to assist them. The roof of the main warehouse has been painted, and the locomotives and stationary engines have been painted and kept in order, and property in the warehouse has been generally overhauled and classified.

SURVEYS.

From the beginning of the fiscal year until August 19 the following field work was done:

Made field observations and surveys necessary to calculate the area of watersheds drained by culverts on miles 14 to 24.

Made a survey on mile 8 of a strip of land on the lands of the Joseph Booher estate upon which to locate a protection levee.

Made borings at lock sites 8 to 21 inclusive.

On August 19 the entire engineer force (except Inspector Browne, who was retained at Tiskilwa to do office work), including office men, and consisting of one inspector, one clerk, one messenger, and two laborers, were transferred to Sheffield for the purpose of engaging on field work from mile 24 to Feeder Junction, near mile 28. These men were kept employed until November 15, 1896, and during that time accomplished the following work: Located three lines of canal from mile 24 to Feeder Junction, near mile 28; one on Penneys Slough route; a second on my survey of 1893; and a third on Mr. Wheeler's survey of 1895; amounting in all to 13.1 miles of located line, and ran levels over and made cross sections of same at 100-foot intervals. Surveyed land lines and connected them with the located line, so as to get data from which to describe tracts of land required for right of way. In connection with this work, ran 13.1 miles of located lines, including curves, 3.9 miles of preliminary line, 13 miles of land lines, 14 miles of levels over surveyed lines, 18 miles of levels over cross sections of located lines, 4 miles of check levels, and 6.1 miles stadia lines in meandering streams.

During the month of September, 1896, surveys were made in the vicinity of the sites of Aqueducts Nos. 2 and 3, to get correct maps in detail of the vicinity, profiles of the ground on the exact location of the aqueducts, borings showing the character of the foundations, and high-water levels.

On the 15th of November, 1896, all field work was suspended, and all employees were laid off except the assistant engineer and one inspector, who continued computations, etc., in the office, one watchman and one laborer to care for property and plant in the warehouse and storage yards at Bureau.

On December 31 surveyed lot 104 on mile 23 and went over the ground with witnesses, who testified in the condemnation suit for right of way.

Took levels and field notes necessary to prepare profiles of the eight highway crossings between miles 1 and 16.

Made necessary surveys to obtain notes to determine the amount of unfinished work from Illinois River, at mile 0 to mile 8.

Marked out boundary of canal right of way from miles 12 to 16, in order to inclose with a barbed-wire fence.

Made a survey of the Carlson gravel pit and land adjoining upon which gravel may be obtained; took levels and cross sections on same, and had borings made to determine the depths of stripping and of good gravel that may be obtained.

Observed the effect of spring freshets in Bureau Creek upon the canal embankments and culverts, and run levels at various points to determine the high-water level.

On June 21 parties were put in the field marking out canal prism and lines of embankments and sites of lock pits on miles 8 to 16, in preparation for the work of construction by the contractor's forces.

MISCELLANEOUS WORK.

Two hundred and fifty pieces of pine timber were loaded on cars and shipped to Assistant Engineer C. V. Brainard, Columbiana, Ill.

Built a temporary wagon bridge over a washout in the public road crossing the canal prism on mile 5.

Took off longitudinal braces and removed two middle bents of the railway trestle over East Bureau Creek to allow drift and floating ice to pass freely during the spring freshets.

Built a wooden bulkhead on top of the breast wall and across the west end of Lock No. 4 to prevent the flow of East Bureau Creek through the canal during freshets.

Repaired and strengthened a protection levee on mile 7 that was leaking and threatening to burst during the spring freshet in Bureau Creek in the month of March, 1897.

Purchased material and made a contract under ten-day proposals for the construction of a barbed-wire fence inclosing the canal right of way from miles 12 to 16. The contract was let to E. W. Eddy, of Wyanet, Ill., and was completed June 7, 1897, and cost as follows:

Mile 13:		
2,651 pounds barbed wire, at $2.17 per hundredweight	$65.42	
718 fence posts, at 13.95 cents each	100.19	
20 braces, at 30 cents each	6.00	
Inspecting material	13.58	
Constructing 1.62 miles fence under contract, at $41.50 per mile	67.52	
		$252.71
Mile 14:		
2,343 pounds barbed wire, at $2.17 per hundredweight	56.26	
713 fence posts, at 13.95 cents each	99.70	
20 braces, at 30 cents each	6.00	
Inspecting material	13.59	
Constructing 1.23 miles fence under contract, at $41.50 per mile	51.22	
		226.77
Mile 15:		
2,563 pounds barbed wire, at $2.17 per hundredweight	62.80	
717 fence posts, at 13.95 cents each	100.10	
20 braces, at 30 cents each	6.00	
Inspecting material	13.58	
Constructing 1.51 miles fence under contract, at $41.50 per mile	62.86	
		245.34
Mile 16:		
2,343 pounds barbed wire, at $2.17 per hundredweight	56.27	
714 fence posts, at 13.95 cents each	99.84	
21 braces, at 30 cents each	6.30	
Material and constructing 30.5 rods woven-wire fence, at 90 cents per rod	27.45	
One gate	2.50	
Inspecting material	13.59	
Constructing 1.23 miles fence under contract, at $41.50 per mile	51.22	
		257.17
Total cost for constructing 5.59 miles fence		981.99
Cost per mile		177.45

Fifty barrels of Portland cement were hauled by wagons to Princeton and loaded on cars and shipped to Assistant Engineer C. V. Brainard at Meredosia, Ill.

EMPLOYEES.

Mr. Charles A. Browne, inspector, was employed during the whole year. Mr. J. D. Truss, jr., inspector, and Mr. C. F. Scott, clerk, were employed until November 15, 1896, when they were laid off, and were reemployed on June 20, 1897. Mr. Henry Fox, Mr. George P. Hawley, rodmen, who were laid off when actual operations on construction were suspended, were reemployed on June 20, 1897. All of these gentlemen have been employed on this work during active operations, and have proved themselves to be thoroughly reliable and competent.

Very respectfully, your obedient servant,

JAS. C. LONG, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

REPORT OF MAJ. W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 16, 1896.

GENERAL: I have the honor to submit the following report upon the final location of the western section of the Illinois and Mississippi Canal from mile 24 to Rock River, and to recommend a location.

Under the provisions of the river and harbor act of August 11, 1888, detailed plans and estimates were reported by me, for the construction of the canal, June 21, 1890 (House Ex. Doc. No. 316, Fifty-first Congress, first session).

That report stated that before final location of the canal further surveys were necessary, and since September 19, 1890, the following changes in the location reported have been made by authority of the Secretary of War.

First. The lower rapids of Rock River passed by a canal on south bank instead of north bank. Approved September 24, 1891.

Second. The feeder has been located four miles west, leaving Rock River at Sterling instead of Dixon. Approved January 27, 1896.

The location of the eastern section as far as to mile 24 remains as originally designed, but the summit level is to be cut down 9 feet below the plan of 1890.

There now remains to be finally located this part of the western section from mile 24 to Rock River at the mouth of Green River, and it is this section that is now in question.

The plans submitted by me June 21, 1890, contemplated the Penney Slough route from the old feeder junction at mile 25 to Rock River at Penney Slough 25 miles distant, but the route is objectionable on account of the bad crossing of Green River, the natural surface of the country being such that a sufficient headroom under an aqueduct can not be economically obtained, but the stream must be carried under the canal through an invert at high water, which plan, in my opinion, is not in accord with good practice, at a drainage channel of the magnitude and character of Green River. The aqueduct would be in danger at every high water carrying drift or ice.

The line also is not on favorable ground, the material being nearly pure sand in some stretches and marsh and bog in others.

The Rock River section of this route is bordered by low bottom lands, the greater part of which is extremely rich agricultural land so low that fixed dams can not be maintained at any useful height, nor movable dams, even at low water, without soaking and injuring quite large areas. The necessary depth can not be secured by dams, but channels must be dredged or blasted in the bed of Rock River to secure 7 feet of water. The stream is also crossed by two low railroad bridges, viz, a double-track bridge belonging to Chicago, Rock Island and Pacific Railroad and a single-track bridge of the Chicago, Burlington and Quincy Railroad. These bridges can not be altered without large cost nor probably until after years of delay. The alteration of these bridges can probably be successfully enforced against the railroad companies, but, in my judgment, if the object desired can be obtained by the United States at no increased expense, without damaging, taking, or interfering with private or corporate property, such course should be pursued. The present project is the construction of a canal of fixed capacity between two given points, and not the improvement of the general navigation of Rock River on its merits. All material for construction must be hauled from 4 to 8 miles from the nearest railroad. On account of these uncertain elements of cost and practical difficulties along the Penney Slough route, I had a survey made by J. C. Long in 1893 of a route from the feeder junction to the mouth of Green River. Mr. Long was instructed to survey a line crossing Green River at a practicable point for an aqueduct and continue the canal on the north side of Green River to avoid the large drainage lines which exist south of the river. The original estimate along this route is published in the Report of the Chief of Engineers for 1893, page 2181. This route is somewhat objectionable on account of bogs and sand hills, but is preferable to the Penney Slough route. Consequently a second route was surveyed from Mile 24 to the mouth of Green River, in 1895–96, by

Assistant Wheeler, with the object of throwing the canal as near as practicable to other lines of transportation and on heavier soil. This line with modifications is practically the route surveyed by Major Benyaurd in 1883, known as the Rock Island route in his report.

In making estimates of cost along this line, we have the advantage of the results of the construction of 13 miles of the canal and of the awards and agreements for the purchase of right of way over some 60 miles of the canal.

On this ascertained basis of cost, I have caused all old estimates to be revised, with the results shown on Mr. Wheeler's report, as far as relate to the section in question, and herein below as far as the entire canal is in question.

The following are the estimates over the three routes from Mile 24 to mouth of Green River:

Penney Slough route	$2,044,223
Green River route, 1893	1,985,472
Green River route, 1896	2,048,445
Mean	2,026,047

The cost, then, as far as may be judged by estimates on equivalent bases, may be said to be practically the same by each of the routes. On the Penney Slough route the damage by flowage is indeterminate. The crossing of Green River is essentially bad, if not entirely inadmissible. The line is most distant from means of transportation and supply, and the nature of the earth is not advantageous for the construction of firm, tight banks for the canal.

The latter objection applies to a less degree to the route of 1893, and least to the route of 1896. The objection to the last-named route is the great number of drainage structures required. Either Green River route will make the canal about 2 miles shorter than via Penney Slough.

As I believe that the Green River route for the western section will be more easily and cheaply constructed, more economically maintained, and presents less doubtful or indeterminate elements of expense than via Penney Slough, I have to respectfully recommend the approval of this route substantially as shown on the maps herewith.

This location, if approved, will complete the definite location of the canal throughout its extent.

REVISED ESTIMATES.

The right of way over 29 miles (5 miles at Milan) having been determined in cost, and about 13 miles of the canal nearly completed, it is practicable to revise the estimates of 1890. The cost of the total actual work already done closely approximates the original estimates. The cost of the right of way exceeds the original estimates by about 60 per cent, because (1) the lands have increased in value in thirteen years, (2) the State laws provide for the payment of all damages to property not taken, by reason of the canal construction, and (3) because it has been necessary to increase the width of the strip taken to provide for drainage ditches, waste banks, and other purposes. The ascertained rate of increase of cost of right of way seems, then, the only well-defined cause for increasing the estimates already sent in, if the old lines are adhered to.

The lines, however, have been changed, as heretofore stated, by entirely relocating the feeder, and probably the western section. The estimates for these relocated lines have been made on the basis of the increase of right of way, and independently of former estimates of 1890.

The revised estimates compare as follows:

Section of canal.	1890.	1896.
Illinois River to mile 24	$2,695,712.80	$2,832,647.07
Mile 25 to Green River	1,816,822.70	2,026,046.67
Green River to Lower Rapids	62,524.00	62,524.00
Around Lower Rapids	492,501.90	514,375.78
Navigable feeder	1,858,398.30	1,654,733.30
Extending Sterling feeder to Green River route	....	67,052.92
Extra cost of right of way over 1890 estimate	201,390.05	....
Total	7,127,349.75	7,157,379.74
Appropriated to June 30, 1896	....	1,235,000.00
To be appropriated	....	5,922,379.74
Revised estimate, 1896	....	7,157,379.74
Original estimate, 1890	....	6,925,959.70
Excess of revised over original	....	231,420.04

These estimates are for a barge and towpath canal. If steam be used, the banks throughout must be protected against wash.

This work is essential and should be included in the estimates. There is no stone convenient along the line of the canal nearer than the Rock River termini, nor in sufficient quantities or quality there. It must be hauled from a distance. This consideration, involving the transportation of over 1,000,000 tons of stone an average distance of 50 miles, must be regarded in locating the western section.

For revetting the banks an additional estimate is submitted. For revetting 90 miles canal banks, at $15,000 per mile, $1,350,000. The paving should be done as the work progresses. For the completion of the canal there will be required, then—

For animal traction canal	$5,922,379.74
For steam traction canal	7,272,237.74

A detailed report upon the survey of the Green River route (with estimates of cost and maps) has been submitted by Assistant Engineer Wheeler and is forwarded herewith.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sterling, Ill., June 3, 1896.

MAJOR: I have the honor to submit the following report upon a survey made by myself for locating the western section of the Illinois and Mississippi Canal from a point on the summit level to the mouth of Green River. The eastern section had been located to the twenty-fifth mile, near the old feeder junction, and the works at Milan had made Rock River navigable to the mouth of Green River. Mr. J. C. Long, United States assistant engineer, in 1893 made a survey between these two points which left the old line in the twenty-ninth mile, kept north of Hickory and Coal creeks, crossed Green River east of Spring Creek, and followed the north bank of

Green River to its mouth. The distance by this line is 1.8 miles less than by the Penney Slough line.

The surveys and estimates made by myself for locations of feeder in 1895 had shown that a feeder leaving Rock River near Sterling would cost $471,680 less than a feeder on the old line, leaving Rock River near Dixon. The line from Sterling was run on the assumption that the summit level of the canal was lowered to grade 199. The estimates made by Assistant Engineer J. C. Long showed that the increase in cost of main line due to lowering the summit level from grade 205 to grade 199 was $45,735. The location of the Sterling Feeder line was approved by the Secretary of War, thereby fixing the grade of the summit level at grade 199.

The survey made by myself, therefore, started with the assumption that the summit level was at grade 199 and had for an object the finding of a line which should avoid some of the objectionable features of previous lines, and approach as nearly as possible the line of the Chicago, Rock Island and Pacific Railroad. The objections to the Penneys Slough line, aside from the flowage damages along Rock River and the uncertainties of cost of improving Rock River are that it is at great distance from any railroad, requiring materials for construction to be hauled long distances over very poor roads or the construction of a railroad for many miles to supply materials, and that the line lies for a large portion of its distance among sand hills and marshes. The crossing of Green River is at too low a grade, which would now be at greater risk than when originally planned on account of the great amount of dredging that has since been done in Green River and its tributaries above the point of crossing.

The line run by Assistant Engineer Long passes over about 2 miles of peaty ground along Coal Creek, where construction would be difficult, and is somewhat objectionable on account of its distance from the railroad, but to a much less degree than the Penney Slough route.

The objection to any line lying south of Green River has been the large number of drainage lines to be crossed requiring a large number of culverts and aqueducts. The character of the soil south of Green River is more favorable for construction, however, than that north of it, and the nearer the main hills south of Green River are approached the heavier the soil.

In making the survey, therefore, I endeavored to keep the line as far south as possible, in order to keep on good ground and to be near the Chicago, Rock Island and Pacific Railroad, and to keep the bottom grade as high as possible in order to cross the drainage lines under favorable conditions.

Before commencing the survey I made a thorough reconnaissance of the whole region included between the Penneys Slough line on the north and the Chicago, Rock Island and Pacific Railroad on the south, and followed out on the ground the old lines as near as I could. I also looked over the region east of the Feeder junction with a view to finding a possible route for bringing the main line near Sheffield. I left Sterling with survey party October 21 by teams, and commenced work the following day. I first ran a transit and level line from near the eighteenth mile on the main line to the summit at Sheffield, one and one-half days being occupied in this work. The levels showed that there would be a maximum cutting near Sheffield of 60 feet, and that the crossing of drainage lines, both east and west of Sheffield, would be difficult. The earthwork would be heavy for a long distance.

I commenced the new line near the middle of the twenty-fifth mile of the main line, crossed the outlet to Devils Slough before it joined Hickory Creek, kept south of Hickory Creek, and, as soon as the nature of the ground would permit, turned southwest toward the railroad.

For a short distance this line is identical with the old Green River line, but they separated after a short distance because I considered the old line to be on too unstable ground. The lines do not meet again until near Spring Creek. They are practically identical from near Geneseo to 1 mile east of Green River Station, where they separate, and do not again unite.

In order to locate the line to the best advantage it was necessary to first approximately fix the grades of the several levels and then fit the line to these grades as closely as possible. The profile of the old line was of great assistance to me in fixing the grades. Levels, cross sections, and borings were kept up with the transit party, and wherever the elevation or character of ground seemed unfavorable an effort was made to improve the location.

The party returned to this office November 16, and the work of reducing and plotting of the notes commenced. The boring party, however, was left in the field to make borings along the Penneys Slough line, which was completed November 23. After the transit and level notes were reduced and plotted, it was evident that the line could be improved in some portions, especially between Annawan and Atkinson, where there were several curves in the line. A small party was therefore put in the field December 11, and several miles relocated. The position of the Feeder junction was also changed and much improved. This work was completed December 17.

I subsequently looked over the country between Atkinson and Geneseo with a view to bringing the line nearer to Geneseo, but was satisfied this could not be done, except at great expense and great damage to property in Geneseo.

The notes of this survey have been plotted on the scale of 1 inch = 400 feet and traced on fourteen sheets, prints of which accompany this report. The profile has been plotted on a vertical scale 1 inch = 6 feet, and horizontal scale 1 inch = 1,600 feet. The locations of the proposed structures are shown on the maps and profiles, except that of the wastewier at the west end of the Summit level, which should be located where the Feeder crosses Hickory Creek, a short distance from the main line. The location is just outside the limit of the map of that portion of the main line. The item, however, has been included in the estimates, as the estimates for the Feeder did not include it. A uniform width of 300 feet has been shown for right of way except at lock sites. It will be noticed, however, that using this width, the right of way lines sometimes differ but little from land lines. In such cases when the final location is made the center line should be moved slightly to make the two agree. For several miles along Green River but one embankment is necessary, it being intended to flow the land to the foot of the hills. This survey was not sufficiently in detail to determine the exact amount of land to be taken, but a uniform width of 300 feet has been included in the estimates. It is probable, however, that the amount of land required or damaged will slightly exceed the amount estimated for in this portion of the line.

An effort was made to keep the line on the south side of Green River all the way to Rock River, but the conditions were so unfavorable on the south side of the river below Colona that I decided to cross Green River east of Green River Station, where a good crossing could be had, and follow the right bank to Rock River. An endeavor was also made to so locate the line that both railroads at Colona could use one bridge, but I did not arrive at any feasible scheme by which this could be done. The Chicago, Burlington and Quincy Railroad can be carried over the canal by a fixed bridge, but I doubt if this can be done with the Chicago, Rock Island and Pacific Railroad, and believe that a double-track pivot bridge will be necessary.

The total estimated cost of the whole line is $2,048,445, of which $575,682 is for earthwork, $409,700 is for locks, $200,800 is for bridges, $503,100 is for drainage structures, $172,941 is for right of way, and $186,222 is for contingencies. In making up these estimates I have used, so far as possible, prices comparable with those used in the estimate of the Penney Slough route and in Mr. Long's estimate of 1893.

In the Report of the Chief of Engineers for 1894 Mr. Long submits an estimate of cost from mile 25 to mile 62.3 of $1,689,781; but this is on the assumption that the summit level is at grade 205. In this estimate, however, he omits a lock of 7 feet lift, which in another estimate he estimates to cost $57,500. There appears to be no estimate for contingencies.

In his comparative estimate of cost of miles 19 to 29, inclusive, the cost of miles 26, 27, 28, and 29 is $233,541, with summit at grade 205, and of miles 25, 26, 27, 28, and 29 is $224,786, with summit at grade 199. He estimates for a width of 250 feet, at prices ranging from $30 to $65 per acre, while I have estimated for a width of 300 feet, at a uniform price of $100 per acre. The width of 300 feet I consider to be none too much, and the prices paid for right of way already acquired show that an estimate of $100 per acre does not cover the cost to the United States. Increasing the right of way to 300 feet width, at $100 per acre, his estimate for right of way becomes $135,600, an increase of $66,449.

His estimate, then, with summit at grade 199 from mile 24 to mile 62.3 would be $1,689,781 plus $57,500, minus $233,541, plus $224,786, plus $66,449, plus $180,497 (contingencies) = $1,985,472.

By your direction I have revised the estimate of cost of the Penney Slough route. This revised estimate has been prepared by using Mr. Long's estimate for cost of summit level at grade 199 from the twenty-fourth mile to the twenty-eighth mile, and increasing the estimates of 1890 by 12½ per cent for all mechanical constructions to Penney Slough over prices of similar structures on the Green River line, and increasing acreage of right of way 50 per cent and making the price $100 per acre. The estimate of cost of miles 52 to 64, inclusive, along Rock River has been taken the same as in the estimates of 1890. The total revised estimated cost, with 10 per cent added for contingencies, is $1,996,208.

Since the survey for the Penney Slough line was made, at least one new highway has been opened requiring one additional bridge, and several large dredged ditches have been dug across the proposed line. The cost of the additional structures required by these changes, with 10 per cent added for contingencies, would be $48,015, which increases the total given above to $2,044,223.

The estimates of 1890 assumed that the owners of bridges over Rock River would modify them at their expense so as to permit navigation past them. It has been decided, however, in the district court of the southern district of Ohio (50 Fed. Rep., p. 406) that sections 4 and 5 of the river and harbor act of September 19, 1890, providing penalty for maintaining obstructions to navigation, are unconstitutional.

Should this decision be sustained, then, it is highly probable that the United States would have to put draw spans in one double-track and one single-track railway bridge, and the cost of the Penney Slough route increased thereby.

The estimated cost of the three routes for reaching Rock River at the mouth of Green River is as follows:

Estimate of 1890, the Penney Slough route	$2,044,223
Estimate of 1893	1,985,472
Estimate of 1896	2,048,445

On account of its being more accessible, it is probable that the last line can be built at a much less price per unit than either of the others, although, as far as possible, the estimates have been made on the same basis. The material met on this line is much better than on either of the others, and a canal built on it would be more cheaply maintained. Throughout all the lines very little material will be met that can be used in structures. There is no rock until Rock River is reached, and no timber that can be made use of in structures. At Colona sandstone can be obtained suitable for riprap or for slope paving, but not hard enough for any masonry which would be touched by boats. Gravel suitable for concrete is not found on either of the lines, and good mortar sand will be very difficult to obtain. Practically all the materials for structures will have to be brought from other sources, and this fact alone should have large weight in determining the route to be adopted.

In making this survey and preparing the maps and estimates I have been assisted by Messrs. A. O. Rowse, Max Heinze, J. G. Palmer, J. B. Bassett, C. J. Chambers, and F. B. Duis.

Very respectfully, your obedient servant,

L. L. WHEELER, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Detailed estimate of the cost of western section from mile 24 to mile 62.3 at mouth of Green River.

Mile 25:	
52,107 cubic yards excavation, at 15 cents	$7,816.05
24,141 cubic yards embankment, at 15 cents	3,621.15
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	15,713.20
Mile 26:	
40,350 cubic yards excavation, at 15 cents	6,052.50
44,766 cubic yards embankment, at 15 cents	6,714.90
1 10-foot arch culvert, at $8,000	8,000.00
1 highway bridge, at $5,800	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	30,843.40
Mile 27:	
13,308 cubic yards excavation, at 15 cents	1,996.20
78,212 cubic yards embankment, at 15 cents	11,731.80
1 10-foot arch culvert, at $8,000	8,000.00
1 highway bridge, at $5,800	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	31,804.00
Mile 28:	
24,187 cubic yards excavation, at 15 cents	3,628.05
68,544 cubic yards embankment, at 15 cents	10,281.60
1 48-inch pipe culvert, at $4,500	4,500.00
1 highway bridge, at $5,800	5,800.00
1 300-foot wasteweir	5,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	33,485.65

Mile 29:

32,008 cubic yards excavation, at 15 cents	$4,801.20
53,596 cubic yards embankment, at 15 cents	8,039.40
1 10-foot arch culvert	8,000.00
2 highway bridges, at $5,800	11,600.00
37.26 acres right of way, at $100	3,726.00
Fencing	640.00
Total	36,806.60

Mile 30:

5,460 cubic yards excavation, at 15 cents	819.00
84,988 cubic yards embankment, at 15 cents	12,748.20
1 48-inch pipe culvert	4,500.00
Lock No. 22, 6 feet lift	38,600.00
Lock-keeper's dwelling	2,500.00
39.35 acres right of way, at $100	3,935.00
Fencing	640.00
Total	63,742.20

Mile 31:

127,466 cubic yards embankment, at 15 cents	19,119.90
2 30-foot aqueducts, at $20,000	40,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	69,195.90

Mile 32:

5,172 cubic yards excavation, at 15 cents	775.80
97,180 cubic yards embankment, at 15 cents	14,577.00
1 48-inch pipe culvert	4,500.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	24,128.80

Mile 33:

39,000 cubic yards excavation, at 15 cents	5,850.00
52,900 cubic yards embankment, at 15 cents	7,935.00
1 48-inch pipe culvert	4,500.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	22,561.00

Mile 34:

6,659 cubic yards excavation, at 15 cents	998.85
97,778 cubic yards embankment, at 15 cents	14,666.70
2 48-inch pipe culverts, at $4,500	9,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	34,742.55

Mile 35:

15,058 cubic yards excavation, at 15 cents	2,258.70
73,774 cubic yards embankment, at 15 cents	11,066.10
1 48-inch pipe culvert	4,500.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	27,900.80

Mile 36:	
8,796 cubic yards excavation, at 15 cents	$1,319.40
79,866 cubic yards embankment, at 15 cents	11,979.90
1 60-foot aqueduct	30,000.00
1 10-foot arch culvert	8,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	55,575.30
Mile 37:	
1,568 cubic yards excavation, at 15 cents	235.20
118,056 cubic yards embankment, at 15 cents	17,708.40
1 48-inch pipe culvert	4,500.00
1 12-foot arch culvert	10,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	42,519.60
Mile 38:	
100,997 cubic yards excavation, at 15 cents	15,149.55
22,090 cubic yards embankment, at 15 cents	3,313.50
2 highway bridges, at $5,800	11,600.00
Lock No. 23, 10 feet lift	48,600.00
Lock keeper's dwelling	2,500.00
37.17 acres right of way, at $100	3,717.00
Fencing	640.00
Total	85,520.05
Mile 39:	
22,927 cubic yards excavation, at 15 cents	3,439.05
64,792 cubic yards embankment, at 15 cents	9,718.80
1 48-inch pipe culvert	4,500.00
1 highway bridge	5,800.00
40.10 acres right of way, at $100	4,010.00
Fencing	640.00
Total	28,107.85
Mile 40:	
40,684 cubic yards excavation, at 15 cents	6,102.60
58,066 cubic yards embankment, at 15 cents	8,709.90
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	24,888.50
Mile 41:	
698 cubic yards excavation, at 15 cents	104.70
100,826 cubic yards embankment, at 15 cents	15,123.90
1 48-inch pipe culvert	4,500.00
1 10-foot arch culvert	8,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	37,804.60
Mile 42:	
108,330 cubic yards embankment, at 15 cents	16,249.50
1 48-inch pipe culvert	4,500.00
1 10-foot arch culvert	8,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	38,825.50

Mile 43:	
22,015 cubic yards excavation, at 15 cents	$3,302.25
66,818 cubic yards embankment, at 15 cents	10,022.70
1 48-inch pipe culvert	4,500.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	27,900.95
Mile 44:	
2,557 cubic yards excavation, at 15 cents	383.55
112,204 cubic yards embankment, at 15 cents	16,830.60
1 90-foot aqueduct	40,000.00
2 highway bridges, at $5,800	11,600.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	73,090.15
Mile 45:	
18,812 cubic yards excavation, at 15 cents	2,821.80
75,778 cubic yards embankment, at 15 cents	11,366.70
2 48-inch pipe culverts, at $4,500	9,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	27,464.50
Mile 46:	
40,156 cubic yards embankment, at 15 cents	6,023.40
49,885 cubic yards excavation, at 15 cents	7,482.75
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	23,582.15
Mile 47:	
24,390 cubic yards excavation, at 15 cents	3,658.50
90,396 cubic yards embankment, at 15 cents	13,559.40
1 10-foot arch culvert	8,000.00
1 48-inch pipe culvert	4,500.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	33,993.90
Mile 48:	
44,217 cubic yards excavation, at 15 cents	6,632.55
56,476 cubic yards embankment, at 15 cents	8,471.40
2 48-inch pipe culverts, at $4,500	9,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	34,179.95
Mile 49:	
9,630 cubic yards excavation, at 15 cents	1,444.50
62,704 cubic yards embankment, at 15 cents	9,405.60
40,304 cubic yards excavation, Green River Cut-off, at 15 cents	6,045.60
1 48-inch pipe culvert	4,500.00
1 highway bridge	5,800.00
1 waste weir 300 feet long	5,000.00
Lock No. 24, 11 feet lift	50,000.00
Lock keeper's dwelling	2,500.00
67.79 acres right of way, at $100	6,779.00
Fencing	640.00
Total	92,114.70

Mile 50:	
5,679 cubic yards excavation, at 15 cents	$851.85
44,272 cubic yards embankment, at 15 cents	6,640.80
1 highway bridge	5,800.00
40.75 acres right of way, at $100	4,075.00
Fencing	640.00
Total	18,007.65
Mile 51:	
5,336 cubic yards excavation, at 15 cents	800.40
83,665 cubic yards embankment, at 15 cents	12,549.75
1 90-foot aqueduct	40,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	57,626.15
Mile 52:	
8,061 cubic yards excavation, at 15 cents	1,209.15
100,689 cubic yards embankment, at 15 cents	15,103.35
1 48-inch pipe culvert	4,500.00
1 10-foot arch culvert	8,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	33,088.50
Mile 53:	
25,053 cubic yards excavation, at 15 cents	3,757.95
41,718 cubic yards embankment, at 15 cents	6,257.70
1 10-foot arch culvert	8,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	22,291.65
Mile 54:	
21,661 cubic yards excavation, at 15 cents	3,249.15
74,734 cubic yards embankment, at 15 cents	11,210.10
1 double 10-foot arch culvert	15,600.00
1 highway bridge	5,800.00
Lock No. 25, 9 feet lift	44,600.00
Lock keeper's dwelling	2,500.00
39.37 acres right of way, at $100	3,937.00
Fencing	640.00
Total	87,536.25
Mile 55:	
38,659 cubic yards excavation, at 15 cents	5,798.85
59,141 cubic yards embankment, at 15 cents	8,871.15
1 10-foot arched culvert	8,000.00
1 highway bridge	5,800.00
Lock No. 26, 10 feet lift	48,600.00
Lock keeper's dwelling	2,500.00
38.31 acres right of way, at $100	3,831.00
Fencing	640.00
Total	84,041.00
Mile 56:	
5,346 cubic yards excavation, at 15 cents	801.90
105,030 cubic yards embankment, at 15 cents	15,754.50
3 48-inch pipe culverts, at $4,500	13,500.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	34,332.40

Mile 57:	
2,832 cubic yards excavation, at 15 cents	$424.80
112,226 cubic yards embankment, at 15 cents	16,833.90
2 48-inch pipe culverts, at $4,500	9,000.00
1 300-foot aqueduct	75,000.00
46.47 acres right of way, at $100	4,647.00
Fencing	640.00
Total	106,545.70
Mile 58:	
68,262 cubic yards excavation, at 15 cents	10,239.30
51,756 cubic yards embankment, at 15 cents	7,763.40
2 48-inch pipe culverts, at $4,500	9,000.00
Lock No. 27, 8 feet lift	42,500.00
Lock keeper's dwelling	2,500.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	76,278.70
Mile 59:	
17,735 cubic yards excavation, at 15 cents	2,660.25
76,309 cubic yards embankment, at 15 cents	11,446.35
2 48-inch pipe culverts, at $4,500	9,000.00
1 highway bridge	5,800.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	33,182.60
Mile 60:	
52,236 cubic yards excavation, at 15 cents	7,835.40
32,381 cubic yards embankment, at 15 cents	4,857.15
35,811 cubic yards excavation, Green River Cut-off, at 15 cents	5,371.65
3 48-inch pipe culverts, at $4,500	13,500.00
1 double-track railway bridge	30,000.00
Lock No. 28, 7 feet lift	40,800.00
Lock keeper's dwelling	2,500.00
58.13 acres right of way, at $100	5,813.00
Fencing	640.00
Total	111,317.20
Mile 61:	
145,267 cubic yards excavation, at 15 cents	21,790.05
15,214 cubic yards embankment, at 15 cents	2,282.10
1 wasteweir	5,000.00
1 48-inch pipe culvert	4,500.00
1 highway bridge	5,800.00
1 single-track railway bridge	20,000.00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	63,648.15
Mile 62:	
40,446 cubic yards excavation, at 15 cents	6,066.90
51,959 cubic yards embankment, at 15 cents	7,793.85
2 48-inch pipe culverts, at $4,500	9,000 00
36.36 acres right of way, at $100	3,636.00
Fencing	640.00
Total	27,136.75
Mile 62.3:	
3,952 cubic yards excavation, at 15 cents	592.80
31,756 cubic yards embankment, at 15 cents	4,763.40
1 48-inch pipe culvert	4,500.00
Lock No. 29, 14 feet lift	76,000.00
Lock keeper's dwelling	2,500.00

Mile 62.3—Continued.	
21.51 acres right of way, at $100	$2,151.00
Fencing	192.00
Total	90,699.20
Grand total	1,862,222.70
Contingencies, 10 per cent	186,222.27
Total estimated cost	2,048,444.97

Summary of cost of western section from mile 24 to mile 62.3.

1,021,010 cubic yards excavation, at 15 cents	$153,151.50
2,740,753 cubic yards embankment, at 15 cents	411,112.95
76,115 cubic yards new channels for Green River, at 15 cents	11,417.25
1 lock, 14 feet lift	76,000.00
1 lock, 11 feet lift	50,000.00
2 locks, 10 feet lift	97,200.00
1 lock, 9 feet lift	44,600.00
1 lock, 8 feet lift	42,500.00
1 lock, 7 feet lift	40,800.00
1 lock, 6 feet lift	38,600.00
26 highway bridges, at $5,800	150,800.00
1 double-track pivot railroad bridge	30,000.00
1 single-track fixed railroad bridge	20,000.00
35 48-inch pipe culverts, at $4,500	157,500.00
10 10-foot arch culverts, at $8,000	80,000.00
1 12-foot arch culvert	10,000.00
1 double 10-foot arch culvert	15,600.00
2 30-foot aqueducts, at $20,000	40,000.00
1 60-foot aqueduct	30,000.00
2 90-foot aqueducts, at $40,000	80,000.00
1 300-foot aqueduct	75,000.00
3 300-foot wasteweirs, at $5,000	15,000.00
8 lock-keepers' dwellings, at $2,500	20,000.00
1,484.29 acres of right of way, at $100	148,429.00
38.3 miles fencing, at $640	24,512.00
Grand total	1,862,222.70
Contingencies, 10 per cent	186,222.27
Total estimated cost	2,048,444.97

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 9, 1897.

MAJOR: Your letter of December 16 last, on the final location of the western section of the Illinois and Mississippi Canal from mile 24 to Rock River, was duly received and submitted to the Secretary of War by indorsement of December 29, recommending the approval of the Green River route as laid down on the maps accompanying your report. This recommendation was approved by the Secretary of War under date of the 1st instant.

By command of Brig. Gen. Wilson:

Very respectfully, your obedient servant,

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

Maj. W. L. MARSHALL,
Corps of Engineers.
(Through the Division Engineer.)

I I 8.

OPERATING AND CARE OF ILLINOIS AND MISSISSIPPI CANAL; CANAL AROUND LOWER RAPIDS OF ROCK RIVER AT MILAN, ILL.

This canal is 4½ miles in length, surmounting a fall of 18 feet, and the works operated and cared for include 3 locks, 3 swing bridges, 7 sluiceways, 1 arch culvert, 3 lock houses, 1 office building, and 2 dams.

The canal was formally opened to navigation April 17, 1895.

On account of three fixed bridges across Rock River a few miles above the head of the canal, its traffic is restricted to excursion craft and to barges and such small steam craft as may pass under the bridges.

Proceedings are in progress to compel the city of Moline to alter its bridge, but the authority of the Secretary of War has been denied by the city of Moline. The United States district court for the northern district of Illinois in a preliminary opinion sustains the United States authority, and the city of Moline has until October, 1897, to answer the information and complaint of the United States.

The canal and its accessory works have been operated and maintained in good order during the past year; all lock gates and sluice gates and the lock keepers' houses were painted, also the fences about lock houses and the signal apparatus at bridges.

Fenders were placed on the crib approaches to guard lock; movable roofs for main supports of sluice gates were constructed and painted; willow settings planted as an experiment to protect canal banks, and lupin seeds planted on sandy banks for the same purpose.

During the season of navigation vessels of 56,621 tons passed through the canal; 1,531 lockages were made; 1,151 passengers and 9,583 tons of freight passed through.

The freight was mainly coal. The amount of it is limited by the obstructive bridges, especially the Moline Wagon Bridge, but the coal by canal controls the price at Davenport and vicinity, and this result has been in effect ever since the opening of the canal. A reduction of price of from 3 to 4 cents per bushel, or approximately $1 per ton, on all soft coal used has resulted, which has already justified the construction of this part of the canal as an independent work.

The change in the Moline Bridge will make this canal an important line of transportation for coal.

There was expended during the year ending June 30, 1897, $4,752.46, exclusive of outstanding liabilities, $869.70.

Disbursements, fiscal year 1897.

Operating locks and bridges	$2,761.94
Dredging at entrance to lower lock	952.12
Care and repair of property and plant	530.26
Superintendence and office	469.93
Property	38.21
Total	4,752.46

Money statement.

July 1, 1896, balance unexpended (outstanding)	$43.61
July 1, 1896, allotment for fiscal year	6,500.00
	6,543.61
June 30, 1897, amount expended during fiscal year	4,752.46
July 1, 1897, balance unexpended	1,791.15
July 1, 1897, outstanding liabilities	869.70
July 1, 1897, balance available	921.45

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

STERLING, ILL., *June 30, 1897.*

MAJOR: I have the honor to submit the following report on the operating and care of canal around Lower Rapids of Rock River during the fiscal year ending June 30, 1897.

The canal was closed to navigation by ice on November 27 and opened again March 27. No serious accident occurred in the operation of the canal and the condition of the banks and structures is practically the same as at date of last report. A heavy run of ice last March, followed by a high stage of water, passed without damaging the works except that the bottom of the river was eroded below the south dam. The river is still at too high a stage to permit a thorough examination of the river bed to be made. The levels were maintained during the winter and permits were sold for cutting ice from the canal, and the proceeds, $64, transmitted to Chicago.

All of the lock gates and sluice gates were painted. The three lock-keepers' houses were given two coats of paint and the roofs also painted. The signal apparatus at the bridges was cleaned, adjusted, and painted. The fences about houses and grounds were painted. Fenders were placed on the crib approaches to the guard lock.

Movable roofs for Taintor gates were designed, materials purchased, and roofs for the three gates at guard lock built. The house at Lock 36 was struck by lightning, a chimney thrown down and other small damage done. The necessary repairs were made.

A number of willow settings were planted as an experiment in protecting embankments against wave wash, and some lupin seeds were sown as an experiment in covering sandy banks with vegetation.

The commerce through the canal is almost entirely confined to the transportation of coal from the mines along Rock River to the cities on the Mississippi. The coal trade is steadily on the increase and before the end of the present season will reach considerable dimensions, provided the boats are able to reach the mines. The Moline wagon bridge so obstructs navigation that if Rock River should be at even a medium stage, the boats now engaged in the coal trade would not be able to pass under it.

Herewith is a table showing commerce through the canal since April 17, 1895, the date when it was opened to navigation.

Very respectfully, your obedient servant,

L. L. WHEELER, *Assistant Engineer.*

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Traffic on the western section Illinois and Mississippi Canal since April 17, 1895.

	Year ending June 30—		
	1895.	1896.	1897.
Steamboats....number..	24	150	389
Barges....do....	9	115	331
Steamboats....tons..	858	4,065	10,037
Barges....do....	679	14,255	46,584
Lockages....number..	186	562	1,531
Passengers....do....	3,539	3,634	1,151
Freight....tons..	6	1,865	9,583

I I 9.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On November 10, 1896, the steam canal barge *China*, about 59 tons net tonnage, while being towed up the North Branch, Chicago River, sunk in one of the draws of the bridge at Chicago avenue and totally obstructed navigation through that draw.

Notice was given to owner and proposals invited for removing and disposing of the wreck, by public advertisement dated November 23, 1896. Proposals were opened December 23, 1896, and the contract awarded to the Dunham Towing and Wrecking Company of Chicago, at $495, under which contract the wreck was removed, towed out into the lake and sunk in 60 feet of water about January 14, 1897. An old boiler and hand steering wheel were saved from the wreck and sold on May 10, 1897, at public auction to the highest bidder for $4.10, which was deposited to the credit of the United States Treasurer on account of appropriation "Removing sunken vessels or craft obstructing or endangering navigation, indefinite."

Money statement.

To allotment (E. D. File No. $\frac{18184}{9}$)		$549.71
By advertising	$28.50	
By printing specifications	25.00	
By amount paid contractor	495.00	
	548.50	
By outstanding liabilities June 30, 1897 *	1.21	
		549.71

I I 10.

PRELIMINARY EXAMINATION OF UPPER ILLINOIS RIVER AND LOWER DES PLAINES RIVER, ILLINOIS, WITH A VIEW TO EXTENSION OF NAVIGATION FROM ILLINOIS RIVER TO LAKE MICHIGAN AT OR NEAR CHICAGO.

[Printed in House Doc. No. 333, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 2, 1897.

SIR: I have the honor to submit the accompanying report of January 27, 1897, by Maj. W. L. Marshall, Corps of Engineers, of the results of a preliminary examination of the upper Illinois River and lower Des Plaines River, Illinois, with a view to extension of navigation from Illinois River to Lake Michigan, at or near Chicago, made in compliance with requirements of the river and harbor act of June 3, 1896.

Major Marshall states that the locality embraces an important commercial route between the Great Lakes and the Mississippi River system, and its utility and worthiness have long been recognized by Congress. The division engineer, Col. Henry M. Robert, Corps of Engineers, is of the opinion that the upper Illinois and lower Des Plaines rivers are worthy of improvement, and I concur in his views.

It is estimated that the cost of the necessary survey and preparation of detailed plans of improvement will be $75,000.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. DANIEL S. LAMONT,
Secretary of War.

* Telegrams to and from Washington, accounts for which were sent to Washington for payment (G. O. No. 8, A. G. O., 1896) December 18, 1896, and January 8, 1897.

REPORT OF MAJ. W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., January 27, 1897.

GENERAL: In accordance with your letter dated August 11, 1896, I have the honor to submit the following report upon a preliminary examination of "the upper Illinois River and lower Des Plaines River, with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago," directed by the river and harbor act of June 3, 1896.

With reference to this proposed waterway I have to say that quite detailed surveys have heretofore been made, dating back to 1825 and in more recent years, by the following officers:

Gen. J. H. Wilson, 1867, report published in House Ex. Doc. No. 16, Fortieth Congress, first session.

Colonel Macomb, Corps of Engineers, Report Chief of Engineers, 1875, Volume II, page 525.

Maj. W. H. H. Benyaurd, Corps of Engineers, Report Chief of Engineers, 1884, page 1958.

Board of Engineers on Hennepin Canal and Illinois and Michigan Canal, Report Chief of Engineers, 1887, page 2125.

Capt. W. L. Marshall, Corps of Engineers, Report Chief of Engineers, 1890, page 2419.

The latter reports are in so full detail that little can now be added to them by any preliminary examinations, as such are understood by me, and all that can be submitted now is simply a repetition of a small part of the information contained in these reports, with a brief statement of the conditions brought about by local engineering works constructed for drainage purposes by the trustees of the sanitary district of Chicago.

Any waterway constructed will extend from Lake Michigan, at the mouth of either the Chicago or Calumet rivers, and terminate at Lasalle or Utica, on the Illinois River. The routes are of about equal lengths from navigable water in Calumet or Chicago rivers to the present head of navigation in the Illinois River, 97 miles.

The Illinois and Michigan Canal is now the only navigable connection, and extends from Chicago River, about 5 miles above its mouth, to Lasalle. It is 96 miles long, 60 feet wide at the water surface, 36 feet wide at bottom in earth excavation, and 48 feet wide in rock, with locks 110 feet long, 18 feet wide, having 6 feet of water over miter sills. It is navigated by boats about 97 feet long, 17 feet 6 inches wide, and 5 feet draft. The lockage is 141 feet, made by fifteen locks.

The sanitary district of Chicago has nearly completed a canal for drainage purposes from Chicago River at Roby street to near Lockport from 18 to 22 feet in depth below the proposed water surface, and varying in width from 160 feet in rock to more than 200 feet in earth, a length of 28 miles, which may be made available as part of any enlarged waterway over the route in question, and is of much greater dimensions than required by any commercial canal adapted for the conditions and requirements of present or prospective traffic by water between Lake Michigan and the region along the water courses of the Mississippi Valley. To comply with the law of the State of Illinois, it has been constructed of a capacity to discharge 600,000 cubic feet per minute through the section excavated in rock, and 300,000 cubic feet per minute throughout the earth section. The law requires a discharge of 20,000 cubic feet per minute for each 100,000 inhabitants of the drainage district, which condition at present requires more than 300,000 cubic feet and in a few years will require the full 600,000 cubic feet discharge through the canal. The taking of water from Lake Michigan, however, for drainage purposes (or rather for dilution of sewage) has not yet been authorized by Congress. This deep channel abruptly terminates at Lockport, and it is proposed to discharge the water through controlling gates into a non-navigable tail race down the slope to and through the city of Joliet into the lower Des Plaines and Illinois rivers. Any navigable channel, therefore, constructed in continuation of the drainage canal must connect with this canal at Lockport and terminate at or above Lasalle, about 66 miles distant, but the lockage after the opening of the drainage canal will be reduced by the amount that the increased discharge will raise the water surface of the Illinois River at Lasalle, increased by the slope in the drainage canal from Lake Michigan to Lockport, or, say, at least 12 feet when the drainage canal is actually discharging. This will result in reducing the number of locks required in any of the proposed schemes by one, but will substitute an obstruction due to the current in the canal and river, repeated in each pool of the river, if the natural channel be improved.

In carrying the improvement from Lockport to the head of navigation on the Illinois River at Lasalle or Utica, it is necessary to either practically enlarge the Illinois and Michigan Canal throughout or adopt a mixed improvement by canal from Lockport to Lake Joliet, 8 miles; canal around Marseilles Rapids, 2 miles; and improve the upper Illinois River the remaining 54 miles to Utica by locks and dams. It has been generally conceded that throughout the distance from either Chicago River or Calumet River to Lake Joliet an artificial channel or canal must be constructed or the existing canal enlarged. From this point to Utica a choice of routes, either by enlargement of existing canal or by river, has been presented. The river route was rejected by the original projectors of the existing water route, but was preferred by Major Benyaurd in his report of survey made in 1883 (Report Chief of Engineers, 1884, p. 1958), whose conclusions were accepted without question by the Board of Engineers of 1886. His estimates from Joliet to Lasalle for locks 350 feet long, 75 feet wide, 7 feet deep, was $3,433,562, and for locks the size of the Hennepin Canal, 170 by 30 feet by 7 feet depth, $1,975,446; but as there are nine locks to be built, and the locks and dams already built on the lower Illinois cost more than $500,000 each, this estimate is evidently much too small even for 7-foot draft. In his report it was assumed without question that the river route is practicable at all stages of water. The hydraulics of the river were not at all considered, nor the conditions under which the works must now be constructed, due to a probable low-water discharge ten times the natural low-water discharge of the stream.

In the 64 miles from Joliet to Lasalle the river's descent is 90 feet, distributed unequally in pools and rapids. Its low-water discharge is to be increased by 10,000 cubic feet per second, which will make the construction and repairs of locks and dams more difficult and expensive, and its extreme high-water discharge will be increased to probably eighty times its present low-water discharge, or to near 80,000 cubic feet per second. A current will be introduced into the so-called slack-water system even at low water, and at stages approaching extreme high water hydraulic formulæ indicate that the improved stream with such slopes as will exist will be not navigable at all by ascending craft over 22 miles of the 43 miles between the mouth of the Kankakee River, where the Illinois River is formed, and Utica, the head of the slack water on the Illinois River. In this connection reference is made to the discussion in the Annual Report of the Chief of Engineers, 1890, page 2439, and on page 2470.

There are four ways of constructing a navigable waterway via the valley of the Illinois and Des Plaines rivers below Joliet practicable at all stages of water.

First. By canaling past the 22 miles where the high-water velocities are excessive.

Second. By constructing the dams so high or so short that the area of spillways shall be small in comparison with the cross section of the pools, either of which means wide overflowed areas.

Third. By much enlarging the natural waterway throughout the pools by excavation.

Fourth. By enlarging the existing canal or constructing another throughout the entire line.

With the understanding that the waterway can not be navigated at the highest stages of water, which are infrequent and of short duration, the route by the river may be constructed at much less expense with capacious locks than a canal of similar capacity for passing vessels; but the river improvement in any event should stop at Lake Joliet, thence to Lake Michigan by canal. This would involve the construction of an enlarged canal for 8 miles from Lake Joliet to the terminus of the navigable portion of the Chicago drainage canal.

DIMENSIONS.

In regard to the capacity of the improvement, the act of June 3, 1896, directing this preliminary survey states its object to be "the extension of navigation from Illinois River to Lake Michigan" or the extension of river navigation to the lake, not lake navigation to the river. The distinction is important in view of the persistent forcing of the project for a 14-foot channel from Lake Michigan to the Mississippi River, when it is well known that the bulk of the commerce of the Mississippi system of rivers is carried in vessels of 8 feet and less draft; that the Mississippi improvements are directed to securing 4 feet of water at low water from St. Paul to the mouth of the Illinois, 6 feet thence to St. Louis, 8 feet thence to Cairo, 10 feet thence to the mouth of the river, and that these plans are not only far from attainment, but that the Mississippi River Commission, after laboring for fifteen years and expending many millions of dollars, have decided by a majority vote that the permanent improvement of the Lower Mississippi River for 10 feet depth of navigation is impracticable, and have embarked upon an attempt to so alter the distribution of part of the cubic miles of sand moving along the Mississippi, by dredges of enormous capacity, as to maintain a navigable channel of such depth across the bars. What success will attend this effort is still for the future to disclose.

The improvement of the Illinois River, the navigation of which it is in question to extend to Lake Michigan, has heretofore been directed toward securing by locks and dams, and dredging, a navigable channel 7 feet in depth at low water from the Mississippi River to Lasalle, a distance of 225 miles.

The preliminary locks and dams have been built, but sufficient money has not been given for dredging the crests of bars in the pools. At present the navigable depth is about 4 feet at low water, and about 4,500,000 cubic yards dredging is required to attain 7 feet.

Of the Illinois River works of navigation, the State of Illinois owns, controls, and collects tolls over 90 miles, and the United States has provided a free canalized river for 135 miles. The State of Illinois also owns and collects tolls over the 96 miles of canal between Chicago and Lasalle. It is evident from these facts that a waterway that will meet the requirements of the Mississippi system of navigation may be much less in depth and cost than the proposed 14-foot channel. The line occupies no very urgent route of transportation. There is no large and pressing bulk of heavy commodities demanding cheap transportation over the line, such, for instance, as between Buffalo and the sea, or between the Pittsburg district and the Great Lakes. The most that may be expected of it is the control of cost of transportation by rail so far as to limit maximum freight charges over competing routes.

The dimensions of the waterways should then be applied to meet the demands of the situation and probable commerce that will seek the route.

In the Report of the Chief of Engineers for 1890 this subject is further discussed, and estimates are made for an 8-foot channel and also for a 14-foot channel with locks 350 feet long and 75 feet width of lock chamber.

It is not likely that the unwieldy and frail Mississippi River boats would ever make use of a canal 160 feet wide, as long as one from Lake Joliet to Chicago, especially when there will be encountered a current therein. The bulk of the freights on the Mississippi system of rivers is carried on barges, in tows, and not in the holds or on decks of the steamboats.

The trustees of the Chicago sanitary district are contemplating constructing their canal with fixed bridges with 22 feet clear headroom over the canal. This is ample headroom for a commercial barge canal of the largest capacity, and the difference in cost between fixed and draw bridges crossing the canal between Chicago and Lake Joliet, with a reasonable allowance for difference in cost of operation, is probably sufficient to construct the canal from the present terminus of the drainage canal to Lake Joliet of from 8 to 10 feet depth, with locks suitable for the passage of the largest Mississippi River barges. Mississippi River towboats could then carry their tows to Lake Joliet, then transfer them to more handy tugs for passage through the more obstructive canal portion of the route. For an 8-foot channel from Lockport to Lake Joliet the estimated cost in 1890, exclusive of bridges, was $3,900,000. Swing bridges from Chicago to Lake Joliet were estimated at $3,653,000. The cost of operating the swing bridges would far exceed the cost of operating the locks, without any corresponding advantages for a commercial canal, other than sentimental, over the part of the route where towing on the Mississippi River style can not be applied.

CONCLUSION.

1. In my opinion the surveys already made are in sufficient detail for preliminary estimates of the cost of any suitable extension of the navigation of the Illinois River to Lake Michigan that does not involve enlargement of the Illinois and Michigan Canal from Joliet to Lasalle.

2. That prior to embarking in any such improvement it is advisable to secure from the State of Illinois the State works along the Illinois River and such parts of the Illinois and Michigan Canal as may be utilized; also to thoroughly complete the lower Illinois River improvement which has slowly progressed for thirty years, resulting in diversion of water traffic to rail.

3. That the dimensions and route of the proposed extension should be examined into and decided by a competent board of engineers, with means and authority to make such additional surveys as their proper enlightenment demands. The expenses and costs of such a board and of the surveys are estimated at $30,000; if detailed plans, etc., are to be made, at $75,000.

The locality embraces an important commercial route between the Great Lakes and the Mississippi River system, and its utility and worthiness has long been recognized by Congress.

Preliminary estimates of cost on various plans have been heretofore made, and reports containing them are referred to hereinbefore.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, February 20, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

I am of opinion that the Upper Illinois and Lower Des Plaines rivers are worthy of improvement with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

I I II.

SURVEY OF WOLF LAKE AND RIVER, ILLINOIS AND INDIANA, WITH REFERENCE TO THEIR NAVIGATION IN CONNECTION WITH THE WATERS OF LAKE MICHIGAN.

[Printed in House Doc. No. 157, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 2, 1897.

SIR: I have the honor to submit the accompanying copy of report of December 24, 1896, with map,* by Maj. W. L. Marshall, Corps of Engineers, of the results of a survey of Wolf Lake and River, Illinois and Indiana, with reference to their navigation in connection with the waters of Lake Michigan, made to comply with provisions of the river and harbor act of June 3, 1896.

Several reports have heretofore been made between 1873 and 1893 by this office concerning this locality and all have been adverse to the expenditure of public money in the construction of a harbor at this point.

Major Marshall presents a very clear and concise description of the

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* Not reprinted. Printed in House Doc. No. 157, Fifty-fourth Congress, second session.

lake and river, together with labor involved in the construction of a harbor at this point, but remarks that—

There are no manufacturing establishments or enterprises requiring transportation by water within a mile of the borders of Wolf Lake, nor establishments of any kind other than three ice houses along its banks.

Major Marshall further states that there is no navigation on Wolf Lake and River, and navigation by other craft than rowboats with flat bottoms and slight draft is impossible on Wolf Lake. To adapt Wolf Lake and River to such navigation as may be possible in connection with Lake Michigan, without creating a navigable artificial system, requires only the excavation of a trench wide enough for the passage of a rowboat across the bar at the mouth of the river and 2 feet deep, at an expense of about $50, but as this can not have been the intent of Congress in ordering the survey he submits a plan providing for constructing an entrance to the river and lake 20 feet in depth, extending from 21 feet in Lake Michigan between piers 300 feet apart; for deepening, widening, and straightening Wolf River; constructing five swing bridges across the channel with drawspans of 100 feet each; building bulkheads or docks in the immediate vicinity of these bridges; constructing a turning or winding basin in Wolf Lake, and for dredging a channel 20 feet deep and 300 feet wide, 7,400 linear feet in Wolf Lake. The estimated cost of this work is $1,395,042.

For reasons given, Major Marshall states that in his opinion the improvement of navigation of Wolf Lake and River, with reference to their navigation in connection with the waters of Lake Michigan, is not now a public necessity, and that the locality at this time is not worthy of improvement by the General Government. His opinion is concurred in by Col. Henry M. Robert, Corps of Engineers, the Division Engineer.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. L. MARSHALL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 24, 1896.

GENERAL: I have the honor to submit the following report upon a survey of "Wolf Lake and River," Illinois and Indiana, "with reference to their navigation in connection with the waters of Lake Michigan," required by the river and harbor act of June 3, 1896.

Numerous reports have heretofore been made concerning this locality, as follows: (1) Maj. D. C. Houston, Corps of Engineers, in 1873; (2) Maj. George L. Gillespie, Corps of Engineers (see Report Chief of Engineers, 1875, p. 241); (3) by Maj. G. J. Lydecker, Corps of Engineers (see Report Chief of Engineers, 1880, p. 1999); (4) by Maj. W. H. H. Benyaurd, Corps of Engineers (Report Chief of Engineers, 1885, p. 2056), and by me in 1893 (see Report Chief of Engineers, 1893, p. 2851).

Majors Gillespie and Lydecker made estimates for a harbor entrance at the mouth of Wolf River on various plans, but the conclusions reached in all these reports have been adverse to the expenditure of money in the construction of a harbor at this point.

The present survey was restricted to work necessary for locating and estimating for a full improvement of this vicinity, and was made by

Assistant G. A. M. Liljencrantz under my direction, whose report, with maps* and estimates showing the works proposed by me, is herewith.

There has been no material change in the condition of this vicinity in the past twenty years, except a gradual recession and shoaling of the so-called lake and river.

Wolf Lake is one of a series of slight depressions between Grand and Calumet rivers and Lake Michigan, covering an area of 3 square miles, more or less, and of an average depth of about 2½ feet, with a maximum depth of about 4 feet, bordered by a growth of sedge and weeds. Its old outlet into Lake Michigan is closed by a bar near its mouth. This outlet—Wolf River, 1 mile, approximately, in length—averages 5 feet, perhaps, in depth, with an occasional deeper hole. It is crossed by four railroad bridges and one street highway bridge. Neither Wolf Lake nor Wolf River is a navigable water of the United States, but the submerged lands are all private property, and parts of them are now being filled in by the owners to make land.

There are no manufacturing establishments or enterprises requiring transportation by water within a mile of the borders of Wolf Lake, nor establishments of any kind other than three ice houses along its banks.

The act of Congress is so indefinite that I am unable to decide its intent. There is no navigation on Wolf Lake and River, and navigation by other craft than rowboats with flat bottoms and slight draft is impossible on Wolf Lake. To adapt Wolf Lake and River to such navigation as may be possible in connection with Lake Michigan without creating a navigable artificial system requires only the excavation of a trench wide enough for the passage of a rowboat across the bar at the mouth of Wolf River and 2 feet deep, at an expense of about $50, which can not be the intent of Congress in ordering the survey.

I have therefore laid out a harbor that is now demanded by the general navigation of Lake Michigan, to accommodate the largest as well as the smallest vessels, and as the act relates to the navigation of Wolf Lake and River, which lie inland, I have projected the work from deep water in Lake Michigan to the southern extremity of Wolf Lake. All this work within the shore line is located on private property, and cuts five highways where expensive swing bridges must be built by the United States unless the owners of these highways voluntarily assume the cost. No estimates are made for rights of way nor damages by reason of the work.

PROPOSED IMPROVEMENTS.

It is proposed to construct an entrance to the river and lake, extending from 21 feet in Lake Michigan, between piers 300 feet apart, by dredging to a depth of 20 feet; to deepen, widen, and straighten Wolf River; to construct five swing bridges across the channel with draw-spans of 100 feet each, and to build bulkheads or docks in the immediate vicinity of these bridges; to construct a turning or winding basin in Wolf Lake, and to dredge a channel 20 feet deep and 300 feet wide, 7,400 linear feet, in Wolf Lake.

The detailed estimates are given in Mr. Liljencrantz's report and may be stated as follows:

1. From shore line to deep water in Lake Michigan	$274, 868
2. From shore line to first bridge	25, 190
3. Through the four railroad bridges	356, 840
4. Dredging Wolf River and constructing one street bridge	333, 344
5. Dredging channel and basin in Wolf Lake	404, 800
Total	1, 395, 042

* One not printed.

The cost of the improvement of this vicinity may then be estimated at somewhere between $50 and $1,395,042, depending upon the character of the navigation to be subserved and the extent of the improvement.

I do not know any public interest that at this time may be subserved by the construction of a harbor at this point. It is not known that any interest, public or private, engaged in or dependent upon transportation by water demands the construction of a harbor here. The lands in the close vicinity are all vacant when not occupied by roadbeds and ice houses, and nine-tenths are owned by not exceeding ten individuals and corporations. The city of Hammond, Ind., desires a channel to Lake Michigan, but its industries are not situated on Wolf Lake. A channel by way of Wolf Lake would be their direct outlet.

Undoubtedly a capacious harbor may readily be constructed here, and, should it be built, the lands bordering the lake would be much increased in value and enterprises that could use the harbor facilities would perhaps spring up. Whether the increase in values of lands and the uses of the harbor would be of such general benefit to the people of the United States as to justify the cost, is a matter for the consideration of Congress. This locality is about 3 miles from the Calumet Harbor and 15 miles from Chicago Harbor. Calumet River has been improved farther than it has been docked by landowners, and its capacity for handling commerce has not been even approximately reached.

In my opinion the improvement of the navigation of "Wolf Lake and River," Indiana and Illinois, "with reference to their navigation in connection with the waters of Lake Michigan," is not now a public necessity, and that the locality at this time is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. L. MARSHALL,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, December 29, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur with Major Marshall in the opinion that the "improvement of the navigation of Wolf Lake and River, Indiana and Illinois, with reference to their navigation in connection with the waters of Lake Michigan, is not now a public necessity, and that the locality at this time is not worthy of improvement by the General Government."

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., December 14, 1896.

MAJOR: I have the honor to submit herewith a report on an "examination of Wolf Lake and River, Illinois and Indiana," made under your direction in pursuance of an act of Congress of June 3, 1896:

The examination was made between the 15th and 23d of October last and consisted in—

1. Soundings taken in Lake Michigan opposite the former outlet of Wolf River

(there is none now) between the shore and a depth in the lake of 20 feet below low water of 1847, which depth was found at a distance of approximately one-half mile from the shore.

2. Determining the location and elevation of the four railroads running along the lake shore and crossing, on timber trestles, the river bed.

3. Locating the Indiana boulevard and bridge, over which runs a double-track electric railroad, the Hammond, Whiting and East Chicago Electric Road.

4. Locating the contours of and taking soundings in Wolf River from the Pittsburg, Fort Wayne and Chicago Railway to Wolf Lake, together with the ice houses and some of the smaller buildings in the immediate vicinity.

5. Locating the east shore of Wolf Lake and running zigzag lines of soundings in this lake, and finally—

6. Locating the boundary line between the States of Illinois and Indiana and some works of improvement made at the southerly end of the river; also locating some of the railroads in the vicinity.

SOUNDINGS IN LAKE MICHIGAN.

The area covered by soundings was 1,300 feet in the direction of the shore line and 2,700 feet out from the shore, or about 80¼ acres. The direction of the shore line at this place is about N. 40° W., i. e., running in a nearly northwesterly direction. The 20-foot contour (referring to Chicago city datum) was reached at an average distance of 2,400 feet from shore and runs nearly parallel to it. The bottom, as far as ascertained, is composed of sand, but clay will undoubtedly be found below, as is usual along this part of the lake shore. At the time of the sounding the water level was 0.5 foot below low water of 1847.

INSHORE WORK.

From the shore line to the first railroad, the Chicago, Lake Shore and Eastern Railway, is a distance of 300 feet. This is at present a single-track road, but a second track is to be built, the grading being nearly done. All the other three are double-track roads. The different roads are at about the following distances apart along the proposed line of improvement: Between the first, the northernmost, and the second, 140 feet; between the second and third, 120 feet; between the third and fourth, 190 feet.

The roads and their track elevations above Chicago city datum at the northwesterly ends of their trestles respectively are—

	Elevation.
1. Chicago, Lake Shore and Eastern Railway (or Hammond and Blue Island Railroad)	8.04
2. Baltimore and Ohio Railroad	9.34
3. Lake Shore and Michigan Southern Railway	9.93
4. Pittsburg, Fort Wayne and Chicago Railway	8.29

Near the old mouth of the river is a pile pier 500 feet long, built by the Knickerbocker Ice Company, out into the lake. At the foot of this pier is a device for pumping water into Wolf River from Lake Michigan in the interest of the ice houses along the river banks. For the same purpose the connection of Wolf Lake with the Calumet River, via Hyde Lake, has been closed up, thus keeping the water level in Wolf Lake independent of the outside fluctuations. As is usual in this vicinity, the shore north of the pier has advanced, about 250 feet since 1879, and that south thereof has retreated during the same period to the extent of about 75 feet, at a point 500 feet south of the pier.

WOLF RIVER.

There is at present no resemblance of a river save a nearly dry river bed with a few shallow-water pools therein north of the Pittsburg, Fort Wayne and Chicago Railway Bridge. Soundings were taken from south of this bridge.

About 700 feet south of the said bridge the river is crossed by the Indiana boulevard, which has a fixed bridge, over which runs a double-track electric road, leading to Hammond and Whiting. South of the Boulevard Bridge the river makes a sharp turn to the southeast, and 600 feet farther again to a southwesterly course, running in about this direction to the second ice house, located at a point formerly the south limit of the river proper. The artificial formation of land in the lake has, however, extended the channel in a due south direction about 2,300 feet farther into the lake. The average depth of the river channel is from 4 to 5 feet, with in some places greater, in others less depth. The bottom consists chiefly of mud, with underlying sand and probably clay.

The commercial enterprises along the river are the three Knickerbocker ice houses and their auxiliary works, such as slips, etc.

WOLF LAKE.

Wolf Lake is divided into nearly two equal parts by the Illinois and Indiana State line, the greater part being in the State of Illinois. The average depth of the lake was 2½ feet at the stage of water found at the time of taking soundings. Reduced to Chicago City datum, it would be 0.6 foot less. The slope of the bottom along the shores is so slight as to make the determination of a definite shore line impracticable. Weeds and rushes grow in abundance along the shores. This is also the case more or less in all parts of the lake, but a small steam craft provided with revolving knives is engaged in cutting down these weeds in the interest of the ice-making. The bottom of the lake consists of sand, and the water therein is generally clear. The original area of the lake has been reduced by, in round numbers, 126 to 128 acres, 28 of which through the construction of the land at the mouth of river and 98 to 100 acres through the construction, in the lake itself and along its easterly shore, of the Hammond and Blue Island Railroad, and, at the south end, of a branch of the Pittsburg, Fort Wayne and Chicago Railway. As heretofore stated, the connection between this lake and Calumet River, via Hyde Lake, has been closed by a dam to maintain a higher level in Wolf Lake. At the south end of the lake and on its east shore is the Hammond Packing Company's ice house. No other commercial enterprise of any kind was found in the immediate vicinity of the lake.

MAPS.

Two maps have been prepared to show the results of the examination. The first shows Wolf River, with soundings therein, principal buildings at or near its banks, and the roads crossing its bed; also soundings in Lake Michigan at the north end of the river and soundings in the north part of Wolf Lake at the south end of the river; also, in red ink, the proposed improvements of the river with a harbor entrance from Lake Michigan. This map is made to a scale of 1 inch = 150 feet.

The second map shows the territory including Wolf Lake and river, together with the adjoining lakes, the contours of which latter, as well as of the west shore of Wolf Lake, were copied from the "Sheffield Association's Survey of 1874." It also shows the railroads crossing the neighboring territory and the proposed improvements. This map is made to a scale of 800 feet to the inch.

The soundings in Lake Michigan have reference to the "plane of reference for the coast charts of Lake Michigan," in compliance with orders from the Chief of Engineers, United States Army, dated December 4, 1893. This plane is 3.06 feet below high water of 1838 and 1.8 feet above Chicago City datum, or low water of 1847.

The soundings of Wolf Lake and river, neither of which is connected with either Lake Michigan or Calumet River, are referred to the water level at the time of the survey, which was 0.6 foot above Chicago City datum. The water level in Lake Michigan was at the same time 0.5 foot below the same datum plane.

PROPOSED IMPROVEMENTS.

The proposed improvements come under three heads, viz:

1. The harbor entrance,
2. The river channel, and
3. The inner harbor, or the improvement of Wolf Lake.

It is proposed to make the improvements conform to the advanced demands of the present day and to what might reasonably be expected as the needs of the near future.

A channel 20 feet deep below low water of 1847 and 300 feet in width is therefore provided for, to be formed by the construction of two parallel piers about perpendicular to the shore line. The existing pier might possibly have been made use of, but in the first place this would make a very undesirable angle at the crossing of the railroads, and in the second place the said pier is hardly adequate for the needs of a first-class harbor. It is proposed to construct the westerly pier from the shore line to the 20-foot contour by building a pile breakwater 20 feet wide, with sand-tight "Wakefield sheet piling," a distance of 1,150 feet, or to the 14-foot contour; thence a 24-foot wide crib pier 900 feet long, or to the 16-foot contour; and, finally, a 30-foot wide crib pier 400 feet in length, reaching to the 20-foot contour. The easterly pier will consist of a 20-foot pile breakwater 1,300 feet long, or from the shore to the 14-foot contour, and thence of a 20-foot wide crib pier 500 feet in length, or to the 16-foot contour—all the crib work to rest on a pile foundation and the channel to be dredged to a depth of 20 feet to within 25 feet from the piers, which are 300 feet apart.

Between the shore line and a point 50 feet south of the Pittsburg, Fort Wayne and Chicago Railway track it is proposed to construct docking 900 linear feet along the westerly and 800 linear feet along the easterly side of the channel; four double-track railroad swing bridges, with double draws of not less than 100-feet wide openings each in the clear, the channel to be dredged as between the outer piers.

From this point southward only dredging is provided for, to a depth of 20 feet and a width of 300 feet, to and through Wolf Lake, except that a highway bridge of similar kind and dimensions as the railroad bridges is provided for at the crossing of the Indiana boulevard. A turning basin is proposed at the north end of Wolf Lake, which, together with the 300 feet of the river channel, will be 600 feet square.

The proposed channel lines along the river are made to conform to the natural shores as near as practicable, except in two places, to wit, south of Indiana boulevard and near the second ice house, at which places it was found necessary to straighten the channel, as shown on the maps.

GENERAL REMARKS.

The town of Hammond, with probably something like from 8,000 to 10,000 inhabitants, has projected the extension of its corporate limits to the shore of Lake Michigan, but, owing to opposition on the part of Whiting, a short distance to the east of the proposed Wolf Lake Harbor, the annexation has not yet become an accomplished fact. The town limits reach, however, at present near to the south shores of Wolf Lake, and the town would probably be benefited by a short water communication with Lake Michigan. It is also claimed that the Standard Oil Company, located at Whiting, would derive benefit from a well-protected harbor in the immediate vicinity.

ESTIMATES.

The estimated cost of the proposed improvement as a whole is divided into five sections, as follows:

A. From the shore line to deep water in the lake—	
2,450 linear feet pile breakwater, at $30	$73,500
500 linear feet crib work, 20 feet wide, at $58.80	29,400
900 linear feet crib work, 24 feet wide, at $70.20	63,180
400 linear feet crib work, 30 feet wide, at $98	39,200
223,000 cubic yards dredging (to 20 feet depth), at 20 cents	44,600
	249,880
Add 10 per cent for contingencies	24,988
Total	274,868
B. From the shore line to the first railroad bridge—	
450 linear feet dock, at $12	5,400
87,500 cubic yards dredging, at 20 cents	17,500
	22,900
Add 10 per cent for contingencies	2,290
Total	25,190
C. Through the railroad bridges—	
1,250 linear feet of dock, at $12	15,000
4 railroad swing bridges, at $71,500 each	286,000
117,000 cubic yards dredging, at 20 cents	23,400
	324,400
Add 10 per cent for contingencies	32,440
Total	356,840
D. Dredging the river to Wolf Lake, 300 feet in width—	
7,400 linear feet dredging=1,315,200 cubic yards, at 20 cents	263,040
1 highway swing bridge	40,000
	303,040
Add 10 per cent for contingencies	30,304
Total	333,344

E. Dredging channel and basin in Wolf Lake—

1,840,000 cubic yards dredging, at 20 cents	$368,000
Add 10 per cent for contingencies	36,800
Total	404,800

AGGREGATE ESTIMATE.

For Section A	$274,868
For Section B	25,190
For Section C	356,840
For Section D	333,344
For Section E	404,800
Grand total	1,395,042

I am, Major, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Maj. W. L. MARSHALL,
Corps of Engineers, U. S. A.

APPENDIX J J.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA, AND OF RIVERS AND HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

REPORT OF CAPT. C. McD. TOWNSEND, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Michigan City Harbor, Indiana.
2. St. Joseph Harbor, Michigan.
3. St. Joseph River, Michigan.
4. South Haven Harbor, Michigan.
5. Saugatuck Harbor, Michigan.
6. Kalamazoo River, Michigan.
7. Holland (Black Lake) Harbor, Michigan.
8. Grand Haven Harbor, Michigan.
9. Grand River, Michigan.
10. Muskegon Harbor, Michigan.
11. White Lake Harbor, Michigan.
12. Pentwater Harbor, Michigan.
13. Ludington Harbor, Michigan.
14. Manistee Harbor, Michigan.
15. Harbor of Refuge at Portage Lake, Manistee County, Michigan.
16. Frankfort Harbor, Michigan.
17. Charlevoix Harbor, Michigan.
18. Petoskey Harbor, Michigan.
19. Removing sunken vessels or craft obstructing or endangering navigation.

SURVEYS.

20. South Haven Harbor, Michigan.
21. Holland (Black Lake) Harbor, Michigan.
22. Ludington Harbor, Michigan.
23. Charlevoix Harbor, Michigan.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., July 20, 1897.

GENERAL: I have the honor to submit herewith the annual reports relative to the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

J J 1.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

The improvement at this harbor dates from 1836, and has resulted in establishing an "inner harbor" for local commerce and partly completed an "outer harbor," designed to facilitate entrance to the former and to serve as a harbor of refuge.

The inner harbor.—This has been made by widening and deepening Trail Creek and protecting the dredged channel by revetments and piers extending to deep water in Lake Michigan. Before improvement the creek was a narrow, shallow stream, whose mouth was obstructed by a bar through which a crooked channel from 3 to 4 feet deep could be found under favorable conditions. The work done between 1836 and 1869 gave a good entrance channel with a depth of 12 feet at mean stages of water in Lake Michigan.

From 1869 to 1882 nothing was done on this portion of the harbor except to make occasional repairs to the piers and dredge the channel as needed to maintain the requisite navigable depth. In 1882 the project of operations was modified to provide for extending the harbor upstream by dredging so far as the local authorities or property owners might build substantial revetments of approved design; in this way the total length of the inner harbor had grown to be about 1¾ miles (9,159 feet) by the beginning of the last fiscal year. The channel depth at entrance was then 13.5 feet, and above the entrance varied from 12 to 13 feet. The total length of piers and revetments built by the Government was 4,844 feet, the width of channel way between them being 225 at entrance and narrowing to 100 feet about 500 feet above. The total expenditure on the inner harbor from 1869 to June 30, 1896, was $418,263.11.

No work was done during the past fiscal year except minor repairs to piers and the usual care and maintenance of plant.

Expenditures during the year on account of the inner harbor amounted to $1,330.35, making the total cost of original improvements and their maintenance from 1836 to June 30, 1897, aggregate $419,593.46.

The condition of the work on the last-named date was as follows: The west pier had a length of 2,157 feet, as built by the Government. The inner section from Station 0 to Station 7+85 has long been occupied by private parties, and is in very poor condition; but the necessary repairs should be made by the occupants or owners of abutting property, as in all other parts of the interior channel. The outer section, comprising a length of 1,372 feet, must be cared for by the Government, and needs some minor repairs to keep it in serviceable condition. The east pier has a length of 1,415 feet, of which the inner 670 is in front of private property and in fair condition. The outlying section, about 745 feet long, is completely decayed above water, and about 115 feet of its outer end is gone to a depth of from 1 to 7 feet below the water surface. The revetment above the east pier is in a dilapidated condition for 1,282 feet of its length. It was built by the United States in 1869–70, and should also be maintained by the owners of the adjoining property. The channel depth at entrance was 13 feet, and inside it was 12 feet, though in some places of insufficient width.

The estimate for the inner harbor for 1899 is as follows: For minor repairs of piers, dredging, and contingencies, $7,500.

Amount appropriated and expended from 1836 to 1869, inclusive	$287,388.92
Original estimated cost of project for inner harbor, 1870, revised in 1892	131,375.00
Whole amount appropriated, 1870 to June 30, 1897	144,375.00
Whole amount expended, 1870 to June 30, 1897	132,209.69

Money statement.

July 1, 1896, balance unexpended	$13,495.66
June 30, 1897, amount expended during fiscal year	1,330.35
July 1, 1897, balance unexpended	12,165.31
July 1, 1897, amount covered by uncompleted contracts	4,000.00
July 1, 1897, balance available	8,165.31
Amount that can be profitably expended in fiscal year ending June 30, 1899	7,500.00
Submitted in compliance with requirements of sections 2 of rivers and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Contract in force for improving inner harbor at Michigan City, Ind.

William A. Starke, dredging, dated March 26, 1897; approved April 9, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

The outer harbor.—The construction of the outer harbor began under a project adopted in 1870, which provided for an outer basin protected by a breakwater of timber cribs filled with stone and located east of the entrance to the inner harbor. In 1882 the project was modified so as to increase the area sheltered by extending the breakwater in a northerly direction and constructing an exterior breakwater to the west of the entrance to the inner harbor, designed to have a length of 2,000 feet. At the close of the last fiscal year there had been completed (1) a pile pier 1,225 feet long, extending in a northerly direction from the shore and closing the basin on the east; (2) a crib breakwater 30 feet wide, extending westwardly from the lake end of the pile pier for a distance of 1,411 feet and covering the basin on the north; (3) the "breakwater pier," a crib structure 30 feet wide, extending northward from the west end of the crib breakwater for a distance of 505 feet; (4) 700 feet of the "exterior breakwater."

The total amount expended in constructing and maintaining the works comprising the "outer harbor" from the inception of the project of 1870 to June 30, 1897, is $753,960.46, of which $1,210.47 was expended during the last fiscal year.

When, in 1882, the existing project for the construction of the harbor of refuge was adopted the draft of vessels navigating this portion of Lake Michigan was but 12 feet. With the increase in the dimensions of vessels a modification of the existing project has become necessary. A board of engineer officers, convened by Special Orders No. 8, Headquarters Corps of Engineers, February 16, 1897, recommended a change in the location of the outer breakwater. Their report is appended. The only work done during the past fiscal year has been to repair injuries to the decking of the breakwater, caused by storms. Further operations have been deferred awaiting Congressional action on the report of the Board.

The estimate for 1899 is as follows: For building 800 linear feet of breakwater, $120,000; for maintenance and repairs of about 3,850 linear feet of existing piers and breakwaters (a great portion of which is from twenty to twenty-six years old), and for engineering expenses and contingencies, $20,000; in all, $140,000. Dredging the outer basin may properly be deferred until the outer breakwater is completed and the old east pier is restored to a serviceable condition.

The harbor is in the collection district of Chicago, Ill., which city is the nearest port of entry. The Light-House Establishment maintains a fifth order coast light on the main shore. There is a life-saving station at the shore line east of the harbor entrance.

Original estimated cost of project for outer harbor, 1870	$324,421.40
Increase by cost of repairs and maintenance to 1882	90,067.10
Project for outer breakwater, including dredging of outer basin, 1882	587,000.00
Total estimate	1,001,488.50
Whole amount appropriated and allotted, 1870 to June 30, 1897	841,875.00
Whole amount expended, 1870 to June 30, 1897	753,960.46

Money statement.

July 1, 1896, balance unexpended	$89,125.01
June 30, 1897, amount expended during fiscal year	1,210.47
July 1, 1897, balance unexpended	87,914.54
Amount (estimated) required for completion of existing project	159,613.56
Amount that can be profitably expended in fiscal year ending June 30, 1899	140,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Michigan City, Ind.

Date.	Outer harbor.	Inner harbor.	Total.
July 4, 1836			$20,000.00
March 3, 1837			30,000.00
July 7, 1838			60,733.59
June 11, 1844			25,000.00
August 30, 1852 *			20,000.00
March 2, 1855 (claim of J. R. Bowes)			470.33
June 23, 1866			75,000.00
July 25, 1868 (allotment)			25,000.00
April 10, 1869 (allotment)			31,185.00
July 11, 1870	$25,000.00		25,000.00
March 3, 1871	15,000.00		15,000.00
June 10, 1872	50,000.00		50,000.00
March 3, 1873	50,000.00		50,000.00
June 23, 1874	50,000.00		50,000.00
March 3, 1875	50,000.00		50,000.00
August 14, 1876	35,000.00		35,000.00
June 18, 1878	50,000.00	$25,000.00	75,000.00
1878 (allotment)	2,500.00		2,500.00
March 3, 1879	40,000.00		40,000.00
June 14, 1880	40,000.00	15,000.00	55,000.00
March 3, 1881	20,000.00	25,000.00	45,000.00
August 2, 1882	60,000.00	20,000.00	80,000.00
July 5, 1884	40,000.00	10,000.00	50,000.00
August 5, 1886	54,375.00	1,875.00	56,250.00
August 11, 1888	90,000.00	5,000.00	95,000.00
September 19, 1890	50,000.00	7,500.00	57,500.00
July 13, 1892	30,000.00	15,000.00	45,000.00
August 17, 1894	20,000.00	10,000.00	30,000.00
June 3, 1896	70,000.00	10,000.00	80,000.00
Total	841,875.00	144,375.00	1,273,638.92

* Amount carried to surplus fund, $5.15.

Abstract of bids for dredging harbors on east shore of Lake Michigan received and opened March 17, 1897, in accordance with advertisement dated February 15, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	From Charlevoix to Pentwater, Mich.[a]		From White Lake to Holland (Black Lake), Mich.[a]		From South Haven to Michigan City, Ind.[a]	
		Dredging, price per cubic yard.	Transfer of plant, price per mile.	Dredging, price per cubic yard.	Transfer of plant, price per mile.	Dredging, price per cubic yard.	Transfer of plant, price per mile.
1	Green Bay Dredge and Pile Driving Co., Green Bay, Wis	$0.13½	$2.00				
2	Green's Dredging Co., Chicago, Ill	.15	2.00	$0.13	$2.00	$0.13½	$2.00
3	William A. Starke, Milwaukee, Wis					.13	2.00
4	C. E. Mitchell & Co., Ludington, Mich	.14	2.25	.14	2.25	.13¾	2.25
5	Arthur H. Vogel, Milwaukee, Wis	.15	2.50	.14	2.50	.14	2.50
6	Norris G. Dodge & Son, Chicago, Ill	.14½	2.50	.14½	2.50	.15	2.50
7	Chicago Dredging and Dock Co., Chicago, Ill	.15	2.50	.15	2.50	.15	2.50
8	John Smith, Manistee, Mich			.15	2.00		
9	Carkin, Stickney & Cram, Detroit, Mich	.16	3.00	.16	3.00	.16	3.00
10	Luther E. Allen, Detroit, Mich	.18	2.00				

[a] Contracts entered into March 26, 1897.

COMMERCIAL STATISTICS, MICHIGAN CITY HARBOR, INDIANA, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,153	208,617	1893	1,577	589,863
1889	795	169,193	1894	389	119,920
1890	921	172,817	1895	343	91,016
1891	837	168,654	1896	437	106,543
1892	1,391	443,055			

NOTE.—No record is kept at Michigan City of traffic between that port and Chicago.

Receipts by vessel, 1896.

[Compiled from statements furnished by the collector of customs at Chicago, Ill., and the Michigan City Harbor Board.]

Articles.	Tons.	Articles.	Tons.
Coal	4,450	Potatoes	99
Fish	47	Salt	8,820
Leather	22	Shingles	1,431
Lumber	96,776	Ties	8,583
Machinery	700		
Merchandise, general	108	Total	121,036

MODIFIED PROJECT FOR IMPROVING OUTER HARBOR AT MICHIGAN CITY, IND.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 12, 1897.

GENERAL: In a letter from your office to Lieut. Col. G. J. Lydecker, dated August 14, 1896, approving the project for the expenditure of $70,000 appropriated for the outer harbor at Michigan City, Ind., authority is granted to submit a modified project for the outer breakwater in advance of any contract being let for further breakwater construction. I have therefore to submit the following:

The works of improvement at Michigan City are divided into an inner and outer harbor. The inner harbor is merely the enlargement of Trail Creek, with the usual pier construction to protect its outlet into Lake Michigan. The outer harbor consists of an outer basin, located east of the entrance to the inner harbor, which was constructed from 1870 to 1885, and an exterior breakwater to the west of the entrance to the inner harbor, which is designed to have a length of 2,000 feet, of which 700 feet have been completed. The location of the various works is shown on the accompanying blue print.

The existing project for the outer harbor was adopted in 1882, and its object is to create a harbor of refuge for vessels overtaken by a storm in the southeastern portion of Lake Michigan. The condition of the shore at the time the project was adopted is shown on a map in the report of the Chief of Engineers for 1882, opposite page 2270, part 3. Attention is invited to the fact that north of the outer basin, where the 24-foot contour is shown on the map of 1882, but 12 feet below the zero of the gauge is now found, and at the end of the west pier to the inner harbor a 15-foot contour replaces the one of 24 feet. As the level of the lake has also fallen about 3 feet, these facts indicate a material shoaling since the project was submitted. The exterior breakwater, which was designed to be constructed in water from 24 to 30 feet in depth, if built on the lines adopted will be in depths varying from 19 to 23 feet, the existing water surface being about 2 feet below the zero of the gauge.

In the Report of the Chief of Engineers for 1890, Part 3, opposite page 2666, is given a map of the harbor of Michigan City from surveys of June of that year. From this map it is noted that from 1882 to 1890 the fill in front of the east breakwater was rapid, and behind the west pier slight, while since 1890 in front of the east breakwater the fill has been less rapid, and there has been a large deposit behind the west pier. In 1889 the construction of the west breakwater was begun, and I consider it evident that sand, which prior to 1890 was caught by the east breakwater, now finds an easy entrance to the outer harbor through the interval between the breakwaters, and finds a place of deposit sheltered by the work constructed after that date. Since 1890 the area available for vessels drawing 15 feet has been reduced from 40 acres to 25 acres, and the areas of depths over 18 feet about 25 per cent. The area of the proposed harbor of refuge for vessels of 12 feet draft is now less than it was in 1890 for those drawing 15 feet. A further shoaling is to be apprehended if the work is completed on the lines adopted.

The area available for vessels of 18 feet draft in the proposed harbor of refuge is inclosed between the breakwater and the 20-foot contour for vessels of 15 feet draft between the breakwater and a broken line shown on the blue print. The limits of the 12-foot area are sufficiently indicated by the 15-foot contour.

While the available area of the harbor inclosed by the breakwater has materially diminished since the adoption of the project, the dimensions of vessels plying the lakes have largely increased. Depths of from 15 to 18 feet are now generally demanded for harbors on the eastern shore of Lake Michigan, although in 1882 12 feet was usually considered ample. Vessels of lengths exceeding 300 feet are not infrequent, and some of the first-class freight vessels, such as the *Coralia*, have lengths exceeding 400 feet. At Michigan City a large part of the commerce is in lumber and salt, which is frequently carried in barges or sailing vessels and towed into port.

Not only is this shoaling diminishing the area available for a harbor of refuge, but it is rendering an entrance to the harbor difficult during storms. Depths of 15 feet are found within 200 feet of the east end of the west breakwater, and of 12 feet within 400 feet. No vessel drawing 15 feet would attempt to enter between the piers and turn under the shelter of the west breakwater during a northwest storm. It would be difficult for a vessel drawing 12 feet, particularly if accompanied by a tow.

In the existing project the obstruction to the entrance of the harbor of refuge, caused by the west pier of the inner harbor, is recognized, and its removal is contemplated as soon as the breakwater is completed. The bar which has formed since 1882 along the pier is, however, as serious an obstacle to navigation as the pier itself, and the result of its removal would be to close the entrance to the inner harbor with a sand bar without materially improving the outer harbor. The further proposition of the existing project to dredge the outer basin east of the piers may be dismissed with the remark that any vessel in distress that passes the end of the west pier of the inner harbor without disaster will make no effort to turn until it enters the inner harbor.

It is therefore evident the proposed exterior breakwater, when completed, will be of service as a harbor of refuge only to vessels of light draft, and as the inner harbor has a navigable channel of 13 feet, which it is easier to enter than either of the outer harbors, the value of the exterior constructions on the lines proposed is not apparent.

Another objection is raised by pilots to the existing structures, that during storms they render the entrance to the inner harbor more dangerous than it would be otherwise; that in a northwest storm a current is produced by the west breakwater which tends to throw the head of a vessel entering the port toward the east. While attempting to straighten from this action the bow suddenly plunges into a reverse current while the stern is being pressed to the eastward, which tends to drive the vessel onto the west pier of the inner harbor, and if it escapes this disaster a second reversal of current renders the east pier to the inner harbor a source of danger. During the storm from the north or northeast a vessel can also enter the inner harbor more readily if the west breakwater be removed. That these objections are not groundless is indicated by the construction by the Government of pile fenders at the end of the east pier of the inner harbor (report of Chief of Engineers, 1896, p. 2674), and by the fact that vessels avoid the harbor during storms.

To obviate these objections it has been proposed to close the opening between the breakwaters, placing the entrance to the harbor at AB, the salient of the proposed western breakwater. While by this means the cross currents resulting from northwest storms in the harbor would be destroyed, an obstructed entrance to the inner harbor would be obtained, difficult to navigate in calm weather. A safer entrance to the outer harbor would result, but the area protected from northwest storms would be diminished, and the motion of sand from the northeast which has already formed a shoal along the east breakwater would rapidly extend along the west breakwater and enter the harbor through the proposed opening.

A second proposition has been to extend the west breakwater to the north to a point H on the blue print. This will protect the entrance to the harbor from northwest storms and give a more direct passage to the inner harbor, but will increase the drifting of sand into the harbor during northeast storms and afford little relief to the contracted entrance to the harbor of refuge.

The extension of the east pier to the northwest to the point E would reduce the flow of sand from the northeast. The area of the harbor of refuge can be increased by locating the west breakwater on the line CD. It could then be more readily entered and the danger from cross currents at the entrance to the inner harbor obviated by the removal of the existing west breakwater. Under such conditions the extension of the outer breakwaters to the points F and G would be advisable, to diminish the dimensions of the waves which could enter the harbor during storms from the west to northwest.

The propriety of building a harbor of refuge at this locality having been definitely determined both by the Engineer Department and by acts of Congress, I have the honor to recommend the following modifications of the existing project: To extend the east breakwater to the point E, connect the east pier of the inner harbor to the east breakwater, and to construct the western arm of the west breakwater at CD. The object of connecting the east pier with the east breakwater is, primarily, to avoid the cost of repairs to the works surrounding the outer basin. It will also have a beneficial effect on the currents at the entrance to the inner harbor.

The following estimates of the cost of completing the existing project and constructing the breakwaters on the lines proposed are submitted:

To complete existing project.

1,300 linear feet of cribs, at $125	$162, 500
Dredging outer basin, 875,000 cubic yards, at 12 cents	105, 000
Reconstruction of east breakwater, 1,420 feet, at $25	35, 500
Repairs to eastern inclosure of outer harbor, 1,100 feet, at $15	16, 500
Removal of piers, 1,175 feet, at $20	23, 500
	343, 000
Contingencies	34, 000
Total	377, 000

To complete project recommended.

Opening between east pier and old breakwater, 460 feet, at $25	$11, 500
Repairs to east pier, 700 feet, at $20	14, 000
Extension of east breakwater to E, 1,100 feet, at $130	143, 000
Exterior breakwater CD, 1,500 feet, at $140	210,000
Repairs to west pier, 535 feet, at $4	2, 140
	380, 640
Contingencies	38, 360
Total	419, 000

To extend the breakwaters to the points F and G and remove the existing western breakwater would increase this estimate about $200,000, an expenditure I do not consider justified by the benefits to be derived.

Very respectfully, your obedient servant,

C. McD. Townsend,
Captain, Corps of Engineers.

Brig. Gen. W. P. Craighill,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. Engineer Office, Northwest Division,
New York, February 2, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army.

The great changes that have taken place since the present project was recommended by the Engineer Board of 1882 show a necessity for changes in the project of such a radical nature that I would recommend that the revision of the project for the improvement of the harbor at Michigan City, Ind., be referred to a special board.

This is an exceedingly troublesome problem, and should be carefully studied by a board before any more money is expended upon it.

Henry M. Robert,
Colonel, Corps of Engineers, Division Engineer.

[Second indorsement.]

Office Chief of Engineers,
U. S. Army,
February 11, 1897.

Respectfully submitted to the Secretary of War.

Capt. C. McD. Townsend, Corps of Engineers, presents for approval a modified project for carrying on the work of improving the outer harbor at Michigan City, Ind.

Inviting attention to the views of Col. H. M. Robert, Corps of Engineers, the division engineer, in first indorsement hereon, I have the honor to recommend that a Board of officers of the Corps of Engineers, to consist of Lieut. Col. G. J. Lydecker, Maj. W. L. Marshall, and Capt. C. McD. Townsend, be constituted to consider and report upon the proposed modifications, the Board to meet at Michigan City upon the call of the senior member, and its expenses to be paid from the funds available for improving Michigan City, outer harbor, Indiana.

With the approval of the Secretary, the order constituting the Board will be issued from this office.

JOHN M. WILSON,
Brig. Gen., Chief of Engineers,
United States Army.

[Third indorsement.]

WAR DEPARTMENT, *February 15, 1897.*

Approved as recommended by the Chief of Engineers.

By order of the Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 18, 1897.

Respectfully referred to Lieut. Col. G. J. Lydecker, Corps of Engineers, for consideration and report by the Board of Engineer Officers constituted by Special Orders, No. 8, Headquarters, Corps of Engineers, February 16, 1897.

It is desired that the Board give this matter full and complete consideration and that its report be rendered at as early a date as practicable.

By command of Brig. Gen. Wilson:

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., March 6, 1897.

GENERAL: The Board of Engineer Officers constituted by Special Orders, No. 8, Headquarters Corps of Engineers, February 16, 1897, convened at Michigan City, Ind., pursuant to call of the senior member, at 1.30 p. m., March 4, 1897. After examining the harbor the Board adjourned to meet at 10 a. m., March 5, 1897, at the United States Engineer Office, Chicago, Ill. The Board met pursuant to adjournment, and after an examination of the modified project submitted, and careful consideration, submits the following report:

The projects of 1876 and 1882 for the construction of an outer harbor at Michigan City, Ind., under which work has heretofore been prosecuted at this locality, contemplated the formation of a harbor of refuge not only for vessels trading at this port, but also for any which may be exposed to storms in the southeastern portion of Lake Michigan. The shoaling which has taken place since the projects were submitted has so reduced the area of waterway protected by the proposed works and rendered the entrances to the protected area so difficult that the Board is of the opinion that the construction of a harbor of refuge on the lines proposed will not adequately fulfill the purposes for which it was intended. It has therefore to recommend that the outer western breakwater (EF) be removed, that the eastern harbor pier be extended a distance of 600 feet on the line shown (AB) on the accompanying map, and that a detached breakwater to protect the harbor from westerly storms be constructed on a line also shown on the map (CD), the length of this breakwater at present to be limited to 1,500.

The Board is of the opinion that a harbor constructed on these lines will subserve the needs of commerce for many years. An entrance (BC) between breakwaters is obtained having a width of 650 feet, and there is a space 1,500 feet wide between the southwestern end of the west breakwater and the 15-foot contour. The entrance to the inner harbor is adequately protected from storms, and an ample area afforded in the outer harbor for such vessels as at the present time might seek shelter from storms in this portion of the lake. While a gradual extension of the shore line in this locality is to be anticipated, a further extension of the breakwaters in a northerly direction can readily be made which will protect the entrance between them from sand encroachment, should it ever become necessary. The area protected from storms can also readily be increased by extending the westerly breakwater in a southwesterly direction, if required by the growth of commerce.

The question of closing the entrance to the outer basin the Board considers one of maintenance, which can more properly be considered when the repairs to the existing structures become necessary.

The estimate of the cost of the work is as follows:

1,500 linear feet crib breakwater, at $125	$187,500
600 linear feet crib breakwater, at $115	69,000
	256,500
Contingencies, 10 per cent	25,650
Total	282,150

The exterior breakwater to be constructed of cribs 30 feet wide on a stone foundation, and the extended pier of same width, founded upon piles, in accord with most improved practice.

The material in the western breakwater, the removal of which is recommended, is considered of value in the construction of the breakwaters proposed more than sufficient to pay for its removal.

All of which is respectfully submitted.

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.
W. L. MARSHALL,
Major, Corps of Engineers.
C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

J J 2.

IMPROVEMENT OF ST. JOSEPH HARBOR, MICHIGAN.

The improvement of St. Joseph Harbor has consisted in deepening the St. Joseph River along the front of the city of St. Joseph, protecting its outlet into Lake Michigan by timber piers, and dredging a canal, about 1 mile in length, from the St. Joseph River to the city of Benton Harbor. The object of the improvement is to provide a navigable channel of the depth of 16 feet from Lake Michigan to the upper limits of St. Joseph, and of 13 feet thence to Benton Harbor. When the work was commenced in 1836, the outlet to St. Joseph River was obstructed by a sand bar, through which a shifting and exposed channel existed with depths fluctuating between 3 and 7 feet, while Benton Harbor was without a navigable waterway to the lake. Work was commenced in 1836, and there had been applied to it $460,835.87 to June 30, 1896. At the close of the last fiscal year there was an available depth of 12 feet at the entrance to the harbor and a narrow channel with a depth of 13 feet within. The extent and condition of the pier work at the same time were as follows:

North pier and revetment, comprising 831 feet pile work and 1,182 feet crib work, had a total length of 2,013 feet, and projected 960 feet beyond the shore line; between Stations 4 + 55 and 13 + 78, a distance of 923 feet, this pier was badly dilapidated, had been several times breached and temporarily repaired and its reconstruction was a matter of urgent necessity; the remainder of the work was in good or fair condition, but lacked filling in some parts.

The *south pier*, comprising 606 feet of pile work and 213 feet of crib work, had a total length of 819 feet, and projected 480 feet beyond the shore line. It was in fair condition, but required a large amount of additional filling, the stone throughout the pile section being gone to below the water level.

The work of rebuilding the north pier was done by Government plant and hired labor. The north pier was cut down to the level of the zero of the gauge between Stations 9+22 and 13+78, a double row of sheet piling was driven in front of the old work, secured between guide timbers, to which they were securely bolted, and protected by white oak piles driven 3 feet between centers, and faced by a 10 by 12 inch white oak wale. At distances of 9 feet, a tie rod passes through the entire structure, being bolted through a rear wale placed behind the rear portion of the old structure. The superstructure consists of five courses of white pine timber in the front wall and three in the rear, suitably joined by cross-ties. The work was completed October 10, 1896.

On May 3, 1897, a contract was entered into with Eslow & Munroe for completing the repairs to the north pier. Operations were begun under this contract May 26, but at the close of the fiscal year the only work done was to cut down the old pier and assemble the material required for the new one.

During the fall of 1896 dredging operations were carried on in this harbor with the U. S. dredge *Saginaw;* 52,575 cubic yards of material were removed from the harbor, resulting in temporarily obtaining a channel 80 feet wide and 18 feet deep from the entrance to the harbor to Station 6, a distance of 1,400 feet, a cut of 40 feet width and 16 feet deep in front of St. Joseph and through the Benton Harbor Canal.

Soundings made in April, 1897, showed an insufficient depth along the docks of the Benton Harbor basin, 11 feet on the shoal at the entrance to the Benton Harbor Canal and 13 feet on the shoal outside the north pier. Dredging, under a contract with William A. Starke, dated March 26, 1897, was commenced April 21, and the harbor reopened by May 29, 52,666 cubic yards of material being removed.

The total amount expended in making and maintaining improvements at this harbor from 1836 to June 30, 1897, is $479,043.74, of which $18,207.87 was expended during the last fiscal year.

In order that the projected improvements at this harbor may be accomplished and maintained, it is most important that the piers be promptly extended, and that both sides of the Benton Harbor Canal be protected by substantial and sand-tight revetments. If an entrance depth of 16 feet is to be obtained and kept, it can only be done by carrying the covering piers out to the curve of 18-foot depths beyond the outer bar. Dredging may open the channel, but the first storm that follows is certain to fill it up again, thereby destroying what has been gained at a large expenditure of time and money, for dredging in the open lake is a slow and expensive operation. It is therefore the poorest possible policy to depend upon any outside dredging for the projected 16-foot entrance channel. To carry the north pier to this 18-foot curve requires an extension of 1,000 feet, and it will take double that for the corresponding extension of the south pier. The St. Joseph and Paw Paw rivers make very considerable deposits in the upper part of St. Joseph Harbor when they are at freshet stages, and dredging will always be required to clear the inner harbor of these deposits. The construction of revetments on both sides of the Benton Harbor Canal is necessary for reasonable permanence of any dredged channel there, but these revetments should not be built at the expense of the United States. Unless the local authorities will take the matter in hand and provide for their construction and maintenance in approved condition, it is a question whether the Government should continue to maintain this channel way, as the dredged channel soon fills up with material washed from its unprotected banks. The north side of the canal is revetted all the way up to Benton Harbor, though some parts of the work are old and nearly unservicable, but on the south side there is no revetment worthy of mention. The canal is, in fact, a long, narrow slip, wholly artificial, dredged from the upper end of St. Joseph Harbor to Benton Harbor for local benefit. It is from 85 to 100 feet wide, over 4,000 feet long, and because it is not properly revetted its navigability is maintained only by repeated dredgings, once a year certainly, and frequently twice. So long as this dredging continues to be done by the Government unconditionally, it does not appear likely that the much-needed revetment will be built at local expense. Nevertheless, the records show that when the Government first entered upon the work of dredging there, it was with the understanding that the necessary revetments would be promptly built in just that way.

While there is indicated above the extent of pier construction that is necessary for securing the entrance depth that is designed for this harbor, the present approved project of improvement provides for only 850 linear feet of pier in addition to what is already built. The estimate for pier construction is therefore limited accordingly. The appropriation made by the river and harbor act of June 3, 1896, will probably be absorbed in putting the old piers in safe and serviceable condition, and in doing the large amount of dredging that is required under existing conditions for keeping the harbor open to navigation and commerce.

The estimate for 1899 is therefore as follows: For 850 linear feet of pier extension, $85,000; for dredging and minor repairs of piers, $10,000; making in all, with an allowance of about 5 per cent for contingencies, $100,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a fourth-order revolving coast light on the bluff south of the harbor, and range lights and fog bell on the north pier. There is a life-saving station near the east end of north pier.

Original estimated cost of the work as revised in 1892	$519,113.00
Whole amount expended to June 30, 1897	479,043.74

Money statement.

July 1, 1896, balance unexpended		$32,276.33
June 30, 1897, amount expended during fiscal year		18,207.87
July 1, 1897, balance unexpended		14,068.46
July 1, 1897, outstanding liabilities	$804.66	
July 1, 1897, amount covered by uncompleted contracts	9,038.21	
		9,842.87
July 1, 1897, balance available		4,225.59
Amount (estimated) required for completion of existing project		100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving St. Joseph Harbor and River, Michigan.

July 4, 1836		$20,000	June 23, 1874	$2,000
March 3, 1837		15,000	March 3, 1875	35,000
July 7, 1838		51,113	August 14, 1876	12,000
March 3, 1843		25,000	June 18, 1878	12,000
June 11, 1844		20,000	March 3, 1879	6,000
August 30, 1852 *		10,000	June 14, 1880	8,000
June 28, 1864 (allotment)		15,000	March 3, 1881	10,000
June 23, 1866		6,000	August 2, 1882	12,000
March 2, 1867		23,000	July 5, 1884	15,000
Allotted from harbors on Northwestern Lakes, 1867	$7,500		August 5, 1886	10,000
Transferred in 1870 to Grand Haven Harbor	500		August 11, 1888	12,000
		7,000	September 19, 1890	20,000
July 11, 1870		15,000	July 13, 1892	59,000
March 3, 1871		10,000	August 17, 1894	30,000
June 10, 1872		3,000	June 3, 1896	30,000
			Total	493,113

*Amount carried to surplus fund, 89 cents.

Abstract of bids for repairing Government pier at St. Joseph, Mich., received and opened April 22, 1897, in accordance with advertisement dated March 24, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	1—To cut down and remove old work, 375 linear feet (price per linear foot).	2—To secure in place in the work the following material to be furnished by the Government. White-oak round piles, 96 (price per pile).	White-oak and pine timber, 105,800 feet B. M. (price per thousand feet).	White-pine plank, 36,000 feet B. M. (price per thousand feet).	3—To furnish the following material and secure it in place. White-pine plank, 82,080 feet B. M. (price per thousand feet).	Driftbolts, 14,000 pounds (price per pound).	Screw bolts, 1,455 pounds (price per pound).	Carriage bolts, 2,530 pounds (price per pound).	Tie rods, 5,950 pounds (price per pound).	Spikes, 1,845 pounds (price per pound).	Approximate total.
							Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	
a1	Eslow & Munroe, Charlevoix, Mich	$1.70	$2.90	$5.25	$5.00	$26.00	2	2¼	2¼	2¼	3½	$4,353.55
2	George Cooper, Manitowoc, Wis	1.50	2.00	4.75	3.00	30.00	2.9	2.9	2.9	2.9	2.9	4,575.08
3	John J. Granville, Saginaw, Mich	2.00	4.50	5.50	7.00	25.00	2½	5	5	5	3	4,970.00
4	Nelson J. Gaylord, Ludington, Mich	2.50	3.00	4.50	2.00	33.25	2¼	2¼	2¼	2¼	2¼	5,082.81
5	John M. Allmendinger, Benton Harbor, Mich	3.37	3.00	6.00	4.00	25.50	2	3	3½	3½	2½	5,090.17
6	W. McIvor, Marseilles, Ill	2.00	4.00	6.50	3.75	29.00	3	3½	3½	3	3½	5,139.58
7	Chicago Star Construction and Dredging Co., Chicago, Ill	2.50	1.50	6.50	4.50	34.00	3	3½	3½	3½	3½	5,554.22

a Contract entered into May 3, 1897.

List of contracts in force for improving St. Joseph Harbor, Michigan.

William A. Starke, dredging, dated March 26, 1897; approved April 9, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

Eslow & Munroe, pier work, dated May 3, 1897; approved May 20, 1897; date of beginning, May 1, 1897; date of expiration, October 1, 1897.

COMMERCIAL STATISTICS, ST. JOSEPH AND BENTON HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Vessels entered.		Vessels cleared.	
	Number.	Tonnage.	Number.	Tonnage.
1890	948	131,607	946	131,395
1891	742	215,334	743	215,591
1892	1,726	707,285	1,727	707,785
1893	1,576	1,125,063	1,575	1,125,938
1894	1,100	900,000	1,100	900,000
1895	779	327,384	727	327,837
1896	835	439,031	833	435,033

Receipts and shipments by vessel at St. Joseph and Benton Harbor, Michigan, 1896.

[Compiled from statements furnished by the Graham & Morton Transportation Company, of St. Joseph, Mich., and the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	1,200	Farm products, miscellaneous	1,500
Flour	70,244	Fish	250
Grain	6,500	Flour	5,070
Gravel	750	Fruit	36,000
Hay and feed	5,583	Lime and cement	39,850
Lime and cement	1,430	Live stock	53
Live stock	61	Lumber	1,108
Lumber	62,800	Machinery	300
Machinery	200	Merchandise, general	184,860
Merchandise, general	168,313	Paper	1,000
Paper	1,850	Pig iron	3,395
Pig iron	1,528	Potatoes	1,600
Salt	26,000		
Wood	4,200	Total	274,981
Total	350,659		

In addition to the above, a total of 140,000 passengers was carried by vessels trading at this port.

J J 3.

IMPROVEMENT OF ST. JOSEPH RIVER, MICHIGAN.

The only portion of this stream now navigated is from the mouth at St. Joseph to Berrien Springs, a distance of about 25 miles by river, though the land distance between the two places is but little more than half that. It is very crooked, obstructed by numerous shoals and ripples over which the water flows in thin sheets, and with channel depths of from 24 to 30 inches; the intervening pools are generally from 4 to 6 feet deep, and some of them 6 or even 8 feet.

The river and harbor act of August 11, 1888, appropriated $2,500 for improving the river within the limits above indicated, and a project for its expenditure with a view to obtaining a low-water channel of 3 feet was approved March 27, 1889. The plan of operations provided for removing snags and sunken logs, closing secondary channels by brush and stone dams, and concentrating the flow of water at other points as found necessary by wing dams. The plan has been followed as far as could be with the small sums appropriated for the work, and has provided the anticipated depth of 3 feet at the improved places, but other shoals remain, and the structures already erected, having necessarily been of a light and inexpensive character, are in need of additions and repairs.

During the past fiscal year no work has been done.

The total amount expended on the river to June 30, 1897, is $4,862.02, of which $12.45 was spent during the past fiscal year.

This navigation may be kept up at an expenditure of $500 annually; and if it is to be done the next appropriation should be $1,000 in view of the established custom of making such appropriations once in two years.

The original estimated cost of the work, in 1880, was $11,300.

Money statement.

July 1, 1896, balance unexpended	$650.43
June 30, 1897, amount expended during fiscal year	12.45
July 1, 1897, balance unexpended	637.98
July 1, 1897, outstanding liabilities	46.50
July 1, 1897, balance available	591.48
Amount (estimated) required for completion of existing project	5,800.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	1,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving St. Joseph River, Michigan.

August 11, 1888	$2,500.00
September 19, 1890	1,000.00
July 13, 1892 (allotment)	1,000.00
August 17, 1894	500.00
June 3, 1896	500.00
Total	5,500.00

Whole amount expended to June 30, 1897, $4,862.02.

COMMERCIAL STATISTICS, ST. JOSEPH RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

The steamer *May Graham* (95 tons, load draft, 30 inches) carried passengers and 6,201 tons miscellaneous freight between St. Joseph and Berrien Springs.

An additional steamer, the *Edna* (2 tons), has run up the river from St. Joseph on excursion business, carrying passengers only.

A new river steamer is being built by Drake & Wallace, of St. Joseph, Mich.

J J 4.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

Before improvement by the General Government the citizens of South Haven had constructed piers and revetments at the mouth of the Black River, and thereby obtained a channel into Lake Michigan 6 or 7 feet deep and 85 feet wide. The improvement thus started was taken up by the Government in 1867, under a plan of operations that provided for increasing the channel to a width of 120 feet between piers extended far enough into Lake Michigan to obtain and hold a navigable depth of 12 feet. The original project was subsequently modified to make the entrance width between piers 177 feet and extend the navigable channel upstream to the highway bridge, about half a mile above the piers. The total length of piers and revetments built up to the year 1888 aggregated 3,145 feet, and no extensions have been made to them since that time.

The condition of the harbor works at the beginning of the last fiscal year was as follows:

North pier, comprising 607 feet of crib work, 524 feet pile pier and revetment, and 463 feet sheet-pile revetment, has a total length of 1,594 feet and projects 650 feet beyond the shore line.

South pier, comprising 557 feet of crib work, 143 feet pile revetment, and 854 feet plank-beam revetment, has a total length of 1,554 feet and projects 470 feet beyond the shore line. The plank-beam revetment is badly wrecked in parts, the remainder liable to give way at any time, and all should be rebuilt; but it is believed that appropriations for the improvement of this harbor should no longer be charged with the expense of maintaining this inferior revetment, as the adjoining property is mostly occupied and used for commercial purposes by private parties and corporations.

The depth of water available was 14 feet, resulting from recent dredging.

During the past fiscal year the superstructure of the north pier from Station 4+65 to 9+87 was rebuilt, and of the south pier from Station 8+54 to 9+97, under a contract with Nelson J. Gaylord dated May 28, 1896. No dredging has been required during the past season, and at the close of the year an available channel existed having a minimum depth of 13 feet.

A contract was entered into May 6, 1897, with Eslow & Munroe for an extension of 350 linear feet to the south pier. Material has been collected but no work done. It is proposed to construct at this locality the sand-tight pier revetment invented by Maj. William L. Marshall, Corps of Engineers, and successfully employed by him in the construction of docks and wharves at Chicago.

The total expenditure by the Government in making and maintaining the improvements at this harbor up to June 30, 1897, is $230,828.47, of which $9,185.53 was spent during the last fiscal year.

In order to realize the approved project of improvement at this harbor it is essential that the piers be extended to 15 feet of water in Lake Michigan, which will require additions of 230 and 450 feet to the north and south piers, respectively. The last approved estimates provide for extensions aggregating but 350 feet, less than half what is needed.

The estimate for 1899 is as follows: For 350 feet of pier extensions, $35,000; miscellaneous repairs and dredging, $5,000; contingencies, supervision, office expenses, etc., $5,000; in all, $45,000.

This harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The light-house establishment maintains a harbor light on the south pier. There is a life-saving station near the inner end of the north pier.

Original estimated cost of work, 1866, amended in 1869, 1872, and 1892..	$262,000.00
Whole amount expended to June 30, 1897	230,828.47

Money statement.

July 1, 1896, balance unexpended		$30,357.06
June 30, 1897, amount expended during fiscal year		9,185.53
July 1, 1897, balance unexpended		21,171.53
July 1, 1897, outstanding liabilities	$12.00	
July 1, 1897, amount covered by uncompleted contracts	15,541.78	
		15,553.78
July 1, 1897, balance available		5,617.75
Amount (estimated) required for completion of existing project		45,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		45,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at South Haven, Mich.

March 2, 1867	$43,000	March 3, 1881	$5,000
July 11, 1870	10,000	August 2, 1882	10,000
March 3, 1871	15,000	July 5, 1884	7,500
June 10, 1872	12,000	August 5, 1886	5,000
March 3, 1873	20,000	August 11, 1888	10,000
June 23, 1874	10,000	September 19, 1890	15,000
March 3, 1875	10,000	July 13, 1892	10,000
August 14, 1876	10,000	August 17, 1894	20,000
June 18, 1878	12,000	June 3, 1896	15,000
March 3, 1879	7,500		
June 14, 1880	5,000	Total	252,000

Abstract of bids for pier extension at South Haven Harbor, Michigan, received and opened April 27, 1897, in accordance with advertisement dated March 29, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	Piles for crib foundation, 578 linear feet.	Piles for sheet-pile pier, 5,472 linear feet.	Hemlock timber, 59,902 feet B. M.	White-pine timber, 63,327 feet B. M.	White-oak timber, 3,420 feet B. M.	White-pine plank for decking, 14,493 feet B. M.	White-pine plank for sheet piles, 187,807 feet B. M.	Driftbolts, 9,368 pounds.
		Cents.	*Cents.*						*Cents.*
a 1	Eslow & Munroe, Charlevoix, Mich	35	35	$14.50	$20.50	$35.00	$19.00	$26.00	2
2	John M. Allmendinger, Benton Harbor, Mich	50	23	15.00	26.00	30.00	22.00	27.00	2
3	Nelson J. Gaylord, Ludington, Mich	38	30	15.00	20.00	32.00	18.00	28.00	2.25
4	Chicago Star Construction & Dredging Co., Chicago, Ill	55	22	17.00	25.00	40.00	19.80	24.00	2.5
5	Hausler & Lutz Towing and Dock Co., Chicago, Ill	50	.23	15.00	20.50	35.00	20.50	29.00	2
6	John J. Granville, Saginaw, Mich	55	35	17.00	20.00	30.00	20.00	25.00	2.5

No.	Name and address of bidder.	Screw bolts, 12,108 pounds.	Carriage bolts, 4,723 pounds.	Tie rods, 3,572 pounds.	Spikes, 924 pounds.	Stone filling, 351 cords.	Sand filling, 2,200 cubic yards.	Dredging for crib foundation, 330 cubic yards.	Approximate totals.
		Cents.	*Cents.*	*Cents.*	*Cents.*		*Cents.*	*Cents.*	
a 1	Eslow & Munroe, Charlevoix, Mich	2.25	2.25	3.25	3	$6.50	20	25	$13,041.78
2	John M. Allmendinger, Benton Harbor, Mich	3	3.5	3.5	2.5	6.00	25	30	13,205.22
3	Nelson J. Gaylord, Ludington, Mich	2.25	2.25	2.25	2.25	6.75	24	24	13,323.66
4	Chicago Star Construction & Dredging Co., Chicago, Ill	3.5	3	3.5	3.5	7.50	30	40	13,437.44
5	Hausler & Lutz Towing and Dock Co, Chicago, Ill	2	3	2	4	7.50	20	25	13,443.46
6	John J. Granville, Saginaw, Mich	4	4	4	4	10.00	40	90	15,381.42

a Contract entered into May 6, 1897.

List of contracts in force for improving South Haven Harbor, Michigan.

William A. Starke, dredging, dated March 26, 1897; approved April 9, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

Eslow & Munroe, pier work, dated May 6, 1897; approved May 24, 1897; date of beginning, May 15, 1897; date of expiration, November 1, 1897.

COMMERCIAL STATISTICS, SOUTH HAVEN HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889 (estimated)	1,080	....	1893	3,822	251,730
1890	2,246	128,880	1894	3,246	228,246
1891	2,994	201,380	1895	3,222	238,060
1892	3,060	212,160	1896	1,218	343,016

During the year an additional line of boats was established between this port and Chicago, Ill.

Receipts and shipments by vessels, 1896.

[Compiled from statement furnished by C. J. Monroe, esq., South Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	877	Brick and gravel	1,290
Coal	6,650	Flour	310
Flour	560	Fruit	29,895
Hay and feed	1,500	Hay and feed	500
Hides	302	Leather	320
Iron and machinery	430	Lumber	5,283
Lime and cement	620	Machinery	1,960
Lumber	6,066	Merchandise (general)	7,187
Merchandise (general)	6,438	Potatoes	405
Salt	570	Slabs	1,200
Stone	1,200	Stone	1,270
Tan bark	3,900	Tan bark	1,200
Total	29,113	Total	51,770

In addition to the above, a total of 4,200 passengers was carried by vessels trading at this port.

J J 5.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

This harbor is at the mouth of the Kalamazoo River and had a channel depth before improvement not exceeding 5 feet. Its condition was first improved by a private company, which built two slab piers for confining the river current and thereby obtained a channel depth of 7 feet temporarily. Its further improvement was commenced by the General Government in 1869. The object sought by the present project of improvement was to obtain an entrance channel to the Kalamazoo River of 12 feet depth, protected by piers 200 feet apart, and to extend the same depth to the town of Saugatuck, 3 miles above the entrance of the river into Lake Michigan. From 1869 to 1882 the piers were extended and interior channel revetments constructed until they had a total length of 1,907 feet on the north and 3,863 feet on the south side, all of pile work. Since 1882, appropriations having been too small to keep these structures in repair, they have gone to decay. The navigable channels opened through the harbor from time to time by dredging fill up again very soon after the departure of the dredge. The lake ends of the piers project less than 175 feet beyond the Lake Michigan shore line and are entirely inadequate to maintain the proposed depths at entrance, even if they were in proper repair.

The condition of the harbor works at the beginning of the fiscal year was as follows: The north pier, with a total length of 715 feet of pile work, filling all gone and seas sweeping through the work without obstruction. The south pier projected 175 feet from the shore line, and with the inshore revetments had a total length of 3,863 feet, all pile work. For a distance of 2,525 feet from the outer end this work is a wreck above water and has lost a large part of its filling; farther inside the timber work is in fair condition, but the filling is nearly all gone.

Operations during the past year were limited to dredging. The U. S. dredge *Farquhar* began operations June 30, 1896, and continued work until October 28, assisted from August 7 to 28 by the U. S. dredge *Saginaw;* 75,713 cubic yards of material was removed, resulting in giving a narrow channel 12 feet in depth from the lake to the town of Saugatuck. Soundings in May, 1897, showed that the effect of the dredging had been effaced, as usual, during the winter, but 4 feet being found on the bar in front of the entrance and a narrow channel of 75 feet between the piers. Under a contract with William A. Starke dredging was resumed June 2, 1897, and at the close of the fiscal year 32,675 cubic yards of material had been removed and the harbor was again open to navigation with light-draft boats.

No work having been done on the piers or revetments during the year, they remain practically as they were at the beginning.

The total expenditure for improving this harbor to June 30, 1897, is $158,760.11, of which $5,535.31 was spent during the past fiscal year.

The port of shipment out of this harbor is the town of Saugatuck, 3 miles above the entrance from Lake Michigan, and the natural difficulties in the way of making and maintaining a reliable navigation by the present line of water travel are exceedingly great. The ultimate abandonment of the existing outlet to the Kalamazoo River is authorized in the river and harbor act of June 3, 1896, which provides for commencing work on an alternative project, as follows:

> Improving Kalamazoo River, Michigan, from Lake Michigan to Saugatuck, in accordance with the alternative project submitted January twenty-eighth, eighteen hundred and ninety-six, five thousand dollars.

The appropriation for "Improving harbor at Saugatuck, Mich.," is therefore being applied to maintaining navigation by the present outlet until provision is made for completing the new one.

The estimate submitted for 1899 is therefore as follows:

For maintenance of the old harbor, $10,000.

This harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The light-house establishment maintains a fifth-order coast light on the north side of the entrance and a harbor light near the end of the south pier.

Original estimated cost of the work, 1867, modified in 1869, 1870, 1875, and 1892	$175,699.46
Whole amount expended to June 30, 1897	158,760.11

Money statement.

July 1, 1896, balance unexpended		$14,214.20
June 30, 1897, amount expended during fiscal year		5,535.31
July 1, 1897, balance unexpended		8,678.89
July 1, 1897, outstanding liabilities	$147.31	
July 1, 1897, amount covered by uncompleted contracts	8,000.00	
		8,147.31
July 1, 1897, balance available		531.58
Amount that can be profitably expended in fiscal year ending June 30, 1899		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations for improving harbor at Saugatuck, Mich.

July 25, 1868 (allotment)	$23,900	June 14, 1880	$5,000
April 10, 1869 (allotment)	6,039	March 3, 1881	5,000
July 11, 1870	10,000	August 2, 1882	8,000
March 3, 1871	10,000	July 5, 1884	4,000
June 10, 1872	15,000	August 5, 1886	8,000
March 3, 1873	10,000	August 11, 1888	5,000
June 23, 1874	10,000	July 13, 1892	5,000
March 3, 1875	10,000	August 17, 1894	12,000
August 14, 1876	3,000	June 3, 1896	10,000
June 18, 1878	2,500		
March 3, 1879	5,000	Total	167,439

Contract in force for improving Saugatuck Harbor, Michigan.

William A. Starke, dredging, dated March 26, 1897, approved April 9, 1897, date of beginning April 1, 1897, date of expiration September 15, 1897.

COMMERCIAL STATISTICS, SAUGATUCK HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	262	132,400	1893	626	163,632
1889	314	76,300	1894	862	106,000
1890	178	42,000	1895	1,256	134,948
1891	492	120,000	1896	848	153,190
1892a	.....	.....			

a Not stated.

During the year the Holland & Chicago Line established a line of boats between this port and Chicago, Ill.

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by Messrs. Griffin & Henry, Saugatuck, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Baskets	1,000	Fish	50
Bricks	500	Fruit	12,103
Coal	1,000	Miscellaneous	57
Flour and feed	600	Potatoes	133
Lime, cement, and salt	167		
Lumber	32,125	Total	12,343
Total	35,392		

In addition to the above a total of 7,850 passengers was carried by vessels trading at this port.

J J 6.

IMPROVEMENT OF KALAMAZOO RIVER, MICHIGAN.

The project of improvement adopted in 1896 provides for dredging the river 1¾ miles below Saugatuck and making a new cut through to Lake Michigan, to obtain an entrance channel with a depth of 12 feet. The condition of the river prior to beginning operations under previous projects is explained in the report on "Improvement of Saugatuck Harbor, Michigan." The estimated cost is $150,000. The first appropriation of $5,000, made in the act of June 3, 1896, is insufficient to begin operations. The essential portion of the project is constructing works which will create a new entrance for the river into Lake Michigan.

Any partial cut will be filled by winter storms in the same manner that the existing entrance is, and the entire estimate of cost should be available before work is undertaken.

The estimate submitted for 1899 is therefore $145,000.

Original estimated cost of work, 1896 .... $150,000

Money statement.

July 1, 1896, balance unexpended	$5,000.00
July 1, 1897, balance unexpended	5,000.00
Amount (estimated) required for completion of existing project	145,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	145,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

J J 7.

IMPROVEMENT OF HARBOR AT HOLLAND (BLACK LAKE), MICHIGAN.

The first steps toward establishing a harbor at this place were taken by the citizens of Holland, Mich., by opening a channel having a navigable depth of about 5 feet from Black Lake into Lake Michigan, and protecting it by piers and revetments made of brush and stone. Continuation of this improvement was taken in hand by the General Government in 1867, existing structures strengthened by pile and crib work, and extended until (in 1880) the north pier and revetment had attained a total length of 1,854 feet and the south pier 1,691 feet. They have remained without extension since that time. The approved project calls for a channel depth of 12 feet, but a depth of from only 8 to 9 feet can be maintained while the piers remain in their present condition. Increased depths are attained temporarily by repeated dredging. The piers are not only far too short to protect an entrance channel, but their older portions permit the passage of large quantities of sand through and under them.

The condition of the harbor at the beginning of the fiscal year was as follows:

North pier, comprising 1,137 feet of pile work and 717 feet of crib work, had a total length of 1,854 feet, and projects 510 feet beyond the shore line. The outer end of the pier has been undermined and settled 6.34 feet below its proper level. The section of old crib work between Stations 3+20 and 5+44 was in a very shaky condition, and about to be rebuilt. The rest of the pier was in fair condition, but needed additional stone filling at various points.

South pier, comprising 993 feet of pile work and 698 feet of crib work, had a total length of 1,691 feet, and projects 695 feet beyond the shore line. The pier was in fair condition. Additional filling was required at numerous places.

At the beginning of the fiscal year dredging operations were in progress with Government plant for the restoration of the required width and depth of channel. The work was completed July 14, 1896, and resulted in giving a channel 80 feet wide and 14 feet deep at the then existing stage of water. By the beginning of November the channel had shoaled to 10.5 feet, and the dredge was sent back to the harbor. Dredging was continued until November 23, when navigation ceasing, the plant went to Grand Haven into winter quarters. The amount dredged during the season by the Government dredge was 10,571 cubic yards. In April, 1897, soundings showed that the channel had again shoaled to a depth of 12 feet on the outer bar and 9 feet at the entrance between piers. Under a contract with the Green's Dredging Company, dredging operations were commenced April 23 and completed June 7, resulting in a dredged channel 50 feet wide and 14 feet deep between piers and 75 feet wide and 16 feet deep across the bar.

The result of dredging done during the year was to maintain the channel in a fairly serviceable condition during the time it was most needed for local navigation and commerce.

The total amount expended for improving the harbor to June 30, 1897, was $299,533.76, of which $6,110.70 was spent during the past fiscal year.

The condition of the piers at the close of the year was substantially the same as at the beginning.

The proposed depth of 12 feet can not be maintained until the piers are made sand tight by sheet piling and extended to the 15-foot curve in Lake Michigan, which is now about 350 feet beyond their lake ends; but as no extensions are authorized, its cost is not included in the estimate submitted below. The repairs to the north pier will be undertaken during the next fiscal year.

The estimate for 1899, being simply for doing what is needed to put the present piers in serviceable condition and provide a temporary channel of requisite navigable depth by dredging, is as follows: For sheet piling about 1,000 feet of piers, $8,000; dredging, $4,000; refilling piers and minor repairs, $2,000, making, with an allowance of about 7 per cent for contingencies, a total of $15,000.

The harbor is in the Grand Haven collection district and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a harbor light near the outer end of south pier. There is a life-saving station near the inner end of south pier.

Original estimated cost of the work, 1866, amended in 1873, 1879, 1884, and 1892	$291,615.31
Whole amount expended to June 30, 1897	299,533.76

Money statement.

July 1, 1896, balance unexpended		$11,191.06
June 30, 1897, amount expended during fiscal year		6,110.70
July 1, 1897, balance unexpended		5,080.36
July 1, 1897, outstanding liabilities	$28.00	
July 1, 1897, amount covered by uncompleted contracts	2,636.38	
		2,664.38
July 1, 1897, balance available		2,415.98
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		15,000.00

Appropriations for improving harbor at Holland (Black Lake), Mich.

Black Lake:		**Black Lake—Continued:**	
August 30, 1852*	$8,000.00	March 3, 1881	$6,000.00
June 23, 1866	55,615.31	August 2, 1882	10,000.00
March 2, 1867	51,000.00	July 5, 1884	15,000.00
July 11, 1870	10,000.00	August 5, 1886	5,000.00
March 3, 1871	10,000.00	August 11, 1888	5,000.00
June 10, 1872	10,000.00	September 19, 1890	10,000.00
March 3, 1873	12,000.00	**Holland:**	
June 23, 1874	15,000.00	July 13, 1892	5,000.00
March 3, 1875	15,000.00	August 17, 1894	15,000.00
August 14, 1876	15,000.00	June 3, 1896	10,000.00
June 18, 1878	10,000.00		
March 3, 1879	6,000.00	Total	304,615.31
June 14, 1880	6,000.00		

* Amount carried to surplus fund, $1.19.

Contract in force for improving Holland (Black Lake) Harbor, Michigan.

Green's Dredging Company, dredging, dated March 26, 1897, approved April 14, 1897, date of beginning April 1, 1897, date of expiration September 15, 1897.

COMMERCIAL STATISTICS, BLACK LAKE HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889	1,087	80,790	1893	2,060	315,150
1890[a]			1894	1,816	159,657
1891	2,676	178,300	1895	809	210,299
1892	2,800	200,000	1896	408	269,182

[a] Not stated.

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by W. H. Beach, esq., of Holland, Mich., and the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick and stone	2,860	Coal	634
Coal	2,400	Farm products	220
Flour	50	Flour	5,465
Grain	5,750	Fruit	2,880
Gravel	4,600	Grain	300
Iron and machinery	381	Hay and feed	7,410
Lime and cement	675	Leather	7,930
Lumber	50,028	Lime and cement	65
Merchandise, general	9,600	Live stock	105
Miscellaneous	11,708	Lumber	6,009
Salt	730	Machinery	350
Slabs	4,900	Merchandise, general	2,880
Tan bark	21,300	Miscellaneous	26,200
		Potatoes	525
Total	114,982	Stone	5,000
		Total	65,973

J J 8.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

This harbor is at the mouth of Grand River, which had a shifting channel with a depth of 9 feet at its mouth before improvement, toward which some steps had been taken by the Detroit, Grand Haven and Milwaukee Railroad Company, when systematic work was commenced by the Government in 1867, under an appropriation of $65,000 made in the river and harbor act of June 23, 1866. The project adopted was the usual one of protecting the entrance channel by piers projecting into the lake, and dredging as found necessary to make and maintain the necessary depth. The outflow of the Grand River has done much toward keeping such depth inside of the piers, but it also acts toward carrying sand in suspension until the velocity of current is checked on reaching the lake, sand deposited, and a bar thereby kept constantly forming in advance of the entrance.

At the beginning of the last fiscal year the condition of the harbor was as follows:

North pier and revetment, with a total length of 3,538 feet, comprising 1,411 feet of crib work and 2,127 feet of pile work, projected 1,512 feet beyond the shore line. It was generally in good condition, needing but few minor repairs in its older portions and some additional filling.

South pier and revetment, with a total length of 5,774 feet, comprising 1,507 feet of crib work and 4,269 feet of pile work, projected 1,681 feet beyond the shore line. It was in good condition, though additional filling was required for 1,500 feet from the east end.

Depth of water.—Seventeen and one-half feet at entrance between piers, 21 feet in the southerly approach, and 19 feet in the northerly approach, with 14.1 feet on the crest of the middle ground between them.

Operations during the year consisted in repairs to the south pier at Stations 18 + 15, 28 + 67, 29 + 52, and 30 + 31, where it had been run into by vessels during storms, repairs to the Government storehouse where it had been injured in a storm on July 14, 1896, and dredging, 8,320 cubic yards of material having been removed. The Government fleet and property is placed in winter quarters in this harbor, and a force was employed during the winter and early spring repairing and putting plant in condition for another season's operations.

Soundings made at intervals during the year showed depths varying from 15 to 16 feet in the channel just inside of the piers, and from 17 to 20 feet in the outside channels of the approach.

The mean stage of Lake Michigan as shown by the automatic gauge at this harbor during the year was —1.799 feet; the highest monthly mean was for June, 1897, viz, —0.961; the lowest monthly mean was for December, 1896, viz, —2.233; the maximum gauge reading was +0.09 foot on June 18, 1897, and the lowest reading was —3 feet on August 4, 1896. The mean reading for the month of June, 1896, was —1.711.

The total amount expended in improving this harbor up to June 30, 1897, is $727,265.77, of which $6,764.96 was spent during the last fiscal year.

The general condition of the harbor works at the end of the fiscal year was good, though additional filling was needed at a number of points. The present approved project calls for an extension of 150 feet to the north pier and 100 feet to the south pier; it also calls for plantings to restrict the drift of sand over the piers into the harbor. With the money appropriated by the last river and harbor act, it is probable that the required extension of the south pier can be made, and both piers be put in good repair.

The estimate submitted for 1899 is, therefore, as follows: For 150 linear feet of pier extension, to complete present project, $18,000; for restraining drift of sand over piers and revetments, $7,000; for incidental repairs of piers and revetments, $3,000; making in all, with an allowance of about 7 per cent for engineering, superintendence, and contingencies, $30,000.

This harbor is at the port of entry for the Grand Haven collection district. The Light-House Establishment maintains a fourth-order flashing coast light south of the entrance, and a harbor light, fog signal, and range light on the south pier. There is a life-saving station near the inner end of north pier.

Original estimated cost of the work, 1866, amended in 1880, 1890, and 1892	$804, 366. 15
Whole amount expended to June 30, 1897	727, 265. 77

Money statement.

July 1, 1896, balance unexpended		$38, 865. 34
June 30, 1897, amount expended during fiscal year		6, 764. 96
July 1, 1897, balance unexpended		32, 100. 38
July 1, 1897, outstanding liabilities	$430. 09	
July 1, 1897, amount covered by uncompleted contracts	9, 000. 00	
		9, 430. 09
July 1, 1897, balance available		22, 670. 29
Amount (estimated) required for completion of existing project		45, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1899		30, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Grand Haven, Mich.

August 30, 1852 (mouth of Grand River)	$2, 000. 00	March 3, 1879	$9, 000. 00
June 23, 1866	65, 000. 00	June 14, 1880	50, 000. 00
March 2, 1867 (mouth of Grand River)	40, 000. 00	March 3, 1881	50, 000. 00
April 10, 1869 (allotment)	1, 866. 15	August 2, 1882	40, 000. 00
July 11, 1870	10, 000. 00	July 5, 1884	50, 000. 00
1870 (allotment)	500. 00	August 5, 1886	30, 000. 00
March 3, 1871	6, 000, 00	August 11, 1888	25, 000. 00
June 10, 1872	15, 000. 00	September 19, 1890	75, 000. 00
March 3, 1873	75, 000. 00	July 13, 1892	90, 000. 00
June 23, 1874	50, 000. 00	August 17, 1894	25, 000. 00
August 14, 1876	15, 000. 00	June 3, 1896	20, 000. 00
June 18, 1878	15, 000. 00	Total	759, 366. 15

Contract in force for improving Grand Haven Harbor, Michigan.

Green's Dredging Company, dredging, dated March 26, 1897, approved April 14, 1897; date of beginning, April 11, 1897; date of expiration, September 15, 1897.

COMMERCIAL STATISTICS, GRAND HAVEN HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1, 508	1, 405, 600	1893	761	613, 425
1889	1, 110	649, 370	1894	641	504, 609
1890	1, 172	834, 089	1895	574	482, 822
1891	819	616, 422	1896	883	727, 209
1892	815	693, 835			

Receipts and shipments by vessels, 1896.

[Compiled from statements furnished by the collector of customs and United States Inspector R. C. Duryea, Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Feed	20, 080	Brick	3, 350
Flour	61, 959	Celery	6, 563
Fruit	240	Flour	35
Grain	229	Fruit	2, 002
Lime and cement	2, 738	Lime and cement	436
Lumber	1, 012	Lumber	1, 122
Merchandise, general	11, 788	Merchandise, general	13, 506
Pig iron	41, 101	Pig iron	3, 941
Salt	450	Potatoes	63
Wood	2, 715	Wood	180
Total	141, 972	Total	31, 197

J J 9.

IMPROVEMENT OF GRAND RIVER, MICHIGAN.

From 1881 to 1884 $50,000 was appropriated for Grand River, and expended in excavating a channel 4 feet deep through the shoal crossings below the city of Grand Rapids. The channels dredged have maintained themselves, but the work did not extend a sufficient distance down the river to materially improve navigation.

The existing project, adopted by Congress in the river and harbor act of June 3, 1896, provides for dredging a channel from Grand Haven to Grand Rapids with a depth of 10 feet and bottom width of 100 feet. The distance by river from the piers at Grand Haven to the foot of Ganoes Canal in Grand Rapids is 40 miles. The Grand River drains a basin of about 5,700 square miles. Its extreme low-water discharge is slightly less than 1,000 cubic feet per second, and subject to considerable fluctuation by the opening and closing of sluice gates at the mills along its banks in Grand Rapids. The fall of the river from Grand Rapids to Grand Haven was, during the low water of 1891, 6.2 feet, of which 5.2 feet occurs in the first 12 miles below Grand Rapids. The slope is, however, affected not only by the stage of the river but also by the fluctuations in the level of Lake Michigan. At ordinary stages the river is navigable for vessels of light draft, but at extreme low water channel depths of less than 2 feet are found on some of the bars. The currents of the river are moderate, the amount of sediment carried during high stages comparatively small, and the banks of the river firm. Borings indicate that in the upper portion of the river the soil through which the channel is to be excavated consists of a mixture of sand, clay, gravel, small stones, and occasional bowlders, the glacial drift which covers this portion of the State of Michigan. No stratified rock was encountered to a depth of 14 feet. In the lower portion of the river the material encountered was a mixture of sand, gravel, and shells.

The estimated cost of this work is $670,500. The appropriation of $50,000 by the river and harbor act of June 3, 1896, is being expended in excavating a channel way with a minimum depth of 5 feet and bottom width of 30 feet, within the limits of the adopted project. Proposals were invited for dredging and bids opened on December 21, 1896. The lowest bid received was for dredging at 19½ cents per cubic yard, and for removing bowlders at 65 cents per cubic yard, which were considered too high and the bid was rejected. It was decided to do the work with the Government plant of this district and hired labor. The U.S. dredge *Farquhar* was overhauled and her dipper adjusted so that she could dredge at 6 feet depth. For removing the material dredged a 12-inch sand pump, with its boiler and engines, was erected on a light-draft scow and connected with wrought-iron pipe placed on floats. The hopper from which the pump raises the material is covered by a heavy iron grillage which holds large stones, logs, and other material which might clog or break the pump; such substances are removed by hand as they accumulate. The plant was placed in position and began work May 26. At first the working of the pump was not satisfactory, but after some further adjustment a rate of removal of 100 yards per hour has been obtained—the capacity of the dredge. The number of cubic yards removed to June 30, 1897, was 14,035.

While the dredging is being done at a cost below the lowest bid received, the plant is not considered adapted for either cheap or rapid work. It was constructed from the materials at hand, as the size of the appropriation would not justify the large original outlay which would be necessary for the purchase of a dredge suitable for the river. To enable the work to be done economically, it will require large enough appropriations to justify the purchase of proper plant, either by a contractor or by the Government.

The improvement will be of comparatively little value until depths are obtained that will enable lake vessels to arrive at Grand Rapids. The work is one that can most economically be done under the system of continuous contracts, and could be completed within three years. The estimate submitted for 1899 is, therefore, $250,000.

Whole amount appropriated and expended, 1881 to 1884, inclusive	$50,000.00
Original estimated cost of project adopted in 1896	670,500.00
Whole amount expended on present project to June 30, 1897	8,420.02

Money statement.

July 1, 1896, balance unexpended	$50,000.00
June 30, 1897, amount expended during fiscal year	8,420.02
July 1, 1897, balance unexpended	41,579.98
July 1, 1897, outstanding liabilities	1,409.63
July 1, 1897, balance available	40,170.35
Amount (estimated) required for completion of existing project	620,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving Grand River, Michigan.

March 3, 1881	$10,000
August 2, 1882	15,000
July 5, 1884	25,000
June 3, 1896	50,000
Total	100,000

Abstract of bid for dredging Grand River, Michigan, received and opened December 21, 1896, in accordance with advertisement dated November 21, 1896, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	Earth, etc., price per cubic yard.	Bowlders, price per cubic yard.	Remarks.
		Cents.	*Cents.*	
1	James H. Pheatt, Toledo, Ohio	19¼	65	Rejected.

COMMERCIAL STATISTICS, GRAND RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1896	282	46,750

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by United States Inspector Duryea, Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Pig iron	39,738	Brick	2,275
		Fruit	487
Total	39,738	Pig iron	1,588
		Potatoes	45
		Wood	2,715
		Total	7,110

J J 10.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

Before the Government did any work at this harbor local enterprise had improved the natural outlet of Muskegon Lake by building revetments and slab piers extending into Lake Michigan, whereby a depth of 13 feet was obtained in the channel way so protected; but the entrance to it was obstructed by a bar in front of the piers over which the channel of best water was usually only 6 or 7 feet deep. Operations were commenced by the Government in 1867, with the purpose of remodeling the old slab piers and extending them by crib work to deep water beyond the bar. This was done, and subsequent extensions followed, as necessitated by the steady lakeward progress of the shore line and sand accretions in advance of it. In this way an entrance channel 12 feet deep was maintained, but the width between piers was only 180 feet, and to attempt to enter this narrow entrance was a dangerous matter in stormy weather. The scheme of improvement was therefore modified by building a detached pier parallel to and 300 feet north of the south pier, the inner end of the new structure being about 120 feet north of the lake end of the old north pier; the opening left thereby introduced a new element of danger, which was obviated by removing a length of 316 feet from the end of the old north pier and closing the interval thus made between it and the detached structure by an oblique connecting pier of crib work 330 feet long.

The condition of the harbor piers at the beginning of the last fiscal year was as follows:

North pier, comprising 1,404.1 feet of crib work, 392 feet of pile-pier revetment, and 786.3 feet of new sheet-pile revetment, had a total length of 2,582.4 feet, and projected 1,220 feet beyond the shore line. Three hundred and twenty-two feet of this crib work was built in 1868–69, and the timberwork above water was badly dilapidated.

South pier, comprising 1,100 feet of crib work and 382½ feet of pile work, had a total length of 1,482½ feet, and projected 1,280 feet beyond the shore line. Timber work generally in serviceable condition, except in the pile-pier section. Considerable additional filling was needed in both piers.

The available depth of water in channel between piers was 14.3 feet.

Under the contract with William A. Starke, dated May 1, 1896, a channel was dredged through the harbor, the two central cuts having a depth of 18 feet and two side cuts of 16 feet, the width of cut being 30 feet. Work was begun August 18, 1896, and completed September 29, 27,259 cubic yards of material having been removed. Soundings in May, 1897, show that the harbor had again shoaled so that but a narrow channel remained of a depth of 15 feet. Dredging operations were resumed on June 15, 1897, under a contract with the Green's Dredging

Company, dated March 26, 1897. At the close of the fiscal year 17,581 cubic yards of material had been removed under this contract.

Under a contract with W. McIvor and W. A. Butterfield, dated June 27, 1896, the superstructure of the north pier was rebuilt a distance of 323 linear feet, the south pier faced with sheet piling from Station 0 to Station 3+80, and a pile projection built at the oblique section to the north pier to intercept the run of high seas along the pier and prevent their deflection across the harbor. Work was begun July 8, 1896, and completed December 20, 1896. The Government plant was also employed in driving a row of sheet piling along the north pier from Station 0 to 2+82. The object of placing the sheet piling along both the north and south piers is to prevent the passage of sand through the pile piers near the shore line, and also to enable increased depths to be obtained by dredging, these portions of the piers having originally been designed for only a 12-foot channel at higher lake levels. Minor repairs were also made to other portions of the piers by the Government force, and consisted in replacing timbers that had been displaced, refilling pockets having insufficient stone, and spiking down decking that had been loosened by storms.

On May 27, 1897, a contract was entered into with Robert B. Rice to construct a 200-foot extension to the south pier. This is to consist of two cribs 100 by 30 by 22½ feet on a pile foundation and with a continuous superstructure 6 feet high. Work was begun June 14, and at the close of the fiscal year twenty-two piles had been driven for the foundation of the first crib, and twelve courses of the first and one of the second crib completed.

The total amount expended for improving the harbor up to June 30, 1897, is $430,341.90, of which $15,921.15 was spent during the last fiscal year.

The approved project of improvement calls for extending the north pier 550 feet and the south pier 500 feet, and the commercial interests of the harbor require these extensions as soon as practicable. Funds now available will suffice for putting the old piers in good repair and for building about 200 linear feet of pier extensions.

The estimate for 1899 is therefore as follows: For 800 linear feet of crib piers, to complete north and south piers according to the approved project, $105,000, for dredging channel between piers to full width and depth, $5,000, making, in all, $110,000.

The harbor is in the Grand Haven collection district and the nearest port of entry is Grand Haven, Mich. The light-house establishment maintains a fourth-order coast light on the south shore and a harbor light, fog bell, and range lights on the south pier. There is a life-saving station near the inner end of the north pier.

Original estimated cost of work, 1866, amended in 1869, 1873, 1881, 1884, 1890, and 1892	$589,000.00
Whole amount expended to June 30, 1897	430,341.90

Money statement.

July 1, 1896, balance unexpended		$49,579.25
June 30, 1897, amount expended during fiscal year		15,921.15
July 1, 1897, balance unexpended		33,658.10
July 1, 1897, outstanding liabilities	$244.56	
July 1, 1897, amount covered by uncompleted contracts	18,131.30	
		18,375.86
July 1, 1897, balance available		15,282.24

Amount (estimated) required for completion of existing project	125,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	110,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Muskegon, Mich.

March 2, 1867	$59,000	August 2, 1882	$25,000
July 11, 1870	10,000	July 5, 1884	20,000
March 3, 1871	15,000	August 5, 1886	12,500
June 10, 1872	10,000	August 11, 1888	45,000
June 23, 1874	10,000	September 19, 1890	50,000
March 3, 1875	25,000	July 13, 1892	75,000
August 14, 1876	15,000	August 17, 1894	30,000
March 3, 1879	5,000	June 3, 1896	30,000
June 14, 1880	7,500		
March 3, 1881	20,000	Total	464,000

Abstract of bids for pier extension at Muskegon Harbor, Michigan, received and opened May 19, 1897, in accordance with advertisement dated April 20, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	Foundation piles, 2,176 linear feet (per foot).	Hemlock timber, 317,344 feet B. M. (per 1,000 feet B. M.).	White pine timber, 115,952 feet B. M. (per 1,000 feet B. M.).	White pine plank, 14,544 feet B. M. (per 1,000 feet B. M.).	White oak timber, 480 feet B. M. (per 1,000 feet B. M.).
		Cents.				
a1	Robert B. Rice, Muskegon, Mich	60	$14.00	$21.00	$16.00	$35.00
2	Charles Schoenberg, Muskegon, Mich	55	15.00	20.00	16.00	40.00
3	Nelson J. Gaylord, Ludington, Mich	38	14.50	21.00	18.00	30.00
4	Love & West, Muskegon, Mich	50	15.00	20.00	17.00	22.00
5	Eslow & Munroe, Charlevoix, Mich	55	14.00	21.00	19.00	25.00
6	Chicago Star Construction and Dredging Co., Chicago, Ill	55	16.25	22.00	19.00	35.00
7	Alex. & William McCurdy, Houghton, Mich.	40	16.00	23.00	20.00	30.00
8	Hausler & Lutz Towing and Dock Co., Chicago, Ill	60	16.00	21.00	21.00	60.00
9	Donald A. McLeod, Manistee, Mich	70	18.00	23.00	20.00	45.00
10	A. W. Clark, Muskegon, Mich	60	19.00	24.00	20.00	40.00
11	W. McIvor, Marseilles, Ill	60	18.00	24.00	18.00	40.00

No.	Name and address of bidder.	Stone, 988 cords (per cord).	Drift-bolts, 45,484 pounds (per pound).	Screw bolts, 15,016 pounds (per pound).	Spikes, 977 pounds (per pound).	Dredging for foundation, 300 cubic yards (per cubic yard).	Approximate total.
			Cents.	*Cents.*	*Cents.*	*Cents.*	
a1	Robert B. Rice, Muskegon, Mich	$5.75	2	2½	3	1	$15,481.30
2	Charles Schoenberg, Muskegon, Mich	5.75	2¼	3	3	25	15,787.08
3	Nelson J. Gaylord, Ludington, Mich	6.50	2	2¼	2¼	5	15,846.07
4	Love & West, Muskegon, Mich	6.00	2½	2½	2½	50	16,039.94
5	Eslow & Munroe, Charlevoix, Mich	7.00	3	2¼	2½	20	16,610.92
6	Chicago Star Construction and Dredging Co., Chicago, Ill	6.50	3	3	3	50	17,159.19
7	Alex. & William McCurdy, Houghton, Mich.	7.00	3	3½	3½	50	17,455.52
8	Hausler & Lutz Towing and Dock Co., Chicago, Ill	7.75	2½	3	4	50	18,585.97
9	Donald A. McLeod, Manistee, Mich	7.00	3	3	3	90	19,245.08
10	A. W. Clark, Muskegon, Mich	7.50	2½	2½	3	20	19,439.88
11	W. McIvor, Marseilles, Ill	8.75	3	3½	3½	55	20,815.91

a Contract entered into May 27, 1897.

List of contracts in force for improving Muskegon Harbor, Michigan.

Green's Dredging Company, dredging, dated March 26, 1897, approved April 14, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

Robert B. Rice, pier work, date of contract May 27, 1897, approved June 11, 1897; date of beginning, June 1, 1897; date of expiration, November 1, 1897.

COMMERCIAL STATISTICS, MUSKEGON HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	2,685	....	1893	2,482	834,049
1889	4,626	884,869	1894	1,423	793,184
1890	3,786	649,540	1895	887	441,289
1891	2,886	704,046	1896	981	562,757
1892	4,174	740,021			

During the year a new line for the transportation of freight and passengers was established by the Muskegon and Grand Rapids Transportation Company.

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by Hon. H. H. Holt, Muskegon, Mich., and collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	1,500	Feed	460
Flour	57,818	Fruit	2,511
Grain	2,073	Grain	240
Gravel	696	Hides	75
Hay and feed	9,574	Lime and cement	101
Lime and cement	6,008	Lumber	59,180
Lumber	50,415	Merchandise, general	31,104
Malt	2,918	Pig iron	600
Merchandise, general	49,695	Plaster	4,815
Pig iron	2,309	Salt	130
Salt	290	Slabs	6,502
Steel rails	2,550	Staves	855
Tan bark	200	Wood	3,222
Total	186,046	Total	109,795

J J 11.

IMPROVEMENT OF WHITE LAKE HARBOR, MICHIGAN.

Before improvement by the Government a narrow and crooked outlet from White Lake to Lake Michigan had been improved by local enterprise so as to permit vessels drawing about 5 feet to pass, but when the improvement by the Government was commenced this channel was abandoned, and a straight cut dredged from lake to lake and covered by lateral revetments and piers. This work was in progress until 1882, by which time 3,959 feet of pile and crib work had been placed, of which 2,294 feet was on the north and 1,665 feet on the south side of the channel. No extensions have been made since 1882, but in the meantime 424 feet of revetment has washed away from the White Lake end on the south side and 166 feet from the north side.

The condition of the harbor June 30, 1896, was as follows:

Available depth of water through channel between piers, 8½ feet.

North pier, a close pile structure, 1,515 feet long, projecting 365 feet beyond the shore line. It was generally in fair condition, but some of the piles were broken away and others loosened, and filling was lacking in many places.

South pier, comprising 1,498 feet of close piling and 356 feet of crib work, had a total length of 1,854 feet, and projected 630 feet beyond the shore line. The west end of the outer crib has been undermined, causing it to settle about 3 feet below its proper level. Timberwork above water was in an advanced stage of decay between Stations 3+56 and 7+23. A large portion of the pier needed considerable additional filling.

No work was done on the piers during the year, which therefore remain substantially in the condition above indicated at its end.

Dredging operations under contract with William A. Starke, dated May 1, 1896, were begun July 9 and completed August 14. A channel 120 feet wide was dredged through the bar from 13 to 15 feet in depth, 32,979 cubic yards of material being removed. Soundings taken at the close of the fiscal year indicate that less shoaling than usual has taken place this season, the least channel depth being 12.4 feet.

The total amount expended for improving this harbor to June 30, 1897, is $280,360.26, of which $4,207.70 was spent during the past fiscal year.

The approved project of improvement calls for a navigable depth of 12 feet through the channel between the piers, but that depth can not be maintained until extensions of about 450 and 250 feet are made to the north and south piers, respectively. The last approved plan of operations provides for extensions of 250 and 200 feet. The old piers need considerable additional filling and scattering repairs.

The estimate for 1899 is as follows: For pier extensions aggregating 450 feet, $45,000; for additional filling and general repairs of old piers, $5,000; a total of $50,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a fourth-order flashing coast light on the shore south of the harbor and a harbor light on the outer end of the south pier. There is a life-saving station near the inner end of north pier.

Original estimated cost of work, 1866, amended in 1873, 1884, and 1892	$337,550.00
Whole amount expended to June 30, 1897	280,360.26

Money statement.

July 1, 1896, balance unexpended	$13,397.44
June 30, 1897, amount expended during fiscal year	4,207.70
July 1, 1897, balance unexpended	9,189.74
Amount (estimated) required for completion of existing project	48,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	48,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving harbor at White Lake, Mich.

March 2, 1867	$57,000	March 3, 1881	$7,500
April 10, 1869 (allotment)	44,550	August 2, 1882	12,000
July 11, 1870	20,000	July 5, 1884	10,000
March 3, 1871	20,000	August 5, 1886	10,000
June 10, 1872	10,000	August 11, 1888	10,000
March 3, 1873	7,000	September 19, 1890	17,000
June 23, 1874	10,000	July 13, 1892	5,000
March 3, 1875	10,000	August 17, 1894	5,000
August 14, 1876	5,000	June 3, 1896	5,000
June 18, 1878	12,000		
March 3, 1879	7,500	Total	289,550
June 14, 1880	5,000		

Contract in force for improving harbor at White Lake, Mich.

Green's Dredging Company, dredging, dated March 26, 1897, approved April 14, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

COMMERCIAL STATISTICS, WHITE LAKE HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,408	147,142	1893	200	1,052,036
1889	732	....	1894	195	18,115
1890	579	62,276	1895	231	84,574
1891	405	47,185	1896	245	27,962
1892	392	58,950			

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	690	Fruit	1,222
Hides	88	Lumber	3,119
Lumber	543	Merchandise, general	55,629
Merchandise, general	7,837	Potatoes	108
		Ties	405
Total	9,158	Wood	1,919
		Total	62,402

J J 12.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

The governmental improvement of this harbor was commenced in 1867, but before that time a narrow channel about 4 feet deep had been made by local action to connect Pentwater Lake with Lake Michigan. The project adopted by the Government was to increase the channel width and depth to 150 and 12 feet, respectively, and protect the channel by lateral piers extended into Lake Michigan. Work on this project has been in progress ever since, but the depth of 12 feet has not yet been obtained, except for short periods following dredging, the piers having never been long enough to maintain such a depth.

The condition of the harbor June 30, 1896, was as follows:

The north pier had a total length of 2,223 feet, of which 1,821 is pile revetment and 402 crib work; it projected 610 feet beyond the shore line.

The south pier, comprising 1,391 feet of pile revetment and 721 feet of crib work, had a total length of 2,112 feet and projected 610 feet beyond the shore line.

Dredging operations were in progress at the close of the last fiscal year under a contract with William A. Starke, dated May 1, 1896, and were completed July 2, 1896, 2,539 cubic yards of material having been removed in the two days of the fiscal year, and 25,471 cubic yards under the contract, the dredged channel being to a depth of 13 feet. Soundings taken in the spring of 1897 showed that the usual shoaling had taken place at the ends of the piers during the winter, the prevailing depth being 10 feet. To restore the required depth of navigation in the channel, dredging was resumed May 18, 1897, under a contract with the Green Bay Dredge and Pile Driving Company, dated March 26, 1897. A channel 100 feet wide and 16 feet deep was dredged from Station 8 to the outer slope of the bar, a distance of 660 feet, and 50 feet wide and 14 feet deep at the inner ends of the piers, the amount of material removed being 14,136 cubic yards. The work was completed June 9, 1897.

The total amount expended for the harbor's improvements to June 30, 1897, is $241,264.96, of which $5,342.72 was spent during the last fiscal year.

The piers reached to but little beyond the 10-foot curve in Lake Michigan, and for this reason a greater navigable depth can not be kept except as dredging serves to give it temporarily. Twelve feet, as called for by the approved project, can be obtained and held with any reasonable permanence only when the piers shall have been extended to the 15-foot curve, now from 300 to 400 feet distant. The limit of extension at present authorized is 200 feet for the south and nothing for the north pier. The old portions of both piers must be rebuilt above water, and the old section of the north pier should also be made sand-tight by sheet-piling.

The estimate for 1899 is as follows: For extending the south pier 200 feet, $20,000; for rebuilding above water and sheet-piling 500 feet of north pier, $10,000; for rebuilding above water 500 feet of south pier, $5,000; dredging, $3,000; minor repairs and refilling pier, $2,000; making in all, $40,000.

This harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a harbor light near the outer end of south pier. There is a life-saving station near the inner end of north pier.

Original estimated cost of improvement, 1867	$327,713.40
Whole amount expended to June 30, 1897	241,264.96

Money statement.

July 1, 1896, balance unexpended		$12,897.76
June 30, 1897, amount expended during fiscal year		5,342.72
July 1, 1897, balance unexpended		7,555.04
July 1, 1897, outstanding liabilities	$15.90	
July 1, 1897, amount covered by uncompleted contracts	193.23	
		209.13
July 1, 1897, balance available		7,345.91
Amount (estimated) required for completion of existing project		78,893.40
Amount that can be profitably expended in fiscal year ending June 30, 1899		40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Pentwater, Mich.

March 2, 1867	$55,000
April 10, 1869 (allotment)	17,820
July 11, 1870	10,000
March 3, 1871	10,000
June 10, 1872	30,000
March 3, 1873	20,000
August 14, 1876	10,000
June 18, 1878	10,000
March 3, 1879	6,000
June 14, 1880	4,000
March 3, 1881	10,000
August 2, 1882	$10,000
July 5, 1884	15,000
August 5, 1886	10,000
August 11, 1888	8,000
September 19, 1890	8,000
July 13, 1892	5,000
August 17, 1894	5,000
June 3, 1896	5,000
Total	248,820

Contract in force for improving harbor at Pentwater, Mich.

Green Bay Dredge and Pile Driving Company, dredging, dated March 26, 1897, approved April 13, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

COMMERCIAL STATISTICS, PENTWATER HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	800	45,000	1893	116	
1889 *a*			1894	60	
1890	27	2,559	1895	500	
1891	1,140	71,260	1896 *a*		
1892 *a*					

a Not stated.

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the Sands & Maxwell Lumber Company, Pentwater, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	88	Fruit, miscellaneous	3,000
Flour	50	Furniture	1,268
Grain	390	Lumber	8,453
Hay and feed	100	Posts and ties	1,324
Lime and cement	78	Potatoes	210
Salt	84	Slabs	1,075
		Tan bark	1,020
Total	740	Total	16,350

JJ 13.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

The Government's part in the development of this harbor dates from 1867, when private enterprise had made, and for some years maintained, a narrow channel, with a depth of 7 feet, from Lake Michigan to Pere Marquette Lake. The plan of improvement then adopted was to dredge the channel to a depth of 12 feet, widen it to 200 feet, and protect its projection into Lake Michigan by lateral piers. The estimated cost was $270,682. The improvement was duly made and subsequently maintained by periodical dredging and occasional pier extensions until 1885–86, when the north pier comprised a length of 951 feet and the south pier and revetment 1,679½ feet.

In 1890 the project was enlarged into one which, by dredging and pier extensions, contemplated a channel 18 feet deep and 250 feet wide at entrance, without change of existing width within the limits of piers already built. The estimated cost of this modification was $111,000. Work thereon was promptly commenced, and in 1891 the authorized pier extensions had been completed by adding 500 feet to the north and 700 feet to the south pier, and the channel depth has been maintained at from 14 to 16½ feet, but the full depth of 18 feet has not yet been secured.

The condition of the harbor works June 30, 1896, was as follows:

Available depth 14 feet, due to a fall of 2 feet in the level of Lake Michigan since the project was adopted.

North pier (all crib work) had a total length of 1,452 feet and projected 930 feet beyond the shore line.

South pier, comprising 567 feet of pile work and 1,814 feet of crib work, had a total length of 2,381 feet and projected 1,550 feet beyond the shore line.

Under the contract with William A. Starke, dated May 1, 1896, dredging was begun at this harbor July 29 and completed September 1, 48,169 cubic yards of material having been removed, resulting in producing a navigable channel 18 feet deep and 120 feet wide between piers and across the bar beyond them. Soundings taken in November showed a channel depth of 17 feet, which was also found in April, 1897, but the width of the channel had considerably diminished at the end of the north pier. To widen the channel at this point the dredge of the Green Bay Dredge and Pile Driving Company, under contract dated March 26, 1897, commenced operations April 28, and removed 10,658 cubic yards, completing the work May 17, 1897.

A contract was entered into with William Brownrigg, dated March 26, 1897, for reconstructing the south pier between stations 8+70 and 11+70, and the north pier between stations 10+35 and 12+35. These portions of the piers are to be cut down to a level 1 foot below zero of gauge, reenforced in front with a wall of Wakefield sheet piling and protected by a row of oak piles. A new superstructure is to be built above, having a height of 6 feet. Operations were begun April 27, and at the close of the fiscal year the front wall of the old work had been cut down along the portions of the piers to be repaired, and in the north pier the sheet piling had been driven and secured by binding timbers and screw bolts. Nine of the front oak piles had also been placed.

The total amount expended in improving this harbor to June 30, 1897, is $368,819.90, of which $8,614.54 was spent during the last fiscal year.

As a further extension of piers has not yet been authorized, the estimate submitted for 1899 is as follows: For repairs to piers, $10,000; dredging, $5,000; making a total of $15,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The light-house establishment maintains a harbor light and fog whistle near the end of south pier. There is a life-saving station near the inner end of north pier.

Original estimated cost of work, 1867	$270,682.00
Estimated cost of enlarged project of 1890	111,000.00
Total	381,682.00
Whole amount expended to June 30, 1897	368,819.90

Money statement.

July 1, 1896, balance unexpended		$28,228.74
June 30, 1897, amount expended during fiscal year		8,614.54
July 1, 1897, balance unexpended		19,614.20
July 1, 1897, outstanding liabilities	$443.14	
July 1, 1897, amount covered by uncompleted contracts	8,995.19	
		9,438.33
July 1, 1897, balance available		10,175.87
Amount that can be profitably expended in fiscal year ending June 30, 1899		15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Ludington, Mich.

March 2, 1867	$50,000.00	August 2, 1882	$12,000.00
April 10, 1869 (allotment)	31,185.00	July 5, 1884	10,000.00
July 11, 1870	10,000.00	August 5, 1886	56,250.00
March 3, 1871	10,000.00	August 11, 1888	60,000.00
June 10, 1872	10,000.00	July 13, 1892	5,000.00
March 3, 1873	25,000.00	August 17, 1894	6,000.00
June 23, 1874	20,000.00	June 3, 1896	25,000.00
March 3, 1875	10,000.00		
August 14, 1876	10,000.00	Total	388,435.00
June 18, 1878	15,000.00	Amount carried to the surplus fund, 1872	.90
March 3, 1879	5,000.00		
June 14, 1880	8,000.00		
March 3, 1881	10,000.00		388,434.10

Abstract of bids for repairing Government pier at Ludington, Mich., received and opened March 17, 1897, in accordance with advertisement dated February 15, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	1.—To cut down and remove old work, 500 linear feet, more or less (price per linear foot).	2.—White oak around piles, 4,125 linear feet, more or less (price per linear foot).	3.—White-oak timber, 5,500 feet B. M., more or less (price per 1,000 feet B. M.).	4.—White-pine timber, 124,512 feet B. M., more or less (price per 1,000 feet B. M.).	5.—White-pine plank, 121,512 feet B. M., more or less (price per 1,000 feet B. M.).
			Cents.			
a1	William Brownrigg, Manistee, Mich	$1.00	28	$35.00	$19.00	$30.00
2	George Cooper, Manitowoc, Wis	1.00	29	36.00	21.00	25.50
3	Green & Anderson, Green Bay, Wis	2.80	28	45.00	21.00	24.50
4	Love & West, Muskegon, Mich	2.50	35	35.00	22.50	26.00
5	Eslow & Munroe, Charlevoix, Mich	3.00	35	35.00	21.50	26.00
6	William McIvor, Marseilles, Ill	2.10	31½	40.75	22.50	32.25
7	Nelson J. Gaylord, Ludington, Mich	2.50	40	40.00	21.00	33.50
8	A. J. Dupuis and William M. Blay, Detroit, Mich	3.10	30	37.00	26.50	33.17
9	Luther E. Allen, Detroit, Mich	4.00	30	35.00	25.00	35.00
10	Jos. A. Beauvais, Charlevoix, Mich	5.50	45	40.00	26.00	35.00
11	G. S. Germain and Peter Scott, Port Huron, Mich	5.00	65	45.00	32.00	45.00

No.	Name and address of bidder.	6.—Driftbolts, 16,640 pounds, more or less (price per pound).	7.—Screwbolts, carriage bolts, and washers, 11,271 pounds, more or less (price per pound).	8.—Tierods, 6,652 pounds, more or less (price per pound).	9.—Spikes, 410 pounds, more or less (price per pound).	10.—Angle irons, 9,148 pounds, more or less (price per pound).	Approximate total.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	
a1	William Brownrigg, Manistee, Mich	2¼	2¼	2¼	2¼	2¼	$8,851.81
2	George Cooper, Manitowoc, Wis	1 1/10	3	2 3/10	3	5	8,867.91
3	Green & Anderson, Green Bay, Wis	2	2¼	2¼	3	3	9,417.10
4	Love & West, Muskegon, Mich	2½	2½	2½	2½	2½	9,950.11
5	Eslow & Munroe, Charlevoix, Mich	2½	4	4	6	4	10,496.01
6	William McIvor, Marseilles, Ill	3	3½	3½	3	3½	10,752.77
7	Nelson J. Gaylord, Ludington, Mich	2½	2¼	2¼	2¾	2¾	10,977.13
8	A. J. Dupuis and William M. Blay, Detroit, Mich	2	3	5	2½	3½	11,655.08
9	Luther E. Allen, Detroit, Mich	2	3	3	3	3	11,952.95
10	Jos. A. Beauvais, Charlevoix, Mich	3	3½	4	3	5	13,935.40
11	G. S. Germain and Peter Scott, Port Huron, Mich	9	10	8	10	9	18,896.32

a Contract entered into March 26, 1897.

List of contracts in force for improving harbor at Ludington, Mich.

Green Bay Dredge and Pile Driving Company, dredging, dated March 26, 1897, approved April 13, 1897; date of beginning April 1, 1897, date of expiration September 15, 1897.

William Brownrigg, pier work, dated March 26, 1897, approved April 9, 1897; date of beginning April 15, 1897, date of expiration September 15, 1897.

COMMERCIAL STATISTICS, LUDINGTON HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,778	277,074	1893	979	211,438
1889	1,759	....	1894	1,466	426,599
1890	2,270	461,997	1895	1,556	594,124
1891	2,420	610,057	1896	1,996	952,469
1892	1,969	538,568			

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by the Flint and Pere Marquette Railroad Company and the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Beans	170	Brick	5,175
Cement	1,080	Feed	90
Coal	2,500	Fruit	11,126
Flour	146,852	Hides	386
Grain	118,500	Lumber	93,183
Hay and feed	39,681	Merchandise, general	35,621
Malt	16,559	Pig iron	30,233
Merchandise, general	30,338	Piles	240
Miscellaneous	463	Salt	188,450
Stone	256	Stone	3,438
Tobacco	282	Sugar	181
		Tan bark	7,279
Total	356,676	Wood	285
		Total	375,687

J J 14.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

The improvement of this harbor by the Government has been in progress since 1867, local enterprise having previously constructed slab piers on each side of the mouth of the Manistee River, so as to obtain entrance temporarily for vessels drawing 7 feet; this was also the limiting depth that could be carried over bars in the river until deep water was reached in Manistee Lake, about 1¾ miles from Lake Michigan. The project of improvement then adopted was to construct two parallel piers of cribs extending about 960 feet into Lake Michigan to the 12-foot curve, using the slab piers, in part, as foundation for the new work, and to dredge a channel 12 feet deep between the piers. The estimated cost of the proposed work was $180,949, and did not provide for any improvement inside the river eastward of the shore end of piers. But when, in 1873, 1,275 feet of crib piers had been built and an entrance afforded for much greater draft than could be carried in the river, the scope of operations was extended to include straightening its lower reach by dredging, and revetting its banks so far as necessary to preserve the improved channel. This was accomplished in 1878, when the total length of the revetment built was 1,794 feet, of which 1,309 was on the north and 490 on the south side of the river. In the meantime the crib piers had been continued lakeward, but not so fast as to keep pace with the advance of sand accretions, which finally became so great as to reduce the depth of water at entrance to 8 feet, or nearly what it was in the beginning. Accordingly, subsequent operations were confined to pier extensions and repairs necessary for maintaining the older structures, with the object of regaining and preserving a channel 12 feet deep at the entrance and between piers. But this depth soon ceased to satisfy the requirements of commerce, and in 1890 the project of improvement was modified to increase it to 15 feet, not only between the piers, but throughout the length of the Manistee River. The approved project for accomplishing this object provided for an extension of the north pier to the 18-foot curve in Lake Michigan, a distance of 550 feet; for extending the south pier to the 14-foot curve on the outer bar, then 350 feet distant, and for dredging a channel 100 feet wide between the piers to the new 15-foot depth, and thence through the river to Manistee Lake a channel of like depth 50 feet wide. Entering at once upon the execution of this project, contracts for the necessary dredging and for the north pier extension were entered into. The work of dredging was completed in 1892, and that of the north pier extension in November, 1893.

The condition of the harbor July 1, 1896, was as follows:

Available depth at entrance, 15 feet; between the piers, 15½ feet; in shoal parts of the unrevetted river above the piers, 11 feet.

North pier—comprising 1,304 feet of pile work and 1,602 feet of crib work—had a total length of 2,906 feet and projected 1,250 feet beyond the shore line.

South pier—all crib work—was 1,199 feet long, and projected 699 feet beyond the shore line.

At the beginning of the year operations were in progress under contract with Nelson J. Gaylord, dated May 28, 1896, for rebuilding parts of the two piers above water. This work was completed August 26, 1896. The superstructure of the south pier rebuilt extends from Station 1+29 to 6+45, and of the north pier from Station 14+95 to 18+84, a total of 905 linear feet. The reconstructed superstructure consists of the usual 12-inch timber walls, six courses high, connected by three tiers of cross ties 8 feet between centers, and filled with riprap stone.

The river and harbor act of June 3, 1896, removed the restriction that had existed for several years past against dredging the unrevetted river above the piers, and on October 19, under the contract with William A. Starke, dated May 1, 1896, the work of clearing out this portion of the channel was begun. The work was completed November 15, and resulted in giving a navigable channel of at least 15 feet depth through the river, except for 20 feet in the vicinity of Station 34 to avoid injury to electric cables and the city water main which here cross the river.

The total amount expended for improving the harbor to June 30, 1897, is $360,001.82, of which $12,175.98 was spent during the past fiscal year.

The harbor piers at the close of the fiscal year were generally in good condition. The available depth of water when the channel was examined May 17, 1897, was 14.6 feet at entrance, 15½ feet in channel between piers, and from 14 to 15 feet in the river above.

By an instrument dated May 31, 1893, the Secretary of War authorized the Manistee and Northeastern Railroad Company to occupy the revetment built by the Government on the north side of the river, from Station o to Station 7+60. The consideration on which this authority was accorded was the promise and agreement of the railroad company to rebuild the revetment and maintain it in substantial repair. The company is now in full occupation of the premises, but thus far has failed to make any of the stipulated repairs, and it seems quite evident that it is the company's intention to pay no attention to its agreement in this respect. The approved project of improvement calls for an addition of 350 feet to the south pier, and it should be made as soon as possible to prevent the adjoining sandy shoal from overlapping its lake end and thereby blocking entrance to the harbor.

The estimate for 1899 is as follows: For extending the south pier 350 feet to complete the present project, $42,000; dredging, $5,000, refilling piers and minor repairs, $3,000, making in all, with due allowance for engineering, supervision and contingencies, $50,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a coast light on the shore north of the harbor and a pier headlight and fog whistle near end of north pier. There is a life-saving station near inner end of north pier.

Original estimated cost of the work, 1866, amended in 1871, 1875, 1890, and 1892	$408,000.00
Whole amount expended to June 30, 1897	360,001.82

Money statement.

July 1, 1896, balance unexpended	$27,174.16
June 30, 1897, amount expended during fiscal year	12,175.98
July 1, 1897, balance unexpended	14,998.18
July 1, 1897, amount covered by uncompleted contracts	1,500.00
July 1, 1897, balance available	13,498.18
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Manistee, Mich.

March 2, 1867	$60,000	March 3, 1881	$10,000
July 11, 1870	20,000	August 2, 1882	15,000
March 3, 1871	9,000	July 5, 1884	10,000
June 10, 1872	10,000	August 5, 1886	10,000
March 3, 1873	10,000	August 11, 1888	10,000
June 23, 1874	10,000	September 19, 1890	50,000
March 3, 1875	25,000	July 13, 1892	50,000
August 14, 1876	14,000	August 17, 1894	12,000
June 18, 1878	15,000	June 3, 1896	15,000
March 3, 1879	10,000		
June 14, 1880	10,000	Total	375,000

Contract in force for improving harbor at Manistee, Mich.

Green Bay Dredge and Pile Driving Company, dredging, dated March 26, 1897, approved April 13, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

COMMERCIAL STATISTICS, MANISTEE HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	3,595	966,221	1893	2,831	959,550
1889	3,524	945,329	1894	3,064	956,463
1890	3,691	975,049	1895	3,054	990,645
1891	3,617	1,079,818	1896	2,355	643,048
1892	4,044	1,028,629			

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	495	Fruit	1,910
Coal	1,184	Grain	805
Feed	3,181	Lumber	299,022
Flour	3,588	Merchandise, general	841
Grain	4,951	Potatoes	83
Lumber	2,056	Salt	182,859
Merchandise, general	17,297	Tan bark	6,468
Miscellaneous	48	Wood	3,456
Total	32,800	Total	495,444

J J 15.

HARBOR OF REFUGE AT PORTAGE LAKE, MANISTEE COUNTY, MICHIGAN.

The necessity of a harbor of refuge on the east shore of Lake Michigan has long been recognized. From Grand Haven to Traverse Bay, a distance of 175 miles, extends a dangerous coast line, the existing harbors having narrow entrances difficult to enter during westerly storms. The peculiar adaptability of Portage Lake led to its selection for this purpose in 1878. The lake has an area of nearly 4 square miles, in which the water is from 4 to 7 fathoms deep. It is landlocked, except its connection with Lake Michigan. The distance between the 18-foot curves of the two lakes is but 2,000 feet, and the locality is close to the line of travel from Lake Michigan ports to the Straits of Mackinac.

The original depth of its outlet was but 4 feet, and the project adopted in 1879 contemplated dredging a channel 18 feet deep from lake to lake and protecting its sides with parallel piers and revetments 300 feet apart, the estimated cost being $189,860. The project was modified in 1890 by increasing the width between piers and the estimate increased to $267,500. The work is designed for the benefit of the general navigation of the lakes and but incidentally for the local commerce, which has heretofore been of slight importance. The first appropriation for the work was one of $10,000 in 1879, and by June 30, 1896, $111,451.61 had been expended, a sum sufficient in one appropriation to have produced results of benefit to the general commerce, but scattered over a period of seventeen years has been frittered away in dredging and other works of maintenance which have been of use only to the limited local interests of Portage Lake.

At the close of the last fiscal year the north pier and revetment, comprising 1,240 feet of pile work and 151 feet of cribs, had a total length of 1,391 feet, projected 560 feet beyond the Lake Michigan shore line and terminated in 8 feet of water. The south pier, having a total length of 1,380 feet, all pile work, projected 340 feet into Lake Michigan and terminated in water having a depth of 7 feet. The piers and revetments were without filling, and above water most of the timber had rotted off, with the exception of a portion of the north pier then under repairs. The general depth over the space between piers was from 3 to 5 feet, through which a channel was being dredged under the contract with William A. Starke, dated May 1, 1896.

During the past fiscal year the reconstruction of the north pile pier and revetment has been completed as described in the Annual Report of 1896. A contract was entered into May 22, 1897, for the reconstruction of the outer part of the south pier from Station 7+70 to 13+80. Operations were begun June 18, and since that date the contractor has been employed collecting material and cutting down the old work. The dredging in progress at the close of the last fiscal year was completed July 13, 1896, 18,444 cubic yards of material having been removed during the month of July. The depth obtained was 12 feet, and width of channel 60 feet. Soundings taken in May, 1897, showed that the channel had shoaled to 10.5 feet. Under the contract with the Green Bay Dredge and Pile Driving Company of March 26, 1897, dredging was resumed June 11, 1897, and at the close of the fiscal year 16,098 cubic yards of material had been removed.

The total amount expended in improving this harbor to June 30, 1897, was $124,107.65, of which $12,656.04 was spent during the past fiscal year.

With the completion of the work under contract there will still be required the repairs of 770 feet of the south revetment to bring the works to the condition that existed ten years ago. To maintain an 18-foot channel, the minimum which is allowable for a general harbor of refuge, will necessitate the extension of the piers to the 20-foot contour. This would require additions of 700 and 900 feet to the north and south piers, respectively, at an estimated cost of $125,000; for dredging and repairs to south pier is estimated $35,000, a total of $160,000 which can profitably be expended in the fiscal year ending June 30, 1899.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a harbor and range light near the outer end of north pier.

Original estimated cost of work, 1879, amended in 1890	$267,500.00
Whole amount expended to June 30, 1897	124,107.65

Money statement.

July 1, 1896, balance unexpended		$39,048.39
June 30, 1897, amount expended during fiscal year		12,656.04
July 1, 1897, balance unexpended		26,392.35
July 1, 1897, outstanding liabilities	$159.03	
July 1, 1897, amount covered by uncompleted contracts	11,318.41	
		11,477.44
July 1, 1897, balance available		14,914.91

Amount (estimated) required for completion of existing project	160,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	160,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for harbor of refuge at Portage Lake, Michigan.

March 3, 1879	$10,000	August 11, 1888	$10,000
June 14, 1880	10,000	September 19, 1890	8,000
March 3, 1881	10,000	August 17, 1894	25,000
August 2, 1882	25,000	June 3, 1896	25,000
July 5, 1884	12,500		
August 5, 1886	15,000	Total	150,500

Abstract of bids for repairing Government pier at Portage Lake, Michigan, received and opened May 14, 1897, in accordance with advertisement dated April 15, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	1.—To cut down and remove old work, 610 linear feet (per foot).	2.—To remove and place in work 149,000 feet B. M. white pine timber furnished by Government (per 1,000 feet B. M.).	3.—To furnish the following material and to secure it in place in the work: White oak round piles, 5,082 linear feet (per linear foot).	White oak timber, 6,960 feet B. M. (per 1,000 feet B. M.).	White pine timber, 8,256 feet B. M. (per 1,000 feet B. M.).	White pine plank for sheet piles, 145,368 feet B. M. (per 1,000 feet B. M.).	White pine plank for decking, 7,632 feet B. M. (per 1,000 feet B. M.).
				Cents.				
a1	Nelson J. Gaylord, Ludington, Mich.	$0.80	$5.00	30	$32.00	$20.00	$26.00	$18.00
2	George Cooper, Manitowoc, Wis.	1.50	5.00	28	35.00	19.00	25.50	17.00
3	Eslow & Munroe, Charlevoix, Mich.	1.50	5.00	35	30.00	20.50	23.50	18.50
4	Love & West, Muskegon, Mich.	2.62	3.50	26	32.00	19.00	24.25	17.00
5	John M. Allmendinger, Benton Harbor, Mich.	2.25	6.00	26	28.00	22.00	25.00	18.00
6	Donald A. & Wm. McLeod, Manistee, Mich.	1.00	6.00	30	40.00	20.00	30.00	20.00
7	Alex & William McCurdy, Houghton, Mich.	3.00	8.00	30	60.00	26.00	24.00	20.00
8	W. McIvor, Muskegon, Mich.	2.10	6.00	34	45.00	21.50	30.00	18.00

No.	Name and address of bidder.	3.—To furnish the following material and to secure it in place in the work: Driftbolts, 17,275 pounds (per pound).	Screw bolts, 5,280 pounds (per pound).	Carriage bolts, 4,600 pounds (per pound).	Tie-rods, 7,250 pounds (per pound).	Spikes, 340 pounds (per pound).	Stone filling, 87 cords (per cord).	Sand filling, 200 cubic yards (per cubic yard).	Approximate total.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*		*Cents.*	
a1	Nelson J. Gaylord, Ludington, Mich	2	2.25	2.5	2.25	2.25	$6.50	25	$8,118.41
2	George Cooper, Manitowoc, Wis.	2.2	2.2	2.2	2.2	2.5	7.00	30	8,419.60
3	Eslow & Munroe, Charlevoix, Mich.	2	2.125	2.125	2.125	2.5	8.00	25	8,452.06
4	Love & West, Muskegon, Mich	2	2	2	2	2	7.00	50	8,543.82
5	John M. Allmendinger, Benton Harbor, Mich.	2	3	3.5	3.5	2.5	6.00	25	8,949.91
6	Donald A. & Wm. McLeod, Manistee, Mich.	2.5	2.5	2.5	2.5	3	7.00	75	9,282.95
7	Alex & William McCurdy, Houghton, Mich.	2	3	3	3	3	10.00	90	10,254.19
8	W. McIvor, Muskegon, Mich.	3	3	3	3	3	8.00	20	10,283.17

a Contract entered into May 22, 1897.

List of contracts in force for harbor of refuge at Portage Lake, Michigan.

Green Bay Dredge and Pile-Driving Company, dredging; dated March 26, 1897; approved April 13, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

Nelson J. Gaylord, pier work; dated May 22, 1897; approved June 3, 1897; date of beginning, June 1, 1897; date of expiration, November 1, 1897.

COMMERCIAL STATISTICS.

No commercial statistics can be obtained.

J J 16.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

Before any work was done at this place by the Government the natural outlet from Frankfort Lake (Lake Aux Becs Scies) to Lake Michigan had been slightly improved by local enterprise and a narrow channel with a navigable depth of from 3 to 4 feet temporarily obtained. This outlet was abandoned by the Government when work was commenced under the appropriation made by the river and harbor act of June 23, 1866, and the project then adopted was to dredge a straight channel from lake to lake about 750 feet south of the old outlet and protect it by revetments and piers 250 feet apart, extending to the 12-foot curve in Lake Michigan, the object having been to establish a reliable entrance channel with a navigable depth of 12 feet. By the river and harbor act of June 3, 1896, a navigable depth in the channel of 18 feet is authorized.

At the close of the last fiscal year a contract was in force with Donald A. and William McLeod for the extension of the north pier 400 feet and of the south pier 200 feet. The cribs had been sunk in their proper position and a portion of the superstructure had been put in place. The superstructure was completed, filled with stone, and decked over by September 11, 1896.

Minor repairs were also made to the piers by day labor and Government plant. A number of holes in the north pier near the shore line were closed by sheet piling, waling replaced that had been injured or removed, 59 cords of stone added where needed, and a sand fence 160 feet long and 7 feet high built in rear of the south pier.

The available depth of water at the close of the last fiscal year was 13 feet. Under a contract with William A. Starke, dated May 1, 1896, dredging was begun on September 8. A channel 90 feet wide was excavated to 19 feet below the zero of gauge (17 feet at the prevailing stage of Lake Michigan) from the inner ends of the piers to deep water in the lake, a distance of about 2,000 feet. The work was completed October 10, and 37,593 cubic yards of material were removed.

On June 25, 1897, bids were opened for reconstructing the superstructure of the north pier between Stations 3+96 and 8+47, and of the south pier between Stations 1+87 and 6+99.

In addition to the work done by the Government, the Toledo and Ann Arbor Railway Company, under authority issued by the Secretary of War, January 10, 1896, has added 400 feet to the south pier, at its own expense, for the better protection of its translake car ferry service. The work was done under the supervision of this office, and consists of four cribs, 100 by 30 by 18½ feet, with a continuous superstructure 6 feet high. Each crib rests on 64 piles having a penetration of from 17.5 to 22.5 feet, and sawed off at an elevation of 18.8 feet below the zero of the gauge. The method of construction was similar to that of the cribs built by the Government in the preceding year and described in the last Annual Report.

The total amount expended in improving this harbor to June 30, 1897, is $324,348.53, of which $33,124.10 was spent during the last fiscal year.

The condition of the piers at the end of the year was as follows:

North pier and revetment, comprising 395 feet of pile work and 1,104 feet of crib work, had a total length of 1,499 feet, and projected 800 feet beyond the shore line.

South pier and revetment, comprising 186 feet of pile work and 1,351 feet of crib work, had a total length of 1,537 feet, and projected 1,050 feet beyond the shore line.

Available channel depth, 17 feet.

An extension of 600 feet to the north pier, supplementing that being made by the railway company to the south pier, is essential to completing the improvement so as to provide a navigable depth of 18 feet as required by the river and harbor act of June 3, 1896. The cost of such extension is estimated at $55,000. The old piers show very considerable decay above water, but it is believed that scattering repairs will keep them in serviceable condition for the next two years.

The estimate for 1899 is therefore as follows: For extending the north pier 600 linear feet to provide a navigable depth of 18 feet (as required by the river and harbor act of June 3, 1896), $55,000; for miscellaneous repairs of piers, and for additional filling, especially to provide for settlement of stone in new crib work, $5,000; for dredging, $5,000; making in all, with due allowance for superintendence, engineering, and office contingencies, $65,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a harbor light and fog bell near the outer end of south pier. There is a life-saving station on the inner end of south pier.

Original estimated cost of the work, 1866, amended in 1868, 1879, and 1892	$325, 659.85
Whole amount expended to June 30, 1897	324, 348.53

Money statement.

July 1, 1896, balance unexpended	$51, 713.92
June 30, 1897, amount expended during fiscal year	33, 124.10
July 1, 1897, balance unexpended	18, 589.82
July 1, 1897, outstanding liabilities	240.16
July 1, 1897, balance available	18, 349.66
Amount (estimated) required for completion of existing project	65, 000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	65, 000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving harbor at Frankfort, Mich.

Aux Becs Scies, Mich.:	
June 23, 1866	$88, 541.00
March 2, 1867	10, 000.00
July 25, 1868 (allotment)	10, 000.00
April 10, 1869 (allotment)	29, 318.85
July 11, 1870	10, 000.00
March 3, 1871	10, 000.00
Frankfort, Mich.:	
June 10, 1872	10, 000.00
March 3, 1873	10, 000.00
June 23, 1874	10, 000.00
March 3, 1875	10, 000.00
August 14, 1876	3, 000.00
June 18, 1878	8, 800.00
March 3, 1879	4, 000.00
June 14, 1880	5, 000.00
March 3, 1881	10, 000.00
Frankfort, Mich.:	
August 2, 1882	$15, 000.00
July 5, 1884	5, 000.00
August 5, 1886	7, 000.00
August 11, 1888	8, 000.00
September 19, 1890	10, 000.00
July 13, 1892	10, 000.00
August 17, 1894	50, 000.00
June 3, 1896	15, 000.00
Total	348, 659.85
Amount covered into the Treasury (Report, 1871, p. 133)	5, 721.50
	342, 938.35

Abstract of bids for repairing Government piers at Frankfort Harbor, Michigan, received and opened June 25, 1897, in accordance with advertisement dated June 11, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and address of bidder.	(1) To cut down and remove old work (963 linear feet) per linear foot.	(2) To furnish the following material and secure it in place. White-oak round piles (7,744 linear feet) per linear foot.	White-oak timber (10,780 feet B. M.), per M feet B. M.	White-pine timber (164,280 feet B. M.), per M feet B. M.	White-pine plank (8,640 feet B. M.), per M feet B. M.	Driftbolts (23,766 pounds), per pound.	Screw bolts (2,554 pounds), per pound.	Tie-rods (11,885 pounds), per pound.	Spikes (870 pounds), per pound.	Approximate total.
			Cts.				*Cts.*	*Cts.*	*Cts.*	*Cts.*	
a1	Nelson J. Gaylord, Ludington, Mich	$1.05	26	$32.00	$19.00	$18.00	2	2	2	2	$7,417.89
2	Love & West, Muskegon, Mich	1.00	28	32.00	18.50	16.00	2	2	2	2	7,425.20
3	George Cooper, Manitowoc, Wis	1.30	29	35.00	19.50	17.00	2	2	2	2½	7,998.65
4	Mathews & Keith, Manitowoc, Wis	1.00	30	38.00	20.00	15.00	2¾	2¾	2¾	2¾	8,171.85
5	W. McIvor, Marseilles, Ill	1.30	29	30.00	20.00	18.00	2½	3	2½	2½	8,239.33
6	I. E. Miller, Sault Ste. Marie, Mich	1.55	32	32.00	21.50	19.00	2	2½	2¼	2½	8,827.70
7	Robert B. Rice, Muskegon, Mich	1.25	40	40.00	19.00	16.00	2	2½	2½	3	8,839.51
8	Donald A. McLeod, Manistee, Mich	2.00	27	40.00	20.00	18.00	2½	2½	2½	3	8,855.43
9	Simon Dumond, Sault Ste. Marie, Mich	2.00	20	40.00	25.00	27.00	2½	2½	3	3	9,271.93
10	John M. Allmendinger, Benton Harbor, Mich	2.00	28	32.00	24.00	20.00	2	3	3	2½	9,472.54
11	A. W. Clark, Muskegon, Mich	3.00	40	38.00	20.00	18.00	2	2	2½	3	10,671.09

a Recommended of acceptance.

Contract in force for improving harbor at Frankfort, Mich.

Green Bay Dredge and Pile Driving Company, dredging, dated March 26, 1897; approved April 13, 1897; date of beginning April 1, 1897, date of expiration September 15, 1897.

COMMERCIAL STATISTICS, FRANKFORT HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	1,342	216,376	1893	968	278,709
1889a			1894	1,101	337,728
1890	443	57,140	1895	1,182	412,951
1891	1,541	258,908	1896	1,374	509,277
1892	910	167,777			

a Not stated.

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Feed	915	Brick	5,888
Flour	3,528	Fruit	85
Merchandise, general	3,014	Lumber	37,514
Stone	19,031	Merchandise, general	362
		Slabs and wood	24,447
Total	26,488	Tan bark	12,955
		Total	81,251

In addition to classified tonnage the car ferries between Frankfort, Mich., and Kewaunee, Wis., carried 11,496 freight cars, average weight 27,000 pounds, making 155,196 tons.

J J 17.

IMPROVEMENT OF CHARLEVOIX HARBOR, MICHIGAN.

The object of the improvement at Charlevoix has been to furnish access to Round and Pine lakes. These two lakes were originally connected by a shallow stream, and emptied into Lake Michigan through Pine River, which had a length of about one-third of a mile and was obstructed at its mouth by a bar having depths over it of but 2 or 3 feet. Local enterprise, assisted by a State land grant, had improved the entrance to Pine River by building short piers into Lake Michigan which increased the available depth over the bar to 6 feet, and had dredged the river to a depth of 11 feet prior to any work having been done by the United States. The first project adopted by the General Government, in 1876, provided for the straightening and enlargement of Pine River to a depth of 12 feet, and the protection of its sides by pile revetments and its outlet into Lake Michigan by crib piers, with a channel way 150 feet wide between them. In 1882 the project was extended to provide for a revetted channel 12 feet deep from Round Lake to Pine Lake.

At the close of the last fiscal year the condition of the harbor and extent of improvement were as follows: Available depth in the lower channel from Lake Michigan to Round Lake 14½ feet, in the upper channel from Round Lake to Pine Lake, 12½ feet. In the lower channel the north pier and revetments, comprising 945 feet of pile work and 790 feet of crib piers, had a total length of 1,725 feet and projected 740 feet beyond the shore line. The south pier and revetment, with a length of 2,030 feet consisting of 1,539 feet of pile work and 491 feet of cribs, projected 375 feet beyond the shore line. In the upper channel the north revetment had a length of 339 feet and the south revetment 366 feet, all pile work. The revetments were generally in a poor condition and the piers required extensive repairs.

A contract was entered into with Joseph A. Beauvais, of Charlevoix, dated April 8, 1897, for the repair of the north pier from station 9+45 to station 14+23. The old timber cribs are to be removed to the water surface and a pile of riprap stone placed behind them, having a width of crown of 10 feet, lake slope of 1 on 2, and channel slope of 1 on 1. The slope on the lake side is to be faced with stone exceeding 1,000 pounds in weight and on the channel side with stone exceeding 300 pounds in weight. Operations under this contract were commenced April 28, and at the close of the fiscal year the contractor had placed in position 356.2 cords of ordinary rubble, 42.2 cords of stone for the channel face, and 71.1 cords of stone for the lake face.

The total expenditure to June 30, 1897, was $118,693.70, of which $3,191.15 was spent during the past fiscal year. The available channel depth at the close of the year was 15 feet in the lower channel and 13 feet in the upper channel.

The completion of the approved project requires an extension of 200 feet to the south pier. The estimate for 1899 is therefore as follows: For pier extension, $18,000; repairs to old piers and dredging, $7,000, a total of $25,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The Light-House Establishment maintains a harbor light near the outer end of north pier.

Original estimated cost of the work, 1868, amended in 1876 and 1884		$186,000.00
Whole amount expended to June 30, 1897		118,693.70

Money statement.

July 1, 1896, balance unexpended		$24,997.45
June 30, 1897, amount expended during fiscal year		3,191.15
July 1, 1897, balance unexpended		21,806.30
July 1, 1897, outstanding liabilities	$625.79	
July 1, 1897, amount covered by uncompleted contracts	5,068.52	
		5,694.31
July 1, 1897, balance available		16,111.99
Amount (estimated) required for completion of existing project		45,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Charlevoix, Mich.

August 14, 1876	$10,000	August 11, 1888	$12,500
June 18, 1878	12,000	September 19, 1890	9,000
March 3, 1879	9,000	July 13, 1892	10,000
June 14, 1880	10,000	August 17, 1894	8,000
March 3, 1881	10,000	June 3, 1896	20,000
August 2, 1882	10,000		
July 5, 1884	10,000	Total	140,500
August 5, 1886	10,000		

Abstract of bids for rebuilding the north pier at Charlevoix Harbor, Michigan, received and opened on March 31, 1897, in accordance with advertisement dated March 1, 1897, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and residence of bidder.	To remove the present cribs and place the stone they contain in new structure (500 feet, more or less), per running foot.	For stone— Exceeding 20 pounds in weight (180 cords, more or less), per cord.	Exceeding 200 pounds in weight (70 cords, more or less), per cord.	Exceeding 1,000 pounds in weight (220 cords, more or less), per cord.	Approximate total.
1	Jos. A. Beauvais, Charlevoix, Mich. *a*	$1.07	$5.27	$7.27	$9.27	$4,031.90
2	Eslow & Munroe, Charlevoix, Mich	2.00	5.00	7.00	9.00	4,370.00
3	Luther E. Allen, Detroit, Mich	3.00	7.00	8.00	10.00	5,520.00
4	Nelson J. Gaylord, Ludington, Mich	1.75	8.00	10.00	12.00	5,655.00
5	William McIvor, Marseilles, Ill	2.00	7.50	7.50	20.00	7,275.00

a Contract entered into April 8, 1897.

List of contracts in force for improving harbor at Charlevoix, Mich.

Green Bay Dredge and Pile Driving Company, dredging, dated March 26, 1897, approved April 13, 1897; date of beginning, April 1, 1897; date of expiration, September 15, 1897.

Jos. A. Beauvais, pier work, dated April 8, 1897, approved April 24, 1897; date of beginning, May 1, 1897; date of expiration, October 1, 1897.

COMMERCIAL STATISTICS, CHARLEVOIX HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1888	526	92, 806	1893	820	144, 978
1889	478	....	1894	1, 701	238, 015
1890	532	75, 224	1895	528	92, 387
1891	584	79, 613	1896	420	75, 265
1892	537	79, 966			

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by W. H. McCartney, village clerk, Charlevoix, Mich., and by the collector of customs at Grand Haven, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	125	Brick	105
Coal	3, 022	Fruit	9
Feed	2, 085	Lumber	61, 131
Flour	93	Merchandise, general	4, 635
Grain	219	Potatoes	183
Merchandise, general	2, 593	Tan bark	20, 300
		Ties and posts	9, 570
Total	8, 137	Wood and slabs	79, 708
		Total	175, 641

J J 18.

IMPROVEMENT OF PETOSKEY HARBOR, MICHIGAN.

The project for the improvement of Petoskey Harbor, authorized in the river and harbor act of August 17, 1894, provides for the construction of an outer and detached breakwater, so designed as to shelter the landing pier from westerly storms and "possibly to furnish an additional area within which vessels could take shelter on occasions." Petoskey is situated on the southeast shore of Little Traverse Bay, and prior to improvement of its harbor the water front was wholly exposed to winds coming from between the west and northwest across Lake Michigan, so that it was hazardous to make a landing in the immediate vicinity during gales from the directions above indicated.

At the close of the last fiscal year there had been constructed 400 linear feet of the western arm of the breakwater and 200 feet of its northern arm, consisting of timber cribs filled with stone.

During the past fiscal year the western arm of the breakwater has been extended 200 feet, under an informal contract with H. O. Rose, of Petoskey. A mound of riprap stone was substituted for the usual timber-crib construction, the water being comparatively shallow and the foundation firm. The mound was given a thickness at the crown of 10 feet, slopes of 1 to 1, and an elevation 6 feet above the zero of the gauge. The slopes were covered with bowlders having a weight of 2,000 pounds on the lake side and of at least 300 pounds on the harbor side. The work was done during the winter months, so that the stone could be hauled to position on the ice. During the spring gales there was some settlement of the stone at the junction of the stone breakwater and timber crib, which can, however, be repaired at a comparatively small cost during the next winter.

The total amount expended to June 30, 1897, is $50,496.12, of which $14,909.19 was spent during the past fiscal year.

The approved project contemplates a further extension of the northern breakwater 400 feet and the ultimate closing of the space between the two breakwaters. This later work should be, however, deferred until its necessity is demonstrated after the completion of the remainder of the project, as the opening affords a convenient entrance during calm weather. Additional riprap is required on the lake side of the cribs in position to prevent settlement.

The estimate for 1899 is therefore as follows: For 400 linear feet of breakwater construction, $45,000; for additional riprap and contingencies, $10,000; total, $55,000.

The harbor is in the Grand Haven collection district, and the nearest port of entry is Grand Haven, Mich. The nearest light-house is at Harbor Point, 4 miles distant.

Original estimated cost of the work	$170,000.00
Whole amount expended to June 30, 1897	50,496.12

Money statement.

July 1, 1896, balance unexpended	$17,413.07
June 30, 1897, amount expended during fiscal year	14,909.19
July 1, 1897, balance unexpended	2,503.88
Amount (estimated) required for completion of existing project	117,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	55,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving harbor at Petoskey, Mich.

September 19, 1890	$15,000
July 13, 1892	20,000
August 17, 1894	10,000
June 3, 1896	8,000
Total	53,000

COMMERCIAL STATISTICS, PETOSKEY HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1893	1,338	8,000
1894	4,160	20,000
1895	4,360	28,000
1896	3,158	24,000

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by Col. Isaac D. Toll, of Petoskey, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	125	Farm products	100
Farm products	35	Fish	500
Fish	300	Flour	300
Fruit	325	Grain	90
Hay and feed	100	Hay and feed	75
Live stock	60	Lime and cement	900
Machinery	25	Live stock	19
Merchandise, general	10,600	Lumber	3,110
Miscellaneous	2,100	Merchandise, general	100
		Miscellaneous	9,892
Total	13,670	Potatoes	300
		Tan bark	600
		Total	15,486

TABLE 1.—*General schedule of dredging by Government plant in 1896 at harbors on east shore of Lake Michigan.*

Harbor.	Dredge.	Dates.	Dimensions of cut.		
			Length.	Width.	Depth.
			Feet.	*Feet.*	*Feet.*
St. Joseph	Saginaw	Apr. 27–May 27	3,145	40	4 to 15
	do	July 15–Aug. 4	1,085	35–40	4 to 12
	do	Aug. 28–Dec. 3	7,480	20–40	2 to 7
South Haven	Farquhar	May 21–June 25	4,195	25	5 to 6
Saugatuck	do	May 2–20	2,975	25	2 to 4
	do	June 26–Oct. 28	14,470	25	3 to 8
	Saginaw	Aug. 4–27	2,250	40	3 to 7
Black Lake	Farquhar	Apr. 18–May 1	1,250	25	3 to 4
	do	Oct. 29–Nov. 23	525	25	3
	Saginaw	June 17–July 14	2,415	30–40	2 to 9
Grand Haven	do	Dec. 4–Jan. 29, 1897	1,265	35–40	3 to 6

Harbor.	Dredge.	Dates.	Bottom of cut below zero of gauge.	Material dredged.	Total dredged.
			Feet.		*Cubic yds.*
St. Joseph	Saginaw	Apr. 27–May 27	12 to 18	Sand, clay, and gravel.	23,345
	do	July 15–Aug. 4	14 to 16	Sand and stone	12,114
	do	Aug. 28–Dec. 3	14 to 20	Sand, gravel, and stone.	40,461
					75,920
South Haven	Farquhar	May 21–June 25	16	Sand	22,150
Saugatuck	do	May 2–20	10	do	10,655
	do	June 26–Oct. 28	12 to 16	Sand, clay, gravel, logs, etc.	58,849
	Saginaw	Aug. 4–27	12 to 14	Sand	17,494
					86,998
Black Lake	Farquhar	Apr. 18–May 1	16	do	6,380
	do	Oct. 29–Nov. 23	16	do	1,572
	Saginaw	June 17–July 14	12 to 17	do	14,924
					22,876
Grand Haven	do	Dec. 4–Jan. 29, 1897	19 to 22	do	8,323
Grand total of amount.					216,267

TABLE 1.—*General schedule of dredging by Government plant in 1896 at harbors on east shore of Lake Michigan*—Continued.

Harbor.	Dredge.	Dates.	Cost.			Cost per cubic yard.
			Wages, supplies, etc.	Repairs.	Total.	
St. Joseph	Saginaw	Apr. 27–May 27				*Cents.*
	....do	July 15–Aug. 4	$5,961.95	$1,329.07	$7,291.02	9.603
	....do	Aug. 28–Dec. 3				
South Haven	Farquhar	May 21–June 25	2,530.88	496.83	3,027.71	13.669
Saugatuck	....do	May 2–20				
	....do	June 26–Oct. 28	6,031.29	183.97	6,215.26	7.144
	Saginaw	Aug 4–27				
Black Lake	Farquhar	Apr. 18–May 1				
	....do	Oct. 29–Nov. 23	2,325.40	251.30	2,576.70	11,263
	Saginaw	June 17–July 14				
Grand Haven	....do	Dec. 4–Jan. 29, 1897	2,325.65	3.85	2,336.50	28.072
General repairs, care of plant, and contingencies			637.05	409.23	1,046.28	......
Grand total of cost, and average cost			19,819.22	2,674.25	22,493.47	10.400

TABLE 2.—*Schedule of dredging operations for the season of 1896—Work and cost of each dredge.*

Dredge.	Commission.	Worked.	Total dredged.	Total cost.	Average cost per cubic yard.
	Days.	*Days of 8 hours.*	*Yards.*		*Cents.*
Saginaw	259	118 7/8	116,661	$12,430.85	10.655
Farquhar	220	128 3/16	99,606	10,062.62	10.102
Total	479	247 1/16	216,267	22,493.47	10.400

Average product per working day of eight hours.

	Cubic yards.
Saginaw	985
Farquhar	773

TABLE 3.—*Distribution of cost of dredging, 1896.*

Dredge.	Services.	Supplies.	Repairs.	Total.
Saginaw	$8,697.17	$2,315.33	$1,418.36	$12,430.85
Farquhar	7,108.63	1,698.09	1,255.89	10,062.62
Total	15,805.80	4,013.42	2,674.25	22,493.47

J J 19.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK OF STEAMER REID.

A portion of the hull of the steamer *Reid* has for several years obstructed the winding basin at the outlet of the Benton Harbor Canal into the St. Joseph River. Efforts made in October, 1896, to find its owner were unsuccessful, and the facts were reported to the Chief of Engineers by letter dated November 6, 1896, with a recommendation for its removal in accordance with section 8 of the river and harbor act of September 19, 1890. By letter from the office of the Chief of Engineers dated December 8, 1896, authority was granted to remove the wreck. Proposals were invited by advertisement dated December 31, 1896, and were opened January 30, 1897. The lowest bid was rejected, the price being considered excessive, and authority obtained to do the work by hired labor by letter from the office of the Chief of Engineers dated February 6, 1897, and on May 23 the wreck was raised, towed out of the harbor, and deposited on the beach about 1 mile south of the entrance of St. Joseph Harbor and abandoned. The cost of removal, including advertising and printing, was $141.18.

The work was in the collection district of Grand Haven, Mich., which is the nearest port of entry.

Abstract of bids for removing wreck of steamer Reid from St. Joseph Harbor, Michigan, received and opened January 30, 1897, in accordance with advertisement dated December 31, 1896, by Capt. C. McD. Townsend, Corps of Engineers.

No.	Name and residence of bidders.	For lump sum.	Remarks.
1	John M. Allmendinger, Benton Harbor, Mich..	$200.00	With centrifugal pumps, etc., and deposited on beach.
2	Charles Peek, Milwaukee, Wis..................	600.00	With dynamite.
		750.00	Deposited alongside of dock.

Bids rejected as excessive.

J J 20.

SURVEY OF SOUTH HAVEN HARBOR, MICHIGAN.

[Printed in House Doc. No. 279, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 6, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 21, 1897, with map,* by Capt. C. McD. Townsend, Corps of Engineers, of the results of a survey of South Haven Harbor, Michigan, made to comply with the provisions of the river and harbor act of June 3, 1896.

Captain Townsend states that periodic dredging will always be necessary to maintain this harbor, but that its condition would be much improved by extending the piers to the 15-foot contour in Lake Michigan and repairing existing structures. The cost of the proposed work is estimated at $108,500.

The revetment of the banks of Black River will also be required, but this work should be done by the property holders to be benefited by the improvement.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

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* Not reprinted. Printed in House Doc. No. 279, Fifty-fourth Congress, second session.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 21, 1897.

GENERAL: In compliance with section 9 of the river and harbor act of June 3, 1896, I have the honor to submit the accompanying map of a recent survey of the harbor at South Haven, Mich., and the following estimate of the cost of improvement:

The existing project for the improvement of the harbor at South Haven contemplates a channel with a navigable depth of 12 feet in Black River from its mouth to the highway bridge in the city of South Haven, a distance of about one-half mile, its outlet to be protected by piers extending into Lake Michigan, with a width between them of 177 feet. The aggregate length of piers and revetments which have been constructed is 3,145 feet. The north pier projects a distance of about 650 feet beyond the shore line, the south about 470 feet.

Due, however, to a fall of the lake level of about 3 feet since the project was adopted, the piers only extend at present to depths in the lake of about 10 feet, and storms in Lake Michigan are liable to close the entrance to the harbor by a bar having not over 9 feet of water on its crest. During freshets in Black River sand is also deposited below the drawbridge and between the piers, so as to seriously impede navigation.

Periodical dredging will always be required to maintain this harbor, but its condition would be much improved if the piers were extended so as to prevent the formation of a bar at its entrance by storms on the lake. To attain this object will necessitate the extension of the piers to the 15-foot contour and repairs to existing structures. The following is an estimate of the cost:

Repairs to pile revetment, 1,130 feet, at $12	$13,560
Repairs to cribs, 708 feet, at $12	8,496
Repairs to cribs, 405 feet, at $15	6,075
Pier extension, 700 feet, at $90	63,000
Dredging, 50,000 cubic yards, at 15 cents	7,500
	98,631
Contingencies	9,869
Total	108,500

The revetment of the banks of Black River will also be required, but the work should be done by the property holders benefited by the improvement.

The improvement of the harbor to the extent covered by the above estimate is considered worthy and justified by the interests of the commerce involved.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, February 1, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

J J 21.

SURVEY OF HARBOR OF HOLLAND (BLACK LAKE), MICHIGAN, WITH A VIEW OF OBTAINING A 16-FOOT DEPTH OF WATER.

[Printed in House Doc. No. 272, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 4, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 5, 1897, by Capt. C. McD. Townsend, Corps of Engineers, of the results of a survey of harbor of Holland (Black Lake), Mich., with a view of obtaining a 16-foot depth of water, made to comply with the provisions of the river and harbor act of June 3, 1896.

The plan of improvement presented for securing a 16-foot channel depth at the present stage of Lake Michigan provides for pier extensions, repairs to existing structures, and dredging, and is estimated to cost $240,000.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

HON. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 5, 1897.

GENERAL: In compliance with section 9 of the river and harbor act of June 3, 1896, I have the honor to forward the inclosed map* of a recent survey of the harbor of Holland (Black Lake), Mich., with an estimate of the cost of "obtaining a 16-foot depth of water."

The existing project for the improvement of the harbor of Holland (Black Lake), adopted in 1867, contemplated a channel from Black Lake to Lake Michigan dredged to a depth of 12 feet, its sides protected by a pile revetment, and its entrance to Lake Michigan by piers constructed of timber cribs filled with stone. The work was completed in 1880, and consists on the north side of 1,137 feet of pile revetment and 713 feet of cribs, projecting 540 feet beyond the shore line; on the south side of 993 feet of pile revetment and 696 feet of cribs, projecting 685 feet beyond the shore line. Since that date the limited funds appropriated have been expended in dredging and repairs to existing work.

Due to the fall which has occurred in the water level of Lake Michigan and the annual growth of the shore line, the depth which can at present be maintained at the entrance to the harbor is about 8 feet.

To maintain a navigable channel of a depth of 16 feet below the existing level of Lake Michigan (minus 2 feet on the gauge at Black Lake) will require an extension of the north pier about 800 feet, of the south

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* Not printed.

pier 700 feet, and repairs to the existing structures. The estimate of cost is as follows:

Pier extension:	
600 feet, at $90	$54,000
900 feet, at $120	108,000
Reconstruction of pile revetment, 2,110 feet, at $15	31,650
Repairs to 246 feet crib work, at $25	6,150
Repairs to 510 feet crib work, at $12	6,120
Repairs to 653 feet crib work, at $4	2,612
Dredging 64,000 cubic yards, at 15 cents	9,600
	218,132
Contingencies	21,868
Total	240,000

The modification of the existing project so as to provide for a channel having a depth of 16 feet at the existing stage of Lake Michigan I consider worthy and justified by the interests of commerce involved. The commerce of Holland has rapidly increased in the past ten years, and is materially interrupted by the formation of sand bars at the entrance to the harbor during severe storms, which need to be dredged before vessels can enter or depart from the port.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, January 28, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

J J 22.

SURVEY OF LUDINGTON HARBOR, MICHIGAN.

[Printed in House Doc. No. 273, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 6, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 2, 1897, with map,* by Capt. C. McD. Townsend, Corps of Engineers, of the results of a survey of Ludington Harbor, Michigan, made to comply with the provisions of the river and harbor act of June 3, 1896.

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* Not reprinted. Printed in House Doc. No. 273, Fifty-fourth Congress, second session.

The plan of improvement proposed contemplates obtaining a channel depth of 18 feet below the present water level of Lake Michigan, and provides for pier extensions, reconstruction and repairs to existing structures, and dredging. The cost is estimated at $210,000.

Captain Townsend states that the reconstruction and repairs to existing structures will be required for the maintenance of the existing project.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., January 2, 1897.

GENERAL: In compliance with section 9 of the river and harbor act of June 3, 1896, I have the honor to submit the following estimate of the cost of improving Ludington Harbor, Michigan, and to inclose a tracing of a map of a recent survey of that vicinity.

The existing project for the improvement of the harbor at Ludington, Mich., adopted in 1890, provides for a channel 18 feet deep and 250 feet wide at the entrance, protected by piers extending from Pere Marquette Lake into Lake Michigan, on the north side of the channel, a distance of 930 feet, and on the south side 1,550 feet.

The piers have been constructed as prescribed by the project and a channel obtained over 17 feet below the level of the lake surface at the time the project was submitted. Due, however, to a fall of the lake surface of about 3 feet, a navigable channel of not more than 14½ feet can at present be maintained without periodical dredging. The depths between piers shown on the map have resulted from recent dredging operations.

The estimate of the cost of improving the harbor so as to maintain a channel 18 feet below the present water level of Lake Michigan (2 feet below the zero of the gauge at Ludington) is as follows:

Extension of north pier 700 feet, at $120 per foot	$84,000
Extension of south pier 300 feet, at $150 per foot	45,000
Dredging 60,000 cubic yards, at 15 cents per cubic yard	9,000
Reconstruction of 1,600 feet piers, at $25 per foot	40,000
Repairs to pile revetment of south pier, 567 feet, at $20 per foot	11,340
Minor repairs to remaining piers	1,660
	191,000
Ten per cent for contingencies	19,000
Total	210,000

The reconstruction and repairs to existing structures will be required for the maintenance of the existing project.

The harbor of Ludington not only has a local commerce of some magnitude, but, due to the lines of steamboats which run from this port to cities in Wisconsin across Lake Michigan, becomes an important link in a line for the movement of freight to and from the Northwest to the Atlantic Seaboard.

The improvement of the harbor, as estimated above, I consider worthy and justified by the interests of commerce involved.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, NORTHWEST DIVISION,
New York, January 28, 1897.

Respectfully forwarded to the Chief of Engineers, United States Army, recommended for approval.

HENRY M. ROBERT,
Colonel, Corps of Engineers, Division Engineer.

J J 23.

SURVEY OF CHARLEVOIX HARBOR, MICHIGAN, WITH A VIEW OF OBTAINING 16-FOOT DEPTH OF WATER.

[Printed in House Doc. No. 144, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 30, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated December 19, 1896, with map,* by Capt. C. McD. Townsend, Corps of Engineers, of the results of a survey of Charlevoix Harbor, Michigan, with a view of obtaining 16-foot depth of water, made to comply with the provisions of the river and harbor act of June 3, 1896.

The plan of improvement presented provides for pier extension and dredging, together with repairs to existing structures, and the total cost of such work is estimated to be $160,000.

Captain Townsend considers the proposed improvement to be worthy and justified by the interests of commerce, but states that no extension of the existing project should be undertaken by the General Government until the local authorities remove the present bridge across Pine River, which would be a serious obstruction to navigation for vessels of greater draft than is contemplated by the existing project. I concur in his views.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 144, Fifty-fourth Congress, second session.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Grand Rapids, Mich., December 19, 1896.

GENERAL: In compliance with the river and harbor act of June 3, 1896, I have the honor to submit the inclosed map of a recent survey of Charlevoix Harbor, Michigan, and the following estimate of the cost of "obtaining 16-foot depth of water" at the harbor.

The existing project for the improvement of Charlevoix Harbor provides for dredging a channel 12 feet deep through Pine River from Round Lake to Lake Michigan, protecting its sides by pile revetments and its entrance by crib piers extending to 12 feet of water in Lake Michigan, with a channelway 150 feet wide between them.

The sides of Pine River have been revetted, the north pier has been constructed to the length required by the project and the south pier to within 200 feet of its estimated length, and a channel obtained with a depth over 12 feet below the level of the lake at the date the project was submitted (1884); but, due to a fall of the lake surface of about 3 feet since that date, the navigable depth of water which can now be maintained without annual dredging is only 11 feet. The depths between piers shown on the map have resulted from dredging during the past season, and a fill during winter storms is to be anticipated.

To secure a navigable channel of a depth of 16 feet at the existing level of Lake Michigan (2 feet below the zero of the gauge) will require an extension of the north pier a distance of 400 feet and of the south pier 500 feet, and a rebuilding and strengthening of existing piers and revetments. This latter work will soon be required to maintain the existing project, as the piers and revetments are timber structures, some of which were constructed by local authorities prior to 1876.

ESTIMATE OF COST.

Extending north pier 400 feet, at $100	$40,000
Extending south pier 500 feet, at $90	45,000
Dredging 40,000 cubic yards, at 15 cents	6,000
Repairs:	
Reconstruction of north plank-beam revetment, 945 feet, at $20	18,900
Repairs to north pier	6,000
Reconstruction of south plank-beam revetment, 1,528 feet, at $17.50	26,740
Repairs to south pier	2,820
	145,460
Contingencies, 10 per cent	14,540
Total	160,000

While the freight entering and departing from the port of Charlevoix is not extensive, the city is becoming a popular summer resort, and requires sufficient depth of water so that large passenger steamers which run on Lake Michigan can enter the port. The modification of the existing project so as to increase the navigable channel to a depth of 16 feet I consider worthy and justified by the interests of commerce involved, but no extension of the existing project should be undertaken by the General Government until the local authorities remove the present bridge across Pine River, which will be a serious obstruction to navigation for vessels of greater draft than is contemplated by the existing project.

Very respectfully, your obedient servant,

C. McD. TOWNSEND,
Captain of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

APPENDIX K K.

IMPROVEMENT OF RIVERS AND HARBORS ON THE EASTERN COAST OF MICHIGAN AND OF WATERS CONNECTING THE GREAT LAKES.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ship canal connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo.
2. St. Marys River at the Falls, Michigan.
3. Operating and care of St. Marys Falls Canal, Michigan.
4. Hay Lake Channel, St. Marys River, Michigan.
5. Cheboygan Harbor, Michigan.
6. Alpena Harbor (Thunder Bay River), Michigan.
7. Saginaw River, Michigan.
8. Sebewaing River, Michigan.
9. Harbor of refuge at Sand Beach, Lake Huron, Michigan.
10. St. Clair Flats Canal, Michigan.
11. Operating and care of St. Clair Flats Canal, Michigan.
12. Mouth of Black River, Michigan.
13. Black River at Port Huron, Michigan.
14. Pine River, Michigan.
15. Belle River, Michigan.
16. Clinton River, Michigan.
17. Detroit River, Michigan.
18. Rouge River, Michigan.
19. Turning Basin in Rouge River, Michigan.
20. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATION.

21. Huron River, Michigan.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich, July 23, 1897.

GENERAL: I have the honor to submit herewith the annual report relative to the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1897.

* * * * * * *

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

K K 1.

IMPROVEMENT OF SHIP CHANNEL CONNECTING WATERS OF THE GREAT LAKES BETWEEN CHICAGO, DULUTH, AND BUFFALO.

This improvement was entered upon in accordance with the following provision of the river and harbor act of July 13, 1892:

For ship channel twenty and twenty-one feet in depth and a minimum width of three hundred feet in the shallows of the connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, three hundred and seventy-five thousand dollars: *Provided,* That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the plans proposed by General O. M. Poe, Corps of Engineers, United States Army, dated January twentieth, eighteen hundred and ninety-one, and printed as House Executive Document, numbered two hundred and seven, second session, Fifty-first Congress, for such ship channel, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate two million nine hundred and sixty-five thousand dollars, exclusive of the amount herein appropriated.

The estimated total cost was $3,340,000.

The work was divided into eight sections, the first four being in the St. Marys River, the fifth at the foot of Lake Huron, the sixth and seventh in Lake St. Clair, and the eighth through the bar at mouth of Detroit River. Contracts for all of these sections were entered into December 31, 1892, and operations under them commenced in the spring of 1893. Work on sections 1, 4, and 6 was completed by or before June 30, 1896; and the Report of the Chief of Engineers for that year, pages 2749–2756, contains a history of operations to that date.

OPERATIONS DURING YEAR ENDING JUNE 30, 1897.

Work was continued on sections 2, 3, 5, 7, and 8, and completed in all except section 8, as follows: Section 2, September 26, 1896; section 3, June 22, 1897; section 5, September 30, 1896; section 7, May 31, 1897. In section 8 work during the year was carried on with one dredge only, and progress was therefore very slow and unsatisfactory; but by the close of the year the work was about finished, only a few shoal spots where bottom grade had not been reached in the general process of dredging remaining to be cleared.

Work was also done at the foot of Mud Lake, St. Marys River, in removing a dangerous shoal (No. 29) that lay at the turning point in the channel off Point Aux Frênes; this work was commenced September 14, 1896, and was nearly completed at the close of the fiscal year.

The following details of the year's work are compiled from the reports of the several assistants in local charge of operations:

Section 2.—Little Mud Lake, improved channel 300 feet wide and 24,000 feet long; the upper and lower angles widened to 700 feet. Contract dated December 31, 1892; C. E. Mitchell & Co., Ludington, Mich., contractors. Rates, 25.9 cents per cubic yard, bank measure, to 21-foot grade, and half rates between 21 and 22 feet. Material, clay, sand, stone, and bowlders.

Work was continued with one dredge till September 26, 1896; time worked 238½ hours; delayed 167½ hours; excavation 5,891 cubic yards, scow measure. Parts of this section were examined several different times with the raft bars before all the spots above 21-foot grade were removed.

Work was begun on this section on May 13, 1893. The computed bank measure of material excavated above 21-foot grade is 464,914.42 cubic yards; between 21 and 22 feet, 182,701.54 cubic yards; below 22-foot grade, or outside of specified side slopes, 232,505.53 cubic yards, making a total of 880,121.59 cubic yards. The scow measure was 766,610 cubic yards.

Section 3.—Sailors Encampment, 300 feet wide by 5,000 feet long, the upper angle widened to 700 feet. Contract dated December 31, 1892; John Hickler, Buffalo, N. Y., contractor. Rates $2.43 per cubic yard, bank measure, to 21-foot grade, and half rates between 21 and 22 feet. Material, limestone rock in situ and bowlders.

Work was continued with three dredges, time 3,127½ hours, delays 287 hours. Excavation 31,699 cubic yards, scow measure; two drill boats, time 1,339 hours, delays, 18 hours. Number of holes drilled, 2,740; the total depth of drilling was 21,010 feet, and 8,688 pounds of dynamite, 40 per cent nitroglycerin, were used; two diving outfits, time 2,076 hours, delays 207 hours. Three thousand one hundred and three yards of rock were raised.

The west half of the channel was open for use of navigation on October 12, 1896, and the entire section was completed on June 22, 1897. The examinations with the raft bars were made in October, May, and June. The season's work closed November 30 and was resumed April 24.

Work was begun on this section June 12, 1893, drilling and blasting being the principal work done during the first season. The total hours worked, 12,107½, delays 128½ hours. Number of holes drilled, 20,826; total depth of drilling, 134,430 feet; the dynamite used from 40 per cent to 65 per cent nitroglycerin, and amounted to 118,799 pounds. The total time of work for diving outfits was 2,410 hours and delays 254 hours, and 4,182 cubic yards of rock were raised.

The computed bank measure of material excavated above 21-foot grade is 106,054.10 cubic yards; between 21 and 22 feet, 24,640.76 cubic yards; below 22 feet or outside of specified side slopes of two to one, 31,698.03 cubic yards, making a total of 162,392.89 cubic yards. The total scow measure is 207,785 cubic yards. The bank measure of material above 21-foot grade is 44 per cent less than the scow measure. The total bank measure is about 22 per cent less than the scow measure.

The completion of this channel enabled the boats to increase their draft about 3 feet.

Section. 4—Shoal 29.—In Mud Lake, St. Marys River, off Point Aux Frênes, 400 feet by 1,400 feet. Contract dated September 19, 1895; W. A. McGillis & Co., of Chicago, Ill., contractors. Rates, earth 65 cents and rock $3.75 per cubic yard, bank measure, to 21-foot grade, and half rates between 21 and 23 feet. Material, bowlders, clay, and limestone rock in situ.

Work was begun with one dredge on September 3, 1896, stopped for season on November 29, and resumed work on May 18. Number of hours worked, 652; delayed, 758. Excavation, 21,432 cubic yards, scow measure.

This section will be completed during July.

Section 5.—Foot of Lake Huron.—Channel 2,400 feet wide, 21 feet deep, and about 8,000 feet long. The east half of the channel, under contract with R. J. Cram, was completed prior to June 30, 1896 (483,882 cubic yards, scow measure, being removed), and that part of the channel was thrown open to navigation. Under contract of December 31, 1892, with McCollum & Lee, 450,932 cubic yards, scow measure, had been removed from the west half to June 30, 1896. Work was completed September 30, 1896, the total excavated being 483,536 cubic yards, scow measure. The contract price was 58 cents per cubic yard, scow measure. Material, sand, clay, gravel, and bowlders.

Section 7.—Grosse Point Flats.—Channel 800 feet wide, 20 feet deep, and about 58,400 feet long. Under contract of December 31, 1892, with Breymann Bros., 4,330,951 cubic yards, scow measure, had been removed to June 30, 1896. Work was continued during the year to completion on May 31, 1897, operations being suspended from December 1 to March 29. One million two hundred and nineteen thousand two hundred and fifty-eight cubic yards were excavated, making the total excavation under this contract, 5,550,209 cubic yards, scow measure. The contract price was 14⅞ cents per cubic yard, scow measure. Material, clay, gravel, sand, and bowlders.

Section 8.—Mouth of Detroit River.—Channel 800 feet wide, 21 feet deep, and about 26,500 feet long. Under contract of December 31, 1892, with L. P. & J. A. Smith, 970,769 cubic yards, scow measure, had been removed to June 30, 1896. The work was continued during the year, except from July 1 to August 10, and December 4 to May 19, the total excavation being 40,354 cubic yards, scow measure. Only one dredge was at work during the year, and progress was therefore slow and extremely unsatisfactory. The contract price is 18 cents per cubic yard, scow measure. Material, sand, clay, gravel, and bowlders.

The total amount excavated at all points during the year was 9,643,179.78 cubic yards, and the general result was the practical completion of work on the ship channel at all places indicated in the report of January 20, 1891, on which the project of 1892 was based. The completion of work in section 3 enabled vessels to increase draft through St. Marys River about 3 feet.

Surveys and examinations.—During the winter ice surveys were made of the areas included in sections 1, 3, 4, and 8, and the soundings reduced and plotted. Several examinations have been made during the year, with raft bars suspended at grade of the different sections, and of other localities in the channel where obstructions were reported to exist. A survey was also made for the purpose of locating on the map the new channel through Lake St. Clair. This channel was examined in April to determine its general condition, and a special report thereon submitted May 4, 1897.

The following statement indicates the total work of excavating, bank and scow measure, done to June 30, 1897:

	Cubic yards.
Bank measure:	
Section 1	109,236.10
Section 2	880,121.49
Section 3	162,392.89
Section 4	292,616.80
Scow measure:	
Section 5	967,418.00
Section 6	648,630.50
Section 7	5,559,209.00
Section 8	1,011,123.00
Shoal 29	21,432.00
Total	9,643,179.78

Further work on this important improvement will be directed toward widening channels heretofore made, with a view to making navigation safer at critical points, and removing detached shoals already developed by surveys, or by the passage of vessels loaded to the deep draft now carried as a result of improvements thus far made; it is highly probable that other shoal areas will be developed in the same way. The sundry civil act of June 4, 1897, also requires that "necessary observations and investigations in connection with the preservation of such channel depth" be made; these investigations will constitute a most important and valuable feature of future surveys and examinations relating to this work.

The appropriation of $1,090,000 made by the act just mentioned brings the aggregate of appropriations made to date up to the total amount of the original estimate. After settlement is made for work completed and in progress, there will be available for further work, surveys, and investigation the sum of $950,000, in round numbers, and it will suffice for completing work authorized by the general project. It is proper to note, however, that the completion of the 20-foot channel, in such a way as to give a safe line of water travel from the heads of Lake Superior and Michigan to Buffalo, will require more than was specified in that project; this is especially the case respecting some portions of the Detroit, St. Clair, and St. Marys rivers. But, as stated above, funds now available will suffice for completing work authorized by the general project, and, therefore, no estimate for additional work is submitted in this report.

Sections 1, 2, 3, and 4 are in the collection district of Superior, Mich. The nearest port of entry is Marquette, Mich., but Sault Ste. Marie is a subport.

Section 1. Nearest lights, Point Iroquois Light-House, St. Marys River upper and lower lights, Point aux Pins Light (Canadian).

Section 2. Nearest lights, Harwood Point ranges, Hen and Chicken ranges, Point of Woods ranges (American and Canadian), East and West Dark Hole ranges.

Section 3. Nearest lights, Rains Hill ranges (Canadian), Point of Woods (Canadian), Encampment Crib Light.

Section 4. Nearest lights, Everens Point range lights (Canadian), Winter Point range lights.

Section 5 is in the collection district of Huron, Mich. The nearest port of entry is Port Huron, Mich., and the nearest light-house is Fort Gratiot Light.

Sections 6, 7, and 8 are in the collection district of Detroit, Mich. The nearest port of entry is Detroit, Mich. The nearest light-houses to section 6 stand on St. Clair Flats Canal; to section 7, Windmill Point Light-House and range lights in vicinity; to section 8, Bois Blanc (Canadian) and the Detroit River Light-House.

Total expended on present project to June 30, 1896	$1,694,394.38
Expended during fiscal year, excluding outstanding liabilities	518,117.97
Total expended to June 30, 1897	2,212,512.35

Money statement.

July 1, 1896, balance unexpended		$558,383.68
Amount appropriated by sundry civil act approved June 4, 1897		1,090,000.00
		1,648,383.68
June 30, 1897, amount expended during fiscal year		518,117.97
July 1, 1897, balance unexpended		1,130,265.71
July 1, 1897, outstanding liabilities	$177,606.88	
July 1, 1897, amount covered by uncompleted contracts	2,610.79	
		180,217.67
July 1, 1897, balance available		950,048.04

Appropriations for ship channel in the connecting waters of the Great Lakes.

July 13, 1892	$375,000.00
March 3, 1893, sundry civil act	875,000.00
March 2, 1895, sundry civil act	500,000.00
June 11, 1896, sundry civil act	500,000.00
June 4, 1897, sundry civil act	1,090,000.00
Total	3,340,000.00
February 19, 1895, repayment of overpayment made R. J. Cram, dredging section 1	2,778.06

List of contracts in force during the fiscal year ending June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Date of expiration.	Remarks.
C. E. Mitchell & Co	Jan. 13, 1893	June 13, 1893	Dec. 31, 1896	Work completed Sept. 26, 1896.
Breymann Bros	do	Apr. 17, 1893	July 1, 1897	Work completed May 31, 1897.
John Hickler	Jan. 19, 1893	June 12, 1893	do	Work completed June 22, 1897.
McCollum & Lee	do	June 14, 1893	Dec. 31, 1896	Closed Nov. 2, 1896.
R. J. Cram	do	May 10, 1894	do	Closed Aug. 25, 1896.
L. P. & J. A. Smith	do	June 1, 1893	July 1, 1897	Not finished.
W. A. McGillis & Co	Oct. 24, 1895	Sept. 4, 1896	July 10, 1897	
Newton & MacBean	Aug. 22, 1896	For fiscal year ending	June 30, 1897	
P. C. Keliher	do			
Do	do			
Ferguson Hardware Co	do			
Frank Perry	do			

LETTER OF THE LAKE CARRIERS' ASSOCIATION.

LAKE CARRIERS' ASSOCIATION,
Buffalo, N. Y., August 16, 1897.

SIR: Early in the present season of navigation the Lake Carriers' Association undertook an investigation of the present condition of the channel improvements in the Detroit, St. Clair, and St. Marys rivers, with a view to calling your attention to supplemental improvements which should be undertaken for the purpose of perfecting the great work which the Government has undertaken, and providing a suitable ship channel between Chicago, Duluth, and Buffalo. As you are aware, the work on the so-called "20-foot channel," under the project recommended by the late General Poe, is nearly completed. It was General Poe's purpose in outlining this project to get a narrow waterway through the difficult points in the rivers, and he fully understood that in certain places the improvements which he outlined were not final in character, as the channels provided were not of sufficient width for the accommodation of the increasing commerce which passes through them. The existing project calls for a ship canal 20 and 21 feet in depth between Chicago, Duluth, and Buffalo, "with a minimum width of 300 feet." Where a greater width could be provided within the limits of the estimate which General Poe made, a greater width than 300 feet has been provided. Thus the improvements at the foot of Lake Huron, just completed, provide a channel 2,400 feet in width. The improvements at the mouth of the Detroit River, now nearly completed, provide for clearing out a 20-foot channel 800 feet in width. So also at Round Island in the upper St. Marys River, and at Grosse Point, the channels are much more than 300 feet wide. At certain points, however, channels only 300 feet in width are being completed under the existing project.

The Lake Carriers' Association has given this matter careful consideration and has had several interviews with the engineer officers in charge of these important works with a view to arriving at some project, reasonable in cost, which might now be adopted as a supplement to the existing project, and which would provide a less dangerous waterway and be more in keeping with the present requirements of commerce.

Commencing at the lower end of the Detroit River, we beg to submit the following suggestions, showing what we deem to be necessary in the way of further improvements of the channels:

LIMEKILN CROSSING.

The cut at Limekiln Crossing is now 440 feet wide, with quite a sharp turn at each end, the edges of the cut being of hard and jagged rock. A project should be adopted for widening the cut to 600 feet and for cutting off the angles above and below to a corresponding extent so as to make an easy approach to the cut.

BALLARDS REEF.

The present improvement at Ballards Reef consists in cleaning out the bowlders from a channel 300 feet in width. The west half of this channel is now cleaned out to a depth of 18 feet, excepting one shoal of considerable size, and a drill boat is now at work on that shoal. The east half of this 300-foot channel is being cleared out to a depth of 20 feet. A project should be adopted here calling for a channel 600 feet wide and 20 feet deep. This work does not consist of excavating solid rock. The soundings show that most of the 600-foot channel is now over 20 feet deep. The work would consist of cleaning out bowlders and small shoal spots. This work is as urgently needed as any on the Great Lakes. The draft of vessels is now limited by the water at this point, there being more water at all other points in the channel than at Ballards Reef.

ST. CLAIR FLATS CANAL.

Another 300-foot channel is imperatively needed at this point. It could be constructed just to the west of the old channel, with an approach of corresponding width below. The approach above is now of natural deep water of ample depth.

ST. CLAIR RIVER.

There are a few shoal spots in the St. Clair River which should be cleaned out, especially those in the American channel on the west side of Stag Island, and the Middle Ground, which encroaches upon the channel at the mouth of Black River. We understand that under the existing project for a ship channel 300 feet wide and 20 feet deep, any shoals in the waters connecting the Great Lakes, not specifically appropriated for otherwise, can be cleared out, and we believe there is sufficient money on hand out of the present appropriation to do this work.

ST. MARYS RIVER.

The existing channel by way of the Middle Neebish is of a width of 300 to 350 feet at Sailors Encampment, Dark Hole, and Middle Neebish Cut. At the latter place there is an available depth of only 18 feet for a distance of about 2,000 feet. This appears to have been caused by the lowering of the levels of Hay Lake through the improvements which have been made to utilize the Hay Lake channel. These channels should all be immediately widened to 600 feet, and the Middle Neebish Cut deepened to a depth of 20 feet, or else a new project should be taken up and adopted for the improvement of the channel through the West Neebish. There is no doubt that the latter course would afford a much better channel than could be provided through the Middle Neebish, and that a distance of 7 miles could thus be saved. This would make a grand improvement in the navigation between Lake Superior and Lake Huron. Down-bound boats could use the West Neebish channel and up bound craft follow the present channel through the Middle Neebish. Whether the improvement of the West Neebish is undertaken or not, the Middle Neebish for a distance of 2,000 feet, where the depth is only 18 feet, should be deepened to 20 feet and widened to at least 350 feet.

UPPER ST. MARYS RIVER.

We understand that authority has already been obtained by the engineers to use money now on hand to widen the west approach to the St. Marys Falls Canal at Rock Shoal to an approximate width of 1,000 feet.

These are the points in the waters connecting the Great Lakes which need further improvement, and, as you will perceive, the improvements here stated are: First, to provide at Ballards Reef and Middle Neebish Cut a depth of 20 feet, which is what has been obtained elsewhere and which is called for by the existing project; second, to widen the channels at the Limekiln Crossing, St. Clair Flats Canal, Dark Hole, and

Sailors Encampment, so as to make those channels reasonably safe for the larger vessels now using them and commodious enough to provide for the still further increase in the lake commerce which must be reasonably looked for and which no one who, like yourself, is familiar with the history of lake navigation can doubt.

Trusting that these recommendations, which are the result of careful examination and which have been approved by the committee of the Lake Carriers' Association appointed to consider the subject, will receive careful consideration at your hands, we remain,

Very respectfully, yours,

LAKE CARRIERS' ASSOCIATION,
By C. H. KEEP, *Secretary.*

Hon. RUSSELL A. ALGER,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 21, 1897.

Respectfully referred to Lieut. Col. G. J. Lydecker, Corps of Engineers, for remark.

Colonel Lydecker's annual report indicates that all these matters have had consideration by him, but it may be decided to be permissible and expedient to introduce this paper and Colonel Lydecker's remarks thereon as an appendix to the report on the 20-foot channel.

A return of the paper with remarks, so as to reach this office not later than August 31, is desired.

By command of Brig. Gen. Wilson:

A. MACKENZIE,
Lieut. Col., Corps of Engineers.

[Third indorsement.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., August 28, 1897.

Respectfully returned to the Chief of Engineers, U. S. A.

It is of the greatest importance, in my judgment, that the matters referred to herein have consideration by Congress at the earliest date practicable, and especially that means be provided for securing a navigable depth of 20 feet in the lower Detroit River; i. e., from the head of Ballards Reef to the head of section 8 of the 20-foot channel between Chicago, Duluth, and Buffalo, a distance of about 4½ miles. At all other points the requisite depth has been secured, except over a short distance in the Middle Neebish, St. Marys River, and it will be obtained there by the 1st of July next. Until the Detroit River section is correspondingly improved, the draft of vessels through that reach must be limited to from 17½ to 18 feet, and the commerce passing that locality (which now approximates 30,000,000 tons of freight annually) must remain unable to realize the benefits of the 20-foot channel already provided at a cost of over $6,000,000, at all other points on the through line of travel.

Increased width in the channels as they now exist is also a matter of vital importance, but its discussion comprehends too much for incorporation in this indorsement, within the limits of time indicated in the second indorsement hereon; I shall therefore make it, and other work referred to in this letter, the subject of a special report at an early date.

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

K K 2.

IMPROVEMENT OF ST. MARYS RIVER AT THE FALLS, MICHIGAN.

At the time of the adoption of the present project the old State locks, built in 1855, and the lock of 1881 were in operation, giving, at the normal stage of water, a maximum draft of about 16 feet. To meet the demands of the large and rapidly increasing commerce between Lake Superior and the lower lakes a lock of greater capacity and an increased allowable draft was urgently required.

The present project, dated October 18, 1886, provides for the construction of a new lock on the site of the State locks of 1855, to have a length of 800 feet between gates, a width of 100 feet throughout, a depth of 21 feet on miter sills, and a single lift approximating 18 feet, the canal being deepened to correspond. The object of the improvement is to benefit commerce between Lake Superior and the rest of the lake region, and the estimated cost is $4,738,865.

The Report of the Chief of Engineers for 1896 (pages 2779–2784) outlines the progress of operations to June 30, 1896, at which date the new lock with its approaches, and the work of deepening the canal, were very near completion.

WORK DONE DURING FISCAL YEAR ENDING JUNE 30, 1897.

The contracts for lock gates, for operating machinery, for stationary pumping plant, and for turbine power plant had all been completed before June 30, 1896; but final payments had not been made awaiting practical working tests. These tests were made during July, 1896, and the contracts were closed. The new lock was opened to navigation August 3, 1896.

Deepening canal prism, section 1.—Under contract of July 14, 1892, with Dunbar & Sullivan, the work was practically completed in June, 1896, but final cleaning up was not finished until August 12, the dredge and diver having removed 710 cubic yards after July 1. The final estimate showed a total excavation above 25-foot grade, as required by the contract, of 133,437.94 cubic yards, bank measure; between grades of 25 and 26 feet, 22,498.50 cubic yards. The contract price for excavation above 25-foot grade was $1.53 per cubic yard, bank measure, and half that for excavation between 25 and 26 feet. The material was sandstone rock in situ and bowlders.

Removing shoals from west canal approach.—Under contract of September 14, 1895, with Dunbar & Sullivan, 48,630 cubic yards, estimated bank measure, had been removed to June 30, 1896. Work was continued during the year, except from November 22 to April 21, and was almost completed at the end of the year; excavation during the year, 32,480 cubic yards, estimated bank measure. The full width of 600 feet could not be secured under this contract, as a shoal was developed containing about 20,000 cubic yards of sandstone rock and the contract limited payment for rock to 2,000 yards.

The contract price for excavation above 21-foot grade is 28 cents per cubic yard, bank measure, for earth and $10 per cubic yard for rock, and half rates between 21 and 23 feet. The material is sand, bowlders, and sandstone rock.

Removing material from and building piers for the lock approaches.—Under contract of June 15, 1895, with James B. Donnelly, work was continued at the required rate to June 30, 1896. By supplemental contract dated May 25, 1896, in consideration of an additional compensation of $12,000 the contractor agreed to complete and throw open to navigation on or before July 31, 1896, channels through the lock approaches of sufficient width for the safe passage of the largest vessels, and to complete the lock approaches in all essential features and throw them open to navigation on or before September 20, 1896.

Under these contracts work was carried on during the year. The channels through the approaches were completed July 31, 1896, to the extent required by supplemental contract, and by September 20 the essential features of work on the lock approaches were finished in substantial conformity with the supplemental contract, so as to make them available for navigation from that date. But the final work of clearing the channel to the prescribed grade was not finally completed until June, 1897. The original contract provided for removing the old movable dam from the canal, but the absence of any provision for replacing it by a suitable substitute made it inexpedient to do so, and the contractor has consented to omit this portion of the proposed work.

Details of work done under the Donnelly contracts, material furnished, and unit prices are given in the following table:

Work done and materials furnished.	Total quantities during fiscal year ending June 30, 1897.	Total quantities on final estimate.	Unit price.
Earth excavated above grade, bank measure..........cubic yards..	9,787	114,246	$0.22
Earth excavated between grade and subgrade..............do....	948	2,109	.11
Rock excavated above grade, bank measure................do....	9,422	28,884	1.40
Rock excavated between grade and subgrade...............do....	4,068	4,968	.70
Filling placed in and back of piers.....................do....	34,761	65,413	.23
White-pine timber furnished and built into piers......cubic feet..	64,053	119,383	.29
Hemlock timber furnished and built into piers...........do....	422	213,843	.19½
Wrought iron furnished and built into piers.............pounds..	44,325	248,157	.03
Cast iron furnished and built into piers................do....	12,247	101,195	.03
Piles furnished, driven, and cut off at grade...........number..	19	69	16.00

Power house and office building.—Under contract of August 11, 1894, with J. V. Gearing, on June 30, 1896, the outer walls had been completed, except some coping stones; floor beams and girders had been placed, and also the larger portion of the terra-cotta floor arches. Work has continued during the year with a small force, and is now very nearly completed. There remains to be done about 25 per cent of the painting and plumbing, 65 per cent of the electric lighting, 70 per cent of the work on the elevator, besides a little plastering, carpentering, masonry, and steel and iron work.

Shoal below Poe Lock.—The work of removing the shoal which had formed at the eastern entrance to the Poe Lock, and upon which many vessels had struck, was begun May 7, 1897, and completed June 10. The plant, consisting of one dredge, one tug, and two dump scows, was furnished by H. W. Hubbell & Co., under oral agreement dated May 7, 1897, the compensation being at the rate of $12.25 per actual working hour. Some small shoals to the east and north of the main shoal and above the 20-foot grade were also removed. The dredge worked 284 hours and 50 minutes, and removed 8,163 cubic yards, scow measure, of material, consisting of bowlders, gravel, hardpan, and some bed rock. The total cost was $3,489.21, making the rate 42¾ cents per cubic yard.

Concrete walks.—During the fiscal year 3,956 square yards of concrete walks have been laid along the sides of the locks and about the canal grounds, especially that part south of the Weitzel Lock. In their construction use was made of the large quantity of limestone chips or shavings which were left by the stone planers used in cutting the stone for the Poe Lock. The foundation of the walks consists of 8 inches of limestone chips, well wetted and rammed. Upon this was laid 5 inches of concrete, mixed in the proportion of 1 part Portland cement and 10 parts limestone chips, no sand being used. The top dressing consists of one inch of Portland-cement mortar, of proportions 1 cement to 1 sand. Walks 8 feet wide are divided into blocks 4 feet square, and those 5 feet wide into blocks 4 by 5 feet. The edges are finished with a quarter round and the joints struck with a jointer. Itemized cost:

1,123 barrels Portland cement, at $1.66	$2,650.28
116 cubic yards sand, at $1	116.00
Labor	3,631.51
Engineering and superintendence	450.00
Total	6,847.79
Cost per square yard of completed walk	1.73

The cost was largely increased by the number of times the planer chips had to be handled and the long distances they had to be conveyed in wheelbarrows.

Surveys.—The canal grounds were resurveyed to include the many changes that have taken place during the past two years. All range lights, buoys, and targets not previously located were located from two or more triangulation stations and their coordinates computed.

A detailed survey, through the ice, was made of Bayfield Rock Shoal, located 1¼ miles below the canal. The field work of ice surveys of this and other localities in the river lasted from January 26 to March 26, 1897. The operations carried the party over 43 miles of the river's length, necessitating the pitching of five camps. The total number of soundings taken was 125,013, at a cost of $2,696.06. The party was in the field fifty-eight days, of which forty-seven were working days.

Cement tests were continued during the year.

Water levels.—Daily water-gauge readings above and below the locks were continued during the year, and the annual mean for the calendar year 1896 and the monthly means for the various months have been computed. In order that these published tables may be kept up to date, the various monthly and annual means of St. Marys River, above and below the locks, and Lake Huron are submitted herewith.

Elevation above sea level.

Month.	St. Marys River.		Lake Huron.
	Above the locks.	Below the locks.	
1896.	*Feet.*	*Feet.*	*Feet.*
July	602.53	582.70	579.58
August	602.55	582.85	579.57
September	602.41	582.71	579.39
October	601.99	582.25	579.19
November	602.02	582.15	579.05
December	601.95	582.06	578.93
Annual mean (calendar year)	601.96	582.50	579.09
1897.			
January	601.72	582.79	579.01
February	601.42	582.63	578.92
March	601.43	582.68	579.06
April	601.57	581.73	579.40
May	601.91	582.19	579.97
June	602.27	582.59	580.21

NOTE.—To obtain the elevation of Lake Superior, the fall of the river between Whitefish Bay and the canal should be added to these readings taken above the locks. This fall for the normal stage is about 0.41 foot. The elevations heretofore published as those of Lake Superior are the readings taken in the St. Marys River above the locks and should be similarly corrected to obtain the elevations of Lake Superior proper. The elevations of the gauges are derived from bench mark 2, on the south wall of the lock of 1881, established by the United States Lake Survey in 1867, by water-level observations. The elevation of the bench mark is 605.87 feet above mean tide at New York.

Differences in elevation.

Month.	Between St. Marys River above and below the locks.	Between St. Marys River below the locks and Lake Huron.	Between St. Marys River above the locks and Lake Huron.
1896.	*Feet.*	*Feet.*	*Feet.*
July	19.83	3.17	23
August	19.69	3.28	22.96
September	19.70	3.32	23.02
October	19.73	3.06	22.80
November	19.87	2.10	22.97
December	19.89	3.13	23.02
Annual mean (calendar year)	19.45	3.41	22.87
1897.			
January	18.93	3.78	22.71
February	18.79	3.71	22.49
March	18.80	3.57	22.37
April	19.84	2.33	22.17
May	19.72	2.22	21.94
June	19.68	2.38	22.06

The commerce passing St. Marys River at this point is reported in detail in reports for operating and care of St. Marys Falls Canal.

The estimated cost of improvement at the falls was $4,738,865, all of which has been appropriated; in addition to this $25,000 was appropriated by the act of March 3, 1893, for improving the Lake George channel, making the total appropriation to date, $4,763,865. The improvements in Lake George were duly made, and the balance of money now available will suffice for completing the work that remains to be done in connection with the canal system at the falls.

Operations connected with these improvements have been conducted under the immediate direction of Mr. E. S. Wheeler, assistant engineer, and his report containing detailed information respecting the work is appended hereto.

The study and preparation of plans for the operating machinery of the Poe Lock was committed to F. M. Dunlap, mechanical engineer, in 1891, and a copy of his detailed report is submitted herewith in order that it may find place in the printed record. It will be referred to hereafter in a special report, which I propose submitting at an early date, respecting modifications of some details that experience shows are necessary to a proper and satisfactory working of some parts of the mechanism.

The work is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. The nearest light-houses are the beacons on the western end of the canal, and Fort Brady is within a mile.

Total expenditure to June 30, 1896	$3,319,161.16
Expended during fiscal year, excluding outstanding liabilities	242,829.96
Total expenditure to June 30, 1897	3,561,991.12

Money statement.

July 1, 1896, balance unexpended	$1,444,742.60	
October 28, 1896, repayment of disallowance of part voucher 24, September, 1896	.80	
		$1,444,743.40
June 30, 1897, amount expended during fiscal year (including 67 cents paid by Treasury Department account Western Union Telegraph Company)		242,829.96
July 1, 1897, balance unexpended		1,201,913.44
July 1, 1897, outstanding liabilities	$59,846.39	
July 1, 1897, amount covered by uncompleted contracts	16,893.35	
		76,739.74
July 1, 1897, balance available		1,125,173.70

Appropriations for improving St. Marys River, Michigan.

August 5, 1886	$250,000.00
August 11, 1888	1,000,000.00
September 19, 1890	900,000.00
March 3, 1891, sundry civil act	600,000.00
March 3, 1893, sundry civil act	1,230,000.00
August 18, 1894, sundry civil act	300,000.00
March 2, 1895, sundry civil act	483,865.00
Total	4,763,865.00
Receipts from sales of fuel to officers, January, May, and June, 1887	26.63
Repayment of disallowance of part voucher 19, August 1894 (see p. 2895, Report Chief of Engineers, 1894)	12.13
Repayment of disallowance of part voucher 24, September, 1896	.80
	39.56

List of contracts in force during the fiscal year ending June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Date of expiration.	Remarks.
Collins & Farwell	Mar. 26, 1889	Apr., 1889	June 1, 1891	In Court of Claims.
Dunbar & Sullivan	July 22, 1892	Aug. 15, 1892	July 2, 1896	Closed Nov. 6, 1896.
Hughes Bros. & Bangs	May 25, 1893	Aug. 28, 1893	Indefinite	Closed Aug. 7, 1896.
Willard S. Pope	Oct. 21, 1893	Dec. 15, 1893	Aug. 1, 1896	Closed Sept. 4, 1896.
Westinghouse, Church, Kerr & Co.	Nov. 7, 1893	Sept. 8, 1894	Sept. 1, 1896	Closed Aug. 25, 1896.
Southwark Foundry and Machine Co.	....do	Sept., 1894	....do	Do.
The Babcock & Wilcox Co.	....do	July 1, 1895	....do	Do.
Joseph Vernon Gearing	Aug. 21, 1894	Sept. 11, 1894	July 1, 1897	Nearly completed.
John P. McGuire	Sept. 25, 1894	Oct., 1894	Sept. 1, 1896	Closed Sept. 14, 1896.
James B. Donnelly	June 29, 1895	Aug. 28, 1895	May 1, 1897	Work completed.
Dunbar & Sullivan	Oct. 19, 1895	Oct. 28, 1895	July 1, 1897	Nearly completed.
J. B. Sweatt	July 18, 1896	For fiscal year ending	June 30, 1897	
The Richmond & Backus Co.	July 23, 1896			
George Kemp	July 18, 1896			
Ferguson Hardware Co.	July 23, 1896			

REPORT OF MR. E. S. WHEELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., June 30, 1897.

COLONEL: I have the honor to submit the following report upon the operations connected with improving St. Marys River for the fiscal year ending June 30, 1897:

GENERAL OUTLINE OF OPERATIONS OF CONTRACTORS ON POE LOCK.

The following general outline of the operations of the several contractors, with a statement of the working force, plant, etc., has been prepared under the direction of Clerk Common by Inspector Fleming:

The work done at Sault Ste. Marie, Mich., during the season of 1896 by the several contractors in connection with the construction of the Poe Lock, power house, and office building, and other contingent improvements, consisted in completing the lock gates, the operating machinery, the pumping plant, constructing the power house and office building, excavating the approaches, and building the piers of the approaches to the lock.

Lock gates (*Willard S. Pope, contractor*).—At the close of the season 1895 the gates were completed with the exception of some calking, fitting the cushions, placing the footbridges, and painting.

The plant was fitted up and the work of calking commenced on May 16, 1896. The calking machine described in my report for the season of 1895 (page 2787 of the Report of the Chief of Engineers for 1896) was used in this work from May 27.

The cushion flange on one of the gates was found to be too wide. This flange was cut off and a recess cut in the masonry in the lock early in June. All work on this contract was completed July 17, 1896, and the plant removed.

Operating machinery (*John P. McGuire, contractor*).—On May 9, 1896, the work of cleaning up and making preparations to test the operating machinery was commenced. The transmission ropes were placed in position May 18; the small pump was operated May 30. From June 17 to July 10, the steel bushings of the winding drums of the wall engines were removed, and bronze bushings substituted. In this work the boring of the drums was done with an electric power drill. The current and motor was furnished by the Edison Sault Electric Light and Power Company. Cables were placed in position and the machinery tested by swinging the gates on July 10. On July 27, 1896, water was admitted into the forebay through the miter-sill valves which form a part of this contract, and on the same date the contractor turned the machinery over to the government.

Boilers of the pumping plant (*The Babcock & Wilcox Co., contractors*).—The work of connecting the boilers of the pumping plant was completed in January, 1896. In May and June the different boilers were submitted separately to the hydrostatic and steam tests required in the specifications, and on June 13 the battery and connections were tested to 150 pounds steam and 250 pounds hydrostatic pressure. In June an elbow in the drainage pipe leading from the blow-off valve was found to be broken, this was subsequently replaced with a new elbow. The pipes were covered with asbestos in June, and on July 9, 1896, all work was completed, with the exception of placing a portion of the exhaust and escape pipes, which could not be placed until the building was further advanced. By agreement, Contractor Gearing placed these pipes in position in August, thus completing this contract

Power house and office building (*Joseph Vernon Gearing, contractor*).—The plant remained the same as at the close of season 1895. During the months of January, February, and March, 1896, a small force built a flat scow to be used in transferring stone, brick, and other material across the canal to the power house. The work of fitting up the general plant was commenced April 24, 1896. Three stone planers were started on May 5, planing stone for the walls of the building. The fourth planer was started May 19. This plant was in operation with a force varying in size until October 4, 1896, when the work was completed and the plant was turned over to the lessees. During a portion of the time a night force was employed. The work of cutting stone was commenced May 4 and continued with a small force until October 21, when this work was completed.

The temporary roof on the power house was removed and the work of laying the brick backing walls was commenced May 8, 1896, and that of laying stone May 9. In May the tower derrick was built 18 feet higher, making it 108 feet above basement floor. The iron beams for the third floor were placed in position in May. In June, 1896, an electric elevator was installed to hoist material from the basement to the upper floor, the current being supplied by the Edison Sault Electric Company. The tower derrick was removed in July, and a guy derrick placed upon the third floor was used in handling stone and other material for the completion of the building. This was operated by an electric motor. The stone for the building was unloaded from scows moored in the Weitzel Lock and the cars run up on a track leading to the west side of the building.

The masonry of the main building was completed July 11, 1896, that of the tower and chimneys October 8, and the derrick removed. The stone steps were laid November 4, completing the exterior masonry. The work of pointing stone masonry was commenced September 17 and was completed November 13, 1896. The tug went out of commission July 7, and scows of stone were afterwards transferred by hand. The iron framework for the roof was placed in position in July and the fireproofing in August, 1896. The work of putting on the metal shingles on the roof was commenced September 14 and completed October 15. The roof was covered with one coat of paint in October. The work of fitting the window and door frames was commenced in August. These frames were all made in Detroit. The work of back plastering was completed in September; the work of lathing October 15. The work of plastering was commenced October 17 and continued with a small force during the remainder of the year. The boiler of the heating plant was placed in position in October and temporary connections were made with some of the radiators, and the building was heated by steam from November 2 to the close of the year. The work of installing the elevator was commenced November 14 and suspended December 22. The water tank was placed in position on the third floor of the building December 19. The marble bases for the iron columns in the corridors were placed in position November 14. The brick floors in the basement were completed November 21. The bill of glass for the building was received December 8, and the work of glazing the sash was done until December 18. The work of covering the trenches in basement for sewer outlet, also that of pointing roofing tile, was in progress at the close of the year. The material for the building was received at intervals during the year.

Lock approaches (*James B. Donnelly, contractor*).—At the close of the year 1895 the movable dam had been closed, the water drawn from the canal above the locks, and the work of excavating "in the dry" for the sites for the piers of the upper approach to the Poe Lock was in progress. The expense of operating the pumps to unwater the lower level of the canal was borne jointly by Dunbar & Sullivan, contractors for deepening canal prism, to enable them to trim the sides and otherwise complete their contract, and by the Edison Sault Electric Company to enable them to rearrange their cables running across the bottom of the canal, and by Contractor Donnelly. On January 12, 1896, the Edison Sault Electric Company completed their work, and the expense of operating the pumps was afterwards borne by Contractors Donnelly and Dunbar & Sullivan.

The work of building the northwest pier was commenced January 13, and that of the west center pier on January 20, 1896. The work of framing the timbers for the center pier east approach was commenced January 27. The ice was not of sufficient strength to commence the construction of this pier in January. The piles for a portion of this pier to rest upon were driven and were cut off under water by a diver in February. The work of lowering a section of the pier was commenced in February.

A portion of the piles for the cribs of the northeast pier to rest upon were driven and were cut off at the required grade by a diver in May, and the remaining portion in July. The framing of the timber for this pier was commenced May 22, 1896. Some of the cribs for the piers for the east approach were built in the canal above the locks and floated to place after the ice had left the canal. In excavating sites for the piers of the west approach two additional derricks were placed on the bank of the canal to handle the material and one placed upon the pier to handle material in filling the cribs of the center pier. As fast as the cribs were built the material from the excavation was placed in them. Sleighs were used in hauling material for filling the cribs at the east approach until March 27, 1896. A large quantity of the rock removed was sold for building purposes. The work of filling piers was done principally at night, in order not to interfere with the work of the carpenters. The excavation for a site for the northwest pier was completed February 29, and for the west center pier March 10. The work of excavating "in the dry" was completed April 7. The plant was removed and water admitted to the canal April 16, 1896. The timber work of the northwest pier was completed April 11, the west center pier, May 21, the east center pier July 22, and the northeast pier September 5, 1896. In preparing foundations for the piers of the east approach a diver was required for a short time. The work of filling the west center pier was completed July 21, the east center pier September 26, the northeast pier September 29, and the northwest pier October 1, 1896. In filling back of the northeast pier a track was laid leading to the spoil banks north of the canal, a distance of about 400 feet, and material from these banks was used in making the fill.

The work of dredging the approaches commenced with one dredge in the east approach April 17 and one in the west April 21, 1896. The timbers of the old cribs were loosened by the dredges and removed from the canal at the west approach by a derrick placed upon the northwest pier.

The work of drilling was commenced May 12, 1896, with one drill boat located in the west approach.

A portion of the material removed by the dredges was deposited directly into the cribs. In some portions which could not be reached by the dredge it was dumped on flat scows and unloaded into the cribs by hand. The balance of the material was deposited in scows and dumped in the river above the rapids.

The work of drilling for the west approach was suspended July 14 and the drill boat removed to the east approach. The drilling at this point was completed August 7, 1896.

In the work of dredging two dredges were employed continuously until May 29, when one was withdrawn waiting the work of drilling and again replaced June 15, when the two worked until August 4, 1896, during the most of the time operating both day and night. A third dredge was employed from July 28 to August 1. One dredge only was employed from August 4 to October 7, when the work of dredging was suspended. On October 31 the one dredge was again placed in the canal to clean the west approach. This work was suspended for the year November 19, 1896.

On August 3, 1896, a portion of each approach was formally opened to commerce by the opening of the Poe Lock. The first boats to make the passage were the U. S. steamer *Hancock*, the revenue cutter *Andrew Johnson*, and the U. S. tug *Antelope*.

From September 23 the work of the dredge consisted principally in removing bowlders and loosened rock. In this work two divers and a crane scow were also employed. The work of removing rock from the east approach was suspended October 21. In sweeping the approach on November 11 some spots were found above grade, and the divers continued the work of removing the same until November 21. The work by the divers in the west approach was suspended November 28, 1896, closing the operations for the year.

The plant, consisting of derricks, etc., was removed from the canal in August.

On February 4, 1896, the blacksmith shop, located on the north bank of the canal, was burned, exploding a small quantity of dynamite and giant powder which was stored in the shop. Through timely warning the employees reached places of safety and no injury was done save the burning of the building.

On February 16 an employee while eating his lunch in the Edison Sault Electric

Company's building near by was struck by a piece of timber which was hurled through an open window by a blast in the old crib work and received injuries from which he died two hours later.

The bolts and washers required for the cribs were received in three consignments—one in May and two in August. The timber for the piers was received and stored on the canal grounds during the season, as follows:

Month.	Feet B. M.	Month.	Feet B. M.
April, 1896	368,000	June, 1896	683,506
May, 1896	343,000	July, 1896	19,400

Below are given tables showing the average daily force employed by months on the various works by the several contractors during the season of 1896.

The term "laborers" used in the following tables has reference to the entire force of employees, including artisans, etc.

WILLARD S. POPE.

1896.	May.	June.	July.
Lock gates: Laborers	*a* 12	14	*b* 10

a=17 days; *b*=16 days.

JOHN P. McGUIRE.

1896.	May.	June.	July.
Operating machinery: Laborers	*a* 7	4	*b* 4

a=17 days; *b*=21 days.

THE BABCOCK & WILCOX CO.

1896.	Jan.	May.	June.	July.
Boilers of the pumping plant: Laborers	*a* 4	*b* 4	5	*c* 8

a=21 days; *b*=18 days; *c*=7 days.

JOSEPH VERNON GEARING.

1896.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Power house and office building: Laborers	2	2	1 *a* 1	3	41	52	70	58	53	47	27	19

a=7 days.

JAMES B. DONNELLY.

1896.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Lock approaches:												
Laborers	125	213	191	39 *a* 10 *b* 7	56 *c* 11 *d* 8	59	79	61	47	15 *f* 11	*e* 11 *g* 9	......
Double teams	3	8	12	2	1	1	1	*h* 1	......	......	......	......
Single teams	2	3	9	......	......	1	......	......	......	......	......	......

a=12 days; *b*=9 days; *c*=23 days; *d*=17 days; *e*=16 days; *f*=6 days; *g*=15 days; *h*=13 days.

Below is given a summary of the average daily force, exclusive of teams employed by the several contractors, for each month of 26 working days for the season of 1896:

1896.	Willard S. Pope.	John P. McGuire.	The Babcock & Wilcox Co.	Joseph V. Gearing.	James B. Donnelly.	Total.
January			3	2	125	130
February				2	213	215
March				1	191	192
April				3	46	49
May	8	5	3	41	71	128
June	14	4	5	52	59	134
July	6	3	2	70	79	160
August				58	61	119
September				53	47	100
October				47	18	65
November				27	12	39
December				19		19
Total	28	12	13	375	922	
Average per month	9	4	3	31	84	

The following report has been prepared by Assistant Engineer J. L. Callard, who has had special charge of this part of the work:

Power house and office building.—The building was designed by Edward Pearce Casey, architect, New York City; Joseph Vernon Gearing, contractor; contract dated August 11, 1894.

The building is 81 feet 6 inches long and 80 feet 9 inches wide, and consists of a basement, in which are placed the operating machinery and pumping plant, two stories for offices, and an attic. Adjacent to and connected with the basement proper are the anthracite and bituminous coal vaults and the boiler room for the heating plant. The chimney for the boiler plant forms the core of and is concealed within a tower. Between the chimney and the outer wall of the tower is a run of steps, leading from the basement floor to the seventh landing. This landing is 98 feet 6½ inches above the basement floor; the top of the chimney is 27 feet 6½ inches above the seventh landing, or 126 feet ¾ inch above the basement floor.

All fronts, main tower, chimneys where exposed above the roof, and wall of area ways are of Kelleys Island limestone. All the cut stones are dimension stones, cut to one-eighth inch joints, the show faces having a tooled finish. The cut stone is set in La Farge cement mortar, mixed in proportion of one part cement and one part sand. The backs of all stones are also covered with this mortar before being backed up with brick.

All walls back of stone facings, chimneys, partition walls in basements and vaults, main chimney flue, and portion of the tower wall within the building are of brick. All brick are laid in Portland cement mortar, mixed in the proportion of one part cement to three parts sand. The main chimney from the bottom to the level of the third floor beams is lined with fire brick.

All the floors, partitions above the basements, projecting pilasters, casings for columns, etc., throughout the building are constructed of hollow terra cotta blocks.

The main roof surface is covered with porous terra-cotta roofing blocks laid in Portland cement mortar between T-iron purlins. The surface of the main roof is covered with sheet-iron shingles.

All roof trusses, plate girders, floor beams, water tank, and columns are of soft steel. Ornamental columns, pilasters, and stairways are of cast iron.

The hallways of the first floor are of mosaic work of ½-inch cubes, having a baseboard of rubbed marble. All other floors are of Georgia pine, except those of the basement, which are of brick.

Window frames and sash, doors and transoms, and all woodwork trimmings are of white pine painted white, except main entrance doors in basement and first floor, which are of oak. The building is heated by steam, direct method, and lighted throughout by incandescent electric lights.

The foundation was built by the United States, and consists of a solid mass of concrete the full size of the building and about 21 feet deep, resting on bed rock.

By far the greater part of the work on cut stone was done by stone planers, including the cutting of the molding and the tool finish.

Work on the building was begun on September 11, 1894, and suspended for the season on November 5. Work was resumed on May 14, 1895, and suspended for the season on November 9. Work was again resumed on May 4, 1896, and has been in operation continuously since then.

The building is now about completed. The elevator is assembled but not quite ready to be tested, the painting is not quite completed, the plumbing fixtures are not yet put in place, a little carpenter work remains to be done, and different parts of the work throughout the building need a little touching up before final acceptance.

The following are the percentages of work done during the fiscal year:

	Per cent.
Mason work	31
Iron and steel work	22
Metal roofing	100
Carpenter work	98
Plastering	99
Steam heating	45
Plumbing	75
Elevator	30
Electric lighting	35
Painting	75

The following are the percentages of the work done to date:

	Per cent.
Mason work	99
Steel and iron work	99
Metal roofing	100
Carpenter work	98
Plastering	99
Plumbing	75
Elevator	30
Electric lighting	35
Painting	75

Removing of material from the movable dam and the Poe Lock approaches; also building piers for the lock approaches. James B. Donnelly, contractor; contract dated June 15, 1895.

The work to be done under this contract consisted of the removal of about 4,327 cubic yards of rock at the movable dam, and of 27,000 cubic yards of rock and 111,000 cubic yards of earth from the approaches to the Poe Lock; also of furnishing material for and building 2,925 linear feet of timber piers for the lock approaches.

Hingston & Woods, of Buffalo, N. Y., subcontracted the dredging of both rock and earth. Their plant employed on the work consisted of one dredge, one submarine drill scow, one tug, four dump scows, and a boarding house. An extra dredge, tug, and dump scows were hired when needed from Hubbell & Co. Drilling and blasting was begun on the 28th of August (1895) and dredging on the 29th, and was suspended for the winter on December 12 (1895). The excavation outside of the cofferdam of the Poe lock for the sites of the southeast and southwest piers was completed. Very little of the excavation was done for the site of the northwest pier until after the movable dam was closed. This part of the work, including the building of the northwest and southwest piers, was done in the dry. The leakage of water through the movable dam and sides of the canal was pumped from the completed part of the canal prism and passed through the lock of 1881. The site for the southwest pier was excavated to canal grade (29 feet below the upper coping of the lock wall), the site for the northwest pier was only excavated to rock, the bottom timbers of the pier being scribed to the rock and the rock in the canal excavated to the plane of the face of the pier. The work of excavating in the dry was carried on by a large force from the time of closing the movable dam December 14 (1895), to the time of opening it, April 16 (1896). Work was begun on the construction of the northwest pier January 13 and completed April 11. Work on the construction of the southwest pier was begun January 27, the substructure completed April 13 and the superstructure on May 21. The construction of the cribs for the southeast pier was begun March 1 and the pier completed July 27. The construction of the cribs for the northeast pier was begun May 13 and the pier completed September 4. The east ends of the northeast and southeast piers extending into deeper water than that of the plane of the required grade of the canal bottom, namely, 26 feet below the lower coping of the lock wall, a sufficient number of piles (69) were driven and cut off at the proper grade to hold the cribs level during the process of filling them.

Dredging was resumed on April 17 (1896) at east approach, and the second dredge was started to work April 21 at the west approach. Work with the drill scow was started at the west approach May 12 (1896). The drilling and blasting was completed at the west approach July 15, and at the east approach August 7. By May 27 (1896) the dredge had removed all the material to be excavated above the rock at the west approach and scraped off the rock preparatory to drilling and blasting. This dredge was then put on other work until June 15, when it was brought back and put to work dredging the rock that had been drilled and blasted in the meantime, and worked until August 4, when it was again put at other work. The dredge at the east approach worked continuously until August 9 (1896), when that part of the work was completed. On October 1 (1896) two divers with the necessary assistants and plant began cleaning up the bottom of the approaches. The east approach being practically completed on August 31, one of the divers and outfit was laid off. The other diver worked at the west approach until November 30 (1896), when compelled to stop work because of floating ice. On March 18 (1897) work of cleaning up the bottom was again resumed at the west approach by the diver and outfit. It was found necessary to do some drilling and blasting in all that part of the face of the northwest pier where the work was done by drill scow and dredge. On account of there being so much material found above grade at the west approach, a dredge was put to work scraping on April 21 to 26, inclusive, and again from May 28 to June 4, inclusive. Work on this contract was completed on June 18 (1897), excepting the removal of the material at the movable dam, from the performance of which part of the contract the contractor had been released.

Channels were completed through the approaches of a sufficient width and depth to allow the safe passage of the largest vessels July 31, 1896, as required under supplemental contract dated May 25, 1896, and the Poe Lock was opened to commerce on August 3, 1896.

The following quantities represent the work done and material furnished during the fiscal year:

Earth excavated	cubic yards..	9,787
Earth excavated between grade and subgrade	do....	948
Rock excavated	do....	9,422
Rock excavated between grade and subgrade	do....	4,068
Filling placed in and back of piers	do....	34,761
White pine timber furnished and built into piers	cubic feet..	64,053
Hemlock timber furnished and placed in piers	do....	422
Wrought iron furnished and built into piers	pounds..	44,325
Cast iron furnished and built into piers	do....	12,247
Piles furnished, driven, and cut off at grade		19

The following quantities represent the total work done and material furnished under this contract:

Earth excavated	cubic yards..	114,246
Earth excavated between grade and subgrade	do....	2,109
Rock excavated	do....	28,884
Rock excavated between grade and subgrade	do....	4,968
Filling placed in and back of piers	do....	65,413
White pine timber furnished and built into piers	cubic feet..	119,383
Hemlock timber furnished and built into piers	do....	213,843
Wrought iron furnished and built into piers	pounds..	248,157
Cast iron furnished and built into piers	do....	101,195
Piles furnished, driven, and cut off at grade		69

Concrete walks.—During the fiscal year 3,956 square yards of concrete walks have been laid. This work was done with labor furnished by the United States during the season of 1896. These walks are laid along the sides of both the Poe Lock and Weitzel Lock and about the canal grounds, mostly about that part of the grounds south of the Weitzel Lock. The United States has at Fort Brady Pier a large amount of limestone chips or shavings, the refuse from the stone planers used in cutting the stone for the Poe Lock.

The walks are composed of a subbase, base and top dressing. The subbase is composed of 8 inches of limestone planer chips well wetted and rammed. The base is composed of 5 inches of concrete mixed in the proportion of 1 part Portland cement and 10 parts limestone planer chips, no sand being used. The top dressing is composed of 1 inch of mortar mixed in the proportion of 1 part Portland cement and 1 part sand. Walks 8 feet wide are divided into blocks 4 feet square, and those 5 feet wide are divided into blocks 4 feet by 5 feet. The edges of the walks are finished with a quarter round and the joints struck with a jointer.

Below is an itemized cost of the work:

1,123 barrels Portland cement, at $1.36 per barrel	$2,650.28
116 cubic yards of sand, at $1 per cubic yard	116.00
Labor	3,631.51
Engineering and superintendence	450.00
Total	6,847.79
Total cost per square yard of completed walk	1.73

The cost of laying the walk was largely increased by the number of times the planer chips had to be handled and the long distances they had to be conveyed in wheelbarrows.

Removing a shoal at east approach to Poe Lock.—This work was done under oral agreement dated May 7, 1897, by the terms of which H. W. Hubbell & Co. agreed to do this and other dredge work in St. Marys River; the plant to consist of one dredge, one tug, and two dump scows, and the compensation to be at the rate of $12.25 per hour for actual time worked.

Work on this shoal was begun on May 7 and completed June 10, during which time the dredge worked 284 hours and 50 minutes, and excavated 8,163 cubic yards of material, scow measure, at a cost of $3,489.21.

The material excavated consisted of bowlders, gravel, hardpan and some bed rock.

CANAL PRISM, APPROACHES, AND RIVER WORK.

The following report has been prepared by Assistant Engineer Joseph Ripley, who has special charge of this part of the work:

Section 1, deepening west half of canal prism.—Contract dated July 14, 1892; Dunbar & Sullivan, Buffalo, N. Y., contractors. Rates, $1.53 per cubic yard, bank measure to 25 feet, and half rates between 25 and 26 feet. Material, sandstone rock in situ and bowlders.

Work was continued till August 12, 1896, with one dredge and one diving outfit. The dredge worked 158 hours and was delayed 33 hours, and excavated 612 cubic yards, scow measure. The diver worked 221 hours, was delayed 20 hours, and raised 98 yards. Several examinations were made with the raft bars during July and August before all the pieces of rock projecting above grade were removed. The duplicate computations for final estimate were completed and submitted in September. The computed bank measure of excavation was 133,437.94 cubic yards above 25-foot grade, and 22,498.30 cubic yards between 25 and 26 feet.

Item A, west approach to canal.—Channel 600 feet wide through shoals. Contract dated September 14, 1895; Dunbar & Sullivan, Buffalo, N. Y., contractors. Rates, 28 cents per cubic yard, bank measure, for earth, and $10 per cubic yard for rock to 21-foot grade, and half rates between 21 and 23 feet. Material, sand, bowlders, and sandstone rock.

Work was continued with two dredges, one diving outfit, till November 21, and was resumed again April 21. Forty-nine thousand nine hundred and sixty-nine cubic yards, scow measure, were dredged. Time worked, 2,485½ hours, delayed 623¼ hours. The diving outfit raised 786 cubic yards, scow measure, during 1,084 working hours; the delays were 246 hours. The shoal between cross section 60 and 70, containing about 20,000 cubic yards, proved to be sandstone rock. A detail survey was made in August, the soundings being taken 10 by 10 feet apart. The contract limited the payment for rock to 2,000 yards, and that amount was removed by the contractor. In March a detail survey was made of Item A and the soundings were extended over the area inclosed between the American and Canadian channels. The removal of the rock shoal and the widening of channel to 1,000 feet will be included in a new contract. Three of the shoals on Item A were finished in November, 1896, and an examination of the same was made with the raft bars. This section will be finished during July.

In August an examination was made with the raft bars of the upper and lower approaches to the Poe lock.

A resurvey was made of the canal grounds which had been changed during the past two years.

Range lights and buoys.—The range lights and buoys at upper and lower approaches to Canadian canal were located from two or more triangulation stations; also all the range lights and targets along the St. Marys River not previously located by my party were similarly read in by transit pointings. The coordinates of all the buoys and lights were computed.

Ice surveys.—A detail survey was made of the Bayfield Rock Shoal, which is located about 1½ miles below the canal; 8,200 soundings were taken. Assistant Engineer Benno Rohnert with a party of 20 men were engaged in the field work of the ice surveys from January 26 to March 26. The operations of the party carried them over 43 miles of the river's length, necessitating the pitching of five camps. Soundings were taken 10 feet apart along the cross sections, while the cross sections were 10, 20, 25, or 50 feet apart. The number of soundings taken during the winter was 125,013, at a total cost of $2,696.06. The party was in the field fifty-eight days, of which forty-seven were working days. The eleven days deducted are eight Sundays, one legal holiday, and two lost on account of stormy weather. Six days were spent in moving camp and six days in staking out. The days actually spent at sounding, therefore, numbered thirty-five. The following table shows how much the number of soundings per day and cost per sounding is affected by Sundays, lost time, moving camp, and staking out work:

Number of days.	Number of soundings.	Total cost.	Cost per sounding.	Number of soundings per day.
			Cents.	
58	125,013	$2,696.06	2.16	2,155
47	125,013	2,184.74	1.75	2,660
41	125,013	1,905.84	1.52	3,050
35	125,013	1,626.93	1.30	3,570

There were 2,228 meals furnished, at a total cost for provisions of $263.07, or $11\frac{8}{10}$ cents per meal. Including the cook's wages, the cost of meals was 15 cents.

The best record made during the winter was on February 16 on Mud Lake; 5,100 soundings were taken 10 by 50 feet apart, over an area 600 feet wide and about 4,200 feet long. The thickness of the ice varied from 24 to 30 inches.

Project for improved channels.—The widening of the present channel via the Middle Neebish or the making of a new channel via the West Neebish is necessary. A supplemental report was submitted in April on proposed new channel through the West Neebish Rapids.

I was assisted by Assistant Engineer Benno Rohnert, Inspector H. C. McNaughton, and Recorder C. M. Ayres.

CEMENT, ETC.

The following statement has been prepared by Assistant Engineer L. C. Sabin, who has special charge of this part of the work:

The cement used on the work from 1891 to June 30, 1897, is as follows:

		Barrels.
Natural, Milwaukee		96,890
Portland:	Barrels.	
Hemmoor	7,876	
Empire	2,497	
Lagerdorfer	2,446	
La Farge	137	
Total Portland		12,956
Total cement		109,846

The purposes to which this cement has been applied are as follows:

	Barrels.
Construction of lock masonry:	
Natural	71,827
Portland	7,815
Construction of lock floor:	
Natural	25,063
Portland	1,226
Power house, Portland	2,487
Sidewalks and miscellaneous, Portland	1,428

From January 1, 1891, to July 30, 1897, a total of 101,560 briquets were made to test the quality of the cement delivered and to investigate the effect of variation in manipulation and use. Many of the results of these investigations have been published in preceding annual reports, and it is now proposed to collate them in a special report which will be presented at an early date.

There have been employed upon this work during the year Assistant Engineers Callard, Ripley, Reed, Sabin, Shenehon; Clerks Common and McArthur; Draftsman Mangelsdorf; Inspectors Fleming, Reed, Conklin, and Barnes.

Very respectfully, your obedient servant,

E. S. WHEELER, *Assistant Engineer.*

Lieut. Col. G. J. LYDECKER,
Corps of Engineers, U. S. A.

REPORT OF FRANK M. DUNLAP, ASSISTANT ENGINEER, ON THE DESIGN AND CONSTRUCTION OF THE MACHINERY FOR THE POE LOCK, ST. MARYS FALLS CANAL, MICHIGAN.

MACHINERY.

The machinery permanently installed at the lock is of two general classes—the pumping plant, designed for emptying the lock chamber in case of accident to any of its parts, and the operating plant, for performing the ordinary operations incidental to the daily use of the lock.

The pumping plant, located in the basement of the power house and office building, consists of three centrifugal pumps, each 30 inches diameter of discharge, driven by three Westinghouse compound engines of 350 horsepower each, for which steam is furnished by a pair of Babcock & Wilcox water-tube boilers.

There is also one centrifugal pump 10 inches diameter of discharge driven by belt power, for drainage.

The pumps are of vertical spindle centrifugal type and are geared directly to the engine shafts by bevel gears.

The boilers are of double-deck type, with wrought-steel manifolds at the tube ends, instead of cast iron. They are set in a steel casing lined with fire brick, instead of the ordinary brick setting, to obviate the danger of cracking the walls by quick firing. They are rated at 750 horsepower nominal, but are capable of being forced to the full horsepower of the engine (1,050 H. P.) for a short run, if necessary. This plant is designed to be of sufficient capacity to empty the lock chamber (2,465,500 cubic feet), in about six hours. The lift varies from 0 to about 35 feet.

The operating plant consists of the valves for filling and emptying the lock chamber and the engines for manipulating them, the gates and machines for swinging them, and two capstans for assisting vessels into and out of the lock. All are driven by hydraulic pressure furnished by pumps and accumulators placed in the basement of the powerhouse and office building and driven by a pair of vertical turbine wheels.

VALVES AND VALVE ENGINES.

Twelve valves placed in the culverts beneath the lock floor, six for filling and six for emptying the lock chamber, are built up of steel plates and shaped with forged-steel trunnions, which are carried in bearings supported on built-up steel frames. These frames are 7 feet 11 inches by 9 feet 11 inches inside, and give a clear waterway 7 feet 11 inches by 8 feet 7 inches, in two parts when the valve is swung open, the valve being about 1 foot 4 inches thick at its middle. The valves are so hung that in opening they present an edge to the current of water. Each valve is furnished, on the upstream side, with a projection carrying a crank pin 2 feet in front of the central plane of the valve and 2 feet below the center line of the trunnions.

The engine for each valve is placed on oak foundation timbers driftbolted to the floor timbers of the pit or well in which it is located.

The engine consists of a plane rectangular bed plate which carries a hydraulic cylinder 8 inches diameter by 48 inches stroke, and guides for its crosshead. The crosshead is a steel casting with a forged steel pin and bronze gibs. It is connected to the crank pin of its valve by an ordinary forged-steel connecting rod with adjustable bronze bearings for the pins. The stroke is limited by a dash pot at each end.

These engines are operated in pairs by vertical balanced piston valves placed on top of the lock wall and connected with them by pressure pipes placed in inclined passages in the wall.

GATES AND GATE ENGINES.

The gates are five in number, each composed of two leaves, segmental in form and cellular in structure, built up of steel plates and rolled shapes. Their design, construction, and erection are treated in separate reports. Three of these—the upper, intermediate, and lower—lock gates are swung by wire cables operated by machinery, one machine for each leaf.

The six machines for operating the gates each consist of a spirally grooved drum for the cable provided with internal gearing and driven in either direction at will by planet gears contained within and controlled by friction bands or brakes. The whole is mounted on and receives its power from a steel shaft which is driven by a pair of three-cylinder hydraulic engines through gearing. The controlling bands, or brakes, are operated by screws and handwheels at the front of the machine and consist of steel bands lined with seasoned basswood blocks. The cast-iron frame or bed plate which carries the machine is rectangular in general plan and inverted trough shaped in section, with the open side toward the masonry; it is stiffened by numerous transverse webs.

CAPSTANS AND ENGINES.

Two capstans are placed on the south wall of the lock for the purpose of assisting such vessels as have no power of their own and for handling heavy weights about the lock. They are of the same size and style as built by the American Ship Windlass Company for vessels of the United States Navy, with slight changes to adapt them to hydraulic power.

Each capstan rests on a heavily ribbed cast-iron base plate, whose top is flush with the masonry and which carries on its under side three single-acting oscillating cylinders with their valve chests. The plungers in these cylinders act on a crank pin which drives the central shaft of the capstan. The gearing in the capstan is so arranged that when running in one direction, the barrel runs turn for turn with the engine, but when the engine is reversed, the barrel runs about 2¼ times slower with proportionately increased force and in the same direction as at first. The engine is reversed by means of a valve of similar design to that used for the valve engines.

TURBINES AND MACHINERY IN POWER HOUSE.

The two turbine wheels, with their supply and draft tubes, were furnished by Hughes Bros. & Bangs, under contract dated May 10, 1893. They work under a normal head of 17 feet. They are supplied through about 986 feet of 48-inch cast-iron pipe, discharging through about 170 feet of the same, which acts as draft tube and tail race. These wheels develop about 30 horsepower each, and can be run singly or together.

From these wheels power is taken to run the 10-inch centrifugal pump belonging to the pumping plant, and intended to keep down whatever leakage may be found after the lock chamber is emptied. They furnish, also, the power for two dynamos to light the building and for the small pumps which serve the water supply and fire protection in the building and grounds; but their principal duty is to furnish power to the high-pressure pumps, which maintain the pressure for various hydraulic machines used in operating the lock.

The high-pressure pumps are three in number, with three single-acting plungers, 4-inch diameter and 10-inch stroke in each. They are driven by rope belting from the horizontal shaft of the turbine wheels. On the pulley shafts of the pumps are bronze pinions 6 inches in diameter, which engage cut-steel gears 30 inches in diameter on the crank shafts. The cranks are set 120° apart, and are supported by four bearings on each shaft.

From the pumps the pressure fluid passes to the main pressure pipe of the system. Its pressure is regulated, and any excess of supply is stored by three dead-weight accumulators, composed of wrought-steel shells and cast-iron plungers. Each plunger carries a heavily ribbed plate, which acts as a crosshead guiding the plunger on four guide rods, and furnishing the attachment for the 24 steel rods which support the weights for loading.

The total moving weight on each accumulator varies from 76,000 to 127,000 pounds, according as the pressure is 300 to 500 pounds per square inch.

PROJECTS—HISTORICAL, ETC.

When the 500-foot lock, now usually called the lock of 1881, was built it was equipped with hydraulic machinery, which has proved so reliable and free from wear or breakage that in getting up the first project for the 800-foot lock it was taken as almost self-evident that the machinery of the same form would be the best that could be adopted for the new work.

The designs for the masonry carried out this idea to the extent of making the passages for the gate cables and the chambers for the lower guide sheaves almost identical in size and shape with those of the lock of 1881.

In designing the gate anchorages, however, it was found necessary to make them so much different in form and so much heavier than in the former lock that the position and direction of the cable passages were changed, to avoid conflict with the anchor rods.

There were four separate projects presented for the operating machinery for the lock.

One project for electrically driven machinery was presumably never put into formal shape, as no drawings of it can now be found in this office.

On October 20, 1891, Mr. F. M. Dunlap submitted sketches and description of a centralized plant of machinery, consisting of a set of winding drums in the basement of the power house driven directly by turbine wheels and connected to the gates and valves by means of cables, thus placing all of the operating machinery under cover and in the control of one man, governed by signals from the lock men on the walls.

This design was based on erroneous data as to the power required to swing the gates, and provided for a large excess over what is now considered necessary.

The requirements of this power called for large cables of special quality which, in turn, necessitated large sheaves and corresponding recesses for them in the walls. This, together with some other difficulties, which might possibly have been overcome in making a complete design, made it seem unsuitable for the work.

The third project in point of consideration, though not in point of time, contemplated the use of horizontal hydraulic cylinders for swinging the gates, substantially as in the lock of 1881. Their stroke was to be one-fourth of the travel of the cable, which was to have its motion multiplied by reaving fourfold over pulleys traveling in a crosshead attached to the piston rod of the engine. One engine was to be provided for swinging each leaf of the gates. Each engine was to be double ended, with a cable for closing the leaf reaved at one end and one for opening at the other.

Under this general project two designs were made. The first, made from the erroneous data above referred to, was intended to give an effective pull of 28,000 to 30,000 pounds on the gate. It was provided with a cylinder of 31-inch bore and 15 feet 8 inch stroke and crosshead sheaves 5 feet 6 inches in diameter for 1¼-inch extra quality cable. In the discussion of this design the superintendent of the lock of 1881 decided that it was not advisable to put so heavy a stress on the new gates for several reasons, and expressed the opinion that it would be better to take more time in swinging the gates than to subject them to so heavy a pull.

These opinions were concurred in and a second design was made along the same general lines, but with less power. The cylinders were drawn 21 inches in diameter and 15 foot 4 inch stroke. The cables were 1 inch in diameter and the sheaves for the upper guide and engine crosshead 42 inches in diameter, while the sheaves for the lower guide were 30 inches and 24 inches in diameter, all measured to the center of cable.

At a working pressure of 120 pounds per square inch, this engine was intended to pull 10,000 pounds on the cable.

When this design was sufficiently advanced for discussion it was found to require a great deal of space on the lock walls, each engine taking a space from 4 feet 2 inches to 5 feet 6 inches wide and 70 feet long, while the cables and upper guide sheaves standing above the coping practically increased the length to 88 feet.

In view of the above, and in an attempt to obtain the required power in more compact form, Mr. F. M. Dunlap submitted verbally September 1 and in writing September 9, 1893, a project for short-stroke hydraulic engines geared to reversible drums upon which the cables could be wound. This project, with some modifications, was the one finally adopted, and the machinery built under it is described in the descriptive paragraphs of this report.

DESIGN OF OPERATING MACHINERY—SOURCES OF DESIGN, ETC.

The valves and valve engines differ only in position and details from those of the lock of 1881.

In the machines for swinging the gates the internal gearing is not new. Its essential principles have long been in use, especially for hoisting purposes in mining machinery. The idea of using short-stroke reciprocating engines with hydraulic power was derived from well-established English hydraulic practice, while the general form of the engines, three single-acting pistons in the same plane on one crank, was suggested by the "Brotherhood" three-cylinder engine which has been in use many years for hydraulic service.

The manner of reversing the drums and the details and arrangement of the engine are, so far as known, new in this plant. The engines for driving the capstans were also believed to be new. but since the design was completed it has been found almost identical with an English hydraulic design.

In the pumps and accumulators nothing radically new was introduced, though some of the details are believed to be new.

LIMITATIONS OF DESIGN.

The fact that the masonry of the lock was designed and partly built before the machine designs were made imposed certain conditions on the form and placing of the machinery, especially on the manner of leading the cables from the drums to the gates and placing the pipes for conveying power to the valve engines and across the lock.

In a work of this kind considerations of safety and freedom from delays caused by breakage far outweigh all others. Therefore, in all computations having to do with strength of materials the working limits of stress were set as low as they could consistently be, in view of the fact that a large reserve force must be provided for in most places. The question of reserve force is discussed in another paragraph, and the limits of stress and pressure of bearing surfaces were fixed at moderate figures for the maximum cylinder pressures to be employed, leaving them quite small when the lesser and more probable pressures are considered.

Cast iron has not been used in any part under severe stress where practicable to avoid it. Where it is used in tension or the tension produced by transverse stress it has been computed at a maximum working stress of 2,000 pounds per square inch.

In steel castings subjected mainly to transverse stress, as in arms and teeth of gears, a maximum fiber stress of 7,000 pounds to 8,000 pounds per square inch (as applied in formulæ for transverse strength) has been used.

Stress in steel forgings, used mainly in direct tension or compression, has been limited to 11,000 pounds or less per square inch.

In sliding or rotating parts it often becomes necessary to take into consideration the intensity of pressure between the parts, as affecting friction, the use of lubricants, etc. The highest bearing pressure on pins, journals, etc., used in this machinery was about 1,000 pounds per square inch. This may have been slightly exceeded where the available space was small and the motion slow.

On account of the loss of head or pressure, of fluids in pipes, due to its being used up in overcoming friction due to the velocity of flow, the piping, passages, and valve ports have, wherever possible, been made of sufficient size to pass the required amount of pressure fluid at velocities from 3 feet to 3½ feet per second. The effect of length and bends on the carrying power of pipes was to some extent taken into consideration in designing them, though no accurate estimate of the number or position of bends could be made in advance of the actual location of the pipes.

There are other considerations than the stresses directly involved in the piece under consideration which often limit its size. In castings of all kinds the thickness of metal necessary to insure sound castings, freedom from shrinkage, strains, etc., often requires much heavier metal than the resistance of externally applied stresses.

So, also, the facility of attaching fittings or other parts, or even keeping a piece in accord with the appearance of others near it, has operated to increase the size of parts above but never to reduce them below that called for by computations of safe working stresses.

Thus it will be seen that considerations entirely aside from computation have in many cases acted to reduce the working stresses materially below the maximum limits given above.

GENERAL COMPUTATIONS FOR SIZE OF ENGINES, ETC.

Valve engines.—Having determined to use horizontal direct-acting hydraulic engines, it remains to determine their power, i. e., size of cylinders. The assumed minimum working pressure is 300 pounds per square inch, and 17 pounds per square inch will be a fair allowance for back pressure as an average.

When the valve is shut it presents an area 7 feet 11 inches by 9 feet 11 inches to a static head of 18 to 20 feet (say 20 feet) of water. 7 feet 11 inches × 9 feet 11 inches= 78.4 square feet, which at 20 by 62.5=1,250 per square foot=98,000 pounds static load.

Now, it is conceivable that when the valve is opening or closing it may take such an angle that the impact of moving water against its surface may throw upon the trunnions a load closely approximating twice the static load.

Assuming, then, a load of 200,000 pounds on the trunnions to cover all contingencies and a coefficient of friction with water lubrication 24 per cent, we have a resistance of 200,000×.24=48,000 pounds acting on an arm of 5½ inches=radius of trunnion, or 264,000 inch-pounds, which is to be overcome by the engine acting on a crank pin whose least radius is 24 inches. 264,000÷24=11,000 pounds, which, divided by 283 (effective pressure per square inch), equals 38 square inches, required net area of piston.

The unsupported length of the piston rod is 49 inches at its maximum and it acts as a compression member fixed in direction (or guided) at both ends.

Taking one-twentieth of its length for its diameter, we have 2.45 inches, to which add ¼ inch, so that it may be re-turned when worn without weakening it, and we have $2\frac{7}{10}$ (say 2¾) inches diameter of rod. The sectional area of a 2¾-inch rod is $5\frac{9}{10}$ inches, which, added to 38 square inches, equals 43.9 square inches, required area of piston equals a 7½-inch circle, nearly.

Now, if we take an 8-inch piston, we have an area of 50.26 square inches. This gives an excess of 6.36 square inches, which, multiplied by 283 pounds (effective pressure), equals 1,799.8 pounds (say 1,800 pounds) for overcoming the friction of the engine. The stroke is fixed at 48 inches by the construction of the valve.

Gate engines—Power required to swing gates.—In arriving at the power of the gate engines considerable uncertainty was felt in regard to the power required to swing the gates, as they were of unprecedented size. The most generally satisfactory formula, however, the one finally used, was suggested by Mr. E. S. Wheeler and is based on the performance of the gate engines of the lock of 1881.

Effort of engine on cable of lower (large) gate of lock of 1881.—Least observed pressure (April, 1893), 90 pounds per square inch; area of piston, 176.71 square inches; cables reaved fourfold; efficiency assumed, 80 per cent. $\frac{176.71\times90\times.80}{4}=3,181$ pounds pull on cable.

The relation of the power of the old to the power required for the new will obviously be expressed by the proportion of $A_oV_o^2:F_o=A_nV_n^2:F_n$—Eq. 1, in which A_o and A_n are the immersed areas of the old and new gates, respectively, V_o and V_n their respective velocities, and F_o and F_n the cable pulls. This relation is more likely to be true, since the relation of each gate leaf to the cross section of the channel in which it swings is practically the same, thus eliminating any retarding influences that the confined channel might have on the motion of the leaf. Now, if the new gates are to swing in the same time as the old, and radii of motion of their miter ends are respectively R_n and R_o, then $\frac{V_o}{V_n}=\frac{R_o}{R_n}=\frac{33.37}{57}=\frac{1}{1.709}$, and substituting for the letters their values in equation 1, making $V_o=1$, $V_n^2=2.92$ $A_n=$ submerged area (one side) $=57\times22=1{,}254$ square feet, $A_o=33.37\times16=534$ square feet, $F_o=3{,}181$ pounds, we have $F_n=\frac{F_oA_nV_n^2}{A_oV_o^2}=\frac{3181\times1254\times2.92}{534}=21{,}812$ pounds (say 21,800 pounds), first case.

But if 1½ times the time of swinging the old gate be allowed for the new, V_n becomes $\frac{57}{33.37}\times\frac{2}{3}=1{,}138$ and $V_n=1.2967$, say 1.3, and $F_n=\frac{1254\times1.3\times3181}{534}=9{,}711$ pounds (say 9,700 pounds), second case.

If, however, twice as much time be allowed as in case one, V_n^2 becomes one-fourth of $2.92=0.73$ and $F_n=\frac{1254\times0.73\times3181}{534}=5{,}453$ pounds (say 5,450 pounds), third case.

It will be noticed that this calculation eliminates the elements of time and velocity from the problem, by substituting relative time and velocity. It is found, however, that a fair average time for swinging the gates of the lock of 1881 will not be far from one minute.

Upon consideration it seems advisable to adopt practically the second case and to provide for a pull of 10,000 pounds on the cable.

RESERVE FORCE.

On account of the unprecedented size of the gates and the difficulty of computing some of the resistances to be overcome, and in view of the fact that it might become desirable to swing the gates faster than is contemplated by the second case under the formula, it was deemed advisable to provide for a large reserve of power above that called for by the formula.

This reserve was obtained by making provision for an increase of working pressure. Assuming, as in the case of the valve engines, a minimum working pressure of 300 pounds per square inch, and designing the engines to give the desired pull on the cables at that pressure, all parts of the machinery were proportioned to resist the stresses which would be developed with a working pressure of 500 pounds per square inch in the cylinders without exceeding the limits of working stress given above.

DESIGN AND COMPUTATION OF DETAILS OF VALVE ENGINES.

Cylinders, 8 inches diameter; maximum working pressure, 500 pounds; thickness of metal 1½ inches to insure against percolation of fluid through walls under pressure. Stress in walls by 500 pounds pressure 500 pounds multiplied by 8 inches $=2\times1.5\times s$ and $s=\frac{4000}{3}=1{,}333$ pounds per square inch.

Heads 2 inches thick in flanges, with seven 1-inch bolts in each; 1-inch standard threads are 0.837 diameter at bottom or 0.55026 area. Maximum tension equals $50\times500=25{,}000$ pounds $7\times0.55026=3.85$ square inches and 3.85) 25,000 (=6,490 pounds per square inch. Combined area in body of seven 1-inch bolts equal $7\times0.7854=5.49$ square inches, 5.49) 25,000 (4,554 pounds (nearly) per square inch; assuming modulus of elasticity for steel bolts 30,000,000, we find that this stress will stretch the bolts 30,000,000) 4,554 (0.0001518 of their length, which in 2 inches will be .0003 + inch, an amount too small to affect the tightness of the joint made up with lead gasket.

The sixteen bolts between cylinder and bed plate are 1 inch diameter; total area of section, 12.56 square inches. The maximum effort to move the cylinder on the bed plate is 25,000 pounds, and assumimg a coefficient of friction only 0.25 between them (it may be as high as 0.30), it will require 100,000 pounds to bind them together so as to resist by friction alone the tendency to slide. This will require $100{,}000\div12.56=$ 7,962 pounds per square inch on the bolts, which is well within their limit, but they are turned bolts in reamed holes capable of shearing resistance, and $25{,}000\div12.56=$ less than 2,000 pounds per square inch in shear alone would be required to hold it in place.

The twelve bolts holding the bed plate to the oak timbers are 1¼ inches diameter, practically the same in combined sectional area, and, on account of the greater friction between iron and oak, even better able to hold the engine safely in place.

The piston rod acts both in compression and tension. When in compression it may have an unsupported length of about 49 inches, guided at both ends. Assuming one-twentieth of the unsupported length for a safe diameter, we have 2.45 inches, to which add one-fourth of an inch for turning down when worn, say $2\frac{3}{4}$ inches final diameter. The area of cross section $2\frac{1}{2}$ inches diameter is 4.9 square inches, whence $25{,}000 \div 4.9 = 5{,}102$ pounds per square inch maximum stress in compression even after turning down. When the rod is in tension the effective piston area is reduced by the area of rod (which is 5.9 square inches) to $50.2 - 5.9 = 44.3$ square inches. This multiplied by $500 = 22{,}150$ pounds, which must not produce tension greater than 10,000 pounds per square inch, giving 10,000) 22,150 (2.21 square inches as least section. This is closely approximated by the bottom of the threads at the screw which holds the piston. A 2-inch United States standard thread is 1.71 inches diameter at bottom or 2.3 square inches area.

The connecting rod is made 4 feet 11 inches center to center of pins, or practically $1\frac{1}{2}$ times stroke. It is conditioned as a compression member guided in one plane at both ends, but free in a plane at right angles to the first. The butts and brasses take up $12\frac{1}{2}$ inches of the length, and the facility of fitting straps, etc., practically fixes the dimension in the constrained plane at 3 inches. This gives a ratio of 3 inches : $46\frac{1}{2} = 1 : 15\frac{1}{2}$. In the free plane the dimensions must be somewhat greater, and were made $3\frac{1}{2}$ inches diameter at the ends and $4\frac{1}{2}$ inches diameter in the middle, both flatted on the sides to 3 inches thick (ratio middle diameter to length, $4.5 : 46.5 = 1 : 10.3$). This gives 8.07 square inches metal in the necks and 11.71 square inches in the middle, giving an intensity of stress in compression $25{,}000 \div 8.07 = 3{,}100$ pounds per square inch, nearly.

These dimensions are considered ample for a member so loaded, but in view of the fact that these engines work under water, and, except by a diver, are inaccessible for a whole sailing season, they are not deemed excessive.

The pins in the crosshead and valve at the ends of the connecting rod are of steel, with hard bronze boxes, or "brasses." The motion between the steel and bronze is very slow, and the maximum bearing stress per square inch of projected area of pin was allowed to rise to 1,033 pounds on the crosshead pin and 800 pounds on the valve pin, the bearings being 4 inches diameter by $5\frac{7}{8}$ inches and $7\frac{5}{8}$ inches length, respectively, and bearing about 24,275 pounds each.

The crosshead itself was made of a steel casting chiefly to get a better hold for the threaded end of the piston rod and a tougher material than cast iron for safety against breakage. The probable excess of strength as regards applied stresses is so great that it has never been computed. The dimensions of parts of the crosshead have largely been fixed by the room needed for the head and key of the connecting rod and thickness of metal sufficient to get sound castings and afford proper attachments for other parts.

The maximum variation of the outer end of the connecting rod above and below the center line of the engine is 5 inches in a length of 59 inches, an angle whose sine is $\frac{5}{59} = 4^\circ\ 52'$, nearly.

The vertical pressure on guides will be rod thrust multiplied by $\sin 4^\circ\ 51' = 24{,}275 \times .08484 = 2{,}059$ pounds. This is received on a surface $2\frac{1}{2}$ inches $\times$ 18 inches $\times\ 2 = 90$ square inches, making a maximum guide pressure of $2{,}059 - 90 = 23$ pounds, nearly, per square inch. This computation, as well as the one for pin pressures, is based on the assumption that the valve may be jammed while using 500 pounds pressure in the cylinder, since, if the computation for size of cylinders on page 2979 is correct, the excess of pressure over 300 pounds would be taken up partly in accelerating the motion of the valve, partly in overcoming increased pipe friction caused by quicker piston motion, and partly in opposing the greater back pressure due to the same cause. Hence all of the increased thrust that can come on the pins, rod, or guides will be that due to the portion of force used in accelerating the motion of the valve and could not reach the full pressures above given unless the valve became jammed. The cylinder ports of this engine have an opening $5\frac{3}{8}$ inches $\times\ \frac{1}{2}$ inch $= 2.69$ square inches. This, at 3 feet per second, or 2,160 inches per minute, will pass $2.7 \times 2{,}160 = 5{,}832$ cubic inches per minute, and will fill the cylinder (capacity, 2,412 cubic inches) in 0.41 minute. This is quick enough, and the passages outside of that point have a least area of 3 square inches and $4\frac{1}{2}$ square inches at different points, so that the flow will be slower. The pipes for filling two cylinders each are 3 inches, extra heavy, having an inside area of about 6 square inches. To feed two cylinders each of 2,412 cubic inches in 0.41 minute will require a flow of $\frac{4{,}824}{.41} = 11{,}766$ cubic inches per minute, or in an area of 6 square inches 1,961 linear inches per minute, or 2.7 feet per second, which is well within the limit set.

The valves for controlling these valve engines (see plate) consist of two concentric cylinders, the inner subject to the same pressure inside and out, but the outer required to resist bursting pressure. It is 9 inches internal diameter and 1 inch thick. The maximum working stress will be $500 \times 9 \div 2 = 2{,}250$ pounds per square inch, but it is stayed by diaphragms $\frac{3}{4}$ inch thick at every 6 inches of its length.

The valve pistons are balanced, having working pressure between and exhaust pressure outside of them; they are 4 inches diameter, and the stem between them is $\frac{3}{4}$ inch diameter, with a thimble 1 inch diameter outside of it. The area exposed is then 4 inches diameter equals 12.56 square inches minus 1 inch diameter equals 0.7854 square inch, equals 11.78 square inches, which at 500 pounds equals 5,890 pounds.

A $\frac{3}{4}$-inch rod equals .4417 square inches and $\frac{5890}{.4417}=13{,}334$ pounds per square inch in stress on rod. Here, as in balancing the piston valves at the throttle of the winding engines, it became necessary to reduce the rod as much as possible in the stuffing box, so as to leave the valve as nearly balanced as possible under exhaust pressure also.

GATE ENGINES.

Referring to page 2979, second case under the formula for power required to move the gates, and to the paragraph "Reserve force," on the same page, it will be seen that we require an engine designed to pull 9,700 pounds on the cable with 300 pounds square inch cylinder pressure. This will give a pull of about 16,000 pounds when supplied with 500 pounds pressure. Either of these is well within the limit of working strength of a 1-inch high-power cable as made by the best makers, some of whom are able to guarantee a breaking stress not less than 96,000 pounds to 100,000 pounds for a 1-inch diameter cable.

It is required, then, to design an engine and geared drum to pull 9,700 pounds on a cable wound on a drum approximately 6 feet pitch diameter, with 300 pounds per square inch cylinder pressure. It is assumed that the gear will be 12 to 1, arranged 3 to 1 from engine shaft to main by 24-inch pinion and 72-inch wheel, and 4 to 1 from main shaft to drum by internal gearing arranged to reverse the motion of the drum. Assuming, again, that the general type of engine has been decided on, i. e., a pair of 3-cylinder single-acting engines. If these engines are given 12-inch stroke, each piston travels 1 foot under pressure (a total of 6 feet) for each revolution, and for each revolution of the drum $6\times12=72$ feet. Now, the cable will wind on the drum (5 feet $9\frac{1}{2}$ inches diameter) 18 feet 2 inches for each revolution. Letting a represent the area of each piston and assuming an efficiency even as low as 75 per cent, with 10 pounds per square inch for back pressure, resultant effective pressure 290 pounds per square inch, we have the equation $290\,a\times72\times.75=9{,}700\times18.16$ feet, and solving for a;

$$a=\frac{9700\times18.16}{290\times72\times.75}=\frac{176152}{290\times54}=17{,}615.2\div1566=11\tfrac{25}{100}, \text{ nearly.}$$

If we give the pistons 10-inch stroke and all other conditions as before, we have 6×10 inches $=60$ inches $=5$ feet per revolution, and for 60 feet per revolution of drum the equation becomes

$$290\,a\times60\times.75=9{,}700\times18.16 \text{ feet, and } a=\frac{176152}{290\times45}=\frac{176152}{13050}=13.5, \text{ nearly.}$$

Again, if we reduce stroke to 8 inches, we have 6×8 inches $=48$ inches $=4$ feet piston travel for each revolution, or 48 feet for each revolution of drum; hence,

$$290\,a\times48\times.75=9{,}700\times18.16 \text{ feet, and } a=\frac{176152}{290\times36}=\frac{176152}{10440}=16.87 \text{ square inches.}$$

Summarizing the three cases and taking the next even diameter above the one called for by the area, we may have the engines 12-inch stroke multiplied by 11.25 square inches area equals $3\frac{3}{4}$ inches + diameter, say $3\frac{7}{8}$ inches; or 10-inch stroke multiplied by 13.5 square inches area $=4\frac{1}{8}$ inches + diameter, say $4\frac{1}{4}$ inches; or 8-inch stroke multiplied by 16.87 square inches area $=4\frac{5}{8}+$ diameter, say $4\frac{3}{4}$ inches; but while the increase in diameter of cylinders will not materially increase the thickness of their walls, shortening the stroke will considerably decrease the size of the central crank case, length of connecting rod, length of cylinder casting, etc. So the third case has been selected for use.

The full area of a $4\frac{3}{4}$-inch piston is 17.72 square inches, and the volume swept per revolution is 17.72×16 inches $=283.52$ cubic inches; and, assuming as a maximum 50 revolutions per minute, we have 14,176 cubic inches swept per minute. The area of the admission and exhaust port is 5.88 square inches (9.42 inches $\times.625$); this will pass 14,176 cubic inches per minute, at a rate of 2,411 inches $=201$ feet per minute, or 3.35 feet per second. Those passages, however, which act only as pressure or exhaust passages, having current through them in one direction need only to pass 21,264 cubic inches per minute for each engine (17.72 square inches $\times$ 8 inches $\times$ 3 cylinders + 50 revolutions), but these are at least 3-inch extra heavy pipes, having an internal area of about 6 square inches. They will therefore pass 21,264 cubic inches at 295 + feet per minute equals 4.92 feet per second, but the customary speed will not be much above 30 revolutions.

In computing strength of parts full pressure (500 pounds per square inch) is used, neglecting back pressure, which, when it acts at all, will tend to balance a part of the working pressure.

Letting t=thickness of cylinder walls, for cylinder 4¾ inches diameter, $500\times4.75=2{,}000\times2t$, $t=\frac{2375}{4000}=.59$ inch thickness of wall required, but it was made 1 inch thick + bronze liner ¼ inch thick.

The pressure passage on the side of the cylinder is 2¾ inches diameter and requires thickness, $t=\frac{500\times2.75}{2000\times2}=\frac{1375}{4000}=.344$ inch, but for the sake of a sound casting it was made ⅞ inch thick.

The exhaust port on the opposite side of the cylinder was made ⅝ inch thick, as it is not exposed to high pressure, and needed only sufficient to insure a good casting.

The valve chest, 3 inches inside diameter, requires thickness $t=\frac{500\times3}{2000\times2}=\frac{1500}{4000}=$ ⅜ inch. It is made 1 inch thick to agree with its central portion (5½ inches diameter) which was made 1 inch thick for fear of porosity.

The ten bolts which hold this valve chest in position are ⅞ inch diameter $=6.013$ square inches total area, and average 6 inches long each. The area of valve chest exposed to pressure is about 24 square inches, giving 12,000 pounds tension on the bolts, say 2,000 pounds per square inch.

Assuming modulus of elasticity 30,000,000 for steel, 2,000 pounds per square inch, will stretch the bolts $\frac{2000}{30000000}=.000066$ of their length $=.000396$ inch, say $\frac{4}{10000}$ inch, not sufficient for any important leakage.

The connecting rod has a spherical bearing in the piston 3¼ inches diameter, 7.67 square inches projected area and receives $17.72\times500=8{,}860$ pounds, i. e., 1,155 pounds per square inch. This it transmits to the crank pin by means of a bronze bearing 2 by 4½ inches, giving a pressure almost exactly 1,000 pounds per square inch, for the maximum angle of the connecting rod is $14^\circ\ 29'$, whence the thrust in the rod must be $8{,}860\times\sec.\ 14^\circ\ 29'=8{,}860\times1.0328=9{,}150$ pounds on 9 square inches.

The body of the rod is 1¼ inches square, equals 1.56 square inches section, and $9{,}150\div1.56=5{,}865$ pounds per square inch compressive stress. The 1¼-inch square portion is 11 inches long. Since these engines are single acting, the connecting rods need neither strap nor adjustment and are provided with only a light detaining ring to prevent the end against the pin from becoming displaced when unloaded.

Valve motion.—Since the cylinder port is ⅝ inch wide and the face of the valve ¾ inch, the travel must be 1⅜ inches, and, since the ends of the lever are 12 and 8 inches long, respectively, the motion of the short (or cam) end will be $1\frac{3}{8}\times8\div12=\frac{11}{12}$ inch; the cam must have $\frac{11}{24}$ inch throw each side of middle position.

The valve lever is 1½ inches by ½ inch in section at its point of support, and at the limiting stress (10,000 pounds per square inch) it would sustain a load, or thrust, on its short end of

$$W=\frac{sI}{8n}=\frac{10000\times.14}{8\times.75}=\frac{1400}{6}=233 \text{ pounds, or } 233\times8\div12=155 \text{ pounds,}$$

at the long end, which appears to be largely in excess of anything needed to move the valve.

Crank pin.—The maximum thrust or crank pin can not exceed 10,140 pounds. This is the resultant of the thrust of two connecting rods acting together at the most favorable angle. It is distributed over the whole length of the pin and equals a concentrated load at a point 2¾ inches from the crank face. $10{,}140\times2.75$ inches equals 27,885 inch-pounds, bending moment at the neck of the pin.

$M_o=\frac{sI}{n}$, where s equals unit stress, I equals moment of inertia of the section, and n equals one-half diameter of pin, equals 1.5 inches, I for 3-inch pin$=.0491\times81=3.98$ and $27{,}885=\frac{s\times3.98}{1.5}$. $S=\frac{27885\times1.5}{3.98}=10{,}500$ pounds per square inch, with a pressure of 500 pounds in cylinders, but at the lower and more probable pressures the stress will be considerably less.

Shaft.—The maximum tangential effort on the crank (at 4-inch radius) by both engines is 17,200 pounds (8,600 pounds each). This is delivered through the shaft pinion at a radius of 12 inches, giving a pressure of 5,733 pounds on the teeth. These teeth are steel castings, unfinished, of 1¼ diametral pitch, $1\frac{1}{16}$ inches thick at the root and ¾ inch from pitch line to root circle. These gears are intended to give three teeth in contact at all times, and in this condition it is customary to assign two-thirds of the load to the middle tooth in action and divide the other third between the tooth just entering and the one just leaving contact. This would give $\frac{2}{3}\times5{,}733=$

3,822 pounds, to be carried by each tooth acting as a beam fixed at the root and loaded at the pitch circle. Each inch of width will bear a pressure $W=\frac{sI}{ln}$, (s=7,000 pounds; I=.099 n=.53)

whence W per inch of face $=\frac{7000\times.099}{.75\times.53}=1{,}732$ pounds. In this case, allowing the full load on one tooth, we require $\frac{5733}{1732}=3.31$ inches face, but, on account of other gears of similar dimensions, this one was made 6 inches face. The dimensions of these teeth fix those of the 72-inch gear which mesh with them.

From p. 2982 it will be seen that the maximum pull that can be expected on the cable and hence on the drum will be 16,100 pounds at a radius of 34¾ inches, which becomes 17,480 pounds when reduced to the pitch circle of the internal gear 32-inch radius, two-thirds of this for load on one tooth equaling 11,656 pounds. Using the formula as above, but allowing the unit stress to rise to 8,000 pounds per square inch, we have W per inch face, $=\frac{8000\times.099}{.75\times.53}=1{,}980$ pounds. $\frac{11656}{1980}=6$, nearly.

The effective width is made 6 inches, and for still greater safety the teeth are shrouded on one end above the pitch line. The teeth of the 24-inch planet gears and 16-inch pinions, which mesh with them, are necessarily of the same size and subject to the same stresses. The teeth of the 16-inch pinions could not be shrouded, on account of difficulty in assembling, and are therefore worked nearer to their limit of strength than the others; but it must be remembered that the limit given (8,000 pounds per square inch) is between one-fourth and one-fifth of the elastic limit, or between one-eighth and one-tenth of the ultimate strength of the material, and also that the load named is a possible maximum with a probable load not more than three fifths as large.

The rims of the wheels are given the usual thickness, 1¼ times the thickness of the tooth.

All the pinions and gears of these machines 24 inches diameter and under have been made without arms, and all over 5 feet pitch diameter have 8 arms each for the sake of uniformity.

The main gear has arms of cross form in section, metal 1 inch thick, 8 inches wide in the plane of the wheel and 6 inches wide at right angles to it. Each arm acts as a beam fixed at one end and loaded 24 inches from the point of support.

Assuming that the load is so distributed by the rim that the nearest arm receives half of it and the remainder is taken by the others. We have, then, a maximum load on any arm $\frac{5733}{2}=2866.5$ pounds and bending moment, Mo=68,796 inch-pounds.

Formula $\frac{sI}{n}$=Mo. I for a cross 8 by 6 inches, with 1-inch metal, symmetrically disposed about the center $=\frac{bH^3}{12}+2\frac{Bh^3}{12}=43+$, $n=4$, required S, $68796=\frac{43s}{4}$ $s=\frac{68796\times4}{43}=$ 6,400 pounds per square inch, nearly.

The arms of the brake rim next to the main gear, and carrying the internal gear, have little or no transverse stress, their duty being only to support the rim.

But the arms of the drum and opposite brake rim must transmit the stress from the pins which carry the planet gears to the outside of the drum, and from the rim of the brake to the pins for the gears. As the distances are identical, the stresses transmitted as nearly alike as possible, and the cross sections of the arms the same, we will investigate but one.

The maximum stress on the drum is, as before seen, 16,100 pounds, given out to the cable at 34.75 inches radius, and produced by a stress on the arms at 20 inches radius, hence, $\frac{16100\times34.75}{20}=27{,}974$ pounds, is the total load on four arms.

These arms, considered as supporting the load on the pins, are in the condition of beams 22¾ inches long, fixed at both ends and loaded at 12¾ inches from one, but considered as transferring that load to or from the circumference, they are fixed at the outer end and loaded at the pin. The connection to the hub serves, with the rim, to partially distribute the stresses between the various arms.

Taking the case in which one planet wheel pin and arm have to bear one-half the load, we have a bending moment, $Mo=\frac{27974}{2}\times12.75=178334$ inch-pounds.

The cross section is H-form metal 1 inch thick; outside dimensions, 7½ by 8 inches, with 8-inch dimension in the plane of the wheel, thus ———. In the formula $Mo=\frac{sI}{n}$, $I=\frac{7\frac{1}{2}\times8^3-6\frac{1}{2}\times6^3}{12}=203$, $n=4$, required s. $Mo=178334=\frac{203s}{4}$, and $s=\frac{178334\times4}{203}=\frac{713336}{203}=3514$ pounds per square inch.

Assuming the load as above, we have 13,987 pounds on one planet gear pin. These pins are 4 inches diameter and $5\frac{3}{4}$ inches long; hence $Mo=13987\times2.875=40213$ inch-pounds. $I=.0491d^4=12.57$, $n=2$, $Mo=\frac{sI}{n}=40213=\frac{12.57s}{2}$, $s=\frac{40213\times2}{12.57}=6663$ pounds per square inch. The bearing pressure on pins will be (loads as before), $\frac{13987}{5.75\times4}=\frac{13987}{23}=608$ pounds per square inch projected area.

The main shaft is 46 inches long between bearings and 7 inches diameter in the middle. It carries about 8 tons (16,000 pounds), fairly distributed along its length, but with center of gravity probably about 20 inches from one end and 26 inches from the other. The pull on the cable loads the shaft horizontally in a plane which varies from one side of the drum to the other, but the limit is so narrow and so near to the plane of the center of gravity of the weights on the shaft that it will not introduce any serious error to consider both forces acting in the same plane at right angles and each at 16,000 pounds. In that case their resultant will lie at 45° from the vertical (either side, according to which cable is pulling), and amount to 16,000 secant $45°=16000\times1.4142=22627$ pounds. Maximum bending moment, $Mo=\frac{22627\times20\times26}{46}=250341$ inch-pounds $=\frac{sI}{n}$, where $I=.0491d^4$, $d=7$ inches, $n=3.5$ inches.

$I=117.89$. $250341=\frac{117.89s}{3.5}$, $s=\frac{250341\times3.5}{117.89}=7432$ pounds per square inch.

Engine shaft.—The maximum force to be transmitted from each end of the shaft to the pinion is 8,600 pounds, at 4 inches radius, 34,400 inch-pounds torsional moment. Unwin's Machine Design, part 1, page 208, gives: Torsional moment, $T=\frac{sd^3}{5.1}$, where s equals maximum stress and d equals diameter in inches. In this case $34400=\frac{d^3s}{5.1}$ and $s=10000d^3=\frac{34400\times5.1}{10000}=\frac{175440}{10000}$ and $d=\sqrt[3]{17.54}=2.596+$, or 2.6 inches diameter. From other considerations the shaft was made 4 inches diameter. This will give us a maximum working stress $s=\frac{34400\times5.1}{64}=\frac{175440}{64}=2741$ pounds per square inch.

The transverse stress on the shaft comes as an upward thrust equal to the load transmitted by the teeth of the pinion, which, by page 2983, is seen to be 5,733 pounds. Now, this is actually reduced by 436 pounds, the weight of the pinion, but for the sake of safety it has been computed as 5,733 pounds on a beam 4 inches diameter, 51 inches between supports, and divided by the load point into segments 6 inches and 45 inches; hence $Mo=\frac{Wab}{L}=\frac{5733\times45\times6}{51}=30351$ inch-pounds. For 4-inch shaft $I=.0491d^4=12.57$, $n=2$, $Mo=\frac{sI}{n}=\frac{12.57s}{2}=30351$, and $s=\frac{30351\times2}{12.57}=4829$ pounds per square inch.

The combined load on both bearings of the engine shaft will be the upward thrust of two pistons plus the resistance of the gear, equals $2\times8,600+5,733=22,933$ pounds. This is distributed $8,600+\frac{5733\times45}{51}$ and $8,600+\frac{5733\times6}{51}$ on the respective bearings, which have each 36 square inches of projected area of metal, exclusive of packing.

Reducing these loads are 13,658 pounds and 9,275 pounds, respectively, giving bearing pressures of 380 pounds and 257 pounds per square inch.

On main-shaft bearings, as before seen, 22,627 pounds is divided between two bearings 6 by 9 inches, equals 54 square inches, an average of $\frac{22627}{108}=209+$, say 210 pounds per square inch projected area.

The bearing area of the drum on the shaft is 7 by $8\frac{1}{2}$ inches, equals $59\frac{1}{2}$ square inches. The load consists of the weight of the drum and its attachments, which at a close estimate is 6,000 pounds vertical, and in a horizontal direction the pull of the cable, maximum, 16,000 pounds. Their resultant is 17,100 pounds, which gives $\frac{17100}{59\frac{1}{2}}=287+$ pounds per square inch projected area. This for cast steel on wrought steel.

In designing the frame or bed plate of the gate machine, conditions of proper room for bearings and attachment of parts as well as appearance fixed most or all of the dimensions so much in excess of what would be given by computations for strength alone that no computations were made, except a few for checks, which uniformly showed such an excess of strength that they were disregarded. The tendency to slip on the foundation can not be greater than the pull on the cable (16,100 pounds). Now, the coefficient of friction between stone and cast iron may be safely taken as 0.3; it is probably much more. Then, $\frac{16100}{.3}=53{,}666$ pounds will represent the holding-down force necessary to prevent slipping. The whole machine weighs over 10 tons, but taking it at 20,000 pounds, we have 33,666 pounds for the necessary stress on holding-down bolts. These are ten; $1\frac{1}{4}$ inches diameter each net area at bottom of threads, 1.22 square inches, or 12.2 square inches total. This gives the necessary stress $\frac{33666}{12.2}=2{,}760$ pounds, nearly, per square inch of bolts.

Unwin's Machine Design gives for leather belts on iron pulleys the coefficient of friction 0.4, and for a wrap of 320° around the pulley, the ratio between the pull on slack and tight sides as 1:10. The coefficient of friction of basswood blocks on the steel rim will not be much in excess of that of leather, so a coefficient .4 has been assumed in this case.

The brakes are so arranged that the pull corresponding to the tight side of a belt is thrown on the standing end of the band, leaving only $\frac{P}{10}=\frac{16100}{10}=1{,}610$ pounds to be exerted on the slack or moving end of the band by the hand wheel and screw. The wheel is 20 inches diameter, and the screw $4\frac{1}{2}$ threads per inch; power moves 282 inches to move work 1 inch; hence 20 pounds or less on hand wheel should set the brakes.

The brake band has $(6-\frac{3}{4})\ \frac{1}{4}=1.31$ inches, net section, and $16{,}100\div1.31=12290$ pounds per square inch of net section is maximum stress.

The rivets holding the band at the standing end are seven, of three-fourths inch diameter, their bearing value in a $\frac{1}{4}$-inch plate (at 15,000 pounds per square inch) is 2,810 pounds each, or 19,670 pounds total, and shearing value at 7,500 pounds per square inch section, in single shear, is 3,310 pounds each, or 23,170 pounds total.

Similarly each band is supported at the standing end by three turned $1\frac{1}{4}$-inch studs in single shear, combined area $3\times1.227=3.681$ square inches, this at 7,500 pounds per square inch, as before, equals 27,607 pounds. Their bearing value is largely in excess (56,250 pounds), as they pass through 1-inch metal.

All the pin connections, except trailing ends, are on $1\frac{1}{2}$-inch turned pins in reamed holes in double shear, giving (at 7,500 pounds as before) 26,505 pounds working shear. Thus it is seen that all parts of the brakes (except the bands, which are thin for flexibility) have large margins of working strength above anything that can be called for, while the band itself is not, at the maximum, worked much, if any, beyond one-third its elastic strength.

THE HYDRAULIC CAPSTANS.

The hydraulic capstans are estimated to pull 12,750 pounds on a $2\frac{1}{2}$-inch diameter line around the barrel, this being about all that can be obtained from a line of that size rated to break at 38,000 pounds when new.

The entire capstan above the base plate was built by the American Ship Windlass Company, of Providence, R. I., and is the same as those built by them for use on the larger battle ships of the United States Navy, and adapted for much heavier work by hand power than that required here. They are geared $2\frac{1}{2}$ revolutions of shaft to 1 of barrel, in one direction, and equal turns in the opposite. The reversal affects the direction of shaft and inner gears only.

The three single-acting oscillating cylinders acting on one crank pin will give a practically continuous tangential effort equal to the thrust of one plunger. Hence a 7-inch plunger (area 38.48 square inches), acting on a crank at 6-inch radius with an effective pressure of 290 pounds per square inch (300 pounds minus 10 pounds back pressure), will give a tangential effort of $290\times38.48=11{,}159$ pounds. The radius of capstan barrel, taken to center of rope, is $10\frac{1}{2}$ inches; assuming 80 per cent efficiency, 11,159 pounds at 6 inches will pull $\frac{11159\times6\times.8}{10.5}=5{,}100+$ pounds on the rope when the barrel turns at the same rate as the shaft, but if reversed, and the shaft runs $2\frac{1}{2}$ turns to 1 of the barrel, the pull will be $5{,}100\times2.5=12{,}750$ pounds. Again, if the pressure be raised to 500 pounds, effective 480, we have $\frac{480\times38.48\times6\times.8}{10.5}=$ 8,443 pounds and 21,100 pounds, respectively.

The maximum thrust on crank pin can not exceed 21,650 pounds, which is the resultant of the thrusts of two plungers acting together at the most favorable angle; 21,650 pounds on a pin 4 inches diameter, 7 inches long, gives a moment $Mo=21{,}650\times3.5=75{,}775$ inch-pounds. Now $Mo=\frac{sI}{n}$, and for 4-inch pin $I=.0491\,d^4=12.57$ and $n=2$; whence $75{,}775=\frac{12.57\,s}{2}$ and $s=\frac{75{,}775\times2}{12.57}=11{,}890$ pounds per square inch of extreme fiber; but this can never happen until 500 pounds per square inch pressure is used, which is an unlikely case.

The maximum bearing pressure is 18,470 pounds (38.48×480 pounds) on a bearing $2\frac{5}{8}$ by 7 inches projected area, equal 18.37 square inches, equal almost exactly 1,000 pounds per square inch.

The rear surface of each cylinder is ground into the chest, which serves also as a valve face for distributing the pressure fluid. Each cylinder has two trunnions concentric with its valve surface and supported in housings with bronze bushings. These serve to prevent the pressure in the pressure port from driving the cylinder out of place while its port is turned toward the exhaust.

The reversal of the engine is effected by a valve which changes the current of fluid from one set of ports to the other as required. Pressure port becomes exhaust, and vice versa. The valve is of the same construction as those used for controlling the valve engines.

The engine cylinders are $7\frac{1}{4}$ inches inside diameter, and 500 pounds pressure requires $\frac{7.25 \times 500}{2} = 1{,}813$ pounds $\div 2{,}000 = .9$ inches (full) thick; they are made $1\frac{1}{4}$ inches thick.

PUMPS, ACCUMULATORS, ETC.

The accumulator capacity needed is dependent on the frequency and amount of the regular or periodic demands for power, and also to some extent on the capacity of the pressure pumps in use at the time of demand.

The pump capacity, however, must be regulated by the greatest continued demand for power that can be made. The greatest sustained demand for power will be when running the capstans. This demand may amount to about 30,000 cubic inches per minute when pulling a full load (12,700 pounds) at 45 to 48 feet per minute, or a light load (5,100 pounds) at about 120 feet per minute.

Each capstan has three cylinders 7 by 12 inches, single acting, making $2\frac{1}{2}$ revolutions to 1 of barrel on maximum pull. The diameter of the capstan barrel to center of rope is 21 inches, circumference 5 feet 6 inches. To pull 48 feet requires $\frac{48}{5.5} = 8.7$ revolutions of barrel, or $8.7 \times 2.5 = 21.8$ revolutions of engine; 7 inches diameter $= 38.48$ square inches, and 21.8 revolutions equal $38.48 \times 12 \times 3 \times 21.8 = 30{,}199$ cubic inches. Since this demand is liable to be continued for several minutes at a time, any practicable accumulator capacity could only supply it for a short time while the pumps are starting. Therefore we are called upon to design pumps to throw 30,000 cubic inches per minute, with reserve capacity in case of accident. This will be accomplished by making three pumps each of 15,000 cubic inches capacity per minute at a pressure from 300 pounds to 500 pounds per square inch.

In order to avoid shock when pumping under pressure, let us assume the use of three-throw, single-acting pumps, i. e., pumps having three cylinders each, with single-acting plungers driven from a shaft having three cranks set 120° apart.

For reasons given the plunger speed has been limited to 100 feet per minute or less. With plungers 4 inches diameter, area 12.56 square inches, the combined area will be 37.68 square inches and will require $37.68\overline{)15{,}000}$ (400 linear inches displacement speed, or 800 inches=66.66 feet plunger speed per minute.

$$\underline{15{,}072}$$

If 10-inch stroke is used, there will be required $\frac{66.66}{1.66} = 40+$ revolutions of crank shaft. Five-to-one gear onto the pinion shaft gives $40 \times 5 = 200$ revolutions per minute of pinion shaft, the same as the turbine shaft. Now each plunger will deliver $12.56 \times 10 \times 40 = 5{,}024$ cubic inches per minute, but as half of the minute is taken up in filling the cylinder the rate of flow through valves and connections will be that due to 10,048 cubic inches per minute.

The valve passages are $2\frac{3}{4}$ inches diameter, less the area of valve spindle wings, etc. $= 5.94 - .89 = 5.05$ square inches, and $\frac{10048}{5.05} = 1{,}990$ linear inches $= 166$ feet nearly per minute average flow through the narrowest passage; hence the maximum can not exceed 332 feet per minute $= 5.54$ feet per second.

Since the circumference of each valve is 8.64 inches minus four wings one-eighth inch thick, it will require a lift of $\frac{5.05}{8.14} = .62$ full to give an opening equal to the area of the passage. It has been set at seven-eighths inch.

As all the other passages are 3 inches diameter or over, the velocity in them is sure to be lower than the above.

The cylinders are 5 inches internal diameter and 1 inch thick. The stress on the metal due to 500 pounds per square inch is then only $\frac{500 \times 5}{2} = 1{,}250$ pounds per square inch.

The direction of motion of the crank shaft has been so chosen that the thrust on the plungers occurs during the lower half of the crank revolution, and in order to reduce as much as possible the deviation of the connecting rod from the center line of plunger when in action the center line of cylinder is placed 2½ inches (one-half crank rod) below the center of crank shaft. The maximum angle of connecting rod, when loaded, is, therefore, that whose sine is $\frac{2.5}{24}=5^\circ\ 59'$, say 6°, and when unloaded it is that whose sine is $\frac{7.5}{24}=18^\circ\ 13'$. The area of a 4-inch plunger is 12.56 square inches, and the greatest pressure that can come on a crosshead pin is $12.56\times500\times\sec.6^\circ=12.56\times500\times1.0055=6{,}314$ pounds on 2 by 3½ inches bronze equals $\frac{6314}{7}=902$ pounds per square inch. The crank pin is 3 by 3½ inches; consequently its bearing pressure is $\frac{6314}{10.5}=601$ pounds per square inch.

The connecting rod is 24 inches long, center to center, and 16½ inches in the body, which is 2½ by 1¼ inches, or 3.125 square inches, section to carry 6,314 pounds, equals $\frac{6314}{3.125}=2{,}020$ pounds per square inch.

The greatest pressure on guides will be the vertical component of the thrust of the connecting rod, which equals 6,314 sin $6^\circ=660$ pounds. This is received on 18 square inches of surface, equals 37 pounds per square inch.

The maximum pressure that can come on any intermediate bearing is one-half the horizontal component of the thrust of the connecting rod on each side, which are 6,300 pounds each. The bearing is 3 by 5¼ inches, equals 15.75 square inches; hence maximum pressure per square inch equals $\frac{6300}{15.75}=400$ pounds. On an end bearing (3 by 7 inches, 21 square inches projected area) the maximum pressure is composed of the effort on the gear plus one-half the horizontal component of the thrust on one connecting rod, equals $2{,}100+3{,}150=5{,}250$ pounds and $\frac{5250}{21}=250$ pounds thrust per square inch projected area.

The bed plate (pl. —) was designed to give as rigid a structure as possible without undue weight. It is deeply ribbed under all points where any tendency to deflection or unsteadiness was believed to exist.

By compounding the thrust on the three connecting rods and reducing to a tangential effort it appears as a practically constant effort of 6,300 pounds at a radius of 5 inches, equal to a torsional moment of 31,500 inch-pounds. By Unwin's formula, as used for engine shaft (p. 2985), we have

$$T=31{,}500=\frac{sd^3}{5.1}.$$

The shaft and crank pins were made 3 inches diameter throughout; hence $d=3$ inches and $d^3=27$. Substituting $s=\frac{31500\times5.1}{27}=\frac{160650}{27}=5{,}950$ pounds per square inch.

From the above the pressure on the teeth of the 30-inch steel gear on the crank shaft will be $\frac{6300\times5}{15}=2{,}100$ pounds at 15-inch radius.

These teeth are 3 diametral pitch, 0.38 or 0.4 inches from root circle to pitch line, one-half inch thick at pitch line, and slightly thicker of the root. For each inch of face at 7,000 pounds limiting stress 1 tooth will support P pounds at the pitch line and 0.4 P=Mo=bending moment.

$\text{Mo}=\frac{sI}{n}$; $s=7{,}000$ pounds; $n=\frac{1}{4}$ inch; $I=\frac{1\times(\frac{1}{2})^3}{12}=\frac{.125}{12}$; $\text{Mo}=\frac{7000\times.125}{12\times.25}$; and $P=\frac{\text{Mo}}{.4}=\frac{7000\times.125}{12\times.25\times4}=729$ pounds, and to carry 2,100 pounds requires $\frac{2100}{729}=2.88$ inches made 3 inches face.

This gear has six arms of cruciform section 9½ inches long from pitch circle to hub. They are of steel, three-fourths inch thick, 4½ inches × 2½ inches with the 4½ inches dimension in the plane of the wheel.

Each arm, then, acting as a beam fixed at one end and loaded at the other, will carry P pounds; 9.5 P=Mo, which$=\frac{sI}{n}$, where $s=7{,}000$ pounds, $n=2\frac{1}{4}$ inches and $I=\frac{bH^3+2Bh^3}{12}=\frac{.75\times91.125+2\times.42}{12}=5.765$, and $\frac{\text{Mo}}{9.5}=P=\frac{7000\times5.765}{2.25\times9.5}=\frac{40355}{21.375}=1{,}888$ pounds.

Now since it is fair to assume that the rim will distribute the load to not less than two arms at any one time, we have 3,776 pounds as the supporting power of these arms at the above limit of stress.

ACCUMULATORS.

As stated (p. 2987), the accumulator capacity needed depends on the extent and frequency of the periodic demands for power in manipulating the lock. The greatest periodic demand for pressure fluid will be for operating one gate immediately preceded or followed by one stroke each of six valve engines.

A demand of this amount must be followed by a lapse of time sufficient to fill or empty the lock, or to place one or more vessels in, or remove them from the lock. Of these two intervals the shorter is the one for filling or emptying the lock, which may be as short as six or seven minutes, but will more probably be eight or ten. We must, therefore, have capacity to store so much pressure fluid as will operate the gate and valve engines once, less such an amount as the pump or pumps can deliver during such operation, which may last from one to three minutes, say two. It will take from 40 to 50 revolutions of the engines to swing a pair of gate leaves. Each leaf having six cylinders 4¾ by 8 inches in action, the total fluid used will be (area 4¾-inch circle) 17.72 square inches $\times 8 \times 12 \times 50 = 85{,}056$ cubic inches for gate engines.

The six valve engine cylinders are 8 inches, diameter, equals 50.26 square inches by 48 inches stroke, and the whole volume swept will be $50.26 \times 48 \times 6 = 14{,}475$ cubic inches.

	Cubic inches.
For gate engines	85,056
For valve engines	14,475
Total	99,531

to be suppled in 2 minutes or less. One pump will supply in 2 minutes 30,144 cubic inches—99,531 less 30,000 leaves 69,531 cubic inches to be stored in the accumulators. On account of the height of ceiling in engine room we are limited to about eight feet stroke, which, if three are used, gives $3 \times 96 = 288$ inches combined stroke. Now, $69{,}531 \div 288 = 241.43$ square inches, nearly, for area of plunger; this equals 17½-inch circle.

The three accumulators were made 18 inches diameter by 8 feet 2 inches stroke. They were designed on a slightly different basis, for use with smaller pumps, before a change in the size and power of the capstans made them the controlling factor in the size of the pumps.

The barrels of the accumulators are of steel, being rolled up and welded from plate three-quarters of an inch thick. They are 19 inches inside diameter; hence, for 500 pounds per square inch pressure the stress in the metal would be $\frac{19 \times 500}{1.5} = 6{,}333$ pounds per square inch. This in steel of 32,000 to 35,000 pounds per square inch elastic limit.

In order to produce the maximum pressure (500 pounds) on an 18-inch ram, the moving weight must be 254.46 square inches $\times 500 = 127{,}230$ pounds. Of this, the plunger itself weighs 2,500 pounds, the lead weights which fill its interior 6,600 pounds, the crosshead plate 5,750 pounds, the lower or weight plate 3,500 pounds, and the 24 rods which support it 1,660 pounds, a total of 20,000 pounds, leaving 107,200 pounds to be made up of plates cast for the purpose—61 courses 1¼ inches thick, as shown.

PULLEYS, CLUTCHES, AND BELTING.

As mentioned the pumps are driven from the turbine shaft by friction-clutch pulleys and rope belting. These pulleys are grooved for three-quarter-inch rope, the sides of the groove are finished to an included angle of 30 degrees and the bottom finished to one-half inch diameter, preventing the rope from bottoming in the groove and by the wedging action increasing its friction to a point where slipping is nearly or quite impossible. Unwin (Machine Design, pp. 338–342) says that with an arc of 180 degrees embraced on the pulley, and grooves whose sides are at an angle of 45 degrees, the ratio of tensions between slack and driving sides may be taken as high as 9.02 and the working strength of the ropes up to one-eighth, or 12½ per cent, of their breaking strength. But in this case the ratio was obtained from different data and used at 4.8, while in most cases not more than 4 or 5 per cent of the breaking strength of the new rope has been used.

A pump delivering 15,072 cubic inches per minute under 500 pounds per square inch requires nearly 24 horsepower to drive. Twenty-four horsepower equals 792,000 foot-pounds. Two hundred revolutions per minute of 36-inch pulley gives $200 \times 9.42 = 1{,}884$ feet per minute belt speed; $792{,}000 \div 1{,}884 = 420+$ pounds total available pull on three ropes, equals 140 pounds on each. Now, if the ratio between slack and tight sides of the belt is 4.8, the initial tension multiplied by 3.8 will be available for driving; hence, to drive 140 pounds the initial tension will have to be $\frac{140}{3.8}=$ 37 pounds, nearly, as a maximum initial tension on each rope, the minimum (for pumping 300 pounds pressure) being 22 pounds.

The main shaft pulleys are driven by friction clutches made by the Brightman Machine Company, Cleveland, Ohio. They are that company's ordinary design, and appear well made and reliable. Each clutch is furnished with a cylinder 3 inches in diameter, placed above the main shaft, whose piston rod is so connected to the clutch lever that pressure admitted to the cylinder will operate the clutch.

These cylinders are connected with the pressure pipe by a pipe in which is a three-way cock controlled by the movement of the accumulators. A cock in each branch leading to a cylinder enables any one or all to be cut off from the control of the accumulators at will.

MERITS AND DEMERITS OF DESIGN.

The design as a whole was adopted as seeming to be the best under the existing conditions. The valve engines of the lock of 1881 had done so well that but few changes were made in them. The engines were placed in the bottom of the pit, both to avoid the obstruction to the flow of water caused by heavy girders across the top of the pit and to enable the valve to be revolved with its edge instead of its flat surface presented to the rush of water as it commences to flow through the culverts. It is believed that this position will also facilitate care and repairs, since each part can be unbolted and hoisted out without disturbing others. Cylinder heads, etc., can be removed without breaking pipe joints.

The three-cylinder engines are believed to be efficient and economical both as regards care and renewals, unless it be in some of the smaller parts.

The climatic conditions, which make it necessary to use oil as a pressure medium for a part of each season, have been met by the use of oil at all times, as it is believed that the waste in use will not be as great as that in changing from water to oil and back. Also, it has been found by those who have studied the question that the water which must remain to some extent in the pipes after changing to the use of oil is drawn along in minute particles with the oil, and in cold weather freezes into very fine crystals, which thicken the oil and occasion large losses of pressure.

The continuous use of oil has enabled the arrangement of the engines in such a way as to be entirely self-lubricating.

The planet-geared winding drums are used because this form admits of a large gear ratio in a very small space. It admits of a very strong construction, and, while it is known that the large number of gears renders them noisy and takes up considerable power in friction, yet at the slow speed here required they will probably be fairly efficient.

HISTORY OF CONSTRUCTION.

Contractor.—The drawings and specifications for the work were completed about July 1, 1894. Application was made and authority given late in July to advertise for proposals for performing the required work.

Pursuant to an advertisement dated August 6, 1894, proposals for the construction and installation of the operating machinery were opened at the United States engineer's office, Detroit, Mich., September 5, 1894, as follows:

No.	Name of bidder.	Address.	Amount.
1	John P. McGuire	Cleveland, Ohio	$59,400
2	Weimer Machine Works Co	Lebanon, Pa	66,701
3	Southwark Foundry and Machine Works	Philadelphia, Pa	81,600
4	Thos. S. Christie	Detroit, Mich	96,225

The bid of John P. McGuire, Cleveland, Ohio, being lowest, a contract was entered into with him September 10, 1894, for the performance of the work. The consideration was $59,400, as per his bid.

Pattern-making and other preparatory work was commenced immediately, and actual construction began about October 1, at the shops of the Variety Iron Works Company, in Cleveland. Work was carried forward in the shops, under the personal supervision of Mr. F. M. Dunlap, without special incident, till its completion, May 9, 1895.

Materials furnished.—The cast iron, steel castings, and steel for forgings were tested for compliance with the specifications, at the works where they were produced, by the inspectors of G. W. G. Ferris & Co., of Pittsburg, Pa. The inspection seems to have been careful and thorough in every respect.

The iron castings were made at the Variety Iron Works Company's foundry, Cleveland, and they were neat in surface and usually very free from defects of any kind, but certain pieces were found to be particularly liable to porous spots, sand holes, or blow holes, which always appeared at or near the same spot. By taking particular care in placing chaplets and in the position of the mold when casting, these difficulties were largely overcome, though at first they threatened to be serious.

The steel castings were made by the Penn Steel Casting Company, of Chester, Pa. Considerable difficulty was experienced in getting steel of high enough ultimate tensile strength and elastic limit to show at the same time the proper elongation and reduction of area at fracture, but when they did succeed in combining those qualities they produced a very fine lot of castings.

The steel for forgings was made at the Carnegie Steel Company's Union Mills and forged to shape at the Variety Iron Works Company's own shops, in Cleveland.

Abstracts of the tests of each of the three varieties of material are appended.*

The phosphor-bronze was not tested for tensile strength, but was roughly tested for toughness and malleability by bending random specimens cut from the castings. They were held in a vise and bent cold by blows from a hand hammer to a radius of about an inch; most of them bent 90 degrees or more before cracking. Similar pieces were forged down cold to three-fourths their original size or to half the original thickness. All were taken as they came from the sand without, annealing or other treatment. These, with the working tests, showed the bronze to be dense, hard, and tough.

Working tests of materials.—During all the work of finishing and fitting up the pieces close watch was kept on the behavior of the metals under the action of cutting tools as a further indication of quality and fitness for use intended.

The steel castings seemed uniformly mild and cut almost like mild forged metal. They were very free from sand spots except in places where they were able to be cut away in the finishing.

The steel forgings showed a good combination of hardness and toughness, but developed many spots so hard that it was impossible to make a tool stand a cut across them. They were, however, removed by reannealing wherever they were found before the work was too far advanced to admit of it.

The cast iron was gray, soft, and tough. It showed good quality throughout. The phosphor-bronze was furnished to the Variety Iron Works by a foundry making it a speciality, and, in general, it was of fine quality, uniform in color and texture, and as hard as could conveniently be worked with steel tools; but for a time—whether from lack of care in casting or want of uniformity in the mixture they could not find out—the castings came apparently sound on the outside, but in turning or boring the metal seemed granular, so that the point of the tool, instead of cutting off a uniform chip, seemed to break off a grain, leaving a series of small, smooth pits, so fine as to be hardly felt by passing the finger over them, but appearing as points of different color from the rest of the surface. They were quite noticable, however, to the finger nail or the point of a sharp pencil. These defects appeared principally in the cylinder liners for the three cylinder engines, but, after rejecting nearly or quite 50 per cent of the pieces cast, enough good ones were obtained to complete the cylinders, and no other parts showed any serious difficulty.

Shipment.—Shipments were made from Cleveland by boat on May 2, 5, and 9, 1895. All the smaller and highly finished parts were boxed or crated, and the whole arrived at Sault Ste. Marie in good order. These three consignments completed the deliveries of material except the extra heavy pipe, the oil, and the patterns, and on their receipt a partial payment was made on a voucher dated May 22, 1895, for $32,670, being all the preliminary payments except for that section to which the piping belonged. This latter portion of the delivery was completed before July 1, and the amount ($2,970) necessary to complete the preliminary payments was paid on a voucher dated July 5, 1895. The patterns were not shipped till about October 1, when there was sufficient room in one of the Government storehouses to receive them.

Erection.—The erection was practically begun June 1, and went on steadily and more or less rapidly till October 23. The number of men employed varied considerably, but an average of one foreman, four machinists, and six or eight helpers will not be far from the truth. Besides these a gang of laborers was employed for a few days in digging pipe trenches.

The chief difficulties encountered in the erection were concerned with the pipe fitting, and the worst of these occurred in the inclined passageways where the pipes crossing the lock and those supplying the valve engines were taken down to the bottom of the lock.

On or about October 23, 1895, the work was as far advanced as it could be before time to make the running trials. The state of other work over which the contractor had no control and the advanced season precluded the possibility of making the trials before the spring or summer of 1896. The Secretary of War therefore authorized the execution of a supplemental contract (dated November 16, 1895) by

* Not printed.

which the sum remaining unpaid on the contracts, less $500, could be paid immediately. The retention of $500 to cover expense of work still to be done, and the continued liability of the bondsmen were held to sufficiently protect the United States.

This contract was approved by the Secretary of War December 19, 1895, and the amount ($23,260) due under it was paid on a voucher dated December 26, 1895.

Operations were resumed about May 15, 1896, the machinery was cleaned up, and oil was admitted to the pipes May 30. In operating the machines for trial on June 6 or 7, the brake rims of two of the gate machines hung on the shaft, showing such signs of cutting that it was decided to bore out the hubs of the brake wheels and drums and bush them with bronze before attempting to run them. In taking the machines apart it was quite evident that their exposure to the weather and drifting sand was responsible for the cutting, for at many of the faces of hubs where sand had an opportunity to get down to the shaft and lodge between adjacent hubs, signs of cutting were found, and in several of them very severe cases, but in no case was any sign of cutting found in the middle of a journal or at any point sheltered from the sand. The expense of this bushing was about $619; it was completed about July 24, and the machines reassembled.

Working trials.—Beyond running for a short time unloaded to make sure that the gears all meshed properly, and that everything was free, there were, strictly speaking, no working trials of the gate engines before they began to be used in operating the lock. This was due to several causes. Among them, the short time between the last assembling of the machines and the date set for opening the lock. This was barely sufficient to couple up the gate cable onto the drums, but during the coupling up advantage was taken of every opportunity to use the machines for swinging the gates, but this had to be limited to the necessary swinging, as there was some danger in swinging the gates without water in the lock. The valve engines were operated several times each, and seemed to operate satisfactorily.

During the first few days' use of the engines they developed some weakness. The levers which actuate the valves of the three-cylinder engines were designed too light in the direction transverse to their plane of motion. Although provided with rollers for riding in their cams, the action of the cam seemed to throw considerable side stress on them and bend them till they left the cam groove. This was remedied by riveting pieces of steel on the sides of the levers, and appears to have been satisfactory. The connecting rods of the same engines were several of them bent, presumably on account of the valves stopping over the exhaust ports when the valve levers bent. Those not too much disabled were straightened and new rods were made for the others, care being taken to make them of stiffer steel.

A few weeks of running disclosed the fact that in the cored ports of the valve-engine cylinders some core sand, wires, etc., were left in the cleaning out, in spite of the fact that the specification (par. 73) required all such cored ports to be pickled with acid solution and the scale loosened cleared out. The ports were difficult of access and almost impossible of inspection.

The work was practically completed and the contractor's representative left July 25. Final payment was made September 14, 1896.

PUMPING PLANT.

Construction, trials, etc.—This machinery was designed by Julian Kennedy, M. E., of Pittsburg, Pa. The drawings and specifications were completed on or before July 1, 1893. They were approved and authority given to advertise for proposals on July 21, and in response to an advertisement dated July 29 the following bids were received and opened at the United States Engineer Office September 27, 1893:

Bidders.	Item A.	Item B.	Item C.
Southwark Foundry and Machine Co., Philadelphia, Pa	$24,935.00		
Mackintosh, Hemphill & Co., Pittsburg, Pa	35,000.00		
Morgan Engineering Co., Alliance, Ohio	46,772.00		
Westinghouse, Church, Kerr & Co., New York		$16,375.00	
Manning, Maxwell & Moore, New York		16,912.00	
Morgan Engineering Co., Alliance, Ohio		17,485.00	
The Babcock and Wilcox Co., New York			$47,574.00
Manning, Maxwell & Moore, New York			48,935.00

The work was let in three contracts—Item A, the centrifugal pumps, with their girders, fittings, and discharge pipe, to the Southwark Foundry and Machine Company, under a contract dated October 20, 1893, for $24,935.

Two written agreements for extra work, dated March 7 and July 18, 1894, respectively, brought the price of Item A up to $25,250.50.

Item B, the Westinghouse compound engines, to Westinghouse, Church, Kerr & Co., of New York, N. Y., under a contract dated October 20, 1893, for $16,375, Item C, the Babcock and Wilcox boilers, with their piping, pumps, heater, and the piping of engines, to the Babcock & Wilcox Company, of New York, N. Y., under contract dated October 26, 1893, for $47,574.

The inspection of materials for items A and C was performed at the mills where it was produced by the Pittsburg Testing Laboratory. An abstract of their test reports compiled by Assistant Engineer Molitor is appended.*

Practically no shop inspection was required, reliance being placed on the well-known reputation of the contractors, and a thorough running test at completion.

As the engines (Item B) were intended to be the standard engines of their class as built by the Westinghouse Company, with all parts interchangeable with those of others of the same size and class, inspection of material or shop work would have been impracticable, as it would have been almost impossible to keep the material for three engines separate while going through the shops. For this item, therefore, a thorough running test, at the shops of the contractors, in the presence of an engineer appointed by the United States engineer officer in charge, was provided.

Work on these contracts was commenced immediately, and the machinery was ready for shipment at or near the contract time, but on account of delay in completing other contracts it could not be erected as soon as originally intended.

The Westinghouse engines were tested at the builders' works June 30 to July 7, 1894, in the presence of Julian Kennedy, M. E., of Pittsburg, Pa., who was appointed by Col. O. M. Poe, Corps of Engineers, to represent him in the premises. A copy of Mr. Kennedy's report is hereto attached. According to this report, the engines were each run ten hours under an external measured load of 400-horsepower, applied and measured by a brake, and showed very creditable economy in the use of steam.

The engines were delivered at the Sault in September, and the centrifugal pumps in October, 1894. The Babcock & Wilcox boilers were completed at or about the same time, but were stored at the works of the makers till July, 1895, when they were delivered.

The erection of the centrifugal pumps was commenced June 5, 1895, and progressed steadily but slowly. A change of location 2 inches toward the south was made necessary by the position of the 48-inch draft tube of the turbines, which lay further from the lock wall than was contemplated when the plant was designed.

The material, in sections, for the boilers was received in two consignments July 1 and 24, erection commenced July 24, and progressed rapidly. The boilers proper, with their setting, were erected early in October, but, by some delay in getting fittings for the main steam and exhaust pipes, the delivery of material was not completed till December 28, 1895.

On or about October 23, 1895, when the work on the centrifugal pumps and the setting of the engines had progressed as far as it could until the floor over the pump well should be put in place, which floor was to be built by the United States, work was suspended for the winter, and a supplemental contract entered into November 21, 1895, by which the final payment was made, excepting $250 which was retained to protect the United States and provide for the slight amount of work yet to be done. The liability of the bondsmen was continued under the supplemental contract. This contract was approved by the Secretary of War December 7, and the amount due under it ($9,850.20) paid on a voucher dated December 23, 1895.

The work on the piping, etc., in connection with the boilers having been completed as far as the progress of work on the power house would permit, and the state of the weather prohibiting any hydrostatic testing, a supplemental contract was also entered into with the Babcock & Wilcox Company, dated November 21, 1895, by which the full amount of their contract less $250, retained to cover completion and testing, being $47,324, was paid to them. This contract was approved by the Secretary of War January 6, 1896, and paid on a voucher dated February 1, 1896.

A supplemental contract of the same date (November 21, 1895) was entered into with Westinghouse, Church, Kerr & Co., by which the retained 10 per cent of their contract could be paid, with the exception of $250 retained to cover the expense of testing and to keep the contract liability of the bondsmen in force. The amount called for was paid on a voucher dated December 28, 1895, for $1,387.50

For the season of 1896 the work on the pumping plant was resumed about May 15. The piping was practically all in place and some testing was done, but trouble was had with the copper gaskets in the main steam pipe. Eventually they were replaced with asbestos.

The hydrostatic and steam tests of the boilers and piping were completed during June, and during the tests of the boilers the engines were turned a few times each, under steam, and worked smoothly, but no run of sufficient length to be called a test could be had until sufficient water could be let into the lock to give the pumps some resistance.

The pumps were run one at a time as soon as possible after the water was let into the lock and about July 27 the lock was pumped dry. During these trial runs the

* Not printed.

engines behaved very well, running smoothly and quietly, but the shaft bearings, particularly those sustaining the thrust of the bevel gears, heated to a considerable extent. With the exception of the bearings taking the thrust of the steel gears on the horizontal shafts the heating was not greater than could be accounted for by their newness and the unfavorable conditions under which they were run.

In the machinery report for July (dated August, 1896) it was recommended that these horizontal shafts be taken up and provision made for loose brass or bronze collars to take the thrust.

Final payment on all three items of the pumping plant was made August 25, 1896.

Respectfully submitted.

FRANK M. DUNLAP,
Assistant Engineer.

REPORT OF MR. JULIAN KENNEDY, MECHANICAL ENGINEER AND CONTRACTOR.

PITTSBURG, PA., *July 10, 1894.*

DEAR SIR: I have the honor to report that, as per your instructions of May 19, I have tested the three Westinghouse engines intended for driving the pumps for the 800-foot lock, St. Marys Falls Canal. These engines are numbered 846, 847, and 848. Each of the engines was run for 10 hours under a steam pressure of 150 pounds, and developing as nearly as possible 400 horsepower on the brakes. Two brakes were used during each test, one on each end of the engine shaft, the outer ends of brake levers being provided with knife edges, which rested on stands on Fairbanks standard scales, which were tested to give as nearly as possible 400 horsepower. During the test one man stood at each brake, and, by varying the pressure by means of a wrench, kept the scale beams in equilibrium with very great nicety.

Each of the engines was run ten hours with two stops intermediate of about four minutes each, allowing the cranks to be examined, but not allowing any appreciable cooling to take place.

The engine 848 did not regulate as closely as the other two, showing a variation of three revolutions, the others not showing over one revolution variation; the governor on this will be changed to remedy this. All three of the engines ran with the utmost smoothness.

During the above-mentioned tests the amount of steam consumed by these engines was very accurately determined. This was done by running all the steam exhausted from the engine into a surface condenser so arranged as to allow the product of condensation to be run into two tanks placed below it on Fairbanks scales. The drain-pipe from the condenser was provided with a quick-acting three-way cock, so that the water could be turned from one tank to the other instantly, and while the engine was running under the steady load the stream of water was turned into the empty tank, the exact time noted by the watch, and the water was then weighed during the 20 minutes' time, at the expiration of which time it was cut off, thus allowing the amount of water to be determined with the greatest nicety. The amount of water which leaked past the pistons in the engine during the same time was carefully weighed and added to the other. Several diagrams were taken from the engine at the time that the water consumption was being measured, and the indicated horsepower of the engine was carefully figured by means of Coffin's planimeter, using five diagrams and taking the average. The steam consumption of these engines per indicated horsepower was 22.39, 21.66, and 21.84 pounds per hour, respectively, the consumption per brake horsepower being about 10 per cent greater. The performance of the engines in this respect was extremely gratifying. The engines were located about 250 feet from the boiler, and the steam used includes all entrained moisture, no corrections or allowances of any kind having been made.

I inclose herewith records of the above-mentioned tests; also two diagrams taken from each of the engines while running under full load. These diagrams are not selected diagrams, but are taken at random, and all the others are equally good. You will notice that the steam distribution in the engines is excellent. The back pressure as shown by the diagrams is somewhat higher than the normal, owing to the fact that the exhaust pipe was rather small and long and had some abrupt bends between the engine and condenser. With a larger exhaust pipe, or with not quite so heavy a load, the back pressure would have been considerably less.

I also inclose one diagram taken from one of the engines running light, which is interesting as showing the very satisfactory action of the valve gear when cutting off extremely close.

After the completion of the tests the engines were taken apart in order to enable the working parts to be carefully examined, and everything was found to be in first-class shape, with the exception of three of the pins in the pistons, which were slightly cut, owing apparently to defective casehardening. I will have these pins replaced by others, and will test the new pins with a ten-hour test, to make sure that they are all right; after which, if the pins shall be satisfactory, I will accept the engines. I expect to leave for Europe the first of next week, so I shall probably not be able to see the completion of this test, but will have the matter looked after by my brother, who has assisted me so far in the tests of the engines, and who will see that these pins are right in every way before accepting them.

The result of the tests of these engines, with the exception noted, has been in every way satisfactory, and I have no doubt that they will give equally good satisfaction in practical working. As soon as the new pins have been tested the engines will be cleaned up, the bright parts repolished, the engines reassembled, and the painting completed.

Kindly advise me at once whether the engines are to be shipped as soon as finished, or whether you prefer to have them held here for a while; the machine-shop people can keep them here for a while if more convenient for you.

A further report will be made to you as soon as the pins have been replaced and tested.

Trusting that this will be satisfactory, I remain, yours, truly,

JULIAN KENNEDY.

Col. O. M. POE,
Corps of Engineers, U. S. A.

Date, June 30, 1894.
Number of engine, 847.
Class of engine, automatic compound.
Size of engine, 18 inches and 30 by 16 inches.
Maker's name, W. M. Co.
Engines used for 800-foot lock, St. Marys Falls Canal.
Tested at shops.
Tested for United States Government.
Steam lap, $1\frac{1}{4}$ inches.
Exhaust lap, 0 inches.

Tester's record.

	1.	2.	3.	4.
Number of engine	847			
Boiler pressure ... pounds	150	152	155	154
Speed	252	252	252	252
Brake load	Brake No. 1, 867 pounds; brake No. 2, 894 pounds.			
Dead weight on scales	Brake No. 1. 90 pounds; brake No. 2, 97.5 pounds.			
Time of start	4.13			
Time of stop	4.33			
Duration of test ... minutes	20			
Full barrel "A" ... pounds	554.5	491	491.5	497
Empty barrel "A" ... do	100	100	100	100
Full barrel "B" ... do	504.5	489	495	420.5
Empty barrel "B" ... do	100	100	100	100
Water used ... do	859	780	786.5	717.5=3143
Water per hour ... do	9,429 + 151.5 = 9,580 total water per hour.			
Vacuum				
Temperature of discharge	111			
Leakage per hour ... pounds	151.5			
Brake radius	Brake No. 1, $63\frac{3}{8}$ inches; brake No. 2, $63\frac{1}{16}$ inches.			
Spring ... pounds	60			
Initial pressure ... do	144.7			
Terminal pressure ... do	23.20			
Ratio of expansion ... do	4.70			
High pressure, M. E. P	69.9			
Low pressure, M. E. P	36.3			
Indicated horsepower ... horsepower	442.31			
Brake horsepower ... do	397.50			
Loss of friction ... do	44.81			
Percentage of loss ... per cent	10.13			
Gross indicated water rate ... pounds	21.66			
Gross brake water rate ... do	24.10			

Date, July 5, 1894.
Number of engine, 848.
Class of engine, automatic compound.
Size of engine, 18 by 30 by 16 inches.
Maker's name, W. M. Co.
Engine used for St. Marys Falls Canal.
Tested at shops.

Tester's record.

	1.	2.	3.	4.
Number of engine	848	....	....	....
Boiler pressure ......pounds..	155	155	....	155
Speed	248	251	....	248
Brake load	Brake No. 1, 895 pounds; brake No. 2, 858 pounds.			
Dead weight on scales	Brake No. 1, 95 pounds; brake No. 2, 58 pounds.			
Time of start	4.02 p. m.	....	....	....
Time of stop	4.22 p. m.	....	....	....
Duration of test ......minutes..	20	....	....	....
Full barrel "A" ......pounds..	500	508	510	493
Empty barrel "A" ......do....	100	100	100	100
Full barrel "B" ......do....	495	505	503	500
Empty barrel "B" ......do....	100	100	100	100
Water used *a* ......do....	795	813	813	793
Water per hour ......do....	9,642+107=9,749 total water per hour.			
Vacuum	....	....	....	....
Temperature of discharge ......degrees..	....	....	....	....
Leakage ......pounds..	39 pounds in 20 minutes; 107 pounds.			
Brake radius	Brake No. 1, $63\frac{3}{8}$ inches; brake No. 2, $63\frac{1}{16}$ inches.			
Spring ......pounds..	60	....	....	....
Initial pressure ......do....	141. 30	....	....	....
Terminal pressure ......do....	23. 30	....	....	....
Ratio of expansion ......do....	4. 10	....	....	....
High pressure M. E. P ......do....	73. 2	....	....	....
Low pressure M. E. P ......do....	36. 4	....	....	....
Indicated horsepower ......horsepower..	446. 33	....	....	....
Brake horsepower ......do....	399. 40	....	....	....
Loss of friction ......do....	46. 93	....	....	....
Percentage of loss ......per cent..	10. 51	....	....	....
Gross indicated water rate ......pounds..	21. 84	....	....	....
Gross brake water rate ......do....	24. 41	....	....	....

a Total, 3,214 pounds.

Date, July 7, 1894.
Number of engine, 846.
Class of engine, automatic compound.
Size of engine, 18 by 30 by 16 inches.
Maker's name, W. M. Co.
Engine used for St. Marys Falls Canal.
Tested at shops.

Tester's record.

	1.	2.	3.	4.
Number of engine	846	....	....	....
Boiler pressure ......pounds..	150	153	153	152
Speed	252	252. 5	253	....
Brake load	Brake No. 1, 888 pounds; brake No. 2, 865 pounds.			
Dead weight on scales	Brake No. 1, 88 pounds; brake No. 2, 65 pounds.			
Time of start	2.35 p. m.	....	....	....
Time of stop	2.55 p. m.	....	....	....
Duration of test ......minutes..	20	....	....	....
Full barrel "A" ......pounds..	510	513	512	523
Empty barrel "A" ......do....	100	100	100	100
Water used *a* ......do....	822	823	815	812
Water per hour ......do....	9,816+87=9,903 pounds, total water per hour.			
Temperature of discharge ......degrees..	108	....	....	....
Leakage (29 pounds in 20 minutes) ......pounds..	87	....	....	....
Brake radius	Brake No. 1, $63\frac{3}{8}$ inches; brake No. 3, $63\frac{1}{16}$ inches.			
Spring ......pounds..	60	....	....	....
Initial pressure ......do....	141. 80	....	....	....
Terminal pressure ......do....	24. 70	....	....	....
Ratio of expansion ......do....	3. 97	....	....	....
High pressure M. E. P ......do....	71. 20	....	....	....
Low pressure M. E. P ......do....	37. 10	....	....	....
Indicated horsepower ......horsepower..	442. 33	....	....	....
Brake horsepower ......do....	405. 01	....	....	....
Loss of friction ......do....	37. 32	....	....	....
Percentage of loss ......per cent..	8. 44	....	....	....
Gross indicated water rate ......pounds..	22. 39	....	....	....
Gross brake water rate ......do....	24. 45	....	....	....

a Total, 3,272 pounds.

K K 3.

OPERATING AND CARE OF ST. MARYS FALLS CANAL, MICHIGAN.

This service is provided for by the indefinite appropriations in section 4, river and harbor act of July 5, 1894, and the estimate made for carrying it on during the year ending June 30, 1897, was $68,000; the amount expended was $79,207.15.

Organization.—The canal force consists of 1 superintendent, 1 clerk, 1 assistant clerk, 3 assistant superintendents, 4 foremen, 1 chief engineman, 3 enginemen, 3 assistant enginemen, 6 watchmen, and 33 lockmen.

A labor party averaging 38 men has been employed during the working season; 6 of these men were employed as lockmen, handling lines, etc.

Opening of the Poe Lock.—The Poe Lock was opened to commerce August 3, 1896, at 10.05 a. m., by the passage of the Government steamers *Hancock*, *Andrew Johnson*, and *Antelope*, east bound. The lock was continued in service thereafter, both that and the Weitze Lock being operated in such a way as to best serve the interests of commerce.

Repairs to piers.—There was 11,336 feet of pine timber used in repairing Fort Brady Pier; 66,252 feet of pine timber and 2,016 feet oak repairing piers at the east and west approaches to the Poe Lock; 5,612 feet of pine timber was used repairing south pier at west end of canal.

Repairs to machinery.—The machinery of the Weitzel Lock called for nothing but ordinary repairs, and throughout the year showed the same perfect efficiency as it always has. The general machinery of the Poe Lock worked satisfactorily, except the gate-operating engines; these are complicated affairs and have been the source of considerable trouble, but modifications made during the winter have resulted in a much more efficient service since the opening of this season of navigation. It is quite certain, however, a radical change in this part of the system will have to be made before entirely satisfactory service can be obtained, and such change is contemplated during the coming winter.

Canal post-office.—During the present year the office received and distributed 82,260 pieces, consisting of 70,334 letters, 4,159 postal cards, 7,440 newspapers, and 327 parcels. In addition to this 687 pieces were returned to the city post-office after being held thirty days uncalled for and 2,193 pieces were forwarded to new addresses. At the close of navigation all mail remaining on hand was returned to the city post-office for such disposal as was proper. The business of the office was transacted with great care and promptness, as evidenced by the fact that no complaints were received during the year.

Commercial statistics for fiscal year 1897.—By an agreement with the Canadian Government the statistics of the traffic through the Canadian and the American canals at Sault Ste. Marie have been exchanged, thus making it possible to give complete statistics for the traffic through the St. Marys River.

The American canal was open to navigation during the fiscal year from July 1 to December 8, 1896, and from April 21 to June 30, 1897, all dates inclusive.

The Canadian canal was open to navigation during the fiscal year from July 1 to December 10, 1896, and from April 21 to June 30, 1897.

Statement of time and cost of locking vessels through St. Marys Falls Canal, Michigan.

Total time during which locks were operated	4,282h 35m
Average time consumed in making a lockage	44m 27s
Total time spent by vessels in passing lock	7,727h 51m
Cost per lockage	$13.51
Cost per passage	$6.35
Cost per registered ton ... mills..	6.36
Cost of freight per ton ... do...	6.60

The following table shows the traffic of St. Marys Falls Canal, Michigan, for the fiscal years 1896 and 1897; also the traffic of St. Marys Falls Canal, Canada, and the total traffic for St. Marys River for the fiscal year ending June 30, 1897:

Items.	Fiscal years— 1896.	Fiscal years— 1897.	Increase.	Decrease.	Traffic of Canadian canal for fiscal year 1897.	Total traffic of St. Marys River for fiscal year 1897.
Vessels ....number..	16, 290	12, 291	....	3, 999	4, 550	16, 841
Lockages ....do....	7, 125	5, 780	....	1, 345	2, 717	8, 497
Tonnage:						
Registered....net tons..	15, 648, 025	12, 277, 458	....	3, 370, 567	3, 655, 885	15, 933, 343
Freight ....do....	14, 399, 332	11, 827, 359	....	2, 571, 973	3, 990, 218	15, 817, 577
Passengers ....number..	28, 518	20, 900	....	7, 618	13, 110	34, 019
Coal ....net tons..	2, 815, 431	2, 064, 270	....	751, 161	871, 557	2, 935, 827
Flour..............barrels..	7, 570, 201	7, 733, 707	163, 506	....	1, 664, 153	9, 397, 860
Wheat...........bushels..	48, 933, 340	41, 799, 722	....	7, 133, 618	18, 096, 265	59, 895, 987
Grain (other than wheat) bushels	11, 865, 127	26, 964, 541	15, 099, 414	....	4, 586, 153	31, 550, 694
Manufactured and pig iron, net tons..................	99, 801	107, 036	7, 235	....	15, 021	122, 057
Salt................barrels..	254, 093	215, 254	....	38, 839	11, 950	227. 204
Copper ....net tons..	106, 881	110, 746	3, 865	....	9, 240	119, 986
Iron ore ....do....	7, 217, 309	5, 414, 188	....	1, 803, 121	2, 130, 269	5, 544, 457
Lumber........M. ft. B. M..	725, 230	664, 123	....	61, 107	18, 330	682, 453
Silver ore.........net tons..	100	240	140	....	....	240
Building stone........do....	18, 527	14, 459	....	4, 068	60	14, 519
Unclassified freight ..do....	418, 855	441, 122	22, 267	....	97, 823	538, 945

ESTIMATES.

The project and estimate for operating and care of the canal during the fiscal year ending June 30, 1898, are as follows:

Labor	$50, 000
General supplies..	7, 500
Repairs, ordinary...	12, 000
Lighting locks and grounds....................................	4, 500
Office expenses, including a fair proportion for the office of the engineer officer in charge..........	5, 000
General contingencies...	10, 000
Total	89, 000

Extraordinary repairs that might become necessary because of some grave accident are not included in the estimates, but should such an emergency arise prompt provision would have to be made to cover such repairs, whatever the cost.

St. Marys Falls Canal is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. Two beacons stand upon the piers at the western end of the canal, and Fort Brady is within a mile.

Money statement.

Expended June 30, 1896..		$581, 011. 30
Outstanding liabilities, June 30, 1896.........................		5, 690. 94
Total expenditures to June 30, 1896........................		586, 702. 24
Expended during fiscal year ending June 30, 1897............	$79, 207. 15	
Deduct outstanding liabilities pertaining to preceding year..	5, 690. 94	
Total pertaining to fiscal year..........................	73, 516. 21	
Add outstanding liabilities June 30, 1897....................	4, 587. 84	
		78, 104. 05
Total expenditure to June 30, 1897 (including outstanding liabilities)........		664, 806. 29

Estimate.

Amount (estimated) for fiscal year ending June 30, 1898	$89,000.00
Balance from allotment for preceding year (estimated)	19,000.00
Additional allotment required for fiscal year ending June 30, 1898	**70,000.00**

Expenditures for operating and care of St. Marys Falls Canal, Michigan.

1882	$31,207.48	1891	$48,330.89
1883	35,509.70	1892	61,389.74
1884	31,212.93	1893	42,412.12
1885	27,242.45	1894	55,213.09
1886	25,400.95	1895	50,908.67
1887	22,138.92	1896	60,763.28
1888	29,898.72	1897	78,104.05
1889	30,749.45		
1890	34,323.85	Total	664,806.29

Statement of receipts and expenditures for fiscal year ending June 30, 1897.

Receipts:		
Balance at close of fiscal year ending June 30, 1896 (including outstanding liabilities)		$29,151.47
July 29, 1896, allotted		68,000.00
January 26, 1897, recovered and deposited by John Power, United States district attorney, on account of damage done to Fort Brady Pier, Sault Ste. Marie, Mich		142.08
		97,293.55
Expenditures:		
Office expenses	$4,094.72	
General supplies	3,002.68	
Repairs	14,174.40	
Labor	50,687.88	
General contingencies	3,950.62	
Lights on locks and grounds	2,193.75	
		78,104.05
Balance at close of fiscal year ending June 30, 1897		19,189.50

List of contracts in force during the fiscal year ending June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Date of expiration.
Emery D. Weimer	Aug. 15, 1896	For fiscal year ending	June 30, 1897
George Kemp	do		
Ferguson Hardware Co	Aug. 19, 1896		

STATISTICS OF COMMERCE OF ST. MARYS FALLS CANAL FOR THE SEASON OF 1896.

The following report on commerce passing through St. Marys Falls Canal during the season of 1896 is submitted. An exchange of statistical reports with the authorities of the Canadian Canal makes it possible to include in this report the entire commerce to and from Lake Superior.

The data received, as well as that afforded by the canal records, were compiled by the regular office force, assisted by the assistant superintendents of the canal, all under the general direction of clerk Andrew Jackson and immediate supervision of office watchman John McMahon.

Where Canadian commerce or vessels are mentioned in this report, freight carried in Canadian bottoms is referred to, irrespective of the canal through which the vessel passed.

In the following, the cost of freight transportation necessarily includes cost of loading and unloading freight and the tonnage is given in net tons of 2,000 pounds each.

Summary of commercial statistics for St. Marys River for season of 1896.

Total mile-tons	13,582,641,886
Total freight carried .... tons..	16,239,061
Total valuation placed on freight carried	$195,146,842.49
Average value per ton of freight carried	$12.02
Total amount paid for freight transportation	$13,511,615.80
Average distance freight was carried .... miles..	836.4
Cost per mile per ton .... mill..	0.99
Average cost per ton for freight transportation	$0.832
Total number registered vessels using canals	859
Total number of passages by unregistered vessels carrying freight..	210
Time American lock was operated .... days..	232
Time Canadian lock was operated .... do...	218
Total valuation placed on registered vessels	$45,141,500
Total number of passengers transported	37,066
Total freight carried by—	
Registered vessels .... tons..	16,227,172
Unregistered vessels .... do...	11,889
American vessels .... do...	15,591,298
Canadian vessels .... do...	647,763
American registered vessels .... do...	15,587,669
Canadian registered vessels .... do...	639,503
American unregistered vessels .... do...	3,629
Canadian unregistered vessels .... do...	8,260

The Canadian freight was 4 per cent of all freight carried.

The amount of freight carried to and from Lake Superior in 1896 exceeds the amount carried in 1895 by 1,176,481 tons, or by 7.8 per cent.

There were 18,615 passages (total American and Canadian canals), 1,141 of these by 72 vessels of less than 100 tons register. The total registered tonnage of these small vessels was 1,977, an average of 28 tons per vessel. The actual amount of freight carried by these vessels was only 276 tons.

There were 135 propellers carrying 2,000 tons and more in their largest cargoes, aggregating 336,300 tons and averaging 2,491 tons; 30 propellers carrying 3,000 tons and more in their largest cargoes, aggregating 100,924 tons and averaging 3,364 tons; 14 propellers carrying 4,000 tons and more in their largest cargoes, aggregating 61,756 tons and averaging 4,411 tons; 7 propellers carrying 5,000 tons and more in their largest cargoes, aggregating 36,132 tons and averaging 5,162 tons.

There were 33 sail vessels that carried 2,000 tons and more, aggregating 81,283 tons and averaging 2,463 tons; 13 sail vessels that carried 3,000 tons and more, aggregating 42,628 tons and averaging 3,279 tons; and 7 sail vessels that carried over 4,000 tons, aggregating 32,607 tons, averaging 4,658 tons; and 4 sail vessels that carried 5,000 tons or more, aggregating 21,270 tons and averaging 5,318 tons.

The greatest number of miles run during the season is to the credit of the propeller *Kearsage*, of the Interlakin Transportation Company, of Cleveland, Ohio, and amounted to 47,709 miles. The greatest amount of freight carried during the season is to the credit of the propeller *Victory*, of the same line, aggregating 96,877 net tons.

The greatest number of mile-tons for the season is to the credit of the propeller *Centurian*, of the Hopkins Steamship Company, St. Clair, Mich., and amounted to 80,559,417.

The largest single cargo by a propeller during the season was carried by the *Queen City*, of the Zenith Transportation Company, of Duluth, Minn., and amounted to 5,376 net tons. The largest cargo by a sail vessel was carried by the tow barge *Aurania*, of the Corrigan Steamship Line, of Cleveland, Ohio, and amounted to 5,850 net tons.

Vessels were delayed 28,828 hours at the head and foot of the American Canal, or an average of one hour and thirty-three minutes per vessel. The passage of trains and boats was not delayed in a single instance by the railway swing bridge at the head of the canal.

The following tables show the details of the items previously given in the summary statement.

Table No. 1 gives the estimated valuation of freight passing St. Marys River in 1896. The valuations are for the lake ports of destination. The relative values of the different commodities are as follows: Coal, 4.3 per cent; cereals, 47.3 per cent; manufactured and pig iron, 15.8 per cent; copper, 12 per cent; lumber, 4.4 per cent, and all other commodities, 16.2 per cent.

Table No. 2 gives the freight rates on articles of commerce for the season of 1896, the last line showing the average of each. All charges of every kind are included in these rates.

Table No. 3 shows the total freight cost on each commodity, the factors being the whole amount carried of each and the average cost per unit as given Table No. 2. The aggregate amount paid for freight on all the commodities is also given.

Table No. 4 gives the number of each class of registered vessels using the American and Canadian canals, together with the valuations of the vessel property and the freight and passengers carried by them during the season of 1896.

Table No. 5 shows for each season from 1887 (inclusive) the average freight rates per voyage on each of the listed commodities.

Table No. 6 shows for each season from 1887 (inclusive) the total cost of transportation, the average length of voyages, and the rate per ton per mile.

TABLE No. 1.—*Showing the estimated value of freight through St. Marys Falls canals, Michigan and Ontario, for the season of 1896.*

Items.	Quantity.	Price per unit.	Valuation.
Coal:			
Anthracite .... net tons..	397,210	$4.75	$1,886,747.50
Bituminous .... do....	2,626,130	2.50	6,565,325.00
Flour .... barrels..	8,882,858	3.85	34,199,003.30
Wheat .... bushels..	63,256,463	.75	47,442,347.25
Grain, other than wheat .... do....	27,448,071	.39	10,704,747.69
Manufactured iron .... net tons..	93,924	50.00	4,696,200.00
Pig iron .... do....	27,948	13.50	377,298.00
Salt .... barrels..	237,515	.75	178,136.25
Copper .... net tons..	116,872	200.00	23,374,400.00
Iron ore .... do....	7,909,250	3.25	25,705,062.50
Lumber .... M. feet B. M..	684,986	12.50	8,562,325.00
Silver ore .... net tons..	240	112.00	26,880.00
Building stone .... do....	17,731	10.00	177,310.00
Unclassified freight .... do....	520,851	60.00	31,251,060.00
Total	....	....	195,146,842.49

Average value per ton of freight for season of 1895 .... $10.60
Average value per ton of freight for season of 1896 .... 12.02

TABLE No. 2.—*Freight rates on articles of commerce for the season of 1896 through St. Marys Falls canals, Michigan and Ontario.*

Merchandise (per ton).	Coal (per ton).	Flour (per barrel).	Wheat (per bushel).	Corn (per bushel).	Grain (per bushel).	Manufactured iron (per ton).	Pig iron (per ton).	Salt (per barrel).	Copper (per ton).	Iron ore (per ton).	Lumber (per M feet B. M).	Silver ore (per ton).	Building stone (per ton).
Dolls.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Dolls.*	*Dolls.*	*Cts.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*	*Dolls.*
......	22.2	......	2.1	......	......	......	......	......	......	0.68	......	......	......
......	27	......	2	......	......	......	......	......	......	......	1.96	......	0.45
......	62.5	......	5	......	......	......	......	......	......	.76	......	......	......
1.42	34	5.9	1.3	......	......	......	......	......	......	1.00	......	......	......
......	33.8	......	2.66	......	3	......	......	......	......	.87	......	......	......
......	32.6	......	2.8	......	2.5	......	......	......	......	.78	......	......	......
......	26	......	2.2	......	......	......	......	......	......	.80	1.63	......	......
......	40	......	2.1	......	......	......	......	......	......	.84	......	......	......
......	30	......	2.9	......	......	......	......	......	......	.73	......	......	......
......	35	......	......	......	......	......	......	......	......	......	1.58	......	.35
......	25	......	2.3	......	1.9	......	......	......	......	.88	2.64	......	......
......	30	......	......	......	......	......	......	......	......	.45	1.78	......	.40
......	30.5	......	2.5	......	2.7	......	......	......	......	.80	1.68	......	......
......	33	......	......	......	......	......	......	......	......	.81	......	......	......
......	34	......	......	......	......	......	......	......	......	.70	......	......	......
......	27	......	2	......	1.6	......	......	......	......	.68	......	......	......
......	39	......	5	......	......	.65	......	......	......	.83	1.87	......	......
......	35.75	......	3	......	1.37	......	1.15	......	......	.87	2.65	......	......
......	35	......	2.75	......	2.5	......	......	5.5	......	.71	......	......	......
......	......	......	......	......	......	.60	......	......	......	.89	1.75	......	......
......	35	......	......	......	......	......	......	......	......	.75	......	......	......
8.50	27	......	......	......	......	......	1.43	......	......	......	......	......	......
......	31.5	......	2.75	......	2.75	......	.63	......	......	.84	......	......	......
......	58	......	......	......	......	......	......	......	......	......	......	......	......
......	31.4	......	2.75	......	......	......	......	......	......	.82	1.75	......	......
......	22	......	2	......	2	......	......	......	......	.90	......	......	......
......	20	......	1.9	......	......	......	......	......	......	.92	......	......	......
......	30	......	......	......	......	......	......	......	......	.82	......	......	......
......	35	......	3	......	......	......	......	......	......	.80	......	......	......
1.00	26.3	10	2	......	1.87	.80	......	......	......	.74	......	......	......
......	35	......	......	......	......	......	......	......	......	.95	......	......	1.50
......	35	......	......	......	......	......	......	......	......	......	2.00	......	1.50
2.50	......	12	3.25	......	......	2.00	......	25	1.50	......	1.85	......	1.84
......	......	10	2	......	2.5	......	......	......	......	.91	......	......	......
1.95	33	13	2.12	......	1.62	1.50	......	15	1.90	......	1.60	......	......
......	35	......	......	......	......	......	......	......	......	.80	1.75	......	......
......	26	......	......	......	......	......	......	......	......	.80	1.60	......	......
......	30	......	1.62	......	2.87	......	......	......	......	.88	......	......	.50
......	26.66	......	......	......	......	......	......	......	......	......	......	......	......
......	30	......	2.75	......	2.1	......	......	......	......	......	......	......	......
2.00	40	......	3.5	......	......	......	......	......	......	.80	1.50	......	......
3.00	......	......	......	......	......	......	......	......	......	.80	1.50	......	......
......	31	......	4	......	1.5	......	......	......	......	.89	......	......	......
1.69	30	......	2.5	......	1.8	......	......	......	......	.90	......	......	......
2.71	......	13.75	......	......	......	......	1.10	......	2.25	......	1.75	......	......
......	......	......	3	......	1.37	......	......	......	......	.80	......	......	......
......	27	......	3	......	......	......	......	......	......	.85	1.70	......	......
......	30.63	......	2.75	......	......	......	......	......	......	.80	1.63	......	......
......	33	......	2.9	......	2.37	.50	......	......	......	.72	2.05	......	1.50
......	32.5	......	......	......	2	......	......	......	......	.89	......	......	......
2.80	32	11	2.5	......	2.25	1.40	1.05	15	1.95	.82	1.80	2.33	1.50

TABLE No. 3.—*Mile-tons, season of 1896—Cost of carrying freight transported through Sault Ste. Marie Falls Canal, Michigan, and Sault Ste. Marie Canal, Canada.*

Items.	Quantity.	Price per unit.	Amount.
Coal ... net tons	3,023,340	$0.32	$967,468.80
Flour ... barrels	8,882,858	.11	977,114.38
Wheat ... bushels	63,256,463	.025	1,581,411.57
Grain, other than wheat ... do	27,448,071	.0225	617,581.60
Manufactured iron ... net tons	93,924	1.40	131,493.60
Pig iron ... do	27,948	1.05	29,345.40
Salt ... barrels	237,515	.15	35,627.25
Copper ... net tons	116,872	1.95	227,900.40
Iron ore ... do	7,909,250	.82	6,485,585.00
Lumber ... M feet B. M.	684,986	1.80	1,232,974.80
Silver ore and bullion ... net tons	240	2.33	559.20
Building stone ... do	17,731	1.50	26,596.50
Miscellaneous merchandise ... do	520,851	2.30	1,197,957.30
Total ...	...	...	13,511,615.80

NOTE.—In this table "tons" mean "net tons," or tons of 2,000 pounds. The total amount of freight paid is $13,511,615.80, which, divided by the total mile-tons, 13,582,641,886, gives the cost per mile per ton as 0.99 mill. The average distance freight was carried was 836.4 miles, which is 6.4 miles more than in 1895.

TABLE No. 4.—*Classification of registered vessels and their valuation, registered tonnage, and traffic for season of 1896.*

Vessels.	Number.	Valuation.	Registered tonnage.	Freight carried.	Passengers carried.
American—				*Tons.*	
Steamers ...	467	$35,151,400	495,362	11,392,046	20,421
Sails and barges ...	325	7,854,800	231,376	4,195,623	...
Total American ...	792	43,006,200	726,738	15,587,669	...
Canadian—					
Steamers ...	42	1,887,300	21,364	486,043	16,645
Sails and barges ...	25	248,000	12,700	153,460	...
Total Canadian ...	67	2,135,300	34,064	639,503	...
Grand total ...	859	45,141,500	760,802	16,227,172	37,066

TABLE No. 5.—*Freight rates on articles of commerce through St. Marys River for seasons indicated.*

Year.	Coal (per net ton).	Flour (per barrel).	Wheat (per bushel).	Grain (per bushel).	Corn (per bushel).	Oats (per bushel).	Manufactured iron (per net ton).	Pig iron (per net ton).	Salt (per barrel).	Copper (per net ton).	Iron ore (per net ton).	Lumber (per M feet B. M.).	Silver ore (per net ton).	Building stone (per net ton).	General merchandise (per net ton).
	Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*			*Cts.*						
1887	90	29	(a)	7	(a)	(a)	$2.35	(b)	18	$2.60	$1.75	$4.00	$3.00	$1.15	$4.00
1888	70	17.5	3.5	(c)	4.33	5	1.80	$1.30	16	2.35	1.28	2.80	1.90	2.05	3.00
1889	47	18	4	8.25	(a)	(a)	2.10	1.45	18	2.25	1.14	2.70	1.90	2.02	3.00
1890	45	13	3	.....	3	2	1.34	1.35	15	2.38	1.10	2.38	2.25	2.00	2.75
1891	43	15	4.1	8.5	(a)	(a)	2.50	1.17	18	2.00	.98	2.70	2.25	2.00	3.58
1892	41	16.5	3.1	3.75	(a)	(a)	2.15	1.25	15	1.40	1.00	2.95	2.25	1.67	3.60
1893	40	17	2.8	2.75	2.5	(a)	2.00	1.30	12	1.75	.80	2.35	2.25	1.36	3.00
1894	40	14	2.5	2.75	2.9	(a)	.90	1.15	12	1.95	.70	1.90	2.25	1.28	2.75
1895	37	14	4.4	4.5	(a)	(a)	1.50	1.05	13	1.66	.82	2.00	2.33	1.20	2.50
1896	32	11	2.5	2.25	(a)	(a)	1.40	1.05	15	1.95	.82	1.80	2.33	1.50	2.30

a Included in grain. *b* Included in manufactured iron. *c* Included in corn and oats.

TABLE No. 6.—*Cost of transportation, average length of voyages, and rate per ton per mile for seasons indicated.*

Year.	Total cost of transportation.	Average distance freight was carried.	Cost of transportation per mile-ton.
		Miles.	*Mills.*
1887	$10,075,153.18	811.4	2.3
1888	7,883,077.40	806.4	1.5
1889	8,634,246.63	790.4	1.5
1890	9,472,214.90	797.2	1.3
1891	9,849,022.81	820.4	1.55
1892	12,072,850.88	822.4	1.31
1893	9,957,483.11	831.9	1.1
1894	10,798,310.29	828.1	.99
1895	14,238,758.02	830	1.14
1896	13,511,615.80	836.4	.99

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS, ON COMMERCE PASSING ST. MARYS FALL CANALS, MICHIGAN AND ONTARIO, DURING 1896.

[Printed in House Doc. No. 242, Fifty-fourth Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., January 22, 1897.

GENERAL: I submit herewith a tabulated statement of water traffic to and from Lake Superior during the season of 1896, similar to such as have been habitually transmitted to Congress soon after the close of each season of navigation on the Great Lakes. The statement includes traffic through the Canadian canal at Sault Ste. Marie, as well as that of the United States canal, arrangements having been made with those in control of the Canadian work for an exchange of statistics on the same form as that heretofore used in our own reports. The harmony of intercourse that has existed with our neighbors in this matter has been a source of great pleasure and advantage to our office, and I trust it has been equally so to theirs.

The United States canal was opened for the season of 1896 on April 21 and closed December 8, the old (Weitzel) lock having been in use throughout this period, and also the new 800-foot (Poe) lock after August 3. The total period of navigation through this canal was 232 days, or one more than during the season of 1895. The Canadian canal was operated from May 7 to December 10, covering a period of 218 days, as compared with 87 days during the preceding season, when it was first opened to traffic.

The total freight through both canals during the season of 1896 was 16,239,061 net tons, exceeding all previous records by nearly one and a quarter millions of tons. But there was a reduction of 3,383,556 tons in the freight passing the United States canal, as compared with that for the season of 1895, a result evidently due to the fact that the Canadian canal has not heretofore participated in traffic during an entire season of navigation. It is probable that this reduction would have been less if the most deeply loaded vessels had not found it expedient to select the Canadian route up to August 3, 1896, when the Poe Lock was first opened to commerce, as our detailed records show that 34 per cent of the freight that passed until that date went through the Canadian lock, but only 22 per cent after it.

The noticeable items of increased freight are nearly half a million tons of soft coal, or 23 per cent more than in 1895; about 17,000,000 bushels of wheat, an increase of 37 per cent, and over 19,000,000 bushels of grain other than wheat, being an increase of 230 per cent. The items in which a decrease is shown are: Hard coal, 10 per cent; salt, 12 per cent; iron ore, 2 per cent; lumber, 8 per cent, and building stone, 26 per cent. But the aggregate in tons of this decrease is quite insignificant when compared with the total service.

We have not yet been able to obtain the information necessary for computing the value of freight involved in this commerce, with respect to prices current during the past season, but estimating it by the same unit prices as were used for the season of 1895 it would aggregate $186,153,429.20, an increase of $26,578,299.77, as compared with that year.

The growth of commerce through the river, since the first United States lock at the falls was opened in 1881, is indicated by the following résumé of previous reports:

Total freight during season of—	Tons.
1881	1,567,741
1882	2,029,521
1883	2,267,105
1884	2,874,557
1885	3,256,628
1886	4,527,759
1887	5,494,649
1888	6,411,423
1889	7,516,022
1890	9,041,213
1891	8,888,759
1892	11,214,333
1893	10,796,572
1894	13,195,860
1895	15,062,580
1896	16,239,061

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

Statement of water traffic to and from Lake Superior for the season of 1896, as shown by statistics of the United States and Canadian canals, at Sault Ste. Marie, Michigan, and Ontario.

Items.	Traffic for 1896.		Total traffic for season of—		Increase, 1896.		Decrease, 1896.	
	United States canal.	Canadian canal.	1896.	1895.	Amount.	Per cent.	Amount.	Per cent.
Vessels a ... number	13,441	5,174	18,615	17,956	659	4	...	...
Lockages ... do	6,423	3,043	9,466	7,734	1,732	22	...	...
Tonnage, registered, net tons	12,896,988	4,352,430	17,249,418	16,806,781	442,637	3	...	...
Tonnage, freight, net tons	11,679,024	4,560,037	16,239,061	15,062,580	1,176,481	8	...	...
Passengers ... number	22,438	14,628	37,066	31,656	5,410	17	...	...
Coal, hard ... net tons	282,469	114,741	397,210	440,477	...	...	43,267	10
Coal, soft ... do	1,780,545	845,585	2,626,130	2,133,885	492,245	23	...	...
Flour ... barrels	7,073,174	1,809,684	8,882,858	8,902,302	...	...	19,444	...
Wheat ... bushels	44,151,599	19,104,864	63,256,463	46,218,250	17,038,213	37	...	...
Grain, other than wheat, bushels	21,158,325	6,289,746	27,448,071	8,328,694	19,119,377	230	...	...
Manufactured and pig iron ... net tons	102,201	19,671	121,872	100,337	21,535	21	...	...
Salt ... barrels	224,324	13,191	237,515	269,919	...	...	32,404	12
Copper ... net tons	103,005	13,867	116,872	107,452	9,420	9	...	...
Iron ore ... do	5,402,166	2,507,084	7,909,250	8,062,209	...	...	152,959	2
Lumber ... M feet B. M	658,640	26,346	684,986	740,700	...	...	55,714	8
Silver ore ... net tons	240	...	240	100	140	140	...	...
Building stone ... do	16,591	1,140	17,731	23,876	...	...	6,145	26
Unclassified freight, b net tons	420,802	100,049	520,851	463,308	57,543	12	...	...

a Steamers, 13,404; sails, 4,391; unregistered, 820; total, 18,615.
b The item of unclassified freight includes 2,358 tons of wool and 31 tons of hides.

The United States Canal was opened April 21 and closed December 8, 1896; season, 232 days. The Canadian Sault canal was opened May 7 and closed December 10, 1896; season, 218 days.

United States canal was open to navigation during the season of 1895, 231 days. United States canal was open to navigation during the season of 1896, 232 days.

K K 4.

IMPROVEMENT OF HAY LAKE CHANNEL, ST. MARYS RIVER, MICHIGAN.

This improvement has been in progress since 1883, the object being to make a deep-water channel for commerce through the St. Marys River by a route that can be navigated at night and that is 11 miles shorter than the one formerly followed. The original estimate was for a channel 17 feet deep and 300 feet wide, but the project has, by subsequent modifications, grown to call for a navigable depth of 20 feet and such width of channel as is essential for safe navigation. The route was opened to navigation June 7, 1894. Work has continued since then to date, with the object of widening the channels first opened. Progress on the work to June 30, 1896, is summarized in the Report of the Chief of Engineers for 1896, pages 2877, 2878.

WORK DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Operations during the year have comprised work as follows:

Item C.—Removing shoal off Six-Mile Point and widening channel above it, under contract with W. A. McGillis & Co., of Chicago, Ill., dated September 19, 1895.

Item E.—Widening channel below cut through Island No. 1, Sugar Island Rapids, under contract with H. T. Dunbar, of Sault Ste. Marie, Mich., dated June 27, 1896.

Item F.—Widening angle at foot of Hay Lake, under contract with Hickler Bros., of Sault Ste. Marie, Mich., dated June 29, 1896.

Item G.—Widening channel of Middle Neebish below dike and at turn into Little Mud Lake, under contract with Hingston & Woods, of Buffalo, N. Y., dated June 30, 1896.

The total amount of excavation accomplished under these contracts during the year was 603,262.45 cubic yards, at rates of $10\frac{1}{4}$ cents per cubic yard for Item C (material, clay, and sand); $9\frac{8}{10}$ cents for Item E (material, clay, and sand); $21\frac{9}{10}$ cents for Item F (material, sand, clay, stone, and bowlders); $34\frac{5}{10}$ cents for Item G (material, clay, sand, and bowlders). These rates relate to excavation of material overlying the specified grades, half rates being paid in each case for material between that grade and a plane 1 foot lower within designated channel limits.

In addition to the foregoing, H. W. Hubbell & Co.'s dredge was engaged in the spring of 1897, with necessary tugs and dump scows, to do some urgent work at different points. The agreed price for work by this plant was $12.25 per hour of actual work. The dredge worked on the Waldo Shoal, Hay Lake, from June 10 to June 28, when the removal of the shoal was completed. Time worked, $144\frac{13}{60}$ hours; total excavation, 6,939 cubic yards of clay, sand, and bowlders; cost, $1,772.78, or $25\frac{1}{2}$ cents per cubic yard. The dredge then moved to the foot of Hay Lake and commenced the work of removing stone and bowlders from the channel that was dredged in 1893–94, the sweeping raft having shown that this portion of the channel has become obstructed since that time. Up to June 30, inclusive, the dredge had worked there 25$\frac{31}{60}$ hours and excavated 1,512 cubic yards.

The result of all work done during the year has been to remove dangerous obstructions from the line of travel, and to so widen the improved channel at some of the most critical points as to make navigation very much safer.

The operations referred to above are more fully detailed in the following extract from a report prepared by Assistant Engineer Joseph Ripley, who had immediate charge of the work:

Item C.—Shoal off Six Mile Point and widening channel 0 to 800 feet for a distance of 10,000 feet.—Contract dated September 19, 1895; W. A. McGillis & Co., of Chicago, Ill., contractors; rates, 10$\frac{1}{4}$ cents per cubic yard, bank measure, to 20 and 21 foot grades, and half rates for first foot below specified grade; material, clay and sand.

Three dredges continued work till December 3 and resumed again April 21. Number of hours worked, 3,402; delayed, 1,617; excavation, 418,941 cubic yards, scow measure. The raft was swung over this section in November and June. The few spots now remaining above grade will be removed during July.

Item E.—Widening channel below islands at Little Rapids, 150 feet width and 8,250 feet long.—Contract dated June 27, 1896; H. T. Dunbar, Sault Ste. Marie, Mich., contractor; rates, 9$\frac{8}{10}$ cents per cubic yard, bank measure, to 20-foot grade, and half rates between 20 and 21 feet; material, clay and sand.

Work was begun with one dredge on August 19, stopped for winter season November 25, and resumed April 28. Time worked, 1,673$\frac{1}{4}$ hours; lost by delays, 468$\frac{1}{4}$ hours; scow measure of excavation, 289,486 cubic yards. The section was finished on June 8, and was so well dredged that no ridges were left between the narrow cuts taken, and it was only necessary to swing the raft once over this section. The duplicate computations for the final estimate were finished June 30 and the computed bank measure of material excavated above the 20-foot grade is 207,375.35 cubic yards; between 20 and 21 feet, 35,396.65, and below the 21-foot grade, or outside specified side slopes of two to one, 73,290.04, making a total of 316,062.04 cubic yards. Total cost for excavation, $22,057.22.

Item F.—Widening angle at foot of Hay Lake, 150 feet wide by 1,750 feet long.—Contract dated June 29, 1896; Hickler Brothers, Sault Ste. Marie, Mich., contractors. Rates, 21$\frac{3}{10}$ cents per cubic yard, bank measure, to 21-foot grade, and half rates between 21 and 22 feet. Material, sand, clay, stone, and bowlders.

Work was begun with one dredge on August 11, stopped November 25, and was resumed on April 23. Time worked, 1,029 hours; delayed, 189 hours. Scow measure of excavation, 68,765 cubic yards. A diving outfit worked during May 100 hours, lost by breakages 8 hours, and raised 101 yards of bowlders. Three examinations with the raft bars were made in May. The section was finished on May 15, 1897. Amounts for final estimate computed in duplicate were 47,348.04 above 21-foot grade, 7,887.70 between 21 and 22 feet, 11,462.46 below 22 feet or outside side slopes, making a total of 66,698.20 cubic yards.

This improvement has been of special advantage to navigation. While no accident has happened at this place, it has been dangerous for the large boats and tows to meet there on account of the large angle of deflection (38$\frac{1}{2}$°) between the two courses.

Item G.—Widening at angle, head of Little Mud Lake, and widening channel from angle to lower end of Middle Neebish Dike, 300 feet wide by 9,600 feet long.—Contract dated June 30, 1896; Hingston & Woods, Buffalo, N. Y., contractors. Material, clay, sand, and bowlders. Rates, 34.5 cents per cubic yard, bank measure, to 21-foot grade; half rates between 21 and 22 feet.

Work was begun on July 23 with one dredge; stopped November 30, when the dredge was sunk by running ice; was raised two weeks later. Work was resumed on April 28. Time worked, 620 hours; delayed 274. Excavation, 50,642 cubic yards, scow measure. The diving outfit worked 132 hours, was delayed 25 hours, and raised 47 yards of bowlders. This section will be finished during July.

Hire of dredge.—Agreement dated May 7, 1897. Rate, $12.25 per working hour. H. W. Hubbell & Co.'s dredge, No. 3.

On October 16, the steamer *Waldo* struck a bowlder on an unknown shoal and broke several plates. The shoal was then located with the raft bars, and a detailed survey made thereof by taking soundings 10 by 10 feet apart. The shoal was about 100 feet west of ranges and 500 feet southeast of the Nine Mile Point Shoal. It was about 30 feet wide and 800 feet long. The shoalest water was 16$\frac{1}{2}$ feet. Hubbell's dredge began work on this shoal June 10, and finished removal of shoal on June 28.

Number of hours worked, $144\frac{43}{60}$; lost by delays, $34\frac{1}{60}$. Excavation, 6,939 cubic yards, scow measure. In that part of the angle foot of Hay Lake which was dredged in 1893 and 1894 there are numerous bowlders, some of which have been moved by the towlines, as the boats always slow down in making the turn. The channel there is being deepened by the Hubbell dredge, which has worked $25\frac{31}{60}$ hours, has been delayed $2\frac{18}{60}$ hours, and has excavated 1,512 cubic yards, scow measure.

General remarks.—Over 100 stakes were driven to mark cross sections and limits of the channel improvements. Thirty gauge boards were placed in position for use of contractors. Over 30,000 soundings were taken for season or final estimates, all of which have been mapped and also platted on the cross-section sheets. New tripods have been placed on 10 triangulation stations. The buoys, ranges, and stone foundations for 4 new light cribs were located and the coordinates computed. The tug *Myra* and quarter boat *Hay Lake* have been extensively repaired.

Surveys and examinations.—During the winter surveys were made covering the areas represented by the four contracts in force, soundings resumed and mapped, computations for final estimates of contract work were made, and also of the amount of material required to be removed for the purpose of widening and deepening the present cut through the Middle Neebish. Repeated examinations were made with the sweeping raft in various localities in connection with work in progress or in searching for suspected or reported obstructions. In this way several small bowlders or loose stones were found projecting above grade in the Middle Neebish Channel, and they were promptly removed, the services of the nearest diving plant being obtained in open market for this purpose.

The improved Hay Lake Channel is now a reasonably safe one, except the Middle Neebish section, where the width is only 300 feet. The cut there is through solid rock, the sides are vertical, and the current is more rapid than at any other part of the route. Vessels passing through this reach generally keep closely on the mid-channel range, thereby risking collision between those moving in opposite directions. If they leave the range and misjudge their distance from it they risk striking on the dangerous edge of the rock cut. In either case there is grave danger of a large vessel being sunk in this narrow channel, and if such mishap should occur a long blockade would follow. This would be a very serious matter for the vast commerce of the river.

The estimated cost of the improvement was $2,659,115, and the amount appropriated to date is $2,165,000. The appropriation of the remaining $494,115 is required for work in the Middle Neebish section in order to make this part of the improvement reasonably safe for navigation. With the vast commerce going through this channel a width of 300 feet in submerged rock cutting and a swift current is not reasonably safe, but decidedly unsafe. This might not be so if all traffic were in one direction or if it were by single vessels, but the meeting of the largest class of deep-draft vessels in tows, bound in opposite directions, is a very different matter.

The commerce concerned in this improvement is that of the St. Marys River, full details of which are given in connection with the report on "Operating and care of St. Marys Falls Canal;" during the navigation season of 1896 it amounted to 16,239,061 freight tons, valued at $195,146,842.49.

Hay Lake Channel is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. The nearest light-house is the entrance light at the north end of the channel, and 26 other lights mark the channel itself. The nearest fort is Fort Brady, at Sault Ste. Marie.

Total expenditure to June 30, 1896	$1,877,858.96
Expended during fiscal year, excluding outstanding liabilities	63,159.41
Total expenditure to June 30, 1897	1,941,018.37

Money statement.

July 1, 1896, balance unexpended		287,283.51
June 30, 1897, amount expended during fiscal year		63,159.41
July 1, 1897, balance unexpended		224,124.10
July 1, 1897, outstanding liabilities	$17,470.35	
July 1, 1897, amount covered by uncompleted contracts	9,886.00	
		27,356.35
July 1, 1897, balance available		196,767.75
Amount (estimated) required for completion of existing project		494,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		494,115.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations for improving Hay Lake Channel, St. Marys River, Michigan.

August 2, 1882	$200,000.00
July 5, 1884	125,000.00
August 5, 1886	150,000.00
August 11, 1888	500,000.00
September 19, 1890	400,000.00
March 3, 1891 (sundry civil act)	300,000.00
August 5, 1892 (sundry civil act)	115,000.00
March 3, 1893 (sundry civil act)	225,000.00
August 18, 1894 (sundry civil act)	150,000.00
Total	2,165,000.00
Receipts from sales of fuel to officers, between March, 1883, and March, 1887	124.90
Repayment of disallowance, voucher 9, November, 1885 (see p. 2245, Report of Chief of Engineers, 1887)	6.75
Repayment of disallowance, part of voucher 8, August, 1894 (see p. 3052, Report Chief of Engineers, 1895)	10.82
Total	142.47

List of contracts in force during the fiscal year ending June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Date of expiration.	Remarks.
W. A. McGillis & Co	Oct. 24, 1895	Apr. 27, 1896	July 1, 1897	Nearly completed.
H. T. Dunbar	July 11, 1896	Aug. 19, 1896	do	Work completed June 8.
Hickler Bros	do	Aug. 11, 1896	do	Closed May 24, 1897.
Hingston & Woods	July 18, 1896	July 23, 1896	do	Nearly completed.

K K 5.

IMPROVEMENT OF CHEBOYGAN HARBOR, MICHIGAN.

The present project of improvement calls for a channel 200 feet wide and 15 feet deep from deep water in the Straits of Mackinaw to the State-road bridge over the Cheboygan River. The improvement was commenced in 1871 and work done since then has served to meet the requirements of commerce up to the present time; the channel was redredged, in part, in 1895. The report of the Chief of Engineers for 1896, pages 2723–2724, summarizes the history of operations to June 30, 1896.

No work has been done during the last fiscal year except record work in the office and that attaching to supervision and examination of the harbor.

Under provisions of the river and harbor act of August 17, 1894, an estimate for increasing the navigable depth to 18 feet was submitted, and the act of June 3, 1896, appropriated $12,000 for this purpose. The total estimated cost of the project was $33,000, and it will not be expedient to enter upon it until the means available will suffice for dredging the entire length of channel to the prescribed depth for a width of at least 125 feet. An additional appropriation of $10,000 would accomplish this object.

Cheboygan is in the Michigan collection district, and the nearest port of entry is Grand Haven, Mich. The nearest light-house is on the crib at entrance to the harbor.

Original estimated cost of dredging and pier construction, 1871	$395,000.00
Whole amount expended to June 30, 1897	147,999.49

Money statement.

July 1, 1896, balance unexpended	$12,070.56
June 30, 1897, amount expended during fiscal year (including $3.05 paid by Treasury Department account Flint and Pere Marquette R. R. Co.).	70.05
July 1, 1897, balance unexpended	12,000.51
Amount (estimated) required for completion of existing project	21,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving harbor at Cheboygan, Mich.

March 3, 1871	$10,000	March 3, 1881	$6,000
June 10, 1872	15,000	August 2, 1882	10,000
March 3, 1873	15,000	July 5, 1884	5,000
June 23, 1874	15,000	August 5, 1886	15,000
March 3, 1875	15,000	August 11, 1888	15,000
August 14, 1876	10,000	June 3, 1896	12,000
June 18, 1878	8,000		
March 3, 1879	3,000	Total	160,000
June 14, 1880	6,000		

COMMERCIAL STATISTICS, CHEBOYGAN HARBOR, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1887	1,587	405,921	1892	1,384	345,174
1888 *a*			1893	1,240	308,129
1889	1,496	453,456	1894	1,350	379,345
1890 *a*			1895	1,211	376,291
1891	1,384	367,550	1896	1,233	379,069

a Not stated.

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by Mr. P. H. Horne and the deputy collector of customs.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	9,618	Flour	700
Flour	1,434	Lumber, ties, poles, etc	330,126
Grain	4,942	Logs	15,000
Groceries and produce	3,271	Mill stuff	619
Hay and feed	2,045	Miscellaneous merchandise, etc	7,506
Logs	107,236	Tan bark	8,060
Lumber, poles, etc	6,994		
Mill stuff	2,194		
Miscellaneous merchandise, etc	12,628		
Tan bark	18,000		
Total	168,362	Total	362,011

K K 6.

IMPROVEMENT OF ALPENA HARBOR (THUNDER BAY RIVER), MICHIGAN.

This harbor is the result of improvements made in the lower reach of Thunder Bay River and the approach to it through shoal water in Thunder Bay. The first improvement was made by local enterprise, work by the Government having been commenced in 1876. The history of operations since then is summarized in the report of the Chief of Engineers for 1896, pages 2725–2726.

No work was done at the harbor during the last fiscal year except to examine the channel in order to ascertain its navigable condition. This examination shows that the channel heretofore dredged to a depth of 15 feet has shoaled to a navigable capacity of only 12½ feet. Funds on hand will permit the dredging to be done that is needed to restore the depth required for the present commerce of the harbor, and the work will probably be done during the ensuing fiscal year.

No estimate is submitted for further work.

Alpena is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron Mich. The nearest light-house is at the entrance to the harbor.

Original estimate of cost, 1876, 1881, and 1889 (aggregate)	$55,851.48
Whole amount expended to June 30, 1897	41,697.28

Money statement.

July 1, 1896, balance unexpended	$9,991.77
June 30, 1897, amount expended during fiscal year	189.05
July 1, 1897, balance unexpended	9,802.72

Appropriations for improving harbor at Alpena (Thunder Bay River), Mich.

Thunder Bay Harbor, Michigan:	
August 14, 1876	$4,500
August 2, 1882	15,000
September 19, 1890	5,500
Thunder Bay River, Michigan:	
September 19, 1890	10,000
July 13, 1892	10,000
Alpena Harbor, Michigan:	
August 17, 1894	4,000
June 3, 1896	2,500
Total	51,500

COMMERCIAL STATISTICS OF ALPENA HARBOR (THUNDER BAY RIVER) MICHIGAN FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1893	940	247,278
1894	1,033	303,681
1895	1,249	325,899
1896	1,040	272,921

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the collector of customs.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	12,274	Lumber, ties, etc	242,710
Fish	400	Merchandise	9,640
Grain, hay, and feed	645	Paper pulp	3,337
Logs and lumber	69,924		
Merchandise	8,634		
Oil	510		
Salt	280		
Stone	900		
Sulphur	500		
Total	94,067	Total	255,687

K K 7.

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

The present project of improvement aims for a channel 200 feet wide and 14 feet deep from Saginaw Bay to the upper limits of Bay City, and from there a channel of the same width 12 feet deep. The report of the Chief of Engineers for 1896, pages 2727–2728, summarizes the history of operations up to June 30, 1896.

OPERATIONS DURING THE LAST FISCAL YEAR.

The contract with Edmund Hall, of Detroit, Mich., dated May 9, 1895, for dredging the bar at mouth of Saginaw River expired June 30, 1896, at which time the amount of excavation called for by the contract was completed. To suspend work at that time would have left an abrupt break in the channel, and it was accordingly arranged that the contractor should continue work until the dredged cut on which he was engaged should be completed to deep water. Work with that object in view was in progress from July 1 to 14, the amount excavated during that period being 7,097 cubic yards. This completed the work as designed and operations were thereupon suspended. The total amount excavated was 119,595 cubic yards and the contract price was 23 cents per cubic yard, scow measure.

The last river and harbor act requires the preparation of—

estimates of cost of improvement of the Saginaw River from its head to a point in Saginaw Bay, with a view of securing a channel two hundred feet wide and an increase in depth to fourteen feet from the head of the river to the Third Street Bridge, so called, in Bay City, thence of the same width to Saginaw Bay, with a view to securing an increase of the depth of the channel to sixteen feet; also, to submit plans and estimates for improving the west channel of the Saginaw River between the Middle Ground and West Bay City, with a view to securing a depth of said channel to fourteen feet; also, to improve the Shiawassee River from the Saginaw River to the Bad River, Bad River to the village of Saint Charles, and the Flint

River from the Shiawassee as far as practicable, to such an extent as will afford a reliable navigation for light-draft boats between Saginaw River and the village of Saint Charles, and on the Flint River as far as practicable.

The party for the required surveys of the river and its tributaries was organized January 21, 1897, and the work required on the main river was completed at the end of the month; it consisted in taking soundings through the ice in the West Channel at Bay City, and across the bar at the mouth of the river in Saginaw Bay. This, with surveys made in 1895, afforded all requisite data for preparing the estimate called for by Congress with respect to the Saginaw River.

The field work of the survey of the Bad, Shiawassee, and Flint rivers was begun February 1 and completed February 19. The reduction of the field notes and the preparation of the maps were completed in April.

The estimates called for by Congress will be submitted in a special report at an early date.

The completion of the improvement under the existing project can be accomplished only by continuous work, and by such large appropriations as would be necessary for that course; but it is believed that the present requirements of commerce may be met by maintaining the present conditions, and for this purpose an appropriation of $20,000 would probably suffice till June 30, 1899. This amount is therefore submitted below, subject to such change as may be determined by Congress on its consideration of the special report in relation to the new project called for by the act of June 3, 1896.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. There is a light-house at the mouth of the river.

Estimated cost of successive projects, 1867 to 1882	$289,795.00
Estimated cost of project of 1882	446,000.00
Total	735,795.00
Carried to surplus fund	1,000.00
Whole amount expended to June 30, 1897	709,117.27

Money statement.

July 1, 1896, balance unexpended	$50,604.19
June 30, 1897, amount expended during fiscal year	11,971.46
July 1, 1897, balance unexpended	38,632.73
July 1, 1897, outstanding liabilities	10.00
July 1, 1897, balance available	38,622.73
Amount that can be profitably expended in fiscal year ending June 30, 1899	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving Saginaw River, Michigan.

June 23, 1866	$67,500	July 5, 1884	$50,000
March 2, 1867	28,000	August 5, 1886	33,750
July 25, 1868 (allotment)	9,000	August 11, 1888	65,000
July 11, 1870	1,500	September 19, 1890	75,000
June 23, 1874	15,000	July 13, 1892	100,000
March 3, 1875	30,000	August 17, 1894	40,000
August 14, 1876	11,000	June 3, 1896	40,000
June 18, 1878	25,000		
March 3, 1879	8,000	Total	748,750
June 14, 1880	15,000	Carried to surplus fund	1,000
March 3, 1881	10,000		
August 2, 1882	125,000	Balance	747,750

COMMERCIAL STATISTICS, SAGINAW RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1893	1,290	393,487
1894	226	72,707
1895	226	72,689
1896	189	48,752

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the deputy collector of customs, Saginaw, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	36,275	Flour	1,125
Logs	407,500	Grain	13,200
Lumber	7,000	Hay and feed	20,000
Stone	20,831	Lime and cement	6,900
		Lumber	120,750
		Machinery	12,000
		Miscellaneous	1,732
		Potatoes	4,800
		Salt	59,989
Total	471,106	Total	240,496

K K 8.

IMPROVEMENT OF SEBEWAING RIVER, MICHIGAN.

The first improvement at this place was made in 1875, when a narrow channel 6 feet deep was dredged from the 6-foot curve in Saginaw Bay to the mouth of the river, and some dredging was also done within the river itself, by which it was straightened and deepened to 6 feet. The total cost of this work was $8,000. The river and harbor act of March 3, 1879, provided for a resurvey of "Sebewaing Harbor," and that of June 14, 1880, appropriated $7,000 for deepening the channel to 7 feet. As recommended in the report on the survey dated April 21, 1880, the money was applied accordingly in 1880–81, and resulted in deepening by about 1 foot the previously dredged channels. Examinations or surveys were again made under the acts of August 2, 1882, September 19, 1890, July 13, 1892, and August 17, 1894.

In accordance with the requirements of the last-named act the following plan of improvement and estimate of cost were prepared and submitted to Congress:

Plan of improvement.—To dredge the entrance channel to a width of 100 feet and depth of 8 feet below the datum plane of the survey of 1895. At the present stage of water in the lake this would give a navigable depth of barely 5½ feet. The length of dredged channel would be about 15,000 feet, and the amount to be excavated is estimated to be 111,267 cubic yards, scow measurement.

Estimate of cost.—The material to be dredged is compact, a mixture of sand and gravel in some parts, hardpan and bowlders in others. The cost of its removal may be averaged at 30 cents per cubic yard, which would make the total cost of the proposed improvement, in round numbers, $37,000, estimated as follows:

Dredging 111,267 cubic yards, at 30 cents	$33,380.10
Add 10 per cent for contingencies	3,338.01
Total	36,718.11

The act of June 3, 1896, appropriated $5,000 for work in accordance with the foregoing plan. It being quite apparent that no useful results could be obtained by the expenditure of so small a sum, work on the project has not yet been commenced. If the improvement is made, it should be started with at least $15,000 available for expenditure. With that amount it would be possible to make a narrow channel from the 8-foot curve in Saginaw Bay to the mouth of the river, the distance being nearly 3 miles.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. There is a light-house at the mouth of the Saginaw River.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
July 1, 1897, balance unexpended	5,000.00
Amount (estimated) required for completion of existing project	32,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving Sebewaing River, Michigan.

March 3, 1875 (river and harbor)	$8,000
June 14, 1880	7,000
June 3, 1896	5,000
Total	20,000

COMMERCIAL STATISTICS, SEBEWAING RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Receipts and shipments.

[Compiled from statement furnished by Messrs. John C. Liken & Co.]

Articles received.	Tons.	Articles shipped.	Tons.
Building stone	4,370	Apples and grapes	1,775
Coal	1,000	Brick	5,000
Drain and sewer pipe	520	Coal	70,000
Lumber, lath, and shingles	5,250	Grain	11,984
Merchandise (general)	32,000	Hay	3,000
Salt	560	Lumber, etc	4,675
		Miscellaneous	1,840
		Staves	25,000
Total	43,700	Total	123,274

Thirty per cent of the above is now carried by water, and it is represented that 30 per cent more will be added to lake shipments after the harbor is improved.

K K 9.

IMPROVEMENT OF HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

This improvement, wholly artificial, was made between 1872 and 1885, and its maintenance is of the most vital importance to all commerce passing through Lake Huron. A condensed history of the work is given in the Report of the Chief of Engineers for 1896, pages 2730–2731.

Operations during the last fiscal year were confined to a few minor repairs of piers, the work having been done by day labor under the supervision of the custodian of the harbor.

The total amount expended in improving the harbor, its maintenance, and for the supervision and control of vessels entering for shelter to June 30, 1897, is $1,196,304.86, of which $5,102.84 was spent during the last fiscal year.

The harbor was carefully examined June 27, 1897. The timber superstructure of the work is in an advanced stage of decay, and that of the main breakwater is so weakened that it is likely to be destroyed by any severe storm in the near future. Its reconstruction can not safely be postponed much longer, and when this is done it should be rebuilt in masonry. An additional appropriation of $250,000 is required for doing the work properly and economically, and it should be available for expenditure during the year ending June 30, 1899.

The number of vessels that took refuge at the harbor during the past fiscal year was 1,143, with a total tonnage of 421,346.73. The grand total of vessels entering for shelter during the calendar years 1877 to 1896, inclusive, is 23,802, the tonnage of which aggregated 7,857,282. The size of vessels sheltered in 1877 averaged 289 tons, and in 1896 this average had increased to 351 tons.

Sand Beach is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. One light-house and three beacons mark the entrances to the harbor, and there is a life-saving station inside.

Original estimated cost of the work	$1,442,500.00
Amount carried to surplus fund	30,000.00
Whole amount expended to June 30, 1897	1,196,304.86

Money statement.

July 1, 1896, balance unexpended	$114,797.98
June 30, 1897, amount expended during fiscal year	5,102.84
July 1, 1897, balance unexpended	109,695.14
July 1, 1897, outstanding liabilities	382.00
July 1, 1897, balance available	109,313.14
Amount that can be profitably expended in fiscal year ending June 30, 1899	250,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving harbor of refuge at Sand Beach (Lake Huron), Mich.

March 3, 1871	$100,000	August 5, 1886	$75,000
June 10, 1872	100,000	August 11, 1888	70,000
March 3, 1873	75,000	September 19, 1890	30,000
June 23, 1874	75,000	July 13, 1892	150,000
March 3, 1875	100,000	August 17, 1894	20,000
August 14, 1876	75,000	June 3, 1896	16,000
June 18, 1878	100,000		
March 3, 1879	75,000	Total	1,336,000
June 14, 1880	75,000	Carried to surplus fund	30,000
March 3, 1881	50,000		
August 2, 1882	75,000	Balance	1,306,000
July 5, 1884	75,000		

No. 1.—*Summary of vessels sheltered in the harbor of refuge at Sand Beach, Mich., from July 1, 1896, to June 30, 1897.*

Direction of wind at time of entering.	1896.						1897.			Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Apr.	May.	June.	
North:										
Steam	22	15	10	14	2	......	2	25	5	95
Sail	9	8	3	4	5	......	......	5	9	43
Tow	9	6	3	4	2	......	5	16	2	47
Total	......	......	......	......	......	......	......	......	......	185
Northwest:										
Steam	1	9	18	29	18	1	14	25	2	117
Sail	4	2	3	4	2	......	1	15	2	33
Tow	......	6	6	17	9	......	11	17	......	66
Total	......	......	......	......	......	......	......	......	......	216
West:										
Steam	6	9	11	20	23	2	......	6	1	78
Sail	7	5	15	8	6	......	2	6	1	50
Tow	4	5	10	15	12	......	......	4	......	50
Total	......	......	......	......	......	......	......	......	......	178
Southwest:										
Steam	2	16	16	7	31	2	7	3	8	92
Sail	7	23	8	4	17	1	6	8	13	87
Tow	1	4	3	7	23	......	1	2	5	46
Total	......	......	......	......	......	......	......	......	......	225
South:										
Steam	......	4	4	12	15	4	4	3	1	47
Sail	......	4	9	11	6	......	1	1	2	34
Tow	......	......	3	2	8	......	......	2	......	15
Total	......	......	......	......	......	......	......	......	......	96
Southeast:										
Steam	3	11	7	4	8	......	12	2	6	58
Sail	6	15	5	3	1	......	2	6	10	48
Tow	......	2	......	......	......	......	5	4	2	13
Total	......	......	......	......	......	......	......	......	......	119
East:										
Steam	......	1	5	4	1	......	......	......	1	12
Sail	......	......	1	2	2	......	......	......	......	5
Tow	......	......	3	1	......	......	......	......	......	4
Total	......	......	......	......	......	......	......	......	......	21
Northeast:										
Steam	1	1	19	5	12	......	17	......	3	58
Sail	2	2	2	3	5	......	5	......	2	21
Tow	......	......	6	......	10	......	6	......	2	24
Total	......	......	......	......	......	......	......	......	......	103
Monthly total:										
Steam	40	66	90	95	110	9	56	64	27	557
Sail	35	59	46	36	44	1	17	41	39	318
Tow	14	23	34	49	64	......	28	45	11	268
Total	89	148	170	180	218	10	101	150	77	1,143

No. 2.—*Classified table of tonnage, by months, sheltered in the harbor of refuge at Sand Beach, Mich., from July 1, 1896, to June 30, 1897.*

Month.	Steam.		Sail.		Tow.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1896.								
July	40	13,764.74	35	2,346.79	14	4,589.04	89	20,700.57
August	60	27,605.78	59	5,271.40	23	10,885.78	143	43,762.96
September	90	54,517.46	46	2,971.48	34	17,181.05	170	74,669.99
October	95	43,826.73	36	3,744.65	49	20,294.57	180	67,865.95
November	110	59,173.65	44	5,802.04	64	28,183.49	218	93,159.18
December	9	1,946.80	1	99.06	......	....	10	2,045.86
1897.								
April	56	35,798.70	17	1,351.06	28	14,077.24	101	51,227.00
May	64	32,702.58	41	3,390.31	45	20,144.88	150	56,237.77
June	27	5,343.04	39	2,495.35	11	3,839.06	77	11,677.45
Total	557	274,679.48	318	27,472.14	268	119,195.11	1,143	421,346.73

No. 3.—*Number and tonnage of vessels sheltered in the harbor of refuge, Sand Beach, Mich., 1877 to 1896, inclusive.*

Calendar year.	Steam.	Sail.	Tow.	Total.	Total vessels.	Average tonnage.
	Tons.	*Tons.*	*Tons.*	*Tons.*		
1877	63,966	27,699	50,954	142,619	493	289
1878	104,025	39,699	99,282	243,006	781	311
1879	133,080	45,750	100,096	278,926	921	303
1880	158,720	55,630	147,260	361,610	1,317	275
1881	144,645	55,960	127,855	328,460	1,176	279
1882	146,132	26,504	114,067	286,703	1,022	280
1883	177,122	32,713	114,091	323,926	1,139	284
1884	156,518	34,724	122,980	314,222	1,142	275
1885	196,364	29,426	151,607	377,397	1,158	326
1886	196,335	33,790	140,862	370,987	1,304	284
1887	271,327	33,689	153,087	458,103	1,447	317
1888	271,917	39,756	202,191	513,864	1,624	316
1889	289,719	37,922	165,896	493,537	1,512	326
1890	325,852	38,826	169,104	533,782	1,575	339
1891	296,917	27,076	171,067	491,060	1,341	366
1892	362,486	29,465	162,605	554,556	1,441	385
1893	243,451	20,897	113,915	378,263	982	385
1894	321,511	22,961	134,034	478,506	1,150	416
1895	356,532	26,898	167,237	550,668	1,204	457
1896	246,477	24,621	105,988	377,087	1,073	351
Total	4,459,096	684,006	2,714,178	7,857,282	23,302	372

K K 10.

IMPROVEMENT OF ST. CLAIR FLATS CANAL, MICHIGAN.

An outline of the history of this improvement to June 30, 1896, is in the Report of the Chief of Engineers for 1896, pages 2881–2889.

No work has been done here since 1892, but in June, 1897, a complete examination of local conditions was commenced, including a resurvey of the waterway. The timberwork of old dikes is wholly rotten above water, and the ice-protecting pilework at their ends must be renewed. The available balance of appropriations for the canal will suffice for this purpose, and therefore no additional estimate is submitted.

St. Clair Flats Canal is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. Two light-houses stand upon its banks.

Money statement.

July 1, 1896, balance unexpended	$4,586.54
July 1, 1897, balance unexpended	4,586.54
July 1, 1897, outstanding liabilities	138.00
July 1, 1897, balance available	4,448.54

Appropriations for improving St. Clair Flats Canal, Michigan.

June 23, 1866	$80,000	June 18, 1878	$5,000
March 2, 1867	150,000	March 3, 1879	3,000
July 25, 1868	86,000	June 14, 1880	2,500
April 10, 1869	142,560	August 5, 1886	18,750
July 11, 1870	16,500	August 11, 1888	75,000
March 3, 1871	1,500	September 19, 1890	80,000
June 10, 1872	4,000		
March 3, 1873	100,000	Total	764,810

NOTE.—The appropriations of 1852, $20,000, and 1856, $45,000, are not taken account of, for the reason that they did not enter into the improvement of St. Clair Flats Canal, the first having been expended in building a dredge and the second in dredging the North Channel of the South Pass. From March 3, 1881, the amounts allotted for operating and care of St. Clair Flats Canal are rendered separately.

K K 11.

OPERATING AND CARE OF ST. CLAIR FLATS CANAL, MICHIGAN.

Conforming to the method that has been followed since the canal was opened to navigation in 1871, a custodian was present on the work during the season of navigation to watch the passage of vessels, enforce regulations respecting navigation through the canal and its approaches, and supervise such work as was requisite for ordinary care and repair of the canal dikes. Expenditures on this account during the fiscal year were $2,162.81.

The estimated cost of operation and care for the fiscal year ending June 30, 1898, in accordance with the methods heretofore followed, is $5,000, viz:

Salary of custodian	$1,500
Labor	1,000
Miscellaneous repairs and general contingencies	2,500
Total	5,000

But it is submitted that the limited project of the past should be very much enlarged, and provision made for a much more effective supervision of the great commerce now passing through the canal. My last annual report outlined what is believed to be needed in this respect, as follows:

> There should be two watchmen on duty at all times, day and night, one stationed at the upper entrance to the canal and the other at the lower entrance. This would require, in addition to the custodian, six watchmen, to serve in three watches or reliefs. A telephone line should be established between the upper and lower watch stations, and the custodian should be supplied with a steam launch, and a suitable office should be erected.

Such an organization is essential to the satisfactory supervision of traffic through the canal, and it would also enable a careful record of passing vessels to be made, thus securing accurate statistics of the commerce between the upper and lower lakes. The value of such statistics needs no explanation, and there is no place at which they could be obtained so readily as at St. Clair Flats Canal.

The dikes of the canal need extensive repairs. The crib superstructure has become thoroughly rotten; large sections of it have fallen away; iron bolts project from 1 to 2 feet above what remains, and, as a whole, it is in an utterly dilapidated and disreputable condition. All the old timbers should be removed down to the water surface and the earth back of the pile revetment graded to suitable slopes. These repairs will cost about $2 per linear foot, or, for the two dikes, a total of $30,000. The old pile structures by which the ends of the dikes are protected are badly rotted above the water and partially broken down. They should all be cut down to and rebuilt above the water surface. The estimated cost of this work is $8,000.

Under this modified project the estimated cost of operating and care of the canal for the next year would be about as follows:

One custodian	$1,500
Six watchmen, at $750 each	4,320
Office building	5,000
Telephone line	2,500
Steam launch	2,000
Operating steam launch	1,500
General repairs of dikes and pile protection	38,000
Contingencies, including office expenses	5,000
Total	59,820

For subsequent years, under this project, the cost of operating and care would probably fall to about $10,000 or $12,000 annually.

St. Clair Flats, is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. Two light-houses stand upon its banks.

Money statement.

Expended to June 30, 1896		$71,519.89
Outstanding liabilities June 30, 1896		388.08
Total expenditures to June 30, 1896		71,907.97
Expended during fiscal year ending June 30, 1897	$2,375.89	
Deduct outstanding liabilities pertaining to preceding year	388.08	
Total pertaining to current fiscal year	1,987.81	
Add outstanding liabilities, June 30, 1897	175.00	
		2,162.81
Total expenditures to June 30, 1897, including outstanding liabilities		74,070.78

Estimates for year ending June 30, 1898.

If old project be continued	$5,000
If new project be adopted	60,000

Expenditures for operating and care of St. Clair Flats Canal, Michigan.

1882	$8,786.69	1891	$2,020.20
1883	5,668.87	1892	1,888.67
1884	2,532.15	1893	2,675.93
1885	4,906.59	1894	3,592.18
1886	9,539.11	1895	1,993.32
1887	1,819.53	1896	2,501.57
1888	1,510.00	1897	2,162.81
1889	20,315.00		
1890	2,158.16	Total	74,070.78

Statement of receipts and expenditures for fiscal year ending June 30, 1897.

Receipts:		
Balance at close of fiscal year ending June 30, 1896 (including outstanding liabilities)		$2,323.43
July 29, 1896, allotted		2,500.00
		4,823.43
Expenditures:		
Ordinary repairs	$231.15	
Salary of custodian	1,500.00	
Contingencies	431.66	
		2,162.81
Balance at close of fiscal year ending June 30, 1897		2,660.62

K K 12.

IMPROVEMENT OF MOUTH OF BLACK RIVER, MICHIGAN.

The bar and middle ground in the St. Clair River at the mouth of the Black was dredged to a depth of 15 feet in the years 1872–1875, and redredged to 16 feet, 1889–1892. An outline of operations to June 30, 1896, is contained in the Annual Report of the Chief of Engineers for 1896, page 2735.

The shoal having re-formed, contract for redredging to a depth of 16 feet was entered into May 13, 1897, with Edmund Hall, of Detroit, Mich. Operations commenced June 1, 1897, but soon afterwards were suspended on account of accident to the contractor's plant. The amount excavated to the close of the year was therefore only 729 cubic yards. It is probable, however, that the work will be completed during the summer (1897).

This shoal encroaches on the main channel in the St. Clair River, through which all commerce between the upper and lower lakes must pass, and it is vitally important to this commerce that the shoal be prevented from re-forming to such an extent as to endanger navigation in that locality; an appropriation of $10,000 for application when the emergency arises would be a wise precautionary measure.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 2 miles.

Original estimated cost (1871) of removing middle ground to depth of—	
15 feet	$67,320.00
18 feet	157,520.00
Whole amount expended to June 30, 1897	86,928.73

Money statement.

July 1, 1896, balance unexpended		$7,614.06
June 30, 1897, amount expended during fiscal year		42.79
July 1, 1897, balance unexpended		7,571.27
July 1, 1897, outstanding liabilities	$94.86	
July 1, 1897, amount covered by uncompleted contracts	5,927.10	
		6,021.96
July 1, 1897, balance available		1,549.31
Amount that can be profitably expended in fiscal year ending June 30, 1899		10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving St. Clair River at mouth of Black River, Michigan.

Mouth of Black River, in St. Clair River, Michigan:	
June 10, 1872	$15,000
St. Clair River, at mouth of Black River, Michigan:	
March 3, 1873	15,000
June 23, 1874	15,000
March 3, 1875	10,000
June 18, 1878	1,500
Mouth of Black River, Michigan:	
August 11, 1888	$10,000
September 19, 1890	10,000
July 13, 1892	10,000
August 17, 1894	4,000
June 3, 1896	4,000
Total	94,500

Abstract of proposals for dredging bar at mouth of Black River, Michigan, received in response to advertisement dated April 17, 1897, and opened May 7, 1897.

No.	Name and address of bidder.	Per cubic yard, scow measurement.
		Cents.
1	Edmund Hall, Detroit, Mich	10
2	Joseph R. McCollum, Port Huron, Mich	29½
3	Carkin, Stickney & Cram, Detroit, Mich	28
4	James Rooney, Toledo, Ohio	21

Contract in force with Edmund Hall for dredging bar at mouth of Black River, Michigan, dated May 13, 1897, approved May 20, 1897. Date of beginning work June 1, 1897; date of expiration July 29, 1897.

K K 13.

IMPROVEMENT OF BLACK RIVER AT PORT HURON, MICHIGAN.

This stream passes through the city of Port Huron, Mich., and empties into the St. Clair River; its improvement was commenced under the river and harbor act of September 19, 1890, which with subsequent acts contemplated dredging the river channel to a depth of 16 feet from the mouth up to Washington Avenue. Progress of the work to June 30, 1896, is summarized in the report of the Chief of Engineers for 1896, pages 2733–2734.

The result of work done up to the close of 1893 was to make a channel 16 feet deep, for a distance of 9,700 feet above the mouth of the river, the width of dredged channel diminishing from 150 feet at the mouth to only 50 feet at the upper section. No work was done between 1893 and the spring of 1897, and by that time the narrower parts of the channel had become so filled that vessels drawing 8 feet could not pass through, and the wider sections below had shoaled in several places to a depth of from 10 to 12 feet. The work of redredging the channel was thereupon commenced May 25, 1897, under a contract entered into May 13, 1897, with Edmund Hall, of Detroit, Mich. The work was still in progress at the close of the fiscal year, the amount of material excavated in the meantime being 16,844 cubic yards.

The approved project for this improvement is that of January, 1891, contemplating a channel 16 feet deep from the mouth of the river to the Grand Trunk Railway Bridge, with a width varying from 160 to 75 feet, according to locality; its estimated cost was $75,000. No estimate for "continuing the improvement up to Washington avenue," as appropriated for by the river and harbor acts of August 17, 1894, and June 3, 1896, has been called for by Congress and none has been submitted.

The total amount appropriated to date is $43,000. It will require the remaining $32,000 of the estimate to restore the depth of channel and complete it with a depth of 16 feet to the limits indicated by Congress. It should be observed, however, that experience shows the narrow channel will very soon become filled up unless the river banks be properly docked or revetted, and it is a question whether such work should not be done by local enterprise as a prerequisite to further dredging by the Government.

This river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 2 miles.

Original estimated cost of 15-foot channel, 1889	$65, 110.00
Original estimated cost of 16-foot channel, 1891	75, 000.00
Whole amount expended to June 30, 1897	35, 234.99

Money statement.

July 1, 1896, balance unexpended		$7, 896.15
June 30, 1897, amount expended during fiscal year		131.14
July 1, 1897, balance unexpended		7, 765.01
July 1, 1897, outstanding liabilities	$1, 531.35	
July 1, 1897, amount covered by uncompleted contracts	4, 152.48	
		5, 683.83
July 1, 1897, balance available		2, 081.18
Amount (estimated) required for completion of existing project		32, 000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		32, 000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving Black River, Michigan, at Port Huron.

September 19, 1890	$25, 000
July 13, 1892	10, 000
August 17, 1894	4, 000
June 3, 1896	4, 000
Total	43, 000

Abstract of proposals for dredging Black River, at Port Huron, Michigan, received in response to advertisement dated April 17, 1897, and opened May 7, 1897.

No.	Name and address of bidder.	Per cubic yard, scow measurement.
		Cents.
1	Edmund Hall, Detroit, Mich	8
2	Joseph R. McCollum, Port Huron, Mich	24
3	Carkin, Stickney & Cram, Detroit, Mich	25
4	James Rooney, Toledo, Ohio	14

Contract in force with Edmund Hall for dredging Black River at Port Huron, Mich., dated May 13, 1897, approved May 20, 1897. Date of beginning work, May 25, 1897; date of expiration, July 17, 1897.

COMMERCIAL STATISTICS, BLACK RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.	Calendar year.	Number.	Tonnage.
1889	1,612	578,489	1893	602	71,415
1890	2,225	547,954	1894	595	68,769
1891	2,320	578,430	1895	587	60,650
1892 a	....	....	1896	628	72,950

a Not stated.

Receipts and shipments by vessel, 1896.

[Compiled from statements furnished by Mr. F. I. Meryman, and the special deputy collector of customs at Port Huron, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	79,510	Laths	600
Coal	31,027	Lumber	1,969
Cord wood	7,087		
Fiber wood	25,848		
Logs	26,000		
Lumber, shingles, etc	17,519		
Miscellaneous	496		
Total	186,987	Total	2,569

Sixty-three vessels, representing a total gross tonnage of 15,128, were quartered here during the winter of 1896–97.

K K 14.

IMPROVEMENT OF PINE RIVER, MICHIGAN.

The improvement of this river was commenced in 1875, when the bar at the junction of the Pine with the St. Clair River was removed, and a channel 100 feet wide and 12 feet deep dredged for a distance of 4,000 feet upstream. The total cost was $5,000.

The river and harbor act of July 13, 1892, called for a preliminary examination of Pine River at St. Clair City, and the act of August 17, 1894, directed that a project be prepared and an estimate of cost made. The latter was submitted under date of November 30, 1895, and is published in Report of Chief of Engineers for 1896, page 2745. At that time the channel had shoaled until there were places with depths of only 9 feet. The plan of improvement adopted was to dredge the river from its mouth to Belknap's brickyard, a distance of about 5,800 feet, the dredged channel to be 100 feet wide and 14 feet deep for a distance of 2,500 feet upstream, and thence 75 feet wide with a depth of 12 feet; the estimated cost of the project was $10,560.

The act of June 3, 1896, appropriated $5,000 for this improvement, and under contract of September 14, 1896, with Carkin, Stickney & Cram, of Detroit, Mich., operations were commenced September 24 and completed November 16, 1896. The channel was dredged to the prescribed depth and width for a distance of 2,500 feet upstream, and thence to the brickyard to a width of about 30 feet (one dredge cut) and depth of 12 feet. The total quantity excavated was 46,326 cubic yards, scow measure; the contract price was 8⅝ cents per cubic yard.

The appropriation of $5,560, being the balance of the estimated cost, will be required to complete the improvement.

The river is in the collection district of Huron. Mich. The nearest port of entry is Port Huron, Mich. The nearest light-house is at Fort Gratiot, distant about 13 miles.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	4,452.95
July 1, 1897, balance unexpended	547.05
Amount (estimated) required for completion of existing project	5,560.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	5,560.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving Pine River, Michigan.

March 3, 1875	$5,000
June 3, 1896	5,000
Total	10,000

COMMERCIAL STATISTICS, PINE RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Receipts and shipments by water.

[Compiled from statement furnished by Messrs. J. R. Whiting & Co., St. Clair, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Limestone	455	Brick	2,228

Eighteen vessels, representing a gross tonnage of 5,619, were quartered in Pine River during the winter of 1896–97.

K K 15.

IMPROVEMENT OF BELLE RIVER, MICHIGAN.

The improvement of this river was commenced in 1880, the object being to obtain a channel 50 feet wide, 13 feet deep to the first bridge, and 12 feet deep thence to the second bridge, the prime object being to provide a winter harbor for vessels. The work was completed in 1885 according to the above project at a total cost of $14,000, and gave satisfaction until 1892, when the width and depth of channel became insufficient to accommodate the increased number and size of vessels seeking refuge during the winter months. The river and harbor act of July 13, 1892, called for a preliminary examination of Belle River, Marine City from its mouth to Broadway Street Bridge, and the act of August 17, 1894, for a survey and estimate of cost of improvement.

The latter was submitted under date of November 30, 1895, and is published in Report of the Chief of Engineers for 1896, page 2746; at this time the channel, completed in 1885, had shoaled until there were places with less than 10 feet of water. The plan of improvement adopted was to redredge the river from its mouth to the second bridge above, a distance of about 5,400 feet; the channel to be made 75 feet wide, with a navigable depth of 15 feet to the first bridge and from there a depth of 14 feet.

The act of June 3, 1896, appropriated $5,000 for this improvement. Under contract of May 13, 1897, with Edmund Hall, operations were commenced June 12, and at the close of the fiscal year 14,086 cubic yards, scow measure, had been excavated. The contract price is 11 cents per cubic yard.

In view of the low contract price for this season's work an additional single appropriation of $10,000 will suffice to complete the approved project, and the estimated cost of completion submitted below is accordingly reduced to that amount, instead of holding to the original estimate, which would indicate $16,340 as the amount requisite.

The river is in the collection district of Huron, Mich., and the nearest port of entry is Port Huron, Mich. The nearest light-house is at St. Clair Flats Canal, distant about 17½ miles.

Money statement.

July 1, 1896, balance unexpended		$5,000.00
June 30, 1897, amount expended during fiscal year		322.72
July 1, 1897, balance unexpended		4,677.28
July 1, 1897, outstanding liabilities	$1,623.82	
July 1, 1897, amount covered by uncompleted contracts	2,450.54	
		4,074.36
July 1, 1897, balance available		602.92
Amount (estimated) required for completion of existing project		10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations for improving Belle River, Michigan.

March 3, 1881 (ice harbor of refuge)	$7,000
August 2, 1882 (ice harbor of refuge)	5,000
July 5, 1884 (ice harbor of refuge)	2,000
June 3, 1896	5,000
Total	19,000

Abstract of proposals for dredging Belle River, at Marine City, Mich., received in response to advertisement dated April 17, 1897, and opened May 7, 1897.

No.	Name and address of bidder.	Per cubic yard, scow measurement.
		Cents.
1	Edmund Hall, Detroit, Mich	11
2	Joseph R. McCollum, Port Huron, Mich	24
3	Carkin, Stickney & Cram, Detroit, Mich	20
4	James Rooney, Toledo, Ohio	14

Contract in force with Edmund Hall for dredging Belle River, at Marine City, Mich., dated May 13, 1897, approved May 20, 1897; date of beginning work, June 12, 1897; date of expiration, July 23, 1897.

COMMERCIAL STATISTICS, BELLE RIVER, MICHIGAN, FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	Number.	Tonnage.
1896	482	101,967

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by the deputy collector of customs.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	1,250	Apples and pears	800
Coal	28,000	Hay and feed	1,400
Lime and cement	300	Salt	19,951
Logs	5,860	Staves and headings	14,598
Lumber, shingles, etc	4,382		
Staves and headings	5,496		
Stone	1,250		
Total	46,538	Total	36,749

Seventy-two vessels, representing a total gross tonnage of 37,134, were quartered in Belle River during the winter of 1896-97.

K K 16.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

Work on the improvement of this river was commenced in 1870, and has been carried on since then as funds were appropriated. The scheme of improvement has been to make and maintain a navigable depth through the river up to Mount Clemens, Mich., which is about 8 miles above the mouth. Progress on the work to June 30, 1896, is outlined in the Report of the Chief of Engineers for 1896, pages 2736–2737.

No work was done between 1893 and June 10, 1897, and the river channel shoaled in the interval to depths of only 4½ or 5 feet in some places. The work of restoring the requisite depth was commenced on the date above mentioned, under a contract entered into May 13, 1897, with Edmund Hall, of Detroit, Mich., and by the close of the year 8,655 cubic yards, scow measure, had been excavated. The result of this work was to redredge the channel through the bar at the mouth of the river to a clear depth of 8 feet; the width of channel being 100 feet and length about 1,200 feet. At least eight shoals in the river, between its mouth and Mount Clemens, remained to be dredged under the contract. Funds available will suffice for redredging all shoal places in the river, and estimate for future maintenance is therefore withheld until duly called for.

The river is in the collection district of Detroit, Mich., which is the nearest port of entry. The nearest light-house is 6 miles distant, at St. Clair Flats.

Original estimated cost of work, 1885, as amended in 1889	$34,564.00
Whole amount appropriated and expended prior to adoption of present project	25,500.00
Whole amount expended on present project to June 30, 1897	35,015.99

Money statement.

July 1, 1896, balance unexpended		$14,735.14
June 30, 1897, amount expended during fiscal year		187.13
July 1, 1897, balance unexpended		14,548.01
July 1, 1897, outstanding liabilities	$1,595.60	
July 1, 1897, amount covered by uncompleted contracts	4,701.75	
		6,297.35
July 1, 1897, balance available		8,250.66

Appropriations for improving Clinton River, Michigan.

August 30, 1852	$5,000	September 19, 1890	$10,000
July 11, 1870	5,000	July 13, 1892	8,564
March 3, 1871	1,500	August 17, 1894	5,000
March 3, 1881	8,000	June 3, 1896	10,000
August 2, 1882	6,000		
August 5, 1886	6,000	Total	75,064
August 11, 1888	10,000		

Abstract of proposals for dredging Clinton River, Michigan, received in response to advertisement dated April 17, 1897, and opened May 7, 1897.

No.	Name and address of bidder.	Per cubic yard, scow measurement.
		Cents.
1	Edmund Hall, Detroit, Mich	15
2	Carkin, Stickney & Cram, Detroit, Mich	24
3	James Rooney, Toledo, Ohio	18

Contract in force with Edmund Hall for dredging Clinton River, Michigan, dated May 13, 1897; approved May 20, 1897; date of beginning work June 10, 1897; date of expiration August 19, 1897.

COMMERCIAL STATISTICS, CLINTON RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Entrances and clearances.

Calendar year.	No.	Tonnage.
1896	420	25,322

Receipts and shipments by vessel, 1896.

[Compiled from statement furnished by Mr. F. R. Eastman, secretary board of trade, Mount Clemens, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Coal	11,050	Apples and pears	410
Gravel	1,950		
Lumber, shingles	14,366		
Miscellaneous	571		
Stone	2,812		
Total	30,749	Total	410

K K 17.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN.

Originally the channel at Limekiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depth being much affected by the direction of the wind.

The original project adopted in 1874, for a curved channel 300 feet wide and 20 feet deep, was modified in 1883, again in 1886, and in 1888, until it finally provided for a straight channel 440 feet wide and 20 feet deep, at an estimated cost of $1,374,500.

The present project, adopted in 1892, contemplates the removal of such shoals in Detroit River between the city of Detroit and Lake Erie as obstruct navigation. The approved estimate under this project provides for a channel 800 feet wide and 20 feet deep from the head of Ballards Reef to the head of Limekiln Crossing, at an estimated cost of $180,000.

Progress under the projects above indicated, to June 30, 1896, is outlined in the Report of the Chief of Engineers for 1896, pages 2893–2895.

WORK DURING THE YEAR ENDING JUNE 30, 1897.

Excavation.—At the beginning of the year work was in progress under contract of October 20, 1894, with Carkin, Stickney & Cram for the removal of shoals near Ballards Reef and 16,097 cubic yards, scow measure, had been removed. The work done during the fiscal year was confined to the east half of the channel and was continued to October 12, 1896; 3,661 cubic yards were excavated, making the total excavation 19,758 cubic yards, scow measure. The contract price was 87 cents per cubic yard, scow measure. Under supplemental contract dated October 19, 1896, the original contract was formally closed in November, for the reason that it was found, by experience, not to be properly adapted to the work in hand. At this time the east half of the channel was not in condition to be used by large vessels, as there were many bowlders left with only 16 to 17 feet of water over them. The west half, however, was soon afterwards cleaned up to a depth of 18 feet by hired labor, except at one place where a rock ledge showed a depth of only 17½ feet.

An effort was also made with a crane scow and diver to clean up to the same depth a strip 150 feet wide east of and adjacent to the center line in order to facilitate navigation, but many bowlders were found within this area with only 16½ to 17 feet of water over them, which could not be removed with the appliances at hand. The work was continued until June 5, 1897, the total number of bowlders removed being 254.

Under contract of June 12, 1897, with Michael Sullivan, operations were commenced June 18 for the removal of bowlders, bed rock, etc., at Ballards Reef to a depth of 21 feet. At the close of the fiscal year 1,513.242 net tons had been removed. The contract price is $4.15 per net ton.

Surveys.—In September, 1896, a survey was made of a shoal abreast of the city of Detroit. During January and February, 1897, an ice survey was made extending from the lower end of Limekiln Crossing to the south end of Bois Blanc Island and for a distance of 1,680 feet over the east half of Ballards Reef. About 46,000 soundings were taken, at a cost of $838.

The approved estimate for this improvement will require material modification, for it does not include all that will be necessary for making a safe channel, conforming to the general project of a through waterway with a navigable depth of 20 feet. Such channel has been opened at all other critical parts of the line, and an appropriation of what is required to give the same depth in this locality is urgently needed, in order that commerce may realize the benefits of the large expenditures already made at all other links in the chain.

The work is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. The nearest United States light-houses are Mammy Judy, and the range lights at the head of Grosse Isle, about 5 miles distant.

Total expenditure to June 30, 1896	$722, 967. 96
Expended during fiscal year	17, 406. 06
Total expenditure to June 30, 1897	740, 374. 02

Money statement.

July 1, 1896, balance unexpended		$70, 142. 45
June 30, 1897, amount expended during fiscal year		17, 406. 06
July 1, 1897, balance unexpended		52, 736. 39
July 1, 1897, outstanding liabilities	$6, 864. 83	
July 1, 1897, amount covered by uncompleted contracts	38, 720. 05	
		45, 584. 88
July 1, 1897, balance available		7, 151. 51
Amount (estimated) required for completion of existing project		91, 257. 34
Amount that can be profitably expended in fiscal year ending June 30, 1899		91, 257. 34

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving Detroit River, Michigan.

June 23, 1874	$25, 000	August 5, 1886	$37, 500
June 18, 1878	100, 000	August 11, 1888	130, 500
March 3, 1879	50, 000	July 13, 1892	30, 000
June 14, 1880	50, 000	August 17, 1894	30, 000
March 3, 1881	50, 000	June 3, 1896	30, 000
August 2, 1882	60, 000		
July 5, 1884	200, 000	Total	793, 000

Receipts from sales of fuel to officers, between October, 1884, and December, 1886	$108. 41
Repayment of disallowance voucher 4, November, 1885 (see p. 2268, Report Chief of Engineers, 1887)	2. 00
Total	110. 41

Abstract of proposals for removal of bowlders, bed rock, or other material from Ballards Reef Channel, improving Detroit River, Michigan, received in response to advertisement dated May 10, 1897, and opened June 1, 1897.

No.	Name and address of bidder.	Per net ton of 2,000 pounds.
1	Michael Sullivan, Detroit, Mich	$4. 15
2	Breyman Bros., Toledo, Ohio	4. 25
3	The L. P. & J. A. Smith Co., Cleveland, Ohio	4. 70
4	Carkin, Stickney & Cram, Detroit, Mich	6. 00

Contract in force with Michael Sullivan, dated June 12, 1897; approved June 29, 1897; date of beginning work June 18, 1897; date of expiration, October 18, 1897.

List of contracts in force during the fiscal year ending June 30, 1897.

Name of contractor.	Contract approved.	Work began.	Date of expiration.	Remarks.
Carkin, Stickney & Cram	Oct. 31, 1894	Nov. 17, 1894	Oct. 1, 1896	Closed Nov. 16, 1896.
M. Sullivan	June 29, 1897	June 18, 1897	Oct. 18, 1897	

Commerce of Detroit River during the season of 1896, comprising staples only, and only such staples as cleared from United States ports.

Commodities.	Tons.	Commodities.	Tons.
Building stone	59,561	Lumber	1,896,968
Cement	226,788	Provisions	427,662
Coal	7,146,668	Salt	186,963
Copper ore	116,412	Shingles	80,000
Corn	2,236,145	Silver ore	240
Flax and grass seed	117,852	Telegraph poles	80,000
Flour	1,363,861	Wheat	2,532,829
Grain	1,178,222	Unclassified freight	2,189,239
Iron ore and finished iron	8,051,110		
Logs	110,000	Total	27,900,520

Number of vessels, 33,290.

Total number of vessels and tonnage cleared from all the collection districts on the chain of lakes.

Vessels	66,472
Registered tonnage (exclusive of Canadian vessels)	53,265,572

Number of cars loaded that crossed Detroit River during 1896.

East bound	219,301
West bound	101,869
Total	321,170

Tonnage at an average of 15 tons per car, 4,817,550.

K K 18.

IMPROVEMENT OF ROGUE RIVER, MICHIGAN.

Under the provisions of the river and harbor act of August 5, 1886, a survey of this river was made with a view to its improvement, and a project prepared for securing a channel depth of 16 feet with a width of 240 feet for a distance of 800 feet from the mouth, and thence with a width of 100 feet to the Wabash Railroad Bridge, about 2⅜ miles farther up; the estimated cost was $31,690.39. At the time of survey this portion of the river had a natural channel from 10 to 17 feet deep, with a general width of about 175 feet. The work of improvement was commenced in 1888 and completed in November, 1892.

No work has been done on the river since 1892, but under the provisions of the river and harbor act of June 3, 1896, the section of river heretofore improved was examined in May, 1897, and survey made for estimating the cost of extending the original improvement about 8,000 feet farther up stream. The results of this examination and survey will be presented in a special report at an early date, and for this reason no estimate for additional appropriation is now submitted.

The river is in the collection district of Detroit, Mich., which city is the nearest port of entry. The nearest light-house is about 5 miles distant, at Grassy Island.

Original estimated cost of the work, 1887	$31,690.39
Whole amount expended to June 30, 1897	31,794.45

Money statement.

July 1, 1896, balance unexpended	$10,677.78
June 30, 1897, amount expended during fiscal year	782.23
July 1, 1897, balance unexpended	9,895.55
July 1, 1897, outstanding liabilities	139.00
July 1, 1897, balance available	9,756.55

Appropriations for improving Rouge River, Michigan.

August 11, 1888	$10,000.00
September 19, 1890	10,000.00
July 13, 1892	11,690.00
August 17, 1894	5,000.00
June 3, 1896	5,000.00
Total	41,690.00

COMMERCIAL STATISTICS, ROUGE RIVER, MICHIGAN, FOR CALENDAR YEAR ENDING DECEMBER 31, 1896.

Receipts and shipments by vessel.

[Compiled from statement furnished by Mr. W. W. Kelly, of Delta Lumber Co., Detroit, Mich.]

Articles received.	Tons.	Articles shipped.	Tons.
Brick	2,500	Lumber	2,905
Cedar posts	3,060		
Lime and cement	600		
Logs	47,500		
Lumber	57,030		
Machinery	300		
Pulp wood	6,000		
Ties	3,600		
Total	120,590	Total	2,905

K K 19.

CONSTRUCTION OF TURNING BASIN IN ROUGE RIVER, MICHIGAN.

The river and harbor act of September 19, 1890, called for an estimate for "locating and constructing basin in said (Rouge) river at a point on the same within 4 miles of its junction with the Detroit River, convenient for the turning and anchoring of vessels." Such estimate was submitted by Col. O. M. Poe, Corps of Engineers, in a report dated December 20, 1890, as follows: Three acres of land for site, at $1,500, $4,500; 74,047 cubic yards excavation, at 15 cents, $11,111.10; total, $15,611.10.

The next river and harbor act, approved July 13, 1892, appropriated $5,000 for acquisition of land and beginning construction, according to the foregoing project. The appropriation has been found too small for purchasing the land needed, and accordingly no work has yet been done or expenditure made in relation to the proposed improvement.

It is doubtful whether the construction of the proposed basin will be really necessary, for private parties have already constructed slips opening into the river (and others will undoubtedly follow) that will supply openings opposite which vessels will in all probability be able to find turning room. If, however, the plan of constructing a turning basin is to be adhered to, work should not be commenced until all the money required to complete it has been appropriated; in this case an additional appropriation of $10,500 should be made, as indicated in the estimate submitted below. But it is suggested that the scheme be abandoned, for the present at least, and the money already appropriated be made available for general dredging in the Rouge River.

Appropriation for construction of turning basin in Rouge River, Michigan, July 13, 1892	$5,000.00
Original estimated cost of the work, 1890	15,611.10

Money statement.

July 1, 1896, balance unexpended	$5,000.00
July 1, 1897, balance unexpended	5,000.00

Amount (estimated) required for completion of existing project	10,611.10
Amount that can be profitably expended in fiscal year ending June 30, 1899	15,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

K K 20.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

WRECK OF SCHOONER BRUCE.

The schooner *Bruce*, owned by J. C. Gilchrist, of Cleveland, Ohio, struck a bowlder in St. Marys River, October 17, 1895, and sank almost immediately. The wreck lay at the head of Mud Lake in such a position as to be no material obstruction to navigation so long as only the old channel in that vicinity was used, but it was directly in the line of approach to the new channel known as section 3 of the 20-foot ship channel of the Great Lakes.

The owner of the vessel was several times communicated with in relation to removing the wreck, and on each occasion he indicated his intention to do so in the near future, but at no time took any active measures in the matter. Finally, when the new channel was about to be utilized, it was recommended to the Department, in a letter from this office dated September 24, 1896, that the wreck be removed by the Government, as provided by the act of June 14, 1-80. This recommendation was approved by the Secretary of War October 1, 1896, and an allotment of $2,500 was made for the work.

Proposals for removing the wreck were solicited by advertisements dated October 17, 1896. Bids were opened November 17, and the contract awarded to Zess Bros., of Sault Ste. Marie, Mich., the lowest bidders, under date of November 28, 1896. Work under the contract was commenced November 30, and, after some interruptions on account of ice, was completed December 20. Subsequent examination shows that there is a depth of not less than 23 feet over any part of the wreck, as referred to the datum plane of improved channels in that locality.

The wreck was broken up by blasting with dynamite, and no portions having any salable value were saved.

Amount allotted for the work		$2,500.00
Amount paid contractor	$730.00	
Cost of advertisement, contingencies, etc	51.93	
		781.93
Balance		1,718.07

All costs having been duly paid, check for above balance of $1,718.07 was transmitted February 11, 1897, to the assistant treasurer of the United States at Chicago, Ill., for deposit to the credit of the Treasurer of the United States.

Abstract of proposals for the removal of the wreck of the schooner Bruce from the St. Marys River, Michigan, received in response to advertisement dated October 17, 1896, and opened November 17, 1896.

No. 1.	Zess Bros., Sault Ste. Marie, Mich	$730.00
No. 2.	Horation N. Jex, Toledo, Ohio	898.75
No. 3.	Hamilton Valentine, Sault Ste. Marie, Mich	1,260.00
No. 4.	John Hickler, Sault Ste. Marie, Mich	1,950.00
No. 5.	Thomas Fowler, Port Huron, Mich	2,185.00
No. 6.	Harris W. Baker, Detroit, Mich	2,400.00
No. 7.	James Reid & Sons, Bay City, Mich	2,600.00
No. 8.	Duff M. Fecteau and Wm. McCulloch, Detroit, Mich	4,430.00
No. 9.	Charles D. Thompson, Port Huron, Mich	9,790.00

Contract with Zess Bros. for removal of wreck of schooner *Bruce* from the St. Marys River, Mich., dated November 28, 1896, approved December 11, 1896; date of beginning work November 30, 1896, completed December 20, 1896, and contract closed.

K K 21.

PRELIMINARY EXAMINATION OF HURON RIVER, MICHIGAN, FROM MOUTH TO THE POINT OF CROSSING BY THE MICHIGAN CENTRAL RAILROAD.

[Printed in House Doc. No. 87, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 16, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated the 13th instant, by Lieut. Col. G. J. Lydecker, Corps of Engineers, upon the results of a preliminary examination of Huron River, Michigan, from mouth to the point of crossing by the Michigan Central Railroad, made to comply with the provisions of the river and harbor act of June 3, 1896.

It appears from this report that the natural conditions of the stream are such that the cost of any material improvement and of maintenance would be strikingly disproportionate to the present or prospective demands of commerce, there being in fact no present local commerce by water, and no likelihood that such a commerce would be developed to any appreciable extent in the near future should the stream be opened to navigation.

Because of the facts and reasons set forth by Colonel Lydecker, he is of opinion, which is concurred in by me, that this river is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 13, 1897.

GENERAL: In accordance with instructions from the Acting Chief of Engineers, I have the honor to submit the following report on a preliminary examination of the Huron River, Michigan, from mouth to the point of crossing by the Michigan Central Railroad, as required by the river and harbor act of June 3, 1896:

The Huron River is a small stream which flows in a southeasterly direction through Washtenaw and Wayne counties, Mich., and empties into Lake Erie at its northwest corner. The distance from its mouth to the Michigan Central crossing is about 4½ miles by the river channel, which is very crooked. There is a highway bridge, with pier in midstream, about halfway between the mouth and the railroad crossing.

The general depth of water found at the time of the examination was from 4½ to 8 feet in the first 2 miles below the railroad crossing, 7 to 10 feet in the next 2 miles, and in the remaining half mile above the mouth from 3½ to 10 feet. At the mouth, which was found entirely covered with a thick growth of rushes, the depth of water was from 2 to 4 feet only. Beyond the shore line the depth increases very gradually until 6 feet is reached at a distance of about half a mile, and 12 feet at a farther distance of a quarter of a mile.

The width of the stream in the section under consideration is about 100 feet and quite uniform. There is a current of about 2 miles per hour and it carries considerable sediment, which is deposited in the still water near the mouth.

The Michigan Central Railroad crossing is at the village of Rockford, and a short distance above this crossing is also that of the Lake Shore and Michigan Southern Railroad. It is understood that the inhabitants of this village desired this examination as a preliminary to the improvement of the stream in such a way as to enable them to have a water outlet for local products and manufactures. The population of the village at the last census was 740, and its principal industries are reported to me as follows: One flouring mill, capacity 175 barrels per day, average output 125 barrels per day, employing 8 men; 1 stave and heading mill, capacity 100 carloads per annum, output for 1895, 40 carloads; 1 brick and tile yard, capacity 8,000 brick and 8,000 tiles, but was not running at last report; 4 basket factories, employing from 20 to 25 men a portion of each year to supply a local trade. There are also 3 general stores, 1 grocery store, 1 shoe store, and 2 agricultural implement stores.

The local traffic of the two railroads for the year 1896 is reported to have comprised freight shipments aggregating about 5,800 tons, freight receipts about 2,500 tons, and a sale of passenger tickets amounting to about $2,500; that for 1895 being stated as about 8,000 tons of freight received, 750 tons shipped, and sale of passenger tickets about $2,900.

A statement was promised me long since from some of the business men of Rockford indicating what increased traffic or other benefits might be anticipated if the river should be improved so as to make it navigable for commerce, but it has not yet been received.

The natural conditions of the stream are such that the cost of any material improvement and its maintenance would be strikingly disproportionate to the present or prospective demands of commerce. There is in fact no present local commerce by water, nor is it likely that such a commerce would be developed to any appreciable extent in the near future if the stream should be opened to navigation.

Because of the facts and reasons indicated above it is my opinion that this river is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

APPENDIX L L.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA.

REPORT OF COL. JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky Harbor, Ohio.
5. Huron Harbor, Ohio.
6. Vermillion Harbor, Ohio.
7. Black River Harbor, Ohio.
8. Cleveland Harbor, Ohio.
9. Fairport Harbor, Ohio.
10. Ashtabula Harbor, Ohio.
11. Conneaut Harbor, Ohio.

EXAMINATION.

12. Raisin River, Michigan.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, July 19, 1897.

GENERAL: I have the honor to forward herewith annual reports for works in my charge for fiscal year ending June 30, 1897.

During the year Mr. William T. Blunt, assistant engineer, has given personal supervision to works of improvement in western portion of the district, and has conducted various special surveys. Mr. F. S. Burrowes, assistant engineer, has given personal supervision to works in eastern portion of the district and has specially assisted in the office.

Very respectfully, your obedient servant,

JARED A. SMITH,
Colonel, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

L L 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

This harbor is formed by the part of the Raisin River from the wharves at Monroe to the end of the piers at the present mouth of the river in Lake Erie, covering a distance of 2½ miles; about 4,000 feet of the distance from wharves to lake is in a canal dredged across the neck of the peninsula as a part of the original project of improvement; somewhat more than 1,000 feet lies between piers outside of the shore line extending to about 10 feet depth in the lake; about 1,400 feet of the distance is through a cut dredged by the city of Monroe as a part of the original project of improvement.

An abridged history of the improvement and its maintenance since 1835 was given on pages 2913 to 2915, Report of Chief of Engineers, 1896.

No work of improvement or repair has been carried on since August, 1895, when the rebuilding of superstructure of south pier and a small section of inner end of north pier superstructure was completed.

The river and harbor act of June 3, 1896, appropriated $5,000 to be applied to dredging the channel. Work under this appropriation has not been commenced for the reason that there is no immediate pressing demand of commerce for which this expenditure will provide, and because the dredging can not be systematically carried on at any place until maps of latest survey have been platted. It is proposed to expend the appropriation for dredging before the close of the present season of 1897.

The river and harbor act above mentioned required a preliminary examination of the "Raisin River from mouth to Government Canal to the wharves," and also required, at the discretion of the Secretary of War, that a survey be made and cost of improvement estimated for "Harbor of Monroe, with a view of obtaining a 14-foot depth of water."

It should be observed that while the preliminary examination is for the "Raisin River" and the survey and estimate is for "Harbor of Monroe," they are both for the same location and the same work.

In compliance with the above requirement of law, a report of preliminary examination of the Raisin River was submitted to the Chief of Engineers December 3, 1896. The conclusion of the report is that "the maintenance of the piers, canal revetment, and light-house involves all the expense which can be justified by the present or probable commerce or business of the place," and this view was concurred in by the Chief of Engineers. The report was printed in House Doc. No. 81, Fifty-fourth Congress, second session. It is also appended hereto.

The report of preliminary examination was adverse to any further extension of the improvement, and it follows that no estimate of the cost of extending the improvement to a depth of 14 feet in the lake has been required. A survey of the channel at the mouth of the river and over the bar into the lake was, however, found to be necessary in order to ascertain, if possible, where the dredging for which an appropriation has been made may be located with a prospect of any benefit to navigation.

The survey of the bar to a depth of 14 feet in the lake was made in November, 1896, but the map has not yet been completed because the assistant engineers in the district have been fully occupied with more pressing and important work.

As the appropriation of $5,000 by act of June 3, 1896, was not based upon any survey, recommendation, or estimate of cost from the office charged with the improvement, the question of locating the part of the channel to be dredged has not been easy to decide. The subject was referred to Mr. William T. Blunt, United States assistant engineer, and his report on the subject is appended hereto. I invite attention especially to the points set forth in Mr. Blunt's report, which are summarized as follows:

First. Soundings in November, 1896, show no perceptible change in the river channel during four years, and no change in the bar at the entrance in more than one year.

Second. During the past eight years several surveys have been made and they all show practically the same depths, except when made immediately after dredging.

Third. Additional depths obtained by dredging in the river in 1888 soon disappeared and the previous conditions returned.

Fourth. The bottom of river at the Monroe docks is of solid rock, with a depth of 8 to 9 feet of water.

Fifth. The channel depth in river and canals is everywhere greater than at the docks, and so remains from year to year.

Sixth. Outside the piers there is an extensive shoal making in from the southward, but by running in and out on a course parallel with outer part of north pier or still further to northward a depth exceeding 9 feet will be found throughout.

In accordance with the recommendations made in Mr. Blunt's report, the channel to be dredged will be "laid out" over the bar for a distance of about 1,800 feet and 150 feet wide, dredging originally to a depth of 13 feet.

As the bar is composed principally of fine sand and is fully exposed to seas from the lake, there is little or no reason to expect that the channel thus dredged will result in any permanent improvement, and therefore no further appropriations for this purpose are recommended.

The revetment of the old canal is in very bad condition, being much decayed, but it is believed that the amount estimated for completion of project, which is the balance not yet appropriated of an estimate for repairs in 1886 and 1891, will be sufficient for all necessities of the immediate future.

The commerce of Monroe Harbor is small, and is almost entirely limited to receipts of telegraph poles, most of which are brought in rafts with tugs of light draft to tow the rafts in the river. During the warm season of summer several small steamers carry passengers to the small resorts near the mouth. These steamers land at the piers and do not generally run to the Monroe wharves.

No commercial statistics for 1896 have been received.

REPORT OF MR. WILLIAM T. BLUNT, UNITED STATES ASSISTANT ENGINEER.

TOLEDO, OHIO, *June 14, 1897.*

SIR: In compliance with your instructions, I beg leave to submit the following notes upon the expenditure of $5,000 for dredging at Monroe, Mich., as appropriated in river and harbor act of June, 1896.

In November, 1896, I made a somewhat extended survey of the channel and entrance to the same out to a depth of 14 feet in the lake. While I have not yet had time to make a finished map of these soundings, a rough plat of them shows no perceptible change anywhere since the entrance survey of June, 1895, and the river survey of October, 1892. In fact every survey I have made since 1888 shows practically the same depths except when made soon after dredging. The additional depths by that dredging, in 1888, soon disappeared. Outside the piers, the contours as far out as that of 13 feet depth, remain almost exactly as found in June, 1895, and the 14-foot contour is 400 feet outside of 13 feet and parallel to it.

In consideration of these facts, I have concluded to make this report without waiting for the platting of the more recent soundings, which may be properly delayed in favor of more urgent work.

The bottom of river at the Monroe docks is of solid rock with a depth of water of 8 to 9 feet.

The depth in river and canals from there to the outer end of piers is everywhere greater than at the docks, and for a good width, remaining so from year to year.

At the immediate mouth of piers the depths are from 10 to 11 feet.

Outside the piers a very extensive shoal makes in from the southward with its peak on line with south pier and 500 feet outside. This top is very flat with contours roughly circular, and a least depth of 8 feet. The 10-foot limit of depth, however, projects into the lake some 1,000 feet from the light-house with a least depth of $9\frac{8}{10}$ feet and hooks abruptly back to the north pier end.

A boat running parallel to the outer (or flaring) section of the north pier and not more than 100 feet southerly therefrom would find nothing less than 9 feet, and probably 9¼ feet. Should he keep a course east by north from the light-house, coming close around the end of north pier, the least depth would be 10 feet, and that only for a distance of 100 feet, as the water deepens rapidly on either side.

I can see no possible reason for dredging in the river, as it has everywhere deeper water than can be used at the docks, which are the only excuse for a channel at all.

If then, this appropriation must be expended for dredging, it should be expended for work outside the pier.

In that case, I suggest that it be all northerly of the line of north revetment produced, so as not to encroach on the extensive bank mentioned above.

A cut 1,800 feet long by 150 feet wide, dredged to a depth of 13 feet, would give approximately 30,000 yards. With the funds available ($4,200) this would allow a price of 14 cents per yard. Under present ruling prices this is a fair figure. The last dredging at Monroe was 1888 and cost 28 cents per yard. I should start the cut 400 feet inside the light-house and extend it to the 12-foot curve in the lake.

* * * * * * *

Very respectfully,

Wm. T. Blunt,
United States Assistant Engineer.

Col. Jared A. Smith,
Corps of Engineers, U. S. A.

The harbor of Monroe is in the collection district of Detroit, Mich. There is a light-house on the outer end of the west pier.

Money statement.

July 1, 1896, balance unexpended	$5,078.19
June 30, 1897, amount expended during fiscal year	96.62
July 1, 1897, balance unexpended	4,981.67
July 1, 1897, outstanding liabilities	15.00
July 1, 1897, balance available	4,966.67
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Amount and date of all appropriations for improving the harbor of Monroe, Mich.

February 24, 1835	$30,000.00	March 3, 1879	$2,000.00
July 2, 1836	15,000.00	June 14, 1880	2,000.00
March 3, 1837	30,000.00	March 3, 1881	1,000.00
July 7, 1838	15,000.00	August 2, 1882	1,000.00
June 11, 1844	20,000.00	August 5, 1886	2,000.00
August 30, 1852	14,000.00	August 11, 1888	5,000.00
June 23, 1866	31,015.27	September 19, 1890	5,000.00
June 10, 1872	10,000.00	July 13, 1892	10,000.00
March 3, 1873	15,000.00	August 17, 1894	5,000.00
June 23, 1874	10,000.00	June 3, 1896	5,000.00
March 3, 1875	10,000.00		
August 14, 1876	5,000.00	Total	245,515.27
June 8, 1878	2,500.00		

L L 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

The channels through Maumee Bay previous to 1866 were very indirect, and in shoalest places the depth did not exceed 8½ feet at mean lake level. A project for deepening the channel by dredging was adopted in 1866 pursuant to the requirements of the river and harbor act of June 23, 1866. The original project was to secure a depth of 12 feet. The plan was amended from time to time until the old channel had been dredged to a depth of 16 feet. In 1892 the midchannel depth in old channel was but 15½ feet, since which time it has not been surveyed.

From 1866 to 1890 nineteen appropriations for old channel were expended, the aggregate being $724,332.61

In 1887 a project for a straight channel 17 feet deep and 200 feet wide on the bottom was adopted in compliance with previous acts of Congress.

Upon the basis of protecting the channel by piers or other type of revetment, the cost was estimated to be $1,875,000.

The project was subsequently modified by increasing the width proposed for outer section of channel, about 3 miles in length, to 300 feet, and by including the dredging of "The Crossing" and "Lake Shore Shoals" in the Maumee River, each about 4,000 feet long, to a depth of 18 feet and width of 400 feet.

Total expenditure upon straight channel in Maumee Bay and channels in Maumee River, 1887 to June 30, 1896, was $735,416.69

The dredging of the straight channel had been practically completed 200 feet wide before the close of the season of 1892, but a large amount of filling was subsequently found to obtain from various causes which have since been made a subject of careful observation. Dredging has been continued not only for the purpose of removing the material filled into the channel, but for increasing its depth to such extent that a shoaling might occur in places, or even throughout, without seriously interfering with navigation.

During the last year the U. S. dredge *Maumee* completed the dredging of channels at "The Crossing" and at the "Lake Shore Shoal," and also dredged at the inner end of straight channel to widen the entrance where the bend made a greater width necessary.

Proposals for widening the outer section of channel to 300 feet were invited by public advertisement dated June 30, 1896. The bids were opened September 2, and a contract was awarded to G. H. Breymann & Bros., of Toledo, Ohio, who were the lowest bidders; the price per cubic yard is 9 cents.

In 1890 a contract for somewhat more than twice the amount was let for dredging the same part of channel at 22 cents per yard. It is probable that several causes have operated to reduce prices of such work, but the fact that a dredge has been built and is being operated by the United States at Toledo Harbor is significant in this connection.

At the end of the fiscal year the widening of 50 feet on north side of channel had been nearly completed, and widening on south side had been commenced. Amount of material removed under this contract to June 30, 1897, 223,000 cubic yards. For a more detailed account of the work of the year, I refer to report of Mr. William T. Blunt, United States assistant engineer, appended hereto.

Mr. Blunt submits a tabulated statement of soundings taken in June, 1897, compared to soundings in same parts of channel in previous years. In the last Annual Report it was shown that the fill in outer part of channel had been very small, and in the last year, over the same part, there has been an actual scour greater than the fill of previous year. Over a distance of more than 2 miles inside of the part where scour is shown the average fill is but one-tenth of a foot, which corresponds very closely with fill of previous year. In middle division the deposit was somewhat more and in the inner division less than in previous year. In the channel dredged at "The Crossing" the fill has been at the rate of 1 foot in four years. These results will doubtless vary somewhat from year to year, and it will require several years' observation to reach definite and reliable conclusions.

At the end of the fiscal year depths exceeded 17 feet in the shoalest places and average depths were about 18 feet.

Expenditures of the fiscal year have been divided as follows:

Dredging under contract in previous year	$7, 516. 37
Repairs to dredge	2, 828. 73
Repairs to tug	1, 184. 94
Repairs to scows	667. 61
Supplies for dredge fleet, fuel, oil, etc	3, 615. 52
Services of crews, dredge fleet	6, 204. 29
Hire of tug	119. 00
Expenses of steamer and crew	2, 532. 20
Purchase of tools and implements	425. 71
Dredging straight channel under contract	9, 844. 30
Contingencies of office and engineering	4, 103. 75
Total expenditures	39, 042. 42
Accounts incurred and unpaid for dredging in straight channel	11, 902. 78

The outer end of the straight channel is 12 miles from the usual convenient boat landings in the city, and the distance to the extreme inner end is 4 miles. It has therefore been necessary to employ a small steamer and crew to lay out the cuts for dredging, make the examinations of channels, and to attend to similar work at other harbors in the district.

The steamer has been hired from year to year, but is now so old as to be unsafe in bad weather, besides lacking in sufficient room and facilities for office work. It is therefore a matter of necessity to obtain a new steamer as soon as practicable.

It is not probable that a suitable steamer can be hired for the purpose, and it will be much better to have one specially built. A suitable steamer can be constructed and completely fitted out with anchors, chains, cordage, lights, and furnishings for a sum estimated not to exceed $27,500. In the last Annual Report the subject was mentioned and the cost of the steamer alone was estimated not to exceed $20,000. More careful figures on the subject obtained from practical shipbuilders placed the actual cost of steamer at $25,000. The furnishings can probably be obtained at a cost not exceeding $2,500.

The steamer is a part of the necessary working plant for properly carrying on the works of improvement in the district, the work in Maumee Bay especially being such as to make the service indispensable. The subject is therefore discussed in this report upon improvement of Toledo Harbor, although applicable in a less degree to all the improvements on Lake Erie west of Pennsylvania.

Arrangements have been completed to obtain designs and specifications for a suitable steamer. It is recommended that the vessel be built as early as practicable, and that the cost be allotted to the various improvements in the district, as nearly as practicable in proportion to amount of service required.

The sundry civil act of June 4, 1897, required "a survey and estimate of cost of deepening and widening the straight channel in Maumee

River and Bay with a view to obtaining and permanently securing a channel of uniform width of 400 feet and 20 feet deep at low water."

Most of the soundings required for the purpose were taken in June, 1897. The work will be completed and a report and estimate submitted as soon as practicable.

Commerce of Toledo Harbor exceeds 2,000,000 tons annually.

Toledo is in the collection district of Miami, Ohio. There are two lights of the sixth order at the mouth of the river forming a range for inner portion of channel. Two towers arranged with three lights to range in both directions are under construction in the part of channel known as "Turnout Section." There is also a light of fourth order on Turtle Island for a guide to old channel.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

TOLEDO, OHIO, *June 30, 1897.*

SIR: I have the honor to submit the following notes upon the work in Toledo Harbor during the fiscal year:

All depths mentioned are given at mean level of Lake Erie, 1860 to 1875, the water during the fall of 1896 having been from 1 to 2 feet below that level, and during this season about at mean level.

STRAIGHT CHANNEL.

Contract, George H. Breymann & Bros.—This contract is for the widening of the channel from cribs to lake (outer division) 50 feet on each side, so as to make the full width 300 feet. Work began October 6, 1896, with one dredge on the northerly bank, and closed for the season November 21. It was resumed on April 23, 1897 with one dredge, a second being put at work May 17, and a third June 2. At the close of the fiscal year there had been removed upward of 223,000 cubic yards. The widening on north side is nearly completed, and two dredges have been transferred to the south side. On account of the wide cut made by each of the two large dredges, the first cut is lapped over onto the old channel, thus removing much of the deposit which has accumulated along its edge. It is found that the small dredge, which can only make the 50 feet by two full cuts, throws up a ridge in the channel which necessitates a third cut for her. Material is disposed of by dumping on the outer face of Cedar Point Bar, 1 mile or more southeast of the channel.

Depths obtained are from 20 to 21 feet.

Dredge Maumee.—The U. S. dredge *Maumee* was employed for part of September and October, 1896, widening the entrance to straight channel at the mouth of the river; about 21,000 cubic yards was removed from the point on the northwest side of channel by one cut 1,800 feet long.

CONDITION OF CHANNEL.

The entire channel was sounded in June, 1897, on cross lines 200 feet apart and extending over each bank at least 100 feet beyond the present proposed widening. These were platted as usual on an enlarged cross scale, and are now on file in your office. I hope to be able this year to file detailed comparisons by sections of 800 feet each, but again I must plead pressure of more important duties which prevented my sparing the large amount of time necessary for the merely mechanical work. These comparisons of individual sections would be a very profitable study, and I hope to accomplish it during the coming year.

The comparative tables I am able to present are on the same basis as those of last year, and in continuation of them. The channel is divided into longitudinal intervals of 10 feet width, numbered from the northerly bank. It is divided into transverse intervals irregularly, principally following the different periods of dredging as most convenient for comparison. The entire length is not shown in the tables, as small portions are influenced by extraneous causes. A portion of the outer division on the north side has been disturbed by dredging since the soundings of 1896, so that the first 50 feet of width can not be compared with the past surveys. Aside from this, there has been no disturbance other than from natural causes.

Over this disturbed area the assumption may be reasonably made, based on the past action of deposits, that the fill would be at most no more than on the corresponding northerly area, i. e., a total of eleven one-hundredths of a foot over the five intervals. This indicates an average annual fill of five one-hundredths of a foot, but making due allowance for error in the assumption, I feel safe in allowing ten one-hundredths of a foot as the average annual fill during 1896–97 over the sections 4 to 17.

Outer division.

[Sections 18 to 21; length, 3,300 feet at outer end of channel; last dredged in spring of 1894.]

	Average depth.		Average fill.	
	June, 1896.	June, 1897.	Feet.	Cubic yards.
Ten-foot intervals from north bank:				
First	17.4	18.3	—0.9	— 1,080
Second	18.3	18.9	— .6	— 720
Third	18.6	19.1	— .5	— 600
Fourth	18.8	19.3	— .5	— 600
Fifth	18.8	19.5	— .7	— 840
Sixth	19	19.4	— .4	— 480
Seventh	19.2	19.5	— .3	— 360
Eighth	19.2	19.7	— .5	— 600
Ninth	19.2	19.7	— .5	— 600
Tenth	19.2	19.7	— .5	— 600
Eleventh	19.2	19.7	— .5	— 600
Twelfth	19.2	19.6	— .4	— 480
Thirteenth	19.1	19.5	— .4	— 480
Fourteenth	19	19.4	— .4	— 480
Fifteenth	18.8	19.3	— .5	— 600
Sixteenth	18.7	19.1	— .4	— 480
Seventeenth	18.6	18.9	— .3	— 360
Eighteenth	18.5	18.7	— .2	— 240
Nineteenth	18.4	18.6	— .2	— 240
Twentieth	18.2	18.2	— .0	....
Total fill June, 1896, to June, 1897, twelve months, indicating an average annual scour of 0.44 feet				—10,440

[Sections 4 to 17; length, 11,200 feet; from cribs outward through bar; last dredged in 1893.]

	Average depth.		Average fill.	
	June, 1896.	June, 1897.	Feet.	Cubic yards.
Ten-foot intervals from north bank:				
First	16.2	(a)		
Second	16.6	(a)		
Third	16.8	(a)	0.11	....
Fourth	17	(a)		
Fifth	17.2	(a)		
Sixth	17.6	17.3	+.3	+1,245
Seventh	17.9	17.8	+.1	+ 415
Eighth	18.2	18.3	—.1	— 415
Ninth	18.3	18.5	—.2	— 830
Tenth	18.4	18.6	—.2	— 830
Eleventh	18.4	18.7	—.3	—1,245
Twelfth	18.4	18.7	—.3	—1,245
Thirteenth	18.1	18.4	—.3	—1,245
Fourteenth	17.7	17.9	—.2	— 830
Fifteenth	17.3	17.4	—.1	— 415
Sixteenth	17	17	+.0	....
Seventeenth	16.7	16.6	+.1	+ 415
Eighteenth	16.4	16.2	+.2	+ 830
Nineteenth	16.2	15.9	+.3	+1,245
Twentieth	15.9	15.4	+.5	+2,075

a Disturbed by dredging between surveys.

Assuming fill over first five intervals to be double that over the last five, there is indicated an average annual fill of +0.10.

Middle division.

[Sections 3 to 14; length, 9,600 feet; from Cribs half way in to river; last dredged in 1894.]

	Average depth.		Average fill.	
	June, 1896.	June, 1897.	Feet.	Cubic yards.
Ten-foot intervals from north bank:				
First	17.6	16.8	+.8	+2,848
Second	18.1	17.3	+.8	+2,848
Third	18.3	17.5	+.8	+2,848
Fourth	18.7	17.8	+.9	+3,204
Fifth	18.8	17.9	+.9	+3,204
Sixth	18.3	17.8	+.5	+1,780
Seventh	18	17.8	+.2	+ 712
Eighth	18	18	+.0	
Ninth	17.9	18	—.1	— 356
Tenth	17.8	18.1	—.3	—1,068
Eleventh	17.9	18.2	—.3	—1,068
Twelfth	18	18.2	—.2	— 712
Thirteenth	18.2	18.1	+.1	+ 356
Fourteenth	18.1	17.9	+.2	— 712
Fifteenth	18.2	17.8	+.4	+1,424
Sixteenth	18.7	17.9	+.8	+2,848
Seventeenth	18.7	17.8	+.9	+3,204
Eighteenth	18.5	17.6	+.9	+3,204
Nineteenth	18.3	17.6	+.7	+2,492
Twentieth	18.1	17.2	+.9	+3,204
Total fill, June, 1896, to June, 1897, twelve months, indicating an average annual fill of 0.45 foot				+31,684

Inner division.

[Sections 1 to 6; length, 4,800 feet from middle division inward; last dredged in 1894.]

	Average depth.		Average fill.	
	June, 1896.	June, 1897.	Feet.	Cubic yards.
Ten-foot intervals from north bank:				
First	17.2	16.4	+0.8	+1,424
Second	18.5	17.5	+1.0	+1,780
Third	18.8	17.7	+1.1	+1,958
Fourth	18.8	17.8	+1.0	+1,780
Fifth	18.8	17.8	+1.0	+1,780
Sixth	18.4	17.9	+ .5	+ 890
Seventh	18	18	+ .0	....
Eighth	17.7	18	— .3	— 534
Ninth	17.6	18	— .4	— 712
Tenth	17.4	18.1	— .7	—1,246
Eleventh	17.6	18.1	— .5	— 890
Twelfth	17.9	18.2	— .3	— 534
Thirteenth	18	18.3	— .3	— 534
Fourteenth	18	18.2	— .2	— 356
Fifteenth	18.1	18	+ .1	+ 178
Sixteenth	18.5	18.1	+ .4	+ 712
Seventeenth	18.6	18.1	+ .5	+ 890
Eighteenth	18.6	18.1	+ .5	+ 890
Nineteenth	18.4	17.8	+ .6	+1,068
Twentieth	17.6	17.2	+ .4	+ 712
Total fill, June, 1896, to June, 1897, twelve months, indicating an average annual fill of + 0.26 foot				+9,256

Inner division—Continued.

[Sections 8 to 13; length, 4,800 feet; at inner end of channel; last dredged in 1895.]

	Average depth.		Average fill.	
	June, 1896.	June, 1897.	Feet.	Cubic yards.
Ten-foot intervals from north bank:				
First	18.8	18	+0.8	+1,424
Second	19.2	18.2	+1	+1,780
Third	19.2	18.2	+1	+1,780
Fourth	18.5	17.7	+ .8	+1,424
Fifth	17.9	17.6	+ .3	+ 534
Sixth	18	17.9	+ .1	+ 178
Seventh	18.2	18.4	— .2	— 356
Eighth	18.6	18.8	— .2	— 356
Ninth	18.8	19	— .2	— 356
Tenth	18.8	19.1	— .3	— 534
Eleventh	18.7	19.2	— .5	— 890
Twelfth	18.7	19.1	— .4	— 712
Thirteenth	18.6	18.8	— .2	— 356
Fourteenth	18.2	18.3	— .1	— 178
Fifteenth	17.9	17.7	+ .2	+ 356
Sixteenth	17.4	17.2	+ .2	+ 356
Seventeenth	17.6	17.4	+ .2	+ 356
Eighteenth	18.4	17.9	+ .5	+ 890
Nineteenth	18.7	18	+ .7	+1,246
Twentieth	18.8	17.9	+ .9	+1,602
Total fill, June, 1896, to June, 1897, twelve months, indicating an average annual fill of + 0.23 foot				+8,188

Summary of indicated average annual deposits.

[See also report of June 30, 1896.]

	Outer division.		Middle division.	Inner division.	
	Sections 18–21.	Sections 4–17.		Sections 1–6.	Sections 8–13.
First year after dredging	....	} 0.82	{0.85} 0.82	0.32	{0.71} 0.54
Second year after dredging	0.82		{....}		{ .23}
Third year after dredging	.44	.09	.45	.26	.....}
Fourth year after dredging	....	.10	....	....	} .20
Fifth year after dredging	....	....	....	....	

In considering these tables, the first point of note is that for the first time in its history, a marked resultant scour took place over a large section of channel and throughout its entire width. This scour is so marked in the portion of channel from 18 to 21 outer division, that the probability is strong of actual resultant scour having extended into the next portion also. In fact, the resultant deposit in this adjoining portion (3 to 17) is so small even upon the liberal allowance mentioned above that it would not be surprising if the scour actually extended throughout this portion also. The exact division can only be determined by comparing individual sections.

Throughout the outer and inner divisions, a marked scour appears along the middle portions while in the middle division the scour is slight and the fill along the sides quite marked. These conditions were reversed in 1895–96, there having then been little scour in outer and inner divisions and considerable in the middle division.

The annual rate of fill for middle division has increased over that of last year while that for inner division has diminished.

I have discovered no cause for these fluctuations in rates of deposit, but further study will be made upon completion of detailed table.

MAUMEE RIVER, LOWER CROSSING.

Work was resumed on this channel early in June, 1897, nothing having been done since 1894. At the close of the fiscal year the United States dredge *Maumee* was working on the last cut to accomplish the full width of 400 feet. Complete soundings were taken in May, 1897, and the table following shows comparisons between soundings of four consecutive years uninfluenced by dredging. While the deposit during the first year after dredging was but two one-hundredths of a foot, and during the second year but ten one-hundredths of a foot, there has in the third year been a decided fill of forty-one one-hundredths of a foot heavier on west side than on east. Depths, are, however, ample for all purposes.

Maumee River, Lower Crossing.

[From line 200 to line 3,200—length, 3,000 feet; dredged in 1894.]

AVERAGE DEPTH.

	August and October, 1894.	May, 1895.	May, 1896.	May, 1897.
Twenty-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	19.9	20	19.6	18.3
Second	20.1	20.2	20.1	18.9
Third	19.7	19.5	19.8	18.9
Fourth	19.7	19.8	19.7	19
Fifth	19.9	19.9	19.7	19.3
Sixth	19.9	19.9	19.7	19.5
Seventh	20.2	20.1	19.9	19.7
Eighth	20.2	20	20.1	19.9
Ninth	19.9	20.1	20	19.9
Tenth	20.2	20	19.9	19.6
Eleventh	(a)	19.3	19.4	19.4
Twelfth	(a)	19.2	19	19.2
Thirteenth	(a)	19.4	19.2	19.1
Fourteenth	(a)	19.4	19.2	19.1
Fifteenth	(a)	19.4	19.4	18.8

a Dredged at this time for only 200-foot width.

AVERAGE FILL.

	1894 to 1895 (8 months).	1895 to 1896 (12 months).	1896 to 1897 (12 months).	1895 to 1897 (24 months).		1894 to 1897 (32 months).	
				Feet.	Yards.	Feet.	Yards.
Twenty-foot intervals from west bank:							
First	—.1	+.4	1.3	1.7	3,774	1.6	3,552
Second	—.1	+.1	1.2	1.3	2,886	1.2	2,664
Third	+.2	—.3	.9	.6	1,332	.8	1,776
Fourth	—.1	+.1	.7	.8	1,776	.7	1,554
Fifth	+.0	+.2	.4	.6	1,332	.6	1,332
Sixth	+.0	+.2	.2	.4	888	.4	888
Seventh	+.1	+.2	.2	.4	888	.5	1,110
Eighth	+.2	—.1	.2	.1	222	.3	666
Ninth	—.2	+.1	.1	.2	444	.0	0
Tenth	+.2	+.1	.3	.4	888	.6	1,332
Eleventh	....	—.1	.0	.1	—222	....	....
Twelfth	....	+.2	—.2	.0	0	....	....
Thirteenth	....	+.2	.1	.3	666	....	....
Fourteenth	....	+.2	.1	.3	666	....	....
Fifteenth	....	+.0	.6	.6	1,332	....	....
Averages and totals	.02	.10	.41	.51	16,872	....	....
Indicated average annual rates	.03	.10	.41	.26	8,436	....	....

MAUMEE RIVER, LAKE SHORE SHOAL.

The dredging of this channel was completed August 13, 1896, to full width of 400 feet, by the removal of about 193,000 cubic yards of material. Depth of dredging was 19 to 20 feet, and soundings taken in May, 1897, show them to still hold well.

Very respectfully,

Wm. T. Blunt,
United States Assistant Engineer.

Col. Jared A. Smith,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1896, balance unexpended		$162,450.70
June 30, 1897, amount expended during fiscal year		39,042.42
July 1, 1897, balance unexpended		123,408.28
July 1, 1897, outstanding liabilities	$11,902.78	
July 1, 1897, amount covered by uncompleted contracts	62,550.80	
		74,453.58
July 1, 1897, balance available		48,954.70
Amount (estimated) required for completion of existing project		980,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Toledo Harbor, Ohio.

Appropriations have been made for old channels as follows:

June 23, 1866	$20,000.00
March 2, 1867	20,000.00
April 10, 1869	29,700.00
July 11, 1870	50,000.00
March 3, 1871	50,000.00
June 10, 1872	15,000.00
March 3, 1873	100,000.00
June 23, 1874	75,000.00
March 3, 1875	75,000.00
August 14, 1876	60,000.00
June 18, 1878	50,000.00
March 3, 1879	$20,000.00
June 14, 1880	30,000.00
March 3, 1881	40,000.00
August 2, 1882	50,000.00
July 5, 1884	20,000.00
August 5, 1886 (see note)	9,632.61
August 11, 1888	5,000.00
September 19, 1890	5,000.00
Total for old channel	724,332.61

Appropriations have been made for straight channel as follows:

July 5, 1884		$25,000.00
Deduct amount appropriated for old channel (see note)		9,632.61
Balance		15,367.39
August 5, 1886		112,500.00
August 11, 1888		150,000.00
September 19, 1890		200,000.00
July 13, 1892		200,000.00
August 17, 1894		70,000.00
June 3, 1896		150,000.00
Total for straight channel		897,867.39
Total of all appropriations for Toledo Harbor	$1,622,200.00	
Total expended to June 30, 1897	1,498,791.72	
		123,408.28
Total on straight channel to June 30, 1897		774,459.11

NOTE.—By act of August 5, 1886, the balance then available of the $25,000 appropriated July 5, 1884, for straight channel was made available for clearing the old channel.

Abstract of proposals for dredging in straight channel through Maumee Bay, Toledo Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Wednesday, September 2, 1896, at 2 o'clock p. m., standard time, in accordance with advertisement dated June 30, 1896.

[Amount available for the work, not exceeding $80,000.]

No.	Name and address of bidder.	For all the dredging called for.	Total bid.
1	Michael Sullivan, Detroit, Mich	$0.098	$80,000
2	Wm. J. Daley, Ogdensburg, N. Y	.10	80,000
3	G. H. Breymann & Bros., Toledo, Ohio *a*	.09	80,000
4	The L. P. & J. A. Smith Co., Cleveland, Ohio	.14	80,000
5	W. A. McGillis & Co., Cleveland, Ohio	$.11\frac{3}{8}$	80,000
6	R. J. Cram, Detroit, Mich	.18	80,000
7	John Stang, Lorain, Ohio	.16	80,000
8	Carkin, Stickney & Cram, Detroit, Mich	$.14\frac{3}{4}$	80,000
9	James Rooney, Toledo, Ohio	.10	80,000

a Lowest bid.

Recommended that the contract be awarded to G. H. Breymann & Bros., of Toledo, Ohio, at the rate named in their proposal, their bid being the lowest received and considered reasonable.

CONTRACT FOR IMPROVING HARBOR AT TOLEDO, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Contract for dredging in straight channel through Maumee Bay.

Name of contractor.	Date of contract.	Date of approval.	Date of commencement.	Date of completion.
G. H. Breymann & Bros., Toledo, Ohio	Sept. 18, 1896	Oct. 3, 1896	Oct. 6, 1896	June 30, 1898

COMMERCIAL STATISTICS.

The following statistics for the year 1896, relative to the commerce of the harbor of Toledo, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	314, 000	Coal	706, 500
Coal	118, 642	Corn	84, 000
Lumber	165, 000	Wheat	90, 060
Sand and gravel	230, 000	Flour	106, 068
Wheat	59, 205	Timber	19, 957
Logs	53, 400	Rye	15, 372
Sugar	22, 323	Oats	576
Salt	16, 818	Merchandise	82, 364
Plaster and cement	10, 867		
Lath	9, 750		
Shingles	2, 048		
Cedar posts	1, 500		
Fruit	1, 100		
Fish	1, 500		
Rye	252		
Merchandise	43, 486		
Total	1, 049, 891	Total	104, 837

Total freight tonnage:

1896	2, 154, 728
1895	2, 037, 500
Increase	117, 228

Vessels.	Number.	Tonnage.
Entering	2, 379	1, 121, 964
Departing	2, 381	1, 130, 430
Built	3	3, 790. 81

Total registered tonnage:

1896	2, 252, 394
1895	1, 806, 673
Increase	445, 721

Draft of largest vessels using harbor, 16 feet.

Largest vessels do not load to full depth.

New line of transportation established was the C. & B. and D. & C. line nightly to Cleveland, and daily to Put in Bay.

L L 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

The river and harbor acts of 1867 and 1870 required examinations or surveys of this harbor with reference to its improvement. The depth over the bar into the lake did not exceed 5 feet, and the available depth inside did not exceed 7 feet.

Under the appropriation of $8,000 by act of July 10, 1872, and an allotment of $2,000 from the same appropriation, the channel was dredged to a depth of 8 feet.

In 1875 a plan was adopted to protect the channel over the bar by a very simple construction of piles and sheet piling with pierheads of timber crib work upon pile foundations filled with stone; a length of 720 feet of the outer end of west pier is of such work, 14 feet in width. Total estimated cost, $90,000.

The piers were completed as far as was considered necessary in 1883. Since that date the piers and pile revetment have been reenforced with a riprap of stone on each side, and the channel has been dredged so as to afford an available depth not less than 10 feet, 100 feet wide in the piers, and 200 feet wide in the harbor proper.

In compliance with requirement of the act of July 13, 1892, the sum of $1,200 was paid for the purchase of a part of the long sand point from which the west pier starts. All other expenditures to June 30, 1896, were for construction and maintenance of the piers and for dredging. The depth of 10 feet has been maintained thus far without further dredging.

Total expenditures to June 30, 1896	$75,629.69
Expenditures in last fiscal year	216.73
Total to June 30, 1897	75,846.42

The expenditures of the last year have been for necessary contingencies and for construction of a substantial fence of wood and wire on the boundary line of the land purchased.

The reason for the delay in expenditure of the amount of $6,000 appropriated by act of August 17, 1894, was fully set forth in last annual report (Report of Chief of Engineers, 1896, page 2926).

The woodwork of the revetment and piers above water is now far advanced in decay. It has been decided that the best method to make substantial repairs, as well as the least expensive, is to pile a riprap of stone against the old woodwork on each side and thus form a solid foundation on which a stone superstructure may be placed when the riprap has fully settled. The work will be inexpensive, because the sheltered position of the harbor requires a work of but small dimensions.

Under date of April 5, 1897, proposals were invited for reenforcing the jetties on the method above described, as far as may be done with available funds. The bids were opened on the 7th of May, 1897, and the contract was awarded to Mr. John Stang, of Lorain, Ohio, who was the lowest bidder.

The contract requires that the work shall be completed on or before November 30, 1897. The contractor has not yet commenced the work, but promises to push it rapidly as soon as he completes the work on stone jetty at Cedar Point for improving Sandusky Harbor, Ohio, upon which he is now engaged.

During the last year the light at Port Clinton Harbor, which had been discontinued for many years, has been reestablished by the completion of a substantial wooden beacon, surmounted by a lantern with a lens of the sixth order showing a red light, near the outer end of west pier. The new light was first shown July 15, 1896.

The harbor of Port Clinton is used by a fleet of tugs and small vessels engaged in fishing. A passenger steamer runs regularly from Port Clinton to Put in Bay during the season when the lake is free from ice.

The commerce of Port Clinton is small.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest light is the one recently established on outer end of west pier.

Money statement.

July 1, 1896, balance unexpended		$12,370.31
June 30, 1897, amount expended during fiscal year		216.73
July 1, 1897, balance unexpended		12,153.58
July 1, 1897, outstanding liabilities	$31.50	
July 1, 1897, amount covered by uncompleted contracts	10,000.00	
		10,031.50
July 1, 1897, balance available		2,122.08
Amount (estimated) required for completion of existing project		15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

List of appropriations for improving harbor of Port Clinton, Ohio.

July 10, 1872	$8,000.00
July 10, 1872 (allotment)	2,000.00
March 3, 1875	5,000.00
August 14, 1876	5,000.00
June 18, 1878	10,000.00
March 3, 1879	10,000.00
June 14, 1880	5,000.00
March 3, 1881	5,000.00
August 2, 1882	6,000.00
August 5, 1886	2,000.00
August 11, 1888	5,000.00
September 19, 1890	$3,000.00
July 13, 1892	10,000.00
August 17, 1894	6,000.00
June 3, 1896	6,000.00
Total	88,000.00
Expended to June 30, 1897	75,846.42
Balance unexpended July 1, 1897	12,153.58

Abstract of proposals for reinforcing, with stone, the jetties at entrance to Port Clinton Harbor, Ohio, received and opened by Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, May 7, 1897, at 2 o'clock p. m., standard time, in accordance with advertisement dated April 5, 1897.

[The amount available for the purpose is about $10,000.]

No.	Name and address of bidder.	Paving stone, 600 tons.		Slope stone, 2,200 tons.		Core stone, 4,400 tons.		Total of bid.
		Price bid.	Amount.	Price bid.	Amount.	Price bid.	Amount.	
1	The L. P. & J. A. Smith Co., Cleveland, Ohio	$3.00	$1,800.00	$1.00	$2,200.00	$1.00	$4,400.00	$8,400.00
2	The P. & T. Degnan Sand Dredging and Lighterage Co., Toledo, Ohio	3.87	2,322.00	1.57	3,454.00	.93	4,092.00	9,868.00
3	F. L. Roth, Port Clinton, Ohio *a*	2.44	1,464.00	1.75	3,850.00	.75	3,300.00	8,614.00
4	John Stang, Lorain, Ohio *b*	1.30	780.00	1.30	2,860.00	.75	3,300.00	6,940.00

a Bid very informal. A single copy of this proposal was received.
b Lowest bid received.

The proposal of Mr. John Stang, of Lorain, Ohio, being the lowest received, is recommended for acceptance.

CONTRACT FOR IMPROVING HARBOR OF PORT CLINTON, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Contract for reinforcing, with stone, the jetties at entrance to Port Clinton Harbor, Ohio.

Name of contractor.	Date of contract.	Dale of approval.	Date of commencement.	Date of completion.
John Strang, Lorain, Ohio	June 30, 1897	Not yet approved.	No date named..	Nov. 30, 1897

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Port Clinton, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.
Lumber and wood	3,152
Miscellaneous	123
Total	3,275

Total freight tonnage:	
1896	3,257
1895	6,641
Decrease	3,384

NOTE.—The above are receipts from outside of the district only. Statistics inside the district are not reported.

Vessels—	Number.	Tonnage.
Entering	29	2,245
Departing	29	1,701

Total registered tonnage:	
1896	3,946
1895	4,814
Decrease	868

Draft of largest vessels using harbor, 12 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

L L 4.

IMPROVEMENT OF SANDUSKY HARBOR, OHIO.

The harbor of Sandusky is in the lower part of Sandusky Bay, the water of which is generally 8 to 12 feet deep. The mouth of the bay between Cedar Point, on the southeast, and another sandy point on the northwest, is about $1\frac{1}{2}$ miles wide and is obstructed by a sand bar across most of the distance. Next to Cedar Point, however, there is a channel, where the depth exceeding 18 feet is about 400 feet wide and one mile long; this channel is known as the "Deep Hole," and its greatest depth is 40 feet.

Improvements were first commenced under the appropriation of June 11, 1844. Until 1888 the improvements consisted in dredging the deepest natural channels from the lake to and along the city front.

From 1888 to 1894, a straight channel was dredged 200 feet wide, 17 feet deep, and 1¾ miles in length, from east end of dock channel to the "Deep Hole." In 1894 the other channels were in bad condition and vessels with more than 13 feet draft found much difficulty in reaching the wharves.

The river and harbor act of August 17, 1894, required a survey and estimate of cost of further necessary improvements. The report and estimate of cost were published in House Ex. Doc. No. 91, Fifty-third Congress, third session, and also in Report of Chief of Engineers, 1895. See map opposite page 2930, Report of Chief of Engineers, 1896. The project includes dredging the inside channels 200 feet wide and 17 feet deep, and dredging over the bar 300 feet wide and 18 feet deep; it also includes the construction of a jetty from Cedar Point 2,500 feet long and a dike of the same length on the opposite side of the channel.

The entire appropriation of $30,000 by act of August 17, 1894, has been expended in dredging and necessary contingent expenses.

Total expended 1844 to June 30, 1896, $430,890.90.

At the end of last fiscal year a channel of 17 feet in depth and 60 to 100 feet in width had been excavated along the city front, and the outer bar had been so much improved as to give a narrow channel exceeding 16 feet in depth. Of the $40,000 appropriated June 3, 1896, $15,000 has been allotted for dredging, and $25,000 for constructing jetty from Cedar Point.

Under date of June 30, 1896, proposals were invited by public advertisement for dredging and for construction of jetty. Proposals were opened August 7, 1896, and contracts were awarded to the lowest bidders.

Dredging under the contract was carried on from September 7 to November 30, 1896, and from April 17 to June 30, 1897.

Amount of material removed to June 30, 1897:

Upper end of dock channel, 33,140 cubic yards, at 17 cents	$5,633.80
Lower end dock channel and straight channel, 36,148 cubic yards, at 9¾ cents	3,524.43
Outer bar, 28,664 cubic yards, at 14 cents	4,012.96

One hundred and fifty-three bowlders too large to be removed from the channel by dredging have been broken up by blasting.

Work on construction of jetty was carried on from September 22 to November 25, 1896, and from May 1 to June 30, 1897.

Amount accomplished on jetty is itemized as follows:

3,414.8 square yards brush mattress, at 29 cents	$990.29
5,771.59 tons stone, at $1.09	6,291.03
5 piles, at $11	55.00

Expenditures do not cover entire amount of work done nor retained percentages.

At the close of the fiscal year the channels were in better condition than ever before known. While the channel over the outer bar is still narrow, vessels drawing 17 feet of water have no difficulty in reaching the wharves when the lake is at mean level.

The jetty is a substantial work of stone upon mattresses of brush. The top and slopes are of very heavy pieces of hard limestone. The top is 10 feet wide, and the slopes such as are most readily formed with the stone, about 1 on 1. A length of 800 feet from the shore has been completed. It is expected that this jetty, when completed, will prevent the spreading of the current to the southeast as it flows from the bay in heavy westerly gales, and will thus result in extending and maintaining a much deeper channel across the outer bar. The length thus far completed is not sufficient to show any practical results.

Work of dredging under the contract will be completed in July. Work of jetty construction will be completed, as far as may be done with available funds, before the close of the season.

The freight tonnage in Sandusky harbor in 1896 was nearly one and a half millions of tons, which was a very large increase over that of the previous year. While the actual freight was much greater than in the previous year, the registered tonnage of the vessels carrying the freight was much less. This apparent discrepancy may be partly due to incorrect returns, but it suggests that with deeper channels the actual freights are greater than the registered tonnage of the carrying vessels, but when the vessels can not fully load the registered tonnage is greater than actual freight.

The large increase in freights has only been made possible by the improved channels leading to the city front.

The river and harbor act of June 3, 1896, required "a survey to be made of the bar at the mouth of the harbor and the cost of improvement to be estimated, with a view to securing and maintaining a permanent channel of sufficient depth next to Cedar Point." The survey for this purpose was made in November, 1896, but the platting of the map has not been completed. The map will be completed as soon as it can be done by an assistant engineer, whose time is very fully occupied with the necessary supervision of several works of improvement.

The work of the fiscal year improving Sandusky Harbor is more fully detailed in the appended report of Mr. William T. Blunt. Mr. Blunt's report also presents comparative tables, showing depths in straight channel during four consecutive years. Midchannel depths now exceed 17 feet throughout the entire channel. Over nearly the entire length the mid-channel depth has increased and the fill has been at the side. During the last year the average depth of channel has slightly increased from natural causes.

Sandusky Harbor is in the collection district of Sandusky, Ohio. There is a light-house upon Cedar Point, with a beacon to mark the range over outer bar, and there is a range of two lights to mark the straight channel.

The construction of two beacons for a range to mark the new channel over the bar is now under contract by the light-house establishment.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER

TOLEDO, OHIO, *June 30, 1897.*

SIR: I have the honor to submit the following notes upon the condition of Sandusky Harbor:

All depths mentioned are given at mean level of Lake Erie, 1860–1875.

Dredging under contract with the Carkin & Stickney Company began September 7, 1895, and on account of the small amount available the work was divided among the localities where most needed in the way of redredging rather than in enlarging. On the outer bar three cuts were made for the entire length from "Deephole" to Lake, removing upward of 28,000 yards and leaving a channel 150 to 180 feet wide. On straight channel, at its junction with the "Deephole," a strong tendency seems to exist to close up the mouth of the channel by deposit of sand on each side. This deposit was being removed at the end of the fiscal year so as to leave a full, free entrance for full width. At the junction of straight channel and dock channel the corner was removed to a straight line, joining points 400 feet each way from the angle, thus giving decided relief to boats making this turn. About 20,000 yards was taken from this locality.

On the old dock channel the work of widening at the upper end was continued to a small extent. The short line extension was widened and redredged to the extent of 33,000 yards, and a large number of bowlders were removed or broken up by blasting.

Under contract with John Stang the jetty from Cedar Point outward was completed for a length of 600 feet and 250 feet additional partly finished.

COMPARATIVE SOUNDINGS IN STRAIGHT CHANNEL.

The first dredging of the channel was completed in 1894, that is, the entire area had then been dredged and channel opened up for full width of 200 feet. Since then no dredging has been done, except that the dock channel and elbow dredging overlapped into the straight channel, and that the outer end has been opened up for a length of about 1,000 feet through the middle. Comparisons can therefore be made between the different sets of soundings of 1894, 1895, 1896, and 1897, uninfluenced by dredging, except in sections 1 and 12. These comparisons are made in the tables following. The channel is for this purpose divided into longitudinal intervals of 10 feet width, numbered from the westerly bank. In each of these intervals the average depth is shown for a length of channel 800 feet, named a section and numbered from the outer end. From these the average fill (or scour indicated by minus signs), during the period between surveys, is obtained, and reduced to an average annual rate of deposit for that period in each section.

Section 1.

	Average depth.				Average fill.		
	June, 1894.	June, 1895.	June, 1896.	May, 1897.	1894–95.	1895–96.	1896–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	15.5	15.1	15.3	16.2	0.4	—0.2	—0.9
Second	16	15.4	15.5	16.6	.6	— .1	—1.1
Third	16.2	15.8	15.7	16.9	.4	.1	—1.2
Fourth	16.6	16.1	15.7	17	.5	.4	—1.3
Fifth	16.7	16.3	16.1	17.4	.4	.2	—1.3
Sixth	16.9	16.5	16.8	17.7	.4	— .3	— .9
Seventh	16.8	16.3	17.4	17.4	.5	—1.1	.0
Eighth	16.5	16.4	17.8	17.9	.1	(a)	— .1
Ninth	16.4	16.5	18	18.5	— .1	(a)	— .5
Tenth	16.6	16.6	18.4	19	.0	(a)	— .6
Eleventh	16.6	16.8	18.6	19.5	— .2	(a)	— .9
Twelfth	16.6	16.8	18.9	19.6	— .2	(a)	— .7
Thirteenth	16.7	16.8	18.9	19.3	— .1	(a)	— .4
Fourteenth	16.8	16.8	18.8	18.3	.0	—2	.5
Fifteenth	16.9	16.6	17.7	18	.3	—1.1	— .3
Sixteenth	16.6	16.5	17.1	17.4	.1	— .6	— .3
Seventeenth	16.5	16.3	16.5	17.1	.2	— .2	— .6
Eighteenth	16.4	16	15.9	16.8	.4	.1	— .9
Nineteenth	15.8	15.7	15.9	16.3	.1	— .2	— .4
Twentieth	15	15.1	15.3	15.7	— .1	— .2	— .4
Average fill in section					.18	....	— .62
Average annual deposit					.18	....	— .67

a Dredged in November, 1895.

Section 2.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	June, 1896.	May, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	14.4	13.7	13.7	13.8	0.7	0.0	— .1	.6
Second	15.4	14.6	13.9	14.1	.8	.7	— .2	1.3
Third	15.8	15.4	14.2	14.7	.4	1.2	— .5	1.1
Fourth	15.8	15.8	14.7	15.1	.0	1.1	— .4	.7
Fifth	16.2	16.5	15.4	15.5	— .3	1.1	— .1	.7
Sixth	16.6	17.4	16.2	16.3	— .8	1.2	— .1	.3
Seventh	17.3	17.8	16.6	17	— .5	1.2	— .4	.3
Eighth	17.8	18.1	17	17.4	— .3	1.1	— .4	.4
Ninth	19.4	18.2	17.8	18.3	1.2	.4	— .5	1.1
Tenth	19.6	18.1	18	18.4	1.5	.1	— .4	1.2
Eleventh	18.4	18.1	18.1	18.3	.3	.0	— .2	.1
Twelfth	16.9	18	18.3	18.5	—1.1	— .3	— .2	—1.6
Thirteenth	17.2	18	18.3	19	— .8	— .3	— .7	—1.8
Fourteenth	17.4	17.7	18.2	18.5	— .3	— .5	— .3	—1.1
Fifteenth	17.5	17.8	18.2	18.2	— .3	— .4	.0	— .7
Sixteenth	17.6	17.7	18.2	17.9	— .1	— .5	.3	— .3
Seventeenth	17.3	17.5	17.8	17.7	— .2	— .3	.1	— .4
Eighteenth	17.1	17.3	17.6	17.4	— .2	— .3	.2	— .3
Nineteenth	16.7	16.9	17.4	16.8	— .2	— .5	.6	— .1
Twentieth	15.6	16.4	16.7	16.5	— .8	— .3	.2	— .9
Average fill in section					— .05	.24	— .16	.03
Average annual deposit					— .07	.22	— .17	.01

Section 3.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	16.1	15.9	14.1	14	0.2	1.8	0.1	2.1
Second	16.6	16.4	15.2	15	.2	1.2	.2	1.6
Third	16.1	16.5	15.8	15.7	—.4	.7	.1	.4
Fourth	15.7	17.3	16.3	16.4	—1.6	1	—.1	—.7
Fifth	17.4	18.2	17.1	16.8	—.3	1.1	.3	.6
Sixth	18.6	18.3	17.4	17.4	.3	.9	.0	1.2
Seventh	19.3	18.6	17.9	17.9	.7	.7	.0	1.4
Eighth	19.2	18.8	18.6	18.5	.4	.2	.1	.7
Ninth	18.4	18.7	19	18.2	—.3	—.3	.8	.2
Tenth	17.4	18.4	19.2	19.1	—1	—.8	.1	—1.7
Eleventh	17.5	18.3	19.4	19.4	—.8	—1.1	.0	—1.9
Twelfth	18.2	18.8	19.1	19.9	—.6	—.3	—.8	—1.7
Thirteenth	18.4	18.7	19	20	—.3	—.3	—1	—1.6
Fourteenth	18.5	18.4	18.8	19.6	.1	—.4	—.8	—1.1
Fifteenth	18.1	18	18.3	18.8	.1	—.3	—.5	—.7
Sixteenth	17.9	18	18.2	18.2	—.1	—.2	.0	—.3
Seventeenth	17.8	18	18.4	18.2	—.2	—.4	.2	—.4
Eighteenth	17.4	17.8	18	18.3	—.4	—.2	—.3	—.9
Nineteenth	17.2	17.5	18	18.2	—.3	—.5	—.2	—1
Twentieth	16.8	17.4	17.6	17.9	—.6	—.2	—.3	—1.1
Average fill in section					—.27	.13	—.10	—.24
Average annual deposit					—.36	.12	—.10	—.09

Section 4.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	17.4	16.9	14.8	14.4	0.5	2.1	0.4	3
Second	17.8	17.6	16	15.7	.2	1.6	1.1	2.9
Third	17.8	17.5	16.8	16.8	.3	.7	.0	1
Fourth	17.7	17.2	17.6	17.6	.5	—.4	.0	.1
Fifth	17	17.2	17.8	18.2	—.2	—.6	—.4	—1.2
Sixth	17.6	18.7	18.3	18.6	—1.1	.4	—.3	—1
Seventh	19.2	19	18.6	18.8	.2	.4	—.2	.4
Eighth	19.3	19	19	19.2	.3	.0	—.2	.1
Ninth	18.9	19	19.1	19.1	—.1	—.1	.0	—.2
Tenth	17.4	18.6	19.3	19.5	—1.2	—.7	—.2	—2.1
Eleventh	16.6	17.4	18.9	19.3	—.8	—1.5	—.4	—2.7
Twelfth	16.9	17.7	18.7	19.4	—.8	—1	—.7	—2.5
Thirteenth	17.5	17.8	18.7	19.2	—.3	—.9	—.5	—1.7
Fourteenth	18	17.8	18.6	19	.2	—.8	—.4	—1
Fifteenth	18	17.8	18.4	18.5	.2	—.6	—.1	—.5
Sixteenth	17.6	17.8	18	18.3	—.2	—.2	—.3	—.7
Seventeenth	17.8	17.8	18	18.3	.0	—.2	—.3	—.5
Eighteenth	17.6	17.6	17.9	17.8	.0	—.3	.1	—.2
Nineteenth	17.6	17.1	17.8	17.5	.5	—.7	.3	.1
Twentieth	17.2	16.7	17.6	16.9	.5	—.9	.7	.3
Average fill in section					—.06	—.18	—.07	—.30
Average annual deposit					—.08	—.17	—.07	—.11

Section 5.

	Average depth.				Average fill.			
	June, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	18.5	17.2	16.3	15.3	1.3	0.9	1	3.2
Second	18.2	17.3	16.8	16.3	.9	.5	.5	1.9
Third	17.6	17.4	17.1	16.6	.2	.3	.5	1
Fourth	18.2	17.8	17.5	17.2	.4	.3	.3	1
Fifth	18.8	18.3	17.6	17.4	.5	.7	.2	1.4
Sixth	19.3	18.2	17.6	17.4	1.1	.6	.2	1.9
Seventh	17.5	17.4	17.2	17.6	.1	.2	−.4	−.1
Eighth	16.4	17.2	17.2	17.6	−.8	.0	−.4	−1.2
Ninth	17	17.3	17.2	17.8	−.3	.1	−.6	−.8
Tenth	16.9	17.1	17.2	18	−.2	−.1	−.8	−1.1
Eleventh	16.7	17	17.6	18.1	−.3	−.6	−.5	−1.4
Twelfth	17.1	17	17.5	18.3	.1	−.5	−.8	−1.2
Thirteenth	17.7	17.5	17.4	17.9	.2	.1	−.5	−.2
Fourteenth	18.1	17.8	17.3	17.8	.3	.5	−.5	.3
Fifteenth	18.2	18	17.3	17.8	.2	.7	−.5	.4
Sixteenth	18	17.9	17.1	17.5	.1	.8	−.4	.5
Seventeenth	18.1	17.8	17	17.4	.3	.8	−.4	.7
Eighteenth	17.8	17.6	16.1	17.1	.2	1.5	−1	.7
Nineteenth	17.8	17.4	16.6	16.8	.4	.8	−.2	1.6
Twentieth	17.8	17.3	16.9	16.9	.5	.4	.0	.9
Average fill in section					.26	.40	−.22	.44
Average annual deposit					.26	.37	−.22	.15

Section 6.

	Average depth.				Average fill.			
	July, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	18.5	18.4	17.6	17.5	0.1	0.8	0.1	1
Second	18.2	18	17.4	17.2	.2	.6	.2	1
Third	17.6	17.6	17	16.7	.0	.6	.3	.9
Fourth	17.4	17.2	16.9	16.9	.2	.3	.0	.5
Fifth	16.7	16.6	16.6	16.8	.1	.0	−.2	−.1
Sixth	16.7	16.5	16.5	16.7	.2	.0	−.2	.0
Seventh	17	16.8	16.8	17.1	.2	.0	−.3	−.1
Eighth	17	17	17	17.5	.0	.0	−.5	−.5
Ninth	17	17.1	17.3	17.6	−.1	−.2	−.3	−.6
Tenth	17.1	16.9	17.2	17.7	.2	−.3	−.5	−.6
Eleventh	16.5	16.8	17.1	17.6	−.3	−.3	−.5	−1.1
Twelfth	17	17.2	17	17.4	−.2	.2	−.4	−.4
Thirteenth	17.5	17.5	17	17.3	.0	.5	−.3	.2
Fourteenth	17.3	17.8	17.2	17.2	−.5	.6	.0	.1
Fifteenth	17.6	17.7	17.2	17.2	−.1	.5	.0	.4
Sixteenth	17.4	17.3	17.1	17.2	.1	.2	−.1	.2
Seventeenth	17.2	17.5	17	17.1	−.3	.5	−.1	.1
Eighteenth	17.5	17.4	16.9	16.8	.1	.5	.1	.7
Nineteenth	17.8	17.5	16.8	16.8	.3	.7	.0	1
Twentieth	17.5	17.2	16.6	16.6	.3	.6	.0	.0
Average fill in section					.02	.29	−.13	.18
Average annual deposit					.02	.27	−.13	.06

Section 7.

	Average depth.				Average fill.			
	July, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	18	18.1	17.3	17.2	—0.1	0.8	0.1	0.8
Second	17.8	18	17.1	17.3	—.2	.0	—.1	.6
Third	17.6	17.6	16.8	17.1	.0	.8	—.3	.5
Fourth	16.8	17.2	16.8	16.9	—.4	.4	—.1	—.1
Fifth	17	17.1	16.8	17	—.1	.3	—.2	.0
Sixth	16.9	17.1	16.8	17	—.2	.3	—.2	—.1
Seventh	17	16.8	16.8	17.2	.2	.0	—.4	—.2
Eighth	17.2	17	17	17.4	.2	.0	—.4	—.2
Ninth	17.4	17.3	17.2	17.5	.1	.1	—.3	—.1
Tenth	17.2	16.8	16.9	17.4	.4	—.1	—.5	—.2
Eleventh	16.3	16.3	16.6	17.1	.0	—.3	—.5	—.8
Twelfth	16	16.8	16.6	17	—.8	.2	—.4	—.1
Thirteenth	16.6	16.8	16.7	17	—.2	.1	—.3	—1.4
Fourteenth	17.2	16.9	16.7	16.9	.3	.2	—.2	.3
Fifteenth	17.1	17	16.5	17	.1	.4	—.4	.1
Sixteenth	16.9	17.2	16.7	16.9	—.3	.5	—.2	.0
Seventeenth	17.2	17.4	16.8	16.9	—.2	.6	—.1	.3
Eighteenth	17.7	17.5	17	17	.2	.5	.0	.7
Nineteenth	17.6	17.5	17	17	.1	.5	.0	.6
Twentieth	17.9	17.4	17	17	.5	.4	.0	.9
Average fill in section					—.02	.33	—.22	.09
Average annual deposit					—.02	.30	—.22	.03

Section 8.

	Average depth.				Average fill.			
	July, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	18.6	17.8	17.2	17.2	0.8	0.6	0.0	1.4
Second	18.5	17.9	17.1	17.2	.6	.8	—.1	1.3
Third	18	17.4	16.9	17	.6	.5	—.1	1
Fourth	16.9	16.8	16.7	16.9	.1	.1	—.2	.0
Fifth	17	16.7	16.6	17	.3	.1	—.4	.0
Sixth	16.9	16.8	16.7	17.2	.1	.1	—.5	—.3
Seventh	16.6	16.8	16.8	17.3	—.2	.0	—.5	—.7
Eighth	17.2	16.9	17	17.4	.3	—.1	—.4	—.2
Ninth	17.3	16.8	17.1	17.3	.5	—.3	—.2	.0
Tenth	16.8	16.4	16.8	17.2	.4	—.4	—.4	—.4
Eleventh	15.9	16.2	16.5	17	—.3	—.3	—.5	—1.1
Twelfth	16.2	16.4	16.5	17	—.2	—.1	—.5	—.8
Thirteenth	17.2	16.8	16.7	17.1	.4	.1	—.4	.1
Fourteenth	17.1	17	16.8	17.1	.1	.2	—.3	.0
Fifteenth	17.2	17.2	16.8	17.1	.0	.4	—.3	.1
Sixteenth	17.6	17	16.9	17.2	.6	.1	—.3	.4
Seventeenth	17.8	17.2	17	17.1	.6	.2	—.1	.7
Eighteenth	18.1	17.7	17.1	17.1	.4	.6	.0	1
Ninteenth	18.2	18	17.2	17.2	.2	.8	.0	1
Twentieth	17.8	17.6	17.2	17.2	.2	.4	.0	.6
Average fill in section					.28	.19	—.26	.21
Average annual deposit					.31	.18	—.26	.07

Section 9.

	Average depth.				Average fill.			
	July, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	18.2	18.2	17.3	17	0.0	0.9	0.3	1.2
Second	18.7	18.4	17.3	17	.3	1.1	.3	1.7
Third	18.1	17.8	17	16.7	.3	.8	.3	1.4
Fourth	17.2	17.1	16.4	16.8	.1	.7	— .4	.4
Fifth	16.6	16.5	16.2	16.7	.1	.3	— .5	— .1
Sixth	16.6	16.3	16.3	16.6	.3	.0	— .3	.0
Seventh	16.8	16.4	16.5	16.8	.4	— .1	— .3	.0
Eighth	16.9	16.5	16.7	17.2	.4	— .2	— .5	— .3
Ninth	16.5	16.4	16.8	17.4	.1	— .4	— .6	— .9
Tenth	16.5	16.6	16.6	17.5	— .1	.0	— .9	—1
Eleventh	16.5	16.3	16.4	17.2	.2	— .1	— .8	— .7
Twelfth	17.3	16.6	16.6	17.2	.7	.0	— .6	.1
Thirteenth	17.9	17	16.7	17.3	.9	.3	— .6	.6
Fourteenth	17.4	17.2	16.6	17.2	.2	.6	— .6	.2
Fifteenth	17.2	17.1	16.6	16.8	.1	.5	— .2	.4
Sixteenth	17.3	17	16.6	16.8	.3	.4	— .2	.5
Seventeenth	17.6	17.4	16.7	16.8	.2	.7	— .1	.8
Eighteenth	18	17.8	17.1	16.9	.2	.7	.2	1.1
Nineteenth	17.7	18	17	16.9	— .3	1.0	.1	.8
Twentieth	17.1	17.9	16.6	16.8	— .8	1.3	— .2	.3
Average fill in section					.18	.42	— .28	.32
Average annual deposit					.20	.39	— .28	.11

Section 10.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	17.8	17.6	16.5	16.2	0.2	1.1	0.3	1.6
Second	18.7	18.2	16.5	16.3	.5	1.7	.2	2.4
Third	18.1	17.4	16.4	16.3	.7	1.0	.1	1.8
Fourth	17.4	17	16.3	16.5	.4	.7	— .2	.9
Fifth	17	16.9	16.1	16.3	.1	.8	— .2	.7
Sixth	15.8	15.9	15.9	16.4	— .1	.0	— .5	— .6
Seventh	16	16.4	16.4	16.9	— .4	.0	— .5	— .9
Eighth	17.4	17.5	17.2	17.6	— .1	.3	— .4	— .2
Ninth	18.7	18.1	17.6	17.7	.6	.5	— .1	1
Tenth	18.8	18.2	17.5	17.7	.6	.7	— .2	1.1
Eleventh	17.5	17.8	17.2	17.5	— .3	.6	— .3	.0
Twelfth	17.5	17.4	17	17.3	.1	.4	— .3	.2
Thirteenth	17.7	17.8	17	17.1	— .1	.8	— .1	.6
Fourteenth	16.8	17.5	16.6	16.9	— .7	.9	— .3	— .1
Fifteenth	16.5	16.7	16.1	16.3	— .2	.6	— .2	.2
Sixteenth	16.8	17	16.2	16.2	— .2	.8	.0	.6
Seventeenth	17.2	17.5	16.4	16.3	— .3	1.1	.1	.9
Eighteenth	18	17.7	16.5	16.4	.3	1.2	.1	1.6
Nineteenth	18	17.8	16.5	16.4	.2	1.3	.1	1.6
Twentieth	17.6	17.6	10.3	16.3	.0	1.3	.0	1.3
Average fill in section					.06	.79	— .12	.73
Average annual deposit					.08	.72	— .12	.24

Section 11.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	June, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1894–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	17.8	17.6	16.4	15.9	0.2	1.2	0.5	1.9
Second	18.2	17.8	16.4	16.8	.4	1.4	— .4	1.4
Third	18	17.4	16.3	16.1	.6	1.1	.2	1.9
Fourth	17.1	17	16.2	16.2	.1	.8	.0	.9
Fifth	16.8	16.6	15.9	16.2	.2	.7	— .3	.6
Sixth	15.7	15.9	15.9	16.1	— .2	.0	— .2	— .4
Seventh	16.2	16.2	16.3	16.7	.0	— .1	— .4	— .5
Eighth	17.4	17.4	16.8	17.3	.0	.6	— .5	.1
Ninth	18.2	17.8	17.3	17.5	.4	.5	— .2	.7
Tenth	18.2	18	17.2	17.4	.2	.8	— .2	.8
Eleventh	17.6	17.4	17.1	17.4	.2	.3	— .3	.2
Twelfth	17.7	17.7	17	17.3	.0	.7	— .3	.4
Thirteenth	18.2	18	17	17.2	.2	1.0	— .2	1
Fourteenth	17.7	17.5	16.6	17	.2	.9	— .4	.7
Fifteenth	16.9	16.6	16.1	16.5	.3	.5	— .4	.4
Sixteenth	16.6	16.7	16	16.2	— .1	.7	— .2	.4
Seventeenth	16.8	17	16	16	— .2	1.0	.0	.8
Eighteenth	17.3	17	16.1	16.1	.3	.9	.0	1.2
Nineteenth	17.6	17.6	16.2	15.8	.0	1.4	.4	1.8
Twentieth	17.5	17.4	16	15.6	.1	1.4	.4	1.9
Average fill in section					.14	.79	— .12	.81
Average annual deposit					.19	.73	— .12	.27

Section 12.

	Average depth.				Average fill.			
	September, 1894.	June, 1895.	July, 1896.	June, 1897.	1894–95.	1895–96.	1896–97.	1895–97.
Ten-foot intervals from west bank:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
First	17.4	17.6	17	17.5	—0.2	0.6	—0.5	0.1
Second	18.2	18.2	17.2	17.4	.0	1.0	— .2	.8
Third	18.4	18.1	17.2	17.5	.3	.9	— .3	.6
Fourth	17.9	17.8	17.4	17.5	.1	.4	— .1	.3
Fifth	17.5	17.4	17.3	17.4	.1	.1	— .1	.0
Sixth	16.7	16.4	17	17.4	.3	— .6	— .4	—1
Seventh	16.2	16.6	17	17.4	— .4	— .4	— .4	— .8
Eighth	16.6	18	17.4	17.8	—1.4	.6	— .4	.2
Ninth	17.1	18.3	17.7	18.2	—1.2	.6	— .5	.1
Tenth	16.9	18.2	17.8	18.1	—1.3	.4	— .3	.1
Eleventh	17.2	18.2	17.6	17.9	—1.0	.6	— .3	.3
Twelfth	17.1	17.9	17.7	17.8	— .8	.2	— .1	.1
Thirteenth	17.3	17.6	17.6	17.9	— .3	.0	— .3	— .3
Fourteenth	17.3	17.1	17	17.6	.2	.1	— .6	— .5
Fifteenth	16.5	16.6	16.5	17.2	— .1	.1	— .7	— .6
Sixteenth	16.3	16.5	16.4	16.8	— .2	.1	— .4	— .3
Seventeenth	16.3	16.6	16.5	16.6	— .3	.1	— .1	.0
Eighteenth	16.8	17.1	16.7	16.4	— .3	.4	.3	.7
Nineteenth	17.4	16.8	16.8	16.4	.6	.0	.4	.4
Twentieth	17.4	16.7	16.3	16	.7	.4	.3	.7
Average fill in section					(a)	.28	— .23	.05
Average annual deposit					(a)	.26	— .23	.02

a Partly dredged in May, 1895.

Summary.

	Average deposit.				Average annual rate.			
	1894–95.	1895–96.	1896–97.	1894–97.	1894–95.	1895–96.	1896–97.	1894–97.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Section 1	0.18	....	—0.62	....	0.18	....	—0.67	....
Section 2	— .05	0.24	— .16	0.08	— .07	0.22	— .17	0.01
Section 3	— .27	.13	— .10	— .24	— .36	.12	— .10	— .09
Section 4	— .06	— .18	— .07	— .30	— .08	— .17	— .07	— .11
Section 5	.26	.40	— .22	.44	.26	.37	— .22	.15
Section 6	.02	.29	— .13	.18	.02	.27	— .18	.06
Section 7	— .02	.33	— .22	.09	— .02	.30	— .22	.03
Section 8	.28	.19	— .26	.21	.31	.18	— .26	.07
Section 9	.18	.42	— .28	.32	.20	.39	— .28	.11
Section 10	.06	.79	— .12	.73	.08	.72	— .12	.24
Section 11	.14	.79	— .12	.81	.19	.73	— .12	.27
Section 12	....	.26	— .23	....	....	.26	— .23	....
Entire channel	.05	.34	— .17	.23	.05	.31	— .17	.07

It will be noted that during the first year after dredging there was no very decided tendency to fill over any part of any section, and the resultant for entire channel was but five one-hundredths of a foot fill. During the second year the fill was at the rate of thirty-one one-hundredths of a foot, and during the third year we find a resultant scour averaging seventeen one-hundredths of a foot over entire channel. There is indicated during the first two years a deposit in the channel of 26,000 yards, and during the third year a scour of 12,000 yards. It will be interesting to note whether in the coming year this scour will continue.

The largest resultant fill is near the inner end of channel where the bottom of the bay is flat and soft. The banks do not appear to slough away to any great extent, and the fill at this locality is the soft mud of the bay bottom, which tends to fill all depressions, while near the outer end the deposit is clean sand, undoubtedly carried in around Cedar Point from the lake.

In the past year each section, without exception, shows a scour which averages annually seven one-hundredths to sixty-seven one-hundredths of a foot over its area, while in 1895–96 only one section showed scour, and that but seventeen one-hundredths of a foot. In the three years sections 3 and 4 only show a resultant scour, and they are located where the channel passes through the crest of the middle ground, with bank depths of but 4 to 6 feet. The greater part of the scour in this portion of the channel is on the east half, the west half showing generally a deposit, as the crest of the middle ground gradually makes into the cut. Section 2 shows the same general features as sections 3 and 4, but the scour on east half has not quite overcome the fill on west half. In this section the tables show in 1894–1896 a decided scour over the east half, and in 1896–97 over the west half. In other parts of the channel the scour is generally along the middle of the cut.

Taken as a whole, I can see no indication of any law of deposit. It seems to be erratic, and is probably governed by changing conditions of currents and water levels. It is a fact, however, that from the first opening up of a narrow cut through the axis of the channel the indications have been that the currents will to a large extent maintain the depths, except in a few localities, such as the outer and at the wall of the "deep hole" and the west bank at the crest of the middle ground. I respectfully refer to my report of June 30, 1895, upon soundings of 1891 and 1893.

Very respectfully,

Wm. T. Blunt,
United States Assistant Engineer.

Col. Jared A. Smith,
Corps of Engineers, U. S. A.

Money statement.

July 1, 1896, balance unexpended		$45,902.10
June 30, 1897, amount expended during fiscal year		16,222.65
July 1, 1897, balance unexpended		29,679.45
July 1, 1897, outstanding liabilities	$6,381.45	
July 1, 1897, amount covered by uncompleted contracts	20,367.00	
		26,748.45
July 1, 1897, balance available		2,931.00
Amount (estimated) required for completion of existing project		185,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		185,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Sandusky Harbor, Ohio.

June 11, 1844	$15,000.00	August 2, 1882	$10,000.00
August 30, 1852	15,000.00	July 5, 1884	20,000.00
June 28, 1864 (allotment)	10,000.00	August 5, 1886	5,000.00
June 23, 1866	38,580.00	August 11, 1888	40,000.00
July 11, 1870	10,000.00	September 19, 1890	45,000.00
June 10, 1872	13,000.00	July 13, 1892	41,712.00
March 3, 1873	25,000.00	August 17, 1894	30,000.00
June 23, 1874	25,000.00	June 3, 1896	40,000.00
March 3, 1875	25,000.00		
August 14, 1876	25,000.00	Total	476,792.00
June 18, 1878	20,000.00	Expended to June 30, 1897	447,012.55
March 3, 1879	1,000.00		
July 14, 1880	12,500.00	Balance unexpended	
March 3, 1881	10,000.00	July 1, 1897	29,779.45

NOTE.—The above is exclusive of $400 appropriated for a survey by act of May 20, 1826.

Abstract of proposals for constructing a stone and brush jetty from Cedar Point, at Sandusky Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, August 7, 1896, at 2 o'clock p. m., standard time, in accordance with advertisement dated July 1, 1896.

[Amount available for the purpose, $25,000.]

No.	Name and address of bidder.	Stone, per ton.	Brush mattresses, per square yard.	Piles, per piece.	Total cost of work, based on bids.
1	Carkin, Stickney & Cram, Detroit, Mich	$1.375	$0.59	$10.00	$33,146.00
2	The L. P. & J. A. Smith Co., Cleveland, Ohio	5.00	.40	15.00	103,910.00
3	Walter E. Friday, Pittsburg, Pa	2.50	1.25	15.00	61,900.00
4	John Stang, Lorain, Ohio *a*	1.09	.40	11.00	24,636.00

a Lowest bid.

Recommended that the contract be awarded to John Stang, of Lorain, Ohio, at the rates named in his proposal, his bid being the lowest and considered reasonable.

Abstract of proposals for dredging at Sandusky Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, at 2 o'clock p. m., standard time, on Friday, August 7, 1896, for work as follows: Redredging outer bar, 22,000 cubic yards; redredging upper end of dock channel, 20,000 cubic yards, and redredging straight channel and lower end of dock channel as far as possible with amount available.

[Amount to be expended for the purpose, $15,000.]

No.	Name and address of bidder.	Outer bar.			Upper end of dock channel.		
		Cubic yards.	Price bid.	Amount.	Cubic yards.	Price bid.	Amount.
1	James Rooney, Toledo, Ohio	22,000	$0.17	$3,740.00	20,000	$0.15	$3,000.00
2	John Stang, Lorain, Ohio						
3	Carkin, Stickney & Cram, Detroit, Mich. *a*	22,000	.14	3,080.00	20,000	.17	3,400.00
4	The L. P. & J. A. Smith Co., Cleveland, Ohio						
5	Geo. H. & John B. Breymann, Toledo, Ohio	22,000	.15	3,300.00	20,000	.12	2,400.00

No.	Name and address of bidder.	Straight channel and lower part of dock channel.			All dredging.			Total dredging to be done for $15,000 (cubic yards).
		Cubic yards.	Price bid.	Amount.	Cubic yards.	Price bid.	Amount.	
1	James Rooney, Toledo, Ohio	68,833.3	$0.12	$8,260.00				110,833.3
2	John Stang, Lorain, Ohio				120,000	$0.125	$15,000.00	120,000
3	Carkin, Stickney & Cram, Detroit, Mich. *a*	87,384.3	.0975	8,520.00				129,384.3
4	The L. P. & J. A. Smith Co., Cleveland, Ohio				83,333.3	.18	15,000.00	83,333.3
5	Geo. H. & John B. Breymann, Toledo, Ohio	77,500	.12	9,300.00				119,500

a Lowest bid.

Recommended that the contract be awarded to Messrs. Carkin, Stickney & Cram, of Detroit, Mich., their bid being the lowest and considered reasonable and they responsible.

LIST OF CONTRACTS FOR IMPROVING HARBOR AT SANDUSKY, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Contract for dredging.

Name of contractor.	Date of contract.	Date of approval.	Date of commencement.	Date of completion.
Carkin, Stickney & Cram, Detroit, Mich	Aug. 17, 1896	Aug. 28, 1896	Sept. 7, 1896	July 31, 1897

Contract for constructing a stone and brush jetty from Cedar Point at Sandusky Harbor, Ohio.

Name of contractor.	Date of contract.	Date of approval.	Date of commencement.	Date of completion.
John Stang, Lorain, Ohio	Aug. 15, 1896	Aug. 25, 1896	Sept. 22, 1896	Sept. 30, 1897

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Sandusky, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	637,017	Coal	379,487
Lumber and wood	115,241	Merchandise	22,344
Sand	110,000	Plaster	5,200
Stone	35,983	Stone	4,983
Merchandise	24,720	Lime	2,240
Wheat	24,222	Cement	1,100
Pig iron	5,426	Lumber	606
Fruit	6,300	Sand	250
Salt	6,526		
Fish	1,810		
Total	967,245	Total	416,610

Total freight tonnage:	
1896	1,383,455
1895	761,208
Increase	622,247

Vessels.	Number.	Tonnage.
Entering	3,248	530,866
Departing	3,213	515,466

Total registered tonnage:	
1896	1,046,332
1895	1,346,233
Decrease	299,901

Draft of largest vessels using harbor, 20 feet. Largest vessels do not load to full depth. New vessel line established was the Sandusky, Windsor and Detroit, comprised of two passenger and freight steamers.

L L 5.

IMPROVEMENT OF HURON HARBOR, OHIO.

Huron is a small town about 10 miles east of Sandusky, where the Huron River flows into Lake Erie.

Formerly the mouth of the river was occasionally closed by a sand bar, and it was in that condition in 1826, when the plan of improvement was adopted. The project was for parallel piers of timber crib work, filled with stone, extending into the lake, 140 feet apart. The channel was dredged at various times, and piers were repaired and extended as necessities required until 1890, when the present project of extending the piers to a depth of 16 feet in the lake was adopted. The estimated cost of that project, revised in 1893, was $145,000, exclusive of all expense for maintenance.

The total expenditure upon the improvement for construction and maintenance to June 30, 1896, was	$162,055.58
Available for expenditure July 1, 1896	10,218.13

The channel then afforded an available depth of 16 feet, but a considerable part of the west pier inside of old light-house pier was in such bad condition as to be past any reasonable possibility of repairs, and its renewal was essential to the preservation of the channel. The alignment of the old work was irregular, and a section of about 125 feet in length, terminating in the old light-house pier, had been given a direction to widen the entrance between piers which the later extensions had partially offset. A length of about 188 feet of the old pier was entirely removed and the site for new pier was dredged, as evenly as possible, to a depth of 20 feet. The exact length to be removed was determined by the divisions between the old cribs, which were generally in lengths of 30 feet, with gains made by spaces where the ends of cribs were not in contact. The number of old cribs removed was as great as was considered possible to replace with the limited amount of funds available.

As the old pier had been originally set upon the natural bottom of the lake, the base of the new pier was several feet lower, and it was 2 feet below the bottom of the more recent construction outside. The difficulties of obtaining an even bottom at full depth at the points where the new work would join the old made it inadvisable to construct the new part to the full size of the opening; it was therefore made 180 feet long, and the spaces at the ends (the principal one of which was next to the oldest work) were subsequently filled with timbers and stone placed as best suited the purpose.

The new part, 180 feet long and 16 feet wide, was constructed in a single piece, without dovetails in any part, so that there are no timber heads exposed to view or to wear; the ends of grillage timbers, however, project 4 feet outside the walls and thus add 8 feet to the width of base. The projecting grillage timbers are covered with plank, forming an apron to prevent undermining. The principal features of the design of the new work at Huron are the same as those shown on second sheet, opposite page 2424, Report of Chief of Engineers, 1895. The reasons for the construction are quite fully given on the page mentioned and at various other places in recent reports of works in this district. The ends of timbers in side walls are now so arranged that they invariably abut at the middle line of one of the vertical timbers, and the abutting ends are secured beneath the head and washer of a screw bolt.

As a matter of economy the tearing out of old pier and dredging of foundations was done by the U. S. dredge *Maumee*, pertaining to the Toledo Harbor Improvement, the expense being paid from appropriation for Huron Harbor.

The superstructure is raised but 4 feet above mean lake level, making the entire height of the work 20.5 feet. The additional half foot consists merely of a half course under the side walls and a similar amount along the middle line between walls, which settles into the earth and does not add to the effective height. Two longitudinal fender strips of oak 12 inches by 6 inches are bolted to the superstructure to prevent injury to vessels.

The cost of the work is itemized as follows:

189,872 feet B. M. hemlock, at $11 per M	$2,088.59
67,642 feet B. M. white pine, at $16 per M	1,075.87
1,800 feet B. M. white oak, at $22 and $25 per M	42.30
21,258 pounds screw bolts and washers, at $1.66 per 100	352.88
10,058 pounds iron rods and washers, at $1.82 per 100	183.05
15,770 pounds drift bolts, at $1.53 per 100	241.28
5900 pounds spikes, at $3.20 per 100	28.80
58 drift bolts, per lot	10.31
190 cords stone, at $4.65 per cord	883.50
Labor and superintendence	1,923.96
Tools purchased	35.71
Tools hired	32.80
Dredge, pay roll, coal, repairs, etc	1,539.69
Total cost of renewing 180 feet	8,438.74
Office and contingent expenses of all kinds	1,031.48
Total expenditures of fiscal year	9,470.22
Balance on hand July 1, 1897	747.91

The work was commenced August 18 and was completed December 24, 1896.

At the prices paid for the last contract work in Huron, which was for extending the pier in 1895, the cost of the new materials and the labor upon them in the 180 feet of new work would exceed the entire cost of removing the old work and building the new by hired labor and open purchases by about $1,100, in addition to the salary of an inspector for the time occupied.

This renewal included removing 188 feet of old work entire and dredging the bottom to a grade 20 feet deep; handling 110 cords of old stone four times; straightening and using part of the old iron for drift-bolts, and filling spaces equal to 8 feet in length of pier with timber from the old substructure. The dredging of the foundations alone, after old work was removed, would have cost $1,290 at the contract price. The cost of the renewal of 180 feet at latest contract prices would therefore have exceeded the actual cost by hired labor and open purchases by about 50 per cent.

In addition to the special features of construction before mentioned, the method of constructing piers with very long cribs has been found especially advantageous both in quality and cost of the completed work. It requires but little more time to tow and put in position a crib of 200 feet or greater length than to place each crib of 30 or 40 feet in length as in former years.

The new method of construction makes the crib so rigid and strong that the only limit to the length which can be built in one piece (with grillage launched in sections) is such as must be determined from some or all of the following considerations, viz:

Amount of funds available.

Location where the crib can be safely constructed and moved.

Amount which can be placed in position and sufficiently ballasted with stone to hold it securely against any ordinary storm within the limits of a single day. This will be greatly modified by the location and facilities for carrying on the work.

The following points are specially mentioned as in favor of greater lengths of cribs:

A reduction in the number of places where cribs abut and, consequently, a more uniform strength and fewer places where water dashes through with consequent increase of wear and decrease of durability.

A more uniform settlement with greatly decreased amount.

A more correct alignment, adding greatly to the appearance of the completed work.

Reduced cost and better type of superstructure, owing to smaller amount of leveling and to straighter lines.

The estimate for completion of project for this improvement covers simply the original cost of extending piers to a depth of 16 feet in the lake.

The amounts now remaining to complete the project are: For east pier, 568 feet; for west pier, 600 feet.

It is not, however, considered advisable to make any further extensions of the piers, but rather to continue the improvement upon the same basis of lengths and estimate of cost, but with a different position and direction to the parts remaining to be constructed. The subject was explained in last Annual Report, with the conclusion that the obstruction of the entrance by bars can never be prevented by the present method of pier extensions. The only feasible method of preventing the formation of bars by the action of seas and currents, caused by winds on the lakes, is to give the piers or breakwaters such directions that the seas which chase along their exposed faces will drive the sand and other drift from the entrance to such points that the reacting wash or undertow can not return it where it can form a bar. This result can be easily accomplished by placing the outer ends of the piers, or breakwaters, as they might be better designated, in water of sufficient depth, and have the inner ends farther apart than at the entrance, as illustrated in the plan for improving Conneaut Harbor, Ohio, shown on map opposite page 2972, Report of Chief of Engineers, 1896; also map of Ashtablula Harbor improvement, opposite page 2964 of same report.

When further appropriations are made available, it is therefore proposed to continue the work upon the new plan, which gives promise of maintaining a reliable and permanent depth at the entrance. This method will not affect the formation of bars by sand or other material brought down the river, but at Huron that element is exceedingly small and, when formed, a bar can be much more easily removed when in a sheltered place.

The commerce of Huron Harbor is not very large, although the total of receipts and shipments in 1896 exceeded half a million tons, and the tendency is to a constant increase in amount.

Huron Harbor is in the collection district of Sandusky, Ohio. There is a fixed white light of the fourth order on the outer end of the west pier.

Money statement.

July 1, 1896, balance unexpended	$10,218.13
June 30, 1897, amount expended during fiscal year	9,470.22
July 1, 1897, balance unexpended	747.91
Amount (estimated) required for completion of existing project	117,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Amount and date of all appropriations for improving harbor of Huron, Ohio.

May 20, 1826	$5,000.00	June 14, 1880	$3,000.00
May 19, 1828	4,413.35	March 3, 1881	3,000.00
March 3, 1829	5,935.00	August 2, 1882	2,500.00
April 23, 1830	1,880.36	July 5, 1884	7,500.00
March 2, 1831	3,480.00	August 5, 1886	3,000.00
July 3, 1832	1,500.00	August 11, 1888	6,000.00
June 28, 1834	6,700.00	September 19, 1890	16,000.00
June 2, 1836	4,300.00	July 13, 1892	15,000.00
March 3, 1837	2,565.00	August 17, 1894	10,000.00
July 7, 1838	5,000.00	June 3, 1896	8,000.00
June 11, 1844	5,000.00		
August 30, 1852	10,000.00	Total	172,273.71
June 23, 1866	39,000.00	Expended to June 30, 1897	171,525.80
June 23, 1874	1,500.00		
March 3, 1875	1,000.00	Balance unexpended	
June 18, 1878	1,000.00	July 1, 1897	747.91

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Huron, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	257,696	Coal	255,971
Lumber and wood	4,000		
Coal	500		
Fish	500		
Stone	100		
Total	262,796	Total	255,971

Total freight tonnage:	
1896	518,767
1895	249,675
Increase	269,092

Vessels.	Number.	Tonnage.
Entering	198	182,121
Departing	203	168,191

Total registered tonnage:	
1896	350,312
1895	230,644
Increase	119,668

Draft of largest vessels using harbor, 18 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

L L 6.

IMPROVEMENT OF VERMILION HARBOR, OHIO.

Vermilion Harbor is formed by part of the Vermilion River near its mouth, about 20 miles east of the entrance to Sandusky Bay, Ohio.

The improvements commenced in 1836, consisting of parallel piers supplemented by dredging and removal of rock, were completed as far as the work now extends in 1879.

During the period 1836 to 1879, inclusive, about forty-four years, there were eleven appropriations, amounting in the aggregate for construction and maintenance to	$113,701.28
From 1880 to 1897 there were nine appropriations, aggregating	19,000.00
Total	132,701.28

All amounts expended since 1879 have been for maintenance.

The amount of $2,000 estimated for completion of existing project is simply the unappropriated balance of an estimate made about sixteen years ago to cover the necessities of that time for repairs. While the total amount of $21,000 would, if made in a single appropriation at the time of the estimate, have been sufficient for that time, after nine appropriations amounting to $19,000 extended over sixteen years the balance of the estimate of $21,000 is now entirely inadequate to make repairs which are indispensable for a proper maintenance of the piers. In fact, the expenditure of so small a sum as $2,000 can not be recommended, because it is not sufficient to make a radical change in conditions, and the aggregate cost of repairs will be much greater if made at various times with such small sums.

The condition of the piers was quite fully described in the last annual report—Report of Chief of Engineers, 1896, page 2935. There is more than 1,000 linear feet of old pier on the west side alone which should be rebuilt, though it may doubtless be made to serve for a few years longer. A length of 750 feet of pier on the east side is in a still worse condition, as much of it has already fallen into the river; but it is less exposed to the seas, so that its preservation is not so essential as the west pier to the maintenance of the channel.

At the beginning of the fiscal year the amount available for repairs was $3,989.44, which was nearly the entire amount of the combined appropriations of August 17, 1894, and June 3, 1896. The sum was so small that no important results could be expected if the repairs were to be made by contract. Under authority of the Chief of Engineers, the work was therefore undertaken by hired labor and by making the necessary purchases in open market, obtaining competition by circular letter to dealers.

The part to which repairs were especially necessary was on the west pier, commencing at the inner end of the crib on which the light-house stands and extending to the inner end of the work. All of this part was in such condition as to be beyond the range of mere repairs, so that it could only be put in satisfactory condition by rebuilding it entire. The old cribs were each 30 feet long, and a space of several inches is found between the consecutive cribs, so that the length required to replace three cribs with their superstructure was somewhat more than 90 feet.

To renew a piece of the pier 90 feet in length required that the entire cost should be less than $44 per linear foot, which is less than any similar work on Lake Erie has ever cost when done by contract.

The work of removing three cribs and superstructure and replacing them with an entire new section of pier was commenced September 1 and was completed November 24, 1896.

All the superstructure and stone above water was first removed, the stone being stored for use in the new crib. Timbers of the substructure were sawed apart at various places as far as they could be reached by the men. The removal of the old work below water, although in such bad condition that it could not be utilized, was a tedious and difficult operation. Judging by the prices which had been previously asked by contractors for removing such work, it would cost at the least one-fourth of the amount of the entire available funds to hire a dredge or other machine to tear away the old cribs.

The dredge belonging to the United States at Toledo Harbor was therefore employed for the purpose, all the expense being paid from the appropriations for Vermilion Harbor. The dredge was employed from October 8 to October 23, fourteen days. The bottom was dredged to the rock and the surface of the rock made nearly level at a depth of 14 feet.

The new pier was constructed in a single crib 90 feet long and 16 feet wide. It rests upon the solid rock and is 20 feet high, 12 courses of hemlock and 8 courses of pine. Two of the pine courses are below mean water level.

The timber of the pier is secured by iron bolts and rods with upright timbers as corner pieces in each interior angle, and no timber heads show on the face walls save the ends of grillage pieces, which will in general be covered by the mud of the river bottom. The ends of timbers in face walls are so arranged as to abut upon the upright angle pieces and not between them, as shown in plan for pier at Conneaut Harbor opposite page 3120, Report of Chief of Engineers, 1895. In other respects the section of pier at Vermilion was built upon the Conneaut plan above mentioned. The short spaces at the ends of the opening not filled by the 90-foot crib were closed by extra pieces and the superstructure was built up without connection with the old work.

This method of construction not only promises to be far more durable than that of securing the timbers by dovetails, but the crib is found to be vastly stronger and more rigid, besides having the additional advantage of smaller cost. All cross walls are solid and thoroughly bolted, but as the timbers do not come through the side walls, a wane, even though on each angle of every timber, does not injure the cross walls below water in the least and above water affects them only in so far as the sap may hasten decay. A cheaper class of timber may therefore be used, and as there is no framing together of pieces, but only square ends on every timber, nearly all the work may be done by laborers without necessity for skilled workmen.

The following is a detailed statement of the cost of the work:

Amount available July 1, 1896	$3,989.44
Per M feet B. M.:	
33,756 feet, white pine, at $16	540.10
42,672 feet hemlock, at $11	469.39
1,593 feet white oak, at $22	35.05
Iron per pound:	
7,519 pounds screw bolts and washers, at $0.0172	129.32
3,940 pounds iron rods and washers, at $0.0188	74.07
4,914 pounds driftbolts, at $0.0159	78.13
300 pounds spikes, at $0.0326	9.78
200 pounds spikes, at $0.03	6.00
75 pounds band iron, at $0.02	1.50
Labor, etc:	
Dredging old pier and foundation	530.50
Tools purchased	12.54
Implements hired	22.08
Paid for labor and supervision	1,201.16
Total cost of pier	3,109.62
Contingencies of office, etc	435.00
Total expended	3,544.62
Balance available July 1, 1897	444.82

The actual cost of the work, for comparison with work done by contract, was therefore $3,109.62, which is at a rate of about $34.55 per linear foot.

For quality of workmanship and cheapness of cost this repair is well worthy of special mention. The repair section was constructed under personal supervision of Mr. Nelson Parsons, of Vermilion, Ohio.

At the prices in the last contracts for Huron and Black River harbors, where each covered amounts nearly twice as great as was available for Vermilion Harbor, the work done at Vermilion would have cost, including salary of an inspector for three months, more than 50 per cent in excess of the actual cost by the method employed.

Vermilion is a small town with only local interests. It is a convenient port for unladen vessels in the winter and for vessels to run into for repairs. It is also a port for a number of small fishing vessels.

Vermilion is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier.

Money statement.

July 1, 1896, balance unexpended	$3,989.44
June 30, 1897, amount expended during fiscal year	3,544.62
July 1, 1897, balance unexpended	444.82
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	2,000.00

List of appropriations for improving harbor of Vermilion, Ohio.

July 2, 1836	$10,000.00	August 2, 1882	$3,000.00
March 3, 1837	20,000.00	August 5, 1886	3,000.00
July 7, 1838	23,626.57	August 11, 1888	1,000.00
June 28, 1864 (allotment)	5,758.97	September 19, 1890	2,000.00
June 23, 1866	15,315.74	July 13, 1892	2,000.00
June 10, 1872	5,000.00	August 17, 1894	2,000.00
March 3, 1873	12,000.00	June 3, 1896	2,000.00
June 23, 1874	3,000.00		
March 3, 1875	10,000.00	Total	132,701.28
August 14, 1876	5,000.00	Expended to June 30, 1897	132,256.46
June 18, 1878	4,000.00		
June 14, 1880	2,000.00	Balance, July 1, 1897	444.82
March 3, 1881	2,000.00		

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Vermilion, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Lumber	2,590	Fish	892

Total freight tonnage:	
1896	3,482
1895	3,668
Decrease	186

Vessels.	Number.	Tonnage.
Entering	50	2,281
Departing	50	2,281
Built	2	30

Total registered tonnage (vessels entering and departing):	
1896	4,562
1895	800
Increase	3,762

Draft of largest vessels using harbor, 11 feet. Largest vessels do not load to full depth. No new vessel lines were established during the year.

L L 7.

IMPROVEMENT OF BLACK RIVER (LORAIN) HARBOR, OHIO.

This harbor is in the city and township of Lorain, Ohio, where the Black River empties into Lake Erie. In its natural condition the depth of water over the bar generally did not exceed 3 feet.

The river and harbor act of May 23, 1828, made an appropriation "toward removing the sand bar at or near the mouth of Black River, in the State of Ohio, by the erection of piers, or other works, seven thousand five hundred dollars." A project for improving the channel by parallel piers was therefore adopted. The piers have been repaired, rebuilt, and extended, and channel has been dredged to keep pace with the requirements of commerce, but no radical change in the original project has thus far been made.

The last extension of east pier was 40 feet in 1893; west pier 40 feet in 1893 and 72 feet in 1895. The east pier is now 1,560 feet in length, besides a pile revetment of 550 feet in length inside the shore line. The west pier has a length of 1,890 feet.

Amount expended upon the improvement from 1828 to June 30, 1896, $262,122.72.

The piers had then been extended to a depth exceeding 16 feet in the lake, and the channel had, ordinarily, a depth of 17 feet. The channel had, however, shoaled so that immediate dredging was necessary. A large part of the piers is in very poor condition, and much of the old work is so much decayed and worn that no satisfactory repair can be made save by rebuilding entire.

A project for expenditure of an amount not exceeding $7,000 of the appropriation of June 3, 1896, was submitted to the Chief of Engineers July 8 and was approved, by telegram, July 10. A dredge was placed upon the work July 14 and continued until November 10.

The channel between piers and into the lake was dredged to a depth of 19 feet and width of 150 feet; amount of material removed was 39,684 cubic yards; the cost per yard was 15 cents. Much of the dredging was below a depth previously obtained, so that the material was very hard. No apparent shoaling has occurred since the dredging.

The project for expenditure of the balance of the appropriation of June 3, 1896, is to remove and rebuild a section of west pier 396 feet in length, commencing at the inner face of old light-house pier and extending inward. The work is being done by hired labor, purchasing materials by informal contract with the lowest bidders, after inviting proposals by circular letter. The part of pier to be removed covers about 400 feet in length and is now occupied by 13 cribs of 30 feet each. The added distance is due to the gain by spaces between cribs. The new part can not easily be made to fill the entire space removed. The inner end will be made to abut the old work, and the space at outer end will be filled by a temporary work.

The part of pier now being constructed is in a single crib, and is believed to be the longest single crib for a river and harbor improvement which has ever been constructed in one place and then floated to its position, sunk, and filled with stone. The experience heretofore gained with long cribs shows that where they can be constructed in sheltered places and be sunk in position and be sufficiently loaded with stone in a single day to prevent being moved by the seas of a possible storm, the method has some decided advantages; the settlement is but very little and is almost absolutely uniform; the pier is straighter and stronger; the cost of superstructure is less, as well as of putting the crib in position and filling with stone. The old work was in four cribs 13 feet wide and nine cribs 11½ feet wide. The new piece will be 18 feet wide throughout, but will have a base 24 feet wide, formed by the projection of grillage timbers 3 feet outside of side walls. The method of construction was devised by the officer in charge of the improvement for the special purpose of preventing the great wear upon exposed heads of dovetails and to give more stability and security from undermining. The principal features of the method of construction are shown upon sheet opposite page 2424, Report of Chief of Engineers, 1894. All timbers in side walls, however, abut over the middle of vertical timbers, and the crib rests upon the hard bottom, dredged to a depth of 19.5 feet. The timbers of grillage rest directly upon the bottom. The superstructure is to be 4 feet above mean lake level. The six upper courses, decking, and vertical timbers are of white pine; the remainder of the timber is of hemlock. The new part is now about six courses high; it will be completed in position before the close of the working season.

The river and harbor act of June 3, 1896, required a survey of the harbor of Lorain to be made "and the cost of improvement to be estimated with a view to providing better access to said harbor and the safety of boats therein." The survey was completed in the season of 1896, and the map has been platted. A report will be submitted as soon as practicable.

The expenditures of the last fiscal year have been distributed, as follows:

Dredging, fall, 1896	$5,952.60
Cost of inspection	516.66
Minor repairs, east pier, 1896, material and services	145.55

Removing and rebuilding part of west pier, 1897.

Plant, hired and purchased	191.97
Timber:	
4,760 feet, B. M., white oak, at $20	95.20
158,676 feet, B. M., white pine, at $19	3,014.83
403,451 feet, B. M., hemlock, at $11.50	4,639.69
Iron:	
34,797 pounds drift bolts, at $0.0134	466.28
23,417 pounds rods, at $0.0139	325.50
43,570 pounds screw bolts, at $0.0143	623.05
2,400 pounds spike, at $0.0149	35.76
3,040 pounds washers, at $0.0143	29.17
1,399 pounds washers, at $0.0139	19.44
Services	778.23
Steamer and screw for survey	207.34
Office and other contingencies	384.67
Total	17,425.94

This work is not yet completed.

It will be observed that the entire appropriation of June 3, 1896, has been, or is to be, expended for maintenance.

The business of Lorain Harbor is increasing. During the last year the Cleveland Ship Building Company has arranged to establish its works at Lorain, and a very large amount of work is now in progress improving the harbor by the city and by corporations to facilitate the increased business which is anticipated.

Black River Harbor (Lorain) is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order on the outer end of west pier and a beacon on the inner end of west pier to form a range for entering the harbor.

Money statement.

July 1, 1896, balance unexpended	$30,082.05
June 30, 1897, amount expended during fiscal year	17,425.94
July 1, 1897, balance unexpended	12,656.11
July 1, 1897, outstanding liabilities	471.96
July 1, 1897, balance available	12,184.15
Amount (estimated) required for completion of existing project	38,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	38,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Black River Harbor, Ohio.

May 23, 1828	$7,500.00
April 23, 1830	8,559.77
March 2, 1831	9,275.00
July 3, 1832	8,000.00
March 2, 1833	2,400.00
June 28, 1834	5,000.00
March 3, 1835	4,400.00
July 2, 1836	6,660.00
March 3, 1837	6,410.00
July 7, 1838	5,000.00
August 30, 1852	5,000.00
June 28, 1864 (allotment)	20,000.00
June 23, 1866	10,000.00
June 10, 1872	20,000.00
March 3, 1873	20,000.00
June 23, 1874	20,000.00
March 3, 1875	10,000.00
August 14, 1876	6,000.00
June 18, 1878	$1,000.00
June 14, 1880	1,000.00
March 3, 1881	7,000.00
August 2, 1882	7,000.00
July 5, 1884	10,000.00
August 5, 1886	10,000.00
August 11, 1888	10,000.00
September 19, 1890	12,000.00
July 13, 1892	20,000.00
August 17, 1894	10,000.00
June 3, 1896	30,000.00
Total	292,204.77
Expended to June 30, 1897	279,548.66
Balance unexpended, July 1, 1897	12,656.11

COMMERCIAL STATISTICS.

The following statistics for the year 1896, relative to the commerce of the harbor at the mouth of Black River, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	215,160	Coal	332,167
Lumber and wood	16,138	Lumber	511
Miscellaneous	1,141	Fish	102
Total	232,439	Total	332,780

Total freight tonnage:	
1896	565,219
1895	564,055
Increase	1,164

Vessels.	Number.	Tonnage.
Entering	532	173,040
Departing	263	185,742

Total registered tonnage:	
1896	358,782
1895	617,126
Decrease	258,344

NOTE.—The statistics received for registered tonnage are apparently incorrect.

Draft of largest vessels using harbor, 15 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

L L 8.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

The first improvement of Cleveland Harbor was undertaken in 1825 by rectifying the channel of the Cuyahoga River at its mouth and protecting it between piers of wood and stone.

The original works were renewed, repaired, and extended as demands of navigation required and the channel was deepened by dredging until 1875, when a project for an outer harbor was adopted in compliance with requirement of the act of March 3, 1875.

The west breakwater was completed in 1883 and the east breakwater had been extended a distance of 2,490.5 feet at the close of the season of 1893, since which no extensions to breakwater have been made.

In 1895 an opening of a little more than 200 feet was made in the shore arm of west breakwater in order to permit such a circulation of water in the harbor as would conduce to sanitary conditions. The appropriation of August 17, 1894, has been expended in making opening in the breakwater, in repairs to breakwaters, dredging to deepen channels, and in removing 450 feet of old east pier and replacing it with a new pier 322 feet long of timber work filled with stone and with a superstructure of stone and concrete masonry.

Total expenditures for all purposes from 1825 to June 30, 1896........ $1,636,612.87

Depth of water at harbor entrance is from 22 to 24 feet. The channel depth is necessarily maintained by dredging and in general it is from 17 to 19 feet.

At the beginning of the fiscal year work was in progress removing old east pier and replacing it with new pier having a superstructure of stone and concrete masonry. The old pier was a construction of piles with a superstructure of timber crib work, both filled with stone. It had become so much decayed above water as to be unfit to walk upon. When the old pier was constructed the depths of channel were much less than are now required and the substructure of piles was entirely unfit to be used as a base for a new superstructure of masonry or even of timber and stone. The old pier was therefore entirely removed and the bottom was dredged to a depth of 22.5 feet as nearly uniform as practicable. After dredging a few places were found too low and they were filled by dropping in small stone.

Drawings showing the design of crib and superstructure are shown opposite page 2952, Report of Chief of Engineers, 1896, and a description of the pier before it was constructed was given on pages 2944 and 2945.

Several minor modifications in details were made to facilitate construction and to avoid cracking of masonry from uneven settlement. As the methods of construction are novel throughout, photographs were taken to illustrate the process at various stages from commencement to completion, and nine separate views accompany this report. Plates numbered 1 and 2 show a section of the grillage with vertical timbers ready to launch. The grillages when placed end to end and built up as a single crib are so arranged that the cross walls are uniformly spaced except one space at outer end. The short verticals seen in the end of grillage are merely to secure ends of four courses of timber in the side walls; the verticals in the abutting end of the next grillage extend to top of crib. There were eight sections of grillage, each 36 feet long, and one section 34 feet long. By the arrangement of projecting grillage timbers the base of crib is increased 12 feet in width, and the apron thus formed prevents any possibility of undermining the pier by the wave action or by scour from wheels of steamers.

Pls. 3 and 4 show the grillages assembled and the method of building up the crib. The long rods which pass entirely across the crib at intervals in the face of each cross wall are not clearly shown in drawings or photographs. An illustration of the location of the rods in the face of cross walls is shown on plate opposite page 3120, Report of Chief of Engineers, 1896, "Crib for Conneaut Harbor, Ohio."

In order to stiffen the ends of the crib a middle wall was built across the end divisions. This middle wall with its vertical timbers also served to support the heavy stone at the ends of the crib. (Pls. 3 and 4.)

When the timber walls of sides and ends were raised to the top of the vertical timbers, 20 feet, they were completed, but the cross walls (except the end walls) were raised 3 feet higher over a length of 12 feet, leaving 4 feet at each end on a level with side walls. The extreme height of crib was then 23 feet, it being intended that the extreme top of interior cross walls would be at mean lake level when the work should be completed.

The crib was easily towed into position and sunk. For the purpose of a proper alignment, strips of board were nailed to a number of the cross walls so that one edge was in the plane of the middle of the crib. When the crib was just sufficiently loaded to rest on the bottom it was moved by a tug and by ropes until the position was practically exact. The greatest variation from the exact alignment of any part of the crib throughout its entire length of 322 feet did not exceed one-third of an inch, as located by a transit.

To sink the crib, planks were first laid the entire length of both sides over a width of 4 feet, and boards were set upon edge against the ends of cross wall additions. Upon the shelf thus made stone was piled until the crib was sunk uniformly in place upon the bottom.

Pl. 5 shows the process of sinking crib while it was yet afloat. At the time of sinking the water was about 2 feet below the mean lake level. The dredge shown in the view was deepening the channel.

The old pier having been 450 feet long and the new work only 322 feet long, the outer end of old pier on which the light-house stood was left until the new pier was complete; the beacon was then transferred to the end of new work and the remainder of old pier was removed.

When the crib was filled with stone to top of side walls the stone used for sinking was removed and blocks 9 feet long, 4 feet wide, and 3 feet thick were laid in such manner as to rest upon the outer and cross walls and upon the ends of the vertical timbers. This brought the tops of stones to mean lake level as nearly as practicable.

The spaces bounded by cross walls and large stones were then decked over so that the top was flush with wood and stone walls, the water as before stated being nearly 2 feet low.

Heavy boxing was then made so that the concrete superstructure should be put on in sections, each section reaching entirely across the pier, 20 feet, and covering a length of 9 feet of the pier, from the middle of one cross wall to the middle of the next. It will be observed that the masonry rests entirely upon the woodwork of the crib.

Sections of the concrete superstructure were constructed at various points along the length of pier in order to distribute the weight and cause a uniform settlement. The spaces were then divided and finally closed. (See pls. 6 and 7.) Tarred paper was placed in the vertical planes between sections to prevent their being united.

Openings, or wells, 4 feet square were left in the concrete over each crib compartment, except in double-end compartments where they were but 3 feet square. The wells in concrete were covered with flagging stones. The openings were intended not only to save concrete but to afford a means of filling any space under the concrete which may be caused by settlement of the stone. (See pls. 8 and 9.

Near the top of every third compartment three gas pipes were laid across the pier and embedded in the concrete. At a level 6 inches below the top of pier three more sections of pipe were similarly embedded. When the pier was finished, long iron rods were run through the gas pipes to secure heavy oak fenders on each side of the pier. (See plate opposite p. 2952, Report of Chief of Engineers, 1896.)

The fenders were covered with plank and provided with mooring rings. In the spring of 1897 it was found that masters of vessels misused the privilege of mooring at the pier to such an extent as to cause unnecessary injury to the masonry and to the fenders. The fenders have, therefore, been sawed off at the level of the top of pier, leaving nothing to which a vessel can be moored except the light-house beacon; but the tendency to misuse such works is so great that even the light-house beacon is frequently used as a means of mooring vessels at the pier.

Careful levels taken on top of pier nine months after its completion show the extreme settlement to be twelve-hundredths of a foot. The inner end has not settled at all, and for about two-thirds of the length of the pier the greatest settlement is five-hundredths of a foot; over the remaining distance the settlement increases to the maximum at the extreme end, which is where the dredging of foundation was deepest and was filled by dropping in stone. No cracks can be discovered in any part of the stone or concrete masonry.

The top of stone course which was planned to be at mean lake level is very nearly horizontal, and averages about fifteen-hundredths of a foot low. When it is remembered that the height of the top of the stone depended on the accuracy of dredging the bottom and the amount which the pier would settle into the bottom, it will be seen that the estimates were very close.

The pier is a substantial piece of work and is a credit to the harbor. The contract price of the work was exceptionally low, and it was only by most careful supervision that a good quality of work was secured. The completed work is shown on pls. 8 and 9. The amount paid the contractor was $28,332.08, which is a trifle less than $88 per linear foot.

The channel in the harbor front east of east pier and between the piers having become so shoal as to cause much inconvenience to vessels, prices for the necessary dredging were obtained by circular letter, and the lowest bidder was employed to do the work without formal contract. The dredge was employed from July 10 to September 10, and removed 64,323.9 cubic yards of material at a cost of 14 cents per yard. The dredging was to a depth of 19 feet, most of it being on the front east of east pier, where the results have been especially beneficial.

During the year various repairs have been made to the breakwater, the cost of which has exceeded $5,000. Most of the repairs are made necessary by the decay of the timber and planks above water, which weakens them to such an extent that the seas and ice tear them away and leave openings which must be closed to prevent much greater injury. Some of the injuries to breakwater are caused by vandalism. Many masters of vessels do not hesitate to tear away the planking in order to secure lines to deck joists, and fishermen tear off pieces in order to use the plank or to obtain stone for ballast.

The river and harbor act of June 3, 1896, required that a survey "be made of said breakwater with a view of determining the advisability of changing the plan thereof so as to abandon the proposed construction of the eastern shore arm, and in lieu thereof extending the said breakwater eastwardly in a general direction parallel with the shore."

For this purpose an extended hydrographic survey was necessary, with numerous borings, to ascertain the character of the lake bottom. The survey was completed in the season of 1896, and a special report will be submitted as soon as practicable.

The expenditures of the fiscal year are summarized, as follows:

Outstanding liabilities of previous year (maintenance, engineering, and contingencies)	$692.69
Construction of east pier by contract	28,332.08
Superintendence of contract work	725.00
Repairing old east pier inside of new pier to replace work necessarily torn out in construction	766.11
Cement tests	131.25
Dredging channels in 1896	9,005.35
Superintending dredging	150.00
Hire of steamer and expense of survey	500.00
Keeping records of water levels	316.13
Care and repair of breakwaters	6,063.06
Office rent and contingencies	498.28
Total	47,179.95

The project for improving Cleveland Harbor, for which contracts were authorized by the act of June 3, 1896, included the following:

Renewing east pier 322 feet outside of harbor line, and renewing west pier a length of 1,738 feet; a total length of 2,060 feet, at $100	$206,000
Dredging to widen channel	40,000
Contingencies of engineering, etc	14,000
Total for piers and widening channel	260,000
Renewing superstructure and sheathing face of cribs of west breakwater outside of shore arm	544,000
Sheathing face of cribs of east breakwater	23,494
Contingencies of engineering, etc	32,506
Total for repairing breakwaters	600,000
Extending east breakwater according to approved project	494,000
Total estimated cost of projects	1,354,000

The most important work for the improvement of the harbor is the widening of river channel and construction of west pier. The widening of channel, however, is contingent upon obtaining title to the land which must be removed and on which the new pier must stand.

Assurances have been received that the land would be obtained by the city and that the title would be transferred to the United States. It is understood that the city has made satisfactory arrangements for acquiring most of the land in question, though the actual title has not been obtained. A small strip of land and certain rights belonging to the Cleveland and Pittsburg division of the Pennsylvania Railway Company, situated at and near the extreme south end of the proposed improvement, has thus far blocked the way to a complete title, owing to the refusal of the railway company to sell the land at any price, or to give title on any terms which the city will accept. This attitude of the railway company is understood to be for the purpose of forcing a settlement from the city of certain other questions which have long been in dispute.

The improvement of widening the river mouth is of too much importance to be abandoned. The land in question is of small value for any real business purpose. If the disagreement between the Pennsylvania Company and the city is to result in much longer delaying the commencement of this improvement, which is so essential to Cleveland Harbor, it may become necessary to ask Congress to authorize measures to procure the land by purchase or condemnation under provisions of law. (See supplement to the Revised Statutes of the United States, vol. 1, 1874–1891, p. 384, chap. 114, and p. 601, chap. 728.) It has been ascertained that the right of condemnation for such a purpose is not vested in the city.

In this connection it should be observed that the entire amount of land required for widening the channel was within the natural limits of the river and lake (except a small sand spit which was not permanent and gave only a riparian privilege) in 1825, when improvement of the mouth of the river was commenced by the United States, and the entire river front was originally occupied and built by the United States. (See four maps opposite p. 3106, Report of Chief of Engineers, 1896.)

As the lack of the necessary title to land has prevented the immediate widening of the river mouth, a contract has been completed for sheathing face of breakwaters with oak and for renewing superstructure of west breakwater only.

Under date of March 2, 1897, proposals for repairing west breakwater under continuous contract were invited by public advertisement. Bids were received and opened April 2, 1897, and a contract was awarded to Hunkin Bros., of Cleveland, Ohio, who were the lowest bidders. The total cost of the work, based upon the estimated quantities of material, is $413,843.78.

Six proposals were received, the difference between highest and lowest bid being more than $145,000.

The entire appropriation of June 3, 1896, has necessarially been reserved for maintenance and contingent expenses during the execution of the projects under contract.

The sundry civil act approved June 4, 1897, having appropriated $350,000 for improving Cleveland Harbor, contractors were at once notified and preparations for commencing the work were immediately begun. It is expected that operations upon the breakwater will be commenced about August 1.

Two sheets of drawings are forwarded to accompany this report. The first sheet shows a section of present breakwater with parapet, and a section of the new work to be constructed. Sheet No. 2 shows certain details of the new work in plan and elevation. These drawings indicate the kind of work to be done in renewing the old superstructure with concrete and covering face of cribs, sufficiently in detail to require no special description at this time.

The commercial importance of Cleveland Harbor is too well known to require any comment. The actual freights by water in 1896 exceeded 5,500,000 tons.

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There are 4 lights to mark the entrance between breakwaters and piers, and a fog signal on pier in rear of east end of west breakwater.

Money statement.

July 1, 1896, balance unexpended		$117,018.74
June 4, 1897, appropriation		350,000.00
		467,018.74
June 30, 1897, amount expended during fiscal year		47,179.95
July 1, 1897, balance unexpended		419,838.79
July 1, 1897, outstanding liabilities	$36.31	
July 1, 1897, amount covered by uncompleted contracts	413,843.78	
		413,880.09
July 1, 1897, balance available		5,958.70
Amount (estimated) required for completion of existing project		924,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Cleveland Harbor, Ohio.

March 3, 1825	$5,000.00
March 2, 1827	10,000.00
March 3, 1829	12,179.00
April 23, 1830	1,786.56
March 2, 1831	3,670.00
July 3, 1832	6,600.00
June 28, 1834	13,315.00
July 2, 1836	15,006.59
March 3, 1837	10,000.00
July 7, 1838	51,856.00
June 11, 1844	25,000.00
August 30, 1852	30,000.00
March 3, 1853	145.69
June 28, 1864 (allotment)	20,000.00
June 23, 1866	59,806.00
July 25, 1868 (allotment)	17,000.00
April 10, 1869 (allotment)	13,380.00
July 11, 1870	20,000.00
March 3, 1871 (allotment for repairs)	636.77
March 3, 1873	1,000.00
June 23, 1874	30,500.00
Total previous to adoption of project for harbor of refuge	346,881.61
March 3, 1875	50,000.00
August 14, 1876	50,000.00
August 14, 1876 (repair of pier)	8,000.00
June 18, 1878	100,000.00
March 3, 1879	100,000.00
June 14, 1880	125,000.00
March 3, 1881	200,000.00
August 2, 1882	175,000.00
July 3, 1884	100,000.00
August 5, 1886	93,750.00
August 11, 1888	100,000.00
September 19, 1890	75,000.00
July 13, 1892	100,000.00
August 17, 1894	50,000.00
June 3, 1896	80,000.00
June 4, 1897	350,000.00
Total appropriations	2,103,631.61

Amount of appropriations since adoption of project for harbor of refuge 1 756,750.00

NOTE.—Since the adoption of project for outer harbor about $70,000 has been expended for maintenance of channel, piers, and breakwater, besides the entire appropriation of $50,000, August 17, 1894, a total of $120,000.

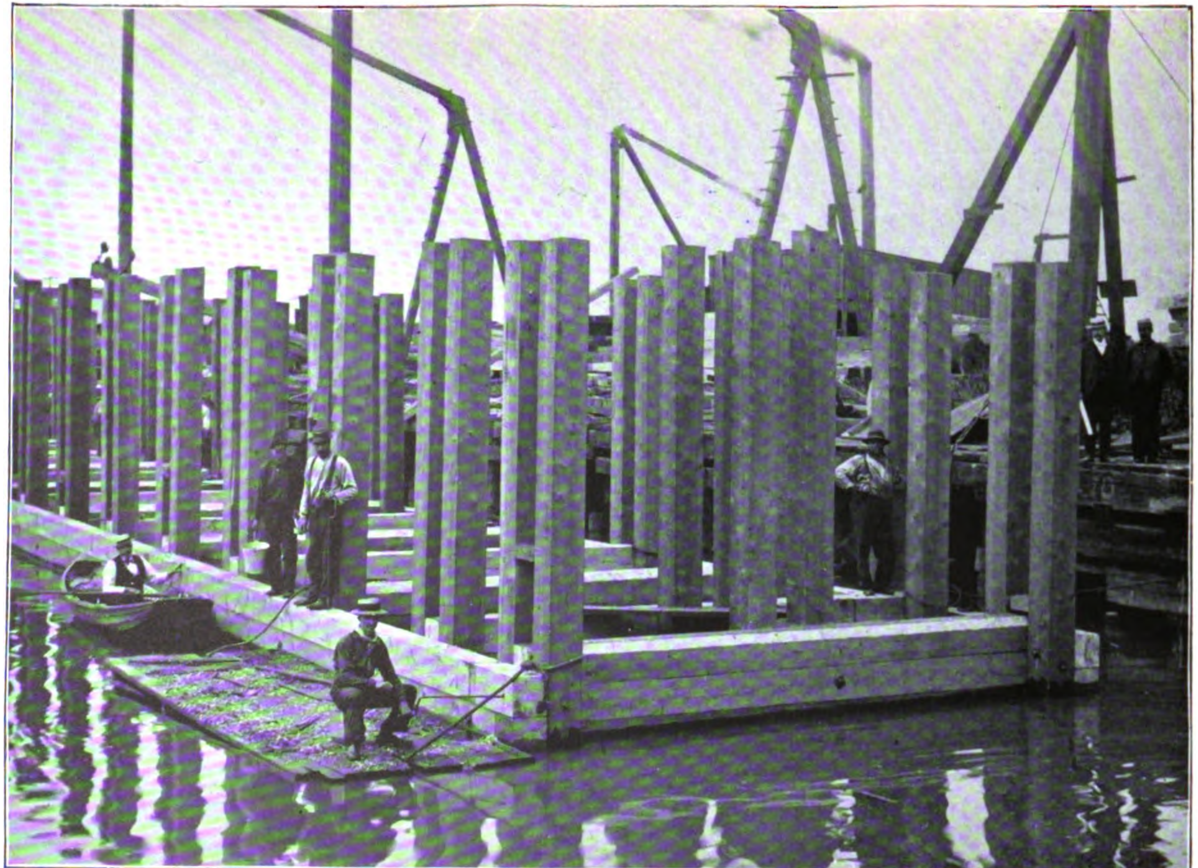
CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO. PLATE No. 1.

GRILLAGE 36 FEET LONG, READY TO LAUNCH; AUGUST 11, 1896.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO. PLATE No. 2.

GRILLAGE 36 FEET LONG, READY TO LAUNCH; AUGUST 11, 1896.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO. PLATE No. 3.



END VIEW OF CRIB AFLOAT AND UNDER CONSTRUCTION; AUGUST 15, 1896.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO.

PLATE NO. 4.

ENTIRE CRIB, 322 FEET LONG, UNDER CONSTRUCTION. NINE GRILLAGES ASSEMBLED. AUGUST 15, 1896.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO.

PLATE No. 5.

SINKING CRIB, 322 FEET LONG, TO DEPTH OF 23 FEET, AT MEAN LAKE LEVEL; SEPTEMBER 18, 1896.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO.

PLATE No. 6.

CONSTRUCTING STONE AND CONCRETE SUPERSTRUCTURE; OCTOBER 28, 1896.

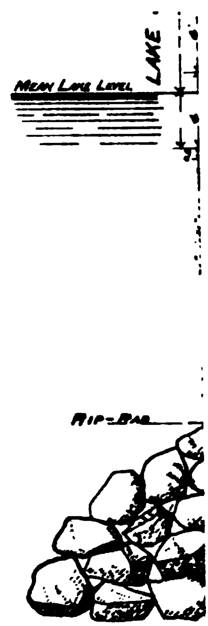
SECTIONS OF CONCRETE IN SUPERSTRUCTURE; OCTOBER 28, 1896.

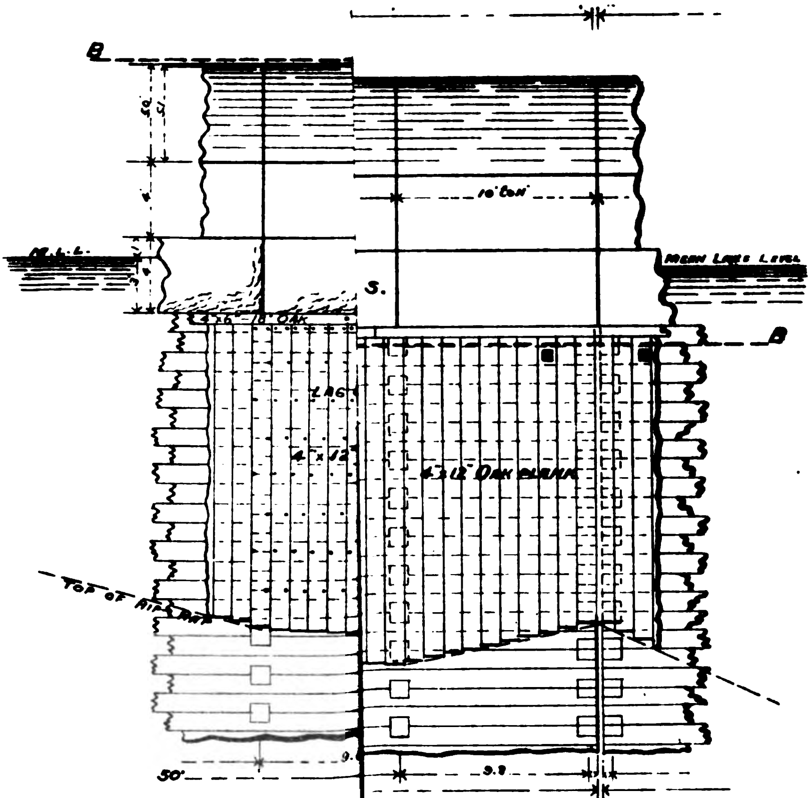
TOP OF COMPLETED PIER; JULY 14, 1897.

CONSTRUCTION OF EAST PIER AT CLEVELAND HARBOR, OHIO.

PLATE No. 9.

TOP AND SIDE OF COMPLETED PIER; JULY 14, 1897.


LAKE
MEAN LAKE LEVEL
RIP-RAP



U. S. Engineer Office.
Cleveland, Ohio.

...mpany annual report for
...ar ending June 30, 1897.

...ada. Smith

Colonel, Corps of Engineers, U. S. Army.

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Abstract of proposals for repairing West Breakwater at Cleveland Harbor, Ohio, received and opened by Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on April 2, 1897.

Items.	Quantities.	Bid per—	No. 1.—McArthur Bros. Co., Chicago, Ill.		No. 2.—Carkin, Stickney & Cram, Detroit, Mich.		No. 3.—Hunkin Bros., Cleveland, Ohio.	
			Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
White oak, feet B. M.	368,076	M feet B. M.	$65.00	$23,924.94	$38.00	$13,986.89	$139.00	$51,162.56
Hemlock, feet B. M.	261,900	do	13.00	3,404.70	18.00	4,714.20	17.25	4,517.78
Old timber, feet B. M.	595,000	do	13.00	7,735.00	15.50	9,222.50	9.85	5,860.75
Stone or concrete blocks, cubic feet.	250,310	Cubic foot	.40	100,124.00	.31	77,596.10	.49½	123,486.27
Stone steps, pieces.	60	Piece	1.00	60.00	2.50	150.00	3.70	222.00
Concrete, cubic yards.	40,700	Cubic yard	7.35	299,145.00	7.60	309,320.00	5.32	216,524.00
Log screws, pounds.	88,230	Pound	.03	2,646.90	.04	3,529.20	.03	2,646.90
Screw bolts, pounds.	12,300	do	.04	492.00	.02¾	338.25	.03	369.00
Iron rods, pounds.	64,104	do	.04	2,564.16	.03	1,923.12	.13	8,333.52
Mooring rings, pounds.	3,710	do	.06	222.60	.03	111.30	.10	371.00
Wire nails, pounds.	7,000	do	.03	210.00	.03	210.00	.05	350.00
Total				440,529.30		421,101.56		413,843.78

Items.	Quantities.	Bid per—	No. 4.—Jas. B. Donnelly, Buffalo, N. Y.		No. 5.—The L. P. and J. A. Smith Co., Cleveland, Ohio.		No. 6.—The Clements Bros. Construction Co., Cleveland, Ohio.	
			Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
White oak, feet B. M.	368,076	M feet B. M.	$79.00	$29,078.00	$60.00	$22,084.56	$100.00	$36,807.60
Hemlock, feet B. M.	261,900	do	20.00	5,238.00	20.00	5,238.00	15.00	3,928.50
Old timber, feet B. M.	595,000	do	10.00	5,950.00	20.00	11,900.00	20.00	11,900.00
Stone or concrete blocks, cubic feet.	250,310	Cubic foot	.44	110,136.40	.75	187,732.50	.68	170,210.80
Stone steps, pieces.	60	Piece	5.00	300.00	3.00	180.00	2.00	120.00
Concrete, cubic yards.	40,700	Cubic yard	7.29	296,703.00	8.00	325,600.00	7.65	311,355.00
Log screws, pounds.	88,230	Pound	.04	3,529.20	.04	3,529.20	.09	7,940.70
Screw bolts, pounds.	12,300	do	.04	492.00	.04	492.00	.08	984.00
Iron rods, pounds.	64,104	do	.06	3,846.24	.03	1,923.12	.10	6,410.40
Mooring rings, pounds.	3,710	do	.05	185.50	.05	185.50	.14	519.40
Wire nails, pounds.	7,000	do	.04	280.00	.05	350.00	.04	280.00
Total				455,738.34		559,214.88		550,456.40

List of contracts for improving harbor at Cleveland, Ohio, in force during the fiscal year ending June 30, 1897.

Name and address of contractor.	Contract.	Date of contract.	Date of approval.	Date of commencement.	Date of completion.
James B. Donnelly, Buffalo, N. Y.	Removing and rebuilding part of east pier.	May 2, 1896	May 26, 1896	July 6, 1896	Nov. 30, 1896
Hunkin Bros., Cleveland, Ohio.	Repairing west breakwater.	Apr. 28, 1897	May 19, 1897	Work not begun.	Continuous contract.

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Cleveland, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	2,707,169	Coal	1,804,455
Coal	3,400	Iron and steel	107,036
Lumber, lath, shingles, etc	400,114	Lumber	1,697
Grain and produce	69,780	Grain and produce	5,917
Iron and steel	82,839	Flour, meal, etc	7,484
Flour, meal, etc	8,646	Miscellaneous	120,753
Stone	68,013		
Sand and gravel	1,336		
Miscellaneous	183,472		
Total	3,474,769	Total	2,047,342

Total freight tonnage:
1896 5,522,111

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IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

The harbor of Fairport, Ohio, is in the Grand River, which is navigable for large vessels about 1½ miles from its mouth and for small vessels a mile farther.

A project for improvement was adopted in 1825 when the mouth of the river was closed by a sand bar. The plan was for parallel piers of timber cribs filled with stone 200 feet apart. The piers have since been modified, renewed, repaired, and extended, and the channel and outer bars have been dredged as the necessities of navigation have required. The latest extensions to piers were made in 1893.

Total expenditures to June 30, 1896, were $364,669.21

The channel between the piers has generally exceeded 18 feet in depth, but bars usually form in the fall and in the spring around the ends of piers so that much dredging is annually required to keep the harbor open.

In September, 1896, the bar had formed to such an extent as to seriously interfere with navigation by loaded vessels. In such cases time does not permit a formal contract after advertising; proposals were, however, obtained by letters to accessible parties, and authority was obtained to do the work at a cost of 16 cents per yard, which was exceptionally low considering the amount, the location, and the time of the year. Dredging was commenced September 15 and continued until November 17, when the material dredged from the bar amounted to 45,172 cubic yards.

In April, 1897, the bar had again formed enough to prevent the passage of loaded vessels. A dredge was therefore employed from April 21 to May 1, inclusive, and the amount of 11,823 cubic yards of material was removed, at a cost of 20 cents per yard. In both cases an examination of the bar was necessarily made and an inspector was employed to superintend the work. The channel was dredged to a depth of 20 feet in each case.

The river and harbor act of June 3, 1896, appropriated $30,000 for improving Fairport Harbor and provided that not less than $20,000 of the amount "shall be applied toward the construction of a breakwater according to the project submitted April third, eighteen hundred and ninety-six." The report mentioned was submitted to Congress in compliance with the requirements of public resolution No. 34, Fifty-fourth Congress, first session, approved March 24, 1896, and was printed with a map showing the location of breakwaters proposed in House Doc. No. 34, Fifty-fourth Congress, first session.

The project for construction of the breakwaters has therefore been approved. The estimated cost, including the dredging of protected area to a depth of 20 feet, is $510,000.

The expenditures of the last fiscal year are as follows:

Liabilities of previous year	$561.14
Dredging in fall of 1896, 45,172 cubic yards, at 16 cents	7,227.52
Dredging in April and May, 1897, 11,823 cubic yards, at 20 cents	2,364.60
Inspector of dredging	362.50
Engineering and office contingencies	417.79
Total	10,933.55
Balance available July 1, 1897	30,270.77

The appropriation of $20,000 by act of August 17, 1894, has been expended for maintenance, save the very small balance of $270.77 remaining July 1, 1897.

In the last two years the cost of dredging the bar alone has been nearly $11,000, exclusive of engineering contingencies. It will be seen, therefore, that if the channel is to be kept open it is not prudent to reserve a less sum than $5,000 per annum for that purpose. To this amount must be added for annual maintenance the cost of repairing the piers, which are now much decayed. The piers have a length exceeding 2,000 feet, in addition to the part on wharf front which has been taken possession of by one of the corporations which control the business of the port.

To expend a sum of $20,000 or even $25,000 in the construction of a breakwater when no other funds are available for continuance of the work, would result merely in placing in the lake a small section of breakwater which of itself could afford no protection or benefit of any kind to the harbor; such a part of the work would cost more in proportion to its length than if built in connection with a larger amount, and before it could be of any service as a component part of the whole it would entail further expense for repairs.

A project for expenditure of the amount of $30,000, appropriated June 3, 1896, was therefore submitted to the Chief of Engineers in a letter, as follows:

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, December 31, 1896.

GENERAL: I have the honor to submit a project for expenditure of amount appropriated by river and harbor act of June 3, 1896, for "improving harbor at Fairport, Ohio: Continuing improvement, $30,000."

The present project consists in constructing two breakwaters, so arranged as to secure a permanent and reliable depth of 25 feet at the outer entrance, the arrangement being as shown on blue-print map, forwarded in a separate roll to accompany and illustrate this project.

The project was submitted to the Chief of Engineers in my letter dated March 31, 1896, to comply with requirements of public resolution No. 34, Fifty-fourth Congress, first session, and was printed in Annual Report of Chief of Engineers for 1896, pages 2956 to 2958.

It is my opinion that the project is a worthy one, and that it is the best that can now be devised. The estimate of $510,000 covers cost of original construction only.

The river and harbor act of June 3, 1896, requires that not less than $20,000 of the amount appropriated by the act "shall be applied toward the construction of a breakwater according to the project submitted April third, eighteen hundred and ninety-six."

On June 30, 1896, there was a balance of $10,643.18 available from appropriation of August 17, 1894, and it was then estimated that the amount would be sufficient for all probable necessities of repairs and dredging for two years, and that the entire appropriation of June 3, 1896, might be applied to the construction of the west breakwater, commencing at the shore and extending outward as far as practicable with available funds.

It has, however, been found necessary to expend a considerable sum in dredging the bars, so that the present balance of former appropriations is less than $3,000, and that it is not prudent to plan for an expenditure on the breakwater exceeding $25,000.

The amount of $25,000 expended upon the breakwater will not construct an amount (including contingencies) exceeding 200 feet in length, that being at a rate of $125 per linear foot.

Upon the blue print map of Fairport Harbor, a part of inner end of breakwater, 282 feet in length, has been shaded with red lines. A glance at the map will show that the construction of a section 200 feet long in any part of the breakwater would not perceptibly change the conditions of the channel or the seas at the entrance between the piers. The small piece of breakwater would therefore accomplish no beneficial result, but it would, on the other hand, be subjected to extreme conditions of injury from ice and other causes, so that it would soon require an expenditure for repairs, and its first cost would be greater than if carried on when it can be built in larger amounts.

I do not, therefore, consider it justifiable either on the score of policy or of engineering to undertake any work upon the breakwater until a larger amount may be made available for the purpose by a further appropriation by Congress.

I therefore recommend that only such part of the appropriation, not in any case exceeding $10,000, be expended as may be required for maintenance of the channel and piers, and that the balance be held to await a further appropriation for the breakwater.

As neither the time nor amount of the necessary dredging or

Errata, Annual Report of the Chief of Engineers, United States Army, 1897.

[To be inserted at page 3085.]

Vessels.	Number.	Tonnage.
Entering	579	847,951
Departing	561	850,858
Total registered tonnage:		
1896		1,698,809
1895		2,184,982
Decrease		486,073

istered tonnage of vessels carrying the freight; this is doubtless due to the greater depth to which vessels are being loaded.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order on the bluff and a range of two beacons on the east pier.

Money statement.

July 1, 1896, balance unexpended	$41,204.32
June 30, 1897, amount expended during fiscal year	10,933.55
July 1, 1897, balance unexpended	30,270.77
Amount (estimated) required for completion of existing project	480,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Fairport Harbor, Ohio.

March 3, 1825	$1,000.00	June 18, 1878	$5,000.00
May 20, 1826	5,620.00	June 14, 1880	3,000.00
May 19, 1828	9,135.11	March 3, 1881	10,000.00
April 23, 1830	5,563.18	August 2, 1882	10,000.00
March 2, 1831	5,680.00	July 5, 1884	10,000.00
July 3, 1832	2,600.00	August 5, 1886	18,750.00
June 28, 1834	10,000.00	August 11, 1888	10,000.00
July 2, 1836	6,000.00	September 19, 1890	20,000.00
July 7, 1838	10,000.00	July 13, 1892	35,000.00
June 11, 1844	10,000.00	August 17, 1894	20,000.00
August 30, 1852	10,000.00	June 3, 1896	30,000.00
June 28, 1864	24,453.24		
June 23, 1866	24,072.00	Total	405,873.53
March 2, 1867	60,000.00	Expended to June 30, 1897	375,602.76
June 23, 1874	20,000.00		
March 3, 1875	15,000.00	Balance unexpended July 1, 1897	30,270.77
August 14, 1876	5,000.00		

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Fairport, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	1,054,920	Coal	398,717
Grain	135,047	Merchandise	154,194
Merchandise	154,192		
Total	1,344,159	Total	552,911

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IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

Ashtabula Harbor is in the Ashtabula River, near its mouth. The first improvements were made under an appropriation of $12,000, by act of May 20, 1826, "to remove obstructions at the mouth of Ashtabula Creek." Water was but 2 feet over the bar, and solid rock was at a depth of 9 feet.

The plan of improvement was the same as for other similar places, the construction of piers of timber work filled with stone on each side of the channel. These were at first placed upon the natural bottom of the lake 168 feet apart. They were subsequently repaired, extended, and renewed, and the channel was made deeper and wider, as the necessities of navigation arose, but the same general features of the original plan were continued until 1893, since which time no extensions have been made to the piers.

On the 30th of June, 1896, the east pier had been extended a length approximately 1,420 feet, to a depth of 16 feet in the lake. The Lake Shore and Michigan Southern Railway Company had, however, under authority of the Secretary of War, removed a portion, making an opening about 380 feet width to the slip on east side. The west pier had been extended to where the surface of rock in lake was 17 feet below mean lake level, and the total length was approximately 2,250 feet. The rock between piers had been removed to a depth of 20 feet, except a small strip 300 feet long and 50 feet wide.

Total expenditures for all purposes to June 30, 1896	$564,465.37

Work under the contract for removing rock and overlying material between piers to a depth of 20 feet was completed July 31, 1896. As the available funds were ample for the purpose the project for dredging was extended to cover the area in the channel as far as the county bridge. (See pp. 2961 and 2962, Report of Chief of Engineers, 1896.)

A supplementary contract was therefore authorized by the Chief of Engineers and was executed for completing all the rock removal with overlying material from work previously completed to the county bridge, a length of about 1,000 feet and an average width of about 160 feet.

Work under the supplementary contract was completed June 14, 1897.

The amount of material removed during the year has been:

23,741 cubic yards of rock, at 19 cents	$23,028.77
Removal overlying material, 109.7 hours' dredging, at $10	1,097.00
Total	24,125.77

Expenditures of the year have been divided as follows:

Liabilities of 1896 (dredging and superintendence)	$6,535.20
Retained payments and percentage, for dredging in 1896	8,548.39
Dredging channel to 20 feet in 1897	24,125.77
Superintendence, examinations of channel, and construction of plant	2,234.00
Office and engineering contingencies	2,766.00
Total	44,209.36

The channel now has a depth of 20 feet throughout from county bridge to the lake.

The east pier outside of Lake Shore slip is in good condition; inside of slip the old pier, a length of about 500 feet, is in such bad condition that most of the work above water has fallen off, and some of the filling of cribs has fallen out into the river.

The outer end of west pier, a length of 240 feet built in 1893, is in good condition, but the remainder of east pier is in poor condition.

The river and harbor act of June 3, 1896, appropriated $50,000 for improving Ashtabula Harbor and provided that "not less than forty thousand dollars shall be applied toward the construction of breakwaters according to a project submitted in the Annual Report of the Chief of Engineers for eighteen hundred and ninety-five."

A map showing the plan of the harbor and proposed breakwaters is shown in Report of Chief of Engineers for 1895, opposite page 3126. The estimate for repairing east pier and constructing breakwaters was $530,600.

The direction of west breakwater will be somewhat modified by making the angle of the meridian 30° instead of 45°, and making the length 1,800 feet, while the breakwater on the east side will be shortened to 1,200 feet.

The project having been approved by Congress and by the Secretary of War, proposals for constructing a section 432 feet in length of west breakwater were invited by public advertisement dated February 10, 1897. Proposals were received and opened March 5, and a contract for the work was awarded to the L. P. & J. A. Smith Company, of Cleveland, Ohio, the lowest bidder.

The work of construction was begun May 5, 1897, and at the end of the year one crib 216 feet in length and 30 feet wide was nearly ready to be placed in position and filled with stone, and work was commenced upon the second section.

When the survey for the location of breakwaters was made, the rock bottom of the lake at that place appeared to be so nearly free from any overlying material that the breakwater would rest upon the rock, and the contract was made upon that basis. An examination in the spring of 1897, however, finds the site for part of breakwater under contract covered with 1 to 2 feet of exceedingly fine sand overlying the rock. It has therefore been necessary to take steps to remove the material before sinking the cribs. A sand-pumping dredge was first employed, with but little success. It was therefore discharged, and an attempt will be made to remove the sand with the common dipper dredge owned by the United States and employed at Toledo Harbor.

The section of breakwater under construction is secured entirely with vertical angle timbers, driftbolts, screw bolts, and long iron rods, without dovetails anywhere and without timber heads exposed in the faces of walls. The grillage timbers project 2 feet outside of outer walls and are covered, making an apron, and thus giving a width of 34 feet at the base of the breakwater.

The section of 432 feet in length will be completed before the close of the working season.

The commerce of Ashtabula Harbor is very large and a more sheltered entrance is much needed. It would be a matter of much economy in the construction of the breakwaters, as well as of value in giving more immediate results, if the work may receive sufficient appropriations to complete it rapidly.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order varied by flashes and a fog signal operated by steam upon the west pier, also a beacon near the shore to form a range with the other light for vessels approaching the harbor.

Money statement.

July 1, 1896, balance unexpended		$97,935.84
June 30, 1897, amount expended during fiscal year		44,209.36
July 1, 1897, balance unexpended		53,726.48
July 1, 1897, outstanding liabilities	$187.82	
July 1, 1897, amount covered by uncompleted contracts	43,139.63	
		43,327.45
July 1, 1897, balance available		10,399.03
Amount (estimated) required for completion of existing project		480,600.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		480,600.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Ashtabula Harbor, Ohio.

May 20, 1826	$12,000.00	August 14, 1876	$5,000.00
May 19, 1828	2,403.50	June 18, 1878	12,000.00
March 3, 1829	6,940.25	March 3, 1879	9,000.00
March 2, 1831	7,015.00	June 14, 1880	20,000.00
July 3, 1832	3,800.00	March 3, 1881	20,000.00
March 2, 1833	3,400.00	August 2, 1882	20,000.00
June 28, 1834	5,000.00	July 5, 1884	22,500.00
March 3, 1835	7,591.00	August 5, 1886	30,000.00
March 3, 1837	8,000.00	August 11, 1888	25,000.00
July 7, 1838	8,000.00	September 19, 1890	40,000.00
June 11, 1844	5,000.00	July 13, 1892	70,000.00
August 30, 1852	10,000.00	August 17, 1894	75,000.00
March 3, 1853	42.64	June 3, 1896	50,000.00
June 23, 1866	24,708.82		
March 2, 1867	54,000.00	Total	662,401.21
March 3, 1871	15,000.00	Expended to June 30, 1897	608,674.73
June 10, 1872	15,000.00		
March 3, 1873	16,000.00	Balance unexpended	
June 23, 1874	35,000.00	July 1, 1897	53,726.48
March 3, 1875	25,000.00		

Abstract of proposals for constructing a part of west breakwater at Ashtabula Harbor, Ohio, received and opened by Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on March 5, 1897.

Items.	Quantities.	Bid per—	No. 1.—Joseph J. Churchyard, Buffalo, N. Y.		No. 2.—The L. P. & J. A. Smith Co., Cleveland, Ohio.	
			Rate.	Amount.	Rate.	Amount.
Hemlock timber.....feet B. M.	754,332	M feet B. M.	$18.00	$13,577.98	$18.00	$13,577.98
White pine.....do	340,344	.....do	28.00	9,529.63	28.00	9,529.63
White oak.....do	35,488	.....do	40.00	1,419.52	35.00	1,242.08
Stone.....cords	2,423	Cord			5.50	13,326.50
Iron rods.....pounds	56,189	Pound	.03	1,685.67	.02½	1,404.73
Driftbolts.....do	78,120	.....do	.02¼	1,757.70	.02¼	1,757.70
Screw bolts and washers..do	77,456	.....do	.03	2,323.68	.02½	1,936.40
Lag screws.....do	5,018	.....do	.05	250.90	.04	200.72
Spikes.....do	4,968	.....do	.03½	173.88	.03	149.04
Iron ladders.....do	297	.....do	.08	23.76	.05	14.85
Total						43,139.63

Abstract of proposals for constructing a part of west breakwater at Ashtabula Harbor, Ohio, etc.—Continued.

Items.	Quantities.	Bid per—	No. 3.—Carkin, Stickney & Cram, Detroit, Mich.		No. 4.—Rabbitt & Spear, Toledo, Ohio.	
			Rate.	Amount.	Rate.	Amount.
Hemlock timber.....feet B. M..	754,332	M feet B. M.....	$19.50	$14,709.47	$23.25	$17,538.22
White pine...............do....	340,344	.....do	26.50	9,019.12	31.50	10,720.84
White oak...............do....	35,488	.....do	36.00	1,277.57	38.50	1,366.29
Stone.....................cords..	2,423	Cord...........	6.75	16,355.25	7.00	16,961.00
Iron rods..............pounds..	56,189	Pound	.03½	1,966.62	$.02\frac{6}{10}$	1,460.91
Driftbolts ....do....	78,120	.....do	.02¾	2,148.30	$.02\frac{6}{10}$	2,031.12
Screw bolts and washers..do....	77,456	.....do	.03	2,323.68	$.02\frac{6}{10}$	2,013.86
Lag screws ....do....	5,018	.....do	.05	250.90	$.02\frac{6}{10}$	130.47
Spikes.....................do....	4,968	.....do	.04	198.72	$.02\frac{6}{10}$	129.17
Iron ladders..............do....	297	.....do	.10	29.70	$.02\frac{6}{10}$	7.72
Total	....	....	....	48,279.33	....	52,359.00

List of contracts for improving harbor at Cleveland, Ohio, in force during the fiscal year ending June 30, 1897.

Contract for constructing part of west breakwater. Name of contractor, The L. P. & J. A. Smith Company, Cleveland, Ohio; date of contract, March 26, 1897; date of approval, April 22, 1897; date of commencement, May 5, 1897; date of completion, September 30, 1897.

COMMERCIAL STATISTICS.

The following statistics for the year 1896 relative to the commerce of the harbor of Ashtabula, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore..............................	2,554,996	Coal	1,105,547
Cedar ties..............................	688	Coke.....................................	5,250
		Powder	200
		Lumber..................................	762
Total..............................	2,555,684	Total..............................	1,111,759

Total freight tonnage:

1896..	3,667,443
1895..	3,735,982
Decrease..	68,539

Vessels.	Number.	Tonnage.
Entering..	1,673	2,036,450
Departing	1,634	1,957,748
Built..	a2	423

a Tugs.

Total registered tonnage (vessels entering and departing):

1896..	3,994,198
1895..	4,410,984
Decrease..	416,786

Draft of largest vessels using harbor, 18 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

L L 11.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

The first improvement of Conneaut Harbor was made under provisions of an act approved March 2, 1829, the place then being designated as Conneaut Creek.

The usual method of confining the channel by parallel piers was continued until 1880, during which time there were seventeen appropriations, an aggregate of $112,629.39, expended for construction and maintenance of piers and channel. As a result the channel was in general deepened from about 2 feet to a little more than 8 feet, which was increased to 11 feet under favorable conditions.

In 1893 a project was adopted to extend parallel piers 200 feet apart to a depth of 17 feet in the lake, and to dredge to same depth between piers.

Estimated cost	$530,000.00
Total expended 1829 to June 30, 1896	192,448.47
Expended upon project of 1893 to June 30, 1896	79,819.08

A part of west pier 400 feet long and 24 feet wide was constructed under the appropriation of June 13, 1892. Under appropriation of August 17, 1894, a length of 600 feet of east pier 18 feet wide and 526 linear feet of pile revetment inside of shore line was constructed, besides dredging channel and bar and repairing old work and the 400 feet of west pier built by contract in 1894.

Most of the dredging of channel has been done by the Pittsburg, Shenango and Lake Erie Railway Company, which commenced making improvements at the harbor in 1892. During the past two years depths of water in the channel have been more than 17 feet.

The river and harbor act of June 3, 1896, appropriated $40,000 for improving Conneaut Harbor, and required that "not less than twenty thousand dollars shall be applied toward the construction of a breakwater according to the project submitted March twenty-fourth, eighteen hundred and ninety-six."

This project is a modification and extension of the project of 1893, and consists of two breakwaters having their outer ends in a depth of about 26 feet and their directions diverging toward the shore at an angle of 30° on each side of the axis of the channel. (See map opposite p. 2972, Report of Chief of Engineers, 1896.)

The project of 1893, as enlarged and amended in 1896, was estimated to cost $610,000.

Experience in construction of part of west pier by contract, as compared to construction of part of east pier by hired labor, indicated very conclusively that the latter method of doing the work at Conneaut is the most economical and advantageous to the United States.

Proposals for timber, iron, and stone were invited by public advertisement dated February 8, and were opened February 26, 1897.

Contracts for pine timber, hemlock timber, iron, and stone were awarded to the lowest bidders, respectively. At the end of the year all the materials had been delivered except stone, which will be delivered as required for filling the cribs and superstructure of breakwater.

The work of framing cribs was commenced April 1. At the end of the year one crib 144 feet long was nearly ready to be towed into position and sunk, being 17 feet high. Three of the four sections of grillage for second crib, which is to be 138 feet long, had been launched, 190 cords of brush had been cut, and 175 fascines 15 inches in diameter and 30 feet long had been made.

The construction is to commence at the inner end of west breakwater. The part now being constructed is to be 24 feet wide with a base made 36 feet wide by means of grillage timbers projecting at the bottom, as shown in design for east pier at Cleveland Harbor, opposite page 2952, Report of Chief of Engineers, 1896. The natural bottom of the lake at the site for this part of the work is of very hard sand, with water 18 to 20 feet deep. Recent examinations have shown that at the site for inner end of west breakwater the sand is underlaid by rock several feet below, but as the rock is irregular, it is not considered advisable at present to attempt to place the breakwater upon its surface. The sand is to be dredged to a depth of 21.5 feet, and it is estimated that the walls of the crib will settle 6 inches into the sand; the grillage timbers will then bear upon the hard sand and no further settling is anticipated.

The cribs, of 144 feet and 138 feet in length, are constructed upon the same general design as the crib for east pier at Cleveland Harbor, shown on sheet opposite page 2952, Report of Chief of Engineers, 1896, and described on pages 2944 and 2945 of same report. The work will, however, have a superstructure of timber filled with stone, and the foundations will be protected with mattresses of brush fascines 30 feet long on lake side of crib apron and 20 feet long on harbor side. The mattresses and aprons are to be fully covered with large stone.

As the law requires that not less than $20,000 shall be expended upon the breakwater, the amount available for other work is of necessity limited to the remainder of the appropriation. The estimated cost of removing the rock between piers to a grade of 20 feet was $22,000, besides the cost of removing other material by dredging. The available funds were therefore insufficient to clear the obstructions in the channel and it would result in little or no benefit to remove a part only.

Part of the old east pier is situated over the rock to be removed in the channel, but as it serves to keep vessels off the rock it is not considered advisable to remove it until the entire channel can be cleared and dredged to full depths.

As the breakwater is of much more present importance than the piers, the project for expenditure of appropriation of June 3, 1896, is to expend $35,000 of the amount upon breakwater and to reserve $5,000 for maintenance and contingent expenses.

It has been ascertained that some of the commercial statistics received for this port, although gathered from sources presumed to be reliable, were inaccurate in some particulars. A new statement is therefore submitted with this report, giving the actual freights from 1892 to 1896.

Previous to 1892 there had been no commercial business at the harbor for many years. On the 3d of November, 1892, the steamer *C. J. Kershaw* arrived at the port with 1,130 gross tons of ore, equal to 1,265.6 net tons. In 1896 the receipts and shipments amounted to 443,031 tons.

The railroad from Conneaut to the coal and iron districts near Pittsburg, Pa., has recently been greatly improved in both curves and grades, and extensive wharves and docks are being constructed at Conneaut Harbor. Some of the largest interests in the country are developing Conneaut Harbor as a port for transfer of coal and iron, and manufacturing companies are likely to follow.

It is anticipated that the present year will show a considerable increase in freights, and that in 1898 the port will be among the largest shipping places on the lake.

Under these circumstances it is especially desirable to complete the breakwaters as soon as practicable.

Conneaut Harbor is 13 miles east of Ashtabula Harbor, and is near the boundary between Ohio and Pennsylvania. It is the collection district of Cuyahoga, Ohio. There are two fixed white lights of the sixth order upon the west pier at the mouth of the river, forming a range for vessels approaching to enter the harbor.

Money statement.

July 1, 1896, balance unexpended		$40,180.92
June 30, 1897, amount expended during fiscal year		1,696.54
July 1, 1897, balance unexpended		38,484.38
July 1, 1897, outstanding liabilities	$13,268.45	
July 1, 1897, amount covered by uncompleted contracts	7,788.00	
		21,056.45
July 1, 1897, balance available		17,427.93
Amount (estimated) required for completion of existing project		495,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		495,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Conneaut Harbor, Ohio.

March 2, 1829	$7,500.00	March 3, 1873	$400.00
April 23, 1830	6,135.65	June 23, 1874	1,500.00
March 2, 1831	6,370.00	March 3, 1875	1,000.00
July 3, 1832	7,800.00	June 14, 1880	6,000.00
July 2, 1836	2,500.00	July 13, 1892	40,000.00
March 3, 1837	5,000.00	August 17, 1894	40,000.00
July 7, 1838	8,000.00	June 3, 1896	40,000.00
June 11, 1844	5,000.00		
August 30, 1852	10,000.00	Total	232,629.39
June 23, 1866	20,513.74	Expended to June 30, 1897	194,145.01
March 2, 1867	10,000.00		
April 10, 1869 (allotment)	8,910.00	Unexpended July 1, 1897	38,484.38
July 11, 1870	6,000.00		

Abstract of proposals for furnishing and delivering timber, iron, and stone for construction of breakwater at Conneaut Harbor, Ohio, received and opened by Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, February 26, 1897, at 2 o'clock p. m., standard time, in accordance with advertisement dated February 8, 1897.

[Amount available for the purchases, $22,000.]

TIMBER.

No. of proposal.	Name and address of bidder.	Hemlock (453,948 feet B. M.).		White pine (200,148 feet B. M.).		White oak (20,258 feet B. M.).		Remarks.
		Per M feet B. M.	Total of bid.	Per M feet B. M.	Total of bid.	Per M feet B. M.	Total of bid.	
1	Edward F. Loud, Au Sable, Mich.	$10.98	$4,984.35					Lowest bid received for hemlock timber.
2	Riley & McCafferty, Greenville, Pa.					$19.50	$395.03	Lowest bid received for white-oak timber.
3	Charles H. Carleton, Cleveland, Ohio.	14.00	6,355.27	19.40	3,883.57	24.00	486.19	Lowest bid received for white-pine timber.
4	Work & Yeend, Ravenna, Ohio.					22.00	445.68	
5	Emery D. Weimer, Ludington, Mich.	14.25	6,468.76	21.25	4,253.91			
6	Cleveland Sawmill and Lumber Co., Cleveland, Ohio.			21.00	4,203.86			
7	Otto T. Wais, Toledo, Ohio.			20.50	4,103.77			

Abstract of proposals for furnishing and delivering timber, iron, and stone for construction of breakwater at Conneaut Harbor, Ohio, etc.—Continued.

IRON.

No. of proposal.	Name and address of bidder.	Screw bolts and washers (52,141 pounds).		Driftbolts (48,971 pounds).		Lag screws (4,437 pounds).		Iron rods (31,048 pounds).		Spikes (4,200 pounds).		Ladders (198 pounds).		Total of bid for all the iron.
		Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	Per lb.	Total.	
		Cts.		*Cts.*		*Cts.*		*Cts.*		*Cts.*		*Cts.*		
8	W. P. Stanton, Cleveland Ohio	1.5	$782.12	1.4	$685.59	1.85	$82.98	1.7	$527.82	1.65	$69.30	5.25	$10.40	$2,157.81
9	Thompson C. Gill & Co., Philadelphia, Pa.*a* ..	1.34	698.69	1.29	631.72	1.34	59.46	1.34	416.04	1.49	62.58	1.59	3.15	1,871.65
10	John P. McGuire, Cleveland, Ohio	2.1	1,094.96	1.7	832.51	1.9	84.30	2	620.96	1.9	79.80	2.75	5.45	2,717.98
11	Wallace M. Pattison, Cleveland, Ohio.....	1.65	860.23	1.375	673.35	3.25	144.20	1.65	512.29	1.7	71.40	10	19.80	2,281.37

a Lowest bid received for iron.

STONE.

No. of proposal.	Name and address of bidder.	Filling stone (6,600 tons).		Riprap stone (2,500 tons).		Remarks.
		Per ton.	Total.	Per ton.	Total.	
12	Breckenridge & Uber, Grove City, Pa.	....	....	$0.95	$2,375.00	Lowest bid received for riprap stone.
13	The Kelley Island Line and Transport Co., Cleveland, Ohio.	$1.18	$7,788.00	1.75	4,375.00	Lowest bid received for filling stone.

Proposals numbered 1, 2, 4, 6, 7, and 9 are informal and incomplete.
Proposal numbered 4 was received in duplicate.
The proposal of Edward F. Loud, for hemlock; Riley & McCafferty, for white oak; Charles H. Carleton, for white pine; Thompson C. Gill & Co., for iron; Breckenridge and Uber, for riprap stone, and The Kelly Island Lime and Transport Company, for filling stone, are recommended for acceptance they being the lowest received in each case.

LIST OF CONTRACTS FOR IMPROVING HARBOR AT CONNEAUT, OHIO, IN FORCE DURING THE FISCAL YEAR ENDING JUNE 30, 1897.

Name and address of contractor.	Contract.	Date of contract.	Date of approval.	Date of commencement.	Date of completion.
Edward F. Loud, Au Sable, Mich.	Furnishing and delivering hemlock timber.	Mar. 26, 1897	Apr. 9, 1897	Apr. 15, 1897	May 30, 1897
Charles H. Carleton, Cleveland, Ohio.	Furnishing and delivering white pine timber.	Mar. 25, 1897	Apr. 15, 1897	Apr. 30, 1897	June 30, 1897
Thompson C. Gill & Co., Philadelphia, Pa.	Furnishing and delivering iron.	Mar. 26, 1897	Apr. 15, 1897	Apr. 15, 1897	May 30, 1897
Breckenridge & Uber, Grove City, Pa.	Furnishing and delivering riprap stone.	Mar. 26, 1897	Apr. 15, 1897	June 1, 1897	Sept. 30, 1897
The Kelley Island Lime & Transport Co., Cleveland, Ohio.	Furnishing and delivering filling stone.	Mar. 19, 1897	May 6, 1897	June 1, 1897	Sept. 30, 1897

COMMERCIAL STATISTICS.

It has been ascertained that in some years the statistics of freight at this harbor have been inaccurate. Certain items in doubt have therefore been omitted, and a comparative table showing freights from 1892 to 1896 is here given. Actual freights are probably slightly in excess of amounts in the table:

Year.	Receipts.		Shipments.		Total.
	Articles.	Quantity.	Articles.	Quantity.	
		Tons.		Tons.	Tons.
1892	Iron ore	1,265.6			1,265.6
1893	do	227,692	Coal	20,103	247,795
1894	do	266,454	do	77,542	343,996
1895	do	330,915	do	74,603	405,518
1896	do	366,928	do	73,016	443,031
	Salt	863			
	Steel billets	2,224			

Total freight tonnage.

1896	443,031
1895	405,518
Increase	37,513

Vessels—	Number.	Tonnage.
Entering	582	761,634
Departing	566	757,539

Total registered tonnage.

1896	1,519,173
1895	927,833
Increase	591,340

Draft of largest vessels using harbor, 17 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

L L 12.

PRELIMINARY EXAMINATION OF RAISIN RIVER, IN MONROE COUNTY, MICH., FROM MOUTH TO GOVERNMENT CANAL TO THE WHARVES.

[Printed in House Doc. No. 81, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of August 26, 1896, by Lieut. Col. Jared A. Smith, Corps of Engineers, of the results of a preliminary examination of Raisin River, in Monroe County, Mich., from the mouth to Government Canal to the wharves, made to comply with requirements of the river and harbor act of June 3, 1896.

Work at this locality has been carried on and is contemplated under appropriations for improving Monroe Harbor, Michigan, and Colonel Smith states that—

In view of the facts regarding the location, condition, and commerce of the Raisin River, it is my opinion that the cost of any extension of improvements heretofore planned would vastly exceed the probable benefits to the commerce of the country. Whatever benefits might accrue would be local in extent, and it is doubtful if even the local benefit would be very great.

The maintenance of the piers, canal revetment, and light-house involves all the expense which can be justified by the present or probable commerce or business of the place.

I concur in his views.

This work is reported upon in the Annual Report of the Chief of Engineers under the title of Improvement of Monroe Harbor, Michigan.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, August 26, 1896.

GENERAL: In compliance with request in letter from Office of Chief of Engineers, dated August 11, 1896, I have the honor to submit the following report of preliminary examination of the "Raisin River, in Monroe County, from mouth of Government Canal to the wharves," as required by section 8 of the river and harbor act of June 3, 1896:

The mouth of the Raisin River is in the westerly end of Lake Erie, about midway between the mouth of the Detroit River and the entrance to Maumee Bay.

The part indicated in the act of Congress requiring this report has been improved at various times, and is usually designated as the harbor of Monroe, Mich.

The mouth of the river was formerly in a small bend in the shore, then known as La Plaisance Bay. By an act of Congress approved May 20, 1826, the sum of $200 was appropriated for a survey of La Plaisance Bay, to ascertain the expediency of improving the navigation thereof and the expense of effecting the same. The report stated that the greatest available depth was 9 to 10 feet, and that the bay was surrounded, except on the side of the lake, by a marsh about 1 mile broad. The construction of a harbor of refuge in the bay was recommended, and this was in progress from 1828 to 1835, when it was completed. The total cost was $19,014.87.

It became apparent that a better refuge for vessels and harbor for Monroe would be obtained by making a direct channel from the lake into the river by a canal which should cross the neck of the swampy peninsula which separated the river from the lake. Accordingly, the act of Congress approved February 24, 1835, appropriated $30,000 "for the construction of a new entrance into the harbor, at or near the mouth of the river Raisin, where it unites with Lake Erie, according to a plan and survey of the said works, made under the direction of the War Department, by Capt. H. Smith during the fall of the year eighteen hundred and thirty-four."

The improvement, as then planned, consisted of a canal 4,000 feet long, 100 feet wide, and 10 feet deep, across the neck of the peninsula at a point about 1¼ miles above the outlet which was then the river's mouth. The mouth of the canal was to be protected by piers on each side projecting to a depth of 10 feet in the lake.

This work was completed many years ago, and in 1849 a light-house was established on the outer end of the north pier, where a light station and keeper's dwelling are still maintained.

From February 24, 1835, to June 3, 1896, inclusive, there were twenty-two appropriations for improving the harbor of Monroe, Mich., the aggregate amount expended to June 30, 1896, being $240,437.08.

The appropriation of $5,000 by act of June 3, 1896, has not been expended, but will probably be expended during the summer of 1897.

The length of channel from ends of piers to wharves, which are about 1 mile from the main portion of the city, is about 2½ miles. On the 17th of July, 1896, a few soundings were taken in the channel between piers and on prolongation of piers into the lake. The depths showed but very little change since 1892. The least depth outward on prolongation of south pier was 8 feet; on prolongation of middle line between piers, 9 feet; on prolongation of north pier, 9.3 feet; greatest depth between ends of piers, 10.6 feet. A channel of nearly 10 feet in depth may generally be found from piers to lake on a line to northward of the extension of piers.

At the wharves, and for a few hundred feet below, the depths are in general from 8 feet to 9 feet; through the remaining part of the river above the canal there is a mid-channel depth of 9 feet to 10 feet over a width of 50 feet to 75 feet; in the canals the depth is 12 feet to 15 feet. All depths refer to mean level, 1860 to 1875.

The commerce of Monroe Harbor has never been very large, and of later years it has declined to a very small amount. In the calendar year 1895 the total receipts were 4,341 tons of cedar poles, 218 tons of sand, and 15 tons of ties and fence posts. There were no shipments from the harbor by water. In 1894 the receipts exceeded 25,000 tons.

The location of Monroe necessarily separates it from the great trunk lines of railroad, and it is midway between the large commercial cities of Detroit and Toledo, both of which have vastly more favorable conditions for railroad and water transportation, so that, were the depth at Monroe much greater than now, it is not probable that any great commercial interests would thereby be developed.

By far the greatest interest in the harbor at present is its use as a resort during the heated summer months. A hotel has been constructed near the beach on the north side of the canal, and, with bath houses and other attractions, added to various club houses and camps, the place is a favorite resort for people, most of whom are from Toledo, and who furnish business for several small steamers, which run only to the piers at the mouth of the canal.

The points regarding commerce of the harbor of Monroe were fully stated and commented upon in my annual report for the fiscal year ending June 30, 1896.

In view of the facts regarding the location, condition, and commerce of the Raisin River, it is my opinion that the cost of any extension of improvements heretofore planned would vastly exceed the probable benefit to the commerce of the country. Whatever benefits might accrue would be local in extent, and it is doubtful if even the local benefit would be very great.

The maintenance of the piers, canal revetment, and light-house involves all the expense which can be justified by the present or probable commerce or business of the place.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

APPENDIX M M.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND OF CERTAIN RIVERS AND HARBORS IN WESTERN NEW YORK.

REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Dunkirk Harbor, New York.
3. Buffalo Harbor, New York.
4. Tonawanda Harbor and Niagara River, New York.
5. Niagara River from Tonawanda to Port Day, New York.
6. Wilson Harbor, New York.

EXAMINATION.

7. Ship canal from the Great Lakes to the Hudson River.

SURVEYS.

8. Erie Harbor, Pennsylvania.
9. Buffalo entrance to Erie Basin and Black Rock Harbor, New York.
10. Report on House bill No. 7775, for widening the locks of the Erie Canal, New York.

HARBOR LINES.

11. Bay of Presque Isle, at Erie, Pennsylvania.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 20, 1897.

GENERAL: I have the honor to forward herewith annual reports * * * of the works under my charge, as follows:

* * * * * * *

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

M M 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

Original condition.—In its original condition the harbor of Erie was landlocked, the only entrance being to the east. The channel leading in and out was narrow and tortuous, variable in position, and with a depth of only about 6 feet.

Project for improvement.—The project for the improvement of the harbor as originally prepared in 1823 and approved in 1824 (at which time the entrance to the bay was narrow and tortuous and only 6 feet in depth), provided for closing all of the eastern end of the harbor by means of a breakwater, in which should be left an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on each side of the opening. This project is substantially in force at the present time, excepting that the piers are 360 feet apart. It is understood that the project includes the necessary work of dredging to keep the channel open to the required width and depth, to make the required repairs to existing structures, and to do such work as may be found necessary from time to time for the preservation and care of Presque Isle Peninsula. This peninsula is the outer inclosure of the harbor of Erie, which is a landlocked bay about 5 miles long, having a maximum width of 1½ miles. The peninsula is a low sand formation about 6 miles long, varying in width from 300 feet at the "neck" to 1½ miles at its widest part. The "neck" is about 2 miles long and joins the body of the peninsula to the mainland at its western end.

The preservation of the peninsula is of vital importance to Erie Harbor, and it is for the purpose of preserving the harbor that the protection of the weak parts of the peninsula has been deemed necessary. The weak portion is the long, narrow neck at the western end. The object for which all the works of protection have been constructed is the prevention of a breach through this narrow neck. The danger exists during severe storms from the westward.

At the present time there are no protection works, except a few dilapidated pile jetties no longer of service, and the main line of piles, mattresses, and stone ballast on mattresses of the shore protection constructed in 1889.

During the past winter the outer shore of the peninsula opposite "Big Bend" was eroded for about a mile in length and 30 to 50 feet in width, but there was no cutting along the narrow portions of the peninsula.

Object.—The objects of the improvements made are—

1. To protect the harbor from severe winds from the east and northeast.
2. To obtain and maintain a channel between deep water in the harbor and the open lake 16 feet deep at low water and of navigable width.
3. To prevent the filling up and damage to the harbor by keeping the peninsula intact.

Present works.—The present works which require to be maintained consist of—

1. A breakwater lying in a north and south direction from the main shore to the south side of the entrance channel.
2. A pier on the south side of the entrance channel nearly east and west in position.
3. A pier on the north side of the entrance channel parallel with and 360 feet distant from the pier above mentioned.

A north breakwater from the north pier to the main portion of the peninsula was also built, but it has fulfilled all its functions and is buried in accumulations of sand, and needs no further consideration or maintenance.

In 1883 there was also built a sand-catch jetty about 3,000 feet north of the channel entrance, but it never fulfilled its purpose and is badly wrecked, and it is not proposed to repair it. It is hardly to be classed as one of the harbor works.

The piers and breakwater consist of timber crib work, filled with stone and covered with a pine-plank deck.

The sand-catch jetty consisted of a single row of piles driven close together and bound with oak walings.

A large amount of work was done in former years at the neck of the peninsula in building pile jetties, shore protection, crib work, sand fences, etc., but these works have either fulfilled their objects and are buried in the sands or have been wrecked, and are not considered worthy of maintenance.

During the spring of 1896 some 2,000 young trees and cuttings were set out on the neck of the peninsula with a view of thickening the plant growth, arresting the drifting sand, and augmenting the width and raising the height of the neck, thus increasing its power to resist erosion, and so lessening the liability of a breach in times of high water and severe storms. These trees as a whole did very well, particularly the locusts, which developed bushy tops, good roots, and a sturdy growth. More of these were planted during the spring just passed, as stated in the report of operations.

Original estimate of cost.—The original estimated cost of the existing project can not well be determined, and would be of little value, as the project has been modified and changed many times and the cost of construction and maintenance could hardly be separated.

The total amount expended by the General Government on the improvement of Erie Harbor to June 30, 1896, was $898,681.33, and the amount expended during the fiscal year ending June 30, 1897, was $11,781.58.

REPORT OF OPERATIONS.

Repairs to piers and breakwater.—The repairs to the piers and breakwater which were being made at the close of the last fiscal year were completed in July, 1896, at a cost of $176.74. The structures have remained intact throughout the year and no further repairs have been necessary.

Dredging in channel.—Under the contract with Hingston & Woods, of Buffalo, N. Y., 29,399 cubic yards of material was dredged from the channel, from September 15 to November 19, 1896. This work placed the channel in good condition, in which it remained to the close of the fiscal year, having a depth at low water of not less than 16 feet for a width of 225 feet.

Riprap stone.—Under the contract with Hingston & Woods, of Buffalo, N. Y., 781 cubic yards of riprap stone was placed along the outer 250 feet of the north pier, from September 14 to October 28, 1896. At the completion of the work there was about 11 feet of water at mean lake over the stone.

Survey of harbor and peninsula.—The survey of the harbor and peninsula was begun July 20, 1896, and the field work was completed September 19, 1896.

The survey was made with transit and stadia, and was based on a closed system of triangulation. Lines of soundings were run in the lake to 25 and 30 feet of water at right angles to the shore from stations about 500 feet apart. Soundings in the harbor were carried over a large portion of its eastern and western ends.

The survey was carefully tied to the city monuments at street intersections. Data for connecting the survey with the official maps of the city was kindly furnished by the city engineer.

All triangulation stations were permanently marked. Cost of the fied work of the survey, $682.82.

Removal of wrecks.—Two wrecks in the harbor, one of a small schooner, the *Pacific*, the other of a small steamer, the *Annie Laurie*, from which all the machinery had been removed, were removed under agreement with Messrs. Thacher & Breymann, of Toledo, Ohio, on August 2 and 3, 1896, at a cost of $300.

Change of water gauge.—The water gauge was raised 1.56 feet on September 7, 1896, so that the zero of the gauge would be at mean lake level, 572.86 feet above mean tide at New York.

Survey of the channel.—A survey of the channel was made April 21–23, 1897, at a cost of $15.15.

Waterworks intake.—The laying of the new intake pipe of the Erie waterworks was completed in August, 1896, and the intake crib placed in Big Bend. This crib is guarded by a white spar buoy. Depth of water over crib, about 14.5 feet.

Harbor lines.—By authority of the Secretary of War, harbor lines were established along the water front of the city of Erie as follows:

> Beginning at a point in the prolongation of the west city line of the city of Erie, Pa., 2,290 feet northerly from the center line of Second street; thence easterly parallel with the center line of Second street to a point 265 feet east of the center line of Holland street extended; thence in a straight line to the northerly end of the United States south breakwater at its junction with the United States south pier.

Approved by the Secretary of War December 17, 1896.

Preservation of Presque Isle Peninsula.—The watchman was on duty throughout the year patrolling the peninsula. No serious depredations were committed during the year. A few sassafras trees were dug up, and a few other small trees destroyed by trespassers. A few small fires occurred during the year.

Tree planting on the neck of the peninsula.—Continuing the work begun last year, 2,400 yellow locust trees were planted on the neck of the peninsula April 13–29, 1897. All of these trees were enriched with manure and leaf mold. In addition, about two bushels of seeds of native shrubs were gathered and carefully planted.

The cost of planting trees and seeds was as follows:

Cost of trees	$154.00
Cost of manure and leaf mold	66.41
Cost of labor, planting	156.05
Total	376.46

So far the work has been a decided success. The trees planted last year, with the exception of the Scotch pines, are growing vigorously. It is not proposed to plant any more trees for the present, as the ground has been well covered.

A fence of heavy cedar posts and barbed wire was built across the neck of the peninsula in August, 1896, to prevent wagons from being driven among the newly planted trees. Cost of the fence, for material, and labor, $34.91.

Current observations in entrance channel.—In order to decide whether dangerous currents are developed between the piers in the entrance channel due to sudden rise and fall of water, it was decided to make observations by means of rod floats. Accordingly, 100 rod floats were prepared in April, 1897. The rods are of white pine, 1½ inches square, and about 8 feet long, weighted with gas pipe about 1½ feet long, so as to float about 1½ feet out of water, or with 7 to 8 feet of rod under water.

A base line 1,000 feet long was laid off on the north pier, with ranges on the south pier, at each end and at the 500-foot point. Observations are to be taken whenever there is a markedly strong current either in or out, as follows: The float to be started back of the initial range and well out into the current, the time then to be taken as it passes each range. Arrangements were made with the crew of the life-saving station for taking these observations.

REMARKS AS TO ERIE HARBOR.

The last river and harbor act required a new survey and preparation of plans and estimates for improvement of Erie Harbor. This was assigned to my charge, and a report upon it was submitted under date of May 24, 1897. As this provides for a new project and makes new estimates of cost, it is not deemed necessary to further refer to the harbor here.

Money statement.

July 1, 1896, balance unexpended		$47,902.79
May 12, 1897, repayment to appropriation		1.00
		47,903.79
June 30, 1897, amount expended during fiscal year		11,781.58
July 1, 1897, balance unexpended		36,122.21
July 1, 1897, outstanding liabilities	$600.00	
July 1, 1897, amount covered by uncompleted contracts	6,550.90	
		7,150.90
July 1, 1897, balance available		28,971.31
Amount (estimated) required for completion of existing project		(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899		(*)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Statement of appropriations and allotments made for improving harbor at Erie, Pa., from 1823 to the present time.

1823, allotment	$150.00	March 3, 1871	$29,000.00
May 26, 1824	20,000.00	1871, allotment	10,000.00
May 25, 1826	7,000.00	June 10, 1872	15,000.00
March 2, 1827	2,000.00	June 23, 1874	20,000.00
May 19, 1828	6,223.18	March 3, 1875	80,000.00
March 3, 1829	7,390.25	August 14, 1876	40,000.00
March 2, 1831	1,700.00	June 18, 1878	25,000.00
July 3, 1832	4,500.00	March 3, 1879	25,000.00
March 2, 1833	6,000.00	June 14, 1880	25,000.00
June 28, 1834	23,045.00	March 3, 1881	20,000.00
March 3, 1835	5,000.00	August 2, 1882	20,000.00
July 2, 1836	15,122.80	July 5, 1884	50,000.00
March 3, 1837	15,000.00	August 5, 1886	37,500.00
July 7, 1838	30,000.00	August 11, 1888	†83,000.00
June 11, 1844	40,000.00	September 19, 1890	40,000.00
August 30, 1852	30,000.00	1891, received from sales	4,716.89
1864, allotment	15,000.00	July 13, 1892	40,000.00
June 23, 1866	36,961.00	August 17, 1894	10,000.00
March 2, 1867	25,000.00		
1868, allotment	40,000.00	Total	946,584.12
1869, allotment	22,275.00	May, 1897, repayment	1.00
June 11, 1870	20,000.00		

*New project reported.

†Includes $60,000 appropriated at the same time for "preservation and protection of Presque Isle Peninsula," reported separately in previous reports.

Abstract of proposal for dredging, and furnishing and placing stone riprap in Erie Harbor, Pennsylvania, received in response to advertisement of June 19, 1896, and opened July 20, 1896, by Maj. T. W. Symons, Corps of Engineers.

Name and address of bidder.	Dredging, per cubic yard, measured in scows.	Stone riprap furnished and placed, per cubic yard, measured on vessels.	Remarks.
Hingston & Woods, Buffalo, N. Y.	$0.19	$2.45	Only bid received. Accepted, and written contract made.

Contract now in force.

Number.	Name of contractor.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration.
1	Hingston & Woods, Buffalo, N. Y.	Aug. 10, 1896	Aug. 15, 1896	Sept. 15, 1896	Nov. 30, 1897

REMARKS.—For dredging, and furnishing and placing stone riprap.

COMMERCIAL STATISTICS OF ERIE HARBOR, PENNSYLVANIA.

Arrivals and departures of vessels for the year ending December 31, 1896.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.	Number.	Tons.
Steam	1,314	1,694,782	75	12,515	1,320	1,700,113	66	3,875
Sail and barges	140	106,338	26	7,449	145	107,957	14	1,813
Total	1,454	1,801,120	101	19,964	1,465	1,808,070	80	5,688

Greatest draft of vessels, 16½ feet.
Total arrivals and departures: Number, 3,100; tonnage, 3,634,842.
Increase of tonnage, 1896 over 1895, 311,170 tons.
Value of imports: By lake, $12,132; by rail, $6,833.
Value of exports: By lake, $16,503; by rail, none.
Enrolled tonnage, port of Erie, 1896, 38,787.60 tons.
No new lines of transportation established.
Amount of revenue collected for year ending December 31, 1896, $5,081.60.

Receipts and shipments by lake.

[Tons of 2,000 pounds.]

RECEIPTS.

Articles.	1891.	1892.	1893.	1894.	1895.	1896.
Merchandise	21,611	37,491	68,374	86,120	82,329	123,387
Barley	1,923	1,900	1,825	9,640	3,716	3,399
Corn	58,720	147,256	210,770	74,252	77,276	191,621
Oats	2,905		5,743	80	805	6,156
Rye	17,440	10,915	6,232	2,656	2,239	4,929
Wheat	206,152	237,620	101,051	67,665	53,315	169,305
Flaxseed	14,690	7,866	6,877	2,055	7,837	20,092
Flour	97,198	200,190	170,438	219,289	191,811	190,720
Malt				516		
Lumber	14,249	21,567	12,843	14,463	26,182	11,762
Laths	352	343	135	93	14,443	300
Shingles		20				22
Stave bolts	1,500	863				
Poles				111	157	
Ties				909		
Iron ore	441,669	720,504	549,205	721,514	907,258	925,071
Pig iron	5,175	4,432		741	5,783	13,810
Copper		704	2,410	14,495	21,572	31,987
Lead			5,544	11,535	1,593	5,333
Limestone	14,343	5,626	12,991			
Stone	4,668					
Plaster	15,169	1,784	21,294	14,614	1,201	2,430
Scrap iron						18,780
Steel billets						631
Produce	3	12				
Total	917,767	1,399,103	1,175,732	1,240,748	1,397,517	1,719,785

SHIPMENTS.

Articles.	1891.	1892.	1893.	1894.	1895.	1896.
Anthracite coal	470,716	428,735	338,973	474,887	537,628	492,563
Bituminous coal	176,704	133,675	78,387	265,037	233,489	179,640
Pig and manufactured iron		400				
Merchandise	109,030	110,592	45,918	89,187	87,323	81,731
Tar and oil	2					
Stone		550				
Total	756,452	673,952	463,278	829,111	858,440	753,934

The following table, compiled from the reports of the Chief of Engineers, gives the combined number of arrivals and departures and the tonnage of arriving and departing vessels for the past ten years:

	1887.	1888.	1889.	1890.	1891.
Arrivals and departures	1,221	2,111	2,488	2,694	2,437
Tonnage	1,451,767	1,852,601	2,351,485	2,480,853	2,343,566

	1892.	1893.	1894.	1895.	1896.
Arrivals and departures	2,180	1,677	2,687	2,936	3,100
Tonnage	2,409,945	1,701,542	3,069,545	3,323,672	3,634,842

M M 2.

IMPROVEMENT OF HARBOR AT DUNKIRK, NEW YORK.

Original condition.—The harbor at Dunkirk is naturally a simple indentation of the south shore of Lake Erie. It lies between Point Gratiot on the west and Battery Point on the east. Between the two points is a distance of about 9,600 feet, and the maximum breadth of the bay behind the line of the two headlands is 3,600 feet. The general natural depth of water in the bay is about 10 feet. The bay is underlaid with rock at an average depth of 15 to 16 feet. The object of the improvement is to form an artificial protected harbor in the indentation or bay above described.

Project for improvement.—The original project was adopted in 1827, and, with its subsequent modifications, provided for the construction of a pier running out from the west shore of the indentation and a detached breakwater parallel with the pier and about 2,000 feet distant from the city front. An opening between the two structures provided a harbor entrance through which a channel leading to the docks was to be deepened to 13 feet. By 1832 the sum of $28,439.84 had been expended on the original plan, and the breakwater was then 2,564 feet long and the pier 1,400 feet long. Subsequently various improvements and repairs were made. In 1848 the breakwater was demolished.

In 1870 the question of the improvement of this harbor was referred to a board of engineers. The board recommended a plan which provided for a detached breakwater 2,860 feet long, one part of which, 2,300 feet long, was to be nearly parallel with the shore, the other part, 560 feet long, to be nearly parallel with the axis of the channel entrance and terminating at the position of the day beacon.

This breakwater and the pier already built were to form the harbor, and the old channel was to be enlarged to 170 feet wide and 13 feet deep.

All the works now existent at Dunkirk have been built in accordance with this plan. The project adopted by Congress and provided for by the river and harbor act of June 3, 1896, consists of completing the breakwater as before planned by the addition of 310 feet to its eastern end, adding the channel arm, 560 feet long, and in addition thereto dredging an entrance channel and a harbor basin, containing in all about 65 acres, to a depth, at mean lake level, suitable for vessels drawing 16 feet. The estimated cost to complete this project was $408,258, divided as follows:

Extension of breakwater, channel arm, construction of day beacon, and repairs to existing structures	$74,900
Dredging for channel and basin to a depth of 17 feet, to secure a navigable depth of 16 feet	306,650
Contingencies, engineering, etc	26,708
Total	408,258

The total amount expended on the harbor by the General Government to June 30, 1896, was $551,721.52.

The amount expended during the fiscal year ending June 30, 1897, was $11,696.71.

The law of June 3, 1896, having authorized the entering into contract for the radical improvement of Dunkirk Harbor, specifications for this work were prepared and on March 22, 1897, bids for the work were opened and the contract was let to Edward J. Hingston, Buffalo, N. Y.

The work contracted for at Dunkirk consists of the excavation of about 555,000 cubic yards of material, of which it is estimated that 475,000 cubic yards is mud, sand, gravel, etc., and 80,000 cubic yards is rock; the replacement of 680 linear feet of the decayed superstructure of the west pier with concrete; the building of a timber crib structure along the eastern edge of the proposed entrance channel; and the extension of the breakwater to the east 310 feet, which extension will consist of a timber and stone foundation surmounted by a concrete and stone superstructure. An illustration showing the different constructions is herewith.

The last annual report for this harbor contained an account and description of existing works and the condition of the harbor. (Chief of Engineers' Report, 1896, p. 3108.)

REPORT OF OPERATIONS.

Actual work under the contract with Edward J. Hingston began on the 5th day of May, 1897, when dredging in the harbor commenced, and it has been actively prosecuted ever since. At the end of the fiscal year there were five dredges and one drill boat, with the requisite tugs and scows, in operation, and the work is progressing with great rapidity. Up to and including June 30, the estimated amount of material excavated under the contract was 111,612.7 cubic yards.

For the timber crib work the operations have consisted in the reception of timber, iron, etc., and preparations for the actual work of construction are being made.

For the concrete work the operations have been preliminary. The contractor has built a large cement shed, and has received 1,000 barrels of Atlas cement, and has nearly completed the erection of his machinery for his concrete work. A complete cement-testing apparatus has been received, and work has been diligently prosecuted testing the cement received and investigating the qualities of the sand proposed to be used.

REMARKS.

It is expected, under the existing contract and with the money available, to complete the work by the close of the next fiscal year.

There is, therefore, no need for further appropriations under the existing project.

Money statement.

July 1, 1896, balance unexpended		$12,357.86
Amount repaid to appropriation May 12, 1897		.50
Amount appropriated by sundry civil act approved June 4, 1897		398,258.00
		410,616.36
June 30, 1897, amount expended during fiscal year		11,696.71
July 1, 1897, balance unexpended		398,919.65
July 1, 1897, outstanding liabilities	$400.00	
July 1, 1897, amount covered by uncompleted contracts	314,105.81	
		314,505.81
July 1, 1897, balance available		84,413.84

Statement of appropriations and allotments for improving the harbor at Dunkirk, N. Y., from March 27, 1827, to the present time.

March 27, 1827	$3,000.00	March 3, 1873	$48,132.95
May 19, 1828	6,000.00	June 23, 1874	35,000.00
March 3, 1829	9,812.75	March 3, 1875	35,000.00
April 23, 1830	1,342.75	August 14, 1876	18,000.00
March 2, 1831	7,102.50	1879	2,500.00
July 3, 1832	10,200.00	June 14, 1880	10,000.00
June 28, 1834	4,000.00	July 5, 1884	10,000.00
March 3, 1835	10,988.43	August 5, 1886	20,000.00
July 2, 1836	11,000.00	August 11, 1888	15,000.00
March 3, 1837	15,000.00	September 19, 1890	20,000.00
July 7, 1838	10,000.00	July 13, 1892	20,000.00
June 11, 1844	5,000.00	August 17, 1894	20,000.00
August 30, 1852	30,000.00	June 3, 1896	10,000.00
March 2, 1867	100,000.00	June 4, 1897	398,258.00
1869	2,000.00		
July 11, 1870	25,000.00	Total	962,337.38
March 3, 1871	25,000.00	May, 1897, repayment	.50
June 10, 1872	25,000.00		

Abstract of proposals for improving harbor at Dunkirk, N. Y., received in response to advertisement of February 15, 1897, and opened at Buffalo, N. Y., March 22, 1897, by Maj. T. W. Symons, Corps of Engineers.

Name and address of bidder.	Channel and harbor excavation.	Repairs to west pier.		Breakwater channel arm and extension.				
	Dredging and removing material (per cubic yard, place measure).	Removing old superstructure (per linear foot).	Concrete in place (per cubic yard).	Dredging for foundation (per cubic yard, scow measure).	Removing old breakwater (for entire removal of 60 linear feet).	Foundation stone in place (per cubic yard, scow measure).	Timber crib structure filled and complete, with 16-foot crib (per linear foot).	Timber crib structure filled and complete, with 8-foot crib (per linear foot).
	Cents.			*Cents.*				
John B. Breyman, Toledo, Ohio	50							
Corkin, Stickney & Cram, Detroit, Mich	57	$3.00	$6.25	48½	$1,000	$1.40	$70.00	$55.00
W. J. Daly, Ogdensburg, N. Y	42½							
Ed. J. Hingston, Buffalo, N. Y	42	13.90	6.69	20	800	1.19	63.89	56.93
L. P. & J. A. Smith Co., Cleveland, Ohio	49	4.00	6.30	55	600	1.50	80.00	49.00
Sullivan & Churchyard, Buffalo, N. Y	41	2.20	5.75	25	800	1.30	64.00	48.00
Rider & Fitzgerald, Dunkirk, N. Y		2.00	6.57					

Name and address of bidder.	Breakwater channel arm and extension.						Total whole work.
	Ten-foot timber crib in place (per linear foot).	Six-foot timber crib in place (per linear foot).	White-pine posts and stringers (per 1,000 feet B. M).	Filling stone in breakwater extension in place (per cubic yard).	Concrete in place (per cubic yard).	Manhole covers (each).	
John B. Breyman, Toledo, Ohio							$277,500.00
Carkin, Stickney & Cram, Detroit, Mich	$15.00	$10.00	$30.00	$1.40	$6.25	$8.00	399,629.94
W. J. Daly, Ogdensburg, N. Y							235,875.00
Ed. J. Hingston, Buffalo, N. Y	15.50	10.42	28.50	1.19	6.73	14.00	*a* 321,386.85
L. P. and J. A. Smith Co., Cleveland, Ohio	14.30	9.32	30.00	1.40	7.00	10.00	356,290.64
Sullivan & Churchyard, Buffalo, N. Y	15.00	8.50	30.00	1.30	6.90	14.00	302,470.44
Rider & Fitzgerald, Dunkirk, N. Y							19,756.00

a Accepted.

Contract in force at close of fiscal year.

Name and address of contractor.	Date.	Date of approval.	Date of beginning work.	Date of expiration.	Remarks.
Edward J. Hingston, Buffalo, N. Y.	Apr. 15, 1897	Apr. 28, 1897	May 5, 1897	June 30, 1898	For harbor excavation and breakwater extension.

Dunkirk Harbor N.Y.

TYPICAL CROSS SECTIONS

of the

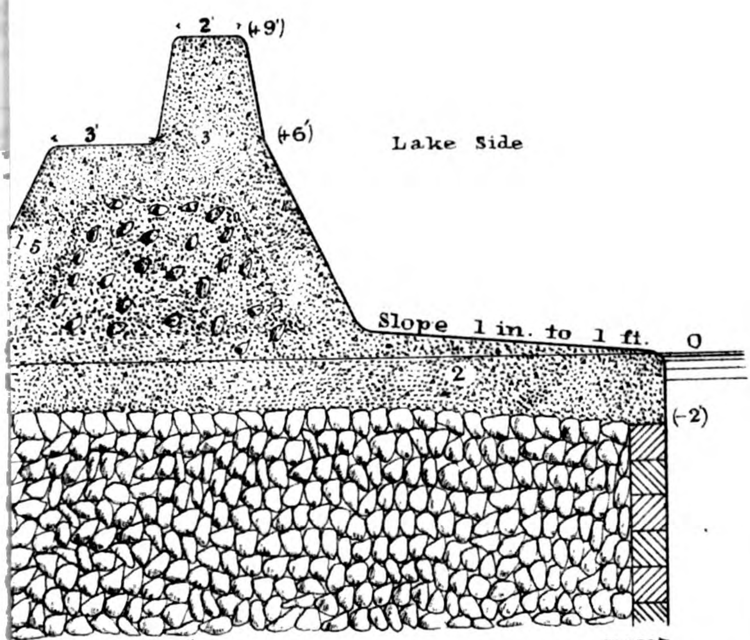
WATER AND WEST PIER STRUCTURES.

To accompany annual report for 1897,

jor Thomas W. Symons, Corps of Engineers, U. S. Army.

0 5 10 15 20

Scale of Feet.



re, to replace old Timber Superstructure.

On West Pier.

U. S. ENGINEER OFFICE,
BUFFALO, NEW YORK.

COMMERCIAL STATISTICS OF DUNKIRK HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1896.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.	Number.	Tons.
Steam	10	1,583	1	281	10	1,583	1	281
Sail	10	4,216	....	....	10	4,216	....	....
Total	20	5,799	1	281	20	5,799	1	281

Total arrivals and departures, 42; tonnage, 12,160.
Decrease in tonnage from 1895, 3,490 tons.
Amount of revenue collected for year ending December 31, 1896, rail, $274.43.
Value of imports, all rail, $4,618.37.
Value of exports, none.
No new lines of transportation established.
Receipts by lake, lumber, 9,968 tons (5,692,000 feet B. M.).
Shipments by lake, none.
Enrolled tonnage, port of Dunkirk, N. Y., 57.49.
Greatest draft of vessels, 11 feet.

The following table gives the total of the arrivals and departures and the tonnage of the vessels arriving and departing for the past ten years, as compiled from the reports of the Chief of Engineers:

	1887.	1888.	1889.	1890.	1891.
Total of arrivals and departures	32	32	68	100	96
Tonnage of arriving and departing vessels	9,992	12,302	17,189	22,496	24,465
	1892.	**1893.**	**1894.**	**1895.**	**1896.**
Total of arrivals and departures	58	137	76	69	42
Tonnage of arriving and departing vessels	18,756	19,158	18,763	15,650	12,160

M M 3.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

ORIGINAL CONDITION OF THE HARBOR.

Buffalo Creek was the original harbor of the port of Buffalo. In its original condition it was shallow and was closed by a gravel bar for most of the year.

PROJECTS FOR IMPROVEMENT.

A statement as to the former projects under which the work at Buffalo has been carried on by the General Government is given in the last Annual Report on this harbor (Chief of Engineers' Report, 1896, p. 3110).

The works built by the United States which require care and supervision are the north and south piers protecting the entrance to Buffalo Creek and the Blackwell Ship Canal and an outer breakwater 7,608.6 feet long, built of timber and stone. The superstructure on 3,879.13 feet of this length has been replaced with concrete.

There is also a sand-catch pier extending out from the lake shore a distance of 879 feet.

The project in force for the further improvement of Buffalo Harbor is:

(1) To maintain existing structures, making the requisite minor repairs and replacing the wooden superstructure of the breakwater with concrete when necessary.

(2) To build an extension of the breakwater from its present southern end to Stony Point, leaving the necessary openings for the convenience of commerce.

(3) To extend the sand-catch pier to the established pierhead line.

As long as only minor repairs are needed the cost of maintenance of existing structures is estimated at $5,000 per year. There is a stretch of 1,015 feet of wooden breakwater lying between the two concreted portions which will soon require to have its superstructure replaced with concrete. This is the portion which gave the most trouble in building and where the foundation and superstructure are most insecure. The next river and harbor act should provide for replacing this 1,015 feet with concrete. It is estimated that this will cost $125 per foot, or $126,875.

Two years of other repairs will cost $10,000, making an estimate for the cost of maintenance for the immediate future of $136,875.

In accordance with the authority contained in the river and harbor act of June 3, 1896, the work of extending the breakwater to Stony Point and the sand-catch pier to the pierhead line was advertised and bids opened on November 30, 1896.

The contract was awarded to Hughes Bros. & Bangs.

Under this contract the work of dumping stone in the Rubble Mound Breakwater was started May 19, 1897, and has continued ever since. Work on the sand-catch pier was started May 25, 1897, which work is still under way.

Under the head of "report of operations" are given the details of the work of repair, maintenance, and new construction.

The total amount expended by the United States on the improvement of Buffalo Harbor to June 30, 1896, was $2,710,831.02.

The amount of money expended by the United States during the fiscal year ending June 30, 1897, was $11,902.13.

REPORT OF OPERATIONS.

No work was done on the north and south piers during the year.

The older parts of the wood superstructure of the breakwater, viz, 1,015 linear feet built in 1873–77 and 1,458 linear feet built in 1884–85, required repairs. These repairs were practically confined to the 1,015-foot section, and consisted of refilling with stone the pockets in which the stone filling had settled 2 feet or more, replacing broken and decayed deck, and rebuilding from water level the superstructure on the ice breaker outside of the outer face of the breakwater. These repairs were made under the contract with Charles A. Dennis, Buffalo, N. Y., dated August 18, 1896. Work was begun on August 24 and completed on October 3, 1896. The total cost of material and labor was $2,933.26. The timber, deck plant, drift and screw bolts, and large blocks of stone were furnished by the United States from old stores on hand.

Under authority of the Secretary of War dated December 14, 1895, arrangements were made with dredging contractors operating in Buffalo River to dump clean rock dredgings within an area measuring 200 feet along the breakwater by 200 feet outward from its lake face, 500 feet from its north end. Arrangements were also made to place waste rock along the front of the breakwater, particularly along the portion built in 1873–77, for the purpose of forming a good toe of rock and gradually getting it into condition for the replacement of the old timber superstructure with concrete. This placement of rock was continued during the year and the riprap raised to about 7 feet below water level along the most of the front of the old structure of 1873–77. During the year 100,548 cubic yards of rock was dumped, under proper inspection.

To further raise the riprap, arrangements were made with contractors to place such large masses of rock as they might have for disposal upon the dumped rock immediately adjacent to the breakwater.

During the year 317.26 cubic yards of this rock was placed, raising the riprap in places to and above water level. The cost of placing the large masses of rock was $1.20 per cubic yard; total, $380.71.

In connection with the placement of rock dredgings, a constant supervision was maintained over the dumping of other dredgings from the various works of excavation carried on by the State and city authorities and private parties, in Buffalo River and Erie Canal. Work of this kind is constantly going on, and the disposal of the dredgings is a matter requiring constant and serious consideration, in order that the interests of navigation may not suffer.

Other operations were in the line of care of public property, and consisted of the construction of a storehouse on United States property adjacent to the south pier at Buffalo, N. Y.; the transfer of two carloads of concrete machinery to Portland, Me., and the transfer of the remaining engineer property from the old storehouse and wharf, occupied by the permission of the New York State canal authorities during the past ten years, to the new storehouse.

The storehouse was constructed under written agreement with Charles A. Dennis, Buffalo, N. Y., the lowest bidder for the work. It is a substantial structure 60 feet long and 30 feet wide, two stories high, on a heavy stone foundation designed especially for the storage of heavy machinery on the first floor, and with storage rooms, carpenter shops, etc., on the second floor. The sides and roof of the buildings are completely covered with corrugated iron. The total cost of the structure was $1,853.26. A substantial platform across the south pier affords facilities for transferring stores from the storehouse to vessels or scows. Construction was begun on March 31 and completed on May 26, 1897.

SURVEYS.

No surveys were made during the year except a survey to determine the character of the lake bottom along the site of the proposed breakwater for the protection of the Buffalo entrance to Erie Basin and Black Rock Harbor. The work was done on ice, March 1 and 2, 1897, at a cost for labor of $7.60.

Examinations incidental to the authorized works of improvement were made as follows:

Examinations by soundings of the riprap stone deposited along the outer face of the breakwater.

An examination of the lake bottom at the entrance around the north end of the breakwater. This examination was made pursuant to a report that the steamer *Mary H. Boyce* had struck bottom in this locality.

Soundings were taken fully covering the entrance November 14 to 25, 1896, and showed the depth of water to be nowhere less than 21 feet. The cost of the labor for the work was $28.

BREAKWATER CONSTRUCTION.

The work of constructing the extension to Stony Point was begun by the contractors, Hughes Bros. & Bangs, on May 19, 1897, by the placing of rubblestone for the rubble-mound breakwater on the lake and harbor sides of the footing of the prescribed cross section.

Previous to the actual work of construction, the axial line of the proposed structure has been marked by large range targets located at Stony Point and on the existing breakwater, and clusters of three piles each driven on the axial line and on the extreme side lines for the northerly 1,000 feet of the proposed rubble mound. The placement of rubblestone in small footing mounds along this 1,000-foot section was carried on. Up to the 30th of June the amount of rubble placed was 13,861.27 tons.

The contractors have also been busily engaged in building the necessary plant for further operations, opening quarries, etc.

SAND-CATCH PIER EXTENSION.

The work of constructing the extension of the sand-catch pier to the established harbor line was begun by the contractors, Hughes Bros. & Bangs, on May 25, and continued until June 30, 1897. The work was seriously delayed by rough weather. Up to the 30th of June the amount of work done was as follows: Piles driven, 105.

REMARKS.

Buffalo has long labored under the necessity of doing business in a very contracted harbor. The congestion in the harbor at times is very great. The extension of the breakwater to Stony Point as provided for by the river and harbor act of June 3, 1896, will provide an outer harbor into which piers and wharves can be extended and where business can be done more advantageously than in Buffalo Creek. It will also be a great relief to the harbor when the breakwater is extended sufficiently to enable an entrance to be made into the extensive interior basins of the Lehigh Valley Railroad Company.

It is desired to push the work to completion as rapidly as possible, and therefore an estimate of the full amount allowed by law is made for the fiscal year ending June 30, 1899.

The contractors are building and getting together a large plant for the work and promise to conduct their operations with vigor, and it is expected that when once fairly started they will earn the money available in any one season.

Besides this work of breakwater extension the existing structures must be kept in repair, and the next river and harbor bill it is hoped will make provision for $5,000 per year for minor repairs and a sum of $126,875 for replacing the wooden superstructure on 1,015 feet of the old breakwater with concrete.

The estimate is therefore:

For continuing work under new project	$550,000
For maintenance	136,875

Money statement.

July 1, 1896, balance unexpended		$127,164.35
Amount appropriated by sundry civil act approved June 4, 1897		481,250.00
		608,414.35
June 30, 1897, amount expended during fiscal year		11,902.13
July 1, 1897, balance unexpended		596,512.22
July 1, 1897, outstanding liabilities	$1,500.00	
July 1, 1897, amount covered by uncompleted contracts	1,754,267.22	
Amount (estimated) required for completion of existing project		1,718,750.00
Amount (estimated) required for maintenance		136,875.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		686,875.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Statement of appropriations and allotments made for improving harbor at Buffalo, N. Y., from May 26, 1826, to the present time.

May 26, 1826	$15,000.00	March 3, 1873	$75,000.00
May 19, 1828	34,206.00	February 23, 1874	20,000.00
April 23, 1830	15,488.00	June 23, 1874	75,000.00
March 2, 1831	12,900.00	March 3, 1875	100,000.00
July 3, 1832	10,300.00	August 4, 1877	85,000.00
March 2, 1833	31,700.00	June 18, 1878	80,000.00
June 28, 1834	20,000.00	March 3, 1879	100,000.00
July 7, 1838	68,500.00	June 14, 1880	90,000.00
June 11, 1844	40,000.00	March 3, 1881	90,000.00
August 30, 1852	14,000.00	August 2, 1882	125,000.00
March 3, 1853	349.05	July 5, 1884	100,000.00
March 2, 1855	452.32	August 5, 1886	112,500.00
June 28, 1864	15,000.00	August 11, 1888	225,000.00
July 2, 1864	37,500.00	September 19, 1890	300,000.00
June 23, 1866	131,000.00	July 13, 1892	300,000.00
March 2, 1867	100,000.00	August 17, 1894	70,000.00
April 10, 1869	89,100.00	June 4, 1897	481,250.00
July 10, 1870	80,000.00		
March 3, 1871	100,000.00	**Total**	3,319,245.37
June 10, 1872	75,000.00		

Abstract of proposals received in response to advertisement of July 13, 1896, for repairing Buffalo Breakwater, and opened July 28, 1896, by Maj. T. W. Symons, Corps of Engineers.

Articles and work.		George C. Talbot, Buffalo, N. Y.	Charles A. Dennis, Buffalo, N. Y.
Tearing out crib work	per linear foot	$1.25	$1.20
Placing timber on ice breaker	do	.30	.30
Placing timber on superstructure	do	.30	.35
Placing deck plank and sheathing	per piece	.65	.60
Placing stone filling	per cubic yard	2.00	1.80
Placing stone blocks	each	4.00	2.75
Placing deck fender	per linear foot	.065	.07
Placing spikes, etc	per pound	.045	.05
Total estimate		2,793.25	2,682.00

Contract awarded to Charles A. Dennis.

Abstract of proposals for extension of breakwater and sand-catch pier at Buffalo, N. Y., opened November 30, 1896, by Maj. T. W. Symons, Corps of Engineers.

Name and address of bidder.	Rubble Mound breakwater.									
	Rubblestone.		Gravel, per cubic yard, scow measurement.	Capping stone, per ton of 2,000 pounds.	Rubblestone in Canada.		Capping stone in Canada, per ton of 2,000 pounds.	Transporting rubblestone from Canada.		Transporting capping stone from Canada, per ton of 2,000 pounds.
	Per cubic yard, scow measurement.	Per ton of 2,000 pounds.			Per cubic yard, scow measurement.	Per ton of 2,000 pounds.		Per cubic yard, scow measurement.	Per ton of 2,000 pounds.	
Andrew Onderdonk, New York, N. Y.	$1.00	$0.80	Cts. 25	$1.92	$0.55	Cts. 45	$0.84	Cts. 45	Cts. 35	$1.08
Hughes Bros. & Bangs, Syracuse, N. Y.	1.00	.80	13	1.25	.75	60	1.00	25	20	.25
Buffalo Dredging Co., Buffalo, N. Y.	.90	.80	27	1.80	.60	50	1.00	30	30	.80
Hingston & Woods, Buffalo, N. Y.	......	......	......	......	.85	......	......	13	......	......
James B. Donnelly, Buffalo, N. Y.	.70	.64	20	3.16	......	......	......	......	......	......
Churchyard & Dunbar, Buffalo, N. Y.	.75	.60	35	1.80	.60	50	1.00	15	10	.80
McArthur Bros. Co., Chicago, Ill.	.97	.78	30	1.65	.80	64	1.35	17	14	.30
The National Contracting Co., New York City	.86	.69	19	2.40	.68	54	1.90	18	15	.50
Chicago Star Construction and Dredging Co., Chicago, Ill.	1.00	.80	32	2.50	......	......	......	......	......	......
Breymann Bros., Toledo, Ohio	1.45	1.20	23	2.50	1.00	80	2.00	45	40	.50
L. P. & J. A. Smith Co., Cleveland, Ohio	1.00	1.00	35	2.20	......	......	......	......	......	......
Christie & Low, Chicago, Ill.	.88	.70	20	1.75	.63	50	1.30	25	20	.45

Name and address of bidder.	Timber crib breakwater.												
	From Rubble Mound to south harbor entrance.					From south harbor entrance to Stony Point.					Standard timber crib breakwater, complete, per linear foot.	Mooring cleats in place, each.	Mooring posts in place, each.
	Excavating trench.		Gravel filling in trench, per cubic yard, scow measurement.	Rubblestone in foundation.		Excavating trench.		Gravel filling in trench, per cubic yard, scow measurement.	Rubble stone in foundation.				
	Per cubic yard, scow measurement.	Per cubic yard, place measurement.		Per cubic yard, scow measurement.	Per ton of 2,000 pounds.	Per cubic yard, scow measurement.	Per cubic yard, place measurement.		Per cubic yard, scow measurement	Per ton of 2,000 pounds.			
Andrew Onderdonk, New York, N. Y.	Cts. 19	Cts. 22	Cts. 23	$1.00	$0.80	Cts. 19	Cts. 22	Cts. 23	$1.00	$0.80	$94.00	$15.00	$50.00
Hughes Bros. & Bangs, Syracuse, N. Y.	18	....	13	1.00	.80	18	....	13	1.00	.80	92.37	6.00	36.00
Buffalo Dredging Co., Buffalo, N. Y.	30	....	27	.90	.80	30	....	27	.90	.80	109.50	4.50	27.50
Hingston & Woods, Buffalo, N. Y.	22	....	18½	.98	......	......	......	......	......	......	100.00	16.50	42.00
James B. Donnelly, Buffalo, N. Y.	22	....	18	.70	.64	22	....	18	.70	.64	82.40	10.00	15.00
Churchyard & Dunbar, Buffalo, N. Y.	18	....	35	.75	.60	18	....	35	.75	.60	90.00	9.00	28.50
McArthur Bros. Co., Chicago, Ill.	21	....	20	1.00	.80	21	....	20	1.00	.80	94.60	15.00	56.00
The National Contracting Co., New York City	19	....	16	.86	.69	19	....	16	.86	.69	86.00	10.00	30.00
Chicago Star Construction and Dredging Co., Chicago, Ill.	20	....	20	1.10	.88	20	....	20	1.10	.88	100.00	20.00	50.00
Breymann Bros., Toledo, Ohio	33	....	23	1.45	1.20	33	....	23	1.45	1.20	125.25	10.80	35.00
L. P. & J. A. Smith Co., Cleveland, Ohio	30	....	35	1.00	1.00	30	....	35	1.00	1.00	111.50	14.00	45.00
Christie & Low, Chicago, Ill.	25	....	20	.88	.70	25	....	20	.88	.70	112.00	15.00	50.00

Abstract of proposals for extension of breakwater and sand-catch pier at Buffalo, N. Y., opened November 30, 1896, etc.—Continued.

Name and address of bidder.	Sand-catch pier.							
	Oak piling, per pile.	Norway piling, per pile.	Beech piling, per pile.	Waling, per linear foot.	Tie-rods, screw bolts, and straps, per pound.	Transporting and fitting pile shoes, each.	Stone filling, per cubic yard, scow measurement.	Total.
					Cents.			
Andrew Onderdonk, New York, N. Y.	$11.00	$10.00	$9.00	$0.16	4	$2.00	$1.00	$2,094,284.00
Hughes Bros. & Bangs, Syracuse, N. Y.	15.00	11.00	....	.25	2½	.25	1.06	a1,765,450.63
Buffalo Dredging Co., Buffalo, N. Y.	7.00	6.00	5.00	.21	3	.25	.90	2,271,084.75
Hingston & Woods, Buffalo, N. Y.	....	....	....	....	....	....	....	799,402.50
James B. Donnelly, Buffalo, N. Y.	9.90	8.75	5.55	.18	2¾	.25	.82	2,092,560.19
Churchyard & Dunbar, Buffalo, N. Y.	9.50	7.90	6.75	.15	2¾	.10	.80	2,081,211.69
McArthur Bros. Co., Chicago, Ill.	8.00	7.80	....	.30	3	4.00	1.10	2,051,857.75
The National Contracting Co., New York City	....	9.00	7.00	.30	3	.75	1.00	1,977,252.75
Chicago Star Construction and Dredging Co., Chicago, Ill.	9.00	8.00	8.00	.35	3	2.50	1.15	2,306,782.75
Breymann Bros., Toledo, Ohio	10.80	9.80	....	3.00	4½	.75	1.60	2,762,152.13
L. P. & J. A. Smith Co., Cleveland, Ohio	7.92	6.00	....	2.88	3	1.00	1.00	2,542,997.75
Christie & Low, Chicago, Ill.	15.00	11.00	....	.35	4	1.00	1.00	2,130,752.00

a Accepted.

List of contracts in force at close of fiscal year.

Name of contractor.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration.	Remarks.
Hughes Bros. & Bangs, Syracuse, N. Y.	Jan. 27, 1897	Feb. 19, 1897	May 19, 1897	Jan. 1, 1901	For extension of breakwater and sand-catch pier.
Do	do	do	June 1, 1897	do	For delivering stone in Canada for breakwater.
Do	Jan. 28, 1897	do	do	do	For transporting stone from Canada to breakwater.

COMMERCIAL STATISTICS OF BUFFALO HARBOR, NEW YORK.

[Compiled from annual reports of the Merchants' Exchange of Buffalo, N. Y.]

Vessels from—	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Domestic ports	4,056	5,229,038	4,227	5,262,864
Foreign ports	1,088	278,441	1,075	282,863
Total	5,144	5,507,479	5,302	5,545,727

Total arrivals and departures:	
Vessels	10,446
Tonnage	11,053,206
Increase of lake tonnage, 1896 over 1895 ... tons	1,440,783
Amount of revenue collected, year ending December 31, 1896	a b $368,770.77
Value of imports, year ending December 31, 1896	a 3,305,913.00
Value of exports, year ending December 31, 1896	a 4,723,584.00
Enrolled tonnage, port of Buffalo, 1896, gross tonnage	193,769.59

a Includes for port of Tonawanda, embraced in Buffalo Creek district.
b All on rail transportation.

Receipts by lake.

Articles.	1891.	1892.	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barley	104,955	110,423	138,995	207,002	262,997	397,565
Corn	858,876	938,956	1,175,659	843,277	1,089,800	1,258,184
Corn meal	....	....	4,172	2,848	2,242	19,062
Flour	695,147	955,120	1,035,085	1,125,876	870,230	1,038,418
Oats	199,266	264,004	831,202	248,964	355,700	641,720
Rye	156,895	36,863	18,049	14,033	24,405	122,343
Wheat	2,308,379	2,347,307	2,047,313	1,505,824	1,417,680	1,648,824
Flaxseed	177,030	163,337	136,542	41,440	105,770	251,190
Feed	89,119	110,671	122,800	133,250	117,880	14,913
Malt	11,919	8,502	9,391	13,429	8,551	704
Oatmeal	890	3,869	....	5,265	1,596	3,284
Pease	6,575	2,015	2,030	3,519	4,786	4,780
Oil cake	30,653	41,952	20,951	16,385	18,530	1,692
Seeds	3,375	5,599	6,397	2,384	946	751
Lumber	459,776	523,215	501,814	419,170	404,701	352,500
Timber	857,170	630,000	836,000	228,900	144,885	68,181
Laths	1,378	3,363	3,813	1,952	1,230	1,052
Shingles	5,389	5,060	6,097	12,618	11,110	12,479
Posts	2,249	700	168	553	2,701	780
Ties	17,893	23,438	18,975	14,709	10,049	1,496
Staves	170	....	....	840	480	778
Stave bolts	14,608	11,840	10,128	7,992	3,142	6,085
Copper	50,934	34,860	64,930	93,658	83,030	102,180
Copper matte	26,420	16,950	13,770	3,752	27,475	42,810
Iron ore	421,890	224,720	243,442	306,670	500,994	443,073
Iron, pig	30,730	46,160	33,950	26,324	33,122	18,935
Lead, pig	27,938	25,309	34,488	21,855	16,877	626,559
Spelter plates	5,894	6,202	9,902	12,400	6,855	1,086
Cheese	....	....	66	75	238	200
Fish	....	....	....	....	4,742	3,935
Glucose	12,600	38,810	43,262	73,012	22,982	109,636
Hay	....	....	58,171	44,324	1,300	18,896
Lard	18,123	20,784	15,559	61,501	16,895	45,397
Pork	4,821	3,440	1,354	3,666	262	3,412
Soap	....	....	525	474	278	1,035
Starch	....	....	840	1,651	800	2,410
Wool	13,841	6,954	2,390	7,315	3,167	5,772
Total	6,614,903	6,609,923	6,447,730	5,506,402	5,578,423	7,272,067

Receipts by lake during the years ending December 31, 1895 and 1896.

Articles.	1895.		1896.	
	Tons.	Per cent.	Tons.	Per cent.
Grain, flour, malt, and seed products	4,281,118	76.74	5,403,430	74.30
Lumber and timber products	578,298	10.36	443,801	6.10
Ores and metals	668,353	12	1,234,643	16.98
Miscellaneous	50,650	.90	190,693	2.62
Total	5,578,423	100	7,272,067	100

Shipments by lake from Buffalo Harbor for the years 1892, 1893, 1894, 1895, and 1896.

Articles.	1892.	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Coal	2,852,330	2,703,673	2,485,255	2,620,768	2,400,068
Cement and plaster	88,936	65,156	71,413	78,766	94,466
Salt	21,688	37,361	104,845	100,362	94,134
Total	2,976,189	2,932,938	2,859,470	2,991,900	2,800,052

Shipments by lake during the years ending December 31, 1895 and 1896.

Articles.	1895.		1896.	
	Tons.	Per cent.	Tons.	Per cent.
Coal	2,620,768	87.60	2,400,068	85.73
Cement and plaster	78,766	2.63	93,937	3.36
Salt	100,362	3.36	94,134	3.36
Sugar	192,004	6.41	211,384	7.55
Total	2,991,900	100	2,799,523	100

The following statistics of the canal commerce of Buffalo are also compiled from the report of the Buffalo Merchants' Exchange:

Canal clearances during the year 1896	5,788
Tonnage of freight coming to Buffalo	398,191
Tonnage of freight leaving Buffalo	1,172,552
Number of steamers and canal boats navigating from Buffalo on the canal, about	1,250
Average freight rate, Buffalo to New York, for wheat and corn per bushel	$0.037

The following gives the canal clearances for the last twelve years:

1885	5,670	1891	6,312
1886	7,414	1892	5,460
1887	7,925	1893	7,725
1888	5,958	1894	6,621
1889	6,855	1895	4,546
1890	6,429	1896	5,788

For comparison the following statement of the last three years is given:

	1894.	1895.	1896.
Tons of articles received by canal	413,631	355,134	398,191
Tons of articles sent by canal	1,437,293	709,846	1,172,552
Value of articles received	$24,760,803	$30,299,568	$35,636,664
Value of articles sent	$37,865,302	$20,279,881	$31,608,123
Barrels of flour sent	3,028	900	64,550
Bushels of grain sent	48,428,521	20,236,114	35,709,258

Assuming that the number of arrivals of canal boats equaled the number of clearances, the grand total of the commerce of Buffalo carried on by lake, river, and canal for the season of 1896 is as follows:

Arrivals and departures, lake and river	10,446
Arrivals and departures, canal	11,576
Total arrivals and departures	22,022

	Tons.
Receipts of freight by lake and river	7,272,067
Shipments of freight by lake and river	2,800,052
Receipts of freight by canal	398,191
Shipments of freight by canal	1,172,552
Total shipments and receipts by water	11,642,862

The amount of wheat and breadstuffs going east by canal in 1895 was the lowest for many years, and the canal freights were the lowest ever known, the average rate, Buffalo to New York, for wheat and corn having been only 2.2 cents.

M M 4.

IMPROVEMENT OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

Original condition.—In its original condition the navigation of the Niagara River from Lake Erie to Tonawanda was obstructed by several reefs and hummocks which materially limited the draft of the vessels traversing it. The water in the harbor between Tonawanda Island and the main shore was shoal, and the river in some places had a very swift current. The object of the improvement is to provide a navigable channel from the head of the Niagara River at Lake Erie to the north end of Tonawanda Harbor, and to dredge that harbor to a depth permitting its use by vessels drawing 16 feet.

Project for improvement.—To remove obstructions so as to make a channel 400 feet wide and 18 feet deep, which includes work at the following places:

1. On the "Horseshoe Reef" at the entrance to Niagara River.
2. On the shoal at the head of Strawberry Island.
3. A few shoal places abreast of the lower end of Rattlesnake Island.
4. The full width of the river between Tonawanda Island and the mainland along the entire front of Tonawanda.

This project was approved in 1888.

By the terms of the river and harbor act of June 3, 1896, the project is extended to include the river to the north line of the village of North Tonawanda.

The cost of the work, as estimated in 1891, was $1,152,987.93. This does not include the work necessary between Tonawanda Island and the north line of the village of North Tonawanda, nor that required in the main river abreast of Tonawanda Island, to which the project has been extended by the terms of the river and harbor act of June 3, 1896.

The amount expended on the general project up to June 30, 1896, was $295,968.20.

At this time the channel through the Horseshoe Reef had been completed. This channel, as completed, is 400 feet wide and 18 feet deep at mean lake level, excepting a few small patches of rock over which there is a least depth of 17½ feet. The length of the channel is 1,500 feet.

At Strawberry Island the reef was excavated to the depth of 18 feet for a width of 160 feet over about two-thirds of the length of the reef. The remaining one-third has a depth of 16½ feet.

At Tonawanda Harbor a dredge cut 20 feet wide was made to the depth of 18 feet along nearly all the length of the harbor front of Tonawanda Island.

During the fiscal year ending June 30, 1897, there was expended on the project $42,488.96.

Work was done during the year on Strawberry Island Shoal, at the foot of Tonawanda Island, and in the harbor between this island and the main shore. As a result of the operations the channel through the Strawberry Island Reef has the full depth of 18 feet and is practically 180 feet wide. A channel 200 feet wide and full 18 feet deep has been excavated through the shoal at the foot of Tonawanda Island, and the most bothersome lumps and ridges have been removed from the channel between the island and the main shore.

The object of the extension of the project to the north line of North Tonawanda was to enable needed work to be done on a shoal off the foot of Tonawanda Island, which work was not included in the original project and estimates. At some distance below the island there is a deep pool, and by excavating across the shoal this could be reached. Beyond the pool no work is demanded by any present interests of commerce.

REPORT OF OPERATIONS.

Work under this project has been done by hiring dredges and drill boats by the day. This is found the most satisfactory method on account of the variable and indeterminable qualities of materials to be excavated.

Work began on Strawberry Island Reef soon after the contract was signed. On October 1 the marine drill boat *Thor* came to the work and was set in position on the range of the west side of the channel excavated the year before and at the upper limit of the rock to be excavated. From the experience gained the previous year it was decided to drill the holes 8 feet apart in the rows and 9 feet between rows, and to drill to 19 feet below mean river level, but never less than 3 feet deep. Four rows of holes were included in each cut except the last two cuts. When the rows in a cut were completed the boat was moved downstream and another position on the cut drilled and blasted, and this continued until deep water was reached, when the upper end of another cut was commenced. This method of successive movements was rendered necessary because the drill boat could not be held broadside to the current.

On November 27 the drill boat finished at the east limit of the channel and was set in position west of the 160-foot range, where a cut of twelve rows of holes 9 feet apart was drilled. On December 17 the softer rock in this cut was reached and the drill boat was discharged. To remove the rock thrown up by the drilling and blasting and some softer rock and hardpan three dredges were employed.

On October 13 one dredge came to the work and began excavation above the drill boat.

On October 17 and on December 24 the other dredges were put to work. The effort was made to complete a channel at least 160 feet wide during the season. Whenever the dredges became crowded in the drilled and blasted portion, one or more were set to work on the softer rock above it, or on the west of the 160-foot range. The final cut east of the 160-foot range was finished and the last two dredges discharged on January 13, 1897.

The following is a summary of the operations and cost of drilling and blasting in the Strawberry Island Channel during the season of 1896 to make it possible to dredge the rock to a depth of at least 18 feet below mean river level:

Work of drill boat.

Days' work of drill boat (days of 8 hours)	168.44
Square yards drilled and blasted	13,628
Amount paid contractors	$12,801.25
Cost per square yard drilled and blasted	$0.939
Blasted rock removed, cubic yards, scow measure	23,775
Cost of drilling and blasting per cubic yard of rock removed	$0.54

Work of dredges.

Total number of days' work of dredges (days of 8 hours)	208.53
Cubic yards of rock and hardpan removed	32,307
Amount paid contractors	$15,061.31
Cost per cubic yard dredging	$0.466

The dredges worked as follows:	Days.
On unblasted rock	61.37
On drilled and blasted rock	133.04
On hardpan	9.12
Total	203.53

Cubic yards dredged, scow measure:	
Unblasted rock	6,657
Blasted rock	23,755
Hardpan	1,895
Total	32,307

Cost per cubic yard dredging, scow measure:	
Unblasted rock	$0.682
Blasted rock	.414
Hardpan	.356

It is believed that one of the best methods of estimating such work as that of drilling and blasting and removing rock of nearly uniform depth is by the square yard of surface gone over, and upon this basis the following summing of the operations and cost of excavating per square yard of the channel is prepared:

Work of dredges (days of 8 hours)	133.04
Square yards dredged over	10,840
Amount paid contractors	$9,844.95
Cost per square yard, dredging	$0.908
Cost per square yard, drilling and blasting	$0.939
Cost of removing rock, per square yard	$1,847

Work began on the shoal at the foot of Tonawanda Island on September 14, 1896, with one dredge, and two days after another dredge was put to work. Operations were continued with these two dredges until December 30, 1896, with the exception of a short time when removed temporarily.

The material excavated was very hard to dig, it being a more or less cemented mass of clay, gravel, bowlders, etc. The dredges employed were of the dipper type and loaded the excavated material into dumping scows, which were towed to a selected dumping ground and dumped. Some of the bowlders were too large to pass through the dipper, and it was found that the best way to dispose of these when raised was to tow the dredge to the dumping ground and lower the bowlders to the bottom with the dipper.

The cut, as completed, begins in deep water at its upper end and extends to deep water at its lower end. It is 1,050 feet long and 200 feet wide, and was excavated to a depth of not less than 18 feet below mean river level. The following is a summary of the work done:

Work of dredges (days of 8 hours)	195.31
Hardpan and bowlders dredged, cubic yards, scow measure	32,841
Amount paid contractors	$14,453.12
Cost per cubic yard dredged	$0.44

TONAWANDA HARBOR.

On the 30th day of April, 1897, a dredge was set to work within this harbor, and on the 31st day of May another was set to work, and operations with them continued until the close of the fiscal year.

In previous years a channel had been dredged to 16 feet deep in the center of the harbor, but the natural bottom remained between this work and the docks on the east side, except in some cases where private enterprise had dredged a vessel width along the dock. This shoal had been cut through or was naturally low at one point, and all the deeper draft vessels came into the docks at this point. The channel along the docks was so narrow that the larger vessels had to wait until the vessels at the dock near this depression were removed before going beyond them.

As it was thought the money available would not be sufficient to remove this obstruction for its whole length, work was begun 1,400 feet below the slip, near the bridge, and continued to the lower end of the docks. This portion of the work has been completed, and work has been started on the necessary excavation of the harbor along the shore below the bridge, to connect with the portion already excavated. Some of the material excavated has been soft and easy to dig, but a considerable portion has been quicksand hardpan, and so very hard that efforts to dredge in the past were abandoned and docks built at this part of the work were built on cribs, as steel-shod piles could not be driven.

The following is a summary of the operations and cost of dredging in Tonawanda Harbor, below the bridge, to increase the depth to at least 18 feet at mean lake level, to June 30, 1897:

Work of dredges, days	$109\frac{1}{32}$
Clay, gravel, and hardpan dredged, cubic yards, scow measure	29,015
Amount paid contractors	$8,068.31
Cost per cubic yard dredged	$0.278

As there is no satisfactory map of Tonawanda Harbor, a boatman was hired with his boat for 27 hours, extending over three days, and with the help of men from the dredges lines of soundings not over 100 feet apart were made from the slips below the bridge to a line joining the Iron and Steel Company's dock with the dock at the lower end of the island. Stations on each side of the river had before been measured and marked. As no map shows all the angles in the docks, a base line was measured on the bridge, and a system of triangles measured to the end of the island with intersecting courses from the transit stations to the various angles in the dock lines and the stations used in sounding. This has been done without any additional outlay except the boatman mentioned above. It has taken much time because of so much rainy weather and the obstruction of points by vessels and piles of lumber.

REMARKS.

The originally estimated cost of the project in 1891 was $1,152,987.93. A very large part of the work embraced by the project and its extension has been done at a cost much below the original estimate.

Taking the sum of the appropriations ($350,000) from the original estimate leaves $802,987.93. The knowledge gained in the conduct of the work indicates that but a portion of this sum will be required to do all the necessary work embraced in the original project, and such work as is at all required in the extension of the project.

It may be explained that the project was extended to the north line of the village of North Tonawanda in order to enable work to be done on the shoal just north of Tonawanda Island and abreast of this island. No good purpose would be subserved by extending the channel 400 feet wide and 18 feet deep through the shoal river along the north front of North Tonawanda.

Recent experiences of vessels and an examination made by this office indicate a lumpy condition and some shoal ridges in the main channel abreast of Tonawanda Island, which will require much work to give the projected channel 18 feet depth and 400 feet width. This work is not specified or estimated for in the original project and estimate, but properly comes within the extended project.

The commerce of Tonawanda is large and increasing, and it is in a high degree desirable that all impediments be removed which interfere with vessels drawing 16 feet of water reaching the docks. An appropriation of $250,000 is estimated for as the amount which can profitably be expended during the next fiscal year under the project.

Money statement.

July 1, 1896, balance unexpended		$54,031.80
May 12, 1897, repayment to appropriation		1.00
		54,032.80
June 30, 1897, amount expended during fiscal year		42,488.96
July 1, 1897, balance unexpended		11,543.84
July 1, 1897, outstanding liabilities	$400.00	
July 1, 1897, amount covered by uncompleted contracts	7,893.22	
		8,293.22
July 1, 1897, balance available		3,250.62
Amount (estimated) required for completion of existing project		802,987.93
Amount that can be profitably expended in fiscal year ending June 30, 1899		250,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
August 11, 1888	$100,000
September 19, 1890	75,000
July 13, 1892	75,000
August 17, 1894	50,000
June 3, 1896	50,000
Total	350,000
May, 1897, repayment	1

Abstract of proposals received in response to advertisement of August 7, 1896, and opened September 7, 1896, by Maj. T. W. Symons, Corps of Engineers.

No.	Name and address of bidder.	Furnishing and operating drill boat per day of 8 hours.	Furnishing and operating dredges each per day of 8 hours.	Furnishing and operating tug per day of 8 hours.	Remarks.
1	Hingston & Woods, Buffalo, N. Y.	$76.00	$74.00	$18.00	Accepted and contract made.
2	Wm. J. Daly, Ogdensburg, N. Y.	84.00	88.00	20.00	

Contract in force at close of fiscal year.

Name and address of contractor.	Date.	Date of approval.	Date of beginning work.	Date of expiration.	Remarks.
Hingston & Woods, Buffalo, N. Y.	Sept. 14, 1896	Sept. 26, 1896	Sept. 14, 1896	Nov. 30, 1897	For furnishing and operating dredging plant in Niagara River.

COMMERCIAL STATISTICS OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK, BY LAKE AND RIVER.

Arrivals and departures of vessels for the year ending December 31, 1896.

[Furnished by the collectors of customs, Buffalo Creek and Niagara districts.]

District.	Vessels.	Arrivals from—				Departures to—			
		Home ports.		Foreign ports.		Home ports.		Foreign ports.	
		No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
Buffalo Creek	Steam	207	44,117	34	1,230	207	43,430	36	1,246
	Sail and barges	187	80,263	9	405	183	78,021	13	1,824
Niagara	Steam	381	125,246	21	5,678	380	122,777	12	3,520
	Sail and barges	439	199,868	33	8,457	429	195,726	21	5,636
Total		1,214	449,494	97	15,770	1,199	439,954	82	12,226

Total arrivals and departures (registered tonnage).

District.	1895.				1896.			
	Arrivals.		Departures.		Arrivals.		Departures.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
Buffalo Creek	270	111,904	255	105,094	437	126,015	439	124,521
Niagara	679	320,588	696	330,179	874	339,249	842	327,659
Total	949	432,492	951	435,273	1,311	465,264	1,281	452,180

Increase of tonnage 1896 over 1895 .... tons..	49,679
Greatest draft of vessels .... feet..	13½
Amount of revenue collected year ending December 31, 1896	None.
Value of foreign imports, Niagara district only, year ending December 31, 1896	$204,407
Value of foreign exports, year ending December 31, 1896	None.
Enrolled tonnage, port of Tonawanda	No record.
New lines of transportation established	None.

Receipts by lake.

[Compiled from the report of the Buffalo Merchants' Exchange.]

Articles.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Lumber	1,255,889	884,646	871,508	752,986	712,087	787,202	821,797
Shingles	6,268	6,307	5,187	3,031	3,776	4,957	4,298
Laths	3,260	2,052	1,561	3,308	2,124	2,187	1,798
Pickets			991				185
Posts	792				1,200	1,167	4,059
Railroad ties, telegraph poles, etc		8,092	21,383	5,152	2,514	7,350	5,972
Iron ore			85,772	66,617	93,684	110,454	134,428
Limestone			7,728	11,868		21,720	4,770
Pig iron			1,140	1,460	4,870	8,371	9,097
Copper					700		
Pulp wood			900	15,770	17,812		25,270
Timber	735,000					1,050	3,772
Total	2,001,209	901,997	996,370	860,142	838,267	894,408	1,015,396

Receipts in tons and percentages for the years ending December 31, 1894, 1895, and 1896.

Articles.	1894.		1895.		1896.	
	Tons.	Percentage.	Tons.	Percentage.	Tons.	Percentage.
Timber and timber products	739,513	88.22	753,863	84.28	867,101	85.4
Iron, copper, etc	98,754	11.78	140,545	15.72	148,295	14.6
Total	838,267	100	894,408	100	1,015,396	100

The following table, giving the entrances and clearances at Tonawanda since 1890, is compiled from the annual report of the Buffalo Merchants' Exchange:

	1890.	1891.	1892.	1893.	1894.	1895.	1896.
Vessels entered...No..	1,422	1,331	1,181	909	849	949	1,311
Vessels cleared...No..	1,402	1,119	1,175	894	830	951	1,281
Entering vessels, tons	584,400	460,627	484,038	400,479	418,438	425,105	466,297
Clearing vessels. tons..	578,667	455,115	478,997	391,175	403,350	441,602	455,000
Articles received by lake in vessels, rafts, etc.............tons..	2,001,209	901,997	996,370	860,142	838,267	894,408	1,015,396
Canal clearances..No..	....	....	3,111	2,502	2,258	2,120	2,062
Shipments by Erie Canal.........tons..	775,729	649,684	584,212	550,864	436,260	403,358	384,889
Lumber shipments by Erie Canal..ft.B.M..	373,569,621	293,211,900	286,329,307	216,116,532	202,110,990	195,836,000	185,580,352

Number of vessels and rafts passing the International Bridge, Niagara River, during the years 1891 to 1896.

[From the report of the Buffalo Merchants' Exchange.]

Vessels.	1891.	1892.	1893.	1894.	1895.	1896.
Steamers	9,597	10,132	8,796	10,408	10,012	9,469
Other vessels	3,544	3,872	2,820	3,057	2,891	1,833
Rafts	61	40	25	13	5	13
Total	13,202	14,044	11,641	13,496	12,908	11,315

Number of vessels passing through the draw of the International Bridge, 1896.

[Furnished by R. J. McMurray, captain of the bridge tug *International*.]

Tugs	3,213
Steamers	2,856
Barges	1,608
Total	7,677

Season of navigation, April to December.....days..	254
Number of times the bridge draw was opened during the season	4,922
Average number of times bridge draw was opened per day	19.38

M M 5.

IMPROVEMENT OF NIAGARA RIVER FROM TONAWANDA TO PORT DAY, NEW YORK.

Original condition.—Port Day is the inlet to the old hydraulic power canal at Niagara Falls. It is not and never has been a practicable port of commerce, owing to shallow water and its proximity to the rapids at the head of Niagara Falls.

From Port Day up, the river in front of the city of Niagara Falls is very shallow and with rock bed until Conners Island is reached. Between Conners Island and the main shore is a snug little harbor with about 5 acres, of an average depth of 12 feet at mean river stage, and with a maximum depth of about 18 feet.

Above the head of the island there was a shoal with a least depth on it of 7½ feet at mean stage. Above this shoal very good water existed until Cayuga Island was reached. Between this island and Tonawanda a shoal exists which requires dredging to give a channel of 12 feet depth at mean river stage.

Project for improvement.—The project for the improvement of the Niagara River from Tonawanda to Port Day as it now stands is to make a channel 200 feet wide and not less than 12 feet depth at mean water level, by excavating through the shoal at the head of Conners Island, and through the shoal above Cayuga Island.

The project also states that "any widening or deepening required should be estimated and provided for after the work outlined above is done."

This is a modification of the original project, which with a history of the modification is given in the last annual report on this harbor. (Chief of Engineers Report, 1896, p. 3122).

The cost of the present project was originally estimated in 1892 at $230,000.

This estimate was reduced last year to $180,000, and it is now determined that the work can be completed for much less than this amount, viz, $50,000, making the total cost of the work contemplated by the project $95,000.

Up to June 30, 1896, there had been expended on the project $26,703.48. The channel through the shoal at the head of Conners Island was completed to its full width of 200 feet and a depth of 12 feet or more at mean river level.

The amount expended during the fiscal year ending June 30, 1897, was $2,233.07.

REPORT OF OPERATIONS.

As no reliable map of the river was in existence of later date than that of the United States Lake Survey of 1875, a hydrographic survey of the east channel was made from Tonawanda to Schlossers Dock, 8 miles, in order to determine the best location for the channel of the project. This survey was begun September 28 and completed November 11, 1896.

The results obtained were a complete examination of the river bed from Tonawanda Island to the foot of Conners Island, the location of shore lines, and soundings on lines across the stream 300 to 500 feet apart. The survey was based on a system of triangulation.

The cost of the survey was as follows:

Service of steam launch	$226.00
Supplies	28.41
Labor	405.50
Total	659.91

With this survey as a basis, the river was carefully studied and approximate pierhead lines 2,000 feet apart were laid out along the river banks. Within this a channel 200 feet wide was located from Tonawanda to Conners Island. This channel was found at every point to have more than 12 feet of water, except at one rocky ledge above Cayuga Island. This shoal is about 700 feet long in the direction of the channel, with minimum depths on it of 9 feet.

Tests were made on this shoal with a powerful dredge to see if drilling and blasting were necessary before it could be dredged. These tests showed conclusively that the rock is too hard to dredge without blasting.

Ranges were established by land targets and buoys, and on June 21 the drill boat *Thor* commenced work in drilling and blasting on this shoal. None of the rock has yet been removed by dredging.

Up to and including June 30 the drill boat had worked $20\frac{1}{8}$ days of eight hours each. Operations with the drill boat are carried on continuously night and day.

REMARKS.

With the completion of the channel 200 feet wide and 12 feet deep through the Cayuga Island reef, and the removal of any bowlders that may be elsewhere discovered, the project may be considered as completed.

It is estimated that in addition to the money that is now available it will cost $50,000 to complete the work on this shoal and under the project. The estimates for this work are very uncertain, as the character of the material to be excavated can not be accurately determined in advance of actual operations.

It is therefore recommended that the sum of $50,000 be appropriated to complete the project.

It is to be noted that there is practically no use made of this channel of the Niagara River below Tonawanda, except by excursion boats running to resorts along the shore of Grand Island.

Money statement.

July 1, 1896, balance unexpended	$18,296.52
June 30, 1897, amount expended during fiscal year	2,233.07
July 1, 1897, balance unexpended	16,063.45
July 1, 1897, amount covered by uncompleted contracts	14,307.75
July 1, 1897, balance available	1,755.70
Amount (estimated) required for completion of existing project	50,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
July 13, 1892	$20,000
August 17, 1894	10,000
June 3, 1896	15,000
Total	45,000

Abstract of proposals received in response to advertisement dated August 7, 1896, opened September 7, 1896, by Maj. T. W. Symons, Corps of Engineers.

No.	Name and address of bidder.	Furnishing and operating drill boat (per day of 8 hours).	Furnishing and operating dredges, each (per day of 8 hours).	Furnishing and operating tug (per day of 8 hours).
1	Hingston & Woods, Buffalo, N. Y.	$76.00	$74.00	$18.00
2	William J. Daly, Ogdensburg, N. Y.	84.00	88.00	20.00

No. 1 accepted and contract made.

Contract in force at close of fiscal year.

Name and address of contractor.	Date.	Date of approval.	Date of beginning work.	Date of expiration.	Remarks.
Hingston & Woods, Buffalo, N. Y.	Sept. 14, 1896	Sept. 26, 1896	Sept. 14, 1896	Nov. 30, 1897	For furnishing and operating dredging plant in Niagara River.

COMMERCIAL STATISTICS, NIAGARA FALLS, N. Y.

Arrivals and departures for the year ending December 31, 1896.

Vessels.	Arrivals from home ports.		Departures to home ports.	
	Number.	Tonnage.	Number.	Tonnage.
Steam *a*	205	27,814	205	27,814

a Excursion boats.

Total arrivals and departures of vessels (tonnage 55,628)	410
Increase of tonnage over 1895	40,367
Greatest draft of vessels ... feet	10
Amount of revenue collected, year ending December 31, 1896	None.
Value of foreign imports, year ending December 31, 1896	None.
Value of foreign exports, year ending December 31, 1896	None.
Enrolled tonnage, port of Port Day	None.
New lines of transportation established	None.

Receipts by river at Schlossers Dock.

	1895.	1896.
Pulpwood ... tons	300	None.
Rosin ... do	100	None.
Total	400	None.

No record of passengers.

There was unloaded from vessels at foot of Grand Island and rafted to Port Day for the paper mills the following:

		Tons.
1894	pulp wood..	28,000
1895	do....	28,284
1896	do....	36,000

Shipments by river, none, except passengers, which are not reported.

M M 6.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

Original condition.—Wilson Harbor is at the mouth of Twelve-Mile Creek, a small stream flowing into Lake Ontario. In its original condition there was a depth of water inside the mouth sufficient for ordinary sized lake craft, but it was closed by a bar upon which there was ordinarily but about 1 foot of water. The object of the improvement undertaken was to obtain a channel of 12 feet depth from deep water in the creek to deep water in Lake Ontario.

Project.—The present project was submitted in 1873 and proposed to extend piers to the 12-foot curve in Lake Ontario and to dredge a channel 12 feet deep between the piers and from the shore end of the piers to the deep water in the creek.

The original estimated cost of the work, as made in 1873, was $90,000. This was increased in 1877 to $100,000.

The amount expended upon the project to June 30, 1896, was $64,978.51. With this money there had been built two piers at the harbor entrance and a shore protection. The piers are prolongations of piers built by private parties in 1846. At present the west pier is 832 feet long and the east pier 850 feet long. There is also a shore protection for the east pier. This is 360 feet long.

The channel was dredged in 1889 to a minimum depth of about 9 feet, but had shoaled since that time.

During the fiscal year ending June 30, 1897, there was expended on Wilson Harbor the sum of $4,984.41. This was expended in repairs to the piers and in dredging a channel between them to the extent admissible.

REPORT OF OPERATIONS.

The dredging of the channel to a depth of 12 feet at mean lake level was begun on August 14 and continued to October 10, 1896, when the funds became exhausted.

A dredging plant was hired of Hingston & Woods, Buffalo, N. Y., the lowest bidders in response to a circular letter inviting bids. This method of doing the work of channel excavation was chosen for the reason that the character of the material to be removed was not definitely known, particularly as to the existence or nonexistence of rock.

At the close of the work the channel had been dredged to its full depth of 12 feet and 80 feet wide from the lake to the docks in the harbor. The material was found to be sand and gravel with a ledge of red shale underlying the outer 400 feet of the channel. This shale was removed by the dredge without material difficulty, and required no blasting.

The following is a summary of the dredging operations, August 14 to October 10, 1896:

Number of days' work of dredge	60.84
Number of cubic yards of sand, hardpan, and red shale dredged	24,025
Amount earned by dredge	$4,173.51
Cost per cubic yard dredged	$0.174

In connection with the dredging the piers were repaired to the extent permissible with the available funds. The superstructures of both piers were filled with stone where needed, which was at their outer ends, and the decks repaired to protect the new filling.

The cost of these repairs was $230.24.

The channel is not stable and fills in quite rapidly with sand driven in by storms. An examination of the channel made March 18, 1897, however, shows that it was then practically the same as at the close of dredging operations.

REMARKS.

The work at Wilson Harbor was never completed, but has been in hand since 1873. The existing piers are badly in need of repairs, and the channel between the piers becomes choked with sand and gravel.

The money appropriated by the act of June 3, 1896, was expended in making absolutely necessary minor repairs, and in dredging as good a channel as possible.

To put this harbor in the condition which is called for by the project will cost about the difference between the estimated cost, $100,000, and the amount already appropriated, $70,000—that is, $30,000. Of this, $15,000 will be required for renovation of the piers and $15,000 for dredging.

About the only business of Wilson by water is the excursion business. Upon Twelve-Mile Creek there are some beautiful picnic grounds with suitable buildings, and several times during the summer boats bring parties of excursionists, chiefly from Canada.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
May 12, 1897, repayment to appropriation	.50
	5,000.50
June 30, 1897, amount expended during fiscal year	4,984.41
July 1, 1897, balance unexpended	16.09
Amount (estimated) required for completion of existing project	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

STATEMENT OF APPROPRIATIONS.

March 3, 1875	$10,000	August 5, 1886	$10,000
August 14, 1876	10,000	August 11, 1888	5,000
June 14, 1880	10,000	June 3, 1896	5,000
March 3, 1881	10,000		
August 2, 1882	10,000	Total	70,000

Twenty-one dollars and forty-nine cents from the appropriation of August 11, 1888, remained unexpended, and was turned into the Treasury, January 22, 1896.

COMMERCIAL STATISTICS, WILSON HARBOR, NEW YORK.

[Furnished by the deputy collector of customs at Wilson, N. Y.]

Arrivals and departures for the year ending December 31, 1896.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	Number.	Tons.	Number.	Tons.	Number.	Tons.	Number.	Tons.
Steam	4	57	15	4,468	4	57	15	4,468
Sail	2	400	......	....	2	400	......	....
Total	6	457	15	4,468	6	457	15	4,468

Total arrivals and departures of vessels (tonnage, 9,850)	42
Decrease of tonnage from 1895	31,970
Greatest draft of vessels ... feet..	10
Amount of revenue collected, year ending December 31, 1896	None.
Value of foreign imports, year ending December 31, 1896	$2,791.94
Value of foreign exports	$4.50
Enrolled tonnage, port of Wilson, N. Y	None.
New lines of transportation established	None.

Receipts and shipments by lake for the year 1896.

RECEIPTS.

	Tons.
Lumber	893
Fruit	.25
Lath	25
Cedar posts	360
Shingles	18
Total	1,296.25

SHIPMENTS.

Fruit	0.25

The following table gives the total arrivals and departures at and from Wilson Harbor, New York, for the last ten years:

	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
Number of vessels arriving and departing	0	43	126	102	80	54	90	78	106	42
Tonnage of arriving and departing vessels	0	5,963	27,996	25,258	19,731	19,992	35,860	27,188	41,820	9,850

M M 7.

PRELIMINARY EXAMINATION FOR A SHIP CANAL BY THE MOST PRACTICABLE ROUTE, WHOLLY WITHIN THE UNITED STATES, FROM THE GREAT LAKES TO THE NAVIGABLE WATERS OF THE HUDSON RIVER, OF SUFFICIENT CAPACITY TO TRANSPORT THE TONNAGE OF THE LAKES TO THE SEA.

[Printed in House Doc. No. 86, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 13, 1897.

SIR: Section 8 of the river and harbor act of June 3, 1896, directs the Secretary of War "to cause to be made accurate examinations and estimates of cost of construction of a ship canal by the most practicable route, wholly within the United States, from the Great Lakes to the navigable waters of the Hudson River, of sufficient capacity to transport the tonnage of the lakes to the sea."

Under date of July 28, 1896, the Chief of Engineers recommended, in a letter to the Secretary of War, that, in view of the insufficient amount of money available to carry out literally the evident requirement of Congress for a survey, the above-quoted item be treated as an ordinary preliminary examination, and that a report be prepared giving such information as was then available, and such facts as could be secured regarding the worthiness of the contemplated improvement, together with an estimate of the cost of such a survey as must precede the preparation of detailed plans and estimate of cost. This recommendation was approved by the Secretary July 30, 1896. Subsequently, on August 11, 1896, the Secretary of War approved the recommendation made by this office on August 7, 1896, that the said preliminary examination be made as proposed at a probable cost of $5,000. The duty of making this preliminary examination was assigned to the charge of Maj. Thomas W. Symons, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report, with illustrations upon the subject, which was transmitted to this office with his letter of June 23, 1897.

Major Symons states that there are three possible routes for a ship canal entirely within the United States from the Great Lakes to the navigable waters of the Hudson.

The first-mentioned route extends from Lake Erie, via the upper Niagara River, to the vicinity of Tonawanda or Lasalle; thence by canal with locks to the lower Niagara River at or near Lewiston, or to some point on Lake Ontario; thence through Lake Ontario to Oswego; thence up the Oswego and Oneida rivers to Oneida Lake and through Oneida Lake; thence across the divide to the Mohawk River, and down said river to the Hudson at Troy; and thence down the Hudson. This is designated as the Oswego route.

The second route follows the line of the Erie Canal from Lake Erie and the Niagara River through to the Hudson, or this line so modified as to provide for a continuously descending canal from Lake Erie to the Hudson. This is designated as the Erie Canal route.

The third route coincides with the first from Lake Erie to Lake Ontario, running thence through Lake Ontario to the St. Lawrence River, and down said river to some point near Ogdensburg; thence crossing the State of New York to Lake Champlain, and up said lake to its head, and thence following in general the route of the Champlain Canal to the Hudson at Troy. While the local officer mentions this as a *possible* route, he is of opinion, for reasons stated, that it is not a *practicable* one.

Allusion is also made in the report to still another route—the St. Lawrence-Champlain route—all of which, except a small portion, is in the United States.

The relative merits of these routes are discussed in the report, and it is the opinion of the local officer that the best route for the contemplated ship canal is that by way of Niagara River, Lake Ontario, Oswego, Oneida Lake, and Mohawk and Hudson rivers; that to build such a canal from the Great Lakes to the ocean, by any of the possible routes mentioned, would, at a rough estimate, cost $200,000,000, depending to a very great extent upon the action of the State of New York in regard to its canals, feeders, reservoirs, etc.; that to maintain the canal and to keep it and all its structures in repair, including operation of locks, bridges, etc., and the maintenance of river channels, reservoirs, feeders, etc., would cost, at a rough estimate, $2,000,000 per year, and that such a canal, if constructed, would have no military value. He is further of opinion that the construction of such canal is not a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would not be properly commensurate with the cost.

Major Symons is also of opinion that the Erie Canal, when enlarged under existing plans of the State of New York, will, if all restrictions imposed by the State upon its use be removed, give commercial advantages practically equal to the commercial advantages that would be given by a ship canal; and that, if it be further improved by enlargement to a size sufficient for 1,500-ton barges, making necessary alterations in its alignment so as to give a continuously descending canal all the way from Lake Erie to the Hudson, and canalizing the Mohawk River, such improved canal, navigated by barges, would enable freight to be transported between the East and the West at a lower rate than by a ship canal navigated by the large lake or ocean vessels. And Major Symons states that the enlargement of the Erie Canal, as suggested, with everything adapted to transport the tonnage of the lakes, is a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would be properly commensurate with the cost, which is estimated to be approximately one-fourth that of a ship canal.

The cost of the necessary surveys for a ship canal along the Niagara-Oswego route is estimated at $190,000. An entirely independent survey for the enlargement of the Erie Canal and the canalization of the Mohawk River will, it is estimated, cost $125,000. It is further estimated that a combined survey for the Niagara-Oswego ship canal and for the enlargement of the Erie Canal would cost $250,000. In this connection it is stated in the report that such surveys must precede the preparation of detailed plans and estimates of cost of improvement, and that the whole plan of survey is based upon using locks of the ordinary type and of the size mentioned in said report.

In transmitting the report to this office the division engineer, Col. G. L. Gillespie, Corps of Engineers, stated as follows:

The subject of transporting the tonnage of the lakes to the sea is exhaustively treated in this report, and the facts stated and the arguments thereon relative to the methods to be followed in order to secure an adequate outlet within our own territory for Western products, are worthy of the closest study by Congress.

The local officer is of the opinion that the best route for a ship canal between the Great Lakes and the ocean is by Niagara River, Lake Ontario, Oswego, Oneida Lake, and the Mohawk and Hudson rivers, and that, when built, will have "no military value," and that the construction of such a canal at an estimated cost of $200,000,000 and over is "not a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would not be properly commensurate with the cost."

He is also of the opinion that the Erie Canal, when enlarged under existing plans of the State of New York, estimated to cost $9,000,000, all restrictions imposed by the State upon its use being removed, "will give commercial advantages practically equal to the commercial advantages that would be given by a ship canal," and that if it be further improved by enlargement "to a size sufficient for 1,500-ton barges, making necessary alterations in its alignment so as to give a continuously descending canal all the way from Lake Erie to the Hudson, and canalizing the Mohawk River, such improved canal, navigated by barges, will enable freight to be transported between the East and West at a lower rate than could a ship canal navigated by the large lake or ocean vessels. The cost of such enlargement would be approximately one-quarter the cost of a ship canal."

It is estimated that "the enlargement of the Erie Canal as suggested, with everything adapted to transport the tonnage of the lakes, is a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would be properly commensurate with the cost."

The estimated cost of a complete survey for a Niagara-Oswego-Mohawk ship canal and also for the Erie Canal enlargement is $250,000, approximately.

No definite conclusions and recommendations can be given relative to location and methods of construction until after the suggested surveys have been made.

The views of the local engineer regarding the expediency of the surveys to determine the cost of enlarging the Erie Canal and the location and cost of a ship canal, at the aggregate cost of $250,000, are concurred in.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., June 23, 1897.

GENERAL: I have the honor to submit the following report of the preliminary examination into the subject of a ship canal from the Great Lakes to the navigable waters of the Hudson River, which was assigned to my charge by Department letter of August 13, 1896. The letter assigning the work to my charge is as follows:

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 13, 1896.

MAJOR: Your letter of the 4th instant, submitting estimate of cost of making preliminary examination from the Great Lakes to the navigable waters of Hudson River, was duly received and submitted to the Secretary of War, with indorsement, of which the following is a copy:

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 7, 1896.

Respectfully submitted to the Secretary of War.

The river and harbor act of June 3, 1896, provides as follows:

"The Secretary of War is hereby directed to cause to be made accurate examinations and estimates of cost of construction of a ship canal by the most practicable route, wholly within the United States, from the Great Lakes to the navigable waters of the Hudson River, of sufficient capacity to transport the tonnage of the lakes to the sea."

The Chief of Engineers, in his letter of the 28th ultimo to the Secretary of War, recommended that, in view of the insufficient amount of money available to carry out literally the evident requirement of Congress for a survey, the above-quoted item be treated as an ordinary preliminary examination, and that a report be prepared giving such information as is now available, such facts as can be secured regarding the worthiness of the improvement, and an estimate of the cost of such a survey as must precede the preparation of detailed plans and estimate of cost.

This recommendation was approved by the Secretary of War July 30, 1896, and Maj. T. W. Symons, Corps of Engineers, in response to a call from this office, now submits the within estimate, amounting to $5,000, as necessary for the preparation of the report proposed.

When this matter was originally presented to the Secretary of War for action, it was not anticipated that so large a sum as $5,000 would be required for collecting information and preparing a report, considering the work as a preliminary examination.

But the information which Major Symons proposed to secure will be of great value to Congress in connection with its consideration of the question of providing for a survey, which Major Symons estimates would cost $100,000; and the information will be desirable in the advance of the making of such survey, and have some bearing on the character and extent of the same.

It is therefore recommended that the preliminary examination from the Great Lakes to the navigable waters of the Hudson River, with a view to the construction of a ship canal wholly within the United States, be made as proposed by Major Symons, at a probable cost of $5,000.

A. MACKENZIE,
Acting Chief of Engineers.

By War Department indorsement of August 11, the letter was returned to this office, "approved as recommended by the Acting Chief of Engineers."

The preliminary examination thus provided for is assigned to your charge, and it is desired that report of its results be submitted through the division engineer to this office as soon as circumstances permit.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Maj. THOMAS W. SYMONS,
Corps of Engineers, Buffalo, N. Y.
(Through the Division Engineer.)

The term "Great Lakes" in the law is understood to refer to the lakes upon which the great commerce between the East and the West is carried. This includes Lake Erie and all the lakes above it, and it is believed that a canal directly from Lake Erie to the Hudson, without touching Lake Ontario, would fulfill the conditions of the law. Lake Ontario can be left out of consideration in the problem, if this is at all desirable, as its commerce is of very small proportions. At the same time it is taken for granted that the condition which requires that the canal shall connect the Great Lakes with the navigable waters of the Hudson will, if Lake Ontario is connected with the Hudson, require Lakes Erie and Ontario to be connected with a ship canal.

By the term "navigable waters of the Hudson River," is understood to be meant waters of equal navigable capacity to those of the canal of which they would form an extension and part of the contemplated highway from the lakes to the sea. The object of the canal being to furnish a through route for ships from the lakes to the seaboard, the project for the canal must include its extension down along the Hudson to deep water, or the improvement of such portion of the river as it may be deemed should properly form a link in the chain of through communication.

The item in the law which requires that the canal shall have "sufficient capacity to transport the tonnage of the lakes to the sea," I have, in the study of the subject which follows, interpreted in two ways:

First. That the canal in all its dimensions and structures shall be of sufficient size to pass the largest vessels now running on the lakes, or which may be expected to run in the near future, all arranged to pass enough of these large vessels and of smaller ones to transport that proportion of the tonnage of the lakes which it may reasonably be considered would seek the through route by the canal.

Second. I have conceived that the law might be interpreted to mean that the canal should have the location and size which will, at the least cost for construction and maintenance, enable the freight passing between the East and West, "the tonnage of the lakes," to be transported at the smallest cost. This latter is the broader view of the subject, and its study has been deemed necessary in order that a correct conclusion, from a business and economic standpoint, might be arrived at.

The amount and character of the tonnage which would make use of a large canal, if one be built, is most problematical, and can at best be but a matter of conjecture. Upon its ascertainment within reasonable limits, depends not only the location, character, and arrangement of the canal and its accessories and structures, but the determination as to whether or not the building of the canal is justifiable. An attempt has been made to determine approximately the amount of this tonnage and the result is given hereinafter.

No matter what route is adopted for a ship canal, which shall give within American territory a continuous passageway for the great ships of the lakes to the sea, such a canal would be a stupendous work, one of the very largest ever undertaken by man, involving the expenditure of an enormous sum of money, roughly approximated at $200,000,000.

To justify the undertaking of such a stupendous work, it should be clearly shown, first, that it is a necessity and will accomplish the object aimed at—of greatly reducing the cost of transportation; second, that the benefits to be derived from it will be commensurate with its cost and the cost of its maintenance, and third, that these or greater benefits are not practically attainable in some other way and at a less cost.

The practical question is, What can a great ship canal be reasonably expected to accomplish?

It is not enough to answer this question by the statement that a ship canal will give free access for ocean vessels to the lakes, and lake vessels to the ocean or the seaboard, and that freight will thus be cheaper. All existing conditions of traffic and transportation, and the conditions which can be reasonably foreseen under all possible contingencies, must be considered. It must be clearly shown how the canal is to reduce freights not only to a lower point than those now existing, but to a lower point than those which can confidently be expected from other sources by the time that the canal can be completed and that the reductions are fairly proportionate to the cost of building, maintaining, and operating the canal.

It would not be a creditable monument to the business management of American public works if the Government should expend $200,000,000 or thereabouts on a ship canal and then find, when it was completed, that it was very little used by the big ships for which it was intended and that the business on it was chiefly transacted in comparatively small vessels, which could be equally well accommodated in a canal of much less size and expense.

We must not fail to give consideration to the effect of such a canal upon the merchant marine of the country, nor should we confound real benefits with a mere transference of location of certain business enterprises and activities which benefit one section at the expense of another.

My study of the problem, in the light of existing conditions and of improvements in these conditions which are rapidly approaching completion, convinces me that the ship canal would not accomplish the object aimed at—of greatly lessening the cost of transportation—and that it is, therefore, not a necessity; that if built it would not be used to any great extent by large vessels, and that the benefits to be derived from it would not be commensurate with its cost and the cost of maintenance.

And furthermore, I am fully convinced that benefits fully equal in practical value to those which would be secured by the construction of a ship canal, at a cost approximating to $200,000,000, could be secured by the enlargement of the Erie Canal to a capacity sufficient for barges of about 1,500 tons net burden, the cost of which enlargement and improvement would, while great, be small in comparison with the cost of a great ship canal.

I therefore state that, in my opinion, the project of a ship canal from the Great Lakes to the navigable waters of the Hudson River, wholly within the United States and of sufficient capacity to permit the passage of the large vessels of the lakes, is not worthy of being undertaken by the United States, while it is my opinion that the realignment and enlargement of the Erie Canal to a size permitting passage to 1,500-ton barges and with capacity to transport the tonnage (the freight) of the lakes to the sea, is worthy of being undertaken by the United States, in the interest of the general commerce thereof, provided proper and satisfactory arrangements can be made with the State of New York.

Any ship or barge canal built in compliance with the conditions of the law must pass through the State of New York, and such a canal would of necessity occupy the site of the Erie or Oswego Canal, or both, in whole or in part, and would have to make use of the accessories and the water supply pertaining thereto. The same, it is believed, would be true of a canal by the Champlain route, which would have the same relation to the Champlain Canal that another would have to the Erie or Oswego Canal.

These canals were built by, and are owned by, the State of New York, and in them the State takes great pride and interest, and is now engaged in their improvement to the extent of $9,000,000, which was voted for the purpose by the people of the State. It must, therefore, be taken into consideration that a prime requisite in the matter of locating, making plans and estimates for, and building a ship canal will be a thorough understanding between the General Government and the State of New York in regard to the obliteration, absorption, or alteration of these canals into the greater ship or barge canal.

If an entirely new great ship canal be the work undertaken, there should be no divided ownership, and everything in every way necessary thereto should be completely ceded to and owned by the United States. If the work to be undertaken be the enlargement and alteration of the existing Erie Canal, it is quite possible that less radical changes in ownership might be found practicable and some sort of a partnership arrangement made between the General Government and the State.

The matter of an understanding with the State of New York would be complicated by the fact that many leases have been made and vested rights acquired in the water power incident to the canal. Whatever authority controls the canals should have full and complete supervision over the water taken and used for power purposes.

As the State of New York would receive the chief benefits at the eastern end of the route from the Great Lakes to the sea arising from the construction of any great canal, and as all her existing canals are at present sources of much expense, and from which no direct revenues are obtained, it would seem that the State would be willing to consent to such transfer of interests as might be deemed necessary.

The project of a great ship canal from the lakes to the Hudson or by any other route to the sea has been before the public for so many years; it has so many ardent, enthusiastic, and interested advocates; and the pictures which it presents of ships loading at Chicago, Duluth, and other lake ports, and thence proceeding on their uninterrupted way to New York or to the ports of Europe, and of shipping from foreign and domestic seaports plying freely and directly to the lake ports without breaking cargo, are so alluring and delightful that I feel that I must give good reason for my belief that the project is unjustifiable and not worthy of being undertaken by the United States, except in the modified form mentioned and outlined herein.

POSSIBLE ROUTES.

There are three possible routes for a ship canal entirely within the United States from the Great Lakes to the navigable waters of the Hudson River.

The first is from Lake Erie by way of the upper Niagara River to the vicinity of Tonawanda or Lasalle; thence by canal with locks to the lower Niagara River at or near Lewiston, or to some point on Lake Ontario; thence through Lake Ontario to Oswego; thence up the Oswego and Oneida rivers to Oneida Lake; through Oneida Lake; thence across the divide to the Mohawk River, and down the Mohawk to the Hudson, at Troy; thence on down the Hudson. This will be hereinafter designated as the Oswego route.

The second route follows the line of the Erie Canal from Lake Erie and the Niagara River through to the Hudson, or this line so modified as to provide for a continuously descending canal from Lake Erie to the Hudson. This will be designated hereinafter as the Erie Canal route.

The third route, mentioned in a report by Mr. Verplanck Colvin, superintendent of the Adirondack survey, coincides with the first from Lake Erie to Lake Ontario; thence through Lake Ontario to the St. Lawrence River; thence down the St. Lawrence to some point near Ogdensburg; thence across the State of New York to Lake Champlain; up this lake to its head; thence following in general the route of the Champlain Canal to the Hudson, at Troy. While this is mentioned as a possible route, it is almost certain that it is not a practicable one, as it is not believed that the portion of New York State lying between the St. Lawrence and Lake Champlain will be found suitable for a canal location. This route at present is not considered worthy of any more serious attention than a reconnaissance.

While it is not strictly within the scope of the report required of me, it seems proper to allude to another route, all of which, except a small portion, is in the United States. This is the route via Niagara Falls, Lake Ontario, the St. Lawrence River, Caughnawaga, Richelieu River, Lake Champlain, and the Hudson. This may properly be called the St. Lawrence-Champlain route, and will be so designated hereinafter.

Upon a map, which is herewith, there is indicated all these possible routes, and upon an accompanying plan the profiles along these several lines as far as these profiles are known.

THE OSWEGO ROUTE.

The construction of a ship canal entirely within American territory from the Great Lakes to the navigable waters of the Hudson River by the Oswego route involves the following work:

1. The improvement of the Niagara River from Lake Erie to the vicinity of Tonawanda.
2. The construction of a ship canal around Niagara Falls from the Niagara River near Tonawanda to the lower Niagara River, or to Lake Ontario, the line preferred being to Lake Ontario at Olcott.
3. The construction of a harbor at Olcott.
4. The radical improvement of Oswego Harbor.
5. The construction of a ship canal from Oswego to Troy.
6. The improvement of the Hudson River from Troy down to a point where ample depth and width are found.

UPPER NIAGARA RIVER.

The problem of improving the Niagara River from Lake Erie to Tonawanda for the accommodation of deep-draft ships is involved and difficult. At the head of the river there is a rocky shoal through which the Government has excavated a channel 18 feet deep at mean stages; below this the river is narrow and very rapid, and obstructed by the Buffalo waterworks intake pier and by the International Bridge, which is located where the river is narrow and swift, and through which there is but one available draw opening 160 feet wide; below this there is another rocky shoal at Strawberry Island, where work is in progress designed to make a channel 400 feet wide and 18 feet deep at mean stages of the river. For several years the river has ordinarily been from 1 to 2 feet and more below mean stage, following the general lowering of lake levels.

To excavate channels in the river which would be amply large for connecting with a ship canal would be expensive, and it would be objectionable inasmuch as it would permit the waters of Lake Erie to run off more rapidly than they do now, and thereby further tend to lower the waters of this lake. It would, moreover, give very unsatisfactory results, for the swift currents and narrow, rocky channels combined with the intake pier and the narrow drawbridge would make navigation for heavily laden vessels difficult and dangerous.

Another feature of the case which is of importance and must not be lost sight of is the demand for the raising or regulation of lake levels. This will require a structure of some sort across the Niagara River at or near its head, or between its head and Niagara Falls.

Two ways are suggested for overcoming the difficulties of navigation and at the same time providing for regulating the lake levels:

One way is to build a dam upon the rocky shoals at the head of the river to raise and regulate lake levels, and in connection therewith to enlarge the Black Rock Canal, and to provide a lock or locks at its lower end of sufficient capacity to pass the through commerce of the ship canal and the local commerce of Tonawanda and points farther down the Niagara River. The river from the locks to Tonawanda could then be deepened at a comparatively small expense. This would avoid all the swiftest water, avoid the passage of the narrow drawbridge in swift water, and avoid all trouble at the intake pier.

The second way is to throw dams across the American and Canadian channels of the river below Tonawanda, thus raising the river at this point to the level of Lake Erie, less the river slope. This latter method would cause the flooding of large amounts of valuable property, particularly at Tonawanda, and might not be found practicable. It would, however, save a large amount of rock cutting in the canal between the Niagara River and Lockport.

Between these two extremes, other and more advantageous plans might be developed by further and more complete surveys and investigations. A complete solution of the problem may require international agreement between the United States and Canada. Whatever method is adopted will undoubtedly involve a very heavy expense.

The distance from the head of the river at Buffalo to the canal entrance below Tonawanda would be about 14 miles, of which, if the first plan be adopted, 4 miles would be by canal from Buffalo to Black Rock and 10 miles by river from Black Rock to below Tonawanda.

THE NIAGARA SHIP CANAL.

The canal route about Niagara Falls, which to me appears preferable, is the Olcott or Eighteen-Mile Creek route. This line runs in a general direction a little east of north from the Niagara River near Tonawanda to Lake Ontario, at Olcott. The entire line lies well away from the frontier, and while it is longer in canal than some other possible lines, it possesses more than compensating advantages.

The total length of this line is about 25 miles and the fall 320 feet. To overcome this fall would require 13 locks, with an average lift of 24½ feet, and a guard lock at the Niagara River. The line mentioned is shown on the accompanying map.

As this Niagara Ship Canal has been under discussion for many years, and a number of surveys of it have been made, it is deemed proper to give a brief history of it and of matters connected with it.

1784.

In 1784 the first survey was made for a canal around the Falls of Niagara with a view to connecting the waters of the Hudson River and those of Lake Erie by a system of canals and slack water and lake navigation, by way of the Mohawk River, Oneida Lake and River, and Oswego River and Lake Ontario, and thence by Niagara River and the projected canal to Lake Erie. This system was partly completed by works on the Mohawk River and Oneida Lake. The works were constructed by the Western Inland Lock Navigation Company, for which, in 1792, General Washington obtained the passage of an act of incorporation by the legislature of the State of New York.

In 1796 this company began its operations and constructed several small canals in the Mohawk Valley at Little Falls, and elsewhere, and improved the natural river channels, in which works it expended $560,000. Between 1812 and 1820 it surrendered its charter to the State (which already owned a part of the stock of the company) for $140,000, this purchase being the first step toward the construction by the State of the Erie Canal, which was decided upon in 1817 and completed in 1825. Nothing was done at Niagara, where, prior to 1825, goods for Lake Erie and the West were taken from Lake Ontario by a 28-mile portage, for which the charge, according to a report made by Mr. James Geddes, on January 20, 1809, was $10 per ton (equal to 35¾ cents per ton per mile) for the Niagara transfer only.

In 1798 a company was chartered by the State of New York to construct a canal around Niagara Falls, capable of passing boats of 80 tons burden, said canal to be completed ten years thereafter.

1808.

Upon the expiration of this period in 1808, the legislature directed the surveyor-general of the State of New York to explore a route for a canal from the Hudson to Lake Erie, and James Geddes, civil engineer, was accordingly employed to survey a route for the canal around the Falls from Schlossers to Lewiston.

In the same year, pursuant to a resolution of the Senate of the United States, the Secretary of the Treasury submitted to that body a report which included the Niagara Ship Canal from Schlossers to Lewiston, via The Devils Hole.

1826.

In 1826 another and more accurate survey was made under the direction of private individuals, with a view to obtaining a charter from the State of New York and of constructing a canal as above described, the cost of which was then estimated at $1,000,000. But this project also failed of accomplishment, and in 1835 the President of the United States ordered a third set of surveys to be made upon a still larger scale "for a ship canal to connect the waters of Lake Erie and Lake Ontario," for which duty Capt. W. G. Williams, of the United States Topographical Engineers, was detailed.

1836.

Under date of March 17, 1836, Captain Williams reported upon five different routes, varying in their lengths from 7¾ miles (from Schlossers to Lewiston) to 32 miles (from Tonawanda, via Lockport, to Eighteen-Mile Creek at Olcott), the report being accompanied by detailed maps and profiles.

The basis of this project was for locks 200 feet long, 50 feet wide, and 10 feet depth of water, with prism of canal 110 feet wide at water line in earth cut and 60 feet wide in rock cut. Captain Williams's estimate of cost varied from $2,568,899.36 for a canal with single locks from Schlossers to Lewiston to $5,041,725.50 for a canal with part single and part double locks from Tonawanda to Olcott.

This report was made in detail, and was fully illustrated by maps and profiles. It was published as House Ex. Doc. No. 214, Twenty-fourth Congress, first session, April 16, 1836.

1837.

Under date of February 14, 1837, the House Committee on Roads and Canals made another favorable report urging the military and commercial needs for the work, which was published as House Report No. 201, Twenty-fourth Congress, second session, February 14, 1837.

1853.

No further action was taken until 1853, when the commissioners named in a charter granted by the State of New York for constructing the Niagara Ship Canal appointed Charles B. Stuart, civil engineer, and Edward W. Serrell, civil engineer, to survey the country between Tonawanda Creek and Lake Ontario and to ascertain the most feasible route for constructing a canal around the falls of Niagara, of the dimensions of the St. Marys Canal then building, for the passage of the largest side-wheel steamers then navigating the Western lakes.

Several routes were then carefully surveyed and their cost estimated for a canal 170 feet wide at the top, 130 feet on the bottom, and 14 feet depth of water, with locks 300 feet long and 70 feet wide in the chamber.

The shortest line, 8 miles in length, was estimated to cost $10,290,471.59 with single locks and $13,169,569.69 with double locks. The cost varied with the scale of navigation adopted and especially with the width of locks, as appears by comparison of the estimates of 1835 and 1853.

1863.

In October, 1863, President Lincoln appointed Mr. Charles B. Stuart, civil engineer, to make a report upon proposed canal improvements to pass gunboats from tide water to the lakes, and in this connection he again reported upon the Niagara Ship Canal under date of March 24, 1864.

The dimensions of canal and locks upon which the 1863 estimates were based, were less than those used in 1853, Mr. Stuart considering that as the average depth of water in the principal Western harbors did not exceed 12 feet, this depth in the canal would "meet all the present requirements of this artificial navigation, * * * the miter sills of the locks to be placed with reference to the future deepening of the prism of the canal when the Western harbors and the channel through St. Clair Flats are materially improved." The dimensions of the canal were 105 feet width on surface of water; 12 feet depth; with locks 275 by 45 feet, and averaging 16 feet lift each.

Five lines were surveyed and estimated in 1863. The shortest one—6.58 miles from Schlossers to Lewiston—being estimated at $6,007,011 for single locks and $7,680,555 for double locks.

This report of Mr. Charles B. Stuart was presented to Congress, with a special message by President Lincoln, dated March 29, 1864, and was published as House Ex. Doc. No. 61, Thirty-eighth Congress, first session.

1867.

No action was taken upon the subject until March 27, 1867, when a joint resolution of the Fortieth Congress was approved, ordering surveys and estimates for a ship canal to connect Lakes Erie and Ontario around Niagara Falls, and the duty was assigned to Lieut. Col. Charles E. Blunt, of the United States Corps of Engineers.

These surveys and estimates were made during 1867 by Mr. James S. Lawrence, civil engineer, and Mr. Stephen F. Gooding, civil engineer.

Six different lines were surveyed; three of these, designated as the Lewiston lines, were from Schlossers on the Niagara River (3 miles upstream from the falls), to the Lake Ontario level of the Niagara River at or near Lewiston. These lines varied in length from 7.05 miles to 9.38 miles, averaging 8.08 miles.

The line next in length was designated as the Four-Mile Creek line, and was located from Schlossers to the mouth of Four-Mile Creek on Lake Ontario, with a length of 14.43 miles.

The next in length, designated as the Wilson or Twelve-Mile Creek line, was from a point on Niagara River, 2 miles upstream from the mouth of Cayuga Creek (and 6 miles upstream from the Falls) to the mouth of Twelve-Mile Creek, or Wilson, on Lake Ontario, with a length of 18.25 miles.

The longest line of those surveyed and estimated was that designated as the "Olcott or Eighteen-Mile Creek" line, running from Olcott Harbor, on Lake Ontario, to Niagara River, at a point opposite the north end of Tonawanda Island and seven-eighths of a mile north of the mouth of Tonawanda Creek, passing through the gorge $2\frac{1}{2}$ miles long near Lockport, known as "The Gulf," in which the main ascent is made. The length on this line is 25.28 miles. It offers special advantages, in that it follows the Lockport Gulf (a gorge 80 to 300 feet wide) for $2\frac{1}{2}$ miles, and the Eighteen-Mile Creek gorge (100 to 400 feet wide) for about 4 miles, and that the ascent is so distributed as to give space for passing basins between the adjacent locks, making double locks unnecessary. Its location is also farthest removed from the national boundary. For these various reasons it has been most favorably regarded in the recent reports upon the subject.

In the 1867 report the following estimates were made upon the basis of 14 feet depth, 100 feet width in rock cuttings, and 90 feet bottom and 125 feet surface width in earth cuts; with locks 275 feet long, 46 feet wide and 14 feet depth on miter sills, with lifts of 15 or 16 feet.

On each of the three Lewiston lines there were proposed 21 lift-locks, all double, and a guard-lock and dam at the Niagara River, and the cost of each varied slightly from the average of $11,418,597.

On the Four-Mile Creek line the rise was effected by 7 single locks and 14 pairs of double locks, with a guard-lock and dam on the Niagara River and a harbor on Lake Ontario. The cost was estimated at $12,673,520.

On the Twelve-Mile Creek or Wilson line the rise was effected by 12 single and 9 pairs of double locks, with a guard-lock and dam on the river and a harbor on the lake. The cost was estimated at $13,993,638.

On the Eighteen-Mile Creek or Olcott-Lockport line the rise of 326 feet was effected by 17 single locks and 4 pairs of double locks, with guard-lock and dam on the Niagara River and harbor on Lake Ontario. The estimate of cost was $12,893,170.

The results of the 1867 survey were published in the Report of the Chief of Engineers for 1868, pages 271 to 287, and the maps and profiles were also published, and no other surveys have since been made.

1888.

In the river and harbor act of August 11, 1888, a revision of the 1867 estimates was called for on a basis of 20 feet draft, and the duty of making the revision was assigned to Capt. Carl F. Palfrey, of the Corps of Engineers. Captain Palfrey considered that only the Wilson and Olcott routes were adapted to present conditions, and he adopted as the basis of his estimates the following dimensions: Twenty and one-half feet depth of canal and 21 feet depth on miter sills; 100 feet width in rock cutting; 150 feet surface, and 100 feet bottom width in earth cuts. Locks, 400 feet long, 80 feet width of chamber and 60 feet width of gates, 21 feet depth, and 18 feet general lift.

The estimated costs were:

The Wilson, or Twelve-Mile Creek route; 18.25 miles in length:	
With single locks	$24, 201, 550
With double locks	29, 347, 900
The Olcott, or Eighteen-Mile Creek route; 25.28 miles in length:	
With single locks	23, 617, 900
(Double locks not needed.)	

Captain Palfrey's report, dated August 19, 1889, was printed with the Annual Report of the Chief of Engineers for 1889, page 2434.

1889.

On December 18, 1889, Representative Sereno E. Payne introduced a bill in Congress providing for a Commission to select one of these lines, and appropriating $1,000,000 for construction upon it. No action was had upon this bill.

1892.

A presentation of the subject made by Representative Bentley, from the Committee on Railways and Canals, in 1892, was published as House Report No. 1023, Fifty-second Congress, first session, April 8, 1892, to accompany H. R. 283.

1896.

In 1896 a bill was introduced (H. R. 34) appropriating $50,000 for surveys, and Representative Chickering, from the Committee on Railways and Canals, made a report sustaining the bill, which was published as House Report No. 423, Fifty-fourth Congress, first session, February 18, 1896.

HARBOR AT OLCOTT.

At Olcott the small creek, known as Eighteen-Mile Creek, flows into Lake Ontario. It has a little enlargement within its mouth.

A small harbor of about 12 feet depth has been constructed here by extending two piers 200 feet apart out into the lake. This harbor is entirely inadequate for the ship-canal project. A proper harbor here must have ample size and depth for the accommodation of a large number of vessels and be thoroughly well protected.

Captain Palfrey proposed the construction of a harbor here at an expense of $644,400, but the harbor so proposed would not be adequate. A suitable, ample, and well-protected harbor, with proper lights and aids to navigation, would cost several times this amount, and would be almost entirely artificial, and require constant expenditures to maintain.

LAKE ONTARIO.

The distance from Olcott to Oswego through Lake Ontario is 112 miles. This is all open, deep-lake navigation.

HARBOR AT OSWEGO.

The present harbor at Oswego is suited for the class of vessels that can pass through the Welland Canal, and which now make use of it, but it is not suited for the class of great lake vessels which ply the waters of the upper lakes, and for the accommodation of which the canal would be proportioned. A radical improvement of the harbor would be necessary. The plans for this improvement would require careful consideration. In what these plans would consist I am not prepared to say.

The harbor is fully exposed to the full sweep of the westerly and northerly storms of Lake Ontario, and the inner harbor is all underlaid with rock. To put this harbor in condition for accommodating the traffic of a ship canal and the business which would naturally center at it under the new conditions would involve heavy expense.

CANAL FROM LAKE ONTARIO, AT OSWEGO, TO THE HUDSON RIVER, AT TROY.

There is an existing canal from Oswego to the Hudson at Troy. This is of the same navigable capacity as the Erie Canal, and is being improved to the same additional capacity with the $9,000,000 voted by the State for the purpose. At Syracuse the two join and proceed eastward together. The distance along the Oswego-Erie Canal from Oswego to Troy is 200 miles. Along the Oswego River the canal runs partly in an artificial cut along the banks, and partly in pools formed by damming the river. Along the Mohawk River the canal is located along the edge of the valley and above the reach of the ice jams and floods of the river, crossing the incoming tributaries by aqueducts. Between and connecting the watersheds of the Oswego and Mohawk rivers is the long summit level of the Erie Canal, known as the "Rome level." This level is 56 miles long and is 181.8 feet above Lake Ontario and is 428.4 feet above tide water in the Hudson at Troy. The water supply for this summit level has always been considered one of the great problems in connection with the enlargement of the canal.

In laying out a ship canal from Oswego to Troy, the route which meets with the most favor from those who have studied the subject is to fully canalize the Oswego River by dams and locks as far as the mouth of the Oneida River, thence by a canal partly along the Oneida River and partly cutting across bends, into Oneida Lake, through Oneida Lake, and by a high-level canal up the valley of Wood Creek and over a summit level and down to the valley of the Mohawk, a few miles to the east of Rome. Thence the route would be by the fully canalized Mohawk River.

The mean elevation of Lake Ontario at Oswego is 246.6 feet above tide in the Hudson at Troy. Oneida Lake is 370 feet above the same datum, and the summit level of the proposed ship canal is 418 feet above the same level, or ten feet below the summit level of the Erie Canal.

The total lockage from Oswego to Troy by this route is 590 feet, requiring 25 to 30 locks of the ordinary type. The number of locks will depend principally upon the slopes of the Mohawk and Oswego rivers and the heights to which the pools can be raised without too great damage to property by flooding. The data for the determination of the number and location of dams and locks can only be had by actual and detailed surveys.

HISTORY OF THE OSWEGO-HUDSON CANAL ROUTE.

It was upon this route that the first works for giving water communication between the Great Lakes and the Hudson River were located. This grand project interested General Washington, and the Western Inland Lock Navigation Company was incorporated by the New York legislature in 1792. It is stated in Jean's "Waterways and Water Transport" that General Washington obtained the charter and was the first president of the company. The State subscribed to the stock of the company, and in 1796 the portion of the route from Schenectady to Seneca Falls was opened for boats carrying 16 tons. The works of the Western Inland Lock Navigation Company were mainly applied to the improvement of the natural river channels, the artificial channels being only 15 miles in length. The works and charter were purchased by the State between 1812 and 1820 as the first step toward the construction of the Erie Canal to Lake Erie and of its Oneida and Oswego branch to Lake Ontario. Different parts of the canal were opened at various times between 1819 and 1828. The first boats were 61 feet long, 7½ feet wide, and drawn by a single horse.

The dimensions of the Erie Canal and its branch to Oswego were: Depth, 4 feet; bottom width, 26 feet; surface width, 40 feet; locks, 90 feet by 14 feet. The construction of these canals and of the Canadian Welland Canal, with locks 110 feet long, 22 feet wide, and 8 feet deep, connected both the Hudson River and Lake Ontario with Lake Erie, and for a time accommodated the commerce of that period.

The growth of this commerce was such as to soon call for enlargements. The first enlargement of the Erie and Oswego canals was to a prism 56 feet wide at the bottom, 70 feet wide at the water surface, and 7 feet deep, with locks 110 feet long, 18 feet wide, and 7 feet deep. This enlargement was begun in 1836 and completed in 1862, and is yet the governing size of the canal. The first enlargement of the Welland Canal was made in 1846, the locks being increased in size to 150 feet length, 26½ feet width, and 10¼ feet depth.

These enlargements were hardly completed before further ones were called for, and in 1887 the second enlargement of the Welland to locks of 270 feet length by 45 feet width and 14 feet depth was completed, and in 1885 the work of doubling the length of the locks of the Erie Canal was commenced as an experiment.

In 1895 the people of New York State voted to expend $9,000,000 on this lock lengthening, and the deepening of the State canals and all structures to 9 feet.

Meantime, several projects for more radical changes were made to supply larger means for traffic from the lakes to the Hudson, but all were limited to proposed increase in the dimensions of the original canals.

The most complete studies and estimates which have been made for the enlargement of the canal are those of 1863 and 1874.

1863.

The former were made by the State engineer of New York, Mr. W. B. Taylor, and were for the construction of a series of enlarged locks alongside the present ones, so as to pass gunboats from tide water to Lake Erie. The results are published in the annual report of that officer for 1863. The enlargement contemplated locks 225 feet long, 26 feet wide, and 7 feet depth. The estimated cost of this enlargement from the Hudson River to Lake Ontario was $10,350,088, and from the Hudson River to Lake Erie was $11,902,888.

1874.

Under the date of June 23, 1874, Congress called for a report and estimate for enlargement of locks to the same diminsions as those last mentioned and for deepening the canal prism to 8 feet. Under date of December 24, 1874, Maj. John M. Wilson reported upon this project and gave estimates of the cost of its execution. Major Wilson's elaborate and detailed report is published in the Annual Report of the Chief of Engineers for 1875, Part II, p. 534.

Major Wilson's estimate of the cost for lock enlargement, leaving the prism at 7 feet depth, from the Hudson to Lake Erie, was $6,676,231, or with deepening of prism to 8 feet included, $8,173,596.

The route from the Hudson to Lake Ontario was considered by Major Wilson upon the basis of deeper draft and larger dimensions, i. e., prism, 10 feet deep, 120 feet bottom and 140 feet surface width, with locks 185 feet long, 29 feet wide, and 9 feet depth; the total length to Albany being 200½ miles. The estimated cost of this work was $25,213,857.

1895.

In the annual report of the State engineer and surveyor of New York for the year 1895 there is a report on a ship canal from Oswego to the Hudson, prepared by Mr. Albert Himes, resident engineer of the eastern division of the New York State canals.

The route proposed by Mr. Himes is in general that hereinafter described: The canal to have a bottom width of 100 feet and depth of 20 feet, with locks 450 feet long, 60 feet wide, and lifts for common locks ranging from 10 feet to 27 feet. The plan includes a mechanical lift in the form of huge counterbalanced tanks, at Cohoes, of 130 feet. It also includes a gigantic summit cut to make the summit level that of Oneida Lake. This cut would be about 50 miles long, with an average depth of 60 feet and maximum depths of about 100 feet, involving, according to Mr. Himes's adopted dimensions and slopes, the excavation of about 80,000,000 cubic yards. By adopting this deep-cut summit level, the total lockage required between Lake Ontario and the Hudson is reduced to 518 feet.

Mr. Himes's estimate of cost was $82,098,601.

1896.

In December, 1896, I submitted a report on the subject of enlarging the locks of the Erie Canal for the passage of modern torpedo boats and vessels of war of similar dimensions. In this report estimates were given for enlarging one tier of the locks to various dimensions and depths, and the advantages of a radical enlargement of the Erie Canal were commented upon. This report is published in House Doc. No. 231, Fifty-fourth Congress, second session.

During 1896 the American Deep Waterways Commission caused an examination to be made of the Oswego-Oneida-Mohawk route for a ship canal. This examination and map and profile were made by Mr. William Pierson Judson, civil engineer, who located an approximate line for a canal, which, with the data obtained, would enable an approximate estimate to be made of the cost of a canal by this route. The length of the line from Oswego to the Hudson, as laid down by Mr. Judson, is 179 miles, or 21 miles less than by the present canal line.

ARRANGEMENT OF LOCKS AND LEVELS.

For the purpose of considering points affecting navigation, the following arrangement of locks and levels has been assumed:

Six locks and dams would be built to overcome the elevation of 124 feet from Lake Ontario to Oneida Lake, the distance between which is 30 miles. Through the pools thus formed and between the upper dam and Oneida Lake much earth and rock excavation would be required. Oneida Lake is 21 miles long, and there would have to be a considerable amount of dredging at its two ends to give suitable channel depths.

The Oneida Lake level can be carried, by excavation through the swampy area around Wood Creek for about 8 miles, to where the valley of the creek is well defined with banks suited to dam location, where a dam and lock with lift of 24 feet would raise the water level to 148 feet above Lake Ontario and 394 feet above tide.

At 4 miles farther (near old Fort Bull) another dam and lock with lift of 24 feet would raise the water line to the summit level, 172 feet above Lake Ontario and 418 feet above tide.

This summit level can be carried for about 11 miles in length, through Rome, with banks of a maximum height (for a short distance) of 25 feet above water level and of 20 feet average height for the highest mile in length. This cut, it is believed, would be wholly through sand, gravel, and clay with layers of hardpan, the whole being a formation of glacial drift.

At 7 miles beyond Rome the descent to the valley of the Mohawk could be made by a dam and lock of 24 feet lift.

This brings the water level down to 394 feet above tide, and this level can be carried for about 31 miles to a point 93 miles from Oswego and to within 7 miles of Little Falls, where another lock brings the level down to that of Oneida Lake, or 370 feet above tide.

This condition has suggested a through cut to this point, as a means of avoiding the locks and of making Oneida Lake the summit level for water supply. This enormous cut would have a length of about 50 miles, a maximum depth of about 100 feet, and an average depth of 60 feet. It would only be justified, if it were not found practicable to supply a higher summit level with water. Possibly careful surveys might develop the fact that a summit level somewhere between the two would be advisable.

At Little Falls (100 miles from Oswego) the descent of 60 feet which occurs within 8 miles can be made in 3 locks to 310 feet above tide.

Here the first rock to the east of Oneida Lake is encountered in the spur of the Adirondacks, which crosses the Mohawk at Little Falls, and through which the river has worn its way for a mile or more. The rock is gneiss and very hard, but beyond this, through to the Hudson at Cohoes, the rock forming the river bed is of Trenton limestone, Utica slate, and Hudson shale. From here on the banks and slopes of the river are such that it is assumed that 7 dams and locks of an average lift of 24 feet will bring navigation to the great fall at Cohoes, although it is quite possible that a greater number of dams and locks of smaller lift will be required. At Cohoes the river descends 155 feet in 4 miles, to the level of mean tide at the State dam at Troy. Here it would require 7 ordinary locks of an average lift of 22 feet to effect the descent to Hudson River. This route from Oswego to Troy would therefore have 27 locks (including one guard-lock) with lifts of 20 to 24 feet; 21 miles of canalized Oswego River and 10 miles of canal into Oneida Lake, 21 miles of Oneida Lake, 50 miles of canal to Little Falls and 73 miles of canalized Mohawk River to Cohoes, and 5 miles of canal to the Hudson River at Troy.

The location through the Mohawk Valley may require more dams and shorter levels, as natural features alone can not be considered, for the valley is already occupied by important railways, factories, and cities, and these are to be considered and radical methods of canalization, such as might be applied to a new country, must be avoided. It is only by the most careful and complete surveys, combined with an estimation of land and property damages, that the most economical and efficient location of the works of canalization can be determined.

It would be necessary under any circumstances to build the upper portions of the dams movable for about 10 feet, so as to allow free way for the run-off of the spring floods.

THE HUDSON RIVER.

A common part of all the routes mentioned herein is the Hudson River from Troy to New York, and one of the important items of expense in the construction of a ship canal from the Great Lakes to tide water at the port of New York is the improvement of this river from the canal outlet at or in the vicinity of Troy to deep water.

From the Battery to the State dam at Troy is a distance of 154 miles. In its original condition the river had ample depth for ocean vessels for the lower two-thirds of this distance. At Barrytown, 98 miles from the Battery, the river begins to shoal. As far up as New Baltimore, 131 miles from the Battery, the original river had ample depth for light-draft river boats, but the upper section of the river from New Baltimore to the Troy dam, 23 miles, has always been obstructed by bars and shoals, due to the existence of numerous islands and sloughs, to the dispersion of the waters over too wide an area, and to rock bottom reaching up to within 7 feet of mean water level. In the improvement of this upper stretch of river the State of New York and the United States have expended large sums of money.

Prior to 1831 all work upon the river was done by the State, and from 1831 to 1867 by the General Government and the State conjointly. In the year 1867 a plan of improvement was adopted by the General Government to secure a navigable channel 11 feet deep from New Baltimore to Albany, and 9 feet deep from Albany to Troy. This was to be accomplished by longitudinal dikes, dredging, tidal reservoirs, and revetting the banks and islands. The work was completed in 1892 at a cost of $1,247,940.

A Board of Engineers in 1891 made a study of the river and estimates for its further improvement. Their report is published on page 752 of the Report of the Chief of Engineers for 1892, and contains a description of the river and its physics. The Board's estimate of the cost of a channel 22 feet deep and 400 feet wide from Hudson City to the State dam, a total length of 36 miles, was $19,507,832, practically $20,000,000. This project was not recommended or adopted.

A second estimate of the Board was for a channel 12 feet deep and 400 feet wide from Coxsackie to Troy, and 12 feet deep and 300 feet wide from Troy to the State dam, a total distance of 29 miles. The estimated cost of the work was $2,447,906, and this was adopted and is now in progress. A study of the profile of the river bottom indicates that there are some points below Hudson City, the starting point in the Board's estimate, which might have to be lowered to provide the full depth required for the safe navigation, at all stages, of vessels drawing 20 feet of water. The work estimated for by the Board of Engineers consisted of dredging, rock removal, and works of regulation.

Accepting this estimate of the Board of Engineers, it may then be assumed that it will require an expenditure af $20,000,000 to put the Hudson River from the State dam at Troy to New York City into condition for accommodating vessels of 20 feet draft.

There can be no doubt that the maintenance of the artificial channels will be very expensive in the way of dredging and repairs to works of regulation.

SUMMARY.

TABLE No. 1.—*The Oswego-Oneida-Mohawk route, from Buffalo (light-house) to New York (the Battery).*

Locality.	Waterway (miles).				Lockage.	
	Lake.	River.	Canalized river.	Canal.	Number of locks.	Feet of lockage.
Black Rock Canal, Buffalo to Black Rock				4	1	6
Niagara River, Black Rock to below Tonawanda		10				
Niagara Ship Canal, Tonawanda to Olcott				25.3	{a1 13}	320
Lake Ontario, Olcott to Oswego	112					
Oswego River, Oswego to near Phœnix			21		6	124
Oneida River cutting, Oswego River to Oneida Lake				10		
Oneida Lake	20					
Wood Creek Valley				10	2	48
Rome summit				11		
Upper Mohawk Valley to Little Falls				29	3	73
Mohawk River channel, Little Falls to near Cohoes			73		10	200
Cohoes to Troy				5	6	145
Hudson River, Troy to New York		153				
Total	132	163	94	94.3	42	916

a Guard lock.

SUMMARY.

Mileage:	**Miles.**
Lake	132
River	163
Canalized river	94
Canal	94.3
Total	483.3
Lockage eastward:	**Feet.**
Descending	744
Ascending	172
Total	916
Lift locks	41
Guard lock	1
Total	42

THE ERIE CANAL ROUTE.

In 1884 Mr. Elnathan Sweet, State engineer and surveyor, outlined a plan for a ship canal across the State of New York following in general the route of the Erie Canal, but with radical changes in part of the route and in the profile. The essential change in location and profile is shown on the map and drawing herewith, and consists in extending the Rome level westwardly to Lock 57, cutting out the Syracuse depression and ten locks, 47 to 56 inclusive, having a total lockage of 80 feet.

This would give a continuously descending canal from Lake Erie to the Hudson River and settle all questions in regard to water supply. Mr. Sweet says this can be effected by swinging the route to the southward near Newark, crossing the Canandaigua outlet, and occupying ground of the proper elevation along the south side of the Clyde River, and crossing the Seneca River at the narrowest part of its valley, which is near the junction with the outlet of Cayuga Lake, from whence it would gradually approach the present route of the canal and connect with it or cross it just east of Syracuse. This change of route, to secure a continuously descending profile from Lake Erie to the Hudson River, is the only deviation from the old route of the canal that is absolutely necessary; but Mr. Sweet thinks that the construction would be simplified and cheapened and the best possible waterway secured by the adoption of an entirely new route from Syracuse eastward. By changing the location to the northward lower ground can be obtained for the Rome level and this level be lowered throughout, as proposed for the Oswego route. From a point near Utica the Mohawk River would be canalized by the erection of locks and movable dams at suitable points in its course and the deepening and rectification of its channel. The Hudson, from the mouth of the Mohawk at Troy to deep water below Coxsackie, would have to be improved by narrowing and deepening its channel.

The only serious difficulty encountered on this route, according to Mr. Sweet, is the crossing of the Seneca River, where the water surface of the canal must be nearly 50 feet above that of the river, and for nearly 2 miles over 40 feet above the surface upon which its embankment must be built. By changing the location of the Rome level to the northward and lowering it to the summit level suggested herein for an Oswego-Oneida-Mohawk ship canal and as suggested by Mr. Sweet, more than 10 feet would be taken from these elevations and the difficulty of the Seneca River crossing greatly lessened. It is quite possible that accurate surveys and plans would show the advisability of still further reduction of those elevations.

This plan may therefore be summarized as the widening, deepening, and necessary rectification of the worst curvatures of the present canal from Buffalo to Newark, about 130 miles; the construction of a new canal from Newark to the vicinity of Utica, about 115 miles; the canalization of the Mohawk River from Utica to Troy, about 100 miles, and the improvement of about 30 miles of the Hudson River. The plan and route coincide with the Oswego plan and route from New York up the Hudson and Mohawk rivers until the point is reached for leaving the latter river near Utica. Here they branch, the Oswego route keeping to the north over the divide and down into Oneida Lake, while the route under discussion keeps more to the south, along the high lands to the south of Oneida Lake, and thence to the west, as described.

The first level of the canal from Buffalo to Lockport would be about 32 miles long. At Lockport 2 locks of about 25 feet lift each would make the descent to the second level of the canal, which, 64 miles in length, would extend to Brighton. At Brighton 2 locks of 24 feet lift each would drop down to the third level of 20 miles in length, extending to Macedon. At this point a lock of 20 feet lift would drop to the fourth level, 12 miles in length, extending to Newark. At Newark a lock of about 20 feet lift would reach the level of the proposed new canal to extend from Newark to Utica, about 115 miles, and which would be the fifth and longest level of the canal. From Utica the Mohawk River (except at Little Falls and Cohoes, where combined locks would be required) would be canalized with dams and locks of 10 to 12 feet lift, making pools of an average length of about 5 miles.

Mr. Sweet proposed a canal 18 feet deep, 100 feet wide at the bottom, and with locks 450 feet long and 60 feet wide. The cost he estimated at from $125,000,000 to $150,000,000, and he estimated the tonnage through the canal at 20,000,000 to 25,000,000 per annum.

A ship canal laid out along the line proposed by Mr. Sweet, and with the Mohawk River canalized as he suggests, would have 37 locks, with an average lift of about 15 feet each; there would be 270 miles of canal; 73 miles of the canalized Mohawk River; 30 miles of contracted river channel in the Hudson, and 123 miles of the deep and wide Hudson.

Since Mr. Sweet's project was outlined in 1884 the number and size of lake vessels have increased, and, as shown in another portion of this report, it is believed to be advisable and proper, if a ship canal is to be built, to provide for vessels drawing 20 feet, necessitating a canal depth of 24 feet. The canal proposed by Mr. Sweet would have to be increased in size to accommodate the present size of lake vessels and to meet the probable requirements of the lake vessels of the future.

By adopting the method of canalizing the Mohawk River suggested herein for the Oswego Canal route, the number of locks proposed by Mr. Sweet would be reduced to 25, besides the necessary guard locks. Allowing for a canal and pool slope of 17 feet in the 352 miles between Lake Erie and the Hudson at Troy, the total lockage would be 555 feet, all one way, which, with 25 locks, would give an average lift of about 22 feet.

As stated, Mr. Sweet's estimate of the cost was $125,000,000 to $150,000,000. Enlarging the canal as suggested, and adopting the changes outlined, it may be roughly estimated that a ship canal on this route, from Lake Erie to the navigable waters of the Hudson, including the improvement of this river, as specified for the Oswego route, will cost about $250,000,000.

TABLE No. 2.—*Erie Canal route, from Buffalo (light-house) to New York (the Battery).*

Locality.	Waterway (miles).			Lockage.	
	River.	Canalized river.	Canal.	Number of locks.	Feet of lockage.
Buffalo to Little Falls			265	[a]1 9	227
Mohawk River, Little Falls to near Cohoes		73		10	200
Cohoes to Troy			5	6	145
Hudson River, Troy to New York	153				
Total	153	73	270	26	572

[a] Guard lock.

TABLE NO. 2.—*Erie Canal route, etc.*—Continued.

SUMMARY.

Mileage:	Miles.
River	153
Canalized river	73
Canal	270
Total	496
Lockage eastward:	Feet.
Descending	555
Canal and river slope	17
Total	572
Lift locks	25
Guard lock	1
Total	26

A ship canal might be built by this Erie Canal route, but the difficulties in the way of it are very great and very serious, sufficiently so as to render it almost impracticable. The route, however, is fully adapted to provide for navigation by barges of the capacity of 1,500 tons, as mentioned herein, at a moderate expense.

If the pneumatic lock to be built at Lockport be successful and its adaptability to large-size boats demonstrated, it would probably be found possible to reduce the number of locks for a barge canal by this route to 12 or 14.

THE ST. LAWRENCE-CHAMPLAIN ROUTE.

Although this route in a portion of its course (113 miles, or about 15 per cent) lies outside of American territory, it must naturally be considered with the other routes mentioned, and it is believed not improper to make a brief mention and give a brief description of it, and to make some comparisons between it and other routes mentioned. It is shown on the accompanying map and profile.

From Olcott, the Ontario end of the proposed Niagara Ship Canal, to the entrance of the St. Lawrence River at Kingston or Cape Vincent, is a distance of 136 miles. Thence to reach the projected Caughnawaga connection of the St. Lawrence River with Lake Champlain the passage of 170 miles of the St. Lawrence must be made. The total drop of the river in this distance is 161 feet, which is mainly concentrated at several rapids requiring canals and locks for their passage. Both the American and Canadian Governments have done work in the improvement of the channels of the St. Lawrence, and Canada has built, and is building and enlarging, a series of canals with locks about the rapids and improving the river. It is expected that the work will be completed in 1899, when the navigable capacity of the river channels and the canals and locks which are essential to the passage of the river, will be the same as those of the Welland Canal, the locks of which are 270 feet long, 45 feet wide, and 14 feet deep.

These canals, locks, and river channels are entirely inadequate for use by the great lake steamers of to-day, and can be considered as of little more than of barge size. To improve the St. Lawrence to a navigable depth of 24 feet and supply the necessary canals and locks for surmounting the rapids by lake and ocean vessels will be a work of great magnitude and require a large expenditure.

Sixteen miles below the end of the Beauharnois Canal and just above the Lachine Rapids is Caughnawaga, on the south side of the river.

At this point the river is 71 feet above tide and 26 feet below the mean level of Lake Champlain. From here there has long been under consideration an artificial connection of the St. Lawrence River with Lake Champlain by means of a new canal 26.6 miles in length, with 26 feet lift, to intersect with the old Chambly Canal, which runs parallel to a portion of the Richelieu River (the natural outlet of Lake Champlain), overcoming the rapids between Chambly and St. Johns. This Chambly Canal has a depth of 7 feet and bottom width of 36 feet and surface width of 60 feet. The proposed route uses about 9 miles of this old Chambly Canal to St. Johns, on the Richelieu River, and thence follows this river for 22 miles to the lower end of Lake Champlain at Rouse Point. In all, there are 113 miles of the proposed route in Canadian territory. This arrangement makes Lake Champlain the summit level and draws on it for lockage water.

Another and perhaps a better arrangement has been suggested, by which 52 feet of lockage is avoided at the expense of 6 or 8 miles more of canal. Instead of locking down to Caughnawaga, as described, and then locking up again to Lake Champlain, this alternative route would leave the Beauharnois Canal 3 miles above its lower end (where its water level is 37½ feet higher than Lake Champlain) and thence carry St. Lawrence water across to Lake Champlain by way of the Chambly Canal and Richelieu River. This is the shortest line, with minimum of lockage, between Lake Ontario and Lake Champlain, unless a still better one may be located farther south. Such another alternative line 26 miles shorter has been examined, leaving the St. Lawrence higher up and entering Lake Champlain by the valley of the Great Chazy River, 6 miles south of Rouse Point, but nothing definite is known about it by me.

From Rouse Point, Lake Champlain extends 111 miles southward to Whitehall. About 40 miles of this lake section lies through what is called the Narrows of Lake Champlain, and in this portion extensive works of channel excavation and channel protection will be needed to increase the present governing depth of 12 feet. From Whitehall, on Lake Champlain, to Fort Edward, on the upper Hudson, is a distance of 24⅛ miles, the dividing ridge being 39 feet above Lake Champlain and 17 feet above the upper Hudson at Fort Edward.

Various designs for crossing this ridge have been considered, the most recent being to cut through it and reverse the flow of Lake Champlain by turning it into the Hudson at a point some miles below Fort Edward.

From Fort Edward by the present line of the Champlain Canal, or by the canalized upper Hudson, the distance to tide water at Troy is 39.8 miles and the descent is about 118 feet.

It has also been suggested to cut across from the head of South Bay (an arm of Lake Champlain) to the upper Hudson, but this has not been sufficiently examined to give any detail of the conditions existing.

Having reached the upper Hudson, it was stated in the 1874 report on transportation routes that the descent of 118 feet must be distributed in 11 locks, some of small lift, in order to avoid such overflow of the banks of the river as would require long and costly levees for protection. There is also a recent project by which this descent is to be effected by a single lift lock at Waterford (just at the junction of the Mohawk and Hudson rivers), but the details are not published, nor is its effect upon the upper Hudson Valley discussed.

Tide water is reached at the State dam, 3 miles below Waterford.

The conditions existing in the tide-water section of the Hudson are referred to in the description of the Oswego route.

The total lockage of this route by way of Caughnawaga amounts to 686½ feet, as follows: Upper Niagara, 6 feet; Niagara Ship Canal, 320 feet; St. Lawrence canals, 161½ feet; Caughnawaga to Lake Champlain, 26 feet; Lake Champlain to Troy, 173 feet. Its total length is 727.7 miles.

TABLE No. 3.—*The St. Lawrence-Caughnawaga-Champlain route from Buffalo (light-house) to New York (the Battery).*

Locality.	Waterway (miles).				Lockage.	
	Lake.	River.	Canalized river.	Canal.	Number of locks.	Feet of lockage.
Black Rock Canal, Buffalo to Black Rock				4	1	6
Niagara River, Black Rock to below Tonawanda		10				
Niagara Ship Canal, Tonawanda to Olcott				25.30	{ a 1 13 }	320
Lake Ontario, Olcott to Cape Vincent	136					
St. Lawrence River, Cape Vincent to Caughnawaga		135		35	7	161½
Caughnawaga Canal, Caughnawaga to Chambly Canal				23.62	2	26
Chambly Canal to St. Johns				8.88		
Richelieu River, St. Johns to Rouse Point		22				
Lake Champlain, Rouse Point to Whitehall	111					
Canal, Whitehall to Fort Edward				24.13	2	38
Upper Hudson River, Fort Edward to Troy			39.80		7	135
Hudson River, Troy to New York		153				
Total	247	320	39.80	120.93	33	686½
Slope of St. Lawrence River						13½
Total lift						700

a Guard lock.

SUMMARY.

Mileage:	Miles.
Lake	247
River	320
Canalized river	39.80
Canal	120.93
otal	727.73
Lockage eastward:	Feet.
Descending	622½
Ascending	64
River slope	13½
Total	700
Lift locks	32
Guard lock	1
Total	33

TABLE No. 4.—*Summary of routes from Buffalo (light-house) to New York (the Battery).*

Route.	Waterway (miles).					Lockage.	
	Lake.	River.	Canalized river.	Canal.	Total.	Number of locks.	Feet of lockage.
Oswego-Oneida-Mohawk	132	163	94	94.30	483.30	42	916
Erie Canal enlargement		153	73	270	496	26	572
St. Lawrence-Caughnawaga-Champlain	247	320	39.80	120.93	727.73	33	700

The two ship canal routes entirely within our territory have each their advantages and disadvantages. The Erie Canal route follows generally an established waterway, and has the least possible amount of lockage and the least number of locks. If properly laid out it would have an unquestionable water supply and the bulk of the traffic would be with the current. Its disadvantages are that it is some 13 miles longer than the Oswego route and is all in river or canal and has no open free lake navigation; that a considerable portion would have to be in aqueduct; there would be a great many drawbridges and culverts, very expensive to build and maintain; and the land damages and damages to vested interests would be enormous; it does not unite Lake Ontario with the Hudson and the upper lakes.

The disadvantages of the Oswego route are that it has a large amount of lockage and a large number of locks, and it may be found necessary to go to a great expense to supply the summit level between Oneida Lake and the Mohawk with water. If careful surveys and actual use should demonstrate that the local supply, together with storage supplies in the Adirondacks, is insufficient it would be necessary either to build a feeder canal from Lake Erie or to make a deep cut through the divide to the level of Oneida Lake.

Of the two routes for a large ship canal the Oswego route is, in my opinion, much more advantageous than the Erie Canal route.

This Erie Canal route, while objectionable as a ship canal route is, however, deemed most advantageous for a barge canal route, if this be made as an enlargement of the Erie Canal. The Erie Canal occupies an extremely valuable location and right of way, with accessories in the way of feeder canals, reservoirs, etc. These would all work in and lessen the expense of the barge canal. Such a canal would permit of navigation by vessels of light and cheap construction, whereas a barge canal by the Oswego route would require stronger and more expensive vessels, due to their exposure on Lake Ontario. Lake Ontario could be brought into large barge communication with the suggested canal by enlarging the Oswego Canal to the proper size.

The size proposed for the barge canal by the Erie route exactly fits in with the channels of the Hudson River as this is being improved.

As compared with the St. Lawrence-Champlain route, the Oswego route for a ship canal appears to me greatly preferable. The St. Lawrence-Champlain route after it leaves Lake Ontario lies in a river forming the international boundary, and the canals and locks for passing the rapids would lie in a sparsely inhabited region and it and commerce upon it would be seriously exposed to hostile attacks in the event of war with Canada. A portion of the route lies in Canadian territory, and it is suggested that no consideration should be given to a ship canal by this route except upon condition that the St. Lawrence be made the boundary as far as the route lies in it, and that the territory to the south of the St. Lawrence and west of the Richelieu River, and within, say, 10 miles of the canal, be ceded absolutely to the United States, thus locating the entire route within American territory and without any limiting or awkward treaty stipulations of any kind concerning it.

This St. Lawrence-Champlain route has less lockage than the Oswego route, but is by way of Caughnawaga, 244 miles longer between Lake Erie and the Hudson, which 244 miles is mostly contracted waterway. This route would be in a high degree objectionable from a military standpoint, as it would tend to increase Canadian commerce and reduce

American preponderance on the Great Lakes. By building a canal about the Lachine Rapids, the route would be extended to Montreal, which would be the real terminus of the ship canal. As Montreal is a small city only open to the sea about six months of the year, and at which but little return freight could be expected, it is not believed that a very heavy amount of freight would go there. The branch from the St. Lawrence at Caughnawaga to Lake Champlain and the Hudson would make a route from the upper lakes to New York so long and so difficult that in my opinion it would be of little value.

It is absurd to suppose that the products of the Northwest destined for foreign ports, having reached to within 10 miles of tide water at Montreal, would turn to the right-about and be passed through 350 miles of contracted navigation to another port still farther away from the European markets than it would be at the point of deflection.

The only value of this St. Lawrence-Champlain-Hudson route would be of a local nature, and I am unable to believe that the advantages conferred by it would be at all commensurate with its cost. If such a canal should be built there would be continued agitation for a cut-off canal by the Oswego route, by which 244 miles of distance could be saved.

Canada is making every possible effort to deflect American commerce to its ports. In connection with the completion of the St. Lawrence canals and improvement of the St. Lawrence River, so that all vessels which can pass the Welland Canal can keep right on down to Montreal, which improvement is expected to be completed in the spring of 1899, the Dominion Government and Great Britain have, it is stated, granted a subsidy of $500,000 per year to a line of transatlantic steamers to run from Montreal and Quebec. The building of a ship canal by the St. Lawrence route would be still further and more completely opening the doors of the lake commerce to the subsidized fleets of Great Britain and Canada.

In this connection it seems proper to invite attention to a few facts concerning the water-carrying business of the world which are believed worthy of attention in considering the subject of a ship canal. Upon the Great Lakes there is a total tonnage of the merchant marine of the United States and Canada of 1,483,499. Of this the United States has 1,324,068 tons, or 89 per cent, while Canada has 159,431 tons, or 11 per cent. This shows that the carrying business on the Great Lakes is nearly all in the hands of Americans and conducted in American vessels.

Upon the ocean the reverse is the case. The registered tonnage of the United States on the ocean amounts to 838,187 tons, and the registered tonnage of the United Kingdom to 8,926,000 tons, or more than ten times that of the United States. What can reasonably be expected would be the result of mingling these commercial elements by building a ship canal which would put all our lake ports in direct communication with a foreign port like Montreal, belonging to the United Kingdom, whose fleets, subsidized whenever necessary, do nearly half the ocean carrying business of the world, and which is the foreign market for nearly 75 per cent of our exports? Can there be any doubt that it would result in placing a very large amount of the carrying business in the hands of Canadians and materially reduce American preponderance on the lakes? This phase of the question is surely worthy of serious consideration before the United States consents to build a canal, the resultant damages of which to certain American interests might equal or exceed the benefits to other interests.

The 25 principal commercial countries of the world have a registered tonnage of vessels engaged in foreign trade on the ocean of 18,228,826 tons. Of this the United States has 4½ per cent and the United Kingdom has 49 per cent.

In selecting the route for a ship canal or an improved canal of smaller size, consideration must be given to the character of the commerce which it would serve, whether foreign bound, domestic, or both. In the general discussions which have been had of the ship canal problem, great stress has generally been laid upon its effect on foreign-bound commerce and comparatively little upon its effect on domestic commerce. This is believed to be exactly the reverse of what should be the case, and domestic commerce should receive the first consideration, and foreign commerce the second.

An investigation has been made to determine the relative value of foreign and domestic Eastern markets to the producers of the West, and while the results are approximate and crude it indicates that the value of the Eastern domestic market is much greater than the value of the foreign market, and should receive the first consideration in the canal question.

Statistics show that during the year 1895 there were raised in the United States 90,640,545 tons of cereals, and there were exported 5,343,823 tons, leaving 85,296,722 tons to be used at home. That is, eighteen times as much of the cereal products of the country are used at home as are shipped abroad. During the same year, 1895, the cereal exports from the six North Atlantic ports, Montreal, Portland, Boston, New York, Philadelphia, and Baltimore were 3,868,254 tons. The receipts at these seaports during this same period amounted to 6,589,610 tons of cereals. This shows that of the cereal products actually reaching these exporting cities 58 per cent is exported and 42 per cent is consumed. As most of the Western products which are consumed in the thickly populated regions of New England, New York, Pennsylvania, New Jersey, etc., never reach the Seaboard, but go directly to points of consumption, the vastly superior importance of the domestic over the foreign market is evident.

The following tables exhibit in detail the receipts and exports of cereals at the ports mentioned:

TABLE NO. 5.—*Receipts at Atlantic ports from the West during 1895 (in tons of 2,000 pounds).*

[Compiled from the annual reports of the Produce Exchange and the boards of trade.]

Port.	Wheat flour, in tons of wheat.	Corn meal, in tons of corn.	Wheat.	Corn.	Oats.	Rye.	Barley and malt.	Pease.	Total received from the West at each port.	Per cent of sum for each port.
Montreal	218,046	....	183,879	72,342	26,806	46	4,248	26,033	480,900	7.3
Portland	62,214	....	4,635	126,519	56,630	141	24	17,215	267,378	4.1
Boston	353,829	5,269	217,599	250,545	107,077	509	8,923	2,462	941,213	14.3
New York	865,412	54,836	868,541	721,148	403,960	4,510	165,613	15,400	3,099,420	47
Philadelphia	415,856	....	67,751	136,635	80,338	1,737	39,475	....	741,792	11.3
Baltimore	510,755	....	145,169	332,065	46,405	10,216	14,297	....	1,058,907	16
Total	2,426,112	60,105	1,437,074	1,639,254	721,216	17,159	227,580	61,110	6,589,610	100

TABLE NO. 6.—*Exports from Atlantic ports during 1895 (in tons of 2,000 pounds).*

[Compiled from the annual reports of the Produce Exchange and the boards of trade.]

Port.	Wheat flour, in tons of wheat.	Corn meal, in tons of corn.	Wheat.	Corn.	Oats.	Rye.	Barley and malt.	Pease.	Total exported from each port.	Per cent of sum for each port.
Montreal	143,383	4,062	109,630	72,993	172	454	19	23,777	354,490	9.2
Portland	5,759	....	905	11,942	....	....	....	....	18,606	.5
Boston	212,968	12,051	216,720	158,661	1,330	....	724	481	602,935	15.6
New York	594,507	16,541	705,627	540,450	23,999	....	2,845	9,303	1,893,272	48.9
Philadelphia	122,044	140	46,163	92,645	953	....	....	....	261,945	6.8
Baltimore	343,241	2,358	119,137	270,189	2,153	....	....	....	737,078	19
Total exports	1,421,902	35,152	1,198,182	1,146,880	28,607	454	3,588	33,561	3,868,326	100
Total receipts from the West	2,426,112	60,105	1,437,074	1,639,254	721,216	17,159	227,580	61,110	6,589,610	......
Percentages of receipts from the West:										
Exported	58.6	58.5	83.4	70	4	2.6	1.6	54.8	....	......
Consumed	41.4	41.5	16.6	30	96	97.4	98.4	45.2	....	......

The two principal cereals exported are wheat and corn. During the past five years the production of wheat in the United States aggregated 2,451,231,088 bushels, and the exports of wheat, flour, etc., amounted to 853,118,262 bushels, or about one-third of the total production.

During the past five years the production of corn aggregated 8,672,-022,763 bushels, and the exports of corn, corn meal, etc., amounted to 250,997,429 bushels, or but one thirty-fourth of the total production.

Detailed statements of these productions, exportations, and consumptions are herewith appended:

TABLE NO. 7.—*Wheat, including flour.*

Year.	Domestic production.	Exports of domestic production.	Domestic production retained for consumption.	Per cent of domestic production— Exported.	Per cent of domestic production— Retained.	Population of United States.	Consumption per capita.
	Bushels.	*Bushels.*	*Bushels.*				*Bushels.*
1892	611,780,000	225,665,812	386,114,188	36.88	63.12	65,403,000	5.91
1893	515,949,000	191,912,635	324,036,365	37.20	62.80	66,826,000	4.85
1894	396,131,725	164,283,129	231,848,596	41.47	58.53	68,275,000	3.41
1895	460,267,416	144,812,718	315,454,698	31.46	68.54	69,753,000	4.54
1896	467,102,947	126,443,968	340,658,979	27.07	72.93	71,263,000	4.78
Total.	2,451,231,088	853,118,262	1,598,112,826	34.80	65.20	....	....

TABLE NO. 8.—*Corn, including corn meal.*

Year.	Domestic production.	Exports of domestic production.	Domestic production retained for consumption.	Per cent of domestic production— Exported.	Per cent of domestic production— Retained.	Population of United States.	Consumption per capita.
	Bushels.	*Bushels.*	*Bushels.*				*Bushels.*
1892	2,060,154,000	76,602,285	1,983,551,715	3.72	96.28	65,403,000	30.33
1893	1,628,464,000	47,121,894	1,581,342,106	2.89	97.11	66,826,000	23.66
1894	1,619,496,131	66,489,529	1,553,006,602	4.11	95.89	68,275,000	22.74
1895	1,212,770,052	28,585,405	1,184,184,647	2.36	97.64	69,753,000	16.98
1896	1,151,138,580	101,100,375	1,050,038,205	8.78	91.22	71,263,000	14.73
Total.	7,672,022,763	319,899,488	7,352,123,275	4.17	95.83	....	....

Nearly 92 per cent of all the live cattle exported from the United States are sent from the four ports of Boston, New York, Philadelphia, and Baltimore, yet but one-third of the live cattle received from the West at these ports are exported.

The following table gives the receipts, exports, and percentage, which illustrate the relative value of foreign and domestic markets in this branch of industry:

TABLE NO. 9.—*Receipts from the West and exports of live cattle in 1895, showing proportion consumed and proportion exported at the principal cattle ports.*

[Receipts are for the calendar year 1895. Exports are for fiscal year 1895-96.]

Name of port.	Number of live cattle.		Per cent of the live cattle received at each port which was exported alive from that port.	Per cent of the total exports of live cattle from the United States which was exported alive from each port named.
	Received.	Exported.		
Boston	170,062	149,126	87.6	40
New York	570,428	121,877	21.3	32.7
Philadelphia	132,260	19,600	14.8	5.3
Baltimore	130,340	50,802	38.9	13.6
Total	1,003,090	341,405	34	91.6

In most of the other items included in the list of tonnage possibly tributary to a ship canal or enlarged Erie Canal, the relative value of the domestic over the foreign market is still greater. Lumber, ore, coal, wool, and hides are entirely domestic shipments, and probably 90 per cent of the iron and steel business would be domestic. It may be briefly summed up by stating that the value of a ship canal to the domestic commerce of the country is several times greater than it is to the foreign commerce of the country, and that in selecting a route it should be with greater reference to its value to domestic commerce than to foreign commerce.

Regarding it from the standpoint of tonnage alone, it is certain that the domestic freight feature of a ship canal is of much more importance than the foreign freight feature. It is also to be considered that a canal which cheapens transportation only on foreign-bound produce benefits chiefly the producer, while a canal which cheapens transportation in domestic products and manufactures used at home benefits both producers and consumers, both the people of the East and the people of the West.

These considerations are mentioned to emphasize the great advantages of a canal by the Oswego or Erie Canal route, which would affect alike foreign and domestic commerce, over one by the St. Lawrence route, which would almost solely affect foreign commerce.

SIZE OF CANAL AND LOCKS.

The size of a ship canal will naturally depend upon the size of vessels which it is designed to accommodate, the number of vessels and the speed with which they will traverse it, and its use for storing and conducting water. The size of canal and locks has an important bearing on the location and should be determined in advance of surveys.

The law of June 3, 1896, requires that the ship canal from the Great Lakes to the navigable waters of the Hudson River shall have sufficient capacity to transport the tonnage of the lakes to the sea. This may be interpreted as meaning that the ship canal shall be sufficient in size for the largest lake vessels.

The Government has entered upon a project for giving a channel of 20 feet depth at mean stages through the upper lakes and their connecting waters. The work upon this project is now approaching completion, and it may be taken for granted that within a comparatively short time there will be a channel through the lakes capable of accommodating vessels of 18 feet and a little over in draft at mean lake stages.

There is a strong and earnest movement among people interested in lake commerce, looking to the deepening of the lakes or the regulating of lake levels by building dams to check the flow of waters at the outlet of Lake Erie and in the narrow channels connecting the upper lakes. It is believed that this should be done, and that it will be done to the extent, at any rate, of preventing the waters of the lakes from falling below the mean level, with the result that the waters in all channels and lake harbors will be maintained in a deeper and more satisfactory condition than they are at present. It is also reasonable to believe that the future will see further work of excavation in the shallow interlake channels, and that the result of this and the regulation of the lake levels will be to give a navigable capacity throughout the lakes for vessels drawing 20 feet. To obtain this, however, will involve a very great expense on the part of the General Government and will take many years.

All the lake harbors have a navigable depth much less than this, the principal ones having 16 to 18 feet. To deepen all these lake harbors and arrange them to accommodate vessels drawing 20 feet will require very large additional expenditures by the General Government, by cities, and by individuals. It is my opinion that 20 feet draft may be considered the maximum draft to which vessels traversing the lakes and accommodated in their harbors will attain; at any rate, for a great many years.

To exceed this and get capacity for vessels of 26 to 30 feet, as has been suggested, would involve expenditures for channels, harbors, and their auxiliaries that would be enormous and unjustifiable and out of all proportion to the benefits to be derived therefrom.

Owing to the conditions on the lakes it is believed that the business of lake transportation can be done as economically with vessels of 20 feet draft as with those of greater draft. In fact, lake vessels of 20 feet draft equal in freight-carrying capacity the large ocean-going vessels suited to the North Atlantic trade of about 28 feet draft.

The latest built large vessels of the lakes are now about 430 feet long, 48 feet beam, and have run during the last year with a maximum draft of 16 feet 8 inches. During the season of 1896 the maximum loads carried were as follows: *Queen City*, 5,796 tons corn; *Sir Wm. Siemens*, 5,310 tons wheat; *Coralia*, 5,699 tons iron ore; *W. D. Rees*, 5,580 tons wheat and barley.

Vessels of the size of these named would, if loaded to 20 feet draft, carry about 7,000 tons, and if lengthened to 500 feet and widened to 50 feet, would, on a draft of 20 feet, carry about 9,000 tons or 300,000 bushels of wheat. If, therefore, a ship canal be made of sufficient capacity to accommodate vessels of 50 feet beam and 20 feet draft and a length of 500 feet, it is believed that it will fulfill the requirements of the law and will afford passage to any vessel that can be engaged in lake traffic for a great many years, if not forever.

If the canal be made larger than this, it should naturally be made of sufficient size for the accommodation of the large vessels engaged in ocean traffic. These large ocean vessels draw from 26 to 30 feet, and even more, and have breadths of 60 feet and over, and a length of nearly 600 feet. It is stated by Colonel Gillespie, in a report on the subject, that the average draft of the outgoing loaded steamers from New York is now 27 feet, and that the draft of some of the larger ones has reached 30½ feet on their outward passage. Based upon these facts, it is proposed to increase the depth of the New York harbor entrance to 35 feet. The new steamer *Pennsylvania*, of the Hamburg-American Line, on her recent trip left New York with a mean draft of 31½ feet. If the harbors of the lakes and the interlake channels were of sufficient capacity for these ocean vessels, it would seem proper to seriously consider the advisability of constructing a ship canal suited to their size, if one is to be built. But these lake harbors and interlake channels are not, and probably never will be, of sufficient capacity for deep-ocean vessels, and, therefore, there is no practical use in considering such a canal suited to them. As stated elsewhere in this report, it is believed impossible for ocean vessels to do business economically on the lakes, or lake vessels to do business economically on the ocean, except in rare cases.

The difference between the cost of a ship canal, together with the accessories and betterments required for navigation by vessels of 20 feet draft, and a ship canal with accessories and betterments in lake and river channels and harbors for vessels of 26 feet draft, would be extremely large. The latter would cost at least 50 per cent more than the former. For vessels of 30 feet draft, the cost of a canal and accompanying improvements would probably be double that of a canal and accompanying improvements for vessels of 20 feet draft.

In the further consideration of this subject, therefore, the ship canal proposed will be for vessels not exceeding the following dimensions: Length, 500 feet; breadth, 50 feet; draft, 20 feet.

The cost of a ship canal will be so great that it will only be justifiable to build it upon the supposition that it will be used by a large number of vessels. These vessels coming and going should be able to meet or pass freely anywhere en route with the minimum chances of collision with each other or with the banks. To arrive at what this width should be, it is assumed that each of the meeting or passing vessels is 50 feet wide; that neither vessel should approach the bank nearer than 15 feet nor each other nearer than 20 feet. This would give the minimum width of the canal at the keel depth of 20 feet, $15+50+20+50+15=150$ feet. Assuming side slopes of 1 on 1½, the width of such a canal at the surface of the water would be 210 feet.

The force required to propel a boat through a contracted waterway depends largely upon the relative sizes of the waterway and the immersed cross section of the boat.

For the ordinary sizes of canal boats it has been established as a general rule that if the waterway is about four and one-half times the width and about five and one-half times the cross section of the immersed portion of the vessel, the power required for propulsion at ordinary canal velocities will not differ greatly from that required for propulsion at the same speed in open water. In a canal of this relative size the resistance of the water and the propulsive force required to overcome it increase very rapidly with the speed of the vessel, and this increase becomes more and more rapid as the canal and boat approach each other in size.

For principal canals of large size and large traffic it is considered that the normal cross section should be at least four times the greatest immersed section of the vessel, and that an increase to five times is, under ordinary circumstances, economically advantageous.

When a vessel is moved through a narrow canal the tendency is to pile the water up in front, and the displaced water must pass to the rear along the sides and under the bottom of the boat. The greater the size of the ship canal in proportion to the size of the boat, the greater the speed obtainable and the less the cost of propulsion; hence it is desirable to have the canal as large as possible.

On the other hand, any increase in the size of the canal beyond that absolutely necessary is obtained only at enormously increased expense. The size fixed upon for a canal is ordinarily a compromise between all the interests involved. After giving due consideration to all the interests involved, as far as I can see them, I would fix upon the following as about the proper size of the canal:

To enable the displaced water to flow with freedom under the vessels, to provide against the tendency of vessels to "squat," and to provide against a moderate amount of shoaling in the canal, and the drawing down and loss of water, it is believed that the normal depth should be 4 feet more than the draft of the vessels navigating it, or 24 feet. The cross section of the water should be at least four times the immersed section of the largest vessels, or 4,000 square feet. With side slopes of 1 on $1\frac{1}{2}$, this, with a depth of 24 feet, would require a bottom width of 138 feet; a width at 20 feet depth of 150 feet, and at the water surface of 210 feet. Such a waterway would have a cross section of 4,176 square feet. The largest vessels proposed—of 20 feet draft and 50 feet beam—could pass through such a canal at fair canal rates of speed. It is, however, to be remembered that the average size of vessels which would pass through the canal would probably be much less than the size mentioned, and for them the cross section would approach more nearly and in many instances exceed the greater theoretical section mentioned. For vessels of 45 feet beam and 18 feet draft the waterway would be over five times the area of the immersed section of the vessel. In a rock cut, or where it might be desirable to replace the side slopes with slope walls, the cross section with a depth of 24 feet and equivalent area would have a bottom width of 170 feet and surface width of 178 feet.

The cross sections suggested are shown in the accompanying sketch

One of the functions of a ship canal in some of its portions would be to convey water to supply other portions, and this may require modifications in the size, so that the velocities developed would not be excessive. Basins would be required at the locks, and these might be obtained in some instances by substituting side walls for the slopes, as indicated by dotted lines in the sketch.

If any aqueducts are necessary along the canal, the cross sections at such points can be materially reduced.

The locks required for such a canal as that described, suitable for the passage of vessels 500 feet long, 50 feet broad, and drawing 20 feet of water, would have about the following dimensions:

	Feet.
Length in clear	530
Breadth	60
Depth on miter sills	22

If the ship canal have the traffic which alone can justify the expenditure necessary for its construction, these locks will have to be in constant operation in passing vessels of large size during the entire season of navigation. If the traffic through the canal attain to the dimensions indicated, it will undoubtedly be found necessary to duplicate the locks or to build other-sized companion locks, which altogether shall fulfill the demands of the business. If the traffic were confined to large vessels, such a series of locks as those suggested could, if everything worked perfectly and there were no detentions or accidents along the line, handle the suggested traffic of 24,000,000 tons per year. But perfection is impossible of attainment, and accidents and detentions are unavoidable, and much of the business of the canal would be done in small vessels, barges, canal boats, etc., so that the maximum tonnage which such a series of locks would pass would probably be from 12,000,000 to 15,000,000 tons yearly. During 1896 the average size of the freight loads on vessels passed through the Sault Ste. Marie locks was 872 tons and during 1895 was 839 tons. In laying out a ship canal, therefore, it would seem to be a prime necessity to provide lands for additional lock emplacements and to contemplate the large expenditures which will be required for the future construction of additional locks. If a ship canal were built with a series of such locks as those suggested, the traffic observations would in a few years determine the proper size and capacity of the additional locks, and arrangements should be perfected in the first instance for building them without interfering with traffic through the first-built locks.

Another interpretation which might be put on the law of June 3, 1896, would be that the canal proposed from the Great Lakes to the navigable waters of the Hudson should provide the means for transporting the tonnage (the freight) of the lakes between the lakes and the Seaboard at the lowest possible cost, in vessels of the most economical type and size, and by the best available route which would admit of the construction and operation of the canal at the least expense.

Interpreting the law as above, and believing that my orders require me to consider the whole proposition from a business standpoint, I have considered the idea of providing for a barge navigation by way of the Erie Canal route, and my investigations convince me that this is by all odds the best business proposition for the Government to consider. A large lake or ocean vessel is not the type of craft that can be used most economically in a long and narrow waterway with many locks such as any route between the lakes and the sea must necessarily be. A proper aggregation of smaller, lighter, and cheaper vessels will do the work on such a route cheaper than can the large vessels.

There is no question in my mind that any canal built by the United States between the East and the West should have its eastern terminus at a great American commercial seaport, and the only such port available and worthy of consideration is New York City. There already exists a canal connecting the Hudson River with the lakes, which as a long artificial waterway of small size is in its importance without a peer in the world. I refer to the Erie Canal, which is 352 miles long between Buffalo and Albany.

This route is not available, and is not the best for a ship canal of large size, but I believe it to be the best available route for a large barge canal, and it is believed that the proposition to enlarge it into such a large barge canal should be seriously considered before the construction of a ship canal by another route is undertaken. My investigations have convinced me that such a canal navigated by barges will furnish a cheaper means of transportation between the East and West than would a ship canal navigated by large vessels, and its cost would be vastly less. I am fully convinced that if a ship canal is built, the great bulk of the business upon it will be done in towed barges and not in large lake or ocean vessels.

The governing size of the Erie Canal between New York and Albany is: Bottom width, 52½ feet; surface width, 70 feet; depth, 7 feet. From Rochester to Buffalo the canal increases in size. At Lockport it has a surface width of 100 feet and bottom width of 79 feet. Above Lockport the canal passes through a heavy rock cutting with a rectangular prism 62 feet wide and about 9 feet deep. To the westward of this for 12 miles it occupies Tonawanda Creek, with a surface width of about 200 feet. Thence to Buffalo the width is from 80 to 90 feet at the surface and from 60 to 72 feet at the bottom. The entire canal is being deepened to 9 feet under the scheme of improvement now being carried out.

To enlarge this canal to a sufficient depth to accommodate barges of 1,500 tons capacity at fair canal rates of speed will require a cross section about as shown on the accompanying diagram. It is assumed that the barges will have a width of 30 feet and a draft of 10 feet, and the canal must be large enough for the boats to meet and pass freely, and that a depth of 2 feet of water under the boat is provided. Such a canal to have a cross section four times the immersed section of the boat, and allowing side slopes of 1 on 1½, would have the following size: Depth, 12 feet; bottom width, 82 feet; width at keel depth of 10 feet, 88 feet, and width at water surface, 118 feet. Where slope or rock walls are substituted for the slopes, the canal, in order to have the same area of waterway, should have an average width of 100 feet. This canal with its side slopes would have a prism cross-sectional area of 1,208 square feet, or four times the submerged area of a fully oaded boat, and a surface width of three and nine-tenths times the width of the boat. By substituting side walls for side slopes, as indicated by dotted lines on the cross section, the cross section could be increased to five times the immersed section of the boat, and this should be done wherever practicable.

For short distances wherever necessary, in passing through cities or in aqueducts, the width shown could be reduced, and in certain instances where bends are necessary the width might have to be somewhat increased. On the accompanying drawing the cross section above described is outlined, together with cross sections of the Erie Canal as it now exists and is being improved.

There are considerable portions of the Erie Canal, which, by simply deepening, would accommodate the barges and traffic mentioned, and as a general thing, the right of way for the Erie Canal, owned by the State of New York, would be sufficient for the suggested canal.

The preferable route for such a canal would be to follow that outlined by State Engineer Elnathan Sweet, cutting out the Syracuse depression, canalizing the Mohawk River, and making a continuously descending canal all the way from Lake Erie to the Hudson. The barges used on such a canal could be constructed at a minimum cost, as they would be exposed to no open water on the lakes, and the whole route would be so situated that advantage could be taken of electrical towage, if this be ever developed into an economical system.

It is believed that a proper-sized lock for this barge canal would be one with a depth of 12 feet on miter sill, a width of 33 feet and length of 420 feet in the clear, with intermediate gates. This length would suffice for two barges, each 200 feet long.

It is not to be understood that the size of barges and barge canal mentioned is to be considered as definitely fixed. It is simply taken as a type of about the size which would be most economical and advantageous. There are business reasons which would indicate that a smaller unit than a 1,500-ton barge would be preferable, and others that a still greater enlargement would be desirable. A careful balancing of all interests would be required to fix upon the most advantageous size. The size fixed upon in this report is to be regarded as a first approximation thereto.

PNEUMATIC LOCKS.

It has been decided by the State of New York to build a Dutton balanced pneumatic lock at Lockport to replace the 5 existing locks and overcome the 57 to 62 feet of elevation at one operation. The lock tank in this is to be 24 feet wide, 12 feet deep, and 240 feet long. If this lock is found in practice to be as successful as it appears to be in theory, there would probably be no reason why it should not be extended to locks of the larger size mentioned, and used at different points along the line where it would be found most advantageous. This is the first lock of the kind to be built, and a brief description of it, taken from the inventor's specifications, is given here.

POSITION.

The new locks at Lockport are to be located in the basin on the south side of the present canal, immediately east from the lower entrance to the present system of 5 combined locks, Nos. 67 to 71, which are to continue in uninterrupted use during the construction and the subsequent tests of the pneumatic locks.

COFFERDAM AND LOCK PIT.

A combined flume and cofferdam is now building across the present canal basin, from the south wall of the present south lock to the opposite side of the basin, inclosing the area which is to be occupied by the new lock pit, which is to be excavated (after the basin has been made dry) to a depth of about 85 feet below the present lower canal bottom, or to 424 feet above mean tide. The anchorage pits will be 13 feet deeper.

APPROACH.

Access to the upper entrance of the new locks is to be by steel aqueducts. The gates opening from the approaches or aqueducts into the new locks are straight sliding gates, like those of the Davis Island Dam lock.

LIFT.

The water surface of the upper level will be as at present, varying from 566 to 572.6 feet above mean tide (572.6 being the mean level of Lake Erie), while the water surface of the lower level will also be about as at present, varying from 510.14 to 512.14 feet above mean tide, the maximum stroke or lift being thus 62.44 feet.

LOCKS.

There are to be 2 locks, identical and side by side, built of soft mild steel, and so designed as to develop the tensile strength of the material. Each lock is in two main structural and functional divisions, an upper lock chamber, with gates to admit and to pass vessels, and a lower open-bottomed air chamber upon which the whole movable structure floats.

The lock chamber is 13¼ to 14 feet deep, 26 feet wide between side walls, and 24 feet between side-guard timbers. The clear opening of gates is 24 feet, the least draft over the sill is 12 feet, and the net length between gates is 240½ feet.

GATES.

All the gates, except those from the aqueduct into the lock, are of the quadrant, ponton type, and are crescent shaped in plan, and have an orbital motion about a vertical axis, and when opened lie out of the way in segmental pockets. Each gate is opened and shut by a single cylinder containing a piston, which is moved by compressed air, and acts both as an opening engine and as pneumatic buffer.

AIR CHAMBER.

The air chamber, which extends under the entire length and width of the lock chamber, is 69½ feet high, measuring from the bottom of its sides to the roof, which is also the floor of the lock chamber. This height gives a 5-foot water seal to the bottom of the air chamber when the lock is raised to its high level.

The air chamber is in eight bays, each 29 feet 11 inches between centers, the bays being segments of cylinders 18 feet 5¼ inches radius at top and 19 feet 1¾ inches radius at bottom. The walls are splayed to equate the working pressures, and tranverse ties are introduced to resist the tendency of the air chamber to assume a cylindrical form.

Chord plates and Y's are also riveted to the curved walls to provide for accidental and local reversals of strains, and also to provide rigid foundations to sustain the guide wheels and the anchor brackets.

GUIDE WHEELS AND ANCHOR BRACKETS.

These are provided to keep the lock level and to synchronize and to step its motions. This is accomplished by a parallel-motion apparatus, consisting of hollow shafts, one on each side of each lock, extending parallel with their length and equipped with pinions which mesh with racks formed on the locks, and also with other similar racks parallel thereto fixed on terra firma.

As the locks move the pinions are to mesh between the opposite parallel racks, and, with the shafts, are to roll between them. The shafts are made of inch-steel plates, spliced and riveted together, each shaft being 4 feet in diameter and 179¼ feet in length between centers of end sets of pinions, and having two intermediate sets of pinions, the distances between centers of pinions on each shaft being equal to two bays of the locks, or 59 feet 10 inches.

Corresponding with these pinions there are four racks on each side of each lock, which extend above the lock body and are framed together overhead by a lattice girder running lengthwise of the lock.

The length and strength of the racks is such that the locks can be raised clear of the water of the lower level and supported on the racks for inspection and repair.

OPERATION.

In operation the locks operate synchronously, one rising as the other is descending, and this is effected by the transfer of the compressed air from the air chamber of the elevated lock to the air chamber of the depressed one. This transfer is accomplished through an air pipe 10 feet in diameter by putting a slight overcharge of water in the elevated lock, and then opening valves which permit the passage of the compressed air to the chamber of the lock to be raised, the latter, meantime, containing in its lock chamber a slightly less weight than the former.

The valve is a water seal in a U-bend of the connecting 10-foot air pipe, and this water seal is drawn off or increased as desired to control the air passage.

ASCENT AND HYDRAULIC STOPS.

In order to stop the ascending lock without shock there are eight hydraulic stops, each suspended from the overhanging end of a pier anchorage girder and consisting of a cylinder and a plunger. The cylinder is filled with water supplied under pressure. Directly in line with the cylinders (which hang upon their plunger rods) are brackets on the side of the lock, which engage the cylinders as the lock ascends. The rising lock thus raises the cylinders and the resistance of the water under pressure contained within the cylinders gradually brings it to rest.

ACCUMULATOR.

Connected with this system of cylinders is an "accumulator intensifier" consisting of a hydraulic ram carrying an annular weight of 150 tons of concrete, which is so arranged that the pressure which it can produce upon the contained water can overmaster any buoyancy of the lock and push it down, if necessary, to the exact point desired.

HYDRAULIC APPARATUS.

This hydraulic apparatus is made heavy and strong enough to sustain the entire buoyant effort of the lock in case it were started upward without any load of water in the lock chamber, in which case the strains upon the stops would be five times as great as in the normal working.

DESCENT.

The descending lock is allowed to go down until it has foundered and rests upon the timber footing in the bottom of the lock pit. Its rate of descent is automatically controlled by devices which adjust the passage of the air from its air chamber into the ascending lock.

After the gates of the lock chamber have been opened and the boats hauled out into the lower level, the buoyancy of the lock is slightly increased by the admission of sufficient compressed air to the air chamber of the foundered lock from the air chamber of the elevated lock and from the accumulator to raise the foundered lock automatically and cause it to float at the top of the water of the lower level, where it is ready to receive a boat desiring ascent.

AMOUNT OF TONNAGE TO BE BENEFITED BY A SHIP CANAL.

The determination of the amount of tonnage that would seek an outlet to the sea by the way of a ship canal connecting the Great Lakes with the Hudson must necessarily be a rough approximation.

The following estimate is based upon a study of statistics, of present conditions, of existing facilities for transportation, and of such changes as a ship canal and the natural progress of events may be expected to produce.

SEASONS OF NAVIGATION.

The lake and canal would be open for an average of seven and one-half months, or two hundred and twenty-four days, of each year. During the other four and one-half months the canal would be closed by ice, and everything would have to be transported by rail. The accompanying chart shows the average open and closed periods for as many years as reliable data can be obtained.

The Erie Canal records show for 72 years an average open season of 224 days. The east end of Lake Erie is open 264 days; Oneida Lake, 253 days; and the Hudson, at Albany, 271 days. This would indicate an average open period on the Oswego Ship Canal route from April 3 to December 16, a period of 247 days, and upon the St. Lawrence and Champlain route from April 15 to December 15, a period of 244 days.

It does not do in practice, however, to predicate an open season for navigation entirely upon these averages as to open water, as is shown by the statistics of the Erie Canal. The actual active season of navigation must consider the chances of early closing and late opening, and will commence some days after and close some days before the theoretical navigation season. The matter will also be determined largely by the regulations of the insurance companies. It is known that the season of navigation on the lower St. Lawrence is only about six months of the year, it being curtailed at both ends by floating ice, fogs, snowstorms, etc., which render navigation possible, but difficult and extra hazardous.

In questions referring to navigation in this report it is believed to be a fair estimate to allow two hundred and twenty-four days as the navigable period on any of the routes or canals discussed in this report, which are entirely within our territory, that is, by the Oswego route or Erie Canal route. For the St. Lawrence-Caughnawaga-Champlain route the period would surely be somewhat shorter.

RAILROADS.

Notwithstanding that a through water route now exists by which the products of the West can be taken to the East, and the further fact that these products can be and are taken at less cost by water than by rail, yet the railroads do by far the greater amount of business. This is due to many causes, among which the principal ones are that the railroads do their work more quickly; that they do it with regularity all the year round; to the fact that the railroads reach out far into the producing regions and secure the freight at its initial point, and to the fact that railroad freights in this country are really very low, intrinsically, and as compared with similar rates in other countries.

Another cause is the never-ceasing, active, far-reaching business energy and combinations of the great army of railroad officials of the country, and still another and very potent cause is the lack of business organization of the Erie Canal traffic, for which there are no terminal facilities and no arrangements for through traffic. Another very important reason for the supremacy of the railroads in the business of transporting freight from the lakes eastward lies in the fact that a large proportion of the Western products going east never reach the seacoast, but are scattered by railroads from the lower lake ports to great numbers of places intermediate between the lakes and the sea, going to points in the mining and manufacturing regions of Pennsylvania and Ohio, and to the manufacturing and commercial regions of New England, New York, New Jersey, etc. These points nearly all have to be reached by rail, and it is, as a general rule, more economical to distribute this freight from the lower lake ports than it would be to take it through a canal to the Seaboard and distribute it from there. Take, for instance, a cargo of 2,500 tons of flour. It is very rare that such a cargo is in one shipment, ordinarily it is in a hundred or thereabouts. It arrives in Buffalo and is divided up, and each shipment is loaded into its proper cars and forwarded to its predestined point of consumption. Nothing would be gained by taking the cargo through to New York, where terminal and handling charges are and always will be higher than in Buffalo and the other lower lake ports.

As indicated in detail in a table of freight rates, transfer charges, etc., which is herewith, the freight rates on a bushel of wheat from Chicago to New York, including transfer charges at Buffalo, for several years, are as follows. The rate on wheat is taken as a standard for purposes of comparison, all other freight rates being presumably proportioned thereto.

TABLE No. 10.

	1891.	1892.	1893.	1894.	1895.	1896.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
By all rail	15	14.23	14.70	12.88	10	12
By lake and rail	8.53	7.55	8.44	7	5.90	6.75
By lake and canal	6.83	6.48	7.18	5.31	4.98	6.32

During the entire year of 1895 there were received in New York 118,707,744 bushels of grain, flour, and meal. Of this amount 103,119,390 bushels, or 86.8 per cent, arrived by rail; 14,690,100 bushels, or 12.4 per cent, arrived by canal, and 898,254 bushels, or eight-tenths of 1 per cent, arrived in coastwise vessels.

During the seven months of open canal and lake navigation in 1895 there were received in New York 84,241,715 bushels of grain, flour, and meal. Of this amount there arrived by rail 69,880,629 bushels, or 82.9 per cent; by canal 14,001,400 bushels, or 16.6 per cent, and by coastwise vessels 349,686 bushels, or one-half of 1 per cent.

During 1895 there was shipped from Chicago to the eastward 153,629,551 bushels of grain, flour, and meal. Of this amount 88,127,996 bushels were shipped by lake and 65,501,585 bushels by rail. Of the amount going by lake destined to the Seaboard at least three-fourths was transshipped to cars at lower lake ports, and not more than one-fourth transshipped to canal boats.

These figures of amounts and rates are intended to indicate the apparent additional value of rail transportation over lake and canal transportation.

Experience shows that the great bulk of materials seeking water transportation are those of a coarse and cheap character, such as grain, flour, meal, lumber, coal, cement, salt, ore, pig iron, etc. If a ship canal were constructed from Lake Erie to reach the Hudson River, the products and materials which it might be reasonable to suppose would be transported through it would be mainly confined to these items, with possibly large amounts of other products not now carried by water.

CEREALS.

By far the most important of the products which are to be considered in relation to a ship canal are the cereal products of the great West.

From a determination of the amounts of the cereals raised and the amounts now shipped by lake, rail, and canal, it is possible to arrive at an approximation of the cereal tonnage which might make use of a ship canal.

During 1895 the following were the amounts of the grains raised in the United States:

	Tons.
Corn	60,231,880
Wheat	14,013,088
Rye	761,882
Oats	13,191,097
Barley	2,089,746
Buckwheat	352,852
Total	90,640,545

The total exports during the year amounted to 5,343,823 tons, leaving for home consumption 85,296,722 tons.

The tonnage of cereal products passing through the Detroit River in 1895 amounted to 5,256,125 tons, or about one-fifth of the entire tonnage of the river. The amount shipped eastward from Toledo was 73,200 tons making a total of east-bound lake shipments of cereals of 5,329,325 tons. As the cost of shipping by lake and rail and lake and canal is not over one-half the cost of shipping by all rail, it is probable that everything possible goes by water, and that this is about the amount of cereal products which can at present be considered directly tributary to a ship canal.

Another indication of the cereal products which might be directly affected by a ship canal would be the receipts at the port of New York. During the year 1895 these amounted, from all sources, to 2,736,120 tons.

Another indication would be the receipts at the five northern ports of Montreal, Boston, Philadelphia, New York, and Baltimore. The following table gives these receipts:

TABLE NO. 11.—*Receipts of cereals during 1895 at the five Atlantic ports named.*

[Tons of 2,000 pounds.]

Port.	Flour.	Wheat.	Corn.	Oats.	Rye.	Barley.	Pease.	Total.	Percentage of total for 5 ports.
Montreal	161,354	133,245	72,313	27,763	46	4,250	25,991	424,962	8
Boston	261,834	217,381	250,445	106,905	508	3,925	2,456	843,454	15
New York	640,403	867,672	720,985	403,314	4,509	83,861	15,376	2,736,120	49
Philadelphia	307,733	67,683	136,579	80,209	1,736	22,154	....	616,094	11
Baltimore	377,959	145,023	331,941	46,331	10,202	3,208	....	914,664	17
Total	1,749,283	1,431,004	1,512,263	664,522	17,001	117,398	43,823	5,535,294	100

The total shipments of flour, wheat, and corn to all foreign countries during the year 1895 from the same ports is shown in the following table:

TABLE NO. 12.—*Exports during 1895 from the five Atlantic ports named.*

[Tons of 2,000 pounds.]

Port.	Flour.	Wheat.	Corn.	Total.	Percentage of total for 5 ports.
Montreal	106,104	104,572	72,004	282,680	8
Boston	160,079	216,820	153,877	530,776	16
New York	434,888	704,921	540,233	1,680,042	50
Philadelphia	94,764	51,284	95,874	241,922	7
Baltimore	255,666	126,502	254,032	636,200	19
Total	1,051,501	1,204,099	1,116,020	3,371,620	100

During the year 1895 the total tonnage of cereal products carried in both directions on all the New York State canals was 612,928 tons. This year—1895—was an abnormally poor year on the canals. During the year 1896, which was a good year on the canals, the total of the cereal tonnage was 1,073,409.

From all these and other data, I have fixed upon 8,000,000 as the possible cereal tonnage which might be considered tributary to a ship canal if it were built to the Hudson River by a suitable route and extended down the river to New York. This is 50 per cent more than the cereal tonnage of the Detroit River, three times the total receipts at New York, 50 per cent more than the total receipts at the five great Northern seaports of Montreal, Boston, New York, Philadelphia, and Baltimore, and about eight times the cereal tonnage of all the New York State canals.

LUMBER.

If the canal were now in operation, much lumber would undoubtedly go through it. During 1895 there passed through Detroit River more than 1,000,000,000 feet of lumber, equal to 1,638,000 tons. This lumber is scattered over and supplied to all the country between the Great Lakes and the sea. This amount might be considered as the lumber tonnage tributary to the canal.

During 1895 there were shipped from Buffalo and Tonawanda by Erie Canal 247,964,499 feet of lumber, or 371,946 tons. All the New York State canals carried, in 1895, 959,949 tons of wood and lumber, which includes the Canadian lumber shipped from Lake Ontario and St. Lawrence points by the Oswego and Champlain canals.

At the same time it must be borne in mind that the great lumber regions of Michigan, Wisconsin, Minnesota, and portions of Canada bordering on the lakes are rapidly being denuded of their timber, and the near future will see the lumber tonnage materially reduced. I believe it is perfectly safe to estimate that by the time a ship canal can be completed the lumber tonnage tributary to it would not greatly exceed the present lumber tonnage of the Erie Canal, or double this and say 750,000 tons, equivalent to about 500,000,000 feet B. M.

IRON ORE.

The greatest single item in the lake transportation business is iron ore. During 1895 there passed through the Detroit River 8,062,209 tons of iron ore, or 31 per cent of its total tonnage. This immense movement of ore was from the mines about Lake Superior to points on Lake Erie, either to be used at these points or to be shipped by rail to the great coal and iron region of which Pittsburg is the center. It seems absolutely certain that the great iron and steel business will always be done at such point or points between the ore regions and the coal regions where ores, coal, coke, fluxes, etc., can meet and mingle with the minimum of transportation and expense. Such economical point of commingling is not to the east of Pittsburg and Lake Erie, and is not upon the Atlantic Seaboard. It will surely be upon the shores of Lake Erie and between there and Pittsburg.

I am unable, therefore, to believe that any great amount of the Lake Superior iron ores can be considered tributary to a ship canal connecting the waters of the Great Lakes and the Hudson. For special uses on the Atlantic Coast it is possible that 1,500,000 tons of Lake Superior ore might be used, and this is allowed as possibly tributary to a ship canal.

PIG IRON AND MANUFACTURED IRON.

The production of pig iron in the United States during 1895 was 9,446,308 tons. Of this amount 4,000,000 tons was produced in the vicinity of the lakes. A possible canal tonnage of 3,000,000 tons of pig and manufactured iron, steel, steel rails, beams, etc., is assumed. This is 45 times the amount of pig, bloom, and bar iron now moved on the New York State canals.

COAL.

The great coal movement on the lakes is from lower lake ports to upper lake ports. From the anthracite regions of Pennsylvania coal reaches Buffalo and vicinity by rail, and is shipped to upper lake ports in returning ships which have come down laden with grain and other products. From the bituminous regions of Pennsylvania, Ohio, and West Virginia the coal goes by rail to various points on the south shore of Lake Erie, and is shipped to up-lake ports in returning ore ships. There is not now any amount of bituminous-coal tonnage tributary to a ship canal to the Hudson, and I am unable to perceive the probability of any great amount in the future.

The amount of coal going through the Detroit River during 1895 was 7,834,942 tons, or about 30 per cent of its total tonnage. It is, however, conceivable that a limited amount emanating from Lake Erie ports might find new markets by using a ship canal, and an estimate of 1,000,000 tons is made for this contingency.

Of anthracite coal the New York State canals carry a considerable amount. The total amount carried during 1896 was 574,032 tons, of which amount 196,443 tons was the amount shipped through and the remainder was way freight. The total west-bound coal shipments, nearly all anthracite, from Buffalo during 1895 were 2,620,768 tons, and during 1896 2,400,000 tons.

It is not much farther from the anthracite regions of Pennsylvania to Buffalo than it is to New York, and coal can be delivered by railroads as cheaply at Buffalo as at New York, due largely to the excess of east-bound over west-bound traffic, which leaves lots of empty cars going west.

It is believed that 2,000,000 tons of anthracite west-bound coal and 1,000,000 tons of bituminous east-bound coal will be all the coal tonnage that can in reason be considered tributary to a ship canal.

COPPER ORE.

This forms a considerable portion of the lake shipments, amounting, in 1895, to 107,452 tons. This ore is reduced at the lower lake ports, where coal is abundant and cheap, and the product distributed by lake, canal, and rail. It is estimated that 100,000 tons of copper and copper ore might find its way through a ship canal.

HOG AND BEEF PRODUCTS.

It is not considered that a ship canal would have any influence upon the shipment of fresh meats. As a means of estimating the quantity of hog and beef products which might use the canal, the following statistics for 1895 are given:

Lard shipped eastward from Chicago by lake, 6,430 tons; by rail, 164,264 tons; total, 170,694 tons. Barreled pork, by lake, 400 tons; by rail, 24,107 tons; total, 24,507 tons. Other meats, all by rail, 291,322 tons; total, 479,693 tons.

The total exports of hog and beef products from the four ports, Boston, New York, Philadelphia, and Baltimore, during the fiscal year 1895-96 amounted to 716,957 tons. This was 93 per cent of the exports for the whole United States.

To allow for other ports and vast increase of business, an estimate is made of 1,000,000 tons as a possible amount of hog and beef products tributary to a ship canal.

WOOL.

Although very little wool is now carried by lake and canal, it is possible to believe that with a ship canal much of the wool clip of the States within reach of the lakes might go thereon.

During 1895 there was shipped from Chicago 31,720 tons of wool. Of this amount 27,164 tons, or 85 per cent, was shipped by rail and 4,556 tons, or 15 per cent, by lake.

The total wool clip of all the States which can be considered as in a near or remote degree tributary to a ship canal amounted, during the year 1895, to 53,243 tons. Of this tonnage not over one-half, or 26,621 tons, could be considered as really tributary to a ship canal.

The wool clip can be expected to increase in the future, and an estimated possible canal tonnage of 100,000 tons of wool is assumed.

HIDES.

During the year 1895 there were shipped from Chicago 87,404 tons of hides. Of this amount 85,157 tons, or 97½ per cent, went by rail, and 2,247 tons, or 2½ per cent, went by lake. A possible canal tonnage of 100,000 tons of hides is assumed for the ship canal.

LIVE STOCK.

There is a vast live-stock movement in the vicinity of the lakes between the West and the East, but it is altogether by rail. The governing causes for this seem to be the desirability and necessity for rapid and sure movement and frequent feeding and watering, lack of stock yards adjacent to deep water, and the expense and time required to fit up and remove accommodations for stock on shipboard. As an indication of the magnitude of the live-stock movement, the following statistics of the live-stock trade of Buffalo are given:

During the year 1895 there were received at Buffalo 84,764 carloads of live stock, as follows:

	Carloads.
Cattle	36,175
Hogs	27,644
Sheep	16,114
Horses	4,831
Total	84,764

Allowing 15 tons to a carload makes this live stock amount to 1,271,460 tons.

There were shipped away from Buffalo 65,780 cars of live stock, as follows:

	Carloads.
Cattle	32,925
Hogs	17,684
Sheep	10,909
Horses	4,262
Total	65,780

Allowing 15 tons to a carload makes this amount to 986,700 tons. There are practically no receipts or shipments by lake or canal. I am unable to see wherein a ship canal would bring about any change or have any influence on this portion of the transportation business of the country, and believe that there would be no perceptible amount of live-stock tonnage pass through a ship canal.

MISCELLANEOUS FREIGHT.

To cover and allow for down shipments of various articles of freight not enumerated above, an estimate of 2,450,000 tons is made.

WEST-BOUND TONNAGE.

An endeavor has been made to determine the relationship of the east and west bound tonnage for the great section of country between the lakes and the Seaboard.

The general statistics of the Erie Canal and the main trunk lines of railroad crossing the belt in question, as far as these were available or obtainable, have been studied. From the data obtained the following table has been prepared:

TABLE NO. 13.—*Showing percentage of freight east bound and west bound during 1895 between the Great Lakes and the Atlantic Seaboard.*

Name of line.	East bound.	West bound.
	Per cent.	*Per cent.*
New York Central and Hudson River R. R.	66	34
Lake Shore and Michigan Southern	56.2	43.8
Michigan Central R. R.	64	36
Delaware, Lackawanna and Western R. R.	78.4	21.6
West Shore R. R.	87.4	12.6
Baltimore and Ohio R. R.	86.8	13.2
Lehigh Valley R. R.	75.8	24.2
Erie Canal	66	34
Mean of percentages	72.58	27.42

This table indicates that, taken as a whole, the west-bound freight will not vary far from three-eighths of the east bound. On the Erie Canal and the New York Central the west bound is one-half the east bound.

This is not, however, the relationship that would exist between the east and west bound tonnage of a ship canal. In the figures above given the way and through business is united, as the data obtained does not in most instances allow these to be separated.

In the case of the New York Central and Hudson River Railroad, the nearest great trunk line to the proposed canal, the separation is practicable. During the two years ending June 30, 1896, the through east-bound tonnage of this road was 5,577,336 tons, and the through west bound was 1,137,663 tons, or about one-fifth of the east bound.

The ship canal would be essentially a through route, and if built by any other than the Erie Canal route would have very little local or way business. A careful consideration of the question convinces me that the west-bound tonnage through a ship canal would not exceed one-third of the east-bound tonnage. An improved Erie Canal, passing as it does through a rich and important section of the State of New York all the way, would have much local business, and the proportion of its west-bound tonnage might be somewhat higher.

For the purpose of approximating to the total tonnage of a ship canal or an improved Erie Canal, and further on in estimating the cost of transportation by different methods, it is estimated that the west-bound tonnage of such a canal would be one-third the east-bound.

TABLE NO. 14.—*Estimated tonnage possibly tributary to a ship canal.*

East-bound tonnage:	
Cereals and cereal products	8,000,000
Lumber	750,000
Iron ore	1,500,000
Pig and manufactured iron, steel, steel rails, etc	3,000,000
Bituminous coal	1,000,000
Copper and copper ore	100,000
Hog and beef products	1,000,000
Wool	100,000
Hides	100,000
Unclassified and miscellaneous freight, as fruits, oils, glass, glucose, glue, etc	2,450,000
Total	18,000,000
West-bound tonnage, including 2,000,000 tons of anthracite coal	6,000,000
Total	24,000,000

This amount of tonnage as tributary to a ship canal is not at present in sight. If it should be attained, it would be by the development of agriculture and its allied industries, and of manufactures, and by the diversion of business from railroads. It is predicated upon the assumption that the ship canal is built from the Great Lakes to New York by the shortest and best attainable route, which is believed to be either by the Erie Canal route or the Oswego route. If the canal should be constructed by way of the St. Lawrence to Montreal, with a Champlain branch to New York, no such amount of tonnage would be attained. Such a canal would be of benefit solely to such portions of the export trade as could be diverted to Montreal, a port open to navigation from the sea for only about six months of the year, and during a portion of which time navigation is rendered difficult and dangerous down the 980 miles of the St. Lawrence River and Gulf by fogs, snowstorms, floating ice, etc. No return freight of any consequence could be expected at Montreal, and in this the route would be sadly handicapped in comparison with a route starting from a great commercial center like New York. The Champlain branch from the St. Lawrence to New York would have little value. The way would be far too long and roundabout, and it could not possibly compete in economy of transportation with the improved Erie Canal. While, of course it would be used somewhat, yet I am confident that it would be used to but a very limited extent, and that the benefit resulting from it would be in no way commensurate with its cost.

The combined tonnage which could be considered tributary to such a St. Lawrence-Champlain Canal would not, in my judgment, exceed one-third to one-half of the tonnage tributary to a canal built by the Oswego route. If such a canal were in existence to-day I am satisfied that there would be a strong demand for a new canal by the Oswego-Oneida-Mohawk route, to cut out the 244 miles of extra distance to reach New York.

OCEAN, LAKE, AND CANAL VESSELS.

In considering the economic questions pertaining to a ship canal from the Great Lakes to the sea, one of the first facts brought to the attention of the investigator is that vessels which ply upon the ocean and those which ply upon the lakes are markedly different in their cost, construction, and operation. So great are the differences that I am convinced that the two can not economically change places; that the highest and most profitable type of lake vessels can not be used at sea, especially in the North Atlantic trade; that the ships fitted for use at sea can not successfully compete in the freight business on the lakes with lake vessels, and that while it is possible from an engineering standpoint to build a vessel which shall combine to a limited extent the particular necessities and advantages of both lake and ocean vessels, such a vessel would not be a good business enterprise. However carefully a vessel may be designed for service on both lakes and ocean, she must necessarily be a compromise between two widely differing types, and inferior to each on its own waters. She can neither carry cargoes on the lakes as cheaply as the lake ships, nor on the ocean as cheaply as the ocean ships, and even supposing that the advantage of the avoidance of transfer will more than make up for these disadvantages and the time necessarily lost in any canal that can be constructed, she would have this advantage for but little more than half a year, and the remainder of the year she must run at a loss on salt water as compared with other ships.

I am convinced that if a ship canal were built so that vessels could pass from Lake Erie to the ocean, and it were found advantageous to use the canal by large vessels, that as a general thing these would be the large lake freighters, and their cargoes would be transferred at the Seaboard, either directly or through the medium of elevators, lighters, storage docks, etc.

The pleasing picture of great ships loading with grain, flour, and produce of all kinds at Chicago, Duluth, etc., and proceeding thence to transatlantic ports, and arriving at these lake ports with foreign cargoes, I can not believe will ever be realized to any great extent, even if a ship canal connecting the Great Lakes with tide water should be built.

The difference between the lake and ocean vessels for the carriage of freight may be illustrated by taking the latest models and highest development of each, describing and comparing them.

OCEAN FREIGHTERS.

As a type of modern ocean freighter the Cunard Line steamer *Sylvania* is taken. The drawing herewith gives the longitudinal and cross sections and deck plans of this ship.

The dimensions of this steamer are as follows:

Length over all	feet..	473
Length of keel	do...	460
Breadth	do...	49
Depth	do...	42¼
Draft, fully loaded	do...	27
Cargo capacity	tons weight..	7,500
Displacement, fully loaded	tons..	12,160
Free-board, fully loaded (from upper deck)	feet..	8½

The hull is built entirely of steel. She has five decks, as shown on the drawings; of these, the orlop, lower, main, and upper decks are of steel. The shelter deck is partially plated and then sheathed with pine. The vessel is propelled by twin screws. There are nine water-tight bulkheads extending to the upper deck, and these are fitted with water-tight doors on each side of the 'tween decks only, to expedite the handling of cargo and cattle. Besides the double bottom which is fitted for water ballast, there are four large, deep tanks for trimming purposes—one aft and one forward, and one at each end of the engine and boiler space—these being additionally subdivided by fore and aft water-tight bulkheads. There are in all 24 compartments for water ballast, and part of the double bottom under the engines may be utilized for carrying reserve fresh water for cattle or boiler use. The bulkheads are so arranged that any two compartments, and in some cases three, may be flooded and still the vessel will keep afloat. The engines and boilers are in the center of the ship.

The vessel has capacity for 6,500 gross tons of dead freight and 420 cattle, for which latter accommodations are provided on the upper deck, as shown in the plan.

There are six holds—three forward and three aft of the engines—each provided with a hatch about 12 feet by 18 feet in size, and these are served by seven large steam winches, each having double derricks. The quarters for the officers are on the shelter deck forward of the engine space and about the engine hatch. There are four steel pole masts, fitted with fore and aft canvas for steadying purposes.

There are two twin sets of triple-expansion engines, the cylinders being 22½ inches, 36½ inches, and 60 inches in diameter, with a stroke of 4 feet. It is estimated that such a ship as that described and illustrated, and fully suited for ocean work, would cost to build in this country about $500,000, or at the rate of $66⅔ per ton of her extreme carrying capacity at 27 feet draft.

As a further illustration of the development to which ocean freight ships have reached, I send a photograph and general description of the new steamer *Pennsylvania*, of the Hamburg-American Line, understood to be the largest freight ship in the world.

This enormous ship recently left New York on her maiden trip with a mean draft of 31½ feet and carrying a dead-weight freight cargo of 12,000 gross tons of paying freight. At this draft the ship has a displacement of 23,400 tons, and a total capacity of 21,760 tons, and a measurement loading capacity of 18,500 tons. It has a live-stock capacity of 450 horses or cattle. It has two balanced quadruple-expansion engines, with cylinders 23, 33, 48, and 69 inches in diameter, with a stroke of 54 inches. The engines and boilers are of 6,000 horsepower.

The ship has a water bottom capable of carrying 1,896 tons of water, and has accommodations for 200 first-class cabin passengers, 120 second class, and [illegible] steerage passengers.

There are [illegible] steam winches and cranes for loading and discharging, and altogether there are on board 45 steam engines with 82 cylinders.

The crew have excellent quarters, the stokers' quarters being provided with shower baths, and the ventilation of the ship is particularly effective, so that even in the stoke room at top speed the air is fresh and cool. The cost of such a ship built in this country would not be far from $850,000, or at the rate of $71 per net ton of carrying capacity.

The following figures as to the capacity and cost of building ocean vessels were furnished me by an eminent firm of American shipbuilders: An ocean vessel 500 feet long over all, 478 feet long between perpendiculars, 60 feet beam, 40 feet depth, fitted with two triple-expansion, surface-condensing engines, each engine having cylinders with 48-inch stroke and 22, 36, and 55 inches diameter, furnished with steam by 8 return tubular steel Scotch-type boilers 11 feet long and 11 feet diameter, with steam steering and hoisting gear, joinery plain and substantial, fitted for freight service, with two steel masts schooner rigged; the type of vessel to be the "three-island" type, which has raised midship house and forecastle and poop decks. Such a ship, it is estimated, would weigh, complete, ready for coal and freight, 6,700 tons; and it would have, at 24 feet draft, a cargo capacity of about 11,000 tons. Her cost is estimated at $725,000, which would be at the rate of $66 per ton of carrying capacity.

An ocean vessel 420 feet long over all, 394 feet long between perpendiculars, 45 feet beam, 30 feet depth, with one triple-expansion engine of 48-inch stroke, with cylinders 28, 45, and 72 inches diameter, furnished with steam by four Scotch-type return tubular boilers 12 feet long and 13½ feet diameter, and all of the same general type as the steamer just mentioned. Such a vessel, it is estimated, would weigh, complete, ready for cargo and coal, 3,500 tons, and would, at 24 feet draft, have a cargo-carrying capacity of 6,200 tons. Her cost is estimated at $415,000, which would be at the rate of $67 per ton of carrying capacity.

LAKE FREIGHTER.

The latest type of steamer developed on the lakes for freight business is illustrated in the drawing herewith. It is the steamer *Geo. Stephenson*, built by F. W. Wheeler & Co., for the Bessemer Steamship Company.

This steamer is constructed of steel, and its dimensions are as follows:

Length over all	feet..	428
Length of keel	do...	408
Breadth	do...	48
Depth	do...	28
Dead weight	tons..	2,700
Cargo capacity:		
On 16-foot draft	tons weight..	5,000
On 20-foot draft	do...	7,000

The ship is built in the simplest manner imaginable, and her lines are not fine. Main deck beams are provided, but there is no main deck laid except at the fore and after ends. The entire storage capacity of the ship is divided by five bulkheads into four great holds extending from the cellular water bottom to the shelter deck. The engines and boilers and coal bunkers are in the extreme after end of the vessel, the boilers being placed athwart ship with fire room between them. The crew are housed in the after deck house and in the forecastle. As the ship must frequently go west without cargo, a deep double bottom for water ballast is provided, which also adds additional security in the shallow channels connecting the various lakes where groundings are frequent. This double bottom, which is 5 feet deep from collision bulkhead to engine bulkhead, is divided by center keelsons and solid floors into eight compartments built on the cellular system, with solid longitudinals extending from the bottom plating to the tank top, continuous fore and aft. The spar deck is of steel complete without wood covering, except inside the houses and on the forecastle deck. The hatch coverings are of wood.

Running only about seven months in the year with a speed, loaded, of about 12 miles per hour in the open water, everything in the design of this ship is subordinated to the rapid handling of cargo in port. For instance, it is usual to put 5,000 tons of iron ore or coal into the ship in three or four hours and take it out in fifteen hours; and grain elevators will load such a ship in two or three hours, and will, under favorable circumstances, take out her load of 5,000 tons, or 167,000 bushels of wheat, weigh it, and store it in ten or twelve hours. This rapid handling of freight is rendered possible by the dock facilities of the lake ports, and by the extraordinary hatch development of the ship. Each of her four holds has three great hatchways, making twelve in all. These are spaced 24 feet apart between centers, and in size are 8 feet in a fore-and-aft direction and 32½ feet abeam in the clear.

As the power is small, the voyage short, and fuel can be obtained at intermediate points if necessary as well as at terminals, the coal bunkers are small and so arranged that coal can be spouted in from high pockets or loaded from floating fuel scows carrying derricks, while the cargo is being unloaded. The engines are jet condensing, surface condensation not being required on the fresh water of the lakes, and never being far from repair shops, few tools or spare parts are carried. The engines are triple expansion, the cylinders being 25, 41, and 66 inches in diameter, by 42 inches stroke. The cost of such a ship fully equipped is about $250,000, or at the rate of $50 per ton of carrying capacity at 16 feet draft, or $35.71 per ton at 20 feet draft.

In many instances, and especially for the vessels engaged in the ore business, a steam freighter has a consort, a motorless barge similarly constructed and about the same freight capacity as the steamer herself, and is towed by the latter. These consorts have a much smaller crew and accommodations therefor than the steamer, and about the only machinery on them is the towing apparatus. The quiet open water of the lakes renders this system of towing practicable. It is not believed that any such system could be safely conducted on the foreign trade on the North Atlantic, although in the transportation of coal from one domestic seaport to other domestic ports, the barge navigation, with barges of moderate size, has assumed very large proportions. I also send a photograph of the *Sir Henry Bessemer*, stated to be the largest vessel on the Great Lakes. This photograph illustrates well the marked characteristics and simplicity of the lake vessels.

LAKE WHALEBACK FREIGHTER.

The American Steam Barge Company have a large fleet of steamers and barges on the lakes of the whaleback type. The fleet consists of nine steamers, varying in size from the *J. L. Colby*, 264 feet length, 36 feet beam, and 22 feet depth, to the *Frank Rockefeller*, one of the latest built, and of which a drawing is herewith, showing sections, plan, and dimensions.

This vessel on a 14½-foot draft carries 3,889 tons of freight, and on a 16-foot draft 4,576 tons. The ship has a water bottom about 4 feet deep. The hold is divided into three portions by bulkheads. The engines and boilers and officers' quarters are in the extreme after part of the vessel and the quarters for the crew in the forecastle. There are 11 main cargo hatches, each 8 feet by 12 feet, situated on the center line of the vessel, and 13 smaller trimming hatches, each 4 feet by 6 feet, situated nearer the side.

The cost of such a vessel is about $210,000, or at the rate of $43.70 per ton of carrying capacity.

The illustrations and descriptions indicate the main difference between the ocean and lake freight vessels of the most recent type. These main differences may be summarized as follows:

Ocean vessels fitted for combating the storms of the North Atlantic are built much heavier, stronger, deeper, and on finer lines than are the lake ships. The machinery differs radically, owing to the salt water, and is more expensive and differently placed. In the ocean ships surface condensers are imperative, and much brass or lead piping is required. The machinery, placed a-midships, interferes with rapid loading and unloading. The hatches are too small and too few, and not properly spaced to suit docks, elevators, etc., and the rapid handling of freight in lake ports. The coal bunkers are too large, occupying valuable room. All deck constructions, the rudder, anchors, chains, etc., are heavier and more expensive than are required for the lakes. The decks add weight and interfere with loading, storing, and unloading bulky, coarse freight. Speaking comparatively, the bottoms of ocean vessels are made for floating and the bottoms of lake vessels are designed for grounding.

The ocean vessels carry hoisting engines and derricks for handling cargo, which on the lake vessels are unnecessary, as all lake docks are fitted with machinery for that purpose.

Making long voyages, the ocean vessel has to carry many spare parts and tools for repairs, and skilled men to use them. A greater number of men are employed on ocean vessels than on lake vessels of the same class, and the officers of the ship must be practical sea navigators.

For the same capacity, ocean ships ordinarily draw much more water than do lake vessels, and the cost per ton of carrying capacity is greater.

Ocean vessels in very many instances combine a freight and passenger business, which lake vessels rarely do.

There is a vast amount of business done on the lakes in vessels which are much smaller and of different type from those described and illustrated herein. Many steamers designed for general business of package and bulk freighters have a main deck laid and have four to six large ports on each side of the ship into the 'tween decks, through which freight is trucked, and hoisting machinery is provided for serving the holds. These steamers are all smaller, and most of them much smaller, than the coarse-freight boats.

The rapid change in recent years in the type and size of lake vessels is an important element in determining the rate of deterioration in the value of vessel property. Many vessels which five years ago were in the front rank have had their value reduced to fully one-half owing to the evolution of lake craft.

There are no lake vessels engaged exclusively in the grain carrying business. During the spring and fall, just after the opening and before the closing of navigation, many ships come to Buffalo with full loads of grain and business is very active. During the midsummer season the grain business dies down and vessels have to seek other commodities to carry, and the season is one of comparative dullness.

Although, as previously stated, it is not believed that ocean vessels would to any great extent run through a canal to the lakes, or that lake vessels would run to distant seaports, yet the fact that they could do so would undoubtedly lead to a minimizing of transfer and port charges in New York and at lake ports. Practically the same thing would result from the inauguration of a system of large barge navigation with barges of about 1,500 tons capacity suited to traverse the lakes and to go if necessary to ocean coastwise domestic points.

One of the benefits claimed for a ship canal by some of its advocates is that it would enable lake ships to go to sea and engage in the transportation business at sea during the closed winter period on the lakes. This is doubly impracticable from the fact that the lake vessels are not fitted for service at sea either in hull or machinery, and would be particularly deficient in winter when the North Atlantic requires craft of the staunchest character, and also from the fact that the business field which they could enter would be fully occupied by vessels engaged in it all the year round.

CANAL VESSELS.

Vessels designed to carry freight on narrow and contracted waterways like canals and rivers can be built in a much cheaper manner than is required for vessels designed to navigate the ocean or the Great Lakes. For the same reason that ocean vessels have to be built heavier and stronger than lake vessels, so lake vessels have to be built heavier and stronger than would boats designed exclusively to navigate canals and rivers between the Great Lakes and tide water.

As the cost of the carrier, by the interest which it represents and the deterioration which the vessel undergoes, is a continual and never-ceasing item of expense, it must be given great consideration in estimating the cost of transportation.

I have hitherto described and given illustrations and estimates as to the value of carriers of the most approved types on ocean and lake.

The present type of Erie Canal boats carries on 6-foot draft 240 to 246 tons, and costs about $3,000 each, or at the rate of $12.19 per ton of carrying capacity. Many of them are capable of being loaded to 8 feet draft. The boats which will navigate the improved Erie Canal will carry about 400 to 410 tons, and it is estimated will cost about $3,500 each, or at the rate of $8.75 per ton of carrying capacity. If these boats are united into fleets of four boats, including one steamer, the cost per ton of carrying capacity of the fleets would be for the present Erie Canal about $19.40, and for the improved Erie Canal $13.67. If six-boat fleets are used, the cost per ton of carrying capacity would be for the present Erie Canal $17.39, and for the improved Erie Canal $12.04.

For large 1,500-ton barges, suitable for use on a still further improved Erie Canal, the value per ton of carrying capacity for the plain barges would be about $8, and for a fleet of three plain and one steam barge about $10.70.

If the plain barges be run in connection with semi-independent steamers, as outlined hereinafter, the value per ton of carrying capacity, including steamer, would be about $10.14.

As illustrations of the very low cost of carrying capacity on narrow waterways, attention is invited to the open coal boats and barges in use on the Ohio and Mississippi rivers.

Coal boats are great rectangular boxes, 170 feet long, 26 feet wide, and 9½ to 10 feet deep. They are loaded to 8 feet draft, and carry 1,000 gross tons of coal. They cost about $500, or at the rate of 50 cents per ton of carrying capacity. Tows of 30 to 40 of these loaded boats, carrying 30,000 to 40,000 tons of coal, are taken down the Mississippi by one towboat. On the lower river coal boats are sold with the coal for the lumber that they contain.

Coal barges are made more substantial than coal boats, and are towed back and forth, chiefly in the Pittsburg-Cincinnati-Louisville-St. Louis trade. The standard dimensions of a coal barge are: Length, 130 feet; width, 25 feet; depth of gunwales, 7½ feet. Their sides are made of 6-inch pine, and bottoms of 4-inch oak. They are loaded to draw 6 to 6½ feet, and their capacity averages 500 tons. They cost $1,000 to $1,100, or at the rate of $2 to $2.20 per ton of carrying capacity.

Coal is taken from Pittsburg to New Orleans, 1,970 miles, at an average cost of 71 cents per ton. The phenomenally low cost of this coal transportation is due to wisely adopting for the work a carrying plant of minimum cost suited to the waterway on which it is to run, and the lesson which the illustration is intended to convey is that economy requires the vessel to be suited as well to the waterway as to the materials carried.

The following is a summary of the estimated round value per ton of carrying capacity of vessels and fleets of vessels mentioned herein:

Steel ocean steamers	$60.00	to	$70.00
Steel lake steamers	35.00	to	50.00
Erie Canal boats, plain	9.00	to	12.00
Erie Canal boats, in fleets with steamer	12.00	to	20.00
Large 1,500-ton canal barges:			
Plain, about	8.00		
In fleets with steamer	10.00	to	11.00
Ohio and Mississippi coal boats	.50		
Ohio and Mississippi coal barges	2.00	to	2.20

MISCELLANEOUS FREIGHT BUSINESS.

In studying the ship-canal problem it has been necessary to investigate into the cost of handling and transferring package freight and freight other than grain, at Buffalo and other lake ports, in order that a comparison of cost of through transportation by various methods might be made.

All the trunk-line railroads terminating in Buffalo have connections with lake vessels operating lake transportation lines, forming what is called a lake and rail line. These lake lines form an integral part of the through route between western ports and New York and other seaports, and are to a great extent controlled by the respective railroads.

The lake line of the New York Central and Hudson River Railroad is the Western Transit Company; that of the Erie Railroad the Union Steamboat Line; that of the Delaware, Lackawanna, and Western Railroad the Lackawanna Transportation Company. The object of these combination lines is to give the railroads opportunity to control their own receipts and shipments. In addition to the lake transportation companies mentioned there are independent lines which forward and deliver such freight as they are able to make arrangements for.

HANDLING PACKAGE FREIGHT AT BUFFALO.

The expense of transferring east-bound package freight at Buffalo from lake vessels to railroad cars is embraced in the following items:

1. Unloading from vessels to the end of the gang plank.
2. Placing in warehouse and sorting.
3. Loading from warehouse into cars.

The same general items reversed are applicable to west-bound freight. The unloading from vessels into warehouse and the loading from warehouse into vessels, so far as the transportation lines running to Lake Superior and Lake Michigan ports are concerned, and handling through freight, are nearly all done by contract. The prices paid for this work range from 16 to 18 cents per ton, the contractor receiving the same price for loading as for unloading. The rates are the same for either net or gross tons, the contractor receiving for payment the billed weights, according to the character of the cargo shipped; pig iron, for instance, being billed in gross tons and flour in net tons.

In addition to the rate paid the contractor for handling package freight, he receives a price for cooperage, to cover the expense of repairs to damaged cases and packages. The general rate for this item is $2 for every 1,000 barrels and 70 cents for every 1,000 sacks handled.

The contractor's forces are generally divided into gangs of 22 men, which is the regular force for one hatch. These gangs work under the immediate direction of an overseer. The number of hatches worked at a time varies to some extent, the size of the vessel determining this.

It may be stated in a general way that the average number is about four. Where a number of gangs are employed in unloading and loading they are controlled by a superintendent, who has general charge. The appliances for loading and unloading package freight are extremely simple, merely winches operated by steam power, the cargoes being lowered and raised in slings. Some of the docks are supplied at the vessel's side with a mechanical appliance for expediting the delivery of cargoes to and from the warehouse. They consist of an endless apron conveyor driven by steam power.

The warehousing, sorting, and loading from warehouse into cars, as stated in items 2 and 3, are either done by contract or by hired labor, as the individual lines elect, but the work is generally done by contract. When performed by the latter method, the mentioned items are combined, and one price paid covering both. The price paid for loading into and from cars, when performed by contract, ranges from 16 to 18 cents per ton.

Package freight can undoubtedly be transferred to and from cars by hired labor at a much lower figure than when done by contract labor, as is evidenced by the system in vogue and the results attained at the docks of the Lehigh Valley Railroad Company.

For the purposes of comparison and illustration, the following details of handling package freight by this company for the season of 1896 are appended:

This company controls a large warehouse and dock for the storage and handling of package freight, which is located at the southern end of the Buffalo city ship canal and on the west side of the same, in a locality generally known as the Tifft Farm. The different transportation companies which delivered to and received freight from this dock were: Lehigh Valley Transportation Company, Northern Steamship Company, Union Transit Company, Soo Line, Minneapolis, St. Paul and Buffalo Steamship Company, Lake Erie Transportation Company, Clover Leaf Line.

The following statement shows the details of the company's business for the season of 1896:

Vessels:	
Arriving with east-bound cargoes	463
Departing with west-bound cargoes	390
Total	853
Freight:	Net tons.
Received from western ports	394,329
Shipped to western ports	95,515
Total	489,844
Average cargo of package freight:	Tons.
East bound	852
West bound	245

The east-bound freight consisted principally of flour and feed in bags and barrels, lard, lead, glucose, spelter, wool, malt, baled hay, shingles, and lumber. The west-bound freight was mainly sugar, coffee, and cement.

The force required in transferring freight from and into cars and warehouse varied somewhat during the season of shipping, but during the busy part it consisted of 180 men. The men operate in squads of 10 men each, one of whom acts as foreman. They are all paid at the rate of 15 cents an hour while engaged in work. The greater portion of the lake traffic mentioned before was handled by the Lehigh Valley Transportation Company, a corporation intimately connected with the railroad company. The cargoes handled by the other lake transportation companies mentioned, and touching at this dock, were merely fractional portions consigned to the railroad company.

The east-bound freight arrives in a steamer in a more or less confused and mixed condition. It is unloaded and placed in the warehouse, the different shipments being sorted and piled up separately. The unloading from the vessel is done by contract at a cost of 18 cents per ton. The sorting and piling in the warehouse is done by the railroad company's force, as is also the moving of the freight from the warehouse into the cars. This combined expense during the season of 1896 was 9.1 cents per ton, making a total cost of transfer on east-bound package freight of 27.1 cents per ton. The cost of transferring west-bound package freight was the same.

Regarding the time of unloading of package freight, one record at this dock is the unloading of 2,515 net tons in 6 hours and 15 minutes. The published joint east-bound freight tariff rate, during the latter part of the season of 1896, for flour and feed from Duluth to New York, was 17½ cents per 100 pounds, of which the lake rate from Duluth to Buffalo was 6.79 cents, and the rail rate from Buffalo to New York was 10.71 cents. The distance from Duluth to Buffalo by lake is 997 miles, while the distance by rail (New York Central) from Buffalo to New York is 440 miles. On the basis of a ton-mile, the respective charges by lake and rail are .135 and .487 cent. Out of the freight rate received, the vessel pays for unloading to and from warehouse and vessels, while the railroad company bears the expense of loading to and from warehouse and cars. The vessel also bears the expense of loading package freight at Duluth. This rate is 18 cents per ton for loading, and the same price is paid for unloading, making a total of 36 cents for each and every ton, to be deducted from the freight rate to get the net rate.

As an illustration of the amount of package freight handled in Buffalo, it may be stated that the receipts of east-bound package freight by the Association of Lake Lines, which is composed of eight separate lines, during the season of 1896, was 1,775,640 net tons. For the season of 1895 it was 1,430,409 net tons. No figures are available for the west-bound traffic.

Package freight received and intended for local use and consumption at Buffalo is handled by hired labor, the force employed varying at the different docks, being dependent upon the extent of the business done. Some of the lake transportation companies also forward west-bound freight received by canal. When this freight is transferred by contract (which is the general practice), about the same rates prevail as those paid for transferring from cars.

Freight received by canal and shipped by one of the lake transportation companies (the Erie and Western) is transferred from canal boats to vessel entirely by hired labor. The wages paid laborers for this work are 20 cents per hour during the spring and summer months. After August the rates usually advance to 25 cents per hour. The earlier months are generally dull, and as business picks up in the fall, wages are voluntarily raised in order to avoid strikes and labor complications. No figures are available as to the cost per ton of handling package freight in this particular instance.

In handling freight from vessels to be shipped by cars, warehousing and storing is more necessary than it will be in handling from vessels to large canal boats and barges. With the business properly and economically managed, it is believed that one handling will suffice for a large proportion of the east and west bound through freight destined to or brought from the seacoast. The canal boats or barges can be laid alongside of the vessel and the cargoes changed from one to the other at a cost no greater than that of the transfer of the same from the vessels to warehouse and the reverse, now being done by contract at 16 to 18 cents per ton. A great deal depends upon the amount and regularity of the business done. Experience at the Lehigh Valley docks shows that package freight can be handled twice at a cost of 27.1 cents per ton. In giving consideration to the cost of through transportation by means of the large lake carriers and the transference at Buffalo into canal boats and barges to run through an improved Erie Canal, it is estimated that on an average all classes of freight other than grain can be transferred at a rate of 25 cents per ton. In the comparisons made hereinafter this rate is only applied to the estimated west-bound package freight transferred at Buffalo. All east-bound freight is reduced to wheat, on which comparisons are based.

COAL AND ORE BUSINESS OF THE GREAT LAKES.

In investigating into certain features of the transportation business on the lakes with reference to their bearings on the ship-canal problem a study was made of the coal and ore business, and particularly into the methods and cost of handling same at lower lake ports.

The tonnage of coal and ore transported on the lakes is very great, and it is believed that the results obtained by the investigation will be of interest and use in the full consideration of the ship-canal problem. The business consists in the carriage of iron ore from the Michigan and Minnesota mines to the ports of northern Ohio, Pennsylvania, and western New York, returning with coal from the mines of Pennsylvania, Ohio, and West Virginia.

COAL.

The following table gives the amount of coal shipped from various Lake Erie ports, including coal supplied to vessels for fuel during the years 1893, 1894, and 1895:

TABLE No. 15.—*The Lake Erie coal trade.*

Lake ports.	1893.	1894.	1895.	1896.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Buffalo, N. Y	2,703,673	2,485,255	2,620,768	3,565,622
Erie, Pa	625,023	711,928	727,184	677,095
Conneaut, Ohio	23,184	89,023	166,073	291,178
Ashtabula, Ohio	787,653	669,735	998,772	1,037,242
Fairport, Ohio	234,089	300,923	325,064	410,307
Cleveland, Ohio	1,512,308	997,513	1,055,480	1,576,583
Lorain, Ohio	526,405	303,690	277,660	137,235
Huron, Ohio	227,444	213,595	208,000	257,059
Sandusky, Ohio	195,276	261,363	223,134	281,351
Toledo, Ohio	938,533	836,232	716,099	707,655
Total	7,773,588	6,869,257	7,318,234	8,941,327

The Buffalo shipments are nearly all anthracite; Erie shipments, part anthracite and part bituminous; and the shipments from other ports, all bituminous. Conneaut did not ship any coal by lake until 1893, when shipments reached 23,184 tons.

HANDLING COAL.

For several years past lake shipments of coal from the Pittsburg, Hocking Valley, and West Virginia districts have averaged about 3,000,000 tons each season. This coal is of a high grade, suitable for fuel and steam purposes and for the manufacture of gas and coke, and shippers have tried various methods of loading it into vessels without damage from breakage.

As far back as twenty years ago attempts were made to handle coal on the lakes by means of chutes, and on the Cleveland docks of the Cleveland, Cincinnati, Chicago and St. Louis Railway, popularly known as the "Big Four," as much as $65,000 was expended on a single plant that had to be abandoned soon afterwards on account of the damage to the coal in handling it. With the advent of big steel steamers and wooden boats of largely increased capacity, rotary derricks, handling at first buckets of ordinary size, and later on buckets of 5 tons capacity, were introduced in the trade, but even with these the vessels were delayed two to four days in loading. Eight or ten men were employed shoveling into buckets from a car 3 feet deep, and there was still the disadvantage of breakage in the coal. The effort, therefore, has been to secure dispatch for vessels approaching that obtained in the ore trade, where ships of 3,000 to 5,000 tons are loaded in a few hours, and at the same time avoid loss in the commercial value of the coal by overcoming, as far as possible, the breakage referred to.

To meet these requirements a number of car-dumping machines have been designed. At present there are four types in practical operation, and much of the bituminous coal shipped by lake from Lake Erie ports, such as Cleveland, Ashtabula, and Fairport, is now handled by car-dumping machines. These machines are known respectively as the Long, McMyler side dump, McMyler end dump, and the Brown.

The Long machine is erected upon the Nypano coal dock at Cleveland, just below the Columbus Street Bridge, on the west side of the Cuyahoga River. Two views of this machine are herewith, one with the car just entered and one with the car raised and dumped.

The car dump consists mainly of a large steel-frame cylinder, with an inside diameter of 11 feet and an outside diameter of 16 feet, the length being 40 and the circumference being 52 feet. This is set 28 feet above the level of the dock, but on a level with the company's tracks, one of which runs through the cylinder when the latter is at rest. The coal-laden car is set in the cylinder by means of a switching engine, and by the time the car is detached from the train it is clamped firmly by means of a beam running along the side. This beam acts by hydraulic pressure, and the car is also held rigid by four iron clamps which fall upon the top of the car, and which are firmly held in place by keys fitting in cogs. These clamps act automatically when the cylinder begins to roll. This clamping process is the work of an instant, and by means of a lever worked from the end of the cylinder an engine on the dock level is started. This engine has a cylinder 30 inches in diameter by 19 feet stroke of piston, and a single stroke is all that is required to roll the cylinder up an inclined plane until the inclosed car is nearly turned over, when the coal rolls out compactly into a chute.

When the coal leaves the car the chute is retained in a horizontal position, which prevents the coal from acquiring any momentum, and when filled is lowered slowly, allowing the coal to run gently into the hold. It is claimed that the breakage is less than when coal is handled by being shoveled into buckets and then dumped into the hold by means of revolving steam derricks. Both the cylinder and chute are operated by wire cables.

The Nypano dock, by reason of its general arrangement, is especially well suited to the machine in the matter of car supply. There is ample room for storing 55 loaded cars on the company's dock and twice as many more within reach of the machine. The rapid unloading and consequent quick release of the equipment is a feature much appreciated by the railroad companies, and reacts, in that it enables them to get the coal forward from the mines more rapidly. The machine is economical of operation. Three men are required—these are the engineer, who also serves as fireman, a man to operate the cylinder, and a third to operate the movement of the chute.

In addition there is a dock superintendent and a small clerical force to attend to the weighing and billing of cargoes. The actual operating expense of transferring coal from cars to vessels is not over one-half cent per ton. The machine has a record of unloading five cars in eleven minutes. The steamer *Yale* was loaded here in September, 1895, at the rate of 18 cars an hour. During the season of lake navigation of 1896, there were handled through the Long coal dumping machine, on the Nypano dock at Cleveland, 23,700 cars of coal, or a total of 549,265 net tons. The actual time consumed in the dumping of a car—that is, from the time it is placed in the cylinder until the coal is dumped and the empty car rolled back in position again—is about twenty-five to thirty seconds.

Two McMyler end car dump machines are in operation. One of these is located at Ashtabula, Ohio, on the tracks of the Lake Shore and Michigan Southern Railroad, and is controlled by Pickands, Mather & Co., of Cleveland, Ohio. The other is located at Fairport Harbor, Ohio, on the tracks of the Pittsburg and Western Railroad, and is operated by the Pittsburg, Fairport and Northwestern Dock Company.

There is sent herewith a view of Ashtabula Harbor, showing the McMyler end car dump in position and operation. The view shows the car being hauled up into position for dumping. This view is a good picture of this typical coal and ore lake harbor, and with the trains of coal-laden cars and piles of ore in the distance gives a good idea of the magnitude of the business.

Describing the machine and its operation: It consists of a tilting-plate girder or bridge, supported on a turntable or portable revolving derrick, the whole carried on four heavy car trucks of four wheels each, running on two lines of rails spaced about 20 feet apart between track centers. These tracks are laid along the edge of the wharf and the vessel to be loaded is moved alongside, so that the short arm of the tilting bridge is over the vessel's hatches.

Opposite the dock and perpendicular to it several lines of railway track are laid. At Ashtabula six double lines of track are laid, spaced about the same as the vessel hatches. In operation the vessel is placed so that the hatches are opposite the tracks, or nearly so, and the machine is moved to the hatch into which it is desired to load. A 1¼-inch steel cable is hooked into the drawhead of the car and the car is pulled up to the upper or shorter end of the bridge, which is so constructed as to form a bumper, against which the end of the car rests when tilted. The bridge is then tilted, and at the same time the end board of the loaded car is automatically withdrawn and the coal flows out through a discharging chute and is concentrated in a telescopic trough or spout, which may be lowered to within a few feet of the bottom of the vessel when the work of loading begins at any of the several hatches, or only at the surface of the coal itself after the bottom of the vessel is covered. In double-decked vessels this chute may be lowered to the bottom deck combings. After the load is discharged the bridge is tilted back, the cable is detached, and the car is allowed to run down and off the incline to the track provided for empty cars. A loaded car is again taken up, and so the operation continues, the machine moving from one set of tracks to another, and from one hatch to another, as may be required by supplies of loaded cars, or to permit trimming the cargo. Through this latter operation a great saving in time is gained, as occasion for shifting a vessel while the work of loading goes on is very rare. Not only can the machine be moved laterally in either direction with a car on the bridge or platform, but it may be swung at the same time to avoid spars or other obstructions on a vessel. One of the best features of the machine is its adaptability to the kind of railway car in general use in the bituminous coal trade. The only change required is that of fitting sliding end boards in the cars, which can be done at a trifling cost.

The number of sets of surface tracks for loaded and unloaded cars depends entirely upon the number of cars it is desired the plant shall handle, and as the entire transferring apparatus is arranged to move along the dock line it can therefore be made to accommodate any desired number of tracks and length of dock.

The bridge is tilted by a hydraulic ram 18¾ inches in diameter mounted on trunnions, and it rights itself by gravity, the ram forming a safe and efficient brake. From a hydraulic accumulator, having at one end a hydraulic piston and at the other a steam piston of ten times the area, pressure water is taken to operate the friction clutches, by means of which one of the operators controls the entire machine. Only four men in all are required to operate the machine. These are the engineer, who handles the whole plant, a fireman, a man on the bridge, and a man to attach the cable to the cars so that they can be drawn up on the bridge. Several records as high as 15 cars per hour unloaded, or a total of 345 tons, have been made with the apparatus, and steamers of 2,000 to 3,100 tons have been loaded in eight to twelve hours. On August 8, 1894, 3,259 tons of coal were put on board the *Yuma* in twelve hours. From June 27 to August 22, 1894, the machine loaded 29 vessels, handling a total of 59,794 tons, the actual total time consumed being three hundred hours and forty minutes, an average of nearly 200 tons, or 8 cars, per hour. The capacity of the machine is claimed to be 13 cars per hour, or over 3,000 tons per day.

As previously stated, the Pittsburg, Fairport and Northwestern Dock Company operate a McMyler end car dump machine at Fairport, Ohio. This machine handled 349,879 net tons of coal during the season of 1896, at an average cost of about 3 cents per net ton. This expense includes the running expenses of the machine, such as wages of the working force required, fuel, and other incidental charges connected with the operation of the plant. In addition there is an expense for trimming boats, for which this company paid at the rate of 2½ cents per ton during the season of 1896, making the total operating expense of transferring coal from cars to vessels about 5½ cents per net ton.

The Cuddy-Mullen Coal Company operate on their dock at Cleveland, Ohio, a McMyler side dump coal car unloading machine, which is connected with the tracks of the Cleveland and Pittsburg Railroad. Photographs giving a front and side view of this machine are herewith.

The machine consists of an iron tower formed of two bents, securely braced, and connected at the tops by lattice girders. The two front posts of the tower are perpendicular, while the three back posts are inclined. The tower is well braced, both longitudinally and laterally, and forms a very rigid structure. At the bottom, within the confines of the forward part of the tower, a movable platform is located, upon which the loaded cars are run and securely attached. The platform is then raised perpendicularly about 20 feet and then momentarily brought to a rest by the front side, or edge, of the platform coming in contact with a fixed stop. The back part of the platform continues to rise, giving a revolving motion to the platform and load, which is continued until the car is partly inverted. The coal then runs out into a projecting apron, made triangular in form and connected at its outer end with a chute, by means of which the coal is transferred through the hatches into the holds of the vessel. After a car is unloaded the platform is righted and lowered and the empty car run off to the storage tracks. Two hundred and ninety-eight cars have been unloaded in twenty-four hours, indicating an hourly capacity of about 15 cars, or 375 tons. The cost of the machine is $35,000. The charge for unloading coal is 10 cents per ton.

The Brown Hoisting and Conveying Machine Company, of Cleveland, Ohio, has just finished a car-dumping machine, which is erected on the dock of the Cleveland and Pittsburg Railroad Company at Cleveland, Ohio. Four other machines of this kind—two at Toledo, one at Huron, and one at Ashtabula—are well along toward completion, and it is expected that they will be ready for the opening of navigation, as their completion depends mainly upon minor alterations that may be made as a result of tests now being conducted with the Cleveland machine. The main feature of the machine is a revolving platform operated by hydraulic power. The loaded car is run upon this platform, securely fastened, when the platform and load is revolved until the car is partly inverted, allowing the coal to run into an apron provided at its outer edge with six chutes having flaps or doors which open automatically, allowing the coal to flow into an equal number of large bottom dump buckets. These buckets rest upon an especially constructed car running upon a track laid parallel with the loading track. The car containing the buckets is then run to the right or left, as the requirements may be, and each bucket is hoisted in turn by an elevated crane (of which there are two), carried over the vessel's hatches and lowered into the hold, and automatically unloaded.

The especial claim made for this machine is the minimum breakage done the coal during the process of transferring and unloading. As the machine is yet in its experimental stage, no figures as to the cost of transferring coal from cars to vessels are available.

Another method of unloading coal is in operation on the docks of the Pennsylvania Company at Ashtabula, Ohio. The plant consists of an elevated trestle provided with two large pockets, into which the coal is unloaded from cars, hopper-bottom cars being especially adapted to the arrangement. By means of sliding doors the coal is allowed to run into large iron cylindrical-shaped buckets. These buckets are then swung over the vessel's hatches and the contents unloaded by means of a detachable bottom.

The following table gives the average rates for transporting bituminous coal, in cents per net ton, from Ohio ports to ports named:

TABLE No. 16.

Year.	Milwaukee.	Escanaba.	Duluth.	Green Bay.	Manitowoc.
1885	63	51	49	....	....
1886	83	60	78	....	....
1887	106	72	89	....	....
1888	84	61	66	....	....
1889	54	49	52	....	....
1890	64	45	49	....	....
1891	61	52	49	....	....
1892	58	43	48	55	49
1893	48	40	38	50	41
1894	48½	39	37½	49½	48
1895	54	39	36½	50	51
1896	33½	27	29½	32½	44

Chicago rate about the same as Milwaukee. Coal of all kinds shipped in net tons and handled without charge to the vessel.

The business of handling the anthracite coal at Buffalo is on a different footing from that of handling bituminous coal at other ports. The coal is brought from the mines in cars of all sorts and unloaded at coal docks located alongside the navigable channels of the harbor.

The coal dock consists of a high wooden trestle extending along and parallel with the channel. It is composed essentially of a number of bents spaced at regular intervals, the intervening spaces being utilized for the coal pockets. Adjacent to the dock are a number of tracks for the storage of loaded and empty cars, these tracks having connection with the loading dock. Loaded cars are pushed by a locomotive to the foot of an incline located at the rear of the trestle and extending nearly the whole length of the same. The cars are then hauled singly to the top of the trestle by means of a wire rope or cable operated by a stationary engine. There are three parallel tracks laid on the top of the trestle, and loaded cars can be run onto any one of these tracks. The tracks are on a descending grade, allowing the cars to run by gravity. There are in the trestle generally 40 to 50 storage pockets. The capacity of each pocket is about 100 tons. The unloading of the cars is accomplished by different means, depending upon the character of the car. Drop-bottom cars are the most readily unloaded, it merely requiring the opening of the drop doors in the bottom of the car to allow the coal to run out of the car and to pass between the rails into the pockets below. Box cars have to be unloaded by shoveling the coal out by hand.

After the contents of the loaded cars is deposited in the pockets the empty cars are allowed to drift to the lower end of the trestle and then they are taken to the storage yards.

Such a coal dock can handle about 3,000 to 7,000 tons of coal per day. It requires about three hours to load a vessel of 4,000 tons capacity. At one of the great coal trestles the following information was secured: The force needed to operate such a plant consists of a foreman, engineer, fireman, bookkeeper, assistant bookkeeper, trestle clerk, weigh master, and errand boy. These men constitute the regular force, and are employed by the month. The wages for the season aggregate about $4,400. In addition to the above, from 5 to 10 brakemen are employed, who are paid by the day. They receive $1.75 per day. The number of brakemen needed varies with the shipments of coal; about 6 are needed for four months of the season and about 9 for the other four months.

After the cars are placed over the pockets the unloading is done by contract. The prices paid for this work are as follows:

For unloading—		Cents.
Hopper-bottom cars	each..	20
Flat cars	do...	40
Box cars	do...	40

The rate for unloading box cars was formerly 60 cents per car. During the season of 1896 hopper and gondola cars were handled exclusively.

For trimming coal in vessels the price paid per ton is 3 cents. This includes the unloading from the coal pockets. The number of gross tons of coal (anthracite) shipped by lake from this dock during the season of 1896 was 270,930. The cost of handling the same from the cars to vessels was 11.34 cents. This covers all expenses, including dock rental, office expenses, etc., except the salary of the sales agent. Excluding the item of dock rental, the total expense of handling coal was 8.51 cents.

The following table gives the ruling rates of freight, in cents per net ton, free in and out, on anthracite coal shipped by lake from Buffalo to the ports named during the season of 1896. The dates show when the changes occurred.

TABLE NO. 17.

Date.	Chicago.	Milwaukee.	Duluth.	Toledo.	Green Bay.	Gladstone.	Ashland.
1896.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
April 25	40	40	25	25	....	....	....
May 16	50	45	25	25	....	25	25
May 30	60	55	25	25	55	....	....
June 13	50	45	30	25	45	....	25
July 11	40	35	25	25	40	....	25
July 18	30	30	25	25	40	....	....
August 1	25	25	25	25	25	25	....
August 8	20	20	20	20	....	....	....
October 10	20	20	20	25	30	20	....
October 17	30	30	20	25	40	30	....
November 21	40	40	30	25	....	30	20
November 28	60	60	50	30	....	50	50

The following table gives the highest, lowest, and average rates of freight on anthracite coal from Buffalo to the lake ports named for the last five years:

TABLE NO. 18.

	1896.			1895.			1894.			1893.			1892.		
	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	Average.
Chicago	60	20	39	90	30	56	75	25	47	60	25	45	75	40	56
Milwaukee	60	20	37	85	30	53	...	...	...	...	...	...	...	...	...
Duluth	50	20	27	30	15	25	35	15	25	50	15	28	100	20	33
Toledo	30	20	25	50	25	28	25	25	25	30	20	28	40	25	27

IRON ORE BUSINESS.

The following tables give, first, the shipments of ore from the various ore-shipping ports of the upper lakes, and second, the receipts of ore at lower lake ports:

TABLE No. 19.—*Lake shipments of iron ore.*

[Gross tons.]

Ports.	1892.	1893.	1894.	1895.	1896.
Escanaba	4,010,585	2,048,981	1,644,770	2,860,172	2,321,928
Marquette	1,026,338	1,086,934	1,424,856	1,079,485	1,578,600
Ashland	2,223,683	1,117,524	1,738,590	2,350,219	1,566,336
Two Harbors	1,165,076	903,329	1,373,253	2,118.156	1,818,992
Gladstone	115,386	203,585	79,108	109,211	220,888
Superior	4,245	80,273	....	117,884	167,245
Duluth	....	440,292	1,369,252	1,598,783	1,988,932
Total by lake	8,545,313	5,880,918	7,629,829	10,233,910	9,657,921
Total by rail	528,030	178,037	118,293	195,127	290,410
Total shipments	9,073,343	6,058,955	7,748,122	10,429,037	9,948,331

TABLE No. 20.—*Receipts of iron ore at lower lake ports.*

[Gross tons.]

Ports.	1892.	1893.	1894.	1895.	1896.
Toledo	139,987	145,515	158,384	260,730	301,794
Sandusky	49,736	4,464	23,043	12,861	58,667
Huron	65,000	137,700	172,775	146,442	226,515
Lorain	190,400	165,667	150,424	214,219	191,445
Cleveland	1,950,224	1,260,716	1,624,573	2,312,370	2,318,170
Fairport	866,611	792,517	976,222	914,617	941,446
Ashtabula	2,555,416	1,845,738	1,987,722	2,474,791	2,272,822
Conneaut	1,130	203,207	237,905	244,967	327,623
Erie	645,230	469,299	624,438	811,989	847,849
Buffalo and Tonawanda*	197,000	808,238	395,839	719,742	545,101
Total	6,660,784	5,333,061	6,350,825	8,112,228	8,026,432

* Buffalo alone to 1893.

Freight rates, 1896.

From Duluth to Buffalo:
- Highest $1.10
- Lowest .... .60

From Escanaba to Buffalo:
- Highest .... .75
- Lowest .... .40

It will be noticed that there is a difference of 1,631.489 tons in the shipments from upper lake ports and receipts at Lake Erie ports for the year 1896. This ore represents the ore that was moved by water to South Chicago and other points on Lake Michigan, as well as a small amount that is moved by water to Detroit each year. In 1895 the shipments to South Chicago and other points just referred to aggregated 2,121,682 tons, or practically half a million tons more than the shipments of this kind during 1896.

HANDLING IRON ORE.

The iron ore received by lake at the various coal ports is handled by means of the Brown hoisting and conveying machine, the King ore hoist and conveyor, and the McMyler revolving steam derrick. The Brown and King machines hoist the ore from the hold of the vessels and transfer the same direct to cars or to stock piles, while the McMyler derricks only load from vessel to car, and are not adapted for transferring and storing ore. The conspicuous elements of the Brown and King machines are the elevated tramway spanning the dumping ground and connecting it with the vessel, cars, or other transportation vehicle, the trolley or carriage traversing the same, and the system of mechanism by which the whole is operated and controlled.

The first Brown machines were cable tramways, but latterly these have been superseded by the bridge tramways.

The Brown machines with bridge tramways are generally built in plants of three or four bridges, two of the bridges supported at their back ends upon a double back pier, the other bridge or bridges being supported singly on a single back pier. An illustration of this machine is herewith.

An engine and boiler house is erected on the double back pier, and contains the boiler and three or four hoisting engines for the three or four bridges, as the case may be. The double back pier also supports, near its top, a covered platform, from which the operators can overlook the dock and control and operate the engines and hoisting machinery. Each bridge is supported in front by an independent pier, which permits the front to be skewed or moved sideways to suit the hatchways of a vessel without moving the rear end, the bridges being hung to the piers with hinged connections for this purpose. The front piers are mounted on wheels and move on a track of a single line of rails; the back piers are on wheels moving on a track of two rails. All the bridges lately constructed are built of iron, except the cross beams and track stringers, which are of wood. The piers are made of wood, thoroughly braced with iron or are made entirely of iron, as required.

These machines hoist the buckets of ore from the vessel, convey it to any point desired on the tramway, and automatically dump the material on the dock or lower the bucket to dock or cars below, as may be required. They will equally well reverse the process, i. e., take the bucket from the dock or car, convey it to the vessel, and lower and dump the contents into the hold; also take from any point under the bridge and deliver it to any other point under the bridge.

Most of the new plants are being made of the cantilever form, with an extension or overhang 92 feet beyond the back pier. The hinged projection over the vessel is 34 feet. The clear space proper is 180 feet, making a total length of tramway of 306 feet. The above description is particularly applicable to the Brown hoist.

The ore hoist and conveyor built by the King Bridge Company, of Cleveland, Ohio, on the docks of the Pittsburg, Youngstown and Ashtabula Railway Company, at Ashtabula, Ohio, is described as follows:

The hoists are built entirely of wrought and cast steel, and are arranged in pairs—that is, two bridges have one support in common at the rear, designated as the rear tower, while there is a separate support or leg at the front for each bridge. All of the towers are supported on wheels, placed on substantial tracks, consisting of two rails at the rear and one in front. The moving of the plant from one point to another is done by steam power at the rear and at the front by means of hand gearing. The bridges are hinged to each side at the top of the rear tower, and at the top of the front tower they are hung by means of adjustable connections. This mode of attachment allows the bridge or projecting apron, without being strained in the least, to be operated directly from the hatchway of a vessel without moving the whole machine.

The principal dimensions of the machine are 180 feet between the towers, with 88 feet cantilevers and 34 feet apron on front tower, which can be raised and lowered by power at will, so as not to interfere with the masts of vessels when they are taking position in front of the plant. There is a clear space under the bridges from top of dock of about 30 feet, which gives ample room for storage purposes, providing it is not convenient to unload a vessel directly into the cars. The bridges are on a grade, to increase the storage capacity of the dock.

The entire purpose of all these different machines is to hoist and convey the ore after it is loaded into buckets. The buckets are made of iron or steel; they have a capacity of 17 cubic feet, containing a gross ton of light, soft ore, a size that goes readily through the hatches, and which can be easily handled by the men, as each bucket is mounted on wheels. The buckets are filled or loaded by manual labor, this work generally being done by contract. The force employed works in gangs of 21 men, 7 men to each hatch, under the direction of an overseer. This allotment of labor is predicated on the use of a machine having three bridges or legs. When more machines are used, this force is doubled, trebled, etc., as the case may be.

The time for unloading a vessel is mainly dependent on the force of shovelers employed and the consequent number of hatches worked.

It is not unlikely that the present method of filling buckets by hand will be supplanted by some mechanical appliance which would greatly augment the speed of unloading and greatly reduce the cost of the same. Automatic "grab buckets" have been used since November, 1894, on the Southern Pacific Railway docks at Oakland, Cal., for unloading coal with good results. At some of the upper lake ports apparatus with automatic grab buckets is also in use for unloading coal. Experiments only would demonstrate whether this method is applicable for unloading iron ore, but it seems as if there could be little doubt about it.

The price paid during 1896 at various Lake Erie ports for loading iron ore into buckets varied from 9 to 11 cents per gross ton. The rate at Fairport and Ashtabula was 9½ cents. To operate a hoist with three legs, a force of four men is required; one engineer, who also acts as fireman, and three operators, one for each bridge or leg. The wages paid the engineer range from \$2 to \$3 per day, while the operators receive \$1.75 per day each. The cost of handling the ore by the machine is from seven-tenths of a cent to 1 cent per ton. In addition, there is a charge for trimming the cars and for picking up iron ore accidentally dropped by the machine. The usual rate paid for this work is 20 cents per car, or approximately 1 cent per ton. For the items stated, the total cost of transferring iron ore from vessels to cars will average 12 cents per ton.

The Pennsylvania and Lake Erie Dock Company, a corporation controlling the ore docks at Fairport, Ohio, operates five Brown hoisting machines, three of which have three bridges each and the other two of which have four bridges each, making a total of seventeen bridges or legs. The four-bridge machines only are supplied with cantilevers. In addition, this company owns 32 McMyler revolving steam derricks, eight of which run on a gauge of 4 feet 8½ inches, and 24 on a gauge of about 15 feet. These derricks are only suitable for unloading from vessels into cars and from stock piles into cars. When unloading ore from vessel into stock pile, the Brown hoisting machines are used.

Much of the stock is loaded into cars during the winter season. The prices paid for this work are as follows:

Cars of 20 tons capacity	$1.00
Cars of 25 tons capacity	1.05
Cars of 30 tons capacity	1.15

or ranging from about 5 to 4 cents per ton. The receipts of iron ore at Fairport for the season of 1896 were 941,446 gross tons.

The steamer *Coralia*, having a cargo of 4,652 gross tons of iron ore, was unloaded at this port in ten hours and five minutes. The plant employed was 1 Brown hoisting machine, with 4 bridges, and 8 McMyler revolving steam derricks. The loading force in the hold of the vessel consisted of 84 men, working in 12 hatches. This would indicate a movement of about 5½ tons per man per hour. The following table shows the amount of work done at other times and ports:

TABLE NO. 21.

Place.	Date.	Steamer.	Gross tons.	Working time.	Number of hatches.	Work per man per hour.
				Hours.		*Tons.*
Erie, Pa	Aug. 31, 1893	Pathfinder	2,671	6	8	7.95
South Chicago, Ill	June 21, 1894	Manhattan	2,048	10	4	7.32
Do	Aug. 29, 1894	Arthur Orr	2,382	9	5	7.56
Do	Sept. 7, 1894	Specular	1,747	8	4	7.79
Fairport, Ohio	June 25, 1894	Thomas Maytham	2,596	15	4	6.18
Cleveland, Ohio	July 4, 1894	Kearsarge	3,718	12	6	7.37
Do	Aug. 16, 1894	Manola	2,361	11	6	5.11

PHILADELPHIA AND ERIE RAILROAD DOCKS AT ERIE.

The receipts of iron ore at this place for the season of 1895 and 1896 were, respectively, 250,000 and 180,000 gross tons. This company uses McMyler revolving steam derricks for unloading. They also use some wooden conveyors for transferring and storing ore. The price paid for shoveling into buckets during 1896 was 10 cents per ton. The estimated capacity of each derrick per day of twelve hours is stated to be about 500 tons, and the daily expense about $6, or 1.2 cents per ton, making a total expense of 11.2 cents per ton for transferring iron ore from vessels into cars. The cost of loading from stock pile into cars during the winter months is about 6 cents per ton.

In addition to the already-mentioned machines there is still another plant, known as the Fast Brown Movable Conveying Apparatus, claimed to be especially adapted to the rapid handling of ore into cars. It was built by the Brown Hoist and Conveying Machine Company of Cleveland, Ohio, and is used on the Cleveland and Pittsburg Railroad Company's dock at Cleveland, Ohio. An illustration of this machine is herewith.

It contains all the essential features and characteristics of the cable and bridge tramways, with the exception that its sole purpose is the direct transfer of iron ore from vessels to cars, and is not adapted for the storing of ore. With this purpose in view, the piers are located closer together. The distance is sufficient for the passage of two tracks between them. The piers are erected on a wheeled base, which can be moved to the extent of the tracks. The space between the piers is spanned by a rigid tramway, on the top of which the grooved wheels of the carriage of the conveying machine travel. There is a tramway projection at the vessel end of 30 feet, and a cantilever projection on the railroad or loading side of 33 feet. The plant comprises two machines of 4 tramways each, making 8 tramways in all. Including the cantilever extensions, the tramways span five railway tracks in all, making it possible to load cars on that number of tracks at one time. It is claimed that the plant has a capacity of 4,200 to 4,500 tons per day of twelve hours. To do the work the following force is required:

2 engineers, at $2 per day	$4.00
8 operators, at $1.75 per day	14.00
4½ tons fuel, at $2 per ton	9.00
Trimming cars (estimated)	18.00
	45.00

making the cost of ore handled by the plant 1 cent per ton. To this is added the cost of shoveling, which is 10 cents per ton, making the total charge 11 cents. The force employed shoveling is 56 men, working 7 men to each tramway. In addition, there are 3 overseers, who exercise a general oversight over the shovelers. The recompense of these overseers is included in the charge of 10 cents.

The movement of the empty and loaded cars is controlled by the railroad companies, which furnish suitable switching engines and crews for this purpose. This expense is independent of the unloading of vessels and loading of cars, and is one of the terminal charges incident to railroad operation, and is included in the freight rate.

COST OF UNLOADING IRON ORE AT LEHIGH VALLEY RAILROAD DOCKS, BUFFALO, N. Y.

This company uses two Brown hoist and conveying machines, having three bridges each, or six in all. For shoveling the ore into buckets hired labor is employed, this work not being done by contract, as is the case at Cleveland, Ashtabula, Fairport, and other ports.

The usual force employed in the hold of the vessel for loading buckets is 48 laborers, being 8 laborers to one hatchway. To operate the machines 9 men are required, 1 machinist having general charge, 2 firemen and 6 operators or lever men. The wages paid are as follows: Machinist, $3 per day; firemen, $1.75 per day; operators, $1.75 per day. The laborers received 25 cents an hour.

Sixty-one thousand two hundred and twenty-two gross tons of iron ore and 609 gross tons of steel blooms and billets, a total of 61,831 tons, were unloaded at this dock from thirty vessels during the season of 1896. In addition, there were 10,642 gross tons of iron ore loaded into cars from the stock pile, making a total of 72,473 tons of material handled during the period stated. The cost of handling this material, exclusive of the expense of operating the Brown hoist, was $5,556.13, or 7.67 cents per ton. The cost of operating the hoisting machinery from April 1 to January 1, 1897, was $2,928.76, or 4.04 cents per ton, an excessive price, due to the small amount of ore handled.

LAKE RATES FOR ORE.

Just before the opening of navigation for the season of 1896 ore dealers made contracts with vessel owners for quite a large amount of tonnage, running throughout the season, at $1.05 per ton from the head of Lake Superior, 95 cents from Marquette, and 70 cents from Escanaba to Ohio ports. It was fortunate for the vessel owners that these contracts were made, as the average rate earned by vessels which had no contracts was only 77 cents per ton from the head of Lake Superior, 66 cents from Marquette, and 52 cents from Escanaba.

Out of the amounts received for carrying iron ore the vessels pay the cost of trimming at loading ports, which, in 1896, ranged from 2½ to 3 cents per ton, and they are also charged at discharging ports from 15 to 16 cents for unloading, making a maximum charge of 19 cents to be deducted from the carrying rates received.

MILITARY AND COMMERCIAL CONSIDERATIONS.

A ship canal from the Great Lakes to the Hudson and the enormous expenditures necessary therefor can alone be justified by the military advantages conferred by it or the commercial advantages, or both.

MILITARY ASPECT.

I am unable to believe that such a ship canal is needed for the military advantages which it would confer. It would only be of use in the event of a war with Great Britain for the passage of our war ships from the sea to the Great Lakes. In the event of such a war, it is inconceivable that any of our war ships would be allowed to leave the seacoast for service on the lakes. All that we have, and many more in fact, would be needed for the protection of our seaports and for aggressive operations against the navy and commerce of Great Britain on the high seas. If proper and comparatively inexpensive precautions are taken, the Great Lakes will, in the event of such a war, need no naval assistance from the seacoast. An English naval force could only reach the Great Lakes by way of the St. Lawrence River and its canals, which latter limit the size of the vessels to those of a small class. These St. Lawrence canals lie along and near our border and within easy reach, and in some cases they can be enfiladed, and even taken in reverse, from good artillery positions on our side of the river. The difficulties of a hostile movement up the river to Lake Ontario would be very great if opposed with vigor, and might easily be rendered impossible by the destruction of some of the canals. Arrived in Lake Ontario, such a hostile force would have acccomplished little, as the great American cities and commerce are upon the upper lakes, to reach which the Welland Canal would have to be passed. This canal is within easy reach of our borders, and subject to being assailed and destroyed by a land force or an improvised naval force on Lake Erie. Upon the upper lakes—Erie, Huron, Michigan, and Superior—the United States has a vast merchant marine, eight times greater in tonnage than the merchant marine of Canada and vastly excelling in individual ships. If the Government, as has been suggested and recommended, would provide at the different lake ports stores of arms and war munitions suitable for arming our best lake vessels, and arrange for taking possession of and arming and manning these vessels quickly and effectively, an American naval force could be improvised upon these lakes which would greatly preponderate over any which could be improvised against it or brought to oppose it.

The money expense to which the American Government need go to provide these arms and munitions and place the upper lakes in a satisfactory condition of defense would be insignificant in comparison with the cost of a ship canal; the cost of one or two locks would be sufficient.

As long as the commerce on the lakes is so preponderatingly in the hands of Americans, a ship canal is not needed for military purposes. The construction of such a canal, opening as it would the lakes to the merchant shipping of the world, would have the effect of reducing the preponderance of American shipping, thus tending to reduce our present undeveloped military superiority. This would be particularly the case with a ship canal built down the St. Lawrence to Montreal, which would permit and encourage the building up of Canadian commerce at the expense of American commerce.

A ship canal must, therefore, be justified, if at all, by the commercial advantages which it will give above the present means of transport, or other and less costly means which may be supplied in the future.

COMMERCIAL ASPECTS.

To build a ship canal from the Great Lakes to the ocean by any of the possible routes herein mentioned entirely within the United States to accommodate vessels 500 feet long, 50 feet broad, and 20 feet draft would, at a rough estimate, cost $200,000,000. This cost will depend to a very great extent upon the action of the State of New York in regard to its canals, feeders, reservoirs, etc. To maintain such a canal, keep it and all its structures in repair, operate locks, bridges, etc., maintain river channels, reservoirs, feeders, etc., would cost, at a rough estimate, $2,000,000 per year.

The amount of traffic which can reasonably be considered as tributary to a ship canal is, as stated in another portion of this report, about 24,000,000 tons annually. To justify the ship canal from a business standpoint, the saving on the transportation of this tonnage over the cost of its transportation by existing means and methods, or those which may reasonably be expected to exist, must at least equal the interest on the cost of the canal plus the annual cost of maintenance and operation.

Assuming an interest charge of 3 per cent, this would amount to $8,000,000, which may be said to represent the annual cost of a ship canal from the Great Lakes to the navigable waters of the Hudson River. This requires a saving of 33⅓ cents on each ton of freight, or if wheat is considered, a saving of 1 cent per bushel.

Will a ship canal effect this saving over the cost of transportation by all rail and by the present lake and canal routes from the upper lake ports to New York, including cost of transfer at Buffalo? Will it effect it over the cost of transportation, including transfer, when the improvements now under way on the Erie Canal are completed? Will it effect the required saving over the cost of transportation by an enlarged Erie Canal, which will permit the use of barges of a similar capacity to the barges now so extensively used in the coastwise coal trade?

To answer all these questions intelligently requires a comparative study of the cost of transportation by rail and lake, and by canal, and from the facts secured to determine the probable cost of transportation by such canal and by the Erie Canal as it is now being improved and as it may be further improved.

Grain and grain products will continue to furnish the chief item of freight between the lakes and the sea, and so the comparative study will be made on the basis of a bushel of wheat. The following table of freight rates and transfer charges has been prepared with much care:

TABLE NO. 22.—*Average freight charges from Chicago to New York per bushel of wheat.*

Year.	By lake and canal, including transfer charges at Buffalo.	By lake and rail, including transfer charges at Buffalo.	By all rail.	Lake freights. Total freight rate, Chicago to Buffalo, including shoveling at Buffalo.	Lake freights. Shoveling charge at Buffalo.	Lake freights. Net freight rate, by lake, Chicago to Buffalo.	Elevating and storage at Buffalo, receiving, weighing, and discharging.	Canal freights. Canal, Buffalo to New York, including tolls and trimming at Buffalo and shoveling at New York.	Canal freights. Canal tolls.	Canal freights. Trimming charge at Buffalo.	Canal freights. Shoveling charge at New York.	Canal freights. Net rate for canal transportation.	Elevating and storage at New York, receiving, weighing, and discharging.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*
1874	15.39	16.9	28.7	4.08	0.40	3.68	1.25	10.11	3.10	0.10	(*a*)	(*a*)	(*a*)
1875	12.43	14.6	24.1	3.42	0.40	3.02	1.00	8.01	2.07	0.10	(*a*)	(*a*)	(*a*)
1876	10.58	11.8	16.5	2.90	0.35	2.55	1.00	6.68	2.07	0.10	(*a*)	(*a*)	(*a*)
1877	12.24	15.8	20.3	3.72	0.32	3.40	1.00	7.52	1.03	0.10	(*a*)	(*a*)	(*a*)
1878	10.15	11.4	17.7	3.07	0.32	2.75	1.00	6.08	1.03	0.10	(*a*)	(*a*)	(*a*)
1879	12.60	13.3	17.8	4.74	0.37	4.37	1.00	6.86	1.03	0.10	(*a*)	(*a*)	(*a*)
1880	13.27	15.7	19.9	5.76	0.40	5.36	1.00	6.51	1.03	0.11	(*a*)	(*a*)	(*a*)
1881	9.065	10.4	14.4	3.44	0.42	3.02	0.875	4.75	1.03	0.125	(*a*)	(*a*)	(*a*)
1882	8.765	10.9	14.6	2.50	0.42	2.08	0.875	5.39	1.03	0.125	(*a*)	(*a*)	(*a*)
1883	9.245	11.5	16.5	3.41	0.37	3.04	0.875	4.96	(*b*)	0.125	(*a*)	(*a*)	(*a*)
1884	7.185	9.55	13.12	2.18	0.38	1.80	0.875	4.13	(*b*)	0.125	(*a*)	(*a*)	(*a*)
1885	6.745	9.02	14.00	2.02	0.37	1.65	0.875	3.85	(*b*)	0.125	(*a*)	(*a*)	(*a*)
1886	9.585	12.00	16.50	3.68	0.37	3.31	0.875	5.03	(*b*)	0.125	(*a*)	(*a*)	(*a*)
1887	9.385	12.00	15.74	4.13	0.40	3.73	0.875	4.38	(*b*)	0.125	(*a*)	(*a*)	(*a*)
1888	6.805	11.00	14.50	2.56	0.40	2.16	0.875	3.37	(*b*)	0.125	0.15	3.095	0.625
1889	7.765	8.70	15.00	2.51	0.40	2.11	0.875	4.38	(*b*)	0.125	0.15	4.105	0.625
1890	6.725	8.50	14.31	1.96	0.40	1.56	0.875	3.89	(*b*)	0.125	0.15	3.615	0.625
1891	6.835	8.53	15.00	2.38	0.40	1.98	0.875	3.58	(*b*)	0.125	0.15	3.305	0.625
1892	6.485	7.55	14.23	2.19	0.40	1.79	0.875	3.42	(*b*)	0.125	0.15	3.145	0.625
1893	7.185	8.44	14.70	1.66	0.40	1.26	0.875	4.65	(*b*)	0.125	0.15	4.375	0.625
1894	5.815	7.00	12.88	1.27	0.40	0.87	0.875	3.17	(*b*)	0.125	0.15	2.895	0.625
1895	4.985	*c*5.90	*c*10.00	1.92	0.35	1.57	0.875	2.19	(*b*)	0.075	0.15	1.965	0.625
1896	6.325	6.75	12.00	1.70	0.35	1.35	0.875	3.75	(*b*)	0.075	0.15	3.525	0.625
Average for last five years	6.059	7.128	12.762	1.748	0.38	1.368	0.875	3.486	......	0.105	0.15	3.181	0.625

a Data uncertain.
b Tolls abolished.
c Actual average rate. Officially published tariffs higher, and which were cut to discredit canal.

EXPLANATION OF TABLE.

This table shows the average freight charges on a bushel of wheat by various modes of transportation from Chicago to New York during the years 1874 to 1896, both inclusive, and certain details and divisions thereof.

Column 2 gives the freight rate by lake from Chicago to Buffalo, and thence by canal from Buffalo to New York, and includes the ordinary transfer charge at Buffalo.

The transfer charge at Buffalo includes the items in columns 6, 8, and 11, shoveling, elevating, and storing and trimming, amounting all told to $1\frac{3}{10}$ cents per bushel, or at the rate of $43\frac{1}{3}$ cents per ton.

The transfer charges on grain are fixed arbitrarily by the Western Elevating Association of Buffalo, a combination controlling all the elevators, except a few small ones. The transfer charges at Buffalo are the source of complaint and dissatisfaction, and there is little doubt that they can be materially reduced and the business still transacted at a profit.

Most of the freight other than lumber originating in upper lake ports and destined for the Seaboard via Buffalo is brought to Buffalo in the regular lines of boats belonging to, and run in connection with, one or the other of the great trunk lines of railway centering at Buffalo. A large part of the lumber coming down the lakes goes by Buffalo to Tonawanda, from which point it is shipped by canal and rail.

The Erie Canal has no terminal facilities and no lines of lake vessels running in connection with canal lines, and so the canal boats as a general rule only get what freight they can pick up in Buffalo and Tonawanda.

Arrived in Buffalo, the one charge which the vessels have to pay is the charge for "shoveling."

SHOVELING.

This work is done under a contract between the Lake Carriers' Association and a private individual.

This grain shoveling consists in feeding the elevator legs after they are inserted through the hatchways into the hold of the vessel.

The elevator legs work in a circumscribed space and do not reach all points of the vessel's hold. To facilitate the rapid unloading of grain, iron scoops similar to road scrapers are employed in the hold to drag the grain to the elevator legs. These scoops are worked by a system of lines and pulleys by means of drums run by steam power, and so arranged as to run forward or backward as the nature of the work demands. Some of the grain, especially that along the sides, can not be reached by the scoops, or steam shovels as they are more generally called, and this grain has to be shoveled toward the elevator legs by hand.

The force employed in the large vessels for shoveling is from 60 to 70 men. On ordinary vessels the force of shovelers consists of from 40 to 50 men.

The capacity of the larger elevators is from 8,000 to 12,000 bushels per hour for each leg, when unloading from large vessels. When loading from elevators into canal boats, the capacity per hour for one spout is about 8,000 bushels.

The charge for shoveling has varied in past years according to the class of vessel, the location of grain in the vessel, and its condition. It was not until 1895 that a definite arrangement for "shoveling" at a fixed price under all conditions and circumstances was entered into. The contractor under this arrangement does all the work of shoveling grain out of vessels of the Lake Carriers' Association at the rate of $3.50 per 1,000 bushels.

Of this $3.50 per 1,000 bushels, $1.50 goes to the Western Elevating Association for the use of the steam shovels or scrapers, which, with the steam power to operate them, are furnished by the elevators themselves. The remaining $2 is divided between the contractor and his men who work in the vessels.

For the season of 1897 the shoveling charge has been reduced to $3.35 per 1,000 bushels, the reduction coming off the shovels, the wages of the men remaining as before.

ELEVATING.

Column 8 of this table gives the cost of handling wheat by elevators at Buffalo. The elevator charges are always paid by the owners of the grain. Most of the grain coming to Buffalo is unloaded into the great elevators and stored until it can be shipped by rail or canal boat; some is transferred directly into cars or canal boats, passing through the elevators without storage. As the operation of elevating the grain out of a vessel proceeds, it is weighed and check weighed. The grain is loaded into canal boats and cars by means of spouts.

The process of elevating, storing, weighing, reelevating, and delivering through spouts to cars or boats is believed to be advantageous to the grain, and particularly so to corn, drying it out somewhat and preventing heating, which is liable to occur to the corn stored in great masses in the steel hulls of the lake vessels, particularly in hot weather.

The Western Elevating Association have since 1881 succeeded in maintaining a rate of seven-eighths of a cent per bushel for elevating, weighing, storing for ten days or less, and discharging grain. The last published rates of the association are as follows:

1896.

THE WESTERN ELEVATING ASSOCIATION OF BUFFALO.

Rates for elevating and storage.—On all sound grain received on and after date, until further notice, the charge for elevating, etc., and storage, will be as follows: For elevating, receiving, weighing, etc., per bushel, five-eighths of 1 cent; for storing each ten days or parts thereof, per bushel, one-quarter cent.

All accrued elevating and storage on grain remaining in store on April 1 in each year must be paid to that date on or before ten days after the opening of canal navigation following, under penalty of one-half cent per bushel additional storage, if not so paid on that date.

Above charge to be paid by the grain. No grain will be received for transfer.

Buffalo, April 15, 1896.

GEO. F. SOWERBY, *President.*
P. G. COOK, JR., *Secretary.*

The statement that "no grain will be received for transfer" implies that no grain will be received for transfer directly from vessels to canal boats, but that in addition to the elevating, receiving, weighing, and discharging rates, also storage rates must be paid, whether the grain merely passes through the elevator or remains in store the full limit of the ten days allowed. This provision brings into the combination any of the floating elevators which could transfer grain directly into canal boats at a very low cost, and compels all grain to pay a minimum elevator charge of seven-eighths of a cent per bushel.

TRIMMING.

Column 11 gives the trimming charge at Buffalo. This charge applies to canal carriers, and the work consists in properly distributing the grain in the hold of the canal boats as it is being delivered by the elevator spouts. The major portion of this work consists in shoveling the grain to points not reached by the spouts.

The charge for this work during the seasons of 1895 and 1896 was 75 cents per 1,000 bushels. The average canal cargo is about 8,000 bushels of wheat, so that the expense for trimming a boat amounts to $6. As previously stated, this charge is included in the freight rate by canal from Buffalo to New York, and is paid by the canal-boat owner. The payment of this trimming charge is not compulsory. The canaler can trim the boat with his own men if he likes, in which case there is nothing to pay.

Column 3 gives the freight rate by lake from Chicago to Buffalo, and thence by rail to New York. The ordinary transfer charges at Buffalo are included in the freight rate given.

Column 4 gives the freight rate by all rail from Chicago to New York.

Column 5 gives the freight rate by lake carriers from Chicago to Buffalo; included in this charge is the expenses for shoveling grain, work incident to the unloading of the vessel.

Column 6 is the shoveling charge, previously described.

Column 7 gives the net freight charge by lake, Chicago to Buffalo, and is obtained by deducting the shoveling charges at Buffalo, as given in column 6, from the total freight rate Chicago to Buffalo, as given in column 5.

Column 8 gives the elevating and storage charges at Buffalo, previously described.

Column 9 gives the freight rate by canal from Buffalo to New York City, and includes the canal tolls shown in column 10 charged by the State of New York during the years 1874 to 1882, both inclusive, trimming charges at Buffalo and shoveling charges at New York.

Column 11 gives the trimming charge at Buffalo, previously explained.

Column 12 gives the shoveling charges at New York during the operation of unloading canal boats. The canaler is obliged to pay the cost of this shoveling. The charge for this work since 1888 has been $1.50 per 1,000 bushels, amounting to $12 for a cargo of 8,000 bushels.

Column 13 gives the net freight rate received for transportation by canal from Buffalo to New York, and is obtained by adding the amounts given in columns 10, 11, and 12 and deducting the result from column 9.

The table shows plainly how much greater the rates are by all rail than by lake and rail or lake and canal. The indications are that the existing water route and competition among the railroads have forced rail rates down as low as they can be made under existing conditions, and that any possible further reduction of water rates would have little effect in reducing rail rates, as the wheat now shipped by rail is that which business necessity compels to be shipped by rail.

The all-rail rates for the years named show a constant reduction, and it is quite certain that changing conditions and improvements will permit of still further reduction in railroad rates. Some of the great items which tend to keep up rail rates are the lighterage and other terminal charges at New York. If some action can be taken to force these exorbitant charges down or to avoid some of them altogether, the railroad rates can be materially reduced. Another very promising possibility of reduction lies in substituting all steel cars for cars built largely of wood. Such cars, it is said, will cost and weigh no more and will carry 5,000 pounds more, and cost less to keep in repair.

The abnormally low rates prevailing in 1895 were said to be due to an effort upon the part of the railroads to reduce the traffic by the Erie Canal to a minimum, and thus discredit it and induce the people of the State to vote against the proposed expenditure of $9,000,000 in canal improvements. To this end they cut prices to very low figures, often to barely enough to pay lighterage charges at New York. The scheme failed, the people voted the money, and in 1896 the rates were advanced.

TRANSFER CHARGES AT BUFFALO.

The transfer charges on grain at Buffalo are believed to be unnecessarily high, and one of the greatest arguments in favor of the ship canal is that it would do away with or materially reduce these charges. If it were certain that these charges were to remain as they are, and that there was no other way to reduce them, the argument would have greatly added force. But this I can not believe. Forces are at work which will tend to render lake and canal commerce more or less independent of this elevating association and compel it to reduce its charges. These forces are: The establishment of lines of steel canal boats which can go to upper lake ports and then through the canal; the improvement of the Erie Canal, now under way, which will allow larger and more remunerative boats to ply on lake and canal; the possible action of the State of New York in building a number of floating elevators for the harbor of Buffalo, by means of which grain could be transferred from vessels to canal boats at a cost of about ½ cent per bushel; the organization of the canal traffic on a business basis to run in connection with lines of steamers, the whole having proper transfer and terminal facilities of its own at Buffalo and New York; the completion of the Canadian Soulanges Canal and other work in progress on the St. Lawrence, which will give at mean stages of the waters a through barge and small-vessel line from the upper lakes to Montreal, of the same capacity throughout as the Welland Canal; and the construction of new and high-class fireproof elevators with new and improved machinery which can afford to do business at a less rate and give better services and more security than can the existing combination.

The adoption of any plan or the carrying out of any improvement which will render it possible to get along without using the ring elevators will certainly bring about a great reduction in transfer charges, and I believe it quite safe to estimate that the near future will see the entire cost of transfer reduced to about three-quarters of a cent per bushel.

For the past five years the average freight rate on a bushel of wheat from Chicago to Buffalo has been 1.75 cents, and the net transportation rate after eliminating the shoveling charge at Buffalo has been 1.37 cents. This does not include insurance on the cargo, which is paid by the grain owner.

For the same period of five years the average grain rate by canal on a bushel of wheat from Buffalo to New York has been 3.43 cents, and, after eliminating the trimming at Buffalo and shoveling at New York, has been 3.18 cents per bushel. This includes insurance on the cargo, which is paid by the canaler.

The rates charged for transportation by lake and canal vary so greatly under different circumstances of supply and demand, and combinations among vessel and railroad managers, that they do not furnish a satisfactory basis for determining the value of a ship canal.

In order to arrive at an approximate estimate of the comparative value of a ship canal, one built by the Niagara-Oswego-Oneida-Mohawk route is assumed, and an effort has been made to approximate the cost of transporting freight through it in large vessels from Buffalo to New York, and in comparison therewith to ascertain the cost of the same transportation by the present Erie Canal, by the Erie Canal as it is now being improved, and by the Erie Canal still further improved to permit the use therein of barges, each carrying 1,000 to 1,500 tons of freight.

At the outset it must be stated that in making the comparison many things have to be assumed, and the determination is in some respects largely a matter of judgment. The comparison is not based entirely upon calculations as to the probable time which it would take a ship or fleet of canal boats to go through locks and canal, lake and river, to New York, or vice versa. These calculations are made, but the comparison is more definitely based upon the actual and probable number of trips which are and can be made during a season of navigation. Into this enters largely the matter of detention in harbors, and this, again, depends greatly upon the organization and business management of the traffic. In all matters I have endeavored to judge the future by the past and the present, giving due consideration to the probabilities of future improvements.

Lake vessels going to New York can never get the quick dispatch that they get at lake harbors. The conditions in this busy and crowded harbor are such that aggravating and serious detentions will occur in unloading and loading a great lake freight carrier, and particularly so with loads of diversified character, which ordinarily are carried.

A fleet of canal boats or barges can be each loaded with a particular kind of freight and scattered about, unloaded, and reloaded and ready to start back, under ordinary circumstances, much cheaper, more conveniently, and sooner than the great ship can if the business is properly managed. The separation of the load into different independent elements would tend to expedite business in the harbor.

The large vessel would ordinarily have loads destined to a number of outgoing ships or consigned to different docks in the harbor, and her upload would also be scattered about in different places. A large proportion of her cargo down and cargo up would generally have to be lightered at large expense of time and money.

The canal boats, on the other hand, could be laid alongside ocean ships and their load transferred thereto at the minimum of expense, or they could go to different docks to discharge and receive loads at a much less expense and in a shorter time than could the large vessels.

The greater rapidity with which a ship can traverse the route between Buffalo and New York is believed to be fully compensated by the greater dispatch which a fleet of canal boats and barges can secure at New York. The large steel ship would have far greater liability to accident and detention in passage through the narrow canal, locks, rivers, and lake channels than would wooden canal boats and barges. This would somewhat compensate for the delay for loading and unloading in Buffalo. Full compensation for this delay it is believed would be made by allowing to the ship one more trip during the season than to a fleet of canal boats or barges.

Of course, it is not intended to assume that any ships would ordinarily do business simply between New York and Buffalo. They would ordinarily go farther to up-lake ports and would make fewer trips. The supposition is made simply with a view to eliminating all elements of lake transportation and getting on common ground for comparison of the costs of transportation.

It is believed that barge or canal-boat navigation would have advantages over the system of fleet navigation now in vogue on the Erie Canal, if the business were managed in the same manner that the coastwise coal-barge transportation business is managed—that is, by a more complete separation of the motive power from the carrying capacity and with no fixed relations between them. It is a study of this coastwise coal-transportation business that has led me to consider its adaptability to the transportation business on the Great Lakes and in a canal connecting them with the ocean.

COASTWISE COAL-BARGE TRANSPORTATION.

There is a very large business on the Atlantic Coast in shipping coal from certain coal-road terminal ports to other domestic ports.

Previous to 1880 this transportation was almost entirely carried on in sailing vessels. In 1879 there was but one barge line. This carried coal to points on Long Island Sound as far east as New Bedford. At this time the rates of freight to Rhode Island points were $1.20 to $1.60 per ton. By a gradual process of evolution, which is readily traceable, this business has changed, until now more than 90 per cent of all coal shipped goes in barges towed by tugs.

The following is a statement of the approximate amount of coal shipped annually from the coal ports named, which serves to indicate the magnitude of the business:

	Tons.
South Amboy, about	2,125,000
Perth Amboy, about	2,700,000
Port Reading, about	1,100,000
Port Liberty, about	1,200,000
Hoboken, about	2,200,000
Weehawken, about	1,000,000
Guttenberg, about	500,000
Edgewater, about	500,000
Cornwall, about	500,000
Newburg, about	1,125,000
Rondout, about	1,500,000
Port Richmond, about	2,500,000
Greenwich piers, about	2,200,000
Total	19,150,000

No figures of the coal shipments from ports south of Philadelphia, such as Baltimore, Newport News, Norfolk, etc., are available, but it is safe to say that the approximate coastwise coal tonnage is from 25,000,000 to 30,000,000 tons annually. There are now some twenty barge lines carrying coal to all points on the coast. Some of these lines have more than forty seagoing barges, with a tonnage of 35,000 to 40,000 tons. The barges vary in size from a capacity of 400 to 3,500 tons, the most popular size being about 1,500 tons. Most of these barges were built for the purpose for which they are used, but many of them are the hulls of sailing ships formerly used in the business of transporting coal under sail, or in other lines of business, and the hulls of steam colliers from which the machinery has been removed.

By the business as now carried on, coal is transported at a cost not exceeding one-third of the cost fifteen years ago.

The tugs used in the business are necessarily powerful seagoing tugs, ordinarily 125 to 170 feet in length, 21 to 29 feet beam, and from 500 to 1,200 I. H. P., costing from $30,000 to $70,000. One of these tugs tows from three to six barges, with an aggregate load of 3,000 to 6,000 tons of coal. The make up of the tows is governed by the particular tugs and barges and the conditions of the weather.

Each barge line has many more barges than tugs; for instance, the Bee Line Transportation Company has 40 barges and 4 tugs. The plan of running such a plant is to keep the tugs moving rapidly and constantly, they having expensive crews and representing considerable capital invested. They can and frequently do make four round trips in a month, towing three loaded barges to the eastward and three light ones to the westward between New York and Boston, Portsmouth, or Portland. The barges, independently of the tugs, remain in port such time as may be necessary for loading and unloading and average about two trips per month.

The reasons for substituting barges for steam colliers are, that the separating of the power plant (the tug) from the cargo carrying capacity (the barges) leads to economy, because the daily cost of running the power plant represented by tugs is high, and the tugs do not have to wait for loading or discharging. As soon as they arrive with a string of loaded barges they can take a waiting string of empties and return. The daily cost of running the carrying capacity, exclusive of towage, is small, and if the barges are delayed it is a matter of small consequence; also the fact that one unit of power plant can be attached to any one unit of carrying capacity gives a freedom of movement which could never be had were each power plant permanently attached to its own carrying capacity as in a steam collier. It is for similar reasons that locomotives are never permanently attached to freight cars.

The reasons for substituting barges for sailing vessels are: The first cost per ton of carrying capacity is less and the expense of running them is less, the added expense for towing the barges being more than compensated for by the fact that they make their trips promptly and regularly, not being delayed except by very severe weather or fogs.

The development of this coastwise barge transportation business has been gradual, and it has now acquired such a definite standing as the most economical system available, and has assumed such enormous proportions, that I have deemed it proper to call attention to it as an alternative to a ship canal, and to the advisability of providing for such a traffic between the Great Lakes and the sea by an enlargement of the Erie Canal, so that fleets of barges of the most popular capacity engaged in the coastwise business can pass through. Such an improvement could be made at a cost small in comparison to the cost of a ship canal from the Great Lakes to tide water sufficiently large to accommodate ocean or lake vessels, and it would, in my opinion, be the best business proposition which could be adopted for giving cheap transportation between the lakes and the Seaboard, benefiting alike the people of the East and of the West, and keeping the transportation business in the hands of Americans.

This improvement would consist in the enlargement and realignment of the Erie Canal to permit the passage, at fair canal rates of speed, of fleets of barges each 200 feet long, 30 feet broad, and 10 feet draft, each carrying about 1,500 tons of dead freight, with locks arranged for the passage of two such boats at one lockage.

In transacting the business of freight transportation between the lakes and the sea, the advantages of the division of the carrying capacity into a number of smaller units capable of splitting up at terminal ports and going to different ships and docks and its separation from the power plant, over the single united power plant and freight carrier, as represented by the present lake freight steamer, would be nearly as great and marked as it is in the transaction of the freight business between coastwise points already mentioned.

Barges of the size mentioned could be made with the ability to go to any point on the lakes deemed desirable, and could pass through New York Harbor and to other seaports if necessary or desirable, and thus bring in wide competition and secure the lowest practicable transfer and terminal charges at the Atlantic Seaboard and at Buffalo and other lake ports.

The conditions of the canal navigation are such that it is not believed practicable or desirable to adopt in its entirety the system of management developed in the coastwise coal-barge navigation business. Each unit for passing through the locks should be of the same size, and for this and various other economical reasons it is believed that the tug which carries no freight should be dispensed with and a steam barge of the same size and draft as the ordinary barges substituted. All arrangements should be made for the rapid loading and unloading of this steam barge and its continuous operation with such plain barges as might be ready for it from time to time at the terminal ports. This would amount to a partial separation of the carrying capacity from the motive power. At present the steam system on the canal is to make up a fleet of a steamer and its consorts, which are always run together. This is not economical, as the steamer with its expensive machinery and personnel has to wait at terminal ports until all of its consorts are ready for a trip.

By having a number of motorless barges in excess of those required to make up the fleets, and all arranged to properly go with one another under one management, the same general economical principles could be applied that now exist in the coastwise coal business.

In making the following comparison of the cost of transportation, the element of lake navigation is eliminated, and the wheat, which is assumed as the standard freight, is supposed to be brought to Buffalo for shipment on to New York; first, in the lake freighter in which it came; or second, by the present Erie Canal; or third, by the Erie Canal as it will be when the pending improvements are completed, using in both cases fleets of canal boats consisting of a steamer and three to five ordinary canal boats; or fourth, by the Erie Canal enlarged to accommodate 1,500-ton barges, a fleet consisting of one steam barge and three motorless barges with the business conducted as at present; or fifth, conducted upon the same general business principles which govern the coastwise coal transportation business.

The cost of transportation by the present Erie Canal is based upon existing conditions and figures and data secured from men engaged in the business of running fleets of steam canal boats and their consorts. A brief description of the development of steam navigation on the Erie Canal and its present condition is here given. No attempt has been made to figure on the cost of transportation by horse boats, as this system is passing away and can have no place in the enlarged canals of the future.

STEAM PROPULSION ON THE ERIE CANAL.

The first impetus given to the construction and use of steam canal boats, especially designed for use on the Erie Canal, was afforded by the passage on April 28, 1871, of a State law which was intended to foster and develop the introduction of steam and other motors for the propulsion of boats.

This law provided for the payment of an award of $100,000 for such inventions or devices, not exceeding three in number, as should be found satisfactorily adapted to the purpose. Only one steamboat was officially considered during the season of 1871; but during the season of

1872 twelve steamers were presented for observation, only three of which, however, made the required three round trips between New York and Buffalo. Investigations were continued during the season of 1873, when five new steamboats were brought to the attention of the commission having the matter in charge.

Since then the permanent introduction of steam canal boats has been assured, and many improvements have been made upon the earlier models. The prevailing number of boats at the present time in a fleet operated by steam power consists of one steamer and three consorts, making four boats in all. The general arrangement is for the steamer to push one consort ahead and to tow two boats coupled together behind. The steamer and its immediate consort are rigidly connected at the bow of the former and at the stern of the latter. The coupling is double, consisting of a connecting arm on each side hooking into a spring buffer and operated by a lever in such a way as to bring a strain upon the powerful spring of the buffer, thus drawing the two boats securely together. In addition, the boats are further secured by lines drawn taut by a windlass. The other two consorts are also coupled together, stern to stern, forming "double headers," and are towed behind by hawsers usually 500 feet long.

Some of the more powerful steamers tow two double headers, in which case the fleet, including the steamer, comprises six boats. This practice is rather limited, the method being employed by but few steamers.

The usual crew employed on a fleet of one steamer and three consorts consists of seven men, who are regularly employed by the month, and two extra men, or trippers, who are paid by the day. These trippers are only hired during the trip through the Erie Canal. When taken on at Buffalo, they are discharged at Troy, and when engaged at the latter place their services are dispensed with on arrival at Buffalo. Thus, when making a trip between Buffalo and New York, the crew employed while towing through the Erie Canal consists of nine men, and of seven men while engaged in navigating the Hudson River and in the harbor at New York.

The whole fleet is in command of a captain, who has immediate charge of the steamer and her accompanying consort. He is assisted by two engineers and two steersmen. No firemen are employed, the engineers doing the firing of the boilers in addition to their other duties. The crew of the two consorts consists of four men, two of whom are regularly employed, the other two being engaged temporarily while towing through the canal, as previously stated.

Subsistence is generally furnished under an arrangement with the captain, who is allowed 50 cents per day for each man, and from this he employs the necessary cooks and purchases the necessary provisions.

The fleets are run day and night, the watches being six hours long each, the crew being thus alternately six hours on and off duty.

Anthracite coal is the fuel ordinarily burned in these steamers, the grade known as egg size being generally used. The capacity of the coal bunkers is from 8 to 9 tons, not sufficient for a trip, so that the supply has to be replenished en route, Little Falls, Syracuse, Troy, and the two termini being the usual coaling stations. In going west, in some instances, sufficient coal is taken on at New York to serve the journey, the surplus beyond the capacity of the coal bunkers being carried on the consort adjoining the steamer.

The steamers also carry two fresh-water tanks for use of the boilers while on the lower Hudson River, their combined capacity being 1,100 gallons.

The coal consumption averages about 40 tons for a round trip, consuming thirty days, or one month. The general assumption is that two tons is the daily coal consumption while running, and one quarter of a ton while in port.

The average time of making a single trip between Buffalo and New York is nine days, of which seven days are consumed in the Erie Canal and the other two in the Hudson River. This would make the running time of a steamer between the points given eighteen days, and would allow for twelve days in port, six days at each end.

The cost of steamers ranges from $6,500 to $10,000 each. Except a little difference as to models, the construction of these boats is practically the same as the best class of horse boats. They are built both with pine and with oak sides. The pine-side boats have the oak frames at bow and stern, but the midship portion is made of pine instead of oak, as in the other case. The pine-side boats are the cheaper ones. The cost given includes the machinery, engine and boilers, the price of which, separately, ranges from $2,500 to $4,500. Consorts cost about $2,500 to $3,000 each. The usual dimensions of the steamers are: Length, 97 feet; breadth, 17 feet 10 inches; depth, 9 feet; the gross tonnage, 130 tons, and the net tonnage, 106 tons. The engines employed are usually ordinary compound engines—diameter of cylinder, 10 inches and 22 inches, with 16-inch stroke. Many of the boilers are of the horizontal type, about 8 feet long and about 7 feet diameter, furnished with 2½-inch direct and 3-inch return tubes. The cost of a good four-boat steam fleet, consisting of one steamer and three consorts, will average as below:

Steamer	$8,500
Three consorts, each $3,000	9,000
Total	17,500

The rates of insurance for steamers are, respectively, 1½ per cent for first-class, 2 per cent for second-class, and 2½ per cent for third-class boats. For boats that are towed the rates for first-class boats are 1 per cent, for second-class boats 1¼ per cent, and for third-class boats 2 per cent.

For insuring cargoes the following rates prevail:

30 cents on $100 value carried on first-class boats.
40 cents on $100 value carried on second-class boats.
60 cents on $100 value carried on third-class boats.

The custom prevails for the canaler to pay the insurance on his cargo going down but not coming up. The average cargo of wheat carried east by a fleet of one steamer and three consorts is 900 tons, or 30,000 bushels, apportioned as follows:

	Bushels.
Steamer (162 tons)	5,400
Three consorts, 246 tons, or 8,200 bushels, each	24,600
Total tonnage	30,000

equal to 900 tons.

Returning from New York to Buffalo, or west, the fleet will carry from 500 to 600 tons of coarse freight, such as salt, cement, iron, etc. The steamer will carry from 130 to 140 tons and the consorts from 140 to 160 tons each. The rates per ton will range from 45 to 60 cents, although during the season of 1896 coarse freight has at times been carried for from 25 cents to 35 cents per ton. The insurance of the return freight west is borne by the shipper; the item of insurance on up freight is left out in making a comparison as to the cost of transportation by different systems.

The following table shows the average rate of wages and cost of subsistence per month of a 4-boat steam fleet—one steamer and three consorts:

TABLE NO. 23.

Crew.	No.	Rate per month.
Steamer and one consort:		
Captain	1	$60
First engineer, licensed	1	50
Second engineer	1	30
Wheelmen or steersmen, $35 each	2	70
Two consorts in tow:		
Captain	1	50
Wheelman or steersman	1	35
Deck hands, 16 days each, $1.25 each	2	40
Subsistence, 182 days, at 50 cents		91
Total wages and board, one month, say one trip		426

COST OF TRANSPORTATION.

The tables which follow represent my determination of the cost of transportation by various canals and systems.

COST OF TRANSPORTATION BY SHIP CANAL.

The following table gives the estimated cost of transportation by a ship canal from Lake Erie at Buffalo to New York City, the canal assumed to be of the proportions named herein, and to be built by the Oswego route, the route regarded by me as most desirable for a ship canal. It is estimated that a ship could make from 8 to 12 trips during a season, and an average of 10 trips is assumed. If a ship canal were built by the St. Lawrence-Champlain route, which is 244 miles, or 50 per cent, longer than the Oswego route, the number of trips which could be made during a season of navigation between Buffalo and New York would not average more than 8 or 9, and a ship canal by this route would be far less able to compete with the smaller canals than would the ship canal by the Oswego route considered herein.

In the preparation of this table of cost information derived from many sources has been used. A number of the managers of lake lines have kindly furnished information of the cost of running vessels. It has been endeavored to reduce the data thus obtained to the conditions which will exist in the navigation of the canal.

The ordinary rates of insurance on the lakes are 3 to 3½ per cent on steel vessels. No insurance man interviewed thinks that the rates would be less for vessels navigating the canal, while many announced that they would be higher, owing to the increased danger of running aground in a shallow and contracted channel and consequent damage to hull, where the canal sides and bottom were composed of rock, and to the danger of collision at locks and with opposing vessels. A rate of 3½ per cent is assumed.

The rates of insurance on cargoes from Lake Michigan ports to Buffalo are from 30 to 33 cents per $100 value. Most of the insurance men interviewed state that in their opinion the rate of insurance between Buffalo and New York would be considerably higher than this. A rate of 35 cents per $100 is assumed. Insurance is estimated on down cargoes of wheat, to make the conditions correspond to those on the Erie Canal, where the canaler pays the insurance. On up freight no insurance is estimated for the opposite reason. For determination of insurance, wheat is estimated in all cases at 75 cents per bushel.

As in the case of the smaller canal traffic, one-third cargoes of up freight are estimated.

Two tables are given for the same ship, valued at the same amount, and run with the same crew, the first table under the supposition that the lake channels, harbors, etc., have been sufficiently improved to allow vessels of 20 feet draft to navigate them, and that the ship is loaded to this draft, carrying 7,000 tons of freight.

TABLE NO. 24.—*Ship Canal, Buffalo to New York, Oswego route.*

Steel lake freighter of largest class drawing 16 feet and carrying 5,000 tons, or 166,667 bushels of wheat at a trip, making ten trips annually. Wheat transported down annually, 50,000 tons, or 1,666,667 bushels. Return up, one-third loads miscellaneous freight, aggregating 16,667 tons annually. Steamer value, $250,000. Value per ton of carrying capacity at 16 feet draft, $50.

SEASON'S EXPENSES.

Wages and subsistence	$9,314.25
Fuel, oil, waste, etc	9,760.00
Ordinary repairs	1,500.00
Insurance on steamer	8,750.00
Insurance on wheat	4,375.00
Interest on cost at 6 per cent	15,000.00
Deterioration, etc., at 6 per cent	15,000.00
Miscellaneous small expenses	750.00
Total	64,449.25

Assuming all up freight reduced to wheat, there would be the equivalent of 1,666,667 + 555,555 = 2,222,222 bushels of wheat carried, and the cost of transportation would be 2.81 cents per bushel, or 94 cents per ton.

TABLE NO. 25.—*Ship canal, Buffalo to New York, Oswego route.*

Steel lake freighter of largest type, drawing 20 feet and carrying 7,000 tons, or 233,333 bushels, of wheat at a trip, making 10 trips annually; wheat transported down annually 70,000 tons, or 2,333,333 bushels; return up, one-third loads miscellaneous freight, aggregating 23,333 tons annually; steamer value, $250,000; value per ton of carrying capacity at 20 feet draft, $35.71.

SEASON'S EXPENSES.

Wages and subsistence	$9,314.25
Fuel, oil, waste, etc	11,675.00
Ordinary repairs	1,800.00
Insurance on steamer	8,750.00
Insurance on wheat	6,125.00
Interest on cost, 6 per cent	15,000.00
Deterioration, etc., 6 per cent	15,000.00
Miscellaneous small expenses	750.00
Total	68,414.25

Assuming all up freight reduced to wheat, there would be the equivalent of 2,333,333 + 777,777 = 3,000,000 bushels of wheat carried, and the cost of transportation would be 2.28 cents per bushel, or 76 cents per ton.

COST OF TRANSPORTATION BY PRESENT ERIE CANAL.

TABLE No. 26.—*Present Erie Canal, Buffalo to New York, four-boat fleets.*

Fleet consisting of one steam canal boat and three consorts, first class. Steamer carries 162 tons, or 5,400 bushels of wheat; each consort carries 246 tons, or 8,200 bushels of wheat; fleet loaded carries 900 tons, or 30,000 bushels of wheat, making 7 trips annually. Wheat transported down annually, 6,300 tons, or 210,000 bushels. Return up freight, one-third loads miscellaneous, 2,100 tons. Present transfer charges at Buffalo, 1.3 cents per bushel of wheat. Estimated transfer charges at Buffalo, 25 cents per ton of up freight.

Steamer value	$8,500
3 consorts at $3,000	9,000
Investment	17,500
Value of carriers per ton of carrying capacity:	
Steamer	$52.47
Consort	12.19
Fleet	19.44

SEASON'S EXPENSES.

Wages and subsistence	$2,982.00
Fuel, oil, waste, and extra towing on canal	1,400.00
Ordinary repairs	196.00
Insurance on fleet	217.50
Insurance on wheat	472.50
Interest on investment at 6 per cent	1,050.00
Deterioration, etc., at 6 per cent	1,050.00
Miscellaneous small expenses	100.00
	7,468.00
Transfer at Buffalo—	
On 210,000 bushels of wheat	2,730.00
On 2,100 tons of up freight	525.00
	10,723.00

Assuming up freight reduced to wheat, there would be the equivalent of 210,000+70,000=280,000 bushels of wheat carried, and the cost for transportation, including transference at Buffalo, would be 3.81 cents per bushel, or $1.27 per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-fourths of a cent per bushel, the cost of transportation, including transference at Buffalo, would be 3.42 cents per bushel, or $1.14 per ton.

Under the same assumption and eliminating all transfer charges entirely, the cost of transportation on wheat would be 2.66 cents per bushel, or 89 cents per ton.

If to this latter cost per bushel we add the trimming charge in Buffalo and the shoveling charge in New York, charges paid by the canaler and included in his freight bill, we have 2.88 cents per bushel as representing the cost of transportation of a bushel of wheat by four-boat fleets on the canal at the present time and in accordance with present customs, all on the assumption that one-third loads back are obtained at rates equivalent to the down rates on wheat.

TABLE No. 27.—*Present Erie Canal, Buffalo to New York, six-boat fleets.*

Fleet consisting of one steam canal boat and five consorts, first-class. Steamer carries 150 tons, or 5,000 bushels of wheat; each consort carries 246 tons, or 8,200 bushels of wheat; fleet loaded carries 1,380 tons, or 46,000 bushels of wheat, making seven trips annually; wheat transported down annually. 9,660 tons, or 322,000 bushels; return up freight, one-third loads miscellaneous, 3,220 tons; present transfer charges at Buffalo, 1.3 cents per bushel of wheat; estimated transfer charges at Buffalo, 25 cents per ton of up freight.

Steamer value	$9,000
5 consorts, at $3,000	15,000
Investment	24,000
Value of carriers per ton of carrying capacity:	
Steamer	$60.00
Consort	12.19
Fleet	17.39

SEASON'S EXPENSES.

Wages and subsistence	$4,275.00
Fuel, oil, waste, and extra towing on canal	1,813.50
Ordinary repairs	240.00
Insurance on fleet	285.00
Insurance on wheat	724.50
Interest on investment at 6 per cent	1,440.00
Deterioration, etc., at 6 per cent	1,440.00
Miscellaneous small expenses	125.00
	10,343.00
Transfer at Buffalo—	
On 322,000 bushels of wheat	4,186.00
On 3,220 tons of up freight	805.00
Total	15,334.00

Assuming up freight reduced to wheat, there would be the equivalent of 322,000+107,333=429,333 bushels of wheat carried, and the cost for transportation, including transference at Buffalo, would be 3.56 cents per bushel, or $1.17 per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-fourths of a cent per bushel, the cost of transportation, including transference at Buffalo, would be 3.11 cents per bushel, or $1.04 per ton.

Under the same assumption, and eliminating all transfer charges, the cost of transportation on wheat would be 2.41 cents per bushel, or 80 cents per ton.

If to this latter cost per bushel we add the trimming charges at Buffalo and the shoveling charge at New York, charges paid by the canaler and included in his freight bill, we have 2.63 cents as representing the cost of transportation of a bushel of wheat by six-boat fleets on the canal at the present time and in accordance with present customs, all on the assumption that one-third loads back are obtained at rates equivalent to the down rates on wheat.

COST OF TRANSPORTATION BY IMPROVED ERIE CANAL.

The Erie Canal is being improved by the State of New York, so that when the work is finally completed it will be passable by boats drawing 8 feet of water. One tier of the locks is being lengthened so that each lock will accommodate two boats each 115 feet long and of the present width. At four places—Lockport, Newark, Little Falls, and Cohoes—where there are several locks close together, it is intended to substitute for several locks of ordinary type mechanical lift locks of some form. At the present time boats draw 6 feet of water, and at each unlengthened lock the fleet has to be broken up, each boat passed through separately, and the whole combined into a fleet below the lock. With the locks lengthened, each double unit making up the fleet can be passed through at one lockage, thus saving much time, which will be materially augmented by the saving of time at the mechanical lifts to be substituted for flights of locks.

The result of this improvement will be that boats of greatly increased capacity can pass through the canal in much less time than is at present possible.

Under the new conditions it is believed that it will be entirely feasible for the fleets to make 9 to 11 trips each season, depending on the business management and dispatch at terminals. In the following table 9 trips annually are allowed:

TABLE No. 28.—*Improved Erie Canal, Buffalo to New York, four-boat fleets.*

Fleet consisting of one steam canal boat and three consorts, first class. Steamer carries 300 tons, or 10,000 bushels of wheat; each consort carries 400 tons, or 13,333 bushels of wheat; fleet loaded carries 1,500 tons, or 50,000 bushels of wheat, making 9 trips annually. Wheat transported down annually, 13,500 tons, or 450,000 bushels; return up freight, one-third loads miscellaneous, 4,500 tons; present transfer charges at Buffalo, 1.3 cents per bushel of wheat. Estimated transfer charges at Buffalo, 25 cents per ton of up freight.

Steamer value	$10,000
Three consorts, at $3,500	10,500
Investment	20,500
Value of carriers per ton of carrying capacity:	
Steamer	$37.04
Consorts	8.75
Fleet	13.66

SEASON'S EXPENSES.

Wages and subsistence	$3,174.00
Fuel, oil, waste, etc	1,962.50
Ordinary repairs	225.00
Insurance on fleet	255.00
Insurance on wheat	1,012.50
Interest on investment at 6 per cent	1,230.00
Deterioration, etc., at 6 per cent	1,230.00
Miscellaneous small expenses	150.00
	9,239.00
Transfer charges at Buffalo—	
On 450,000 bushels of wheat	5,850.00
On 4,500 tons of up freight	1,125.00
Total	16,214.00

Assuming up freight reduced to wheat, there would be the equivalent of 450,000 + 150,000 = 600,000 bushels of wheat carried, and the cost of transportation, including transference at Buffalo, would be 2.70 cents per bushel, or 90 cents per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-fourths of a cent per bushel, the cost of transportation and transference at Buffalo would be 2.29 cents per bushel of wheat, or 76 cents per ton.

Under the same assumption and eliminating all transfer charges the cost of transportation on wheat would be 1.54 cents per bushel, or 51 cents per ton.

If to this latter we add the trimming charge at Buffalo and the shoveling charge at New York, charges now paid by the canaler and included in his freight bill, we have 1.76 cents per bushel, which will fairly represent the cost according to present customs of transporting a bushel of wheat by four-boat fleets on the new Erie Canal when the improvements under way are completed, all on the supposition that one-third loads back are obtained at rates equivalent to the down rates on wheat.

TABLE NO. 29.—*Improved Erie Canal, Buffalo to New York, six-boat fleets.*

Fleet consisting of one steam canal boat and five consorts. Steamer carries 285 tons, or 9,500 bushels of wheat; each consort carries 400 tons, or 13,333 bushels of wheat; fleet loaded carries 2,285 tons, or 76,167 bushels of wheat, making 9 trips annually. Wheat transported down annually, 20,565 tons, or 685,500 bushels. Return up freight, one-third loads miscellaneous, 6,855 tons. Present transfer charges at Buffalo, 1.3 cents per bushel of wheat. Estimated transfer charges at Buffalo, 25 cents per ton of up freight.

Steamer value	$10,000
5 consorts at $3,500	17,500
Investment	27,500
Value of carriers per ton of carrying capacity:	
Steamer	$37.04
Consort	8.75
Fleet	12.04

SEASON'S EXPENSES.

Wages and subsistence	$4,725.00
Fuel, oil, waste, etc	2,453.00
Ordinary repairs	337.00
Insurance on fleet	325.00
Insurance on wheat	1,542.37
Interest on investment at 6 per cent	1,650.00
Deterioration, etc., at 6 per cent	1,650.00
Miscellaneous small expenses	200.00
	12,882.37
Transfer charges at Buffalo—	
On 685,000 bushels of wheat	8,911.50
On 6,855 tons of up freight	1,713.75
Total	23,507.62

Assuming up freight reduced to wheat, there would be the equivalent of 685,600 + 228,500=914,000 bushels of wheat carried, and the cost of transportation, including transference at Buffalo, would be 2.57 cents per bushel, or 86 cents per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-fourths of a cent per bushel, the cost of transportation and transference at Buffalo would be 2.16 cents per bushel, or 72 cents per ton.

Under the same assumption and eliminating all transfer charges, the cost of transportation on wheat would be 1.41 cents per bushel, or 47 cents per ton.

If to this latter we add the trimming charge at Buffalo and the shoveling charge at New York, charges now paid by the canaler and included in his freight bill, we have 1.63 cents per bushel, which will fairly represent the cost, according to present customs, of transporting a bushel of wheat by six-boat fleets on the new Erie Canal when the improvements under way are completed, all on the supposition that one-third loads back are obtained at rates equivalent to the down rates on wheat.

COST OF TRANSPORTATION BY LARGE BARGE CANAL, ERIE CANAL ROUTE.

The next table gives the estimated cost of transportation by an improved Erie Canal to give passage for barges 30 feet broad, 200 feet long, and drawing 10 feet of water, the locks reduced in number and arranged to give passage to two such barges at one lock, with mechanical lifts to replace flights of locks where advisable, all on the supposition that the business is managed as at present by fleets consisting of one steam barge and three motorless consorts, running between Buffalo and New York. Barges all estimated strong enough for running on the Great Lakes, but insurance is only computed at canal rates.

It would probably not be found practicable to run boats of this size and capacity in larger fleets than the four mentioned. The crowded condition of the Hudson River and the necessity of keeping full control of the fleet in its waters would probably render it impracticable to run a six-boat fleet.

TABLE NO. 30.—*Suggested barge canal, Buffalo to New York, four-boat fleets.*

Fleet consisting of one steam barge and three consorts, each 200 feet long, 30 feet wide, and 10 feet draft. Steam barge carries 1,200 tons, or 40,000 bushels, of wheat; each consort carries 1,500 tons, or 50,000 bushels, of wheat; fleet loaded carries 5,700 tons, or 190,000 bushels, of wheat, making 9 trips annually. Wheat transported down annually 51,300 tons, or 1,710,000 bushels; return up freight one-third loads miscellaneous freight, 17,100 tons annually; present transfer charges at Buffalo, 1.3 cents per bushel of wheat; estimated transfer charges at Buffalo, 25 cents per ton of up freight.

Value steam barge	$25,000
Value three consorts, at $12,000	36,000
Investment	61,000
Value of carriers per ton of carrying capacity—	
Steam barge	$20.83
Consorts	8.00
Fleet	10.70

SEASON'S EXPENSES.

Wages and subsistence	$4,840.00
Fuel, oil, waste, etc	3,435.00
Ordinary repairs	350.00
Insurance on fleet	735.00
Insurance on wheat	3,847.50
Interest on investment at 6 per cent	3,660.00
Deterioration, etc., at 6 per cent	3,660.00
Miscellaneous small expenses	200.00
	20,727.50
Transfer at Buffalo—	
On 1,710,000 bushels of wheat, at 1.3 cents	22,230.00
On 17,100 tons of up freight	4,275.00
Total	47,232.50

Assuming all up freight reduced to wheat, there would be the equivalent of 1,710,000+570,000=2,280,000 bushels of wheat carried, and the cost for transportation and transference at Buffalo would be 2.07 cents per bushel, or 69 cents per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-quarters of a cent per bushel, the cost of transportation, including transference at Buffalo, would be 1.66 cents per bushel, or 55 cents per ton.

Under the same assumption, and eliminating all transfer charges at Buffalo, the cost of transportation on wheat would be 0.91 of a cent per bushel, or 30 cents per ton.

If to this latter we add the trimming charge at Buffalo and shoveling charge at New York, charges paid by the canaler and included in his freight bill, we have 1.13 cents per bushel, which will fairly represent the cost according to present custom of transporting a bushel of wheat by a barge canal of the size indicated herein, all on the supposition that one-third loads back are obtained at rates equivalent to the down rates on wheat.

The next table gives the estimated cost of transportation by this improved Erie Canal, on the supposition that the business is conducted on the same general lines as the coastwise coal-barge transportation business, with steam and motorless barges properly proportioned in numbers to allow the steamers to work continuously and the barges to take the necessary time for loading and unloading.

In the estimate herewith it is assumed that with each steamer there are provided four barges; that the steamer makes 12 trips during the season and each barge 9 trips; and that a moving fleet consists of one steam and three motorless barges. The proper combination for the economical transaction of the business between New York and Buffalo would have to be worked out by practical experience. In the tables the operations and cost of one steamer and four barges are considered.

TABLE No. 31.—*Erie Canal improved to accommodate barges, as suggested.*

Unit fleet, consisting of 1 steamer and 4 motorless barges; moving fleet, consisting of 1 steamer and 3 motorless barges; steam barge makes 12 trips during season; each motorless barge makes 9 trips during season; steam barge carries 1,200 tons, or 40,000 bushels, of wheat per trip; each plain barge carries 1,500 tons, or 13,500 bushels, of wheat per trip; each steam barge carries 14,400 tons, or 480,000 bushels, of wheat per season; each motorless barge carries 13,500 tons, or 450,000 bushels, of wheat per season; all 5 steam and plain barges carry 68,400 tons, or 2,280,000 bushels, of wheat per season; return up freight, one-third loads miscellaneous, 22,800 tons; present transfer charges on wheat at Buffalo, 1.3 cents per bushel; estimated transfer charges on up freight at Buffalo, 25 cents per ton.

Steam barge, estimated value	$25,000
Four plain barges, at $12,000	48,000
Total	73,000
Value of carriers per ton of carrying capacity for the system—	
Steam barge	$20.83
Consorts	8.00
Fleet	10.14

SEASON'S EXPENSES.

Wages and subsistence	$6,040
Fuel, oil, waste, etc	4,465
Ordinary repairs	400
Insurance on fleet	855
Insurance on wheat	5,130
Interest on investment at 6 per cent	4,380
Deterioration, etc., at 6 per cent	4,380
Miscellaneous small expenses	250
	25,900
Transfer at Buffalo—	
On 2,280.000 bushels of wheat	29,640
On 22,800 tons up freight	5,700
Total	61,240

Assuming up freight reduced to wheat, there would be the equivalent of 2,280,000+76,000=3,040,000 bushels of wheat carried, and the cost for transportation and transference at Buffalo would be 2.01 cents per bushel, or 67 cents per ton.

Under the same assumption, if the transfer charges on wheat at Buffalo were reduced to three-quarters of a cent per bushel, the cost of transportation and transference at Buffalo would be 1.60 cents per bushel, or 53 cents per ton.

Under the same assumption and eliminating all transfer charges, the cost of transportation on wheat would be 0.85 of a cent per bushel, or 28 cents per ton.

If to this latter cost per bushel we add the trimming charge at

Buffalo and the shoveling charge at New York, charges paid by the canaler, we shall have 1.07 cents per bushel, which would fairly represent the cost of transporting a bushel of wheat from Buffalo to New York, according to present customs, on an Erie Canal improved, as stated; all on the assumption that one-third loads back are obtained at rates equivalent to the down rates on wheat.

The following table is a summary of the last six tables and enables a comparison of the cost of transportation by different systems and under varying conditions to be made:

TABLE No. 32.

	Estimated cost by ship canal.		Estimated cost with wheat transferred at Buffalo at cost of 1 $\frac{3}{10}$ cents per bushel, and up freight transferred at cost of 25 cents per ton.		Estimated cost if transfer charges at Buffalo were reduced to $\frac{3}{4}$ of a cent per bushel, and up freight at 25 cents per ton.		Estimated cost of transportation with all transfer charges eliminated.	
	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.
1	2	3	4	5	6	7	8	9
By ship canal:	Cents.	Cents.	Cents.		Cents.		Cents.	Cents.
In 5,000-ton vessels	2.81	94	....	....	....	....	....	....
In 7,000-ton vessels	2.28	76	....	....	....	....	....	....
By Erie Canal in its present condition:								
With four-boat fleets	....	....	3.81	$1.27	3.42	$1.14	2.66	89
With six-boat fleets	....	....	3.56	1.17	3.11	1.04	2.41	80
Erie Canal as it is being improved:								
With four-boat fleets	....	....	2.70	.90	2.29	.76	1.54	51
With six-boat fleets	....	....	2.57	.86	2.16	.72	1.41	47
1,500-ton barge canal:								
Business conducted with four-boat fleets as at present	....	....	2.07	.69	1.66	.55	.91	30
With semiindependent motive power and consorts	....	....	2.01	.67	1.60	.53	.85	28

	Estimated cost of transportation, with trimming charges at Buffalo and shoveling charges at New York added.		Estimated cost, Chicago to New York, including lake rate at 1.37 cents per bushel, transfer charges at 1.30 cents per bushel, and 10 per cent profit on cost of transportation between Buffalo and New York.		Estimated cost, Chicago to New York, including lake rate at 1.37 cents per bushel, transfer charges at $\frac{3}{4}$ of a cent per bushel, and 10 per cent profit on cost of transportation between Buffalo and New York.	
	Per bushel.	Per ton.	Per bushel.	Per ton.	Per bushel.	Per ton.
1	10	11	12	13	14	15
By ship canal:	Cents.	Cents.	Cents.		Cents.	
In 5,000-ton vessels	....	....	4.46	$1.49	4.46	$1.49
In 7,000 ton vessels	....	....	3.88	1.29	3.88	1.29
By Erie Canal in its present condition:						
With four-boat fleets	2.88	96	5.60	1.87	5.05	1.68
With six-boat fleets	2.63	88	5.32	1.77	4.77	1.59
Erie Canal as it is being improved:						
With four-boat fleets	1.76	59	4.36	1.45	3.81	1.27
With six-boat fleets	1.63	54	4.22	1.41	3.67	1.22
1,500-ton barge canal:						
Business conducted with four-boat fleets as at present	1.13	38	3.67	1.22	3.12	1.04
With semiindependent motive power and consorts	1.07	36	3.60	1.20	3.05	1.02

A study of this table indicates that a ship canal would furnish cheaper transportation than the present Erie Canal can do with the present transfer charges at Buffalo, or with the charges materially reduced.

With freight carried in a 5,000-ton ship, the advantage would be 33 cents per ton, while in a 7,000-ton ship the advantage would be 51 cents per ton over freight carried through the canal in four-boat fleets, and 23 and 41 cents over freight carried in six-boat fleets.

Assuming an annual canal tonnage of 24,000,000, the advantage for the 5,000-ton ship would be $5,520,000 to $7,920,000 per annum, and for a 7,000-ton ship, $9,840,000 to $12,240,000 per annum. Under these conditions it is assumed that it would be a good business proposition to build the ship canal, as the mean of the saving, $8,880,000, would pay the interest on cost and operating expenses, and particularly as the existing Erie Canal can not handle any such amount of tonnage.

Even were the transfer charges at Buffalo reduced to three-fourths of a cent per bushel, the advantage would still be largely with the ship canal over the present Erie Canal; for the 5,000-ton ship over the four-boat fleets, 20 cents per ton, and over the six-boat fleets, 10 cents per ton, or $2,400,000 to $4,800,000 per year; and for the 7,000-ton ship over the four-boat fleets, 38 cents per ton, and over the six-boat fleets, 28 cents per ton, or $6,720,000 to $9,120,000 per year, a mean saving of $5,650,000 per year.

But with the Erie Canal as it is being improved the advantages of the proposed ship canal largely disappear.

With the transfer charges as they are at present, the improved Erie Canal will have an advantage over the 5,000-ton ship in the ship canal of 4 cents per ton for four-boat fleets and 8 cents per ton for six-boat fleets, or $860,000 to $1,920,000 per year; while the 7,000-ton ship will have an advantage over the improved Erie Canal navigated by four-boat fleets of 14 cents per ton, and over the same canal navigated by six-boat fleets of 10 cents per ton, or from $2,400,000 to $3,360,000, respectively.

A mean of the boats and fleets would represent an advantage of the ship canal over the improved Erie Canal of $720,000 per annum on a tonnage of 24,000,000 per annum, not nearly enough to pay the estimated cost of operation and maintenance.

If the transfer charges at Buffalo be reduced to three-fourths of a cent per bushel, the advantages of the improved Erie Canal over the 5,000-ton ship would be 18 and 22 cents, respectively, for four and six boat fleets, or $4,320,000 to $5,280,000 per year. Under this supposition of reduced transfer charges, the 7,000-ton ship would be exactly on a par with the improved Erie Canal, navigated by four-boat fleets, while the latter, navigated by six-boat fleets, would have 4 cents per ton advantage over the ship canal, or $960,000 per year.

The mean of the ships and fleets would represent an advantage to the improved Erie Canal under the supposition of transfer charges reduced as stated of $2,640,000 per year.

As the business of transportation through the canal would by no means all be done in vessels of the largest capacity, it is believed that the ship canal would have no advantage in furnishing cheap transportation over the improved Erie Canal with the transfer rates as at present, while with a reduction of transfer rates to three-fourths of a cent per bushel, the advantages would be decidedly with the smaller canal.

Comparing the ship canal with the Erie Canal radically improved to accommodate 1,500-ton barges, we see an advantage of the barge canal with the business conducted in fleets as at present over the 5,000-ton ship of 25 cents per ton, or $6,000,000 per annum, and over the 7,000-ton ship of 7 cents per ton, or $1,680,000 per annum, a mean advantage of $3,840,000 with the Buffalo transfer charges remaining as at present.

It may therefore be stated that the large barge canal would offer marked advantages to the shipper, even provided the Buffalo transfer charges remain as at present. As the barge canal would not cost more than one-fourth as much as the ship canal, its advantages as a business proposition are apparent.

If the transfer charges at Buffalo be reduced to three-fourths of a cent per bushel, the advantages of the barge canal over the 5,000-ton ship would be 39 cents per ton, or $9,360,000 per year, and over the 7,000-ton ship would be 21 cents per ton, or $5,040,000 per year, an advantage of $7,200,000 over the ship of mean size. This illustrates in a still greater degree the advantages of the barge canal as a business proposition.

Still further considering this barge canal, if we assume the partial separation and independence of motive power and carrying capacity and the transaction of business practically as it is done by the coastwise coal barge companies, the advantages of the barge canal over the ship canal appear in still greater relief.

Under this assumption, with the transfer charges at Buffalo remaining as at present, the advantages of the barge canal over the 5,000-ton ship would be 27 cents per ton, or $6,480,000 per year, and over the 7,000-ton ship they would be 9 cents per ton, or $2,100,000 per year, an advantage over the ship of mean size of $4,290,000.

With the transfer charges reduced to three-fourths of a cent per bushel, the advantages of the barge canal over the 5,000-ton ship would be 41 cents per ton, or $9,840,000 per year, and over the 7,000-ton ship would be 23 cents per ton, or $5,520,000 per year, an advantage over the ship of mean size of $7,680,000 per year.

As a barge canal of the size proposed would accommodate barges of a size sufficient to go anywhere on the lakes with safety, it is assumed that it would be able to force down transfer charges at any point to a minimum, and the last-named figures, therefore, represent approximately the advantages to the shipper of the barge canal over the ship canal.

As the barge canal, by the enlargement of the Erie Canal, can be constructed at a cost probably not exceeding one-fourth of the cost of a great ship canal, its double advantages in regard to first cost and economy in usage are very great. So great appear the advantages of barge navigation in a long canal over navigation by large vessels that I am convinced that were the ship canal built it would be little used by large vessels, and the bulk of the business would be done by barge lines, which could be accommodated almost equally well in a canal of much smaller size and of far less cost. I am, therefore, convinced that a ship canal from the Great Lakes to the Hudson is not a project worthy of being undertaken by the United States.

Comparing the proposed 1,500-ton barge canal with the Erie Canal, as it is now being improved by the State of New York, and navigated by six-boat fleets, we see an advantage in favor of the barge canal of 17 cents per ton, if the business on the barge canal is conducted with united fleets, and of 19 cents per ton if conducted with partial separation and independence of motive power and carrying capacity, or an average of 18 cents per ton. This means a saving on 24,000,000 tons of $4,320,000 per year. Allowing $1,000,000 per annum for operating expenses, care of canal, etc., over and above these expenses for the Erie Canal, we have left $3,320,000, which represents the interest on the justifiable cost. If interest be 3 per cent, which rate has been assumed in the matter of the ship canal, this would be $110,666,667, or in round numbers, $110,000,000, which represents the amount that could be profitably expended in the construction of a barge canal of the capacity proposed, over and above the amount necessary to make the improvements at present under construction.

It would not cost half the sum named.

All the figures given represent as nearly as practicable the actual cost of transportation with a fair allowance for interest on investment and deterioration.

In the last table, columns 12–13 and 14–15 represent the fair comparative through rates by the bushel and ton of wheat from Chicago to New York. These rates are determined as follows: To the net rate from Chicago to Buffalo, which for the past five years has averaged 1.37 cents per bushel, is added the net rates given in the table from Buffalo to New York, increased by 10 per cent for profit, contingencies, etc., and in the case of the small canals, first, by the present cost of transfer at Buffalo, 1.3 cents per bushel, and second, by the hypothetical reduced transfer cost of three-fourths of a cent per bushel.

With the largest ship of 7,000 tons capacity and the smaller canals operated in the most economical manner, all continuously and with existing transfer rates, the comparative attainable rates on a bushel of wheat, Chicago to New York, are as follows:

	Per bushel.	Per ton.
	Cents.	
By ship canal	3.88	$1.29
By present Erie Canal	5.32	1.77
By improved Erie Canal	4.22	1.41
By suggested barge canal	3.60	1.20

With the largest ship of 7,000 tons capacity and the smaller canals operated in the most economical manner, all continuously, but with transfer charges reduced to three-fourths of a cent per bushel, the comparative attainable rates on a bushel of wheat, Chicago to New York, are as follows:

	Per bushel.	Per ton.
	Cents.	
By ship canal	3.88	$1.29
By present Erie Canal	4.77	1.59
By improved Erie Canal	3.67	1.22
By suggested barge canal	3.05	1.02

In the figures given, no allowance is made for the loading or unloading expenses in the harbor of New York, nor for office expenses, commissions, or agents at different ports.

The figures are based on the assumption that the canals will be used and business transacted on them in a thoroughly businesslike and broad-gauge manner, which would require the abrogation of the very unwise and absurd restriction which New York now places on the canal by limiting its use to corporations with $50,000 or less capital. A corporation to do business in a proper and economical manner should have several fleets of canal boats, with its own terminal facilities and control of lines of lake steamers, and with the ability to give through bills of lading from the points of departure to any point along the canal. These objects are not attainable with a capital of $50,000.

The effect of this restriction is to seriously handicap business on the canal, and if it is to remain in effective force the money which New York is expending on the canal may be practically regarded as wasted. An effort was made to have this foolish law annulled during the session of the New York legislature just closed, but without success.

The figures given are also based upon the continuous operation of the vessels, boats, or barges during a season of navigation. As a matter of fact, such continuous operation can not be expected. Business will surely slacken up at times and cargoes will be difficult to obtain, and accidents will happen, and the vessels or boats will have to be idle for periods of varying length. During such periods of delay and enforced idleness certain items of expense, such as interest on cost, insurance, deterioration, wages, and subsistence of crew would run right along, and these expenses would be much greater in the case of the big vessel than in the case of canal boats or barges.

A knowledge of the business conditions affecting navigation will show that this is really an important item which materially swells the advantages of the smaller craft over the large vessels.

There is another advantage which the Erie Canal or the suggested barge canal might have over the ship canal, and this refers to the possible development of cheap electrical towage. Many men are studying the problem, and it is quite within the range of possibility that cheaply generated electricity may furnish the motive power along the canal in the not far distant future. If this should ever be attained, the advantages of the smaller canals over the ship canal would be increased.

NEW YORK HARBOR.

It has been deemed proper in completing this report to give a brief statement of the conditions, methods, and expenses attending the receipt, storage, transfer, and shipping of grain in the harbor of New York.

GRAIN TRANSFER AT NEW YORK CITY.

Grain is received at the port of New York by rail, by river and coast vessel lines, and by canal.

The canal route is generally understood to comprise the Erie Canal and branches and the Hudson River between Albany or Troy and New York City.

The receipts of flour and grain at New York by these routes, from May 1 to December 1, 1896, the time during which the canal was open, is shown in detail by the following table:

TABLE No. 33.

Route.	Bushels.	Per cent.
New York Central and Hudson River R. R.	23,042,001	20.55
Erie R. R.	17,942,473	16
Pennsylvania R. R.	3,781,101	3.37
Delaware, Lackawanna and Western R. R.	1,469,758	1.31
New York, West Shore and Buffalo R. R	13,335,228	11.89
Lehigh Valley R. R.	16,785,805	14.97
Baltimore and Ohio R. R.	610,311	.55
Various other railroads	3,047,389	2.72
Total receipts by rail	80,014,066	71.36
River and coast	435,389	.39
Canal	31,672,499	28.25
Total receipts by water	32,107,888	28.64
Total receipts by rail and water	112,121,954	100

Grain arriving at New York by rail is stored and transferred by large elevators. There are four of these, all controlled by the railroads, located in the immediate port of New York, three of which, the Pennsylvania, the Erie, and the New York, West Shore and Buffalo elevators, are situated on the New Jersey side of the North River, while the other, the New York Central and Hudson River elevator, is located in New York City proper, at the foot of Sixtieth street, North River. These elevators have a reported capacity each of 1,500,000 bushels, or a total of 6,000,000. Their general construction is similar, varying only in matters of detail. The Erie elevator is a long, narrow building, through which two railroad tracks are laid. The tracks within the limits of the building have a capacity of 10 cars each, or 20 cars in all. Situated between the tracks, and at intervals corresponding to the length of a car, are 10 elevator legs, consisting of an inclosed endless chain of metal buckets which carry the grain to the top floor of the elevator.

Located at the foot of these elevator legs are large receiving pits, which at the track level are covered with a grating, which extends under the car.

The loaded cars are run in on the tracks, the doors opened, and the grain allowed to run out and through the grating mentioned into the receiving pit below. To assist in unloading the grain from the end portions of the cars, large scoops or wooden scrapers are used, one in each end. These are drawn forward by a rope attached to a drum at the side of the elevator leg, the drum being operated by steam power. On reaching the car door the power is cut off automatically and the scoops are drawn back by hand, and the operation continued until the car is unloaded.

A car containing 1,000 bushels can be unloaded in about twenty-five minutes. The regular force employed in this work is two men in the car and one outside, called the elevator-leg tender.

The general practice is to unload cars from one track at a time, as the contents of each car is weighed separately. This weighing is done after the grain has been elevated or carried to the top floor of the building, where the weighing apparatus is situated. This consists, essentially, of a revolving garner, beneath which is placed the weigh hopper. The weighing operation is simple, the receiving garner being alternately filled and emptied, the grain flowing into the weigh hopper, where the procedure is the same.

The quantity usually weighed is from 500 to 1,000 bushels at a time, or at a draft, as it is called.

After weighing the grain it is either run directly through spouts to lighters, or else to bins and held for storage.

When grain is shipped from store, it is reelevated and reweighed.

When the elevator is running to its full capacity a force of from 75 to 80 men is required. This includes the foreman, clerical force, grain shovelers, engine and fire-room force, weighers, and the laborers trimming grain lighters.

The unloading capacity of the Erie elevator is stated to be 200 cars per day of ten hours, which is equivalent to 200,000 bushels.

The Pennsylvania elevator varies from the Erie in that the building is wider, but shorter. It is entered by 8 parallel railroad tracks, between each pair of which are located the elevator legs. There are 4 of these, or 16 in all. The grate-covered pits are similar in construction to those of the Erie elevator.

At the Pennsylvania elevator there is no receiving garner, but instead there are two weigh hoppers, the grain being alternately run into one or the other as they are being filled, weighed, and emptied. The weigh hoppers hold 500 bushels each. Unlike the Erie elevator, which has a water front on two sides, this elevator has a water front only at one end.

In transferring grain from the weigh hoppers direct to lighters, it is carried by belt conveyors to the end of the building, where the discharging spouts are attached.

In addition to the elevator there is also a separate shipping pier extending out into the North River. To load lighters from this pier, grain from the discharging spouts is run into other belt conveyors, which convey it to the pier, and it is there discharged by suitable spouts into lighters.

The New York Central and Hudson River elevator is also a long, narrow building containing 3 railroad tracks. Two of these are called receiving tracks, being the tracks from which the loaded grain cars are unloaded. The other track is termed the delivery track, and is used exclusively for loading cars containing grain, mainly corn and oats, intended for local consumption. As at the Erie and Pennsylvania elevators, the elevator legs here are located between two parallel tracks, there being 10 of these legs. The details of the grate-covered receiving pits are as those of the other mentioned elevators.

The New York Central and Hudson River elevator has a water frontage on one side and at one end. To load into lighters from the side, 15 spouts are provided, with another at the end, making 16 in all. Two hundred cars of grain have been unloaded at this elevator during ten hours, but this is very exceptional work. The average receiving capacity is 160 cars per day, equivalent to 160,000 bushels.

The New York, West Shore and Buffalo elevator is situated on the New Jersey side of the North River, almost opposite the New York Central and Hudson River elevator. It has a water frontage on two sides. Two tracks enter this elevator, and the number of elevator legs is 8, accommodating that number of cars on each track. For loading into lighters, 24 spouts are provided, 12 on a side.

From the above description, it will be inferred that the railroad elevators at New York City differ very radically in construction from the Buffalo elevators, in that they are not adapted to unloading grain from large vessels, and only two, the Erie and the New York Central and Hudson River elevators can unload from canal boats. In the case of the Erie elevator, these facilities are contained in a separate building, located adjacent to the main elevator, while at the New York Central and Hudson River elevator an elevator leg, arranged for this work, is located at one end of the main building.

Wheat intended for home consumption is delivered to flouring mills or to their adjacent docks from the different elevators, mainly in lighters or canal boats.

But two of the four large flouring mills of New York and vicinity have water fronts. These are the Jewell Mill, in Brooklyn, and the Staten Island Mills, on the island of the same name.

Hecker's, and Jones's, two large mills located in New York City, are some distance back from the water front, and grain, after it is unloaded at the dock or pier by small floating elevators, is carted to the respective mills.

The terminal and harbor facilities at New York City are peculiar, and the cost of handling traffic is excessive. Owing to the geographical conditions which prevail at this port it is not possible to unite the railroad and vessel interests at one common point, but instead terminals and docks are required to be maintained at Jersey City, New York City, and Brooklyn. Owing to this condition railroads are in a position to impose upon traffic an expensive elevator, lighterage, and warehouse system. The conditions briefly stated are that freight from the west is received in Jersey City, stored in Brooklyn, and shipped in New York City, the points of receipt, storage, and shipping being thus widely separated.

In the transportation of grain from the Western grain-producing and storing centers the trunk lines terminating in New York City for many years have made it part of the transportation agreement that they (the railroads) shall deliver the grain alongside of the ship without charge therefor, except as included in the freight rate.

In pursuance of this agreement, the railroads transfer grain from their cars through elevators into lighters, by which it is transported in the harbor alongside of vessels, and for which transportation or lighterage a charge of 3 cents per 100 pounds, equal to 1.8 cents per bushel of wheat, is exacted by the lighterage companies doing the work.

After the grain is put alongside of vessels it is transferred thereto by floating elevators, concerning which operation mention will be made further on.

In order to avoid the expense of lightering, the railroads some years ago determined to transfer grain direct from stationary elevators into ocean vessels, and for that purpose constructed large and expensive elevators, fully adapted to the requirements of this business. The result of the building of these railroad elevators was the direct delivery of grain from them to vessels which came to the elevators to load. A large and constantly growing business was thus being built up, and the lighterage fee of 3 cents per 100 pounds saved.

This mode of delivery conflicted materially with the operations of the floating elevators, whose operations were being gradually confined to transferring grain arriving in canal boats from the Erie Canal. In order to allow the floating elevators to regain this business, and to prevent a threatened rate war with Boston railroads, a set of rules and tariff of charges were promulgated, under date of October 16, 1882, by the railroad elevators in the port of New York, and of which rule 5 reads as follows:

> Receiving, weighing, and storing (grain) for the first ten days, or any part thereof, one-quarter of a cent per bushel, and an additional charge of 1 cent per bushel if delivered to ocean vessels, and one-quarter of a cent per bushel for all subsequent ten days or parts of the same, so long as the grain remains in store and in good order.

This method is known as a direct delivery, being direct from the railroad cars through the elevators to vessels, without the intervention of lighters. The charge for this direct delivery is now practically the same as that exacted by the International Elevating Company of New York, a concern which has a monopoly of the floating elevator transfer business in New York Harbor.

In consequence of the charge made by the railroad elevators for transferring grain direct, ocean vessels have mostly abandoned this method of loading grain, and load instead from lighters (brought alongside of the vessels) by means of the floating elevators.

This is of advantage to vessels running in regular transportation lines, as the grain is brought to the steamer pier and no time is lost in going to elevators.

As previously stated, the railroad freight rate on grain includes the free delivery alongside of vessels. This is also applicable to any warehouse, dock, mill, etc., situated within the lighterage limits and having water facilities.

The lightering is done by towboat lines more or less intimately connected with the railroad companies, as well as by concerns which are especially engaged in the towing business.

To recompense the roads having termini in New York Harbor for the expense of lightering grain, an amount equal to 3 cents per 100 pounds, or 1.8 cents per bushel of wheat is deducted from the freight rate, which sum represents the cost of lightering, or, in other words, the amounts paid by the railroad companies to the lighterage companies for performing this service, and called the "lighterage arbitrary."

It is believed that the actual cost of lighterage in New York Harbor does not exceed one-half to three-fourths of a cent per 100 pounds.

After the deduction of 3 cents per 100 pounds from the freight rates, the residue is retained by the railroad company as its share for transportation charges.

Grain arriving at New York and destined for immediate export is subject to no charge while passing through the railroad elevator to lighters and towed alongside of ocean vessels.

Consignees are allowed to hold grain in lighters four days (exclusive of Sundays and legal holidays) free of expense. After that time, demurrage accrues at the rate of one-eighth of 1 cent per bushel per day, which on a cargo of 8,000 bushels (the usual lighterage cargo) amounts to $10 per day. This rule is not at all rigidly enforced.

Conditions are not always favorable for immediate shipment, in which event the grain is stored for such periods as may be elected, the rate for storage being one-fourth of 1 cent per bushel for every ten days or a fraction thereof. This charge is more fully set forth in rules 1 and 5 of the rules and tariff of charges of the railroad elevators in the port of New York. Rule 1 reads as follows:

Consignees electing to have grain (received on railroad bills of lading, subject to free lighterage) remain in elevator or storage, subject to the railroad elevator rules and rates of storage, will be granted free lighterage in delivery from elevator; provided, however, that such grain inspects in good order on its arrival, and notice to store be given in writing before such grain is received in elevator, the right being reserved to store only such kind and grade of grain as may be from time to time agreed upon by the different railroad elevators; and after such grain is delivered from the elevator it will be allowed three days, including that of its arrival (prior to 6 p. m.) at a specified point of destination, free of charge, and shall thereafter pay $10 demurrage for each twenty-four hours, or part thereof, on each order for delivery of 10,000 bushels or less of one grade of oats, and 8,000 bushels or less of any other grain, until discharged; on deliveries made at 7 p. m. demurrage will be made for the following day.

The part of rule 5 relating to storage reads as follows:

* * * and storing for first ten days, or any part thereof, one-quarter of a cent per bushel, * * * and one-quarter of a cent per bushel for all subsequent ten days, or parts of same. * * *

It has been previously stated that the charge for loading grain is practically the same whether ships go to the elevators or the grain and floating elevators go to the ships. The steamships of the regular lines avail themselves of this advantage by remaining at their respective piers or docks and having the grain brought alongside, as much time is saved to them. After arrival from a foreign port, as soon as a particular hatchway is unloaded of inbound freight, this same hatch can at once be used for loading grain. As these line vessels carry a miscellaneous cargo, the fact of being enabled to load from a fixed pier or warehouse and at the same time receive a cargo of grain is of importance, especially when time is a factor.

The operation of unloading grain arriving in cars at railroad elevators has been stated at length.

If the grain is intended for immediate export, it is at once spouted to lighters. The lighters generally used for transporting grain from the elevators to alongside of vessels are canal boats of the same class as those which navigate the Erie Canal. These boats as a rule are the property of individual holders, and are rented or hired to the various lighterage or tugboat companies by the day. The rate paid by these companies ranges from $1 to $5 per day of twenty-four hours, the charge depending upon the demand for lighters, which fluctuates greatly during the year. The boat owners are held responsible for the proper maintenance of the boats, in order that they may be kept in a water-tight and serviceable condition.

The New York Central and Hudson River Lighterage Company controls a special fleet of lighters, consisting of about 20 boats, which are modeled after ordinary canal boats, but are larger in every dimension, and with capacities ranging from 15,000 to 18,000 bushels.

After the lighters are loaded they are taken in charge by the tugboats and towed to points of destination, as, for instance, alongside of an ocean vessel. On arrival, the lighters are taken in charge by the floating elevators, which transfer the grain from the lighters to the vessel.

These floating elevators, of which there are twenty, are all owned by the International Elevating Company. Ten of them are provided with machinery for propelling themselves, while the other ten require to be towed. Their cost is stated to be from $30,000 to $70,000 each.

Some of the floating elevators also lighter grain, the holds of the larger ones being utilized for its storage. The holds of three of these provide a storage capacity for 24,000 bushels each, while that of four others is 4,000 bushels each, or a total capacity for the seven of 88,000 bushels.

The crew required to man one of these elevators is as follows: One superintendent, 1 captain, 1 engineer, 1 fireman, 1 deck hand, 1 to 3 weighers, 1 millwright, and 1 night watchman. The wages paid this crew range from $600 to $700 per month.

In addition to the crew required to operate the floating elevator, there is a gang of shovelers which accompanies the elevators from place to place. This gang consists of from 18 to 23 men, whose work is shoveling the grain to the elevator legs in the lighters or canal boats and trimming the same in ocean vessels. For this work of shoveling and trimming they receive a fixed rate of $3.50 per 1,000 bushels, which is paid to them by the elevating company.

The operation of transferring grain may be briefly described as follows: The floating elevator is placed between the lighter and the vessel to be loaded. An elevator leg is then inserted into one of the hatches of the canal-boat lighter and a portion of the cargo transferred. Each hatch is treated in succession, making a partial removal at a time for the purpose of obviating a strain in the lighter, which would result from the complete discharge of a hatch after the first insertion.

The grain upon being elevated drops into a weigh hopper, where it is weighed in lots of 50 to 75 bushels, varying with the size of the elevator. It is then reelevated, passed over a screen and cleaned, and again elevated, and finally spouted to the hold of the receiving vessel,

The transfer capacity of an elevator may be stated to be about 4,000 bushels per hour. The expense of transferring grain from the lighter to ocean vessels is borne by the grain, and the charge for this work per bushel is as follows:

	Cents.
Receiving, weighing, and discharging	0.625
Transportation of elevator	.500
Canal-boat trimming, $1.50 per 1,000 bushels	.150
	1.275

or $1\frac{11}{40}$ cents per bushel; or, as generally stated, $1\frac{1}{4}$ cents.

In addition to the above charge the ocean vessel pays to the elevating company for trimming grain in the hold $2 for every 1,000 bushels loaded. No charge is made to the grain for this work, but it is included in the ocean freight rate.

It will be observed that the elevating company receives a net rate of $1\frac{1}{8}$ cents for every bushel transferred, as the sums received for trimming canal boats (lighters) and ocean vessels, $1.50 per 1,000 bushels and $2 per 1,000 bushels, respectively, or a total of $3.50 per 1,000 bushels, are paid to the shoveling gang mentioned before for performing this work.

Assuming the floating elevator to work ten hours per day, the quantity of grain transferred during the time would be 40,000 bushels, and at $1\frac{1}{8}$ cents per bushel would amount to $450.

The daily expense of operating a floating elevator is not over $100, including wages, fuel, oil, repairs, incidentals, and interest on investment and deterioration, so that the actual cost of transfer is about one-fourth of a cent per bushel. This computation of cost is predicated on constant employment, which, in fact, is not the case. Were the elevators employed only half the time the cost would be one-half cent per bushel, which would still leave quite a large margin for contingencies and profit.

During the year 1895, 45,731,125 bushels of grain were exported from New York. It may be assumed that two-thirds of this quantity, or say 30,000,000 bushels, was transferred by the floating elevators. This would indicate an average daily shipment of 100,000 bushels for 300 days, or only 5,000 bushels daily for each of the floating elevators engaged in this trade, showing a very large reserve power, and from which it may be inferred that only a small number of elevators are constantly employed.

Considerable grain is transferred at night, and when this occurs ocean vessels are charged double rates for trimming, or $4 per 1,000 bushels. Out of this additional rate the shoveling gang receives $1.50 per 1,000 bushels as their share of the work, and the other 50 cents is divided among the elevator crew. No expense, however, is attached to the grain owing to this extra charge.

In addition to the transfer charges there are also inspection charges. Railroad grain on arrival is inspected in the car, for which the charge is 50 cents per carload, equivalent to this amount per 1,000 bushels, the usual carload.

For what is termed out inspection and superintending at place of delivery of grain afloat the charge is 50 cents per 1,000 bushels. These charges have especial reference to grain intended for immediate shipment abroad on arrival.

Much of the grain arriving in New York City by rail is held in store in the Brooklyn warehouses, which are virtually owned by the Brooklyn Wharf and Warehouse Company, a concern having a capital stock and bonded debt of about $30,000,000 and an estimated storage capacity of 15,000,000 bushels of grain.

Grain is delivered free by the railroad companies in lighters alongside of these warehouses, the same as alongside of ocean vessels, the expense of the lighterage being included in the freight rate. When direct delivery to ocean vessels is made through these warehouses the charges are identical with those of the International (floating) Elevating Company, and are as follows:

	Cents.
Receiving, weighing, and discharging, including ten days' storage	0.625
Extra storage	.500
Trimming lighters, $1.50 per 1,000 bushels	.150
Total	1.275

or $1\frac{1}{10}$ cents per bushel. To which must also be added the inspection charges, 50 cents per 1,000 bushels.

Should, however, the grain be held for storage there would be a charge termed inspection into regular warehouses, which is 50 cents per 1,000 bushels, and also a charge known as inspection out of regular warehouses, which is again 50 cents per 1,000 bushels.

It will be readily observed that under certain conditions the inspection charges can aggregate $1.50 per 1,000 bushels. Taking the case of grain held for storage for a period of fifty days, the total charges would be as follows:

	Cents.
Storage for ten days free	0.000
Storage for forty days, one-fourth cent for each ten days	1.000
Transfer charges	1.275
Inspection charges	.150
Total	2.425

or nearly $2\frac{1}{2}$ cents per bushel.

The statement that ocean vessels do not load directly through the elevators does not apply to the Brooklyn warehouses (so called), where much grain is transferred direct (without the intervention of lighters) to ocean vessels.

This grain is taken by vessels classed as "tramps" (to distinguish them from the regular ocean liners) and belonging to individuals or companies having no docks or piers of their own in New York Harbor. Vessels of this class usually take full cargoes of grain, to the exclusion of other freight. In cases where grain is lightered from the Brooklyn warehouses to alongside of ocean vessels and transferred to them, the charge is given below:

	Cents per bushel.
Half weighing at warehouse	0.3125
Lighterage	.5000
Floating elevator charges	1.2750
Total	2.0875

or $2\frac{1}{10}$ cents per bushel, to which must be added the usual storage and inspection charges.

There are also other possible charges, such as for screening and blowing grain, either on receipt or delivery, one-fourth of a cent per bushel; mixing grain of different grades, on receipt or delivery, including screening and blowing, one-half of a cent per bushel.

For delivery in bags, a charge ranging from 1 to $1\frac{1}{2}$ cents per bushel is made. Grain run to special bins for delivery to teams is subject to an additional charge of one-half cent per bushel; transferring grain while in store, one-fourth of a cent per bushel. This has reference to changing grain from one bin to another, as in the case of hot grain, in order to cool it, and for other reasons. Many of these charges are optional and are not compulsory, as are the transfer charges.

Owing to the limited capacity of the railroad elevators, railroad grain is also largely stored by the railroad companies in lighters, canal boats and barges being used for this purpose.

It is stated that during the winter of 1896 and 1897 as many as 600 lighters were used for this purpose, the contents approximating 5,000,000 bushels. The storage rates are the same as if stored in the railroad elevators and Brooklyn warehouses, the barges being hired by the railroad companies by the day, without regard to storage rates.

INSURANCE RATES.

The insurance rates charged for grain stored in railroad elevators range from 2 to 2½ per cent per annum, while the Brooklyn warehouse rate is three-fifths to three-fourths of 1 per cent per annum.

For grain stored in lighters the marine insurance rate is one-tenth of 1 per cent for every ten days.

CANAL GRAIN.

Canal-boat fleets after leaving the Erie Canal and entering the Hudson River are, in the case of horse-boat fleets, assembled in large tows of from 50 to 60 boats, and then towed by powerful tugs to New York.

Steam canal boats, possessing their own propelling power, tow their immediate consorts to the same destination.

The charge for towing horse canal boats from Troy to New York is $28 per boat, and from Albany the charge is $25, this charge being paid by the boat owner.

The landing place of the Erie Canal boats in New York City is between piers 3 and 8, East River, which is the recognized canal district, having been especially set apart by the city of New York for this purpose. Grain consigned to New York is required to be delivered at any point accessible by water within a radius of 15 miles of the Battery, if so desired by the consignee, the grain paying all harbor towing from and to the usual place of landing.

Three days are allowed by canal boats for unloading cargo, after which a charge of $5 per day is made for demurrage, which must be paid by the grain. This demurrage charge was formerly $10 per day.

Canal boats are charged for wharfage, the rate for which is 50 cents a day for loaded and 30 cents a day for light (or empty) boats. The rates charged for towing grain canal boats vary as to distance and locality.

The towing charges are paid by the grain. After grain canal boats are put alongside of vessels the grain is transferred by the International Elevating Company in the same manner and by the same methods as the grain arriving by railroads and transported alongside of vessels in lighters.

The charges to the grain for transferring from canal boats to vessels are as follows:

	Cents per bushel.
Receiving, weighing, and discharging	0.625
Transportation of floating elevator	.500
Total	1.125

or 1⅛ cents per bushel.

The floating elevator also makes a charge for trimming canal boats and ocean vessels, which is the same as for railroad grain, viz, $3.50 per 1,000 bushels. Of this the canal pays $1.50 per 1,000 bushels and the ocean vessel the remainder, viz, $2 per 1,000 bushels. In both cases the trimming charges are included in the freight.

Inspection charges are the same as for railroad grain. As to insurance, the Buffalo rates carry for five days after arrival, and should boats be unloaded within this period of time, the rate for the first subsequent month is 20 cents for every $100 value and 10 cents for each additional month.

Canal grain intended for storage in the Brooklyn warehouses is subject to the same charges and conditions as railroad grain. Briefly stated, the charges for railroad and canal grain are as follows:

RAILROAD GRAIN.

Freight rate to New York City includes free delivery alongside vessels, warehouses, mills, etc., having water front. The railroads pay the expense of transfer from cars through the railroad elevator to the lighter, and the towing of the lighter. The grain pays for the trimming from lighters and the transfer from lighters to vessels, warehouses, and mills; also the inspection and insurance charges. Ocean-vessel trimming is paid for by the vessel.

CANAL GRAIN.

Freight rate to New York includes the delivery to canal district at the foot of Whitehall street, and also the trimming of the canal boat when put alongside of vessels, warehouses, and mills. The grain bears the expense of lightering or towing, transferring from canal boats to vessels, and inspection and insurance charges. Ocean-vessel trimming is paid for by the vessel. There is a slight variation in the charges between export grain and grain intended for home consumption. Flouring mills generally have their own elevating appliances, and can thus transfer grain on their own account, making a charge of five-eighths of a cent per bushel, and $1.50 per 1,000 bushels for trimming, all of which is paid by the grain.

The following table shows the yearly receipts of wheat by rail, river, and coast, and by canal for the years stated:

TABLE NO. 34.

Year.	Rail.	River and coast.	Canal.	Total.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
1891	38,881,542	156,715	21,962,594	61,000,851
1892	46,337,008	36,877	17,208,375	63,582,260
1893	15,633,395	73,990	33,070,600	48,777,985
1894	4,376,225	55,001	26,344,200	30,775,426
1895	22,255,000	148,727	6,523,700	28,927,427

There are also wide variations in the relative quantities of wheat carried by the various lines of transportation. Referring to the table, it will be seen that the railroad and canal shipments for the years 1894 and 1895 are reversed. The large falling off in canal shipments for the year 1895 is attributable to the fact that during the season of 1895 the railroads carried wheat at extremely low freight rates. Many of the canal-boat owners were unable to meet this competition, the railroad rates being fixed at such a figure as to offer no remuneration for canal transportation except in the cases of the large steam canal-boat fleets.

It has been asserted that the action of the railroad companies was for the purpose of discrediting canal transportation, and thereby influencing the appropriation of $9,000,000 for the improvement of the canals, which was voted upon in November, 1895.

The receipts of wheat at tide water by canal for the season of 1896 were 11,195,366 bushels, or nearly double the quantity carried for the previous year.

Regarding the decline in the receipt of wheat (and other grain) at New York, it is claimed that this is brought about by the action of the Joint Traffic Association, of which a number of trunk-line railroads are members, allowing certain Atlantic ports, such as Baltimore, Norfolk, and Newport News, certain differences in rates, termed "differentials." The freight rates for the ports named are 3 cents per 100 pounds less than the New York rate, and this, it is claimed, has the effect of attracting trade to Baltimore, Norfolk, and Newport News and withdrawing it from New York City.

It has been previously stated that canal grain cargoes were allowed three week days during which to unload. On the expiration of this time demurrage was charged at the rate of $10 per day or part of a day until the cargo was fully discharged. This charge was equivalent to a storage rate of one eighth of a cent per bushel per day, or 1¼ cents for ten days, as against one-quarter of a cent charged by the warehouse for storage.

For the season of 1897 this demurrage charge has been reduced one-half, or to $5 per day, equivalent to a storage rate of one-sixteenth of a cent per bushel per day, on the assumption of an 8,000-bushel grain cargo.

Assuming the construction of a ship canal, and taking the case of a grain lake freighter arriving with a cargo of 5,000 tons of wheat, or 166,667 bushels, and making a charge of one-sixteenth of a cent per bushel for demurrage, the daily charge would be $104.17. As the daily expense of a great steamer, including allowances for interest and deterioration is from $200 to $300, this demurrage charge would have to be much increased to properly compensate the vessel.

It is not likely that consignees would be content to pay even this amount when elevator or warehouse rates are only one-fortieth of a cent per bushel per day. This rate applied to a cargo of 166,667 bushels would be $41.67 per day.

The large percentage of grain exported from New York is shipped by the regular line steamers, which take grain along with other cargoes. These shipments are termed "berth," in contradistinction to full cargoes. In 1895 wheat shipped in full cargoes was 33 per cent of the total shipments, while in 1896 only 22 per cent was shipped in this manner.

To illustrate the comparative shipments during the year the following table, showing monthly shipments of wheat during the year 1895, is appended:

TABLE No. 35.

Month.	Wheat.	Percentage.	Month.	Wheat.	Percentage.
	Bushels.			*Bushels.*	
January	2,690,534	11.1	August	878,620	3.6
February	1,594,952	6.6	September	2,117,730	8.7
March	2,013,315	8.3	October	2,271,728	9.3
April	2,870,217	11.9	November	2,672,479	11.1
May	1,868,013	7.7	December	3,270,212	13.5
June	1,191,883	4.9			
July	800,116	3.3	Total	24,239,799	100

Conforming to present conditions, large grain lake freighters arriving in New York through a ship canal with grain cargoes of from 5,000 to 7,000 tons would in most cases be obliged to go alongside of the regular lines to unload. Owing to the contracted size of many of the slips of the present piers, this would be impossible, especially as there would of necessity be some space required for a floating elevator to transfer the grain. The present floating elevators are adapted for unloading from canal boats and lighters and not from large vessels, consequently they could not be utilized in transferring grain from large grain lake freighters, and it would become necessary to construct such others as would be adapted to the new condition of things.

The grain lake freighters of the capacity mentioned would generally find it impossible to transfer grain immediately on arrival, and as it would not be economical or expedient to have these vessels serve in a storage capacity, grain would have to be transferred to some elevator or warehouse.

None of the present railroad elevators are designed for this work, and would consequently have to be remodeled to suit the exigencies of the case. Neither are the Brooklyn warehouses arranged for unloading these proposed grain freighters, their unloading arrangements being confined to unloading canal boats, lighters, and schooners. The maximum unloading capacity of one leg of the Brooklyn warehouses is 9,000 bushels per hour, while the average unloading capacity is about 5,000 bushels. No steam shovels, such as are employed at Buffalo, are used. These appliances greatly expedite the work of unloading, which explains the fast work done at Buffalo.

So far as can be learned, the largest single amount of grain unloaded at the Brooklyn warehouses was a cargo of 41,000 bushels of wheat from a schooner.

Unless the entire cargo of a grain lake freighter was consigned to one certain or particular ship it would, on arrival at New York, be necessary to go alongside as many different vessels as there were consignees. This would, even if possible, entail extra towing from point to point. This condition would be especially applicable in cases where the cargo was composed of different kinds of grain and each intended for different vessels for exportation.

A grain lake freighter complying with these conditions would actually become a large and expensive lighter.

It would hardly be considered practicable to transfer grain in small quantities, continually shifting around.

As to the cost of transferring grain from a grain lake freighter to an ocean vessel, the expense, if proper facilities and machinery were furnished, should not vary materially from the present method of unloading from canal boats and lighters. As previously pointed out, floating elevators especially designed would be required.

Regarding the unloading of grain from lake freighters into elevators or warehouses, the expense would be identical with that of unloading from canal boats and lighters. In fact, with the use of modified elevators, such as are used in Buffalo, the operation of transferring grain would be an exact counterpart of that employed in that city.

Viewed from any standpoint, the transfer of grain from lake freighters assumed to arrive in New York Harbor could not be done any more economically than it is now done from canal boats, while in the great majority of cases it seems probable that the cost would be much higher.

It can not be gainsaid that the rates for transfer service could be reduced to a great extent, but this in no event could be considered an advantage as far as lake freighters are concerned, as the reduced charges would as well apply to grain arriving in canal boats and barges.

The following table, compiled from the reports of the New York Produce Exchange, gives the freight rates on various commodities from New York to Liverpool by steamer for the nine years 1887 to 1895:

TABLE No. 36.—*Ocean freight rates by steamer from New York to Liverpool (per ton of 2,240 pounds).*

[Compiled and reduced from annual reports of New York Produce Exchange.]

Year.	Grain, average of 58 pounds per bushel.	Flour, in sacks.	Beef, in tierces of $4\frac{1}{2}$ per ton.	Pork, in barrels of 6 per ton.	Provisions.	Oil cake.	Average rate per ton for each year.
1887	\$1.98	\$2.23	\$2.95	\$3.49	\$3.64 $\frac{3}{16}$	....	\$2.88
1888	2.20 $\frac{8}{16}$	2.33	3.34 $\frac{4}{16}$	2.97	3.85 $\frac{4}{16}$	....	2.94
1889	2.55 $\frac{4}{16}$	3.33 $\frac{8}{16}$	4.94 $\frac{5}{16}$	5.62 $\frac{8}{16}$	5.71 $\frac{9}{16}$	\$3.12	4.22
1890	1.92	2.45 $\frac{5}{16}$	3.81 $\frac{6}{16}$	3.67 $\frac{4}{16}$	4.37 $\frac{3}{16}$	2.18	3.07
1891	2.46	2.95 $\frac{1}{16}$	3.99 $\frac{7}{16}$	3.80	4.36 $\frac{5}{16}$	2.61 $\frac{9}{16}$	3.36
1892	2.12 $\frac{4}{16}$	2.49 $\frac{3}{16}$	3.20 $\frac{1}{16}$	2.77 $\frac{3}{16}$	3.66	2.22 $\frac{3}{16}$	2.76
1893	1.81 $\frac{6}{16}$	2.26 $\frac{7}{16}$	3.11 $\frac{3}{16}$	2.97 $\frac{1}{16}$	3.68 $\frac{4}{16}$	2.20	2.67
1894	1.49 $\frac{4}{16}$	1.88	2.75	2.56 $\frac{7}{16}$	3.39 $\frac{1}{16}$	1.79 $\frac{4}{16}$	2.31
1895	1.69 $\frac{3}{16}$	1.89	2.51 $\frac{4}{16}$	2.13 $\frac{5}{16}$	2.77 $\frac{7}{16}$	1.84 $\frac{5}{16}$	2.14
Average of the rates for each commodity for nine years	2.03	2.43	3.41	3.33	3.94	2.28	2.93

These rates are all for tons of 2,240 pounds, upon which unit all freights going to Great Britain are based.

Reduced to tons of 2,000 pounds, which ton is the unit upon which the lake and canal freights are based, and considering the item of grain alone, the average cost for the nine years would be \$1.81 per ton from New York to Liverpool, which in the case of wheat would be 5.43 cents per bushel.

If wheat is shipped directly through New York the average transfer charges, including demurrage, extra storage, etc., will amount to about 50 cents per ton, or $1\frac{1}{2}$ cents per bushel.

Adding these items to the attainable rates on wheat from Chicago to New York previously given, with the lake freighter of 7,000-ton capacity and the Buffalo transfer charges as at present, we have the following as the practical attainable cost of shipping wheat from Chicago to Liverpool by various methods between the lakes and the sea.

	Per bushel.	Per ton.
	Cents.	
By ship canal	10.80	\$3.60
By present Erie Canal	12.24	4.08
By improved Erie Canal	11.16	3.72
By suggested barge canal	10.53	3.51

Assuming the Buffalo transfer charges to be reduced to three-fourths of a cent per bushel, these rates from Chicago to Liverpool become:

	Per bushel.	Per ton.
	Cents.	
By ship canal	10.80	\$3.60
By present Erie Canal	11.70	3.90
By improved Erie Canal	10.59	3.53
By suggested barge canal	9.99	3.33

With proper business arrangement it is believed to be practically possible to ship wheat through the lakes and through the Erie Canal, enlarged, as suggested, to New York, and thence to Europe, with a fair margin of profit, at a cost not exceeding 10 cents per bushel.

ESTIMATED COST OF SURVEYS.

There are submitted herewith estimates of the cost of surveys for ship canals along the Niagara-Oswego-Mohawk route, and along the Erie Canal route, the two ship-canal routes wholly within the United States, which surveys must precede the preparation of detailed plans and estimates of cost.

By the survey provided for accurate information would be procured of the topography of the country in the vicinity of the canal, the character of the materials along the line of the canal, the location, elevations, and grades of all railroads, highways, water courses, etc.; all streams would be gauged and all property lines determined, with buildings, lists of owners, assessed valuations, etc., of all property which would be affected by the construction of a canal, and all railway and highway crossings fixed, etc.

The whole plan of survey is based upon using locks of the ordinary type and of the size mentioned in this report, with emplacements provided for the additional locks which may be demanded in the future.

NIAGARA SHIP CANAL.

This canal is indissolubly connected with the improvement of the upper Niagara River, and this again with the question of regulating the lake levels, and they must to a certain extent be considered together. Accurate plans and estimates for a Niagara Ship Canal can not be prepared until the general plan and policy of treating the upper river and the lake levels is determined.

It is estimated that the determination of these questions to the extent sufficient will require an expenditure of $5,000 for survey work and the study and consideration of all possible or proposed plans for the attainment of the objects in view.

The 1876 surveys of the Niagara Ship Canal are considered as showing in general all the practicable routes, and it is assumed that a study of their maps and profiles, and such further reconnaissance as may be deemed advisable, will show conclusively that the Lockport-Eighteen-Mile Creek-Olcott route is the most desirable, and that the complete survey can be limited to that route and to determining the exact location of the line and structures. The survey would show all the natural and artificial features, buildings, railways, highways, streams, property lines, ownerships, assessed valuations, etc., for a strip 2,000 feet in width for the entire line, 25.3 miles in length. Accurate contours 5 feet apart would be put in and borings and pits sunk sufficient to give accurate and full information as to the character of the materials. The basis of the survey would be five base lines run 400 feet apart along the route with stations every 100 feet. At the probable lock locations the surveys would be in great detail. The borings would be made by contract under careful supervision, and all specimens would be carefully and systematically filed away for future reference.

The following is the estimated cost of the work:

Field work along main line of canal	$12,000
Field work at lock sites	2,250
Field work of cadastral survey	2,800
Office work	6,400
Traveling expenses	1,000
Subsistence in field	3,120
Instruments	1,000
Borings	6,000
	34,570
Add 10 per cent for contingencies, gauging, etc	3,457
	38,027
Niagara River survey	5,000
Total	43,027

OSWEGO-ONEIDA-MOHAWK ROUTE.

As this line must of necessity follow the thalwegs of the natural valleys indicated by its title, there is little to be done in the choice of location except at the Oneida crosscut, the Rome summit, and the descent into the Hudson near Cohoes Falls.

In general, it will be necessary to run base lines along each side of the river, with stakes of alignment and elevation every 100 feet and with lines of soundings between opposite stations, and other base lines on the higher ground of the river bank on each side. Large numbers of borings will be needed to determine the best dam and lock locations, and in some instances diamond-drill borings will be required.

For the section of canal proper along the route the general plan outlined for the Niagara Ship Canal survey would be followed.

Along the route special attention will have to be given to various items.

WATER SUPPLY.

This must be carefully studied by experts, and the proper location of the canal can only be determined after the question of water supply is settled. If the water supply for a high-level canal above Oneida Lake is not found sufficient, then the alternative would be presented of a deep cut to the level of Oneida Lake or a feeder to Lake Erie.

PRESENT CANALS.

It would be necessary primarily to know what policy to adopt in regard to the present New York State canals, whether they are to be left intact and undisturbed, or to be ignored and absorbed in the greater ship canal. As stated in the body of this report, a full understanding with the State should, if practicable, precede any operations.

The cadastral surveys along this route, and especially in the Mohawk Valley, will be of great importance, and must extend over all the areas liable to be flooded by the structures put in to canalize the river. The location of dams and locks will have to be determined in general by a balancing of many interests.

The following is the estimated cost of the survey:

Field work along lake, canal, and canalized rivers, and for determination of water supply problem	$50,000
Field work at lock and dam sites	6,000
Field work of cadastral survey	8,400
Field work, Oneida Lake	1,000
Office work	27,000
Traveling expenses	3,000
Subsistence in field	12,000
Instruments	2,000
Borings	18,000
	127,400
Add 10 per cent for contingencies	12,740
Total	140,140

ERIE CANAL ENLARGEMENT.

The following estimate of the cost of enlarging the Erie Canal is based upon the supposition that it is to be enlarged to a size capable of passing barges of 1,500 tons capacity, with locks, curvatures, etc., capable of passing two such barges hitched together tandem; that it is to be so located as to provide for a continuously descending canal all the way from Lake Erie to the Hudson; that the Mohawk River is to be canalized; that locks of the ordinary type are to be used, and that the recent full surveys of the Erie Canal made by the State engineer department and the records of the State engineer's office would be available and would be utilized in preparing a new project for its enlargement.

If this survey and preparation of general plans of enlargement of the Erie Canal is done in addition to the ship canal survey by the Oswego route, no additional work through the Mohawk Valley would be required, as the two would coincide. The new line to be surveyed would be the 70 miles between Rome and Newark. The methods of this work would be similar to those outlined for the Niagara and Oswego routes. The line from Newark to Buffalo would have to be carefully studied, and extensive surveys would be required in some cases where other locations would be required or where locks would be placed.

The following is the estimated cost of the work required upon the preceding suppositions:

Field work on survey proper	$18,000
Field work on cadastral survey	6,000
Field work on special surveys	4,000
Office work	12,000
Traveling expenses	2,000
Subsistence in field	4,000
Instruments	1,000
Borings	8,000
	55,000
Add 10 per cent for contingencies, etc	5,500
Total	60,500

If the survey for this Erie Canal enlargement is made independently of the survey for a ship canal by the Oswego-Oneida-Mohawk route, it will require in addition to the above the sum required for the survey of the Mohawk River with a view to its canalization, which sum is estimated at $60,000.

THE HUDSON RIVER.

Boards of Engineers having made plans and estimates for the improvement of the Hudson River to the extent required in any of the cases mentioned in this report, it is not believed that any money need be expended for additional surveys of this river.

The following is a summary of the estimates, in round numbers:

NIAGARA-OSWEGO-MOHAWK SHIP CANAL.

Niagara River and ship canal	$43,000
Oswego-Oneida-Mohawk Canal	140,000
	183,000
Expenses of administration	7,000
Total	190,000

ERIE CANAL, ENLARGED TO CAPACITY FOR 1,500-TON BARGES.

Lake Erie to Rome	$60,000
Rome to the Hudson	60,000
	120,000
Expenses of administration	5,000
Total	125,000

COMPLETE SURVEY FOR NIAGARA-OSWEGO-MOHAWK SHIP CANAL, AND ALSO FOR ERIE CANAL ENLARGEMENT.

Niagara-Oswego-Mohawk Ship Canal	$190,000
Erie Canal enlargement, Lake Erie to Rome	60,000
Total	250,000

Making such estimates of the cost of surveys is very unsatisfactory. It may be found that all necessary work can be done for less than the amounts named, but the project is of such great importance and the works would be so costly that it is believed to be the part of wisdom to provide liberally for the surveys required and for gathering all information bearing upon the subject.

As some of the work would have to precede other portions, it is estimated that two field seasons would be required to complete the surveys in the most satisfactory manner.

SUMMARY.

The following is a summary of the findings and conclusions reached and more fully discussed in this report:

A ship canal which would permit lake vessels to reach tide water and ocean vessels to reach lake ports would be valuable in reducing and regulating lake freights, transfer charges, etc., on such freight as might be tributary thereto.

To justify construction, the benefits to be derived from such a canal should be clearly shown to be suitably commensurate with its cost and the cost of maintenance and necessary improvements.

The present and prospective conditions of lake and interlake channels and harbors limit the reasonable depth of a ship canal to that required for vessels of 20-foot draft.

Any ship canal built should be entirely within the territory of the United States, and should terminate at a first-class American seaport and commercial and manufacturing center, in order that Western products for domestic consumption, as well as those designed for exportation, may be transported at minimum cost, and that return freight of the greatest possible magnitude may be secured, and the canal benefit alike the people of the West and of the East.

Any ship canal built should not only subserve the interests of foreign-bound commerce, but as well the domestic commerce between the centers of population in the East and the producing regions of the West.

The domestic commerce is of more importance to consider than the commerce destined to or from foreign countries.

A ship canal by the St. Lawrence route to Montreal, or by the St. Lawrence-Champlain route to New York, does not fulfill these conditions, and should not be considered by the United States.

The route considered best for a ship canal is by the Niagara River, Lake Ontario, Oswego, Oneida Lake, and the Mohawk and Hudson rivers.

For the highest economy in transportation, special types of vessels are needed for use on the ocean, on the lakes, and on the canals, and neither can replace the other in its proper waters without suffering loss of efficiency. Ocean vessels could not, as a general rule, engage in the business of passing through a ship canal and the lakes to upper lake ports; and lake vessels are not fitted for use upon the ocean, and if they made use of a canal they would have to transfer their cargoes at the Seaboard. For economical transportation through a canal from the Great Lakes to the sea special vessels, differing from and far less costly than ocean or lake vessels, are required.

Important and serviceable canals already exist between the Great Lakes and the Hudson, the Erie Canal connecting Lake Erie with the Hudson, and the Oswego-Erie Canal connecting Lake Ontario with the Hudson. By these canals low rates of freight are attained.

These canals are being improved by the State of New York to the extent that when completed the capacity of the boats navigating them will be increased about 70 per cent, the time of transit will be materially reduced, and it will be possible and practicable to move freight between Lake Erie and New York for about 60 per cent of the present cost.

Under existing conditions and methods, these canals require, and will when improved require, the transference of freight from lake vessels to canal boats, and vice versa, at lower lake ports.

This transference is an important and expensive item in the cost of through freight, and its avoidance or material reduction is very desirable.

Transference at lower lake ports is necessary for economical distribution of a very large part of the freight shipped in lake vessels, and this would be the case regardless of any canal.

The present cost of transference at lower lake ports can be materially reduced and business still be done at a profit.

Any canal which will enable this transference to be avoided will cause its reduction to a minimum.

The amount of tonnage which it is estimated may be possibly tributary to a ship canal is 24,000,000 annually, 18,000,000 tons transported eastward and 6,000,000 tons transported westward.

The cost of a ship canal suitable for use by the largest vessels of the lakes from Lake Erie to New York, and necessary work in connection therewith, would be approximately $200,000,000, and the cost of operation and maintenance would be approximately $2,000,000 per year. The cost would depend largely upon the arrangement which could be made with New York State for the possession of its canals, feeders, reservoirs, etc., which would necessarily be absorbed in the greater canal.

The Erie Canal, as it is being enlarged by the State of New York, will, if all restrictions upon its use be removed, give commercial advantages practically equal to the commercial advantages which would be given by a ship canal.

If the Erie Canal be further improved by enlarging it to a size sufficient for 1,500-ton barges, making necessary alterations in its alignment so as to give a continuously descending canal all the way from Lake Erie to the Hudson, and canalizing the Mohawk River, such improved canal, navigated by barges, will enable freight to be transported between the East and West at a lower rate than could a ship canal navigated by the large lake or ocean vessels. The cost of such enlargement would be approximately one-quarter the cost of a ship canal.

If a ship canal were built, the business thereon would not be done in large lake or ocean vessels, but in barges and boats which could be equally well accommodated in a canal of much less size.

A ship canal between the Great Lakes and the ocean would have no military value.

The construction of a ship canal from the Great Lakes to the sea is not a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would not be properly commensurate with the cost.

The enlargement of the Erie Canal as suggested, with everything adapted to transport the tonnage of the lakes, is a project worthy of being undertaken by the General Government, as the benefits to be derived therefrom would be properly commensurate with the cost.

The cost of the necessary surveys for a ship canal by the Niagara-Oswego route is estimated at $190,000.

The cost of an entirely independent survey for the enlargement of the Erie Canal and canalization of the Mohawk River is estimated at $125,000.

The cost of a combined survey of the Niagara Oswego Ship Canal and for the enlargement of the Erie Canal is estimated at $250,000.

A thorough understanding with the State of New York with reference to its canals should, if possible, precede action of any kind.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

M M 8.

SURVEY OF ERIE HARBOR, PENNSYLVANIA.

[Printed in House Doc. No. 70, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 9, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated May 24, 1897, with map,* by Maj. Thomas W. Symons, Corps of

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* Not reprinted. Printed in House Doc. No. 70, Fifty-fifth Congress, first session.

Engineers, of the results of a survey of Erie Harbor, Pennsylvania, made to comply with the requirements of the river and harbor act of June 3, 1896.

The plan of improvement proposed by Major Symons contemplates repairs to and extension of north and south piers, repairs to south breakwater, dredging in entrance channel and harbor, sand-catch and shore-protection jetties, and encouragement of plant growth on Presque Isle Peninsula. This work, including contingencies and the sum of $20,000 proposed to be reserved for preservation of the peninsula, will, it is estimated, cost $397,000.

In the opinion of Major Symons, with which opinion I concur, the proposed improvement is worthy of being carried out, and is justified by the present and prospective interests of commerce.

The division engineer, Col. G. L. Gillespie, Corps of Engineers, in forwarding the report to this office, concurs in the views of the local officer, so far as relates to the general project of improvement, but states:

I am not prepared at this time to give unqualified approval to the proposed plans for repairs to old jetties and the direction given to the north pier extension, nor to the location and method of construction of the new jetties proposed to be built on Presque Isle exterior to the harbor of Erie.

The general plans of improvement are approved.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., May 24, 1897.

GENERAL: I have the honor to submit the following report on the survey and cost of improvement of Erie Harbor, Pennsylvania. This work was assigned to my charge by your letter of September 5, 1896.

ERIE HARBOR.

This is generally considered to be the best natural harbor on Lake Erie. There is no indentation of the shore line, the harbor being made by the singular low, sandy peninsula of Presque Isle, which is about 6 miles long and from 300 to 7,000 feet wide, and which extends out a distance of 2½ miles into Lake Erie beyond the general shore line. The harbor itself is 4½ miles long by 3,500 to 7,500 feet wide, with depths up to 27 feet.

The entrance to the harbor is at its easterly end and three-fourths of a mile from the mainland. The prevailing winds and severe storms are from the west, and from these the entrance is thoroughly protected and can be made in safety under all conditions. In the lee of the peninsula is a safe anchorage from westerly storms, which is frequently used by wind-bound vessels.

SURVEYS.

Surveys of the harbor have been made as follows: 1819, 1839, 1865, 1875, 1884, 1888, and 1896.

Survey of 1896.—This survey was begun July 20 and completed September 20, 1896. The survey was a transit and a stadia survey, based on an accurate system of triangulations made during the survey.

The base line of this survey is situated on the bluff between the Kakwa Club and Sommerheim. It was established in 1891 and its azimuth determined. In 1888 the azimuth was also observed at the east end of the harbor. The latter was the azimuth used on this survey.

Along the narrow western part of the peninsula, known as the "neck," cross sections were taken by stadia and transit, and also for 3,000 feet north of the north pier. A line of levels was run over the stadia line to give elevations of transit stations.

Soundings were taken to 25 feet of water along the whole lake shore of the peninsula, while around the harbor entrance and to the east the soundings were carried to 30 feet of water. Soundings were also taken over a large portion of the west end of the bay and of the east end.

The manner of locating the soundings was as follows: Ranges were set at transit stations about 500 feet apart. The soundings were then taken from a rowboat on these ranges and every fifth or sixth sounding intersected by transit from a distant station.

Soundings were taken with a lead and chain, so that no correction for shrinkage of line was required. All important triangulation stations were permanently marked and their elevations determined.

Comparison of surveys, 1888 and 1896.—A comparison of the maps of the surveys on a scale of 1 inch to 500 feet as a whole is not practicable; but by fitting fixed points east and west from the flash light as a center a good idea can be obtained as to the changes on the outer beach of the peninsula. The difficulty in fitting surveys lies in the fact that the map of 1888 was made up by joining together reductions of the contour map of that survey on a scale of 1 inch to 200 feet, which was of the outer shore of the peninsula only. Having no geodetic points to close upon distortion resulted, and was further augmented by compiling further from old maps. The survey of 1896, in which all shore lines and locations are based on a closed system of triangulation, makes this the best and most exact survey of the harbor and peninsula ever made.

Beginning at the shore end of the "neck," the shore protection, built in 1889, has resulted in accretion behind it for its entire length. This accretion amounts to 100 feet in width behind the portion of the protection fence still intact at the shore end, and it gradually decreases to little or no accretion 2,400 feet easterly. The bay shore along the narrow portion of the neck is practically the same, such changes as have occurred being accretive.

From the easterly or outer end of the protection work, thence easterly 13,000 feet, erosion has occurred. This erosion amounts to 100 feet in width immediately east of the protection work, and has been equally severe opposite the Chimney Ponds. At other points it has been less marked, varying from a few feet to 50 feet.

For the remaining distance to the United States light-house jetty, 5,000 feet, accretion to a maximum of 100 feet in width has taken place, due to the arresting of material by this crib jetty. For 3,600 feet immediately east of the United States light-house jetty the principal action has been erosion, amounting to as much as 150 feet in width for a stretch over 1,000 feet long.

From the point 3,600 feet east of the jetty eastward to the old pile jetty the most notable change has taken place in the form of excessive accretion around the northeasterly knuckle of the peninsula. This amounts to 500 feet in width at its widest point and extends over 8,400 feet of shore line. Immediately below the old pile jetty erosion has occurred for 1,000 feet, and thence to the north pier is found the large accretion, which has formed the wholly inclosed new pond.

OFFSHORE CHANGES.

There does not appear to be any marked change in depths offshore along the neck of the peninsula. Shoaling, however, in depths of 18 feet and 24 feet is indicated. Along the cutting shore, as far as the United States light-house jetty, it is noticeable that offshore erosion seems to accompany the shore erosion out to the depth of 12 feet, which is generally 800 to 1,000 feet from shore, such erosion being heaviest where the shore erosion is most severe. Shoaling in depths of 18 and 24 feet is here also noticeable.

Where the large accretion has occurred on the northeasterly knuckle the shoaling corresponds to the advance of the shore line.

Around the east end of the peninsula there is practically no change in depths out to 15 feet. In the deeper water beyond this depth shoaling has occurred, the 18-foot contour now occupying the location of the 20-foot contour in 1888 and the 24-foot contour having advanced lakeward 500 to 600 feet.

The same shoaling has occurred in the "pocket" south of the channel entrance. The most marked change in depth, and the change which may be regarded as a permanent one, is the shoaling in water over 18 feet deep. Making due allowance for difference in water level to which the surveys are referred, it would appear that the shoaling of deep water has amounted to 0.75 foot in eight years, or 0.1 foot per year. Shoaling of this character is likely common all along the lake shores, and may be accounted for by the theory that wave action in lake storms extends to a depth of about 15 to 18 feet. Between these depths and the shores the bottom material is subject to the disturbance of wave action and the undertow carries material outward until it reaches the quiet water in depths greater than the depth of wave action. Then the material drops to the bottom.

FORMER WORKS OF IMPROVEMENT.

The map which accompanies this report shows Erie Harbor. The shore lines and hydrography, except in the middle of the bay, are from the survey of 1896-97. The work which has been done by the United States for the improvement and preservation of Erie Harbor may be summed up as follows:

1. Construction of a breakwater, 2,530 feet long, lying in a north and south direction from the main shore to the south side of the entrance channel.
2. Construction of a breakwater lying in a north and south direction from the north side of the entrance channel, about 2,900 feet long, to connect with the solid portion of the peninsula.
3. Construction of a pier 1,220 feet long on the south side of the entrance channel, nearly due east and west in position.

4. Construction of a pier 2,737 feet long on the north side of the entrance channel, nearly parallel with the south pier and distant therefrom 360 feet.

5. Construction of crib and pile work and sand fences to protect the neck of the peninsula and to stop channels which have broken through this neck.

6. Construction of a pile sand-catch jetty about 3,000 feet north of the harbor entrance.

7. Plant growth has been encouraged on the neck of the peninsula by setting out trees, bushes, seeds, etc.

8. Dredging has been done in the entrance channel whenever necessary to maintain the desired navigable depth, which latterly has been 18 feet.

9. The piers, breakwater, etc., have been repaired whenever deemed necessary and advisable.

PROPOSED PROJECT FOR IMPROVEMENT OF ERIE HARBOR.

In formulating a plan for the further improvement of Erie Harbor a careful study has been made of the existing conditions and their relation to past conditions, the existing natural forces and changes which affect these conditions, the further changes in conditions which may be reasonably expected in the future, and the present and prospective demands of commerce.

The project for future work is summarized as follows:

1. Repairs to existing structures.
2. Extension of north pier.
3. Extension of south pier.
4. Dredging entrance channel to 20 feet depth.
5. Dredging area at eastern end of bay to 20 feet depth.
6. Building four protection jetties along outer side of Presque Isle Peninsula.
7. Maintenance of entrance channel.

Repairs to existing structures—North pier.—Both the piers at Erie are timber crib structures filled with stone. The superstructure of the western portion of the north pier, 1,200 feet in length, is badly decayed and must soon be replaced. It is proposed to replace the old timber superstructure with a superstructure of concrete. This, being subjected to but little exposure, can be made of small cross section. The cross section proposed is to cap the cribbing (16 feet wide) with 2 feet of concrete and upon this to mount a concrete parapet 4 feet high, 8 feet wide at the base and 4 feet wide at the top. It is estimated that this work will cost \$21 per running foot, or 1,200 at \$21 = \$25,200.

The superstructure of the next 515 feet of the north pier to the southward is also commencing to decay, and will require a considerable expenditure for maintenance. It is estimated that an expenditure of 50 cents per foot each year will keep it in good serviceable condition for the next five years at least. This would require the sum of \$1,287.50.

This makes a total expenditure for repairs to north pier of \$26,487.50.

South pier.—A series of observations has been undertaken to determine upon the desirability and advisability of widening the entrance channel. This is now 360 feet wide. Upon the assumption that the present channel is of proper width, and that the south pier will be maintained in its present position, the following estimate of the necessary repairs to it is made.

There is 650 feet of this pier which is in bad condition and will require to be torn out to a depth of 4 feet below low water and a grillage 2 feet thick built upon the underlying portion, and this surmounted by a concrete superstructure.

There is 150 feet more which will have to be torn out to 2 feet below mean lake level and surmounted by a concrete superstructure. The concrete superstructure proposed is similar to that proposed for the north pier. For the outer 425 feet it is proposed to cut down from its present height of 6 feet to the height of 4 feet above mean lake level and put on a new deck.

The estimated cost of the work is as follows:

Tearing out 650 feet to 4 feet below mean lake level and putting in a grillage, at $9	$5,850
Tearing out 150 feet to 2 feet below mean lake level, at $4	600
800 linear feet of concrete superstructure, at $14	11,200
Repair of outer 425 feet and erection of day beacon on end, at $5 per foot	2,125
Total estimate for repairs to south pier	19,775

South breakwater.—The condition and situation of the south breakwater is such that minor repairs are needed yearly. It is impossible to do more than approximate in a rough manner what will be the cost of the repairs that may be required, but it is believed that $500 per year for five years will be sufficient for all purposes, or $2,500 in all for five years.

Extension of north pier.—The north pier at Erie fulfills two important functions; it limits, controls, and marks the entrance channel on the north, and it acts as a sand catch to prevent the ever-moving sands getting into the channel and to cause them to settle into comparatively permanent locations along the eastern front of the peninsula. The sand, traveling along the lake front of the peninsula and stirred up by the waves, moves along the eastern front of the peninsula and forms, to a greater or less extent, a bar in front of the harbor entrance. To regulate the sand movements and prevent the formation of a troublesome bar to the greatest extent practicable requires the extension, from time to time, of the north pier.

For the immediate future it is believed that an extension of 500 feet is requisite. This would terminate at the contour of 16 feet depth at mean lake level. The best results will be obtained by deflecting the pier from its present direction 20° to the north, as shown upon the map. A channel following this direction would be about normal to the deep-water curve of 30 feet depth, and the pier would best fulfill the functions of a sand-catch pier. The general project and scheme of improvment should provide for a further extension of this pier whenever required to keep its outer end abreast of the 16-foot curve. It is proposed to build the cribs of the ordinary type 30 feet wide, this width being required to give the requisite dead weight and stability.

The estimated cost of the crib structure complete is $100 per foot, or for the 500 feet $50,000.

Extension of south pier.—It is believed that the south pier should be extended about 1,000 feet to better define the channel, better direct the waters flowing into and out of the harbor and thus secure their cutting effects on the bar, and the more effectually to retain the materials from the south and keep them from the channel.

The south-pier extension, being protected by the north pier from severe storms, can be made much lighter than the north-pier extension. For this work it is proposed to use a crib 20 feet wide and 16 feet high, surmounted by a superstructure 4 feet high. This would be founded upon a rubblestone mound brought to the proper grade, the foundation for the outer 100 feet extending to a depth of 22 feet to compensate for scour by currents and wave action. The cost of this structure is estimated at $64 per foot, or for the 1,000 feet $64,000.

This extension of the south pier should be made on the divergent line of the east part of the present pier. This, when carried to a point abreast of the east end of the existing north pier, will there give an entrance width of 490 feet.

Dredging.—The situation at Erie is such that more or less dredging will always be required to keep the channels open to their full depth. The outer portion of the entrance channel is situated in the midst of a vast subaqueous field of sand, easily moved by the storm action of the water and liable to be deposited in the channels. It has also happened before and is liable to happen at any time that a vessel getting aground in the vicinity of the channel will stir up such a commotion in the sand that it will be heaped up in a mound in the channel and have to be removed by dredging. The probable early completion of the 20-foot channel through and between the lakes renders it advisable that the new project for Erie Harbor should conform thereto. It is therefore proposed that the entrance channel under the new project shall be 20 feet deep at mean lake level and 300 feet wide. This is provided for in the project herein recommended. The estimate for this work is as follows: Dredging sand, 178,000 cubic yards, scow measure, at 15 cents, $26,700.

In order to meet the requirements of commerce it is also proposed to excavate to 20 feet depth the area marked A on the accompanying map, lying in the eastern end of the bay, outside the established harbor lines and to the west of the easternmost dock. Vessels now going to these eastern docks have great trouble, owing to the location of shoals in front thereof.

The estimate for this work is: Dredging 870,000 cubic yards, scow measure, at 15 cents, $130,500.

In both the channel work and the inside harbor work the estimates include dredging to a depth of 21 feet at mean lake level to secure a full navigable depth of 20 feet at all stages, except possibly at extreme low water.

After the work of excavating the channel and basin shall have been completed, it is expected that there will be required from time to time the expenditure of money for their maintenance. The amount required is indeterminate, and as it will not be required immediately no special estimate therefor is made.

Protection of Presque Isle Peninsula.—The sandy peninsula of Presque Isle juts out into Lake Erie, and presents its broad side to the lake storms from the north and northeast. The direction of the lake shore line coincides generally with the most violent storms which come from the southwest, and undoubtedly these storms were and are the determining cause of the upbuilding and maintenance of the peninsula. The storm work is constantly going on, new sand is brought along from the west, and the peninsula sands are being constantly stirred up and carried along the lake front to find a final resting place under the lee of the peninsula to the east.

The history of the peninsula shows that along the lake front the process of degradation and upbuilding is constantly going on, but in varying locations, the general line of the shore being maintained with a fair degree of permanency, while very considerable changes take place at different localities. A particular section of the front will be in a condition of apparent stability for years—long enough to grow large trees—then, due to some inscrutable cause, the lake will attack it and tear it down. During the winter just passed the lake has attacked a stretch of beach lying outside of the portion of the bay known as Big Bend, and for a distance of over 4,000 feet has washed it down for a width of about 50 feet, dropping its trees into the lake and causing an unfavorable appearance of devastation apparently threatening the whole peninsula.

As long as this cutting is confined to the wide portion of the peninsula it can do very little harm. If, however, it should take place at the "neck," or the narrow upper portion of the peninsula, it would properly give cause for great apprehension. It is necessary to guard this neck in every way, and while it is possible to build structures on the outside of the peninsula which will prevent or materially limit the cutting of the beach at certain portions and cause filling in other portions, it is necessary to consider the possible effects of these structures in causing cutting at other points. Everything that is done to this end must be done with extreme caution to prevent more damage than benefit resulting therefrom.

An estimate is made herein for four jetties to be built out from the lake side of the peninsula as sand catches and to prevent the beach from cutting, and the approximate locations therefor are marked on the accompanying map.

Not more than one of these jetties should be built in any one year, and its effects should be carefully studied before building another. By proceeding with great caution it is possible that the further erosion of the north beach and the transfer of materials to the eastern end of the peninsula may be lessened.

The jetties proposed are planned to be 300 feet long from the shore line and to consist of tight timber cribs, filled with stone and decked over. They would be built to approximately fit the foreshore, which would be dredged where necessary to secure proper emplacement. The cribs would be 12 feet wide and extend from about 8 feet below to 3 feet above mean lake level, with suitable and substantial connection with the weather beach.

It is estimated that each jetty complete in place will cost $5,400, or $21,600 for the four. This building of sand-catch and protection jetties must be regarded as experimental, and is not proposed with any great conviction as to their necessity or confidence in their results.

It will be desirable to continue the encouragement of plant growth along the neck of the peninsula, so as to hold more securely the sand of which it is composed. So far this has been very successful. An estimate of $1,500 is made for this work to cover a period of five years.

Summary of project and estimate proposed for the improvement of harbor of Erie, Pa.

Repairs to north pier	$26,487.50
Repairs to south pier	19,775.00
Repairs to south breakwater	2,500.00
Extension of north pier, 500 feet, at $100	50,000.00
Extension of south pier, 1,000 feet, at $64	64,000.00
Dredging in channel, 178,000 cubic yards, at 15 cents	26,700.00
Dredging in harbor, 870,000 cubic yards, at 15 cents	130,500.00
Sand-catch and shore protection jetties, four, at $5,400	21,600.00
Plant growth on peninsula	1,500.00
	343,062.50
Contingencies, engineering, etc., 10 per cent	34,306.25
Total	377,368.75

In round numbers, $377,000.

As the danger of a breach in the neck of the peninsula is ever present, and as the work of closing such a breach could ordinarily be done with great relative cheapness if promptly taken in hand, it is believed wise to retain in the project the provision for the reservation of $20,000 to be used for this work only in case of need.

This, added to the $377,000, makes a total of $397,000 as the appropriation required for carrying out the project outlined.

A complaint having been made that the present entrance is too narrow, causing at times dangerously swift currents, a series of observations has been undertaken to determine the velocities of the currents through the entrance.

As these currents are due entirely to storm action, it will be necessary to continue the observations during an entire season to obtain any satisfactory data.

If a careful study of conditions should show conclusively that the entrance channel is too narrow, the above-outlined project would be changed by replacing the south pier by one farther to the south.

A special report on this subject will be made after the season's observations are concluded.

* * * * * * *

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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SURVEY OF BUFFALO ENTRANCE TO ERIE BASIN AND BLACK ROCK HARBOR, NEW YORK.

[Printed in House Doc. No. 72, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 16, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated May 18, 1897, with map,* by Maj. Thomas W. Symons, Corps of Engineers, upon survey of Buffalo entrance to Erie Basin and Black Rock Harbor, New York, made to comply with the provisions of the river and harbor act of June 3, 1896.

Major Symons states that the improvement needed to meet the demands of the commercial interests is the protection of the entrance from storm and sea on Lake Erie, and that such protection can only be done by the construction of a breakwater.

The plan of improvement submitted contemplates the construction of a breakwater 2,300 feet in length, consisting of a timber crib filled with stone and surmounted with a concrete and stone superstructure, to be located as shown upon the map. The cost of the work is estimated at $248,000.

In the opinion of Major Symons this design of breakwater is the best suited and most economical for the purpose proposed. To provide,

*Not reprinted. Printed in House Doc. No. 72, Fifty-fifth Congress, first session.

however, for any change in the type of the structure which might be desirable at the time of beginning construction, he presents four alternate designs for a breakwater, whose relative merits are recited in the report.

Major Symons further states that the aforesaid estimate of cost would be sufficient for a breakwater on the location shown on the map or on a location farther inshore; but were the structure placed farther out in the lake its cost would be increased, owing to deeper water and greater exposure to wave action, which would require more of the structure of large cross section and deep foundations.

In transmitting the report to this office the local officer expressed the opinion that the proposed improvement is worthy of being carried out, and is justified by the interests of commerce involved, and his views were concurred in by the division engineer, Col. G. L. Gillespie, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., May 18, 1897.

GENERAL: I have the honor to submit the following report on a survey and estimate of the cost of improvement of the "Buffalo entrance to Erie Basin and Black Rock Harbor, New York," to comply with the provisions of section 9 of the river and harbor act of June 3, 1896, and of your instructions of September 5, 1896.

The entrance to Erie Basin and Black Rock Harbor is an opening 2,300 feet wide between two breakwater structures located near the shore along the lake front of Buffalo, N. Y., as shown on the accompanying map. These breakwaters were built by the State of New York many years ago. The southerly structure, known as the State breakwater, and inclosing Erie Basin, is a substantial stone structure. The northerly structure, known as the Bird Island pier, is a timber crib structure, fully serving its purpose in protecting the upper end of Black Rock Harbor. This harbor extends northerly 3 miles along the Niagara River front of Buffalo to the ship lock which connects the harbor and the Erie Canal, merged into one body of water, with the Niagara River at Black Rock. The harbor is on the level of Lake Erie and the Erie Canal, which level is 4 to 5 feet above the level of Niagara River at the ship lock above mentioned. This ship lock is 200 feet long and 36 feet wide. The ruling depth of the harbor is about 8 feet, and it is used by vessels without cargoes returning to Buffalo from the lumber and other wharves in Niagara River at Black Rock and Tonawanda. By its use these vessels avoid heavy towing upstream, from the ship lock to Lake Erie, against the strong current of Niagara River.

The upper end of the harbor, from Porter avenue southerly to the Reading coal trestle, is now unprotected from lake storms. Its shore is regarded as a favorable location for wharves for the many excursion steamers now obliged to use crowded commercial wharves in Buffalo River. The improvements proposed would fully protect the harbor entrance and shore, now exposed to heavy seas from the lake, and admit of the construction of ample wharfage for excursion and commercial purposes.

The Erie Basin is used by both lake vessels and canal boats engaged in Buffalo commerce; vessels of large size entering the basin through the entrance under discussion to reach the Reading coal trestle at the north end of the basin.

The improvement needed to meet the demands of the commercial interests involved is the protection of the entrance from storm and sea on Lake Erie. This can only be done by the construction of a breakwater, as shown on the tracing herewith. The proposed location shown on the tracing is considered the best, because it best meets the conditions involved, in that it fully protects the entrance from lake storms, does not obstruct or restrict the entrance to Buffalo Harbor around the end of the United States breakwater, does not obstruct or restrict the entrance to the Erie Basin through the deep-water channel around the north end of the State breakwater, does not obstruct or restrict the free navigation of the "Emerald" Channel leading to the Niagara River, and affords a good anchorage area for small craft which frequent this portion of the harbor.

The total length of the breakwater needed to fully protect the entrance is 2,300 feet.

There is submitted herewith a tracing* showing the profile of the lake bottom and the underlying rock bottom on the line of the proposed structure, together with plans for a stone-filled timber crib and concrete breakwater.

The bottom profile was determined by driving a steel rod to rock every 50 feet. The work was done on ice, thus insuring a good determination of the character of the bottom material. The proposed breakwater is located in water varying from 22 feet in depth at its southern end to 5 feet depth at its northern end. The borings made along the line adopted determined the rock bottom at a depth varying from 30 feet to a little more than 5 feet, the stratum over the rock being gravel, sand, mud, and clay of varying degrees of consistency. The character of the material overlying the rock will not furnish a stable foundation for crib work. The design for the work, therefore, provides for dredging out the material overlying the bed rock and for founding timber cribs on the solid rock, the cribs being fitted as nearly as possible to the rock, and the irregularities corrected with rubblestone deposited where needed to level up the rock surface. With cribs thus founded, the conditions are favorable for constructing thereon a permanent concrete superstructure, as shown on the tracing. This timber-crib-concrete structure would cost about 20 per cent more than a structure of the same dimensions built entirely of timber-crib work, but it would be practically permanent, without repairs in the future. The timber-crib-concrete design is considered the best one for the location and purpose, as it would occupy a minimum area and afford mooring facilities for small vessels and yachts.

The structure proposed is a timber crib filled with stone, built up to 3 feet below mean lake level, and surmounted with a concrete and stone superstructure. Both the cribs and superstructure vary in size according to depth of water and exposure. For 1,200 feet at the southern end the cribs are 36 feet wide and 18, 20, and 22 feet high, founded on the rock bottom directly, or on the rock bottom thoroughly cleaned off and brought to proper grade by rubblestone filling, which filling would extend at least 10 feet beyond the cribs. Upon these 36-foot

*Not printed.

cribs the superstructure would be 12 feet high above mean water level and of the form shown.

The remaining 1,100 feet on the north end has cribs 24 feet wide and 4, 10, 12, and 16 feet high, founded, as nearly as practicable, on the rock bottom. On this portion the superstructure would be 10 feet high and of the form shown. It is intended that the cribs should vary in height within the limits here given to fit them more closely to the rock bottom.

The cribs themselves vary little from those which have hitherto been built here and at other points on Lake Erie, about the only difference being the arrangement of the top timbers to provide proper footing for the concrete superstructure.

The concrete superstructure proposed consists of concrete blocks and concrete in place. The concrete blocks would be 5 feet high, extending from 3 feet below to 2 feet above mean water level; 5 feet long in the direction of the breakwater and 6 feet wide in a direction normal thereto. Each block would weigh about 10 tons, and they would be set in place along each face of the breakwater. The filling stone and concrete would then be brought up to a level with their upper surface and the concrete in place and filling stone added, the concrete being retained in place by proper molds.

The great mass of the concrete in place would be cheapened by adding stone of large size, but within a foot of the surface unadulterated concrete only would be used.

Wells 3 feet in diameter are provided for adding filling stone when necessary and for access to the interior of the structure. In the 24-foot portion of the breakwater these wells are 20 feet apart. In the 36-foot portion there are two rows of wells, the wells in each row being 20 feet apart, but alternating. The concrete in place would be put in in sections 20 feet in length, the planes of weakness thus formed being deemed advisable to provide for the slight unequal settlement liable to occur.

Upon the southerly 1,200 feet of the work iron mooring posts are provided for 100 feet apart.

Estimate of cost.

For 2,300 linear feet of breakwater, hemlock-timber cribs, founded on rock bottom, surmounted by concrete superstructure, provided with mooring posts 100 feet apart, along banquet:	
Dredging for foundation, 34,000 cubic yards, scow measure, at 20 cents	$6,800.00
Foundation stone, 7,000 cubic yards, at $1	7,000.00
Hemlock cribs filled with stone—	
400 linear feet, 22 by 36 feet, at $56	22,400.00
300 linear feet, 20 by 36 feet, at $51	15,300.00
500 linear feet, 18 by 36 feet, at $46	23,000.00
200 linear feet, 16 by 24 feet, at $30	6,000.00
200 linear feet, 12 by 24 feet, at $22	4,400.00
400 linear feet, 10 by 24 feet, at $18	7,200.00
300 linear feet, 4 by 24 feet, at $8	2,400.00
Concrete superstructure, filled with stone—	
1,200 linear feet, at $66.19	79,428.00
1,100 linear feet, at $46.50	51,150.00
Mooring posts, 12, at $40	480.00
Total estimate	225,558.00
Contingencies, 10 per cent	22,555.80
Total cost	248,113.80

In round numbers, $248,000.

As stated hereinbefore, the timber-crib-concrete design, for which plans and estimates are submitted, is regarded as the one best suited and most economical for the purpose.

Whenever the work comes to be done it may be advisable to adopt some other type of breakwater, and reference is therefore made to other designs here. The designs referred to are:

(1) Timber cribs with timber superstructure, filled with stone and decked over.

(2) Rubble mound, similar to the rubble-mound breakwater now under construction on the Stony Point extension of the Buffalo breakwater.

(3) A combination of 1 and 2 or of 2 and the timber-crib-concrete design.

(4) Timber cribs with stone superstructure, similar in section to the concrete superstructure of the timber-crib-concrete design described in detail in the report.

(1) In a structure of timber-crib work throughout, the requirements for the foundations and cribs would be the same as in the timber-crib-concrete breakwater. The cost of this portion of the work would therefore be identical with that of the timber-crib-concrete design. Suitable timber superstructure over the cribs would require building it to the height of 12 feet, as in the timber-crib-concrete design, which is also the height of the timber superstructure on the timber-crib breakwater already built at Buffalo and now under construction to Stony Point.

The cost of a timber-crib breakwater on the designated location 2,300 feet long is estimated at $200,000. The life of the superstructure may be taken at twenty years, at the end of which time complete renewal would be necessary, at a cost of about $50,000. To this must be added a large but indeterminable amount for repairs after the first ten years of the existence of the structure and before complete renewal becomes necessary.

(2) A rubble-mound breakwater which would meet the requirements of the proposed location would imply a construction similar to that of the rubble mound now in process of construction on the extension to Stony Point. At the southerly end the structure would be nearly as large in cross section as that structure, diminishing gradually toward the northerly end.

The cost of a rubble-mound breakwater on the proposed location 2,300 feet long is estimated at $215,000. This construction would occupy a considerable area, and the necessarily long slopes under water would everreach seriously on navigable water, particularly at the southerly end, where it would occupy water over 20 feet deep adjacent to the entrance channel to Buffalo Harbor.

(3) This difficulty could be remedied to some extent by constructing the southerly 400 linear feet on the timber-crib-concrete design and the remaining distance of 1,900 linear feet on the rubble-mound design. The cost of this combination of timber-crib and concrete and rubble-mound structure on the designated location 2,300 feet long is also estimated at $215,000.

The rubble-mound portion would probably require the placement of additional stone at intervals after its construction before it would be stable under wave action. This would cost an indeterminate amount.

(4) A structure built of timber cribs, surmounted by a superstructure of stone blocks of essentially the same cross section as the concrete design and similarly filled with small stone, may be briefly considered. The cost of cutting, fitting, and securing the stone blocks, which must necessarily be of large size to withstand wave action, would not be less than $12 per cubic yard. Stone of this kind, placed in the existing breakwater as an experiment, cost more than $12 per cubic yard. As this is practically double the cost of concrete, this design of structure may be rejected on account of excessive and unnecessary cost.

In conclusion, it may be stated that the estimate herein of $248,000 for the timber-crib-concrete breakwater recommended will cover the cost of original construction of any of the designs of structure above noted except the cut-stone superstructure. The full timber-crib design would cost less at first, but its ultimate cost would probably be greater. The ultimate cost of the rubble-mound design would be about the same as for the timber-crib-concrete structure recommended, but there are objections to it, as stated herein.

The sum named would be sufficient for a breakwater on the location shown on the map accompanying the report or on a location farther inshore; but if the structure were located farther out in the lake the cost of the structure would be increased, due to the deeper water and greater exposure to wave action, which would require more of the structure of large cross section and deep foundations.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS, UPON HOUSE BILL 7775, FIFTY-FOURTH CONGRESS, FIRST SESSION, PROVIDING FOR WIDENING THE LOCKS OF THE ERIE CANAL, IN THE STATE OF NEW YORK.

[Printed in House Doc. No. 231, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 17, 1896.

SIR: I have the honor to acknowledge the reference to this office of a letter, dated May 9, last, from the chairman of the Committee on Railways and Canals of the House of Representatives, inclosing copies of House bills Nos. 7775 and 8074, to make appropriations for widening the locks in the Erie and Oswego canals, respectively, in order to permit the passage of modern torpedo boats and other vessels of war of similar dimensions.

In this letter the Secretary of War is requested "to cause to be made an examination of the subject," and report to the committee "as to the practicability of the enterprise and the probable cost of the same."

The subject of widening the locks of the Erie Canal has been investigated by Maj. Thomas W. Symons, Corps of Engineers, and that of widening the locks of the Oswego Canal by Maj. W. S. Stanton, Corps of Engineers, and the reports of these officers are herewith submitted,* with recommendation that they be transmitted to the chairman of the committee. These reports contain much matter of interest, and it appears desirable that they be printed.

It is proper to add in this connection that, in accordance with a provision in the river and harbor act of June 3, 1896, an examination to determine the feasibility and cost of construction of a ship canal by the most practicable route from the Great Lakes to the navigable waters of the Hudson River is now in progress, the report on which may, when submitted, afford additional information on the subject embraced in these bills.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. THOMAS W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., December 1, 1896.

GENERAL: I have the honor to submit the following report in reference to House bill 7775, Fifty-fourth Congress, first session, entitled—

A BILL to appropriate two million dollars to widen the locks in the Erie Canal so as to permit the passage of modern torpedo boats for the protection of the lake cities.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he hereby is, directed to enter into necessary contracts to widen the locks in the Erie Canal, State of New York, in order to permit the passage of modern torpedo boats and other vessels of war of similar dimensions, to the end of protecting the lake cities in case of war; and that for this purpose there be appropriated, out of moneys in the Treasury not otherwise appropriated, the sum of two million dollars.

This report is called for by your letter of May 14, 1896.

GENERAL DESCRIPTION OF ERIE CANAL.

The Erie Canal, extending across the State of New York from Buffalo to Albany, is 352.18 miles long. It connects with Lake Erie at Buffalo, with the Niagara River at Black Rock and Tonawanda, and with the Hudson River at West Troy and Albany. A map † showing the route of the canal is herewith. Upon another drawing † is given a profile of the canal and some typical cross sections, and a sketch illustrating the method of enlarging the locks, both as actually done by the State of New York and as estimated for herein.

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* For report of Major Stanton on Oswego Canal, see Appendix N N 20.

† Not reprinted. Printed in House Doc. No. 231, Fifty-fourth Congress, second session.

The governing size of the prism of the canal is the size of that portion between Rochester and Albany. This has a surface width of 70 feet, bottom width of 52½ feet, and depth of 7 feet. From Rochester to Buffalo the canal increases in size. At Lockport it has a surface width of about 100 feet, bottom width of 79 feet, and depth of 7½ feet. Above Lockport the canal passes through a heavy rock cutting with a rectangular prism 62 feet wide at the surface and bottom and about 9 feet deep. To the westward of this for 12 miles it occupies Tonawanda Creek with a surface width of 200 feet and depth of about 9 feet. Thence to Buffalo the width is from 80 to 90 feet at the surface and from 60 to 72 feet at the bottom, with depths varying from 6 to 9 feet.

There are on the line of the canal a number of aqueducts with interior widths varying from 40½ to 65½ feet.

Lake Erie is 572.23 feet above the Hudson at Albany. The total lockage between Albany and Buffalo is 656.558 feet.

The current in the Erie Canal flows easterly from its western termination at Buffalo for 153.5 miles to the Seneca River. In this distance there are 20 locks, with a total descent from the level of Lake Erie of 175.182 feet.

Two locks then give an ascent of 16.997 feet to a short summit level fed from neighboring storage lakes.

There is then a descent by one lock of 7.872 feet to the low level at Syracuse, which is 168 miles from Albany and 184.18 miles from Buffalo. Three locks, with a total ascent of 27.704 feet, then bring the traffic to a long summit level 56 miles in length, which is fed from storage streams of the Adirondacks.

From this long summit level the descent is continuous through 46 locks, with a total fall of 428.803 feet to the river level at Albany. The currents in the canal vary from a scarcely perceptible movement at certain points to a velocity of 1.2 miles per hour. The high velocities are to the eastward, in which direction the bulk of the traffic of the canal moves.

The banks of the canal have, in general, slopes of one vertical on one and one-fourth horizontal. These slopes are roughly paved with bowlders or quarry stones, and this paving or "slope wall," as it is called, is continued to the top and rounded over the edge of the bank, its normal height being about 2 feet above the water surface.

The towpath is generally about 18 feet wide, and slopes 6 inches away from the canal in this width.

The berme bank is 12 feet wide with a similar slope.

Where the canal passes through towns, and at some other points, the slope wall is replaced by a nearly vertical wall, to economize space and to give boats an opportunity to receive and discharge their cargoes.

Locks.—On the line of the canal there are 144 lift locks. These were all built in pairs, two locks side by side, identical in size and lift, making 72 locks to be passed by a boat going from one end of the canal to the other.

The locks as they were built were each 110 feet long between quoin posts, 18 feet wide at the lower water level, with a batter to the side walls of one twenty-fourth, and with a depth of 7 feet on the sills. Their lifts vary, the maximum being 15½ feet. The locks on the main line are numbered consecutively from Albany westward. The locks were all substantially built of stone. Most of them have wooden gates of the ordinary miter-sill type, though there are some tumble gates on the line.

There are also, besides the regular lift locks on the main line of the canal, several others, as follows:

Two double locks on the West Troy side-cut into the Hudson River.

Two single locks at the Port Schuyler side-cut into the Hudson River.

One guard lock at Sulphur Springs, to protect the canal from Tonawanda Creek when in a freshet stage.

One river lock connecting the canal with the Niagara River at Tonawanda.

There is also a "ship lock," so called, connecting Black Rock Harbor and the Erie Canal with the Niagara River at Black Rock. This lock is 36 feet wide and 200 feet long.

For the purpose of passing boats from Lake Erie at Buffalo to the Hudson at Albany, none of these need be considered except the Sulphur Springs guard lock.

Boats.—The boats in use on the Erie Canal have a regulation length of 98 feet, and width of 17 feet 5 inches, and when loaded to 6-foot draft carry about 240 tons. The boats are nearly all of wood. A number of steel boats have been built and are used on the canal and traverse Lake Erie to Cleveland and Erie. They run in fleets of four boats, one steam-propelled boat pushing one and hauling two boats.

A large proportion of the boats on the Erie Canal are of the plain ordinary type which are drawn by animals. There are, however, many steamboats which propel themselves and tow others of the ordinary type. These steamboats are of the ordinary type, with an engine and propeller wheel. There are on the canal about 100 steam canal boats and about 3,000 ordinary canal boats.

In the operation of the canal the practice became common, for economical reasons, of using two boats lashed together, one immediately behind the other, so that both could be handled by one steersman and drawn by three animals with one driver. This was the case both with boats propelled by animal power and with those propelled by steam. There was great dèlay in locking such pairs of boats because of the necessity of separating them, passing each one separately through each lock, and again fastening them together upon leaving the lock.

To do away with this delay to the greatest practicable extent the experiment was made in 1885 of lengthening one lock so that two boats could go through at one lockage. The work was so satisfactory and the advantages so marked that the work of lengthening one tier of the locks has progressed ever since as fast as the necessary funds could be obtained from the State.

At the present time, of the 72 locks in one tier on the main line, 40 have been lengthened, leaving 32 yet to be lengthened or otherwise treated. Two of these are under contract to be lengthened during the coming winter.

The locks are lengthened either at the head or foot as found most convenient. The distance between the upper and lower gates in most of the locks which have been lengthened is 220 feet, and the available length is 208 feet. The locks under contract will be lengthened to a clear net length of 230 feet, and all will be ultimately increased to 230 feet, so as to permit the passage of two boats each 115 feet long coupled tandem. Upon the drawing which is herewith the general plan of a lock lengthened by the foot to 230 feet in the clear is shown.

It was found very difficult and time-consuming to get the boats in or out of the lengthened locks on account of their fitting so closely. To remedy this three devices to aid in the operation are employed.

The first is to widen the lengthened portion of the lock, so as to permit the displaced water to run by the boat more freely; the second is to put in a small power plant at each lock, consisting of a turbine wheel and its connections, which furnishes auxiliary power to draw ascending boats into and out of the lock; and the third is to put in paddle valves in the upper and lower gates to aid descending boats through the lock. This is done by opening the valves in the lower gate, thus creating a current into the lock which helps the boat in; then when the upper gate is shut and the lower opened the paddle valves in the upper gate are opened and the boat is "swollen out" by the current thus created through the lock.

In its present condition the capacity of the canal is limited to boats 98 feet long, 17 feet 5 inches beam, and a draft of 6 feet.

IMPROVEMENTS CONTEMPLATED AND UNDER WAY.

At the general election held in New York in 1895 the people of the State voted to expend $9,000,000 in improving and enlarging the capacity of the State canals. The State authorities are pushing the work with vigor, and contracts for a large amount of work have already been let.

The work to be accomplished on the Erie Canal under this scheme is the following:

At Cohoes, where there are 16 locks; at Little Falls, where there are 4 locks; at Newark, where there are 3 locks, and at Lockport, where there are 5 locks, the old locks are to be replaced with modern double-length steel lift locks. All the other unlengthened locks of the tier will be lengthened. At Cohoes it is understood that the change will be made by using a portion of the Champlain Canal, including two lift locks and one guard lock. These three locks will be lengthened. The total lift of the 16 locks at Cohoes is 163.8 feet. Of this 23 feet is in the Champlain Canal locks, leaving 140.8 feet to be overcome by the steel lift lock.

The locks which have already been lengthened will be still further lengthened by substituting a tumble gate for the upper miter gates and placing it nearer the end so that their capacity will be sufficient for two boats 115 feet long or one boat 115 to 230 feet long. All the locks to be changed are to have this length. The governing width will still be that of the old locks, i. e. 18 feet.

The canal will be deepened throughout, in its prism and in all permanent structures, to 9 feet, so that the boats can load to 8 feet and still have 1 foot of water under their keels at all points.

The exact type of the steel lift locks to be adopted has not yet been determined. It is understood that the lift locks are to consist of steel tanks raised and lowered by hydraulic or mechanical power, the tanks to be 20 feet wide and 245 feet long, with 9 feet or over depth of water.

All permanent structures over the canal are to be arranged to give a clear height of at least 12 feet above the water surface.

PASSAGE OF TORPEDO BOATS.

In considering the capacity of the Erie Canal for the passage of "torpedo boats and other vessels of war of similar dimensions," it is proper to consider, not what the canal is now, but what it will be when the improvements in progress and for which money has been appropriated are completed.

The Erie Canal will then permit the passage of boats of 17½ feet beam, 8 feet draft, and up to 230 feet in length.

The following table gives the dimensions of the torpedo boats of our Navy which have been built and which are now under contract to be built:

Name.	Length.	Breadth.	Mean draft.	Displacement.	Height above water line.
IN SERVICE.	*Feet.*	*Feet.*	*Feet.*	*Tons.*	*Feet.*
Cushing	138.9	14.1	5.3	110	14
Ericsson	150	15.6	4.9	120	15
Destroyer	210	21.7	5.5	300	....
No. 3	160	16	5	138	15
No. 4	160	16	5	138	15
No. 5	160	16	5	138	15
No. 6	175	17	5.5	180	16
No. 7	175	17	5.5	180	16
No. 8	170	17	5.5	180	16
UNDER CONTRACT.					
No. 9	147	16.3	4.75	146	10.5
No. 10	147	16.3	4.75	146	10.5
No. 11	210	20.3	6	273	17.3
No. 12	146	15.3	5.3	117	9.5
No. 13	146	15.3	5.3	117	9.5
No. 14	147	15.8	4.5	103	11.6
No. 15	100	12.5	3.5	46.5	9.2
No. 16	100	12.5	3.5	46.5	9.2
No. 17	101.5	12.5	4.25	65	7.8
No. 18	101.5	12.5	4.25	65	7.8

From this table it is evident that when the work in progress on the Erie Canal is completed, the canal will be capable of passing from the seaboard to the lakes any of the torpedo boats now in service or under contract with the exception of two, the *Destroyer*, which has a beam of 21.7 feet, and *No. 11*, which is to have a beam of 20.3 feet. This clearly indicates that under existing conditions there is little necessity for the Government to take any action toward widening the locks for the purpose of passing torpedo boats through the canal. The top works of some of the boats would have to be lowered or temporarily removed for the passage under bridges, etc.

In the United States Navy there are no "other vessels of war of similar dimensions" to torpedo boats. The nearest approach is the class of gunboats *Nos. 10, 11, 12, 13, 14,* and *15*, which are 168 to 174 feet in length, 34 to 36 feet beam, and which draw 12 feet of water.

Widening or enlarging the locks of the Erie Canal would not permit the passage of these boats through to the Great Lakes, as their draft is too great. It is, however, quite probable that they could be lightered so as to be passed through the canal after it is deepened to 9 feet.

In the English service the regular torpedo boats vary in length from 56 to 150 feet; in breadth from 7.5 to 15.5 feet, and in draft from 3 to 6 feet. The English "torpedo boat destroyers" make up a class which are ordinarily about 200 feet long, 19 feet beam, and 7 feet draft. On the list there are four 210 feet long and 21.7 feet beam.

There is in the English service a class of gunboats built for coast defense which usually carry one gun of large caliber. Their general size is: Length, 85 feet; beam, 26.1 feet; draft, 6.5 feet. Some of them are 110 feet long, 34 feet beam, with a draft of 5.7 feet.

There are also two classes of larger gunboats, one class having about the following dimensions: Length, 135 feet; breadth, 26 feet; draft, 10.5 feet; and the other, length, 165 feet; breadth, 31 feet; draft, 11.6 feet.

There is a class known as the "sloop" class of gunboats, which have a general length of 185 feet, breadth of $32\frac{1}{2}$ feet, and draft of $11\frac{1}{4}$ feet.

A consideration of the above data indicates: First, that the Erie Canal, as it is being enlarged by the State of New York, will be sufficient in size for the passage of ordinary torpedo boats, but that it will not be large enough for the passage of the largest class of torpedo boats and torpedo-boat destroyers. Second, that the canal will not have sufficient capacity for the passage of gunboats like those in the service of the United States or England.

It is deemed proper, therefore, to submit estimates of the cost of enlarging the locks in the Erie Canal sufficiently to render it capable of passing gunboats of various sizes. As the depth of water in the canal under the authorized improvements will be 9 feet, no gunboats could pass unless their draft was less than 9 feet or unless they could be lightered to less than 9 feet, and their top works lowered to a height of 12 feet above the water line.

It being deemed possible that the future may see the Erie Canal deepened to 11 feet so that boats drawing 10 feet could be passed, additional estimates are also made for deepening the locks to 11 feet.

PLAN.

In order to prepare the estimates it has been necessary to fix upon a plan. The plan adopted is one which fulfills the spirit and intent of the bill, and one which, if carried out, would be in the highest degree useful; not only providing for the passage of torpedo boats, gunboats, etc., but also serving the interest of general commerce.

The State of New York, as previously mentioned, has lengthened more than half of the locks in one tier of the Erie Canal, and proposes in the immediate future to lengthen the remaining ones of the tier, so as to accommodate two canal boats of the present type increased in length to 115 feet. In the estimate made herein it is proposed to leave these lengthened locks undisturbed and to provide for widening the locks of the other tier and increasing their length, so that they will be capable of passing two boats, each 115 feet long, coupled together tandem.

Estimates are submitted for locks 9 feet deep, 250 feet long, and 25 feet wide, 31 feet wide, and 37 feet wide, large enough for the passage of boats 24, 30, and 36 feet wide, respectively. Estimates are also submitted for the same locks increased in depth to 11 feet.

Estimates are also given of the cost of widening the locks which have already been lengthened by the State to the sizes above mentioned.

The sketch herewith shows the situation at a typical lock, and outlines the modifications covered by the estimates.

On the drawing the full black lines show the old unlengthened lock 110 feet long and 18 feet wide at the lower water level, and its twin lock as it has been or is to be lengthened by the State. The added portion of the latter lock is 111 feet from the old lower quoin post to the new lower quoin post. The sketch shows how an additional length of 18.5 feet is gained by substituting a tumble gate for the upper miter gates. The total length of the lengthened lock from the upper gate to the lower quoin post is 239.5 feet. Allowing 9.5 feet for the swing of the lower gate, an available length of 230 feet is left. The width in the old portion is 18 feet and in the new portion is 20 feet at the lower water level. The red lines in the sketch indicate the proposed plan for enlarging the old unlengthened lock to a lock 31 feet wide at the lower water level, and with an available length of over 230 feet. The length from the lower face of the tumble gate to the quoin post of the lower miter gates is 250 feet.

The estimates include the enlargement of 44 small lift locks and one guard lock on the Erie Canal and two lift locks and one guard lock on the Champlain Canal, by substituting therefor enlarged locks of the ordinary type of the sizes above stated, all with a clear depth of 9 feet of water. They provide for steel lift locks to replace the 16 locks at Cohoes, the 4 locks at Little Falls, the 3 locks at Newark, and the 5 locks at Lockport.

This enlargement would permit of quick passage through the locks all the way from Lake Erie to the Hudson River of boats 230 feet in length, and of such width as it might be determined to build the structures.

ESTIMATES.

The estimates herein were made with the assistance of Mr. Emile Low, civil engineer, who made an inspection of the entire line of the Erie Canal. The estimates are based, as far as practicable, upon contract prices for the current work on the canal under the State authorities. In the locks which are to be lengthened and widened the lock walls are to be concrete, faced with cut stone, and the lock gates are to be of timber.

For the steel lift locks at Lockport, Newark, Little Falls, and Cohoes the estimate is approximate only. No definite plans for the work have been considered, but from the best information available the sum named, it is believed, will be sufficient to provide at each place a lift lock of first-class modern construction, sufficient in strength and capacity to pass boats of the proper size rapidly and safely from one level to another. The estimates include the enlarging of the two lower lift locks and the guard lock of the Champlain Canal, as it is from the third level of the Champlain Canal that the lift of 140.8 feet would be made to the level of the Erie Canal above Lock 18.

The estimates, which are given more in detail further on, may be summarized as follows:

ENLARGING SMALL LOCKS.

Enlarging 48 locks on the Erie and Champlain canals and putting in single-chamber steel lift locks at Cohoes, Little Falls, Newark, and Lockport. All locks and lifts to be 250 feet long, 9 feet deep, and 25 feet wide, suitable for boats of 24 feet width and 8 feet draft.

Estimated cost.

Masonry locks	$2,559,000
Steel lift locks	1,728,000
Total	4,287,000
Same, with locks and lifts increased to 31 feet width:	
Masonry locks	2,895,000
Steel lift locks	1,929,000
Total	4,824,000
Same, with locks and lifts increased to 37 feet width:	
Masonry locks	3,231,000
Steel lift locks	2,130,000
Total	5,361,000

If these locks and lifts are deepened to 11 feet to permit the passage of boats drawing 10 feet, the following is the estimated total cost:

Locks and lifts 25 feet wide:	
Masonry locks	$2,991,000
Steel lift locks	1,788,000
Total	4,779,000
Locks and lifts 31 feet wide:	
Masonry locks	3,375,000
Steel lift locks	2,009,000
Total	5,384,000
Locks and lifts 37 feet wide:	
Masonry locks	3,711,000
Steel lift locks	2,230,000
Total	5,941,000

The following are the estimates of the cost of enlarging a typical lock with a lift of 10 feet to the sizes specified, for boats of 8 feet draft:

	Estimated cost.
Lock 250 by 9 by 25 feet	$55,000
Lock 250 by 9 by 31 feet	62,000
Lock 250 by 9 by 37 feet	69,000

The following are the estimates of the cost of enlarging a typical lock with a lift of 10 feet to the sizes specified, for boats of 10 feet draft:

	Estimated cost.
Lock 250 by 11 by 25 feet	$64,000
Lock 250 by 11 by 31 feet	72,000
Lock 250 by 11 by 37 feet	79,000

ENLARGING LENGTHENED LOCKS.

If, instead of enlarging the small locks along the line of the Erie Canal, the locks as lengthened by the State were widened, the cost would be somewhat reduced.

The estimated cost to widen a typical lengthened lock of the Erie Canal to provide for the passage of boats of 8 feet draft is as follows:

	Estimated cost.
Lock 250 by 9 by 25 feet	$44,000
Lock 250 by 9 by 31 feet	50,000
Lock 250 by 9 by 37 feet	56,000

If, at the same time, these lengthened locks were also increased in depth to provide for the passage of boats of 10 feet draft, the estimated cost would be as follows:

	Estimated cost.
Locks 250 by 11 by 25 feet	$53,000
Locks 250 by 11 by 31 feet	60,000
Locks 250 by 11 by 37 feet	66,000

The total cost of widening the tier of lengthened locks on the Erie Canal all the way through, supposing them to have all been lengthened, together with the necessary single-chamber steel lifts at Cohoes, Little Falls, Newark, and Lockport, for boats of 8 feet draft is as follows:

Locks and lifts, 250 by 9 by 25 feet:	
Masonry locks	$2,112,000
Steel lift locks	1,728,000
Total	3,840,000
Locks and lifts, 250 by 9 by 31 feet:	
Masonry locks	2,400,000
Steel lift locks	1,929,000
Total	4,329,000
Locks and lifts, 250 by 9 by 37 feet:	
Masonry locks	2,688,000
Steel lift locks	2,130,000
Total	4,818,000

For boats of 10 feet draft the cost of the above would be as follows:

Locks and lifts, 250 by 11 by 25 feet:	
Masonry locks	$2,544,000
Steel lift locks	1,788,000
Total	4,332,000
Locks and lifts, 250 by 11 by 31 feet:	
Masonry locks	2,880,000
Steel lift locks	2,009,000
Total	4,889,000
Locks and lifts, 250 by 11 by 37 feet:	
Masonry locks	3,168,000
Steel lift locks	2,230,000
Total	5,398,000

The State of New York has not yet completed its designs and plans for the steel lift locks at Cohoes, Little Falls, Newark, and Lockport, and if it could be induced in building these lift locks to increase them in size so as to provide for the passage of larger boats, it would only be necessary then to enlarge the 48 masonry locks on the through line.

The increased cost of the steel lift locks of the larger size, over the cost of the smaller size proposed by the State, would be small in comparison with the cost of new lift locks of the larger sizes mentioned herein.

A very desirable size for these lift locks would be to make them long enough for two boats, as proposed by the State authorities, and to increase the width to 37 feet, which would be wide enough for two boats of the present type. The lock would then accommodate four boats, an entire steam fleet as the fleets are commonly made up.

It is estimated that to put in double steel lifts at each of the four places mentioned, with lock chambers 245 by 9 by 20 feet, will cost about $2,500,000, and if these were increased to 245 by 11 by 37 feet, the cost, it is estimated, would be about $4,000,000, a difference of $1,500,000.

If lifts with single lock chambers were adopted instead of double lock chambers, the cost would be for the locks 245 by 9 by 20 feet, $1,500,000, and for the locks 245 by 11 by 37 feet, $2,400,000, a difference of $900,000.

Looking to the future enlarged use of the Erie Canal, it would seem to be a highly commendable proposition to build these steel lift locks now of the large size indicated.

Detailed estimate of the cost of enlarging one lock of Erie Canal of 10 feet lift to 250 feet length, 25 feet width, and 9 feet depth of water.

Items.	Price.	Amount.
Grubbing and clearing	$100.00	$100.00
Bailing and draining	1,000.00	1,000.00
Removing platforms and supports	65.00	65.00
Removing fender piles and waling	45.00	45.00
Removing gates and sills at foot and head of lock	150.00	150.00
Removing timber foundation of old lock	250.00	250.00
Cutting off old pile foundation	150.00	150.00
4,700 cubic yards excavation of earth	.30	1,410.00
1,080 cubic yards excavation of old masonry	1.50	1,620.00
1,600 cubic yards embankment	.20	320.00
1,400 cubic yards filling between lock walls	.30	420.00
260 cubic yards gravel lining	.75	195.00
500 cubic yards puddling	1.00	500.00
100 cubic yards stone filling	1.50	150.00
1,100 cubic yards cut-stone lock masonry	12.00	13,200.00
1,870 cubic yards concrete lock masonry	8.00	14,960.00
400 cubic yards vertical wall masonry	3.00	1,200.00
420 cubic yards concrete foundation masonry	4.50	1,890.00
150 cubic yards waste wier culvert masonry	10.00	1,500.00
17,000 feet, B. M., white oak in foundations	35.00	595.00
15,000 feet, B. M., white oak in cribs	35.00	525.00
168,000 feet, B. M., hemlock in foundations	18.00	3,024.00
14,000 feet, B. M., white-pine lining, lock chamber	30.00	420.00
9,000 linear feet bearing piles driven	.30	2,700.00
250 linear feet snubbing posts, set	1.00	250.00
9,500 pounds wrought iron in foundation and cribs	.05	475.00
300 pounds cast iron	.04	12.00
7,000 pounds spikes and nails	.04	280.00
1 pair miter gates	600.00	600.00
1 tumble gate	900.00	900.00
1 reenforcing foundation of old lock walls	1,000.00	1,000.00
		49,906.00
CREDIT.		
Materials which can be utilized in new work.		
360 cubic yards face stone, $3.50	1,260.00	
720 cubic yards backing stone, $1.50	1,080.00	
4 composite valves and fixtures, $15	60.00	
		2,400.00
		47,506.00
Add 15 per cent for contingencies and engineering		7,125.90
Total		54,631.90
In round numbers		55,000.00

Detailed estimate of the cost of enlarging one lock of the Erie Canal of 10 feet lift to 250 feet length, 31 feet width, and 9 feet depth of water.

Items.	Price.	Amount.
Grubbing and clearing	$100.00	$100.00
Bailing and draining	1,000.00	1,000.00
Removing platform and supports	65.00	65.00
Removing fender piles and waling	45.00	45.00
Removing gates and sills at head and foot of lock	150.00	150.00
Removing timber foundation of old lock	250.00	250.00
Cutting off old pile foundation	150.00	150.00
6,000 cubic yards excavation of earth	.30	1,800.00
1,080 cubic yards excavation of old masonry	1.50	1,620.00
1,900 cubic yards embankment	.20	380.00
1,400 cubic yards filling between lock walls	.30	420.00
260 cubic yards gravel lining	.75	195.00
500 cubic yards puddling	1.00	500.00
150 cubic yards stone filling	1.50	225.00
1,210 cubic yards cut-stone lock masonry	12.00	14,520.00
2,057 cubic yards concrete lock masonry	8.00	16,456.00
400 cubic yards vertical wall	3.00	1,200.00
470 cubic yards concrete foundation masonry	4.50	2,115.00
150 cubic yards waste weir culvert	10.00	1,500.00
20,000 feet, B. M., white oak in foundations	35.00	700.00
20,000 feet, B. M., white oak in cribs	35.00	700.00
190,000 feet, B. M., hemlock in foundations	18.00	3,420.00

Detailed estimate of the cost of enlarging one lock of the Erie Canal of 10 feet lift to 250 feet length, 31 feet width, and 9 feet depth of water—Continued.

Items.	Price.	Amount.
25,000 feet, B. M., white-pine lining, lock chamber	$30.00	$750.00
10,300 linear feet bearing piles driven	.30	3,090.00
250 linear feet snubbing posts, set	1.00	250.00
11,400 pounds wrought iron in foundations and cribs	.05	570.00
350 pounds cast iron	.04	14.00
9,100 pounds spikes and nails	.04	364.00
1 pair miter gates	800.00	800.00
1 tumble gate	1,000.00	1,000.00
Reenforcing foundation of old lock wall	1,000.00	1,000.00
Widening approaches to lock	651.00	651.00
		56,000.00
CREDIT.		
360 cubic yards face stone, $3.50	1,260.00	
720 cubic yards backing stone, $1.50	1,080.00	
4 composite valves and fixtures, $15	60.00	
		2,400.00
		53,600.00
Add 15 per cent for contingencies and engineering		8,040.00
Total		61,640.00
In round numbers		62,000.00

Detailed estimate of the cost of enlarging one lock of the Erie Canal of 10 feet lift to 250 feet length, 37 feet width, and 9 feet depth of water.

Items.	Price.	Amount.
Grubbing and clearing	$100.00	$100.00
Bailing and draining	1,000.00	1,000.00
Removing platform and supports	65.00	65.00
Removing fender piles and waling	45.00	45.00
Removing gates and sills at foot and head of lock	150.00	150.00
Removing timber foundation of old lock	250.00	250.00
Cutting off old pile foundation	150.00	150.00
7,500 cubic yards excavation of earth	.30	2,250.00
1,080 cubic yards excavation of old masonry	1.50	1,620.00
2,200 cubic yards embankment	.20	440.00
1,400 cubic yards filling between lock walls	.30	420.00
260 cubic yards gravel lining	.75	195.00
500 cubic yards puddling	1.00	500.00
200 cubic yards stone filling	1.50	300.00
1,320 cubic yards cut-stone lock masonry	12.00	15,840.00
2,244 cubic yards concrete lock masonry	8.00	17,952.00
400 cubic yards vertical wall masonry	3.00	1,200.00
520 cubic yards concrete foundation masonry	4.50	2,340.00
150 cubic yards waste wier culvert masonry	10.00	1,500.00
23,000 feet, B. M., white oak in foundation	35.00	805.00
23,000 feet, B. M., white oak in cribs	35.00	805.00
215,000 feet, B. M., hemlock in foundation	18.00	3,870.00
30,000 feet, B. M., white-pine lining, lock chambers	30.00	900.00
11,600 linear feet bearing piles driven	.30	3,480.00
250 linear feet snubbing posts, set	1.00	250.00
13,000 pounds wrought iron in foundation and cribs	.05	650.00
450 pounds cast iron	.04	18.00
10,000 pounds spikes and nails	.04	400.00
1 pair miter gates	1,000.00	1,000.00
1 tumble gate	1,200.00	1,200.00
Reenforcing foundation of old lock wall	1,000.00	1,000.00
Widening approaches to lock	1,305.00	1,305.00
		62,000.00
CREDIT.		
360 cubic yards face stone, $3.50	1,260.00	
720 cubic yards backing stone, $1.50	1,080.00	
4 composite valves and fixtures, $15	60.00	
		2,400.00
		59,600.00
Add 15 per cent for contingencies and engineering		8,940.00
Total		68,540.00
In round numbers		69,000.00

Estimated cost of enlarging one tier of locks on Erie Canal from Hudson River at Albany to Lake Erie at Buffalo.

[Locks to be enlarged to 25 feet width, 250 feet length, and 9 feet depth of water, with single-chamber steel lift locks at Cohoes, Little Falls, Newark, and Lockport.]

Locks.	Lift.	Location.	Character of foundation.	Estimated cost.
1	15.159	Albany	Piles	$70,000
2	9.495	.....do	.....do	54,000
a1	11.500	Cohoes	Rock	55,000
a2	11.500	.....do	.....do	55,000
a3	0.000	.....do	.....do	48,000
3–18	140.863	.....do	Steel lift lock	600,000
19	8.441	Near Crescent	Hardpan, lock on concrete	52,000
20	10.418	Near Rexford Flats	.... do	55,000
21	11.126	Rexford Flats	Soft, piles about 25 feet long	60,000
22	11.609	.....do	Soft, piles about 10 feet long	58,000
23	8.318	Near Schenectady	Piles	53,000
24	8.191	.....do	.....do	52,000
25	7.716	Rotterdam Junction	.....do	52,000
26	8.365	Near Port Jackson	.....do	55,000
27	7.886	.....do	Soft material, piles 25 feet long	55,000
28	7.723	Near Fort Hunter	Hard gravel, piles 7 feet long	52,000
29	7.399	.....do	.....do	52,000
30	10.213	Fort Hunter	Soft clay, piles 20 feet long	59,000
31	5.867	Sprakers	Piles, average 13 feet long	49,000
32	8.126	Fort Plain	Piles, 8 to 14 feet long	52,000
33	5.704	St. Johnsville	Gravel, lock on concrete	47,000
34	8.483	Mindenville	Hardpan, lock on concrete	49,000
35	7.785	Indian Castle	Piles, 5 to 8 feet long	52,000
36–39	39.174	Little Falls	Steel lift lock	360,000
40	8.524	Jacksonburg	Gravel, lock on concrete	51,000
41	8.286	Fort Herkimer	Piles, average 6 feet long	53,000
42	7.954	Mohawk	Piles, average 10 feet long	52,000
43	8.069	.....do	Piles, average 13 feet long	52,000
44	10.737	Ilion	Piles, 8 to 14 feet long	57,000
45	11.172	Frankfort	Soft, piles 24 to 30 feet long	60,000
46	3.000	Utica	Piles	48,000
47	10.175	Syracuse	Hard foundation	53,000
48	10.538	.....do	Quicksand, piles 12 to 14 feet long	56,000
49	6.991	.....do	Hard foundation	48,000
50	7.872	Geres	Piles	53,000
51	5.580	Jordan	Quicksand, piles 16 to 20 feet long	52,000
52	11.417	Port Byron	Soft, piles 20 to 25 feet long	61,000
53	4.755	Clyde	Piles	50,000
54	7.360	Lock Berlin	Rock	49,000
55	6.251	Lyons	Hardpan	46,000
56	9.848	Poor House	Rock	52,000
57–59	24.034	Newark	Steel lift lock	288,000
60	9.886	Macedon	Piles	59,000
61	6.601	.....do	.....do	51,000
62	8.807	Pittsford	.....do	55,000
63	8.719	Brighton	.....do	55,000
64	10.108	.....do	.....do	56,000
65	10.102	Rochester	Rock	53,000
66	8.859	.....do	.....do	51,000
67–71	57.427	Lockport	Steel lift lock	480,000
	0.000	Sulphur Springs	Hard	51,000
72	2.425	Black Rock	Piles	49,000
		Total		4,287,000

a Champlain Canal locks.

If the locks are widened to 31 feet, the addition to the above will be $7,000 to each lock and $201,000 for the additional cost of the steel lift locks, making a total of $4,824,000.

If the locks are widened to 37 feet, the addition to the estimated cost of the 25-foot locks, will be $14,000 for each lock and $402,000 for the additional cost of the steel lift locks, making a total of $5,361,000.

The total estimates for the locks and lifts increased to 11 feet depth as given herein was computed with the foregoing as a basis of computation. The same may be said of the estimated cost of widening the present lengthened locks.

To summarize, I would state that it is perfectly practicable, from an engineering standpoint, to widen the locks of the Erie Canal in the manner indicated in the bill. That the cost will depend upon the selection of the locks to be enlarged, and the size of their enlargement, and upon whether the State of New York will cooperate by building the steel lift locks at four points large enough to correspond with the enlargement decided upon for the masonry locks.

COMMERCIAL ASPECTS.

It is impossible to overlook the fact that such an improvement in the Erie Canal as that proposed would have a very important bearing upon its capacity and use for commercial purposes, and it seems proper to give some slight consideration to this aspect of the question in this report. It may be stated broadly that the function of the Erie Canal is to furnish part of a free watery highway from the grain, ore, and lumber regions of the Northwest to the great metropolis and seaport of the country, New York. While it is a fact that there is carried upon the canal but a small portion of the products of the Northwest going to New York, yet, by the cheap method of transportation which it furnishes, it has undoubtedly exercised a wide influence in keeping down freight rates on the railroads which carry the greater portion of the products, and has inspired these railroads in their efforts to reduce the cost of transportation.

The railroads have been constantly bettering their transportation facilities by improvements in their roadbeds, in the size, capacity, and economy of their locomotives and cars, in their terminal facilities, and in the greater perfection of their organization for securing and doing business. The Erie Canal has not kept pace with this march of improvement, and it may be asserted that conditions have been reversed and, whereas in former years the Erie Canal forced down rail freight rates, that of late the railroads have forced the canal rates down to such an extent that under existing conditions of the canal there is little profit to boatmen, and the amounts carried are very limited. The canal, to fulfill its highest functions, must continually be improved to keep pace with the railroad improvement, and these canal improvements should not drag along after the rail improvements, but should precede them or at least be coincident with them.

The State of New York has appreciated this in providing for the improvements which are under way with the $9,000,000 appropriation, but when these are accomplished the demand will be for still more and greater improvements. When the current improvements are completed it is fair to estimate that, with boats 115 feet long and drawing safely 8 feet of water, in connection with the time which will be saved in lockage, the capacity of the canal will be increased fully 75 per cent; that is, a single boat of the larger size can, in a single season, transport 75 per cent more grain than one of the present type of boats can under existing conditions.

The added expense for this additional amount transported will not exceed 25 per cent of the cost of transporting the smaller amount under the present conditions.

This would reduce the net first cost of transporting a bushel of wheat from Buffalo to New York to about 71 per cent of the present cost, and if this present first cost is assumed at 2½ cents,[1] it will, under the new conditions, with boats 115 feet long and drawing 8 feet of water, be reduced to 1.78 cents.

[1] During 1895 the average canal freight charge from Buffalo to New York was 2.2 cents per bushel, varying from 3 cents to 1.9 cents. These are the lowest rates ever known.

If the capacity of the canal were still further increased so that boats 24 feet wide could be used without any increase in draft beyond 8 feet the capacity of each boat for doing business would be increased to about 2.43 times the capacity of the single boat under the present conditions. Assuming that the increased cost of operating would be 15 per cent over the cost of operating a 17½-foot boat for an equal number of trips, this would reduce the net cost of transporting a bushel of grain from Buffalo to New York to about 60 per cent of the present cost, or 1½ cents per bushel.

If the capacity of the canal were increased so that boats of 30 feet width could be used without any increase in draft beyond 8 feet, the capacity of each boat for doing business would be 3.02 times that of a boat under present conditions. Making proper allowances for increased cost of doing greater business, this would reduce the net cost of transporting a bushel of wheat from Buffalo to New York to about 50 per cent of the present cost, or 1¼ cents per bushel.

If the capacity of the canal were increased as above to provide for boats of 36 feet width, its capacity would be increased 3.54 times, and the cost of transporting a bushel of wheat reduced to 44 per cent of the present cost, or 1.11 cents per bushel.

It is believed that this could be still further reduced by deepening the canal and widening it where necessary; by bettering the terminal facilities; by a perfected organization which will labor to secure business and do away with delays at terminal points and keep boats going continuously during the period of navigation and secure return freight to the greatest possible extent; and by the total elimination of the mule as a motive power and the complete substitution therefor of steam and possibly of electricity.

It is believed that the goal, the aim of all interested in the Erie Canal, may well be to put the canal into such condition that it will be possible to transport wheat from Buffalo to New York at a cost of 1 cent a bushel, and other articles in proportion. Such a cost I believe to be reasonably capable of attainment, and the enlargement of the locks as estimated for herein would be a great and decided step thereunto.

Such an improvement would lead to the enlargement of the boats engaged in the commerce of the canal, and this in turn would lead to the necessity of enlarging the prism of the canal.

As is well known, the size of a water way has an important bearing upon the power required to propel a boat through it. The smaller the water way in proportion to the immersed section of the boat, the greater the power required for propulsion.

The economical width for a long canal is estimated to be about four and one-half times the width of the boats traversing it. The prism of the Erie Canal as it is now built, and as it is to be deepened and enlarged, is and will be fairly suitable in size for the passage of the present type of canal boats, which are 17 feet and 5 inches wide.

If the canal prism remained as at present, it would not be practically economical to use boats of much larger size than those at present employed in the canal traffic, for the resistance to the boat of the water in the confined channel would increase rapidly with the size of the boat, and the power required for propulsion would soon be greater in proportion than the additional load carried.

Assuming that the canal should be four and one-half times the width of the boats employed upon it, it would have to be increased to 108 feet for boats 24 feet wide, 135 feet for boats 30 feet wide, or 162 feet for boats 36 feet wide.

No estimate is made of the cost of widening and enlarging the canal prism. This is work which can in general be done gradually and without interfering with the use of the canal. With the locks widened, boats of corresponding size could pass through the canal, and then every mile that the prism should be enlarged would give just that much additional benefit.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
Washington, December 11, 1896.

Respectfully forwarded to the Chief of Engineers, concurring in the views of Major Symons as to the practicability and probable cost of the enlargement of the locks of the Erie Canal, in the State of New York, as proposed in House of Representatives bill No. 7775, Fifty-fourth Congress, first session.

A thorough study of the subject of the enlargement of the Erie Canal was made by me in 1874, and under date of December 24, 1874, I submitted a detailed report, which will be found in the Report of the Chief of Engineers for 1875, volume 2, page 534 et seq.

Realizing that twenty years must have made great changes, probably affecting the water supply, I telegraphed Major Symons upon the receipt of this report asking whether water supply had been carefully considered in his suggested enlargement of the canal prism, and received a reply that it had been considered, and he had no doubt of an available supply for the suggested enlarged canal.

JOHN M. WILSON,
Colonel, Corps of Engineers,
Division Engineer, Northeast Division.

NOTE.—For report of Maj. W. S. Stanton, Corps of Engineers, relative to widening locks in the Oswego Canal, see Appendix N N 20.

M M II.

ESTABLISHMENT OF HARBOR LINES IN THE BAY OF PRESQUE ISLE, AT ERIE, PENNSYLVANIA.

ERIE, PA., *September 29, 1896.*

SIR: Pursuant to resolution of councils, as follows:

By Selectman Rockafellar:

Resolved, by the Select and Common Councils of the City of Erie, That his honor the mayor is hereby authorized and requested to make application to the Secretary of War, to cause harbor lines to be established in the harbor of Erie, beyond which no piers, wharves, bulkheads, or other works shall be extended or deposits made, except under such regulations as may be prescribed by the Secretary of War, according to act of Congress in such case made and provided.

Erie, Pa., September 21, 1896, select council, adopt.

T. HANLON, *Clerk.*

Erie, Pa., September 28, 1896, common council, concur.

SAM B. KENNEDY, JR., *Clerk.*

Approved September 29, 1896.

ROBT. J. SALTSMAN, *Mayor.*

I would most respectfully ask that harbor lines be established for the Bay of Presque Isle, at Erie, Pa., this fall if possible, as property owners contemplate building works this winter that may extend beyond where the lines should be established. I have the honor to remain,

Very respectfully,

ROBT. J. SALTSMAN, *Mayor.*

Hon. DANIEL S. LAMONT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 2, 1896.

Respectfully referred to Maj. Thos. W. Symons, Corps of Engineers, for report.

If, in the opinion of Major Symons, the establishment of harbor lines is essential to the preservation and protection of Erie Harbor, he is requested to submit a map showing the lines recommended.

To be returned.

By command of Brig. Gen. Craighill.

GEO. W. GOETHALS,
Captain, Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Buffalo, N. Y., December 1, 1896.

Respectfully returned to the Chief of Engineers. It is my opinion that the establishment of harbor lines is essential to the preservation and protection of Erie Harbor, and I have the honor to submit herewith a map showing the harbor lines recommended. The description of the harbor line is upon the map sent.

This line was fixed upon after meeting with the city authorities and representatives of the shipping interests, and, as far as can be ascertained, meets with the approval of all concerned.

THOMAS W. SYMONS,
Major, Corps of Engineers.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 7, 1896.

Respectfully referred to Col. John M. Wilson, Corps of Engineers, division engineer, northeast division, for his views and recommendations.

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

NORTHEAST DIVISION, ENGINEER OFFICE,
Washington, December 8, 1896.

Respectfully returned to the Chief of Engineers, concurring in the views of the local engineer and recommending that the harbor lines indicated on the tracing submitted by Major Symons shall be approved.

JOHN M. WILSON,
Colonel, Corps of Engineers, Division Engineer, Northeast Division.

[Sixth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 11, 1896.

Respectfully returned to the Secretary of War.

The establishment of harbor lines for the Bay of Presque Isle at Erie, Pa., having been requested by the mayor of the city of Erie, the matter was referred to Major Symons, in charge of the harbor improvements at that place, and attention is respectfully invited to his report of December 1, contained in the third indorsement hereon.

Concurring in the views of Major Symons and of Colonel Wilson, the division engineer, it is recommended that the lines selected for Erie Harbor be approved, and that the Secretary place his approval both upon this paper and upon the accompanying tracing, which has been prepared for his signature.

A. MACKENZIE,
Acting Chief of Engineers.

[Seventh indorsement.]

WAR DEPARTMENT, *December 17, 1896.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX N N.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO EAST OF OAK ORCHARD, NEW YORK, AND OF RIVERS AND HARBORS IN VERMONT AND NORTHERN NEW YORK.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Charlotte Harbor, New York.
2. Pultneyville Harbor, New York.
3. Harbor at Great Sodus Bay, New York.
4. Harbor at Little Sodus Bay, New York.
5. Oswego Harbor, New York.
6. Harbor at Sacketts Harbor, New York.
7. Harbor at Cape Vincent, New York.
8. Shoals between Sister Islands and Cross-over Light, St. Lawrence River, New York.
9. Ogdensburg Harbor, New York.
10. Burlington Harbor, Vermont.
11. Channel between North and South Hero islands, Lake Champlain, Vermont.
12. Otter Creek, Vermont.
13. Narrows of Lake Champlain, New York and Vermont.
14. Removing sunken vessels or craft obstructing or endangering navigation.

EXAMINATIONS.

15. Mohawk River, New York.
16. Black River, New York.
17. Harbor at Alexandria Bay, New York.

SURVEYS.

18. Oak Orchard Harbor, New York.
19. Missisquoi River, Vermont.
20. Report on House bill No. 8074, for widening the locks in the Oswego Canal, New York.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 19, 1897.

GENERAL: I have the honor to transmit herewith annual reports for the fiscal year ending June 30, 1897, upon the works of river and harbor improvement under my charge.

Very respectfully, your obedient servant,

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

N N 1.

IMPROVEMENT OF HARBOR AT CHARLOTTE, NEW YORK.

This harbor is in the Genesee River the depth of whose channel, for the 5 miles next above its mouth, is not less than 18 feet at low water.

The improvement is to increase and preserve the depth of the channel at the entrance to the river from Lake Ontario, by confining and protecting it between two piers nearly parallel and about 460 feet apart, built of cribs of timber ballasted with stones, and by dredging.

The history of the improvement may be found on pages 3131-3137, report of 1896, and a plan faces page 2458 in the report for 1894.

The present project, adopted in 1882, is to extend the piers an aggregate length of 3,250 feet into Lake Ontario and to dredge 120,000 cubic yards of sand to obtain a depth of 15 feet at low water. The piers having been extended an aggregate length of 1,444 feet, the project was modified by letters (7594-3) of July 18, 1896, and (7594-4) of March 2, 1897, to obtain and preserve the depth of 16 feet at low water (zero of Charlotte and Oswego gauges) by dredging, without further extension of the piers into the lake, at least for the present.

Since dredging commenced in 1888, 332,735 cubic yards of mud, silt, and sand have been dredged from the channel to June 30, 1897.

Dredging by hired labor with the U. S. dredge *Frontenac* commenced September 27, when the dredge was transferred from Great Sodus Harbor, and to December 19, 1896, when the working season closed, 18,840 cubic yards of mud, silt, and sand were dredged from the channel and 300 cubic yards of ballast which had fallen from the piers. The dredging averaged 362 cubic yards per calendar day on which work was done. The time, 30½ days, lost by bad weather so late in the season caused this dredging to cost 15 cents per cubic yard, 3½ cents in excess of the average cost, 11½ cents, of dredging with the *Frontenac* under ordinary conditions of weather.

In November a breach, 50 feet long and 5 feet high, was made in the west pier between 1,100 and 1,200 feet from its outer end, which was repaired, and minor repairs were also made to the decks of both piers by the renewal of occasional planks in December.

The expenses during the year have been:

For dredging, including maintenance of dredge	$3,205.61
For maintenance of piers	443.30
For pay of assistants, office expenses, surveys, printing, and advertising (including services of watchman)	1,128.64
Total	4,777.55

The controlling depth is now 14 feet at low water. The *Frontenac* being unable, with the dredging necessary at Great Sodus, to obtain the increased depth as soon as requisite for the interests of commerce, advertisements were issued for proposals, opened April 16, 1897, for dredging 29,000 to 41,000 cubic yards to obtain a channel 16 to 16½ feet deep at low water, 200 feet wide and about 4,000 feet in length. The lowest of the proposals was 18 cents per cubic yard measured in scows, and they were rejected. By open market transaction dredging at 15 cents per cubic yard measured in scows will commence early in July.

Braddock Point, 5 miles west and 4 miles north of the entrance to the river, protects it in a measure from being choked with sand that is borne easterly along the shore by the littoral current caused by the prevailing northwesterly winds and gales. Between surveys made in November, 1896, and April, 1897, while the outer end of the channel at the entrance to Great Sodus Harbor in a less protected location, 32 miles east of Charlotte, shoaled about 2 feet, there was no appreciable shoaling of the channel at Charlotte either in advance of or between the piers. The principal cause to be contended against in preserving the depth in the channel between the piers and in the lake in advance of them, is sediment deposited by the river in freshets of exceptional height, an example of which is given on page 3185 of the report for 1895, where it is stated that in the spring of 1894 not less than 60,000 cubic yards were deposited between the piers, reducing the depth in places as much as 4 feet. Besides dredging there are 5,000 linear feet of piers to be maintained, for whose maintenance in the twenty-five years, 1871 to 1896, there was expended annually an average of 98 cents per linear foot. (Report for 1896, p. 3135.)

Coal is transported from the mines in Lackawanna and Lucerne counties, Pa., a distance of 250 to 300 miles by rail to Charlotte, whence, in 1896, 437,972 tons were shipped upon the lake, about 1 per cent through the Welland Canal, about 21 per cent to Canadian ports on Lake Ontario, and 78 per cent, or about 342,000 tons, down the St. Lawrence River, of which about 150,000 tons went to Ogdensburg Harbor, which is being dredged to admit vessels with a draft of 16 feet. The owners of vessels plying between Charlotte and Ogdensburg state that these vessels are capable of carrying about 1,600 tons of coal on a draft of 16 feet, and that the maintenance of a depth at Charlotte sufficient for that draft would enable them to carry "at least 16,000 to 18,000 tons of coal more each season without any additional cost whatever."

Besides the transport of coal the passenger transport in and out of the harbor amounts annually to about 50,000 excursionists from the city of Rochester situated on the river at the crest of the Genesee Falls, about 7 miles from the mouth, with which it is connected by a line of electric cars on each bank.

The approach to Charlotte Harbor is so well protected under the lee of Braddock Point in the prevailing northwesterly winds and gales, it is a very good harbor of refuge near the middle of the American shore of the lake or about midway between the Niagara and St. Lawrence rivers.

Charlotte Harbor is in the collection district of Genesee, N. Y.

Money statement.

July 1, 1896, balance unexpended	$14,183.74
June 30, 1897, amount expended during fiscal year	4,777.55
July 1, 1897, balance unexpended	9,406.19
July 1, 1897, outstanding liabilities	50.00
July 1, 1897, balance available	9,356.19
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 23, 1828	$300.00	$300.00	April 10, 1869 [a]	$1,000.00	$281,578.40
March 2, 1829	10,000.00	10,300.00	July 11, 1870	12,000.00	293,578.40
March 3, 1829	13,335.00	23,635.00	March 3, 1871	10,000.00	303,578.40
March 2, 1831	16,670.00	40,305.00	March 3, 1875	5,000.00	308,578.40
February 24, 1832	16,000.00	56,305.00	June 18, 1878	1,000.00	309,578.40
March 2, 1833	15,000.00	71,305.00	March 3, 1879	1,000.00	310,578.40
June 28, 1834	20,000.00	91,305.00	June 14, 1880	5,000.00	315,578.40
March 3, 1835	2,390.00	93,695.00	March 3, 1881	2,500.00	318,078.40
July 2, 1836	20,000.00	113,695.00	August 2, 1882	35,000.00	353,078.40
March 3, 1837	10,000.00	123,695.00	July 5, 1884	20,000.00	373,078.40
July 7, 1838	25,000.00	148,695.00	August 5, 1886	26,250.00	399,328.40
June 11, 1844	10,000.00	158,695.00	August 10, 1888	45,000.00	444,328.40
August 20, 1852	20,000.00	178,695.00	September 19, 1890	25,000.00	469,328.40
March 3, 1853	176.10	178,871.10	July 13, 1892	25,000.00	494,328.40
June 28, 1864	25,000.00	203,871.10	August 17, 1894	15,000.00	509,328.40
June 23, 1866	75,607.30	279,478.40	June 3, 1896	12,000.00	521,828.40
July 25, 1868 [a]	1,100.00	280,578.40			

[a] Allotment.

Abstract of proposals for dredging received in response to advertisement dated March 17, 1897, and opened at noon April 16, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.
		Cents.
1	Jos. R. McCollum, Port Huron, Mich	20
2	Wm. E. Hingston, Buffalo, N. Y	24½
3	W. J. Daly, Ogdensburg, N. Y	19¾

The bids were considered too high and were rejected.

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	437,972	Posts and wood	3,215
Poles and railroad ties	1,025	General merchandise	1,337
Lumber	423		
Shingles	298	Total	444,557
Oil	287		

Increase over last year, 75,140 tons. Passengers carried, 50,892.
Navigation opened April 18 and closed December 2, 1896.

Statement of vessels at Charlotte Harbor, New York, for calendar year ending December 31, 1896.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	711	130,230	57	3,021	66	23,299
Foreign	229	94,820	191	86,527	205	75,917
Total	940	225,050	248	89,548	271	99,216
American owned	721	133,739	44	1,330	188	67,423
Canadian owned	219	91,311	204	88,218	83	31,793

Total arrivals, 1,459; registered tonnage, 363,814.

DEPARTURES.

Home	725	136,980	47	2,146	29	10,319
Foreign	213	87,253	208	40,434	235	87,655
Total	938	224,233	255	42,580	264	97,974

Total departures, 1,457; registered tonnage, 364,787.

Greatest draft of vessel ......feet.. 16
Greatest tonnage of vessel ......registered tonnage.. 1,548
Greatest load of vessel ......net tons.. 1,584

N N 2.

IMPROVEMENT OF HARBOR AT PULTNEYVILLE, NEW YORK.

This improvement was to make a harbor by dredging Salmon Creek, Wayne County, N. Y., a width of about 40 to 50 feet and length of 900 feet from its mouth to a point where its bed is rocky and its depth only 1 or 2 feet, and by protecting the approach to its mouth by building two piers, of cribs of timber ballasted with stone, in Lake Ontario, and dredging between them.

A history of the improvement may be found at pages 3137–3139 of the report for 1896, and a plan faces page 2462 of the report for 1894.

The decks of the piers were dilapidated, and, August 19 to October 24, 1896, when the funds available were exhausted, a new deck was put on the shoreward 350 linear feet of the west pier, which was there cut down 1 foot in height by removing the decayed upper course of timbers, minor repairs were made to the timbers and to the deck of the other 560 linear feet of the west pier, its end wall in the lake, which had been stove to the depth of 9 feet below water, was renewed, and 1,600 linear feet of Wakefield sheet piling which were on hand, were driven along 100 feet of its inner face forming a tight sheathing, to arrest the drifting of sand through the pier; a new deck was put on 60 linear feet at the outer end of the east pier, and minor repairs were made by renewing a deck plank here and there along its other 510 linear feet.

In northeasterly winds the waves, turbid with sand, impinge obliquely against the west pier and race along it to its angle, then expanding, as the pier abruptly flares away to the west, they form an eddy and so rapidly deposit sand in the channel leading to the mouth of the creek, frequent dredging is requisite to maintain a depth sufficient for the smallest class of schooners.

The original depth at the mouth of the creek was about 20 inches. The channel was dredged in 1874 to 1880 to the depth of 8 feet at low water between the piers and somewhat deeper in the creek. In 1893, 10,700 cubic yards of sand were redredged from it and in the report for 1894 the depth was stated "about 10 feet at low water in the lake." The depth at low water is fully 8 feet in the creek; but where sand is deposited in the channel leading to its mouth the depth was 6 feet in July, and only 4 feet, three months later, in October, 1896.

The estimated cost of the improvement, as increased in 1875, was $71,000, and $77,000 have been expended upon it. Pultneyville is a village of 300 inhabitants, and the small commerce of the harbor consists of cedar posts, shingles, and bricks imported from Canada in such quantities as are consumed within such a distance as they can be conveniently hauled over country roads.

By authority from the Chief of Engineers of December 12, 1896, this work, after the submission of this report, is to be dropped from the list of duties in charge of this office.

Pultneyville Harbor is in the collection district of Genesee, N. Y.

Money statement.

July 1, 1896, balance unexpended	$2,435.42
June 30, 1897, amount expended during fiscal year	2,435.42

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 11, 1870	$5,000	$5,000	March 3, 1879	$4,000	$62,000
March 3, 1871	5,000	10,000	June 14, 1880	3,000	65,000
June 10, 1872	10,000	20,000	March 3, 1881	2,000	67,000
March 3, 1873	10,000	30,000	August 2, 1882	4,000	71,000
June 23, 1874	10,000	40,000	September 19, 1890	2,000	73,000
March 3, 1875	10,000	50,000	July 13, 1892	1,000	74,000
August 14, 1876	3,000	53,000	August 17, 1894	1,500	75,500
June 18, 1878	5,000	58,000	June 3, 1896	1,500	77,000

N N 3.

IMPROVEMENT OF HARBOR AT GREAT SODUS BAY, NEW YORK.

The object of this improvement is to increase and preserve the depth of the channel that connects the bay with Lake Ontario by narrowing it to about 475 feet by a breakwater of timber cribs ballasted with stones built along the crest of the narrow beach that separates the bay from the lake, by confining and protecting it between two piers of like construction extending from the breakwater into the lake, and by dredging.

The history of the improvement and a description of the bay, which is a commodious and good anchorage, may be found on pages 3139–3144 of the report for 1896, and a plan faces page 2468 of the report for 1894.

The present project, adopted in 1882, is to obtain the depth of 15 feet at low water (zero of Oswego gauge), and by instructions (7593–7594) of July 18, 1896, it is to be obtained and preserved by dredging without further extension of the piers into the lake, at least for the present.

Dredging by hired labor with the U. S. dredge *Frontenac* commenced July 11, 1896, and to September 26, when the dredge was transferred to Charlotte Harbor, 24,780 cubic yards (measured in scows) of sand and gravel were dredged, obtaining a channel 150 feet wide and 15 feet deep from the bay to the lake. At the close of March, 1897, shoaling had occurred so that the 15-foot curve had receded to a point 600 feet within the end of the weather (west) pier, the 15-foot curves between the piers and in the lake were 1,000 feet apart, and the depth on the crest, about 100 feet wide and 300 feet in advance of the west pier, was only 12 feet at low water. Dredging by the *Frontenac* was resumed April 1, 1897, and 23,840 cubic yards of sand and gravel were dredged to June 30, when the channel was not less than 15 feet deep from the bay to the lake, 150 feet wide between the piers and flaring to 280 feet wide outside of them. Including all the calendar days on which she worked in the seasons of 1896 and 1897, the dredge averaged 312 cubic yards per day. The cost was 13 cents per cubic yard, including all expenses for maintenance. It is hoped that changes can be made in the dredge and her equipment that will increase her small capacity and reduce the cost of her work.

During the year the expenditure has been:

For dredging 48,620 cubic yards, including maintenance of dredge	$5,764.00
For pay of assistants, office expenses, and surveys	924.72
Total	6,688.72

The principal obstacle to be contended against in maintaining this channel is the sand borne into its outer end by the prevailing northwesterly storms. Some sand also drifts into it over the west pier to arrest which a grove of willow trees has been planted and is maintained on a part of the 40 acres of accretion along its west side. Besides the dredging entailed by this movement of sand there are 5,000 linear feet of breakwaters and piers to be maintained.

Coal is transported from various mines in Pennsylvania a distance of from 237 to 360 miles by rail to Great Sodus, whence, in 1896, 34,540 tons were shipped upon the lake; 46 per cent down the St. Lawrence River, and 54 per cent to Canadian ports on Lake Ontario.

Great Sodus is in the collection district of Oswego, N. Y.

Money statement.

July 1, 1896, balance unexpended	$11,334.39
June 30, 1897, amount expended during fiscal year	6,688.72
July 1, 1897, balance unexpended	4,645.67
July 1, 1897, outstanding liabilities	876.40
July 1, 1897, balance available	3,769.27
Amount that can be profitably expended for maintenance in fiscal year ending June 30, 1899	12,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
May 23, 1828 (survey)	$400.00	$400.00	June 10, 1872	$15,000.00	$306,771.80
March 2, 1829	12,500.00	12,500.00	June 23, 1874	15,000.00	321,771.80
March 3, 1829	15,280.00	27,780.00	March 3, 1875	10,000.00	331,771.80
March 2, 1831	17,450.00	45,230.00	August 14, 1876	5,000.00	336,771.80
February 24, 1832	17,000.00	62,230.00	June 18, 1878	5,000.00	341,771.80
March 2, 1833	15,000.00	77,230.00	March 3, 1879	2,000.00	343,771.80
June 28, 1834	15,000.00	92,230.00	June 14, 1880	3,000.00	346,771.80
March 3, 1835	11,790.00	104,020.00	March 3, 1881	5,000.00	351,771.80
July 2, 1836	12,600.00	116,620.00	August 2, 1882	25,000.00	376,771.80
March 3, 1837	12,000.00	128,620.00	July 5, 1884	10,000.00	386,771.80
July 7, 1838	10,000.00	138,620.00	August 5, 1886	16,875.00	403,646.80
June 11, 1844	5,000.00	143,620.00	August 10, 1888	24,000.00	427,646.80
August 20, 1852	10,000.00	153,620.00	September 19, 1890	10,000.00	437,646.80
June 23, 1866	53,151.80	206,771.80	July 13, 1892	15,000.00	452,646.80
March 2, 1867	80,000.00	286,771 80	August 17, 1894	15,000.00	467,646.80
July 11, 1870	5,000.00	291,771.80	June 3, 1896	8,000.00	475,646.80

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	34,540	Posts and wood	140
Grain	1,122	General merchandise	123
Malt	420		
Telegraph poles	26	Total	36,371

Decrease since last year, 7,195 tons. Passengers carried 622.
Navigation opened April 29 and closed December 7, 1896.

Statement of vessels at Great Sodus Harbor, New York, for the calendar year ending December 31, 1896.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	72	5,420	19	1,936	11	2,777
Foreign	23	1,780	36	5,475	19	6,999
Total	95	7,200	55	7,411	30	9,776
American owned	79	5,723	17	1,616	17	5,259
Canadian owned	16	1,477	38	5,795	13	5,517

Total arrivals, 180; registered tonnage, 24,386.

Statement of vessels of Great Sodus Harbor, New York, etc.—Continued.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	64	3,612	15	806	17	4,907
Foreign	30	2,664	41	6,415	14	5,059
Total	94	6,276	56	7,221	31	9,966

Total departures, 181; registered tonnage, 23,463.

Greatest draft of vessel .... feet..	16
Greatest tonnage of vessel .... registered tons..	1,030
Greatest load of vessel .... net tons..	1,190

N N 4.

IMPROVEMENT OF HARBOR AT LITTLE SODUS BAY, NEW YORK.

This bay is separated from Lake Ontario by a narrow, low strip of beach across which there was a channel about 18 inches deep.

The improvement has consisted in increasing and preserving the depth of the channel by building, of timber cribs ballasted with stone, a breakwater along the crest of the beach and confining and protecting the channel between two parallel piers, 250 feet apart, of like construction, extending from the breakwater into the lake, and by dredging.

A plan faces page 2446, report for 1881, and there is a description of the bay with history of the improvement at pages 3145–3150, report for 1896.

The present project approved in 1882, when $220,551.96 had been expended, is to obtain a depth of 15 feet at low water (zero of the Oswego gauge) by extending the piers a total farther length of 1,500 linear feet and by dredging, at an estimated further cost of $80,000. Since the adoption of this project the piers have been extended a total length of 835 feet, and $91,055.03 have been expended in construction of the piers, maintenance of the piers and breakwaters, and dredging.

The channel was surveyed in July, 1896, and April, 1897, between which dates there was no appreciable decrease in its depth.

Under contract entered into May 22, 1897, with W. J. Daly, of Ogdensburg, N. Y., to dredge about 16,000 to 21,500 cubic yards of sand and 3,000 to 3,700 cubic yards of hardpan and bowlders to obtain a channel 15 to 15½ feet deep at low water, 150 feet wide, and about 2,500 feet in length from the bay to the lake, dredging was commenced June 5, and to June 30, 1897, 21,080 cubic yards of sand had been removed.

The expenditures during the year were:

For pay of assistants, surveys, office expenses, printing, and advertising... $782.25

Besides redredging, which has hitherto been sand and averaged only about 2,000 cubic yards per year, there are 5,000 linear feet of breakwaters and piers to be maintained, which are reported to have cost in fifteen years an average of 65 cents per linear foot per year.

Anthracite coal is transported from the mines in Sullivan and Luzerne counties, Pa., a distance of 155 to 220 miles, by rail to Little Sodus, whence, in 1896, 63,501 tons were shipped upon the lake, about 65 per cent down the St. Lawrence River, and about 35 per cent to Canadian ports on Lake Ontario.

Little Sodus is in the collection district of Oswego, N. Y.

Money statement.

July 1, 1896, balance unexpended		$9,944.62
June 30, 1897, amount expended during fiscal year		782.25
July 1, 1897, balance unexpended		9,162.37
July 1, 1897, outstanding liabilities	$3,972.71	
July 1, 1897, amount covered by uncompleted contracts	2,746.30	
		6,719.01
July 1, 1897, balance available		2,443.36
Amount that can be profitably expended in fiscal year ending June 30, 1899		5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.		

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
August 20, 1852	$10,000.00	$10,000.00	August 14, 1876	$5,000.00	$179,441.77
April 9, 1864	1,778.36	11,778.36	June 18, 1878	10,000.00	189,441.77
Do	2,224.00	14,002.36	March 3, 1879	5,000.00	194,441.77
Do	99.00	14,101.36	June 14, 1880	20,000.00	214,441.77
June 23, 1866	33,840.41	47,941.77	March 3, 1881	20,000.00	234,441.77
March 2, 1867	50,000.00	97,941.77	August 2, 1882	25,000.00	259,441.77
April 10, 1869	1,500.00	99,441.77	July 5, 1884	10,000.00	269,441.77
July 11, 1870	5,000.00	104,441.77	August 5, 1886	12,500.00	281,941.77
March 3, 1871	15,000.00	119,441.77	August 10, 1888	16,000.00	297,941.77
June 10, 1872	15,000.00	134,441.77	September 19, 1890	13,000.00	310,941.77
March 3, 1873	15,000.00	149,441.77	July 13, 1892	6,000.00	316,941.77
June 23, 1874	15,000.00	164,441.77	August 17, 1894	8,000.00	324,941.77
March 3, 1875	10,000.00	174,441.77	June 3, 1896	8,000.00	332,941.77

Abstract of proposals for dredging received in response to advertisement dated March 23, 1897, and opened at noon April 29, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Hardpan and bowlders, per cubic yard, measured in scows.	All other dredging, per cubic yard, measured in scows.
		Cents.	*Cents.*
1	Pliny B. McNaughton, Buffalo, N. Y	50	20
2	W. J. Daly, Ogdensburg, N. Y	49.9	18

Recommended that award be made to No. 2—W. J. Daly.

Contract in force.

Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration.
W. J. Daly	June 3, 1897	On approval of contract	Sept. 15, 1897

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	63,501	Iron	133
Poles and railroad ties	1,184	Fish	1
Posts and wood	284		
Lumber	315	Total	65,418

Increase over last year, 1,710 tons.
Navigation opened April 17 and closed November 25, 1897.

Statement of vessels at Little Sodus Harbor, New York, for the calendar year ending December 31, 1896.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	26	1,789	9	1,124	26	8,523
Foreign	22	1,860	67	9,560	55	19,318
Total	48	3,649	76	10,684	81	27,841
American owned	25	1,432	8	132	27	9,232
Canadian owned	23	2,217	68	10,552	54	18,609

Total arrivals, 205; registered tonnage, 42,174.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	24	1,444	1	317	20	6,859
Foreign	24	2,205	76	10,275	61	20,982
Total	48	3,649	77	10,592	81	27,841

Total departures, 206; registered tonnage, 42,083.

Greatest draft of vessel..........feet.. 12
Greatest tonnage of vessel..........registered tonnage.. 567
Greatest load of vessel..........net tons.. 882

N N 5.

IMPROVEMENT OF HARBOR AT OSWEGO, NEW YORK.

A plan of the harbor faces page 3220, report for 1895, and there is a history of the improvement on pages 3150–3157, report for 1896.

During the year the following work has been done:

1. Along the inside of the inner west breakwater about 3½ acres have been deepened to 15 feet by dredging, the face of the breakwater has been cleared of four old spur cribs and a boathouse, and nine cast iron mooring posts have been set giving vessels access to the breakwater and in all gales a secure mooring along its face, 900 feet in length, at a cost of $6,360.28.

2. The superstructure of the southerly part, 100 feet in length, of the pier that extends north from the light-house pier, and which was very dilapidated, has been rebuilt from the water line at a cost of $4,480.56.

3. *Outer breakwater.*—Nine breaches, amounting in length to 173 feet, in the outer wall of 12-inch timbers were closed by fitting into them timbers bolted to oak posts which were set against the back face of the wall and bolted to it, usually in the angles at the cross walls. Of these breaches, 138 linear feet were on the lake arm and 35 feet on the westerly shore return. They averaged about 3 feet high, and were all in a belt about 5 feet wide immediately below the water line. This work had to be done by a diver, only in the best of weather, and required the removal and replacing of the deck and of the ballast in the pockets to considerable depths below the water, and was expensive, but saved many times its cost in preventing the breaching of the breakwater itself by the storms of last winter.

To, as far as possible, prevent these small breaches in the outer timber wall, all its horizontal joints and all the joints at the ends of the cross-ties, that were more or less open, were closed with wedges well driven and nailed, along 6,500 linear feet of breakwater face.

December 18, 19, 1896, a northwest storm breached the breakwater at a point 1,200 feet east from its northwest angle by carrying away the face of a crib 35 feet long, for a depth of 11 feet, extending from 18 inches under to 12½ feet under water, emptying the pockets of 100 cords of stone ballast and driving up the planks of the banquette behind the parapet. The exposed interior of the breakwater on each side of the breach was closed and protected by building bulkheads, which were carried up from the end walls of the two adjoining cribs to the top of the parapet, which was the utmost that could be accomplished so late in the season with ice rapidly covering the breakwater. These bulkheads, together with the walls of the parapet that spanned the breach, remained intact through the winter.

The breach has been closed by dredging away the old crib to the depth of 17 feet below water, sinking a new crib, and building a new superstructure upon it. The work commenced April 1, and was completed substantially at the close of the fiscal year at a cost of:

For timber	$2,941.01	For towing	$275.00
For stone	640.35	For labor	3,535.82
For iron	400.00		
For dredging	310.00	Total	8,102.18

The deck planks and stone ballast in several places on the banquette, which were carried away during the winter and spring, have been replaced, and minor repairs made by renewing decayed or broken planks here and there along the breakwater.

There has thus been applied during the year to the maintenance of the outer breakwater the sum of $20,220.57.

4. Twenty-seven cast-iron mooring posts have been placed on the outer breakwater at a cost of $41 each in place and anchored.

5. Some loose stones on the rocky bed of the river, upon which vessels occasionally grounded, were removed by a diver at small cost.

6. A point of rock which extends nearly to midchannel from the east pier opposite the lower island in the Oswego River has been drilled and blasted, and its removal to the depth of 16 feet will be completed in July, 1897.

7. Contractors for the State of New York have, by rock excavation, deepened to 10 feet the approach in the Oswego River from Seneca street to the canal basin at Bridge street, and to 9 feet the basin itself. All the large fragments of rock were sold by the contractors for structural purposes. The smaller fragments were deposited in the lake east of the prolongation of the line of East Ninth street, Oswego, and beyond the 5-fathom curve, under the supervision of an inspector acting under the orders of this office, by authority of the Secretary of War of December 28, 1896.

Proposals were opened April 29, 1897, for excavating about 4,600 cubic yards of rock in the Oswego River and for dredging about 21,500 cubic yards of sand in and at the entrance to the outer harbor. The lowest proposal was $3.24 per cubic yard for the rock and 18 cents per cubic yard for the sand. The proposals were rejected, and the prices, per cubic yard, of 15 cents for the dredging and of $3 for the rock excavation, were obtained in open market. The excavation of the rock will extend the excavation over a triangular area upstream nearly to the north side of Seneca street on the east side of the river, as far as it has been excavated along the wharves by wharf owners, and will remove the point of rock before mentioned in the channel below.

In the Oswego River above the two islands, in an area of 3½ acres which has been deepened to 15 feet, extending from Van Buren street to a line 80 feet from the lower (north) side of Seneca street, the commerce in 1896 amounted to 423,763 tons and was 49 per cent of the entire commerce of the harbor. It consisted chiefly of coal, 367,148 tons shipped from the trestles on the east bank, and of grain delivered at the elevator on the west bank. Many of the steamers or barges carrying this coal and grain are 220 to 240 feet long, and they can not be readily handled in the area above the islands without danger of colliding with the rocky banks or with the breast of rock, about 5 feet high, extending across the river at the line 80 feet north of Seneca street.

The removal by dredging of all that part of the upper island that is between Van Buren and Schuyler streets would add (including the narrow space between the island and west bank) 2½ acres (about 70 per cent) to this small and useful part of the harbor at about one-third of the cost of obtaining as great an increase in area by the excavation of a thickness of 5 feet of solid rock, at $3 per cubic yard. Business men have offered to convey to the United States, without cost, the title to that part of the island provided it will be removed. By letter (7652–48) of March 6, 1897, it was announced that "it is the opinion of the Chief of Engineers that the action heretofore taken by Congress has not been sufficiently definite as to the widening of the inner harbor by the removal of the island south of Van Buren street to bring such work within the adopted project," and authority was given "to again call attention to this matter" in this report "so that it may be before Congress when the improvement of Oswego Harbor is again under consideration," it having been presented in the report for 1896 and Congress not having yet had "an opportunity to take action regarding it."

It is very desirable that so much as may be necessary, estimated at about $12,000, of the next appropriation be applied to removing the island, and with its removal to a very small amount of rock excavation and dredging between the island and west bank. Twelve thousand dollars so applied will obtain as much increase in area with a depth of 15 feet as can be obtained by the expenditure of $36,000 where rock is now being excavated.

THE PRESENT PROJECT.

1. It was announced June 23, 1896, by the Chief of Engineers that "Congress by making specific appropriations for rock excavation in Oswego River has added such improvement of the inner harbor to the general project for Oswego Harbor, but no expression has yet been given by Congress as to how much of such work should be eventually carried out." The excavation of rock (about 4,600 cubic yards) in progress during the present season was authorized by the Chief of Engineers March 6, 1897 (7652–48), after receipt of the following letter:

COMMITTEE ON RIVERS AND HARBORS,
HOUSE OF REPRESENTATIVES,
Washington, D. C., January 18, 1897.

SIR: The river and harbor act of June 3, 1896, contains an appropriation of $60,000 for improving the harbor at Oswego, N. Y., in accordance with the modified project for this improvement, and I understand that there is some uncertainty in the minds of the officers of the War Department respecting the limit of work contemplated by Congress to be done under this provision of the law.

In view of this uncertainty I beg to say, as chairman of the Committee on Rivers and Harbors, that it was the intention of Congress that the authority conveyed by the act should extend to and include the removal of rock from the Oswego River beyond the limits proposed heretofore in course of execution and also such dredging as may be necessary for increasing the capacity of the inner harbor.

Very respectfully,

W. B. HOOKER, *Chairman.*

Gen. W. P. CRAIGHILL,
Chief of Engineers.

2. The three wharves in the extreme westerly part of the outer harbor which receive about 65,000 tons of lumber, amounting to about 7½ per cent of the commerce of the port, annually, are exposed to the seas that surge through the opening, 175 feet wide, that was made in the outer breakwater 500 feet east of its northwest angle by a storm in December, 1884. "At such time as may be deemed expedient in the application of future appropriations for the maintenance of the improvement" this opening is to be reduced to the width necessary only to permit the circulation requisite to preserve the purity of the water in the harbor. (Ind. 7652–18, June 20, 1896.)

3. Pursuant to a requirement in the sundry civil act of March 2, 1895, a project was submitted in the report for 1895 (p. 3213 et seq.) for an east breakwater estimated to cost $197,000. The river and harbor act of June 3, 1896, appropriated $60,000 for continuing the improvement of Oswego Harbor "in accordance with the modified project for its improvement." The Chief of Engineers announced June 23, 1896 (7652–18), "there is no definite information in this office as to what is included in the 'modified project' referred to in the Oswego item in the river and harbor act of 1896, but without further information it would appear necessary to assume that such appropriation is based on the special report. * * * Annual Report Chief of Engineers for 1895, pages 3213 et seq."

By Special Orders No. 30, dated Headquarters Corps of Engineers, August 24, 1896, a Board of Officers of the Corps of Engineers was convened September 8, 1896, to consider the question of the improvement of this harbor. The Board's conclusion was as follows:

The commerce of Oswego Harbor has not increased in amount in the past twenty-six years, but on the contrary has shown a very great falling off, amounting approximately to one-half the former amount. The Board is, however, of the opinion that for the safety of vessels entering the harbor, as well as for convenience of vessels and facilitating business within the harbor during storms, the project of constructing an east breakwater is a worthy one and it is considered a necessary and proper complement to the works of improvement.

Upon the merits of any project to build an east breakwater "for the protection of the harbor and to render entrance to it easy and safe," much light is thrown by the following notable facts:

1. There is no record of damage to steam vessels in entering the harbor which enter it with ease and safety, and the very few vessels that have been wrecked or injured were sailing vessels, the numbers and use of which are greatly diminishing on the lake.

It is reported that on the Great Lakes in 1862, the sailing tonnage was double the steam tonnage. In the report of the Commissioner of Navigation for 1895, it appears that on the northern lakes the steam tonnage at the close of that fiscal year was 2.85 times greater than the sailing tonnage, that 3¼ times more steam than sailing tonnage were built on those lakes during that year, and that no sailing tonnage was built east of Lake Huron.

The entrances of sailing vessels into Oswego Harbor were 1.140 less in 1896 than in 1883, being 1,827 in 1883 and only 687 in 1896, 82 per cent of which were Canadian vessels. Of the sailing vessels now entering the harbor, which have decreased 14 per cent since 1895, it is reported that none is newly built, and that the larger proportion is fully twenty years old. Many of them enter without cargoes and leave with coal, in the transport of which the towed barge will replace them as soon as they become too old for service. Therefore, both the record of the last thirty years and present conditions strongly indicate that sailing vessels will, in a few years, enter the harbor only in insignificant numbers.

2. In the thirteen years since 1883 there have been 17,154 entrances of sailing vessels into Oswego Harbor and only six wrecks, being one wreck to 2,859 entrances, or a little more than one-thirtieth of 1 per cent, while from statistics it appears that 4¾ per cent of all the sailing vessels of the United States were lost in 1895, which is about 140 times greater proportion lost in one year than was lost in entering this harbor in thirteen years, the rate of loss among all United States sailing vessels on the sea and lakes being about 1,800 times greater than among sailing vessels entering Oswego Harbor. The very rare cases in which sailing vessels were lost were due almost wholly to poor seamanship of their masters in resigning control of their vessels too soon before the tugs which go out to tow them in made fast to them.

3. Steam barges, which frequent this harbor towing three, and sometimes five, consorts, making tows one-third, and sometimes one-half, a mile in length, would require so great a width of entrance between the present breakwater and the proposed east breakwater, to keep the rear barges from being carried against the latter in the prevalent westerly to northwesterly winds and gales, the east breakwater would protect the entrance only in northeasterly gales which, as shown by the accompanying diagram, are so infrequent and have so short a sweep over the lake there is no complaint or record of injury done by them to shipping or wharf property in the harbor.

4. The area between an east breakwater and the shore would be worthless for an anchorage, both because it would be exposed through the wide entrance to seas in the prevalent westerly to northwesterly gales and because the bottom is too rocky to hold an anchor.

5. An east breakwater, 1,435 feet long, would add 25 per cent to the length of outer breakwater which has consumed a very large part of the sum, about $20,000, which has for a number of years past been applied annually to the maintenance of the improvement. The sum applied to the maintenance of the outer breakwater alone during the past year has been $20,220.57.

A definite expression of the will of Congress regarding the project for this improvement seems both desirable and necessary for guidance in future expenditure.

APPLICATION OF AMOUNT REQUIRED TO JUNE 30, 1899.

In the Oswego River the dock between the coal trestles is so oblique to the direction of the river, vessels backing out of it after loading with coal are in danger of carrying their sterns against the breast of rock, 5 feet high, that extends across the river only 200 feet above the dock. To remove this danger the excavation of rock this season, of 1897, will be from a triangular area to move the face of rock about 140 feet upstream on the east side of the river, but will not move it at all on the west side and will leave it extending obliquely across the river.

The excavation of an equal triangular area on the west side with the next appropriation would be useful, not only in increasing the area of this small basin in the river, that serves 49 per cent of the commerce of the port, but in leaving the abrupt face of rock straight instead of obliquely across the river, so that it could be more readily avoided by vessels.

There will be required:

For such extension of rock excavation in the Oswego River	$15,000
For removing the island between Schuyler and Van Buren streets and a small amount of dredging and rock excavation between it and the west bank	12,000
For narrowing the opening in the outer breakwater 500 feet east of its northwest angle to 75 feet by rebuilding 100 linear feet of breakwater	18,500
For contingencies and for such repairs to the outer breakwater as may be necessary to prevent extensive damage and greatly increased cost	24,500
Total	70,000

This amount, $24,500, for contingencies and repairs to the outer breakwater for the two fiscal years to June 30, 1899, is $8,000 less per year than has been actually applied to the repair and maintenance of the outer breakwater for several years past.

Oswego is a port of entry.

Money statement.

July 1, 1896, balance unexpended	$70,811.06
June 30, 1897, amount expended during fiscal year	34,236.44
July 1, 1897, balance unexpended	36,574.62
July 1, 1897, outstanding liabilities	2,766.79
July 1, 1897, balance available	33,807.83
Amount that can be profitably expended in fiscal year ending June 30, 1899 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	70,000.00

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
March 20, 1826	$200.00	$200.00	April 10, 1869, allotment	$22,275.00	$473,362.87
March 2, 1827	33,348.64	33,548.64	Do	6,000.00	479,362.87
May 19, 1828	9,583.39	43,132.03	July 11, 1870	50,000.00	529,362.87
March 3, 1829	7,472.00	50,604.03	March 3, 1871	100,000.00	629,362.87
March 2, 1831	2,812.92	53,416.95	June 10, 1872	100,000.00	729,362.87
Do	18,600.00	72,016.95	March 3, 1873	100,000.00	829,362.87
Do	519.00	72,535.95	June 23, 1874	75,000.00	904,362.87
Do	84.92	72,620.87	March 3, 1875	90,000.00	994,362.87
February 24, 1832	19,000.00	91,620.87	August 14, 1876	90,000.00	1,084,362.87
March 2, 1833	8,400.00	100,020.87	June 18, 1878	90,000.00	1,174,362.87
June 28, 1834	30,000.00	130,020.87	March 3, 1879	90,000.00	1,264,362.87
July 2, 1836	20,000.00	150,020.87	June 14, 1880	90,000.00	1,354,362.87
March 3, 1837	15,000.00	165,020.87	March 3, 1881	50,000.00	1,404,362.87
July 7, 1838	46,067.00	211,087.87	August 2, 1882	80,000.00	1,484,362.87
June 11, 1844	20,000.00	231,087.87	July 5, 1884	80,000.00	1,564,362.87
August 20, 1852	40,000.00	271,087.87	August 6, 1886	71,250.00	1,635,612.87
August, 1860, allotment transferred from light-house	30,000.00	301,087.87	August 10, 1888	100,000.00	1,735,612.87
			September 19, 1890	30,000.00	1,765,612.87
June 28, 1864, allotment	25,000.00	326,087.87	July 13, 1892	40,000.00	1,805,612.87
June 23, 1866	45,000.00	371,087.87	August 17, 1894	37,000.00	1,842,612.87
March 2, 1867	60,000.00	431,087.87	June 3, 1896	60,000.00	1,902,612.87
July 25, 1868, allotment	20,000.00	451,087.87			

Abstract of proposals for rock excavation and dredging received in response to advertisement dated March 23, 1897, and opened at noon April 29, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Rock, per cubic yard, measured in place.	Dredging, per cubic yard, measured in scows.
			Cents.
1	Pliny B. McNaughton, Buffalo, N. Y.	$3.50	22
2	W. J. Daly, Ogdensburg, N. Y.	3.24	18

The bids were considered too high and were rejected.

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	600,335	Salt	280
Lumber	131,146	Fish	66
Grain	31,915	Lime	35
Posts and wood	13,130	Oil	13
Laths	1,999	General merchandise	3,894
Ashes	806		
Shingles	858	Total	783,972

Increase over last year, 34,397 tons. Passengers carried, 5,173.
Navigation opened April 14 and closed December 5, 1896.

Statement of vessels at Oswego Harbor, New York, for the year ending December 31, 1896.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	256	94,728	104	26,191	163	59,735
Foreign, on lake	343	100,848	583	105,536	193	54,074
Total	599	195,576	687	131,727	356	113,809
American owned	403	153,824	121	34,172	139	47,636
Canadian owned	196	41,752	566	97,555	217	66,173

Total arrivals, 1,642; registered tonnage, 441,112.

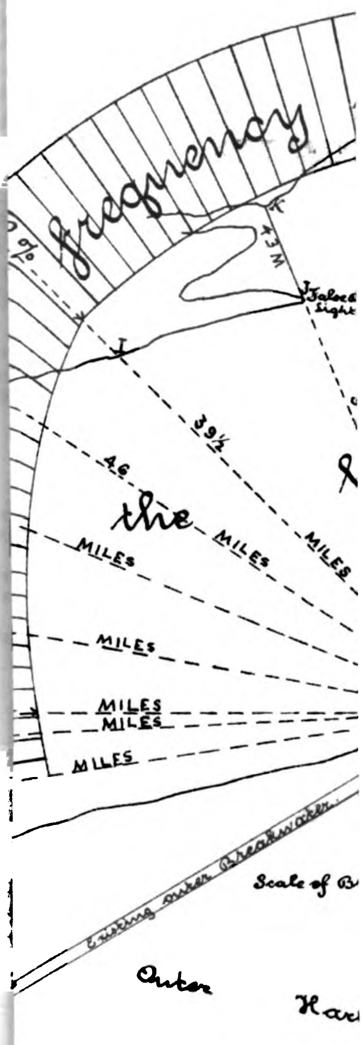
DEPARTURES.

Home, on lake	290	140,369	119	36,822	39	14,196
Foreign, on lake	306	54,004	570	96,082	313	98,463
Total	596	194,373	689	132,904	352	113,659

Total departures, 1,637; registered tonnage, 440,936.

Arrivals and departures on river.

Steam vessels		139
Barges		841
Freight	net tons	84,428
Greatest draft of vessel	feet	14
Greatest tonnage of vessel	registered tonnage	2,166
Greatest load of vessel	net tons	2,032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N N 6.

IMPROVEMENT OF HARBOR AT SACKETTS HARBOR, NEW YORK.

The history of this improvement is given at page 3160 of the report for 1896.

In August, 1896, two groins of stone were built to protect the point which forms this small harbor, from erosion, which had been reported in August, 1895, by the officer then in charge as evident from a comparison of surveys made in that year and in 1859. The point between the high and low water line is composed of beach shingle, and the small effect of the groins in causing accretion shows the travel of the shingle and the erosion to be very slow.

A survey of the harbor made in June, 1897, by Mr. F. M. Barstow, assistant engineer, shows that since it was dredged to the depth of 12 feet in 1884, the depth at which rock is struck at the entrance, it has shoaled 1 to 2 feet. To restore the depth to 12 feet, for an area of a little more than 5 acres, will require the dredging of about 15,000 cubic yards of mud and silt, which, it is expected, will be accomplished in July and August, 1897.

The commerce of the harbor is small, consisting annually of about 5,000 tons of coal and about 2,000 tons of hay; but it is useful as a harbor of refuge for vessels of the lighter drafts that ply between Lake Ontario and the St. Lawrence, its small area being well sheltered.

Sacketts Harbor is in the collection district of Cape Vincent, New York.

Money statement.

July 1, 1896, balance unexpended	$4,387.32
June 30, 1897, amount expended during fiscal year	805.61
July 1, 1897, balance unexpended	3,581.71
July 1, 1897, outstanding liabilities	20.00
July 1, 1897, balance available	3,561.71

Appropriations.

Date.	Amount.	Aggregate.
May 20, 1826	$3,000	$3,000
May 23, 1828	3,000	6,000
August 2, 1882	7,000	13,000
August 11, 1888	2,000	15,000
August 17, 1894	5,000	20,000

COMMERCIAL STATISTICS.

Class of goods.	Net tons.
Coal	5,600
Hay	1,780
General merchandise	895
Posts and wood	259
Lumber	57
Total	8,591

Increase over last year, 109 tons.

N N 7.

IMPROVEMENT OF HARBOR AT CAPE VINCENT, NEW YORK.

The report of the preliminary examination presented a project (Report for 1889, p. 2433) to build, in the St. Lawrence River, a breakwater 1,600 feet long, estimated to cost $320,000. The breakwater was to be "1,450 feet long parallel to and 600 feet distant from front of railroad dock, with return at upstream end 150 feet long." In the opinion of the Chief of Engineers the locality was "not at present worthy of improvement," and a survey was not made.

The act of June 3, 1896, appropriated $25,000 for the improvement "according to the project submitted in the Annual Report of the Chief of Engineers for 1889."

In August, 1896, and May, 1897, the site was surveyed and the bottom probed for a foundation. On the line parallel with and 600 feet from the railroad wharf the depth of water, at low water, is 26 to 29 feet; the bottom is soft blue clay 5 to 7 feet thick, under which it is reported that there is a hard stratum, about 1 foot thick, of what appears to be gravel and hardpan, underlaid by stiff blue clay, about 4 feet thick, and extending to the rock which was struck at an average depth of 35½ feet below low water for a length of 800 feet. Along the lower 600 feet of the site for the long arm, probings 36½ to 39 feet below low water did not reach the rock.

On a line 100 feet nearer, that is, 500 feet from the railroad wharf, the rock was found for a length greater by 500 feet, that is, for a length of 1,300 feet; the depth to the rock, below low water, is about 2½ feet less, 33 feet; the depth to the thin stratum of hardpan or gravel about 18 inches less, 29½ feet; and the depth of water is about 4 feet less, 22½ to 25 feet.

As the breakwater is designed not to protect an anchorage but for vessels to moor to and to protect vessels moored at the wharves, there would be sufficient room were it to be built 500 feet from the railroad wharf where a better foundation can be obtained at a less depth, where the depth of water is less and where the breakwater would be less costly.

Therefore a project to build the breakwater parallel with and 500 feet from the railroad wharf was, March 6, 1897, submitted to the Chief of Engineers. March 13 he authorized the district engineer "to present the proposed plans fully in his next annual report so that the modified project may be before Congress when a further appropriation is provided," and announced that "until Congress has taken action on such modified project it is not considered permissible to commence the work."

The following project is therefore respectfully submitted: That the breakwater be built 1,400 feet long parallel with and approximately 500 feet from the railroad wharf (sheet 1, herewith); that if it be found necessary for the protection of vessels, a return be built at the upper end of such length not to exceed 150 feet as may be necessary and will permit tows of barges to pass easily and safely between it and the wharves at the point about 700 feet above; that the soft clay be removed by dredging to the stratum of gravel, or hardpan or by dredging to the rock if it be found necessary at any part of the site during construction; that the trench be filled with riprap stones to be carried up to the level 20 feet below low water (zero of Oswego gauge); that upon the riprap mound cribs of timber about 70 to 100 feet long and about 27 feet wide be placed and be carried up to low water, at which level they be surmounted by a continuous superstructure of timber to be built up, on the river face, to 8 feet, and on the harbor face to 5 feet, above low water, the one-third of the width of the superstructure at the river face to form a parapet 3 feet high, and the timber cribs and superstructure to be ballasted with stones.

The estimated cost is as follows per linear foot:

For the riprap mound (including the dredging, stone at 75 cents and dredging at 50 cents per cubic yard)	$22.50
For the timber cribs with ballast (hemlock below and pine above low water)	73.10
For contingencies and all other expenses, 33⅓ per cent	31.87
Total per linear foot	127.47
1,400 linear feet parallel with wharf	178,458.00
150 linear feet of return, if necessary, at $135	20,250.00
1,550 linear feet of breakwater, say	200,000.00

Regarding the width of the cribs.—At Oswego where the exposure is to the prevalent gales that sweep nearly the whole length of the deepest of the Great Lakes, the cribs, in 18 to 20 feet of water, are 35 feet wide and stand well when staunchly built. At Burlington, Vt., where the greatest exposure is to northwesterly winds sweeping 15 miles over the lake, 100 to 200 feet deep, the cribs, in 31 to 38 feet of water, are of the various widths of 30, 34, and 36 feet. Upward of 1,100 linear feet of them 30 feet wide have stood well for many years. About 240 linear feet of cribs 24 feet wide placed on a rubble mound carried up to 18 feet below low water have not given entire satisfaction. At Cape Vincent the greatest exposure is to northeasterly winds sweeping up the river for 5 miles and the width proposed for the cribs is 27 feet.

The report of the examination of the bottom which was made in August, states: "The material forming the bottom was the softest of blue clay of 7 to 13 feet (average 10 feet) thickness, beneath which rock was found (on the line 500 feet off) at depths varying from 31 to 37 feet below zero." The project submitted to the Chief of Engineers March 6, therefore embraced the removal of the clay down to the rock.

Mr. John C. Churchill, jr., assistant engineer, by whom the bottom was examined in May, states, in his report herewith, that thirty probings that he made penetrated a hard stratum about 1 foot thick, there being 4½ to 7 feet of soft blue clay above it, and about 3½ feet of stiff blue clay under, between it and the rock; that along the lower 400 feet (about) of the site the thin stratum is apparently hardpan. along the upper 1,000 feet gravel, and that about 200 feet above the site it was not found, the blue clay becoming stiff at about the level where the hard stratum was found elsewhere and continuing to the rock. In the project here submitted it is proposed to remove only the soft clay down to the stratum of gravel or hardpan, unless in executing the work pockets be found where the soft material continues to a greater depth.

To dredge and carry the riprap down to the rock would increase the cost at least $15.20 per linear foot.

Cape Vincent is on the St. Lawrence River 2½ miles below its head, at the foot of Lake Ontario. The channel in that distance is nearly three-fourths of a mile to a mile and a quarter wide, straight, and clear. At Cape Vincent the river changes its course 34 degrees and abruptly widens to fully 2½ miles. Immediately below, the channel lies between broad shoals extending along it 1½ to 3 miles, and 3 miles below is Carleton Island the first of the "Thousand Islands." For 45 miles down to Brockville the river is not only studded with these islands, which have rocky margins, but on either side of the channel there are many ledges. Thus Cape Vincent is at the head of a long stretch of the river dangerous to navigate at night and is a convenient location for vessels to lie which are going down the river and enter it at nightfall or in thick weather, and for those which are storm bound when going up the lakes, where they can get the weather reports and lose no time in setting out upon the lake as soon as the weather permits.

Westerly to northwesterly winds which are prevalent on the lake, blow right onto the wharves, with a sweep of nearly 3 miles over the river, so that vessels can not moor there. The water deepens so rapidly and the bottom is in places so rocky, vessels can not trust to their anchors which they are liable to drag and go ashore. If they anchor under the lee of Carleton Island in any wind their anchors are liable to drag on the more or less rocky bottom and when the wind changes they are liable to drag their anchors and go ashore on the island itself, especially as many of the vessels are large barges without their own propelling power.

Such, after a careful canvass of the reasons for this improvement, are those presented by the interests urging it which state that the breakwater to which vessels could moor and which would protect the mooring at the wharves would be of much use to almost all vessels whose route embraces both the lake and the river.

Cape Vincent is a port of entry.

Money statement.

July 1, 1896, balance unexpended	$25,000.00
June 30, 1897, amount expended during fiscal year	223.00
July 1, 1897, balance unexpended	24,777.00
Amount (estimated) required for completion of existing project	295,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

COMMERCIAL STATISTICS.

Class of goods.	Net tons.	Class of goods.	Net tons.
Grain	3,515	Laths	42
Coal	1,552	Shingles	29
Hay	1,443	Fish	250
Lumber	1,926	General merchandise	694
Stone and gravel	314		
Posts and wood	168	Total	9,933

Passengers carried, 21,374.

Statement of vessels at Cape Vincent, N. Y., for the year ending December 31, 1896.

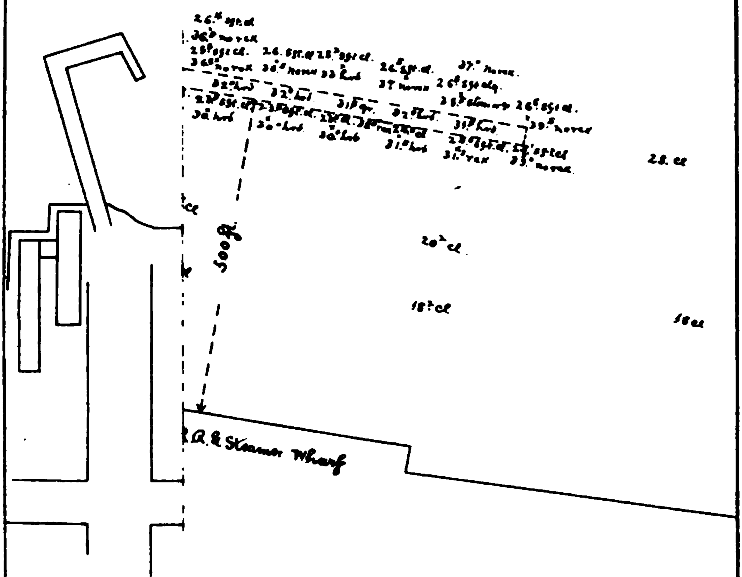
ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	147	31,944	106	6,421	56	20,739
Foreign	485	59,436	13	864	29	9,356
Total	632	91,380	119	7,285	85	30,095
American owned	247	38,328	107	6,875	55	19,951
Canadian owned	385	53,052	12	910	30	10,144

Total arrivals, 836; registered tonnage, 128,760.

Cape   Sheet 1.

showi



pany the annual report

Major of Engineers, U.S.A.

Of the foregoing vessels the following sought the harbor for shelter:

28 steamers .... registered tonnage.. 23,722
15 sailing vessels .... do.... 2,879
41 barges .... do.... 16,394

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	137	29,865	104	6,356	61	21,087
Foreign	488	57,633	13	845	25	9,015
Total	625	87,498	117	7,201	86	30,102

Total departures, 828; registered tonnage, 124,801.

The departures include the vessels above detailed which sought the harbor for shelter.

Greatest draft of vessel .... feet.. 15½
Greatest tonnage of vessel .... registered tonnage.. 2,127
Greatest load of vessel .... net tons.. 933

REPORT OF MR. JOHN C. CHURCHILL, JR., ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 30, 1897.

MAJOR: I have the honor to report as follows on an examination of the bed of the St. Lawrence River at the proposed site of the breakwater at Cape Vincent, N. Y., made under your instructions May 18 and 19, 1897.

Borings were made with a pointed iron rod of two parts, the first being of round iron three-fourths inch in diameter and 16 feet long and the second of iron pipe screwed onto the rod, the total length being about 40 feet. Thirty borings were made, most of them within the lines of the foundation as located 500 feet from the railroad wharf. The borings made along the proposed site showed the following:

First, a depth of water from 21½ to 25 feet; second, a bed of soft mud and clay from 4½ to 7 feet thick; third, a stratum of gravel or hardpan about 1 foot thick; fourth, a bed of stiff blue clay averaging about 3½ feet thick; and lastly, rock, which was found along the site at depths varying from 31 to 35 feet, except at the lower end where for about 100 feet no rock was encountered to the depth of 39 feet, the extreme depth which could be reached with the rod.

Borings taken farther out from the railroad wharf showed that the rock receded. At 600 feet from the railroad wharf no rock was struck at depths from 36½ to 39 feet for about 600 feet of the lower end. Above this it was found at about 34 feet depth, all depths being below zero of Oswego gauge.

In all the borings on the proposed site the gravel or hardpan stratum was struck and difficulty was had in forcing the rod through it, showing that it had considerable strength. The clay beneath was stiff and tenacious, which was shown by the force required to pierce it and by the clay which adhered to the rod after it was withdrawn.

I would respectfully say that it is my opinion that the site at 500 feet from the railroad wharf gives a better foundation than one at 600 feet, having rock under its whole length at no great depth, except for a short distance, and that the rubble foundation may be safely placed on top of the gravel or hardpan stratum, supported as it is by stiff blue clay upon rock.

Very respectfully,

JOHN C. CHURCHILL, Jr.,
Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers.

N N 8.

IMPROVEMENT OF SHOALS BETWEEN SISTER ISLANDS AND CROSSOVER LIGHT AND BETWEEN OGDENSBURG AND THE FOOT OF LAKE ONTARIO, ST. LAWRENCE RIVER, NEW YORK.

The channel of the St. Lawrence from Lake Ontario to Ogdensburg, 7 miles above the rapids, is 60 miles long and 30 to 100 feet deep. From the conformation of the rocky bed and the experience of vessels the dangerous ledges in or near their track were believed to be confined to the 30 miles of channel extending from Blanket Island, 10 miles below the lake, to the foot of Brockville Narrows, and those 30 miles were swept in 1895, as described in the reports 1895, page 4250, and 1896, pages 4062–4067.

From that sweeping it was concluded that all the ledges so near the course of vessels as to require removal are in the 11 miles of channel extending from Sister Islands light down to the head of Brockville Narrows, 15 miles above Ogdensburg. Interspersed along those 11 miles there are twelve dangerous ledges located as shown on the accompanying sheet.

During the fiscal year they have been surveyed by Mr. John C. Churchill, jr., assistant engineer. Dark Island ledge (K), Pilot ledge (M), Blind Bay ledge (G), and Coles Light ledge (B), were surveyed from the ice in February and March with all the detail and accuracy requisite to ascertain the quantity of rock that is to be excavated and paid for. The other eight ledges were surveyed in May and June with sufficient accuracy to estimate the approximate cost of removal. In the exposed position of the ledges Mr. Churchill contended against unfavorable weather both in February and March, and in May and June.

The least depth of water over these ledges at low water (zero of Oswego gauge), the quantity of rock to be excavated from them down to 18 feet below that stage, and the quantity heretofore excavated from seven of them to 18 feet below the zero of the Ogdensburg gauge (16.6 feet below the zero of the Oswego gauge), are as follows:

Ledge.	Distance above Ogdensburg.	Least depth.	Cubic yards.	
			Heretofore excavated.	To be excavated.
	In Canadian water:			
	Miles.	*Feet.*		
A	15	8		3,350
B	17	14		686
C	15¾	16		120
	In American water:			
	Miles.			
D	20⅛	16.5	106.4	102
E	19	16.5	245.6	98
F	21	16.5	53.8	60
G	21	15.5	115	150
H	21	16.5	14.9	33
J	21¼	16.5	256.6	100
K	23⅛	9.5		3,412
L	24⅛	16	586	250
M	26¼	10		1,724
	Total		1,377.8	10,085

The three shoals at A, B, and C are in Canadian water, and in compliance with letter (7538–8) of August 14, 1896, a map showing their location was transmitted April 6, 1897, to the Chief of Engineers to accompany an application to the Dominion of Canada for consent for their removal.

Proposals were opened June 1, 1897, for the excavation of 3,562 cubic yards of rock to remove Dark Island and Blind Bay ledges to 18 feet below the Oswego gauge. The lowest was $7.50 per cubic yard and was rejected. The removal of those ledges at the price obtained in open market, $7.25 per cubic yard, amounting to $890.50 less than the lowest proposal, will commence early in July.

Excavation upon these ledges heretofore has been to obtain the depth of 18 feet below the zero of the Ogdensburg gauge which is 17½ feet below the average monthly mean level of Lake Ontario each year for twenty-five years, 1871 to 1895, and 18 feet below the average of the lowest monthly mean in the navigation season, May 1 to November 30 each year during that period, but provided only 16¾ feet of water over them at the mean stage of Lake Ontario and the St. Lawrence during the navigation season of 1895, 15.9 feet in November, 1895, 17¼ feet during the navigation season of 1896, 16.4 feet in November, 1896, and 17.1 feet at the opening of the season of 1897.

Some of the steamers carrying grain from the upper lakes to Ogdensburg load to a draft of 16 feet, lightering through the Welland Canal by transferring a part of their cargoes from Port Colborne to Port Dalhousie by rail; and of about 350,000 tons of coal shipped annually down the St. Lawrence from Charlotte Harbor half, or 175,000 tons, is carried in large steam barges which load to a draft of 16 feet whenever they can carry it out of Charlotte Harbor which will be dredged in August to permit that draft of water.

Steamers on the St. Lawrence run about 12 miles an hour. Regarding the change in trim and increased immersion of vessels when in motion which depend upon the speed, form, and size of the vessel and depth (and width) of the channel, there is little data available, but the Bureau of Construction of the Navy Department states that "a report from the *Minneapolis* during a trial of speed shows that at 23 knots the change of trim by the stern due to rapid forward motion of the vessel was 11 inches, and the sinkage bodily or squat somewhat less than 1 foot, so that the total increase of draft was probably within an inch or two of 16 inches. This was in deep water and would have been largely increased in shoal water."

The longest dimensions of the dangerous ledges are parallel with the course of vessels, and masters state that, owing to the increase in draft when running about 12 miles an hour and to its further increase when crossing shoal places, they can not safely run over the ledges which have been excavated under the project to the depth of 18 feet below the zero of the Ogdensburg gauge and continue to avoid them.

April 13, 1897, the Chief of Engineers authorized the removal of Dark Island and Blind Bay ledges to the depth of 18 feet below the zero of the Oswego gauge, a depth 1.4 feet greater than the excavation heretofore, and further authorized an estimate to be submitted in this report for his consideration in connection with section 4 of the river and harbor act of June 3, 1896, "of the cost of removing the obstructions to the depth of 18 feet below the zero of the Oswego gauge with a statement of the necessity for the additional work."

The increased depth of excavation is necessary for the facts and reasons herein presented and is respectfully recommended.

The removal of the ledges to the depth of 18 feet below the Oswego gauge is estimated, by Mr. Churchill's survey, to require the excavation of 10,085 cubic yards of rock at an estimated cost, including allowance for contingencies, surveys, and office expenses, amounting to $60,000, in addition to the funds now available.

These ledges are in the track of vessels that carry nearly the entire commerce of the St. Lawrence River which amounted to 1,133,200 tons in 1896, 77 per cent of which was carried in American vessels.

Money statement.

July 1, 1896, balance unexpended	$28,065.60
June 30, 1897, amount expended during fiscal year	1,151.37
July 1, 1897, balance unexpended	26,914.23
July 1, 1897, outstanding liabilities	12.15
July 1, 1897, balance available	26,902.08
Amount (estimated) required for completion of existing project	60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations.

Date.	Amount.	Aggregate.
Act of—		
September 19, 1890	$5,000.00	$5,000.00
July 13, 1892	10,000.00	15,000.00
August 17, 1894	8,000.00	23,000.00
June 3, 1896	25,000.00	48,000.00

Abstract of proposals for removing ledges in the St. Lawrence River, New York, received in response to advertisement dated April 30, 1897, and opened at noon June 1, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Rock excavation at Dark Island Shoal, per cubic yard.	Rock excavation at Blind Bay Shoal, per cubic yard.
1	Frank Pidgeon, Saugerties, N. Y.	$7.93	$7.93
2	Jos. R. McCollum, Port Huron, Mich.	7.95	7.95
3	W. J. Daly, Ogdensburg, N. Y.	7.50	7.50

The bids were considered too high and were rejected.

N N 9.

IMPROVEMENT OF HARBOR AT OGDENSBURG, NEW YORK.

This improvement is to deepen, by dredging, a channel 1⅝ miles in length close along the front of Ogdensburg on the St. Lawrence and Oswegatchie rivers, and three entrance channels across the shoal between Ogdensburg and the main channel of the St. Lawrence.

The upper entrance channel, 2,500 feet long, leads to the Oswegatchie at the upper limit of the city and is used by ferryboats drawing not more than 12 feet, that ply between Ogdensburg and Prescott, Canada, carrying railroad freight cars in the transfer of freight between the Canadian Pacific Railroad and New York; also by barges drawing not

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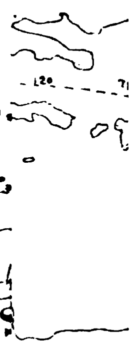

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more than 14 feet, which carry annually about 10,000 tons of coal and about 13,500 tons of grain to the wharves in the Oswegatchie.

The two other entrance channels, 1 mile below the Oswegatchie channel, 1,200 feet apart and 600 and 800 feet in length, lead to the elevator and large freight sheds at the terminus of the Central Vermont Railroad where are transferred the grain and manufactures exchanged between the upper lakes and New England. In 1896 the grain and manufactures amounted to 370,000 tons, which, with 147,000 tons of coal brought from Lake Ontario ports and 58,000 tons of lumber, carried the commerce of these two lower channels to 575,000 tons.

The grain brought from the upper lakes amounted in 1896 to 247,000 tons. Some of the vessels which bring it load to a draft of 16 feet, lightering through the Welland Canal by transferring a part of their cargoes by rail from its Lake Erie terminus to its Lake Ontario terminus.

The latest project, of 1890, is to obtain in all the four channels the depth of 16½ feet below the zero of the Ogdensburg gauge. The level and oscillations of Lake Ontario and the St. Lawrence are very much the same. From a comparison of the records of those two gauges at different periods embracing sixty-three months between 1869 and 1895, it appears that the zero of the gauge at Ogdensburg is 1.4 feet above the zero of the gauge at Oswego. The depth to be obtained under the project of 1890 in the channels at Ogdensburg is therefore practically the same as the depth (15 feet below the zero of the Oswego gauge) to be obtained under present projects in the harbors on Lake Ontario for vessels of draft as great as can be carried through the Welland Canal. To admit vessels of the greater draft of 16 feet which, by lightering through the canal, bring grain to Ogdensburg, the Chief of Engineers, February 27, 1897, authorized the depth of 16 feet below the zero of the Oswego gauge to be obtained in the two lower entrance channels, which will not increase the cost beyond the estimate ($316,950) of the cost of the project of 1890, of which sum in February, 1897, $261,989.43 had been applied. That depth is 16.9 feet at the mean of the lowest levels of Lake Ontario and the St. Lawrence monthly the entire year, and 17.4 feet at the mean of their lowest levels monthly during the navigation season (May 1 to November 30) for twenty-five years (1871 to 1895), but only 15¾ feet at the mean level of the lake and river during the navigation season of 1895, and 16.6 feet at their mean level in the navigation season of 1896.

The four channels were all surveyed in January, 1897, by Mr. John C. Churchill, jr., assistant engineer.

A contract with W. J. Daly, of Ogdensburg, N. Y., was made April 16 and approved May 1, 1897, for dredging 126,000 to 136,000 cubic yards of sand, silt, mud, clay, and sawdust, and about 1,400 cubic yards (three-quarters in the Oswegatchie) of hardpan and bowlders, at 13 cents per cubic yard (measured in scows) for the former and 40 cents for the latter. Dredging commenced May 15, 1897. To June 30, 23,951 cubic yards of mud, clay, and silt had been dredged, and the lower, easterly, entrance channel had been deepened to 16 feet (from 14 feet) and widened to 270 feet (from 200 feet).

The interests of commerce require depths (below the zero of the Oswego gauge) as follows: In the two entrance channels to the lower harbor and continuing along the wharves, at the westerly one, 500 feet southerly and at the easterly one west 500 feet and east 800 feet from the old elevator wharf, 16 feet: in all other parts of the channel along the city front (except the 900 feet next above Franklin street), in the upper entrance channel and in the Oswegatchie, 15 feet.

The channel, 900 feet in length, next above Franklin street, is used only for occasional communication between the Oswegatchie and the lower harbor by boats of lighter draft and is continually shoaling from the discharge by sewers. The depth requisite there is not more than 14 feet.

This requirement as to depth is here presented by authority from the Chief of Engineers of February 27, 1897.

Ogdensburg is in the collection district of Oswegatchie, N. Y.

Money statement.

July 1, 1896, balance unexpended		$20,010.57
June 30, 1897, amount expended during fiscal year		1,898.41
July 1, 1897, balance unexpended		18,112.16
July 1, 1897, outstanding liabilities	$2,087.89	
July 1, 1897, amount covered by uncompleted contracts	13,826.37	
		15,914.26
July 1, 1897, balance available		2,197.90
Amount (estimated) required for completion of existing project		37,944.44
Amount that can be profitably expended in fiscal year ending June 30, 1899		24,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations and allotments.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
August 30, 1852	$3,000.00	$3,000.00	July 28, 1880 (from appropriation for "examinations, surveys, and contingencies of rivers and harbors")	$50.00	$110,355.56
March 2, 1867	40,000.00	43,000.00	August 2, 1882	10,000.00	120,355.56
July 11, 1870	15,000.00	58,000.00	July 5, 1884	15,000.00	135,355.56
March 3, 1871	25,000.00	83,000.00	August 5, 1886	10,000.00	145,355.56
June 10, 1872	10,000.00	93,000.00	August 11, 1888	15,000.00	160,355.56
March 3, 1873	6,000.00	99,000.00	September 19, 1890	42,000.00	202,355.56
June 23, 1874	6,000.00	105,000.00	July 13, 1892	40,000.00	242,355.56
March 3, 1875	5,000.00	110,000.00	August 17, 1894	20,000.00	262,355.56
December 11, 1877 (from appropriation for "repairs of harbors on northern lakes")	5.56	110,005.56	June 3, 1896	20,000.00	282,355.56
September 10, 1879 (from appropriation for "examinations, surveys, and contingencies of rivers and harbors")	300.00	110,305.56			

Abstract of proposals for dredging received in response to advertisement dated March 9, 1897, and opened at noon, April 8, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.	
		For hard-pan and bowlders.	For all other dredging.
		Cents.	*Cents.*
1	William E. Hingston, Buffalo, N. Y	49	$14\frac{3}{4}$
2	W. J. Daly, Ogdensburg, N. Y	40	13

Recommended that award be made to No. 2, W. J. Daly.

Contract in force.

Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration.
W. J. Daly	May 1, 1897	On or before May 15, 1897	On or before Nov. 15, 1897.

Tonnage of vessels entered and cleared, foreign and coastwise, during 1896.

	East of Ogdensburg.			
	American vessels.		Foreign vessels.	
	Entered.	Cleared.	Entered.	Cleared.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Foreign	31,692	4,857	98,112	64,040
Coastwise	3,444	3,225		
Total	35,136	8,082	98,112	64,040

COMMERCIAL STATISTICS.

FOREIGN.

Class of goods.	Net tons.	
Received:		
Lumber	81,606	
Cereals	4	
Hay	1,201	
Miscellaneous	15,141	
		97,952
Shipped:		
Coal	115,286	
Cereals	69,880	
Cheese	2,165	
Oil	3,865	
Miscellaneous	18,679	
		209,875
Total		307,827

COASTWISE.

Received:		
Lumber	46,478	
Grain	217,181	
Flour	29,350	
Coal	181,156	
Miscellaneous freight—		
East bound	6,642	
West bound	216	
Bran and feed	35,079	
		516,102
Shipped:		
Miscellaneous freight—		
East bound	1,187	
West bound	61,322	
		62,509
Total		578,611

Increase over 1895, 192,613 tons.

Total duties collected	$46,374.74
Total fees collected	1,039.70
Value of imports	4,597,428.00
Value of exports	3,252,101.00
Value of merchandise entered for warehouse and transshipped in bond	31,422.00
Value of merchandise entered for transshipment and export	401,262.00
Amount of duties on above	86,925.37
Value of merchandise entered for immediate transportation without appraisement (5,388 packages)	23,256.00
Estimated duty on above	14,669.46

Merchandise received under consular seal from foreign ports, 1896.

Class of goods.	Packages.	Value.	Class of goods.	Packages.	Value.
	Number.			*Number.*	
Matting	5,595	$62,745.00	Curios	3,783	$84,230.00
Silk goods	985	518,043.00	Wool	198	6,923.00
Tea	91,231	666,922.00	Matte	1,538	19,935.00
Chinese groceries	14,276	39,004.00	Miscellaneous	8,016	145,730.00
Straw braid	8,144	174,268.00			

Estimated duties on the above, $426,510.

The foregoing commercial statistics, and other data relating to the commerce of Ogdensburg, were furnished by Hon. George E. Van Kennen, collector of customs, Ogdensburg, N. Y.

N N 10.

IMPROVEMENT OF HARBOR AT BURLINGTON, VERMONT.

This improvement has formed a harbor by building a breakwater to protect the wharves of Burlington, which without it would be fully exposed to the seas of Lake Champlain. The greatest exposure is in the prevalent northwesterly gales, which have a sweep of 15 miles obliquely across the lake.

The breakwater was commenced about 1836. It is built of timber cribs ballasted with stones, in 30 feet to 38 feet of water and on a zigzag line, as shown on the accompanying sheet No. 1.

To 1886, 3,560 linear feet had been built. September 28, 1886, the Chief of Engineers approved a project to extend the breakwater 500 feet northerly and 1,000 feet southerly, "keeping the line generally at a distance of 800 to 1,000 feet from the general line of the wharves."

Of the 1,500 feet of extension so authorized, 603 feet have been built, namely, 240 feet of the southerly extension completed in 1888, and 363 feet of the northerly extension completed in 1890, and built with a stone superstructure. This northerly extension is separated by an interval of 200 feet from the old breakwater.

The width of 1,160 linear feet of the breakwater is 34 feet, of 2,000 linear feet 30 feet, of 400 linear feet 36 feet, and of 603 linear feet, completed in 1888 and 1890, 24 feet.

Except the 363 feet completed in 1890, the breakwater was built of timber to its full height of 8 feet above low water. August 24, 1894, the Chief of Engineers approved a project to replace the 8 feet above water, which had become much decayed and dilapidated, with a superstructure of stone. Under this project 873 linear feet of stone superstructure have been built, all under a contract with Luther Whitney, of Keesville, N. Y., which contract was completed under the officer then in charge, July 30, 1896. The stone superstructure so built is at the location shown on sheet No. 1.

The 363 linear feet of detached breakwater, completed in 1890, consists of cribs 18 feet tall and 24 feet wide, resting on a rubble mound about 19 feet high. In a severe northwest gale, December 26, 1895, many of the cap and face stones in its stone parapet were disturbed, and some of them, with a little rubble, were carried away. Proposals opened July 24, 1896, by the officer then in charge for repairing this stone parapet were all rejected because they were too high, and the parapet was repaired and put in good condition, September 3 to November 13, 1896, by hired labor, at a cost of $2,306.54. The repair of the stone parapet of this detached part of the breakwater and the completion of the 873 linear feet of stone superstructure under the contract with Luther Whitney, comprise all the work done during the fiscal year.

The part of the approved project which has not been executed June 30, 1897, is a further extension of the breakwater 897 linear feet and the replacing of 2,927 linear feet of old timber superstructure with a superstructure of stone, including the 240 linear feet built in 1888, when its superstructure becomes decayed. The cross sections approved by the Chief of Engineers (7535–15) April 8, 1897, with which the stone superstructure is to be built, are shown on sheet 2 herewith.

A contract with Edgar S. Fleury, of Isle Lamotte, Vt., was made June 1 and approved June 11, 1897, for building the stone superstructure on a part of the breakwater 34 feet wide, at $31.50 per linear foot, to the amount of $7,000 to $9,500. Work under the contract will commence as early in July as the stage of the lake will permit, at the point shown on sheet 1.

For building the stone superstructure on that part of the breakwater which is most decayed and where it is most urgently needed, $50,000 can be advantageously applied to June 30, 1899.

Burlington is a port of entry.

Money statement.

July 1, 1896, balance unexpended		$19,350.36
June 30, 1897, amount expended during fiscal year		8,982.55
July 1, 1897, balance unexpended		10,367.81
July 1, 1897, outstanding liabilities	$22.85	
July 1, 1897, amount covered by uncompleted contracts	9,500.00	
		9,522.85
July 1, 1897, balance available		844.96
Amount (estimated) required for completion of existing project		185,250.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
July 4, 1836	$10,000.00	$10,000.00	March 3, 1875	$25,000.00	$357,980.20
March 3, 1837	10,000.00	20,000.00	August 14, 1876	20,000.00	377,980.20
July 7, 1838	50,000.00	70,000.00	June 18, 1878	20,000.00	397,980.20
June 11, 1844	10,000.00	80,000.00	March 3, 1879	15,000.00	412,980.20
August 30, 1852	10,000.00	90,000.00	June 14, 1880	10,000.00	422,980.20
May 19, 1864	308.00	90,308.00	March 3, 1881	10,000.00	432,980.20
June 23, 1866	27,672.20	117,980.20	August 2, 1882	12,000.00	444,980.20
March 2, 1867	80,000.00	197,980.20	July 5, 1884	50,000.00	494,980.20
July 11, 1870	25,000.00	222,980.20	August 5, 1886	18,750.00	513,730.20
March 3, 1871	30,000.00	252,980.20	August 11, 1888	35,000.00	548,730.20
June 10, 1872	30,000.00	282,980.20	September 19, 1890	20,000.00	568,730.20
March 3, 1873	25,000.00	307,980.20	August 17, 1894	10,000.00	578,730.20
June 23, 1874	25,000.00	332,980.20	June 3, 1896	10,000.00	588,730.20

Abstract of proposals for repairs to breakwater at Burlington, Vt., received in response to advertisement dated June 24, 1896, and opened at 2 p. m. July 24, 1896, by Capt. Smith S. Leach, Corps of Engineers.

No.	Name and address of bidder.	4,000 cubic yards rubble.	500 yards facing stone.	Relaying facing stone, 360 running feet.	Total.
1	Adgate Bros., Keesville, N. Y	$0.85	$2.90	$29.00	$12,230.00
2	Edgar S. Fleury, Isle Lamotte, Vt	.85	2.75	27.50	11,615.00
3	Elisha R. Goodsell, Burlington, Vt	.90	2.85	30.00	12,585.00

Bids were considered too high and were rejected.

Abstract of proposals for building stone superstructure on part of breakwater at Burlington, Vt., received in response to advertisement dated April 17, 1897, and opened at noon, May 17, 1897, by Maj. W. S. Stanton, Corps of Engineers.

No.	Name and address of bidder.	Building stone superstructure, per linear foot.	Furnishing and setting quarry-faced stones, per cubic yard.	Filling spaces between cribs, per cubic yard.
1	Willard Johnson, Fulton, N. Y	$31.80	$5.50	$0.75
2	Luther Whitney, Keesville, N. Y	35.90	4.00	.50
3	Adgate Bros., Keesville, N. Y	34.00	6.00	1.00
4	Edgar S. Fleury, Isle Lamotte	31.50	6.00	.50

Recommended that award be made to No. 4, Edgar S. Fleury.

Contract in force.

Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration.
Edgar S. Fleury	June 11, 1897	On or before June 15, 1897.	On or before Dec. 15, 1897.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels, 1896.

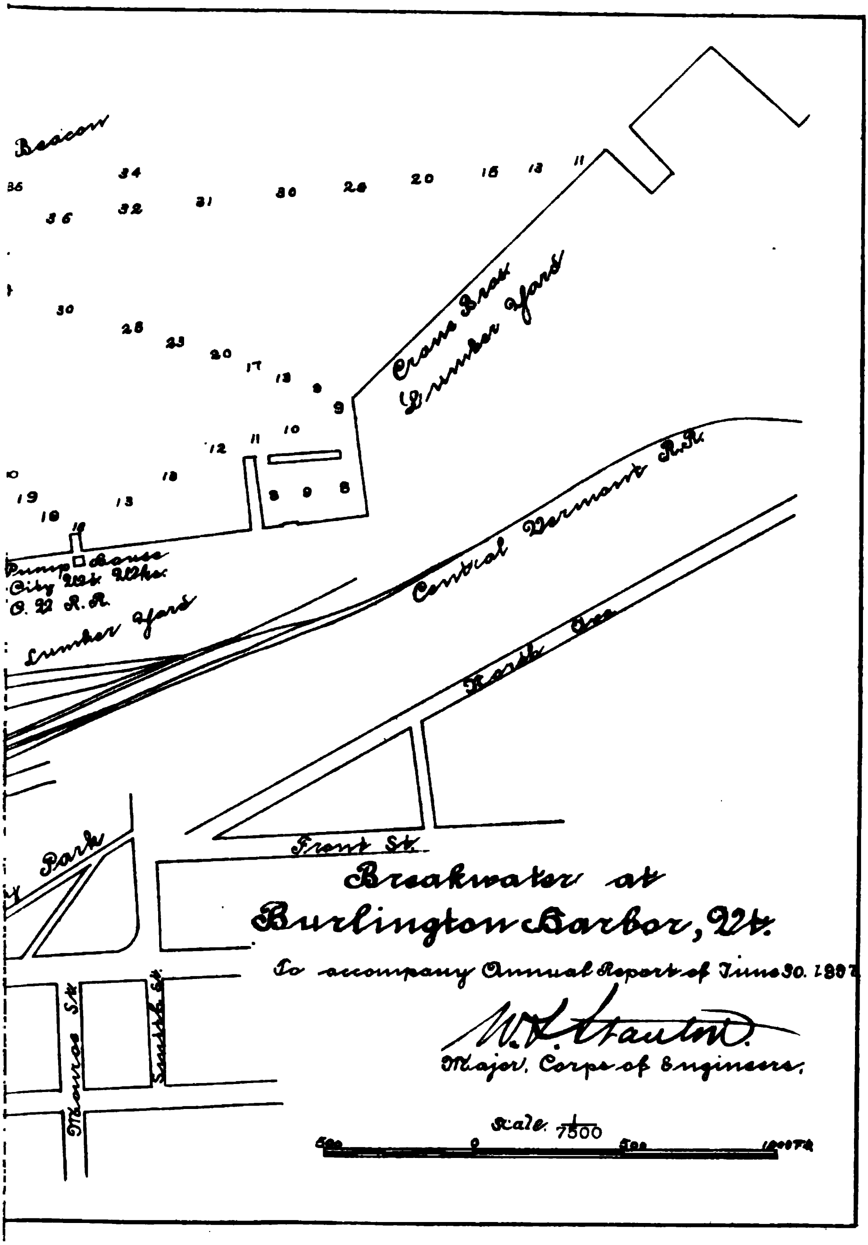
	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
From and to lake ports	1,950	575,703	1,947	575,409
From and to Canadian ports	74	8,738	63	7,835
Total	2,024	584,441	2,010	583,244

Merchandise received and shipped, 1896.

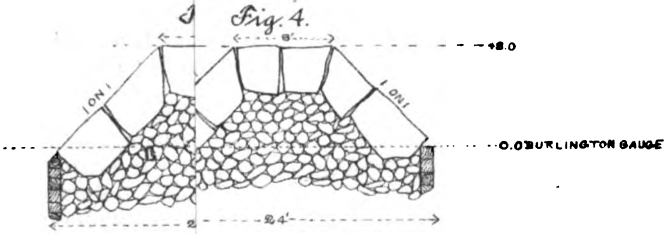
Articles.	Net tons.	Articles.	Net tons.
Coal	71,888	Laths	290
Lumber	19,784	General merchandise	32,774
Stone	17,170		
Pickets	3,110	Total	145,961
Gravel	956		

Decrease since last year, 34,365 tons.

The foregoing commercial statistics were supplied by Hon. B. B. Smalley, collector of customs, Burlington, Vt.


Beacon
Crane Bros Lumber Yard
Central Vermont R.R.
Pump House
City Wat. Wks.
C. V. R.R.
Lumber Yard
Park
Front St.
Monroe St.
Breakwater at
Burlington Harbor, Vt.
To accompany Annual Report of June 30. 189
Major, Corps of Engineers.
Scale $\frac{1}{7500}$

B r built in 1890 at D to E, 323' (Sheet 1)
" " '95 & 96 " A B C 873' "
" at C to H. 2,687 (34' to 36' wide) }
" " A. K. 240' (24' ") } APPROVED 1645/18 APRIL 8 '97



al Report of June 30. 1897.

W. L. Stanton.
Major, Corps of Engineers

N N 11.

IMPROVEMENT OF CHANNEL BETWEEN NORTH AND SOUTH HERO ISLANDS, LAKE CHAMPLAIN, VERMONT.

This channel, about 1½ miles long, was obstructed at its west entrance by a bar composed of heavy bowlders, gravel, and clay, through which the channel was 40 feet wide and 7 feet deep, and at its east entrance by a bar composed of small gravel, clay, and a few bowlders, through which the channel was 100 feet wide and 8 feet deep.

The project (Annual Report for 1887, p. 2414) was to obtain a channel 150 feet wide and 10 feet deep at both entrances, at an estimated cost of $14,300.

The act of August 11, 1888, appropriated $10,000, upon the expenditure of which, September 30, 1889, the improvement was reported as completed.

Complaint having been made of obstructions in the west entrance, that channel was examined by Mr. F. M. Barstow, assistant engineer, in January, 1897, who reports:

> The dredging in the eastern entrance appears to have been well done, and navigators have no trouble there.
>
> At the western entrance a large bowlder was left in the dredged channel which seriously interfered with navigation as it renders useless about one-third of the channel.
>
> This bowlder is located 158 feet northwesterly from the corner of the beacon crib, 50 feet south of the north channel bank and within 25 feet of mid-channel. Its highest point is only 6 feet below low-water level. Its presence in the channel is a source of danger to every vessel passing through and its immediate removal is unhesitatingly recommended.

Mr. Barstow further states that the channel at the west entrance is in the middle 1 to 2 feet and at the edges 2 to 4 feet shallower, and is 25 feet narrower than the depth and width that were prescribed in the project.

The Chief of Engineers, April 14, 1897, authorized a full statement of the facts regarding this improvement to be presented in this report and a request in the money statement "for the appropriation of the unappropriated balance of the original estimate for work at this locality, or so much thereof as may be required for the necessary work."

Two steamers carrying freight and considerable numbers of passengers, each pass through this channel twice daily during the season of navigation.

This improvement is in the collection district of Burlington, Vt.

Money statement.

Amount (estimated) required for completion of existing project.......	$4,300.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	4,300.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

N N 12.

IMPROVEMENT OF OTTER CREEK, VERMONT.

This improvement was undertaken under the project of 1872 to obtain the depth of 8 feet (at zero of Burlington gauge) from the mouth of the creek in Lake Champlain a distance of about 8 miles, "as far up as the horsenail company's wharf at the foot of the falls" at Vergennes, Vt., by dredging silt, sawmill débris, clay, and sand, at seven localities, and by removing a few loaded cribs, piles, and trees, at an estimated cost of $58,146. (Annual Report for 1872, pp. 275, 276.)

The localities (descending) were at Vergennes, Bull Brook, Smiths Bend, Brick Yard, Dead Creek, Crittenden Bend, and Fort Cassin (at the mouth).

The original estimate embraced the removal of "stone, clay, and sand" at Bull Brook, but by a change in the location of the channel the necessary depth was obtained by dredging.

In 1882 (Report for 1882, pp. 711, 712) a shoal just below Vergennes was reported to consist of solid limestone with only a slight covering of sand, and the estimate was increased to $73,748.40.

In November, 1894, at all the foregoing seven localities, and at another, Sharkeys Bend between the Brick Yard and Smiths Bend, the required depth of 8 feet had been obtained, and the steamboats and tugs towing canal boats could easily ascend to the public wharf on the right bank in the basin at Vergennes, and the improvement, so far as it would subserve the general commerce of Vergennes, was completed. The only rock excavated to that date was 1,559 cubic yards from the limestone ledge opposite the reform school wharf, 1,400 feet below the public landing.

The project of 1872 embraced the making of a channel 100 feet wide above the public landing and on the opposite, left, or west bank as far up "as the horsenail company's wharf at the foot of the falls," by dredging "silt and sawmill débris," but in 1891 it was found that the cutting of such a channel to the horsenail company's wharf would require the excavation of a thickness of about 4 feet of solid slate rock.

August 24, 1894, a project was approved to apply the sum of $5,000 then available to rock excavation, and October 15, 1894, a contract was made by the officer then in charge with Lynch & Hannan, of Ogdensburg, N. Y., and approved October 23, 1894, for excavating about 1,160 cubic yards of rock under the project, to cut a channel above the public landing to the horsenail company's wharf. June 24, 1896, the officer then in charge reported this project to cut this channel above the public landing to that company's wharf by rock excavation in his opinion worthy of prosecution, and a project submitted by him to apply $5,000 appropriated June 3, 1896, to rock excavation in continuation of that project, was approved July 6, 1896.

Rock excavation above the public landing under the contract of October 15, 1894, at $5 per cubic yard was commenced June 25, 1896, and the contract was completed by the excavation of 1,160 cubic yards September 19, 1896.

By open-market transaction after ten days' advertisement, to take advantage of the presence of the plant at the locality, Lynch & Hannan were engaged by written proposal and written acceptance to continue, on the completion of their contract of October 15, 1894, the rock excavation under the appropriation of June 3, 1896, but at $4 per cubic yard, at which price they excavated 1,010½ cubic yards of rock to October 22, 1896, when work was stopped by the near exhaustion of funds.

The excavation of the foregoing 2,170½ cubic yards of rock by Lynch & Hannan above the public landing, has obtained a channel 8 feet deep, 40 feet wide, and 350 feet long, extending to the lower corner of the horsenail company's wharf.

The freight received by the horsenail company by boat is reported to amount to 700 tons annually, and the output shipped by boat to amount to 225 tons annually; total, 925 tons.

In the several localities below Vergennes where dredging was last done in 1891, considerable shoaling has occurred, and October 22 to November 4, 1896, 3,196 cubic yards of sand and silt were redredged from the channel at Bull Brook Bend, and 1,330 cubic yards of the same material from the channel at Crittenden Bend, by employing the contractors' plant by the day, at an expenditure of $787.50.

The excavation of 2,170½ cubic yards of rock from the channel above the public landing, and the redredging of 4,526 cubic yards of sand and silt from Bull Brook Bend and Crittenden Bend, comprise, with the survey of the shoals, all the work of the fiscal year.

In redredging at Bull Brook Bend, Sharkeys Bend, Brick Yard, Dead Creek, Crittenden Bend, and at the mouth, it is estimated that $5,000 can be advantageously applied to June 30, 1899.

Otter Creek is in the collection district of Burlington, Vt.

Money statement.

July 1, 1896, balance unexpended	$11,028.94
June 30, 1897, amount expended during fiscal year	11,020.46
July 1, 1897, balance unexpended	8.48
Amount (estimated) required for completion of existing project	12,248.40
Amount that can be profitably expended in fiscal year ending June 30, 1899	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations.

Date.	Amount.	Aggregate.	Date.	Amount.	Aggregate.
June 10, 1872	$10,000.00	$10,000.00	August 2, 1882	$2,000.00	$34,000.00
March 3, 1875	5,000.00	15,000.00	August 11, 1888	2,500.00	36,500.00
June 18, 1878	8,000.00	23,000.00	September 19, 1890	5,000.00	41,500.00
March 3, 1879	5,000.00	28,000.00	July 13, 1892	10,000.00	51,500.00
June 14, 1880	2,000.00	30,000.00	August 17, 1894	5,000.00	56,500.00
March 3, 1881	2,000.00	32,000.00	June 3, 1896	5,000.00	61,500.00

COMMERCIAL STATISTICS.

Statement of vessels at Otter Creek, Vermont, for year 1896.

Character of craft.	Arrivals.		Departures.	
	Number.	Tons.	Number.	Tons.
Unrigged	45	4,653	45	4,653
Sail	6	400	6	400
Steam tugs	50	462	50	462
Steam vessels	400	4,500	398	4,450
Total	501	10,015	499	9,965

Arrivals and shipments, 1896.

Class of goods.	Net tons.	Class of goods.	Net tons.
Coal	5,000	Nails	250
Lumber	2,352	General merchandise	200
Iron	800		
Kaolin	450	Total	9,052

Decrease since last year, 973 tons.

The foregoing commercial statistics were furnished by Hon. B. B. Smalley, collector of customs, Burlington, Vt.

N N 13.

IMPROVEMENT OF NARROWS OF LAKE CHAMPLAIN, NEW YORK AND VERMONT.

This improvement has embraced the deepening to 12 feet and the widening of the channel at the six following localities in the 15 miles of the narrows, extending from Whitehall, N. Y., the northern terminus of the Champlain Canal, north to Benson Landing, Vt., to permit safe and easy navigation by tugs having a draft of 8½ to 10 feet which tow an average of about 17, and not infrequently as many as 25 canal boats at once.

1. In Whitehall Harbor extending about 1 mile to the "Elbow," dredged in 1889 and having shoaled 1 to 2 feet, 22,681 cubic yards of mud and silt and 48 cubic yards of logs were redredged from it in 1896.
2. At Cedar Mountain, within 2½ miles south of Benson Landing, dredged in 1889.
3. At Kenyon Bay, within 1½ miles south of Benson Landing, dredged in 1887 and 1888.
4. At South Bay Bend dredged in 1893.
5. At Beacon No. 3 dredged in 1893.
6. At Chiltons Bend dredged in 1893.

During the fiscal year 22,681 cubic yards of mud and silt and 48 cubic yards of logs were dredged from the channel extending from Whitehall Harbor to and including the "Elbow," under a contract with Lynch & Hannan, of Ogdensburg, N. Y., to August 26, 1896, when the contract was completed and work suspended from the exhaustion of funds.

An examination of the 15 miles of channel from Whitehall to Benson Landing, made by Assistant Engineer John C. Churchill, jr., immediately upon the completion of the above work, shows that the channel in Whitehall Harbor and thence to the "Elbow" has shoaled 1 to 2 feet since it was dredged in 1889, that at Cedar Mountain the channel has shoaled about 2 feet for a length of 1,600 feet and width of 100 feet since it was dredged to the depth of 12 feet and width of 200 feet in 1889, and that at Kenyon Bay the channel has shoaled 1 foot over its entire width of 200 feet and length of 1 mile which was dredged to 12 feet in 1887 and 1888.

To restore the channel at these localities to the depth of 12 feet and width of about 100 feet (the full width of the waterway from Whitehall to the "Elbow," 150 feet at the "Elbow"), and to the width of 200 feet at Cedar Mountain and Kenyon Bay, Mr. Churchill estimates will require dredging:

In Whitehall Harbor and to and at the "Elbow," ....cubic yards..	8,000
At Cedar Mountain ....do....	12,000
At Kenyon Bay ....do....	40,000
Total redredging required in maintenance of former improvement, cubic yards in situ	60,000

Mr. Churchill's report shows further that within the limit of 15 miles from Whitehall to Benson Landing, embraced by the original project, an extension of the improvement is needful for the towing of these flotillas of canal boats at the following localities:

1. About 2,000 feet above Beacon No. 9 (No. 1 old number), 1¾ miles from Whitehall, at a shoal about 1,400 feet long with a depth of 10 to 11½ feet, to obtain a channel 12 feet deep and 150 feet wide will require the dredging of 12,000 cubic yards. While the tugs strike there only at extreme low water the depth of 12 feet specified in the project is needful for tugs hauling such heavy tows.

2. About 2 miles below Whitehall, opposite the drawbridge at South Bay Bend, when heavy south winds, which are frequent, blow out of the bay, tows passing each other collide the one or the other with the bank, and the channel formerly dredged should be widened about 20 feet for about 600 feet along the Vermont shore, requiring the dredging of about 5,400 cubic yards.

3. At Chubbs Dock, Beacon No. 12, 6 miles from Whitehall, the natural channel has narrowed by shoaling along the Vermont shore so that delays and expense are entailed upon tows by collision with the east bank, to avoid which the channel there should be widened and deepened by the removal of about 14,000 cubic yards.

4. Below Beacon No. 8, at the bluffs known as the "Narrows," about 8 miles from Whitehall, the long tows after passing the bend just above the "Narrows" are sometimes blown against the point of rock on the west bank by the strong south winds which prevail, causing damage to the boats. Needful relief of the boats from this difficulty can be best obtained by cutting off the bend and straightening the approach by the removal of about 11,000 cubic yards.

The estimated aggregate amount of dredging requisite to extend the improvement to embrace these four localities is 42,400 cubic yards, measured in place.

At Puts Rock, a few hundred feet below the "Elbow," the waterway is about 100 feet wide between bluffs of rock, and the damage which boats suffer by colliding against the rocky New York shore could be prevented or lessened by bolting fender timbers to protect them from the rough face of the rock as piles can not be driven.

Fender piles driven along the rocky bluffs for about 60 feet at the "Narrows," below Beacon No. 8, and for about 30 feet at Pulpit Point, would prevent or diminish injury to boats when they, in such long tows, unavoidably collide with these rocks that rise directly from the bold channel.

For dredging about 100,000 cubic yards (60,000 in maintenance of former improvement and 40,000 in extending it to the four other localities above named), for protection of vessels from the rocky banks, and for maintenance, the sum of $25,000 can be profitably expended to June 30, 1899.

These facts are presented in this report by authority from the Chief of Engineers of October 10, 1896.

Whitehall is in the collection district of Plattsburg, N. Y.

Money statement.

July 1, 1896, balance unexpended	$5,279.75
June 30, 1897, amount expended during fiscal year	5,264.24
July 1, 1897, balance unexpended	15.51
Amount that can be profitably expended in fiscal year ending June 30, 1899. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	25,000.00

Appropriated.

Date.	Amount.	Aggregate.
Act of—		
August 5, 1886	$30,000.00	$30,000.00
August 11, 1888	15,000.00	45,000.00
July 13, 1892	18,500.00	63,500.00

COMMERCIAL STATISTICS.

Number of boats and tows and tonnage that passed into and out of Whitehall Harbor, New York, during the year 1896.

Whole number of tows	252
Average number of boats in a tow	16
Total boats towed	4,032
Total tonnage	604,800
Estimated value of cargoes	$4,233,600

N N 14.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Wreck in Henderson Harbor, New York.—In July, 1896, complaint was made of "a troublesome wreck reported as obstructing Henderson Harbor, New York." It was immediately examined, and found to consist of an old canal boat, which, with its cargo of 60 to 70 tons of stone, had been sunk at the end of a wharf, for the purpose of forming an extension to the wharf by the owner of the wharf and adjacent hotel. In August, 1893, in a storm, the boat drifted so as to project about 30 feet outside the line of the wharf, in 12½ feet of water, with about 3½ feet of water over its bow and with its stern about 18 inches out of water.

The harbor is 2,000 feet wide. Vessels entering it for refuge and the few vessels engaged in the commerce of the harbor did not need to go near the wreck. The only vessels touching the wharf near which it lies are pleasure craft, which go there only during the short season while the hotel is open for summer guests. It was therefore reported that the wreck appeared to form no obstruction to public navigation.

By direction of the Secretary of War (Ind. of August 5, 1896) the wreck was entirely removed. Work commenced September 17 and was completed November 17, 1896, by W. A. Hovey & Co. by open-market transaction, all the proposals in response to ten days' advertisement having been rejected. The cost was $300, and was defrayed from an allotment from the permanent indefinite appropriation for "removing sunken vessels or craft obstructing or endangering navigation."

N N 15.

PRELIMINARY EXAMINATION OF MOHAWK RIVER, NEW YORK, BETWEEN ROME AND TOWN OF SCHUYLER.

[Printed in House Doc. No. 92, Fifty-fourth Congress, second session.]

Office of the Chief of Engineers,
United States Army,
Washington, D. C., December 3, 1896.

Sir: I have the honor to submit the accompanying copy of report, dated November 13, 1896, by Maj. W. S. Stanton, Corps of Engineers, upon preliminary examination of Mohawk River, New York, between Rome and the town of Schuyler, provided for by the river and harbor act of June 3, 1896.

It is the opinion of Major Stanton and of the division engineer, Col. John M. Wilson, Corps of Engineers, that this portion of the Mohawk River is not worthy of improvement by the General Government.

I concur in the views of these officers.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., November 13, 1896.

GENERAL: I have the honor to submit the following report of the preliminary examination of "the Mohawk River, New York, between Rome and the town of Schuyler," made in compliance with your instructions of June 16, in accordance with a requirement of section 8 of the river and harbor act of June 3, 1896.

The examination was made September 17 to 21, 1896, under my instructions, by Mr. John C. Churchill, jr., assistant engineer, who commenced it at Rome and continued it to Utica, where, about 3 miles from Schuyler, the examination was concluded by my instructions to Mr. Churchill, upon receipt from him of a message announcing the scope and object of the examination in the intent of those at whose solicitation the item requiring it was inserted in the act above cited.

After stating that "the water of the river down to the city of Rome is entirely utilized during the season of navigation by the Erie Canal, there being a State dam at Rome for the purpose of diverting the water to the canal;" that the many bends in the river "make its length between Rome and Utica about 43 miles, while the distance between those points by railroad is 15 miles," and that the "channel is from 50 to 75 feet wide from Rome to Oriskany, and from 60 to 100 feet wide between Oriskany and Utica," Mr. Churchill reports:

Just below the State dam at Rome the quantity of water was less than 1 cubic foot per second, and a short distance above Oriskany the flow was approximately 24 cubic feet per second.

This, I was informed, was the ordinary summer flow. The examination from Oriskany to Utica was made after and during a heavy rain, which raised the water in the stream over a foot.

Notwithstanding this rise, however, difficulty was encountered in passing over some of the shoals in the rowboat, and it was evident that the same conditions existed in ordinary weather as above, with a somewhat increased flow of water.

At Utica the scheme which was contemplated in the item calling for the examination was learned. What is desired is the cutting of a channel between the bends of the Mohawk River in front of the city of Utica, * * * for the purpose of allowing the old river bed to be filled up and encouraging the spread of the city of Utica in that direction; also to improve the sanitary condition of the city by causing the removal of the sewer outlets to the new channel, the summer flow of the river being so small as not properly to carry the sewage away.

There is no commerce carried on the Mohawk River now, and it is not contemplated that the proposed cut will provide for any.

The stretch of the Mohawk where examination has been required by the act above cited is not only, as described by Mr. Churchill, unnavigable itself, but furthermore, is separated by falls at Little Falls and at Cohoes and by dams both in the Mohawk and in the Hudson from navigable water in the latter river. The expenditure of money upon it could, therefore, have no relation to navigation.

At my inspection of the river at Utica on the 2d instant I found the purpose of the preliminary examination to be, avowedly, as stated by Mr. Churchill—to provide for making a cut-off that would move the river farther from Utica to permit the city to more easily extend in that direction, and to make its condition more sanitary—which enterprise would manifestly benefit the municipality of Utica exclusively.

The foregoing facts and reasons compel me, in fulfillment of a requirement of your letter, to state that in my opinion "the Mohawk River, New York, between Rome and the town of Schuyler," is not worthy of improvement by the General Government.

Respectfully submitted.

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
Washington, November 16, 1896.

Respectfully forwarded to the Chief of Engineers.

For the reasons given by the local engineer, I concur in his views that "the Mohawk River, New York, between Rome and the town of Schuyler," is not worthy of improvement by the General Government.

JOHN M. WILSON,
Colonel, Corps of Engineers,
Division Engineer, Northeast Division.

N N 16.

PRELIMINARY EXAMINATION OF BLACK RIVER, NEW YORK, TO HARBOR AT DEXTER.

[Printed in House Doc. No. 143, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated December 15, 1896, by Maj. W. S. Stanton, Corps of Engineers, of the results of a preliminary examination of Black River, New York, to harbor at Dexter, made in compliance with requirements of the river and harbor act of June 3, 1896.

From the facts and reasons presented, Major Stanton is of the opinion, which is concurred in by the division engineer, Col. John M. Wilson, Corps of Engineers, and by me, that this locality is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., December 15, 1896.

GENERAL: I have the honor to submit the following report of the preliminary examination of "Black River, New York, to harbor at Dexter," made in compliance with your instructions of June 16, in accordance with a requirement of section 8 of the river and harbor act of June 3, 1896.

The examination was made October 26 and 27, 1896, by Mr. William Pierson Judson, assistant engineer. At its conclusion I inspected with him the shoals where the improvement of the channel is desired by the business men of Dexter. Mr. Judson's report of his examination, to which attention is invited for information in detail, is herewith.

The river flows into Black River Bay, an arm of Lake Ontario, joining the lake 15 miles from the head of the St. Lawrence. The bay is 6 miles long and a mile to a mile and a half wide.

From its mouth at the head of the bay to the head of navigation at Dexter the river is about 1 mile long and has a channel of good width, which, Mr. Judson reports, has a controlling depth of 7 feet at extreme low stage of the lake over a bed, near Dexter, of ledge rock. In their course down the foothills of the Adirondacks the river and its principal tributaries are reported to flow through a soil of light, sandy loam, and for the first 29 miles above Dexter the river is reported to have an average fall of 16 feet per mile, and a bed and banks of solid rock. Through this sluice-like and rapidly descending channel the sand washed from the foothills is quickly swept by the strong current into the slack water of the bay, where, with large quantities of sawdust and tan bark from sawmills and tanneries formerly on the banks, it has doubtless formed a great part of the extensive marsh and shoals which occupy the upper mile and a half of the bay from shore to shore. (See Lake Ontario Coast Chart No. 1.)

The improvement desired by the manufacturers and other business men of Dexter is the obtainment and maintenance through these shoals in the bay of a channel as deep as that in the mile of river from the shoals up to Dexter—7 feet when the lake is at zero of the Oswego gauge.

In 1836 to 1839 the sum of $36,071.14 was expended by the United States in building of timber and stone two converging jetties to scour a channel through those shoals, and in 1844, by a further expenditure of $3,000, the south jetty was extended 390 feet. A north jetty 4,700 feet long, and a south jetty 2,700 feet long, built at the above cost of $39,071.14, are reported to have increased the depth 4 or 5 feet, and to have obtained a channel, said by old residents of Dexter to have been navigable for vessels of about 6 or 7 feet draft, at what stage of the lake they can not state. By the formation of a shoal below the jetties, which naturally followed their construction, the channel reverted to its former inadequate depth.

The channel, thus for a time improved, was straight, and the northerly of two channels which then extended from the mouth of the river through the shoals to a good navigable depth in the bay below them. The southerly channel was circuitous, and the south jetty was built across its head near the mouth of the river. When the depth on the shoal formed below the jetties became less than the depth of the south channel, the south jetty was cut (where it crossed that channel), and the south channel was used by vessels until it in turn became shoaler than the north channel, when the use of the latter was resumed and has continued to this time. Meantime the shoaling of the south channel continued even to its entire obliteration for a considerable number of hundred feet near its head, where no trace of it can be seen in the marsh which has been formed where vessels passed after they had abandoned the improved channel.

In 1873, by the expenditure of $5,000 a cut 35 feet wide and 7 feet deep was made 3,000 feet in length through the shoal below the jetties with but transient effect, as anticipated by the engineer officer then in charge. The history of these attempts at improvement will be found on pages 378 and 268 of the Annual Report of the Chief of Engineers, respectively, for 1873 and 1874.

Mr. Judson, who also then surveyed the shoal, reports that the depth in the channel on its crest is now 2½ feet when the water surface of Lake Ontario is at the zero of the Oswego gauge, and that the crown of the shoal is 500 feet wider in the channel than it was in 1873 and has advanced 600 feet down the bay in the twenty-three years since that date.

The slope and sandy soil of the upper part of the area which the river drains, and the short length, rapid descent, and swift current of the river thence to the bay, are, as shown by the above record, efficient causes of the formation of shoals in the slack water of the bay which must ever be contended against in maintaining a navigable channel through them. A renewal of the attempt at improvement by contraction would require, to be successful, a great extension of the jetties to push the deposit, constantly made below them, down the bay into deep water, as their lower ends are now about 3,200 feet above the 12-foot and about 4,200 feet above the 18-foot curve. If a channel of the requisite depth were obtained by dredging without contraction, it could be maintained only by redredging and only so long as periodical redredging were to be continued. In view of the greater shoaling of the southerly channel, even to the entire obliteration of a considerable part of it by the formation of a marsh, its adoption for improvement would not be a promising alternative.

The improvement undertaken in 1836 to 1844 was in the era of canals and before activity in railway construction. Dexter is now within 2 miles of the Cape Vincent branch of the Rome, Watertown and Ogdensburg Railroad, and is 16 miles from its terminus at Cape Vincent on the St. Lawrence River. The least depth in the channel on the shoals—2½ feet at zero of the Oswego gauge—is 4¾ feet at the average stage of water in Lake Ontario and 5½ feet at the average higher stage in June and July. Dexter thus has now such advantages for transportation as are afforded by a waterway of the above depths and by a railway 2 miles distant. It is reported to contain 1,300 inhabitants, 5 wood-pulp factories, 2 paper mills, a woolen mill, and 2 lumber mills, employing about 250 men. It is reported to receive annually about 17,050 tons of raw materials, consisting of pulp wood, pulp, sulphite, and brimstone, and 5,120 tons of coal. The annual output of its manufactories is reported to be about 8,000 tons of paper and wet pulp.

Were the desired increase in the depth of the channel on the shoals to be obtained and maintained in providing for these raw materials and for coal cheaper water transportation to Dexter without lightering, the improvement would unquestionably benefit Dexter, its manufactures, and, in some degree, its vicinity, but the benefits of the improvement would be limited to those interests and to that locality, and have no relation to general commerce.

Your instructions require my opinion as to the worthiness of the desired improvement, and the facts and reasons upon which it is based. From the foregoing facts, and for the reason that the benefits of the improvement would inure to interests no greater than those at Dexter, and would not extend beyond Dexter and its immediate vicinity, and because the improvement would entail not only the cost of obtaining the increased depth of channel, but periodical outlays for maintaining it, it is my opinion that "Black River, New York, to harbor at Dexter" is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
Washington, December 17, 1896.

Respectfully forwarded to the Chief of Engineers.

For the reasons given herein by the local engineer, Maj. W. S. Stanton, I concur in his opinion that "Black River, New York, to harbor at Dexter" is not worthy of improvement by the General Government.

JOHN M. WILSON,
Colonel, Corps of Engineers,
Division Engineer, Northeast Division.

REPORT OF MR. WILLIAM PIERSON JUDSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., November 12, 1896.

SIR: I have the honor to report as follows upon the results of the preliminary examination of the "Black River to harbor at Dexter, N. Y.," called for in river and harbor bill of 1896.

The examination was made October 26–28, 1896.

The Black River enters the eastern end of Lake Ontario through Black River Bay, an arm of Henderson Bay. Dexter is situated at the head of navigation, 1 mile upstream from the outlet of the river into the bay, and is a growing manufacturing place, with a population of 1,300. Lake navigation is here limited by a dam 11 feet high, which furnishes power for the Dexter factories. These are 5 wood-pulp factories, employing about 175 men; 2 paper mills, employing 50 men; a small woolen mill, besides 2 lumber mills and a coal company, which together employ about 45 men, and are said to supply the surrounding country within radii of 6 to 20 miles.

During the past five years the average annual freight reported by the deputy collector of the port to have been brought by water has been by 68 steamers and barges, carrying about 120 tons each of Canadian pulp wood and 33 similar loads of coal and 2 of sulphur, equal to an annual aggregate of 103 loads, or 12,360 gross tons, of freight. This has all been transferred at the bar and brought into Dexter by lighters. It is claimed, and with apparent reason, that these quantities would be doubled or trebled and that a daily line of passenger steamers would run to the Thousand Islands if the entrance to the harbor were deepened.

The navigable depth of the river is fixed by the ledges of rock forming the bed of the river near Dexter at 7 feet below extreme low water of Lake Ontario, and this is the greatest depth which the commerce of the place either asks or needs for the passage of the classes of barges and vessels which are best adapted to the local business. The present obstructions to the use of the harbor consist of shoals formed outside the river mouth by the deposits of sand, sawdust, and tan bark which have been, and still are, brought down by the river current during times of extreme freshet. Although the law forbidding the throwing of sawmill waste into streams is generally obeyed, the deposits of sawdust already in the old mill ponds of the upper river and in the bay do not decay, and vast additional quantities of sand come into the upper river from caving banks, which in many cases are broken off by mill owners during freshets in order to thus enlarge their mill ponds, which are also sometimes cleared of old deposits by openings made for that purpose in their dams.

In March, 1896, a tract of sand 5 acres in extent and 20 feet in depth was cut out by the river around Herrings Dam, near Carthage, and the material was carried down by the current, thus adding some 160,000 cubic yards to the shoals in the bay.

This free movement of material is a natural result of the character of the river and of the industries which have long made use of its many water powers.

The river has a length of about 130 miles, measured along its course, from its mouth, near Dexter, to its head waters among the Adirondack lakes, in the center of Lewis County, 74 miles distant. The drainage basin of the river and of its tributaries has an aggregate area of about 1,857 square miles, and comprises parts of Jefferson, Oneida, Lewis, Herkimer, and Hamilton counties of northern New York. The flow from about 275 square miles of the southern part of this area is diverted to feed the Erie Canal at Rome; but the main flow, which supplies water power at Carthage, Great Bend, Felts Mills, Black River, Watertown, Brownville, and Dexter, is (at Watertown) about 1,030 cubic feet per second at low stage of a dry season and about 9,950 cubic feet per second at high stage.

This flow, if confined by jetties, is sufficient to scour and to maintain a channel of navigable depth at the river mouth.

Above Carthage the river and its tributaries (the Moose, Deer, and Beaver being the most important ones) flow through a region whose soil is largely of light, sandy loam. From Carthage to the bay near Dexter the distance by river is 29½ miles and the fall is 477 feet, while the banks and bed of the river are of solid rock. In this section of the river there is a theoretical water power at ordinary low stage of 70,000 horsepower, of which about one-tenth is developed and in use. These figures are given in that part of the Tenth Census of the United States relating to the water power of New York State. Some of the tributaries have even steeper slopes than this, and the silt, sand, and sawdust which they bring to the river are quickly carried to and beyond the mouth, where the extensive and increasing shoals have thus been formed in what was once the deep basin in the bay.

The rate of this increase may be deduced from the following statement of the history of the place:

From 1836 to 1844 the sum of $40,000 was expended by the United States in constructing converging jetties of crib work, filled with loose stones, for the purpose of confining the current of the river, and thus eroding and maintaining a channel through the bar. The north jetty (or the one on the right hand going out of the river) was made 4,700 feet long, and the south one 2,700 feet long. The distance between their shore ends was 1,250 feet, from which they converged until, at the outer end of the south jetty, the space was 400 feet.

Under date of December, 1839, Lieut. J. E. Johnston, of the Corps of Topographical Engineers, reported that the outer cribs sunk during that season were placed in 10 feet of water; that the effect of the jetties had been to deepen the channel between them 4 or 5 feet, and that there was then 9 to 10 feet depth between the jetties. These depths were actual, and at the time when they were measured the lake level was at 2¼ to 3 feet above the plane of zero of the United States engineer gauge at Oswego, which was established in 1838, and which has since been the standard for all Lake Ontario harbor gauges. Its zero has been extreme low-water level until 1895 and 1896, when the lake surface was at eight-tenths foot and two-tenths foot, respectively, below this zero.

The material which was scoured from the deepened channel was, of course, deposited beyond the ends of the jetties, and, as they were not extended after 1844, the entrance was in a few years so reduced in depth that small vessels of 6 to 7 feet draft could not use it, but were obliged to enter by the way of the circuitous natural passage, known as "the South Channel," which ran through the marsh south of the jetty channel, and which entered the river through an opening which was cut for that purpose in the south jetty near its inner end.

In June, 1873, the writer made a detailed survey and map of the vicinity, which shows that the shoal in front of the ends of the jetties had then a governing depth of 2½ feet below zero of the Oswego gauge, and that there was a depth of 3 feet or less for about 100 feet outward from a point on the prolongation of the center line of the jetty channel 1,400 feet outside the outer end of the north jetty. Between the jetties the depth was then 9 to 10 feet.

Later in 1873 $5,000, which had already been appropriated "for removing the bar," were expended in a cut 3,000 feet long, 35 feet wide, and 7 feet deep below zero, located on the center line of the jetty channel prolonged across the bar. The engineer officer in charge anticipated that the unprotected cut would soon fill again, which it did, leaving no lasting effect.

In October, 1896, it is found that the crown of the shoal has advanced 600 feet farther into the bay and is 500 feet wider than in 1873, there now being a governing depth of 2½ feet below zero of Oswego gauge and a depth of 3 feet or less for about 600 feet outward from a point on the prolongation of the center line 1,700 feet from the outer end of the north jetty. Between the jetties the depth appears to be but little changed since 1873.

This increase of the shoal in advance of the jetties is, however, less marked than have been the changes during the same period on either side for nearly the full width of the bay, which is here about a mile wide. Across this whole space the shoal has advanced as much or more by the deposit of vast quantities of sand and of water-logged sawdust and tan bark. These materials form shifting banks and islands, whose exposed parts are readily moved about by the waves and currents, as well as in a peculiar manner, which is not known to the writer to have been described as occurring elsewhere, but which must have been an important factor in the distribution of these shoals over so wide an area. It is as follows:

During this examination (on October 27 and 28, 1896) sand was found floating freely upon the surface of the water, and was seen to be thus transported to a distance of a quarter of a mile or less from its starting places.

During a calm time, when the water of the bay was glassy, it was observed that about 5 per cent of the area for about 1 square mile of open water was covered with floating patches of clear sand varying in size from 2 square inches to 8 square inches each in area and generally about one-sixteenth of an inch thick.

Each group was formed of separate particles of the fine quartz and silex composing the adjacent sand islands and shoals, and all continued to float and to move with the slight currents until shaken by the ripples of a breeze, when the particles were seen to separate and to sink. The particles of sand were all wet and appeared to be sustained by minute bubbles of air imprisoned among them. No sawdust or other buoyant or oily material of any kind was mixed with the clear sand, which was generally of coarse grain. Several ounces of the sand were gathered from the surface of the water at a quarter of a mile offshore by slipping a piece of paper beneath it. The floating sand had apparently been lifted from the margins of the adjacent sand islands and beaches, as the water level of the bay was raised by the slight "seiches" or tides of an inch or two rise and fall, which usually occur along the lake at about twenty-minute intervals.

Taking the thickness of the layer of floating sand at one thirty-second of an inch, only one-half the observed thickness, it is computed that 120 cubic yards of sand were thus afloat at once, and this action would recur many times on every calm day.

A fixed channel can only be made through this shifting mass by extending one or both of the jetties to deep water and again extending them farther when the eroded material forms a new shoal beyond them. This effect might be produced by the north jetty alone if the existing 4,700 feet of it were rebuilt to 3 feet above its present top (from which three courses have been cut and stolen, so that now it is at about extreme low-water line), and if 3,400 feet of new extension were then built out to the present 8-foot curve. If it then proved that both jetties were needed, as would probably be the case, then the south jetty must also be raised and 5,400 feet must be added to it, making 7,400 feet of old work to be raised and 8,800 feet of new extensions to be built.

The estimated cost of these works in even the cheapest form would be so great as to be prohibitory.

A practicable channel, whose first cost will be less and whose maintenance will be less difficult, can be made on the general line of the natural "South Channel" by cutting through the marsh on the south of the south jetty, and thus reaching by a direct line the naturally deep channel from Muscallonge Creek and Spring Creek, which runs close along the south shore of the bay and around Stores Harbor Point. By directing the line of the cut toward a place about midway between Catfish Point and Stores Harbor Point, its outer end will be under their shelter and the need for protecting jetties will be nearly avoided.

This location will be about 2,000 feet shorter than the natural line of the old "South Channel," and will be 5,600 feet long. * * * This location is aside from the main current of the river, which will continue to pass out between the jetties, and it does not appear that the silt, sand, and sawdust which will continue to come down the river during freshets will enter the proposed cut in any considerable quantity.

A floating shutter to close the passageway through the old south jetty during times of extreme freshet would cost about $400, and would have a good effect.

The situation and the material are peculiarly suited to the cheaper use of a suction dredge, if one were available.

* * * * * * *

Respectfully submitted.

Wm. Pierson Judson,
Assistant Engineer.

Maj. W. S. Stanton,
Corps of Engineers, U. S. A.

N N 17.

PRELIMINARY EXAMINATION OF HARBOR AT ALEXANDRIA BAY, NEW YORK.

[Printed in House Doc. No. 205, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 20, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 9, 1897, by Maj. W. S. Stanton, Corps of Engineers, giving the results of a preliminary examination of harbor at Alexandria Bay, N. Y., provided for by the terms of the river and harbor act of June 3, 1896.

For the reasons given Major Stanton is of the opinion, which is concurred in by the division engineer, Col. John M. Wilson, Corps of Engineers, and by me, that the harbor at Alexandria Bay is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., January 9, 1897.

GENERAL: I have the honor to submit the following report of the preliminary examination of Alexandria Bay, N. Y., made in compliance with letter of August 20, from your office, and in accordance with a requirement of section 8 of the river and harbor act of June 3, 1896:

Alexandria Bay is a village on the bank of the St. Lawrence River, about 28 miles below Lake Ontario.

It contains about 1,200 inhabitants, but has two large summer hotels, and being at a picturesque part of the river opposite a group of the Thousand Islands, upon which expensive summer residences have been built, it is a popular summer resort.

The president and trustees of the village state that during the season of 1895, 14,000 guests registered at the two hotels, and that with the number at small hotels and boarding houses upward of 17,000 guests registered in the village in that season.

The hotels and the principal part of the village stand on a small peninsula extending between two shallow coves to deep water in the river. (See blue print herewith.)*

The large number of passengers and the supplies for the hotels carried by the steamers that touch daily in passing between the St. Lawrence River and Lake Ontario ports of the United States and Canada constitute the sole transportation of any importance to and from Alexandria Bay. This transport of passengers and supplies continues only during the three and a half months annually, from June 1 to September 15, which is the entire period when the St. Lawrence is a popular route of travel and the large hotels in the village receive guests. The river front between the two coves is 1,700 feet long, and the large number of guests brought by the steamers are landed there in safety during the mild season while the hotels are open and the travel lasts.

But it is reported that in that time steam and sailing yachts resort to

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* Not printed.

Alexandria Bay in considerable numbers annually, belonging, some to summer residents of the Thousand Islands, some on the Upper Lakes, and some on the Atlantic coast. It is also said that there are owned in the vicinity about 25 commercial boats and yachts for charter and about 20 scows and house boats for small local traffic or for use for pleasure during the season.

The river is deep, its bottom is rocky, and the only secure anchorage or mooring for these quite numerous crafts, used chiefly for pleasure, and all sizes, from large steam yachts down to naphtha launches, is in the two coves, which have muddy bottoms and are so shallow the requisite room in them is not available. The improvement contemplated in the request for the preliminary examination is the dredging of these two coves to the depth of 10 feet to provide anchorage for those miscellaneous crafts during the travel or summer-resort season.

The upper cove is 700 feet wide at its mouth and extends back about 600 feet from the river. Its depth is about 10 feet at its mouth, 2½ feet at its back part, and 4½ feet midway. The lower cove is 730 feet wide at its mouth, and extends about 600 feet back from the river. Its depth is about 10 feet at its mouth, about 1 foot at its back part, and about 6 feet midway. If dredged a small stream which discharges into it might cause shoaling. In each cove a rock curtails the swinging room for vessels at anchor.

The dredging of these coves to the depth of 10 feet would provide in each cove a good and useful harbor for yachts and for the numerous smaller pleasure crafts used by the large number of guests at Alexandria Bay in the summer, and would doubtless be of material benefit to the hotel and all other local interests that may be promoted by any increase in the attractions which the place presents to summer guests. Either cove would be a very cramped area for the swinging of even one freight barge at anchor, and as the depth of 10 feet would not be sufficient to admit a barge, the improvement, if made, would be of little benefit in stress of weather to the large transport of freight on the St. Lawrence, which is chiefly by the steam barge towing several consorts.

For the reason that the dredging of these coves would benefit interests almost exclusively local, would not be of appreciable benefit to any interest during about eight months annually, and would not "subserve the general commercial and navigation interests of the United States" (section 231, Revised Statutes), Alexandria Bay, N. Y., is not, in my opinion, worthy of improvement by the General Government.

Respectfully submitted.

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
Washington, January 12, 1897.

Respectfully forwarded to the Chief of Engineers.

For the reasons given by the local engineer I concur in his views that Alexandria Bay, N. Y., is not worthy of improvement by the General Government.

JOHN M. WILSON,
Colonel, Corps of Engineers,
Division Engineer, Northeast Division.

N N 18.

SURVEY OF OAK ORCHARD HARBOR, NEW YORK.

[Printed in House Doc. No. 281, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 6, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 26, 1897, by Maj. W. S. Stanton, Corps of Engineers, of the results of a survey of Oak Orchard Harbor, New York, made to comply with the provisions of the river and harbor act of June 3, 1896.

Major Stanton submits a plan for making available the depth heretofore obtained at the harbor entrance. It provides for the excavation of a channel 12 feet deep at low water, 150 feet wide, and 430 feet long from the ends of the piers to the 12-foot curve in Lake Ontario, for dredging between piers and near the south end of the west pier, and for repairs to piers. The cost is estimated at $10,500. Redredging would be necessary from time to time to maintain the channel depth, and about $1,000 would be required annually for maintenance of piers.

The cost of obtaining a depth of 15 feet at low water and width of 150 feet from the lake to deep water within the harbor is estimated at $38,000.

In transmitting the report to this office Major Stanton expressed the opinion that further improvement by the General Government is not justified by the interests of the very meager commerce involved, and that the locality would be of little or no value as a harbor of refuge. He states, however, that an expenditure of $1,000 upon the repair of the two piers would result in longer preserving the present channel depth between them.

The views of the division engineer, Col. John M. Wilson, Corps of Engineers, upon this subject, which are concurred in by me, are as follows:

> For the reasons given by the local engineer in his report herewith, I believe that any extended improvement of Oak Orchard Harbor, for the purpose of gaining a greater depth than that heretofore obtained between the piers, is a work not worthy to be undertaken by the United States.
>
> I think that it would be well to make available the depth heretofore gained, by removing the rock to a depth of 12 feet out to the 12-foot curve, the sand, mud, gravel, etc., between the piers and near south end of west pier, and to repair the present piers at a total cost of $10,500, as estimated, but not recommended, by the local engineer in his report of January 26, 1897, herewith.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., January 26, 1897.

GENERAL: I have the honor to submit the following report of a survey of Oak Orchard Harbor, New York, with an estimate of the cost of improvement, made in compliance with a requirement of section 9 of the river and harbor act of June 3, and with your instructions by letter of September 14, 1896.

The survey was made by Mr. William Pierson Judson, assistant engineer, whose report of December 5, 1896, with plat* and estimate of the cost of improvement, is transmitted herewith.

The harbor is Oak Orchard Creek, which flows into Lake Ontario 32 miles west from the Genesee River. From the landward end of the piers to "Two Bridges," where it divides into two branches, it is a mile and a half long and is stated in the published reports of its improvement to be 12 to 20 feet deep and 120 feet wide. So far as Mr. Judson's survey extended, 800 feet above the end of the west pier, the greatest width of the natural channel is 50 feet between the 15-foot and 70 feet between the 12-foot contours at low water. Below "Two Bridges" it usually has little, if any, current and the natural depth at its mouth is reported to have been "only from 2 to 4 feet."

In 1836 work was commenced under a project for the improvement of the entrance by building two piers nearly parallel, 186 to 194 feet apart, with the design of obtaining the requisite increase in depth between them by scour by the current in freshets; but the current failed to sufficiently increase the depth, and dredging was resorted to. Beneath a stratum of "sand, mud, gravel, cobblestone, hard clay," etc., a ledge of soft red sandstone was found, and its excavation was in turn undertaken.

To 1892, when the last expenditure was made, $204,578.34 had been expended for the improvement of the entrance, in building piers, dredging, rock excavation, and a little shore protection.

The west pier is 1,300 feet and the east pier 1,010 feet long, both built of timber cribs filled with stone. Between the piers there is a channel 150 feet wide and 1,100 feet long, in which the surface of the rock is at an average depth of 11.55 feet below low water of Lake Ontario (zero of the Oswego gauge).

At the ends of the piers where the excavation of the rock ceased, the rock rises abruptly to its natural surface, 9¾ feet below low water; and this surface of rock slopes in the first 430 feet outside the piers to 12 feet below low water. At low water the 15-foot curve, where the bottom is of stones, is 780 feet outside the ends of the piers. Between the piers, in the excavated channel, this rocky bed is overlaid throughout its length of 1,100 feet by 10,200 cubic yards of sand, mud, clay, and gravel, having an average thickness of 20 inches, which reduces the average available depth of water in the channel to 9.9 feet at low water. The present controlling depth of the entrance is 9.3 feet at low water, and is at the outer ends of the piers where about 6 inches of sand overlies the highest part of the rock in mid-channel. This quantity, 10,200 cubic yards, is measured in place, and is the excavation necessary to uncover the rock, or to obtain the depth of 12 feet in places, here and there, where the surface of the rock is below that depth.

To make available the depth hitherto obtained by rock excavation between the piers there would be requisite—

Rock excavation (soft sandstone):	
For a channel 12 feet deep at low water, 150 feet wide, and 430 feet long from the ends of the piers to the 12-foot curve, 3,450 cubic yards, at $1.40	$4,830
Sand, mud, clay, and gravel overlying rock in channel between piers, 10,200 cubic yards, in place, at 20 cents	2,040
Mud extending 700 feet from near south end of west pier, 7,000 cubic yards, in place, at 15 cents	1,050
Total for excavation and dredging	7,920
For repairing piers	1,000
	8,920
Contingencies, superintendence, and inspection, about 18 per cent, say	1,580
Total	10,500

*Not printed.

By the expenditure, then, of $10,500 the available depth in a channel 150 feet wide would be that on the highest parts of the rocks, here and there, along in the channel between the piers, which is 10½ feet at low water (or below the zero of the Oswego gauge), and an average of about 1 foot would be left over the rocky bed of the channel for shoaling before the depth would be reduced below 10½ feet. So far as the soundings indicate, taken 20 feet apart in rows 100 feet apart, there are only eight places where a small amount of rock excavation would increase the controlling depth over the rock in the channel between the piers to 11 feet below low water.

The cost of maintenance of the piers at Charlotte, at the mouth of the Genesee River, averaged (including superintendence and office expenses) in twenty-five years 98 cents per linear foot per year. If the maintenance of the 2,310 linear feet of piers at Oak Orchard cost at one-half that rate, it will amount to about $1,100 annually, and there would doubtless be besides some expense for redredging, if the depth of 10½ feet is to be obtained and maintained.

Mr. Judson's estimate, amounting to $38,000, for obtaining the depth of 15 feet at low water, adapted to the draft (14 feet) of vessels that can pass through the Welland Canal, embraces excavating 12,000 cubic yards of the soft sandstone at 80 cents per cubic yard, which, in his judgment, based on his own observation of previous work upon it, is the price for which it can be excavated with a powerful dredge. For the sandstone which was last excavated at Oak Orchard in 1892 (Annual Report for 1892, p. 2538), the price paid was $1.40 per cubic yard. Should a lower price than $1.40 per cubic yard not be obtained for the rock excavation, the total cost of obtaining the depth of 15 feet would be $45,200.

In the estimate of $10,500 for obtaining an available depth of 10½ feet, the cost of excavating the sandstone is assumed at $1.40 per cubic yard, as both the thickness and quantity to be removed are small, and the excavation being all in the lake would be in a more exposed position than in the channel between the piers.

Oak Orchard is a village at the mouth of the creek and about 3 miles from the Rome, Watertown and Ogdensburg Railroad. It contains less than 100 inhabitants, and its commerce is very meager, consisting, by water, of posts, shingles, and lumber, in the quantities consumed within a distance of about 10 or 12 miles.

When the improvement of the entrance to Oak Orchard Creek was commenced in 1836, the American commerce on Lake Ontario consisted largely of salt (from Syracuse) and railroad iron, both shipped to the West from Oswego, and of wheat shipped from the West to the large flouring mills on the Oswego River, driven by water power. Those products were carried in small schooners about 60 feet long, 18 feet beam, and carrying about 70 tons of cargo, with a draft of about 5 feet. In 1838 a schooner was built at Oswego, about 100 feet long, 20 feet beam, capable of carrying about 230 to 240 tons, or about 7,000 bushels of wheat, and was the largest vessel then on the lake. Oak Orchard Creek contained room for a good number of vessels of that size, and doubtless was a useful harbor of refuge for vessels of that size and class, without steam power, in the storms that so suddenly arise.

But the conditions are now utterly changed, because the steam barge has driven sailing vessels, both large and small, in a great degree from the lake, and they are still diminishing in number, few are being built, and the most of those now on the lake are old and belong to Canada.

From the four American ports on Lake Ontario, Oswego, Charlotte, Little Sodus, and Great Sodus, in 1895, the total departures in tonnage amounted to 831,540 tons, of which 641,300 tons, or 77 per cent, were of steam, and only 190,248 tons, or 23 per cent, were of sailing vessels. Of the steam tonnage, including steam barges and their consorts, 339,548 tons, or 53 per cent, were Canadian, and 301,752 tons, or 47 per cent, American, while of the sailing tonnage 167,347 tons, or 88 per cent, were Canadian, and 22,901 tons, or only 12 per cent, were American. A single steam barge now will carry with a draft of 13½ feet 60,000 to 65,000 bushels of wheat, or as much as nine sailing vessels of the size of the largest on Lake Ontario in 1838. Grain is carried mostly in the single barge, but coal and lumber by a steam barge towing four consorts, the five barges carrying about 3,000 tons of coal.

So while in 1836, when the improvement of the entrance of Oak Orchard Creek was commenced, freight on the lake was carried chiefly if not wholly, in sailing vessels, and those vessels were all small. Only 190,248 tons, or 23 per cent, of the tonnage now clearing from the American shore is of sailing vessels, and of that only 22,900 tons, or 12 per cent, is American.

The channel of Oak Orchard Creek is, as before stated, a mile and a half long, and its width is much less than the length of a steam barge, and masters of barges say that were its entrance deepened they would not attempt to enter it for shelter on account of its exposed situation, but in the prevalent northwesterly or westerly winds and gales that they would, when bound west, seek shelter behind Braddock Point, where there is a good lee in such winds; that in a northeast gale, if bound east, they would work over to the Canadian shore and go down the lake in a good lee, and if bound west and caught as far east as Big Sodus they would either work over to the Canadian shore or run before it; in an east gale, if bound east, it might be necessary to run back to the Niagara River, but if they could get past Charlotte they would have a pretty good lee near the south shore. The width of the lake opposite Oak Orchard is 40 miles, the distance a steamer would have to run in seeking the lee of the opposite shore.

The approach to Oak Orchard is exposed, because it is on a straight stretch of shore, which is the most northerly part of the southerly shore of the lake.

Thirty-two miles east from Oak Orchard is the port of Charlotte, at the mouth of the Genesee River. It is easy of approach in the prevalent northwesterly and westerly gales, because in a bight of the shore and under the lee of and 6 miles southeasterly from Braddock Point. Masters of vessels express the opinion that if deepened to admit vessels of the greatest draft on the lake, the harbor of Charlotte would make an excellent harbor of refuge. It is the most westerly of the ports of any importance on the American shore of the lake, and its situation is advantageous, both because it is easy and safe to approach and because it is about midway between the Welland Canal and the lower end of Lake Ontario. Its tonnage in 1895, was 82 per cent of the tonnage of Oswego, and for 4½ miles above the piers the river has a deep channel twice as wide as the channel of Oak Orchard Creek, which, from all the foregoing, seems to be of importance neither for its commerce nor as a harbor of refuge.

Very respectfully, your obedient servant,

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. WILLIAM PIERSON JUDSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., December 5, 1896.

SIR: I have the honor to report as follows upon the results of the survey of Oak Orchard Harbor, New York, called for in river and harbor bill of June 3, 1896:

The survey was made September 23-26, 1896.

The harbor is at the mouth of Oak Orchard Creek, which enters Lake Ontario about 30 miles west of Charlotte Harbor (at the mouth of the Genesee) and 45 miles east of the mouth of the Niagara River.

Its improvement was begun in 1836, and the value of the place as a harbor of refuge has been stated, in the various reports since that date, to be the main reason for continuing it.

For a record of the early operations which form the basis of the present works, reference is made to a history, prepared by the writer, which was published in the Annual Reports of the Chief of Engineers for 1874 and 1876.

The present works consist of nearly parallel piers, 194 feet apart at the inner ends and 186 feet apart at the outer ends, extending northward about 1,300 feet into the lake to the 9¼-foot curve.

This and all other depths mentioned in this report, and upon the map of the survey accompanying it, refer to the plane of zero of the United States standard gauge at Oswego, which was established in 1838 with its zero at the extreme low-water plane of 1819. This has since been extreme low-water level of Lake Ontario, except in 1895 and 1896. It is 2.27 feet below the mean level for 1860 to 1895. These piers consist of timber crib work, filled with loose stone and sunk upon the natural bottom. The space between the piers has been excavated to an average depth of 11.55 feet below zero, the last excavation being made in 1891. But this work has been limited to the space between the piers, and no excavation has been made in the lake outside, where the governing depth is 2 feet less. To utilize the depth made between the piers would have required the extension of the rock excavation 200 feet out into the lake; but this has not been done, and the useful depth of the harbor is therefore limited by the governing depth existing just outside the line of the pierheads, on which the average depths are 9.4 feet to the surface of the loose material and 9.7 feet to the surface of the rock.

The present survey was made with borings as well as soundings at every needful point, in order to determine separately the quantities of rock and of overlying loose material which must be removed to give 15 feet depth below zero of gauge from the lake into the deep creek channel within the harbor. The rock at this place is a peculiarly soft red sandstone (locally known as "redhorse"), which a powerful dredge can excavate without blasting. Outside the piers the material is either clear rock or rock covered by fragments of stones.

Between the piers the rock exists at an average depth of 11.55 feet, but covered by a deposit of sand, clay, gravel, and mud of an average thickness of 2¼ feet. There is also a pile of broken rock lying midway between the inner ends of the piers, on which there is only 7.8 feet depth, and which is said to have been struck several times by vessels.

Inside the inner ends of the piers no rock exists, and the material to be removed is all of mud, clay, and sand.

From the basin just within the piers the channel is sheltered by high wooded banks and has a navigable width and a depth of over 12 feet for about 2 miles upstream to the place called Two Bridges, where the stream divides into two equal branches, and where there is a grain storehouse, which was used (before the railroad was built a mile farther south) for the shipment of the crops from the surrounding region. The published lake survey chart shows a figure "3" as being the channel depth just within the mouth of the creek, at a point where the writer sounded 20 feet depth in 1870 and again in 1896.

To make a cut 150 feet wide (keeping about 20 feet off each pier) the various quantities of excavation and their estimated costs are as follows:

Estimate.

1. Outside the pierheads for a length of 800 feet and width of 150 feet, 12,000 cubic yards of soft sandstone, rock, and stone, at 80 cents		$9,600
2. Between the piers, 1,300 feet long and 150 feet wide, overlying loose material, 18,400 cubic yards, at 15 cents	$2,760	
Soft sandstone rock, 22,040 cubic yards, at 80 cents	17,632	
		20,392
3. South of inner end of west pier, 500 feet long and 150 feet wide, mud and sand, 18,000 cubic yards, at 10 cents		1,800
		31,792
Contingencies and supervision, about 20 per cent		6,208
Total		38,000

Since 1892 the harbor has been dreaded by sailors because of the existence in the lake off the harbor of an unlocated shoal, upon which the burning schooner *Pomeroy* was grounded in 1892 and on which she lay for a month or more. Special pains were taken to find and identify this shoal, which was variously described as being far out in the lake, but which was finally determined to be as shown on the map herewith.* Search was made with a sweep, and a shoal with 9.8 feet depth was found, and upon this boats were anchored. A man who was employed as watchman on the wrecked vessel, and who spent most of the time on her while she was on the shoal, was then called upon, and he satisfied himself by ranges that the boats were in the position formerly occupied by the wreck.

The place is 800 feet out from the west pierhead and 100 feet west of its line prolonged. The usefulness of the harbor would be much increased if this dangerous shoal were marked by a buoy.

On the piers there are three points at which there is urgent need of immediate repairs to prevent serious injury. The northeast corner of the west pier and the northwest corner of the east pier are each broken and opened below water, and each needs a steel plate extending 2 feet around the angle on each face and 14 feet from the bottom upward.

Near the inner end of the west pier, 227 feet to 340 feet northward from the inner angle, at about the junction of the pier with the beach line, the pier has been undermined on the channel face, the stone filling has gone out, the pier has settled 4½ feet toward the channel, and the work is likely to be breached by a severe storm. If breached, the sand from the west beach will quickly form a bar clear across the channel and close the harbor. The cost of repairing these defects is estimated at $1,000.

The commerce of the harbor for the calendar year 1895 (as reported to me by the light-house keeper with the agreement of the deputy collector of customs of the port) was as follows: Eleven steamers, of a total tonnage of 2,785 registered tons; 25 sailing vessels, of a total tonnage of 507 registered tons; for refuge, 3 sailing vessels, of a total tonnage of 150 registered tons; the steamers carrying passengers and the sailing craft bringing posts, shingles, and lumber for the supply of a radius of 10 to 12 miles.

There is no apparent reason to expect any material increase in the local traffic unless a company (which was organized for the purpose in 1894) should build a projected railroad from the Pennsylvania coal regions to Oak Orchard Harbor. The main reason advanced by the advocates of an improvement to 15 feet depth is the general need of the passing lake commerce for a harbor of refuge here, where it would be used by vessels and tows which are now obliged to run back to Charlotte or to the Niagara River.

Respectfully submitted.

WM. PIERSON JUDSON,
Assistant Engineer.

Maj. W. S. STANTON,
Corps of Engineers, U. S. A.

N N 19.

SURVEY OF MISSISQUOI RIVER, VERMONT, FROM SWANTON TO LAKE CHAMPLAIN.

[Printed in House Doc. No. 253, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 30, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated January 23, 1897, with map in three sheets,† by Maj. W. S. Stanton, Corps of Engineers, of the results of a survey of Missisquoi River, Vermont, from Swanton to Lake Champlain, made to comply with the provisions of the river and harbor act of June 3, 1896.

It is estimated that to excavate to a depth of 4 feet from Swanton to the lake, via the middle mouth of the Missisquoi, would cost $43,000;

*Not printed.

†Not reprinted. Printed in House Doc. No. 253, Fifty-fourth Congress, second session.

a 5-foot depth would cost $78,000, and a 6-foot depth $122,000. Considerable expenditure in periodic dredging would be required to maintain the improvement.

Major Stanton states that a channel depth less than 5 or 6 feet would serve only a minor navigation and would not give Swanton the benefit of uninterrupted navigation by the Missisquoi, via the Hudson and St. Lawrence rivers, for heavy traffic in bulk.

The middle and eastern mouths of the river can be entered only from Canadian water, and it appears that dredging through the bar at the outlet of the middle mouth would extend a few feet into Canadian territory. The western mouth could be entered without traversing Canadian water, but the improvement of this mouth would increase the estimated cost of the work to $45,586, $82,253, and $127,739 for depths of 4, 5, and 6 feet, respectively.

In transmitting the report to this office Major Stanton expressed the opinion that the cost of the proposed improvement, together with that of maintenance, would be greater than is justified by the interests of commerce involved. The division engineer, Col. John M. Wilson, Corps of Engineers, concurred in this opinion.

Very respectfully, your obedient servant,

A. MACKENZIE,
Acting Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. S. STANTON, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., January 23, 1897.

GENERAL: I have the honor to submit the following report of a survey of "Missisquoi River, Swanton to lake," Vermont, with an estimate of the cost of improvement, made in compliance with a requirement of section 9 of the river and harbor act of June 3, and of letter from your office of September 5, 1896.

Preliminary to the survey I examined the river from Swanton to its mouth in Lake Champlain, accompanied by Mr. F. M. Barstow, assistant engineer, by whom the survey was made October 6 to 19, 1896, and whose report of January 5, 1897, with estimate and plat of the survey (in three sheets), is herewith transmitted.

Mr. Barstow reports that from Swanton to the lake the river is 8 miles long; that its width is 200 to 650 and averages about 450 feet; that its bed, excepting considerable slate rock in the first mile and a half below Swanton, is of fine sand, of which are formed shoals of great length, upon which the depth in several places is only a few inches, but varies generally between 2 and 4 feet, the pools between the shoals being 6 to 12 feet deep; that shoals of this fine sand, upon which the average depth of water is about 18 inches, extend about 1,700 feet into the lake beyond the mouth of the river; that below Swanton the water is slack, the water level of the lake extending to Swanton, where the river flows over a ledge of rocks, where the slope of its bed commences, and where there is a dam across it providing water power for manufactories.

Below Swanton the river, then, is in character an estuary, where are deposited in slack water the large volumes of sand which Mr. Barstow reports are brought down by the current from the sandy soil drained by the river above. The delta mouth is an indication of the extent to which the material borne down by this river and through the estuary in freshets has obstructed its outlet into the lake, the flow obstructed by the deposit in front of the original single mouth seeking less obstructed courses and forming the other mouths.

The length of excavation necessary to obtain the depth of 4 feet at low water in Lake Champlain (when the surface is at zero on the gauges at Burlington and Rouse Point) up to Swanton is about 3.7 miles in sand and 1,800 feet in rock, making a little more than 4 miles; to obtain 5 feet it is 4.6 miles in sand and 2,600 feet in rock, making a little more than 5 miles; and to obtain 6 feet it is 5.4 miles in sand and 3,900 feet in rock, making fully 6 miles the total lengths of excavation to obtain 4, 5, and 6 feet being respectively about 50, 62, and 75 per cent of the whole distance from Swanton to the mouth.

Estimating the cost of dredging the sand at 20 cents per cubic yard, of rock excavation at $5 per cubic yard for the thinnest cutting to obtain a depth of 4 feet, and at $4.50 and $4 per cubic yard, respectively, to obtain 5 and 6 feet; assuming the width of cut in rock to be 40 feet for all three depths; assuming the width of dredging in sand to be 60 feet for a depth of 4 feet and 70 feet for the depths of 5 and 6 feet in the river, and 100 feet for all three depths on the bar in the lake, the estimated cost, including an allowance of only 10 per cent for supervision, inspection, office expenses, and contingencies, is:

To obtain a depth of 4 feet	$43,000
To obtain a depth of 5 feet	78,000
To obtain a depth of 6 feet	122,000

In addition to the first cost, the improvement should be expected to entail for maintenance considerable expenditure for redredging periodically to remove from so long a cut in the river, sand deposited in it by freshets, and from the long cut through the bar in advance of the mouth not only the deposit by freshets, but the sand which would be drifted into it by waves in the lake.

The two waterways communicating with Lake Champlain are through the Champlain Canal, 65 miles long, to the Hudson, and through the Chambly Canal to the Richelieu and St. Lawrence rivers. The controlling depth in the Champlain Canal is now 4½ feet; 28 miles of it have been deepened to 6 feet, and the State has sanctioned a project to deepen it to 7 feet. In the Chambly Canal the depth over the lock sills is 7 feet. The lake is closed by ice usually from about December 1 to about May 1. Of the other seven months it is at its low stage about three months, from about the middle of July to about the middle of October, during which period the depth up to Swanton would be only that obtained and maintained at the above cost. A less depth than 5 or 6 feet would serve only a minor navigation by pleasure or passenger boats and other small craft engaged in local traffic, and would not give Swanton the benefit of uninterrupted navigation by the Missisquoi through, from, and to the Hudson and the St. Lawrence for heavy traffic in bulk.

Swanton is reported to have about 3,500 inhabitants, a marble mill, grain elevator, grist, saw, and planing mills, and some minor plant, and to ship and receive by rail annually about 87,000 tons of freight. It is on two lines of railroad, and at Swanton Harbor, in Maquam Bay, Lake Champlain, 2 miles from the village, $70,500 have been expended under a project for the construction of a breakwater, regarding which the latest report is on pages 2455 to 2458 of the Annual Report of the Chief of Engineers for 1889.

The Missisquoi River flows into that part of Lake Champlain named Missisquoi Bay, and so near the northern boundary of the United States that the middle and easterly mouths can be entered only from Canadian water. The estimates which have been given are the cost of improvement if the middle mouth be adopted, and it appears on the United States Coast Survey chart No. 1 of Lake Champlain that the dredging through the bar would extend a few feet into Canadian territory. The westerly mouth could be entered without going into Canadian water, but improvement by that mouth would cost $2,586, $4,253, and $5,739 more to obtain 4, 5, and 6 feet, amounting, respectively, to $45,586, $82,253, and $127,739.

Respectfully submitted.

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. F. M. BARSTOW, ASSISTANT ENGINEER.

BURLINGTON, VT., *January 5, 1897.*

SIR: I have the honor to submit the following report on the survey of the Missisquoi River, Vermont, from Swanton to Missisquoi Bay, Lake Champlain:

The Missisquoi River rises in Lowell, Vt. Pursuing a northerly course it crosses the north line of the State into Canada, where it receives a large stream from the northeast. After running several miles in Canada it returns into Vermont about 1 mile west from the northeast corner of Richford; thence it flows southwesterly through the corner of Berkshire, where it receives the Trout River, into Enosburg; thence westerly through Sheldon into Highgate; then bends southerly into Swanton, and after taking a circuit of several miles in this town returns into Highgate, and running northwesterly flows by three distinct mouths into Missisquoi Bay, Lake Champlain, near the international boundary line. Besides those mentioned above, Black Creek and Taylors Branch are its most considerable tributaries. It has no tributaries between Swanton and the lake, not even a brook.

The length of this river is about 75 miles, and it receives the waters of about 600 square miles in Vermont and probably of about 150 square miles in Canada. There are several falls and rapids in the stream above Swanton, but the river is generally wide and shallow, with moderate current. From Swanton to the lake it is slack water, and if a channel were dredged the lake would set back to Swanton, filling the channel at all times.

At Swanton, 8 miles from its mouth, the river flows over a ledge of rocks on which a water-power dam is built, making a complete interruption to navigation. Below Swanton the river flows for about 1¼ miles between bluff banks nearly 25 feet high. At this point the banks drop to from 4 to 8 feet above low water, and are overflowed during the spring floods. The banks do not appear very stable, being sand and sand loam. Above Swanton for several miles the river flows through a light sand soil, which is continually being brought down and deposited in the slack water below Swanton.

I am told, in time of flood, that if a pail of water is caught at the dam there will be an inch of sand in the bottom after settlement. The Swanton Marble Company use about 6,000 cubic yards of sand annually in sawing marble, which also is at present allowed to run into the river, after serving its purpose.

The bed of the river, where not rock, is composed of fine sand, which shifts about during every flood. This must be so, as I found an almost continuous shoal for 3 miles where there were only a few short shoals one year ago. (Report of Capt. Smith S. Leach, Corps of Engineers, 1895. Report Chief of Engineers for 1895, part 5, page 3243.) The bar at the mouth is also composed of fine sand, which changes its position during river floods and also during severe gales on the lake. Several places were pointed out to me by seine fishermen where the channel used to be through the bar.

For the first mile and a half below Swanton considerable slate rock was encountered that will require blasting to remove it. No rock was encountered elsewhere with a steel bar that was forced by hand to 9 feet below low water.

From Swanton to the delta the river is usually wide and shallow, its least width being 200 feet, increasing to a maximum width of 650 feet, its approximate average width being about 450 feet. The present prevailing depth is from 2 to 4 feet. This prevailing depth is interrupted in several places, both by shoals with only 2 or 3 inches of water on them and by deeper pools with from 6 to 12 feet of water. The bar at the mouth extends 1,700 feet into the lake, the average depth of water on it being about 1½ feet. In places, however, it is 1½ feet above low-water line.

In its present condition there can be practically no navigation of the river, as it is usually closed by ice from December 1 to May 1, and by low water from the middle of July to the middle of October. It is usually possible to use the river for vessels of 4½ feet draft for a short time during May and June of seasons of extremely high water, and it is now so used during these months to a small extent by sail vessels that bring a few loads of Isle La Motte limestone to the Swanton marble mill. These vessels are of 6 feet draft, but load light for this especial trip. The entire navigation of the river is now confined to these few loads of stones during two months of the year and to a few small light-draft naphtha pleasure yachts.

If a navigable channel were provided and maintained, it might be utilized by the lake sail and canal boats, usually of about 6 feet draft, to bring in coal, lumber, grain, and limestone, and to take out rough and manufactured marble.

To provide a channel of least depth of 4 feet at low-water stage from the foot of the rapids at Swanton to deep water in the lake would require the blasting and removing of slate rock in four places, aggregating 1,800 linear feet, and dredging through 3.7 miles of sand in eleven localities. A channel 5 feet deep would require the removing of slate rock for 2,600 feet in four places and dredging through 4.6 miles of sand in ten places. A channel 6 feet deep would require the removing of slate rock for 3,900 feet in five places, and dredging through 5.4 miles of sand in eleven places.

Any channel of a less depth than 6 feet at low-water stage would seem to be of no commercial importance, as the Champlain Canal will soon be deepened to this depth by the State of New York.

If any improvement of this river is undertaken, the marble company should not be allowed to annually place 6,000 cubic yards of sand in the river, and also the opening in the drawbridge of the Vermont Central Railroad Bridge over Missisquoi Bay should be enlarged so as to admit any boat navigating the waters of Lake Champlain.

It is believed that any channel dredged through this shifting sand would not be permanent, and that it would be necessary to send a dredge here after every river flood, even if it was not found necessary to have one on the bar all the time, in order to keep the channel open for navigation. A system of dikes some 8 miles long might serve to keep this channel open, but the great expense of these dikes when compared with the commerce to be benefited, and its entirely local character, would seem to make this idea so absurd that no estimate of their cost is submitted.

The entire commerce of this river would be furnished by Swanton, which is a prosperous village of some 3,500 inhabitants. Its manufacturing interests, now running, include a marble mill, grain elevator, grist, saw, and planing mills, and other minor plants.

Swanton would appear to already have good facilities for freight transportation, as it is situated at the junction of the Central Vermont and Boston and Maine railroads, which are in a great measure competing lines. It is also only 2 miles by either the highway or by the Boston and Maine Railroad from Swanton Harbor (locally called Maquam) on Lake Champlain, from which place there is a daily passenger and freight boat to Plattsburg and other lake ports.

Swanton is a good, safe harbor, with 9 feet of water at low-water stage, the General Government having already expended $70,500 for a breakwater there.

The commercial statistics were obtained from Mr. T. M. Tobin, secretary of the Swanton Board of Trade, who reports that 3,100 carloads of general merchandise, lumber, coal, and grain were received, and that 3,600 carloads of rough marble, manufactured marble, lime, manufactured lumber, hay and other farm products were shipped at Swanton during the past year.

Swanton is in the collection district of Burlington. The nearest light-house is at the north end of Isle La Motte, and the nearest defensive work is at Rouse Point, New York.

In the following estimates for a 4, 5, and 6 foot channel, and the turning basin at Swanton, the rock is estimated in place for a channel 40 feet wide.

The sand is estimated for a rectangular prism 60 feet wide and a 4-foot channel, and 70 feet wide for a 5 and 6 foot channel in the river, and 100 feet wide across the bar for all depths. It is thought that after the side slopes have formed themselves in the sand that a navigable channel 40 feet wide would be obtained.

The estimates are figured for a depth 6 inches greater than the depth of water intended to be obtained, and 15 per cent has been added to the measurements in place to allow for scow measurement. All dredged material is to be loaded into scows and dumped in the two branches at the mouth not intended to be used for navigation, so as to force all the water through the middle branch, which seems to be the most feasible for navigation.

ESTIMATES.

Channel 4 feet deep:	
1,926 cubic yards of rock, at $5 per cubic yard	$9,630.00
146,305 cubic yards of sand, at 20 cents per cubic yard	29,261.00
Contingencies	4,000.00
Total	42,891.00
Channel 5 feet deep:	
5,065 cubic yards of rock, at $4.50 per cubic yard	22,792.50
246,569 cubic yards of sand, at 20 cents per cubic yard	49,313.80
Contingencies	6,000.00
Total	78,106.30
Channel 6 feet deep:	
9,750 cubic yards of rock, at $4 per cubic yard	39,000.00
366,870 cubic yards of sand, at 20 cents per cubic yard	73,374.00
Contingencies	10,000.00
Total	122,374.00

Very respectfully submitted.

F. M. BARSTOW, *Assistant Engineer.*

Maj. W. S. STANTON,
Corps of Engineers.

N N 20.

REPORT UPON HOUSE BILL 8074, FIFTY-FOURTH CONGRESS, FIRST SESSION, PROVIDING FOR WIDENING THE LOCKS IN THE OSWEGO CANAL, IN THE STATE OF NEW YORK.

[Printed in House Doc. No. 231, Fifty-fourth Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., October 19, 1896.

GENERAL: A copy of House bill 8074, Fifty-fourth Congress, first session, designing "to widen the locks in the Oswego Canal, State of New York, in order to permit the passage of modern torpedo boats and other vessels of war of similar dimensions," was received with letter of May 14, 1896, from your office, requiring me to report "prior to December 1 next on the practicability and cost of the proposed enterprise."

The Oswego Canal joins the Erie Canal at Syracuse and connects it with Lake Ontario through the mouth of the Oswego River at Oswego, N. Y. The canal is 38 miles long from Syracuse to its terminus in the Oswego River, 3,200 feet from the lake. Five sections, having a total length of 18 miles, are canalized stretches of the Seneca and Oswego rivers, and the other 20 miles are canal trunk in excavation or embankment.

The rise from the lake to Syracuse is 155 feet, and is accomplished by 17 locks having an average lift of a little more than 9 feet. There are also 5 guard locks, making 22 in all, locks and guard locks.

Their width is 18 feet, their depth 7 feet; they were all built 110 feet long, and the length of 8 locks and of 3 guard locks has been increased to 221 feet.

The foregoing information is from the published official reports of the State engineer and surveyor of the State of New York for 1890 and 1894. In a letter of August 26, 1896, from the State engineer's office, the deputy State engineer says: "The lengthening of all the unlengthened locks on the Oswego Canal is contemplated by us in the improvement authorized by chapter 79, laws of 1895. We hope to have all the work authorized by this law completed during our term, which expires January 1, 1899."

The State has authorized the depth of the locks to be increased to 9 feet, which increase in depth, it is understood, will soon be commenced.

The Bureau of Construction, Navy Department, has informed me, by letter of August 20, 1896, that "the dimensions of the largest torpedo boats now under construction are—length, 175 feet; extreme breadth, 17 feet; maximum draft, 6 feet 6½ inches." It is also stated by the Board of Construction, Navy Department, by indorsement of September 21, 1896, "that the Navy has no other vessels of war of similar dimensions."

Some of the canal boats which have been long navigating the Oswego Canal are 17 feet 10 inches wide. As they freely pass through its locks, and are 10 inches wider than the largest torpedo boats now under construction, and as the Navy has no other vessels of war of similar dimensions, I have the honor to report that "to widen the locks of the Oswego Canal, State of New York, in order to permit the passage of modern torpedo boats and other vessels of war of similar dimensions" no expenditure is necessary.

Very respectfully, your obedient servant,

W. S. STANTON,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

APPENDIX O O.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

REPORT OF COL. CHAS. R. SUTER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 20, 1897.

GENERAL: I have the honor to submit herewith my annual report on the river and harbor works in my charge.

Very respectfully, your obedient servant,

CHAS. R. SUTER,
Colonel of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

This harbor consists of the estuary of San Antonio. Before improvement the low-water depth at the entrance was only 2 feet, admitting at high tide vessels drawing from 6 to 8 feet. The original project for improvement contemplated two half-tide jetties at the entrance, dredging in the harbor proper, the excavation of a tidal basin at the inner end, cutting a canal from this basin to San Leandro Bay, and the construction of a dam and tide gate across the entrance to this latter bay, so as to divert the flow of the ebb tide to the canal and out through Oakland Harbor. It was expected that this increased tidal flow would accomplish most of the deepening required. Subsequent modifications of the project authorized were to raise the jetties to high tide and to increase the width of the canal from 300 to 400 feet. In the work so far carried out the jetties have been completed, the tidal canal has been begun at both ends, but not completed, the tidal basin has been dredged to a depth of 3 feet below low water, a channel 200 feet wide and 8 feet deep has been dredged on the north side of this basin, along the East Oakland front, and a channel 300 feet wide has been dredged from the Webster Street Bridge to the end of the jetties. This channel varies in depth, there being at low tide 14 feet through the jetties and 20 feet above, except for a distance of 1,800 feet, where only 18 feet has as yet been obtained. At high tide vessels drawing 19 feet can enter the harbor and pass up to the Oakland wharves. With the exception of a shoaling of about 21 inches in the East Oakland channel the depths obtained have maintained themselves very well. A further extension in length of the south jetty, amounting to 550 feet, has been thought necessary. The dredging has been done with a hydraulic dredge, the material being pumped ashore and used in reclaiming the marshy shores of the estuary.

The river and harbor act of June 3, 1896, appropriated $20,000 for continuing the improvement of this harbor, with the further proviso that contracts could be entered into for the completion of the work to the extent of $666,000, in addition to the amounts already appropriated.

In his annual report for 1895, Colonel Mendell placed the amount needed to complete the authorized work at $741,000. He subsequently, however, caused a revised estimate to be made, which placed the cost of completion at $1,065,968.

The amount authorized by the act of June 3, 1896, viz, $686,000, was therefore manifestly inadequate to carry out the approved project in its entirety. Having become convinced, from the manner in which the dredged channels have maintained themselves, that the projected canal to San Leandro Bay was entirely unnecessary to the object proposed, viz, the improvement of Oakland Harbor, I submitted on July 8 a revised project, in which this item of expense, some $512,000, was left out, and the cost of all the work deemed necessary was brought within the limit of the sum authorized by Congress. On January 2, 1897, I was notified that work under this revised project could go on, but on February 5 this authority was countermanded by telegraph, and I was subsequently informed that it was not deemed possible under the wording of the law to undertake the completion of any but the original project. As the sum allowed by Congress for this purpose was inadequate, nothing could be done without further legislative action.

In consequence of this decision no work has been done on the improvement during the year beyond renewing the flooring of the Park Street Bridge over the tidal canal, which had become worn out and dangerous.

The sundry civil act of June 4, 1897, appropriates $200,000 for continuing the improvement of Oakland Harbor, and at the same time modifies the act of June 3, 1896, so as to allow this improvement to go on under the existing project, but without reference to its completion, to the extent of $686,000, and authorizes continuing contracts, which, however, must not obligate the Government in advance of appropriations for a larger expenditure in any one year than 25 per cent of the total amount authorized to be expended viz, $686,000.

As soon as a project for this expenditure can be submitted and approved, contracts for carrying on the work will be let.

CONDITION OF THE WORK.

A survey of the harbor has just been completed and shows that there has been no change in the dredged channels during the year except a shoaling of about 3 inches in what is known as the Brooklyn Channel along the north side of the tidal basin. This is somewhat less than the rate in previous years. Everywhere else the full depths have been maintained. The Brooklyn Channel alluded to has shoaled to the extent of 21 inches since 1893, and of this 18 inches had accrued prior to 1896. Between the end of this dredged channel and the bridges across the estuary, a distance of 6,000 feet, no work has ever been done, but the natural depths remain unchanged.

Below the bridges occurs the first division of the dredged channel, 20 feet deep and 300 feet wide, followed by 1,800 feet of dredged channel 18 feet deep and 300 feet wide. These artificial channels were completed in 1895; they are now twenty-eight months old and have remained unchanged. Next comes the second division of the 20-foot channel, also 300 feet wide and 6,000 feet long. This was dredged in 1895 and is now eighteen months old. No change has occurred there either. The jetty channel proper was dredged to a depth of 14 feet only. It was finished in 1890 and is, therefore, over seven years old, but the depth artificially obtained remains unchanged. The bar in front of the jetties was originally dredged to the same depth, viz, 14 feet, but between 1892 to 1894 a shoaling took place to the extent of 1 foot, and this depth of 13 feet has remained constant ever since. It was to extend the action of the jetties farther into the bay, so as to remove this tendency to shoal, that an extension of the south jetty has been thought advisable.

It will thus be seen that from the bridges to the end of the jetties the artificial channels have remained entirely unaltered, and there is no reason to anticipate any change in this respect. Underlying the entire harbor, the line of the tidal canal, and out to the present ends of the jetties is a layer of hardpan nearly as solid as rock. Almost all the dredging has been done in this material, and the bottom of the deep channel lies in it throughout. As no stream flows into the estuary, there is but little chance for deposit, and such material as may come in is readily swept out by the ebb tide. The tidal flow, as at present provided, is ample for all requirements, and the canal to San Leandro Bay, which, with its accessory works, was intended to increase the tidal prism, is now seen to be totally unnecessary. It is proper to state here, however, that the principal object of this canal as defined in the original project was to scour out the harbor and the channel between the jetties, thereby saving expensive dredging. It was supposed, on the authority of numerous borings, that the bottom was mainly composed of loose sand and mud, which would readily yield to a strong flow of water. Instead of this it has been found to be almost as solid as rock, and the hardest kind of dredging has been required to open channels through it.

When the 20-foot channel reaches the deep water of the bay all the tidal movements will be much facilitated, and I have no doubt as to the permanence of the channel thus obtained. So far as concerns shoaling in the tidal basin this is inevitable and can never be prevented. All loose material gathered up by the flood tide is swept into this wide, shallow area and dropped there. If the canal were cut through and the water of San Leandro Bay diverted in this direction, this action would probably be increased instead of diminished, as deposit would be received on the ebb as well as on the flood tide. A sediment-bearing current can not pass from a contracted section to a much larger one without dropping some portion of its load. Hence dredging will always be needed here, but judging from past experience it will be only at considerable intervals of time. To make these as long as possible I think that the basin should be dredged to a greater depth than at present and a channel should be opened entirely round it. This dredging would be mainly in soft mud and comparatively inexpensive.

As stated in the last annual report, the Secretary of War has ordered the reconstruction of the drawbridges across the harbor, which are located at the foot of Alice and Webster streets. The order directs that the draws shall give at least 150 feet clear opening, and shall be turned by other than hand power. As it was deemed very desirable to reduce the number of these bridges if possible, the Secretary of War extended the time of completion in order to give an opportunity for the various interests concerned to get together and decide on some plan which would enable one bridge to carry the whole traffic. This hope, however, has not been realized, and the Southern Pacific Railroad Company have secured approval for a bridge to be used only for railroad traffic, and which is located at the foot of Harrison street. No action has yet been taken by the owners of the Webster Street Bridge.

OPERATIONS FOR THE COMING SEASON.

Contracts will probably be let for carrying on the work to the extent now authorized by Congress.

Money statement.

July 1, 1896, balance unexpended	$32, 431. 06
Amount appropriated by sundry civil act approved June 4, 1897	200, 000. 00
	232, 431. 06
June 30, 1897, amount expended during fiscal year	4, 280. 28
July 1, 1897, balance unexpended	228, 150. 78
July 1, 1897, outstanding liabilities	925. 00
July 1, 1897, balance available	227, 225. 78
Amount (estimated) required for completion of existing project	521, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1899	171, 500. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

List of appropriations.

June 23, 1874	$100, 000	August 5, 1886	$60, 000
March 3, 1875	100, 000	August 11, 1888	350, 000
August 4, 1876	75, 000	September 19, 1890	250, 000
June 18, 1878	80, 000	July 13, 1892	150, 000
March 3, 1879	60, 000	August 18, 1894	100, 000
June 14, 1880	60, 000	June 3, 1896	20, 000
March 3, 1881	60, 000	June 4, 1897	200, 000
August 2, 1882	200, 000		
July 5, 1884	139, 600	Total	2, 004, 600

The total amount expended is $1,776,449.22.

COMMERCIAL STATISTICS.

The following is a tabulated statement showing increase in traffic by vessels and steamers passing through the channel way between the jetties during past calendar years:

Year.	Traffic by ferries.				Traffic by vessels.		
	Number.	Trips.	Passengers.	Freight.	Number.	Register.	Freight.
				Tons.		*Tons.*	*Tons.*
1874	1	600	None.	60, 000	1, 415	70, 750	94, 300
1878	3	5, 400	216, 240	129, 000	1, 085	109, 125	211, 627
1881	3	8, 800	858, 352	1, 051, 788	1, 129	129, 714	173, 448
1882	3	9, 400	892, 210	1, 150. 379	1, 004	144, 004	257, 614
1883	3	8, 000	974. 901	1, 142, 918	1, 031	143, 886	215, 829
1884	3	8, 000	1, 553, 769	1, 202, 230	1, 156	163, 553	255, 738
1885	3	6, 000	444, 142	1, 439, 134	1, 326	200, 226	305, 437
1886	3	6, 000	318, 402	1, 487, 924	1, 673	188, 974	264. 050
1887	3	8, 520	210, 428	1, 654, 451	1, 224	130, 913	231, 660
1888	3	8, 520	200, 000	1, 876, 635	1, 384	162, 957	295. 932
1889	3	8, 600	100, 000	1, 755, 247	1, 745	185, 358	338. 123
1890	3	8, 600	100, 000	1, 925, 957	2, 153	213, 971	393. 478
1891	3	8, 600	100, 000	2, 259, 086	2, 310	232, 706	437, 923
1892	3	8, 600	96, 006	2, 202, 170	2, 277	223, 148	443. 011
1893	5	10, 521	506, 125	2, 142. 460	1, 686	195, 090	306, 865
1894	4	9, 561	554, 932	2, 119, 267	1, 741	175, 750	309, 350
1895	4	9, 600	335, 868	2, 188, 908	1, 966	200, 070	349, 788
1896	5	10, 500	249, 343	2, 131, 491	1, 946	208, 155	366, 098

The classified freight, embracing staple articles carried by sailing vessels entering this port during the past year, comprises 366,098 tons, composed as follows:

	Tons.
Wood, coal, and coke	143,600
Grain and flour	16,500
Lumber	78,125
Building materials	68,200
Sundries	59,673
Total	366,098

It is impracticable to classify the freight transported by steam ferries, which last year amounted to 2,131,491 tons, a dropping off of 58,000 tons as compared with previous year's report. This is undoubtedly due to hard times in general, which are prevalent throughout the country.

The following comparative grand totals of general traffic through the jetty channel show important growth in water transportation in the past twenty-two years:

General traffic—	1874 (before improvement).		1896 (after improvement).	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*
By ferries	None.	60,000	249,343	2,131,491
By vessels	None.	94,300	....	366,098
Total	....	154,300	249,343	2,497,589

APPENDIX P P.

IMPROVEMENT OF RIVERS AND HARBORS IN CALIFORNIA SOUTH OF SAN FRANCISCO.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. San Luis Obispo Harbor, California.
2. Wilmington Harbor, California.
3. San Diego Harbor, California.

EXAMINATIONS.

4. Colorado River, Arizona.
5. Suisun Creek, California.

SURVEYS.

6. Alviso Slough, California.
7. Redwood Creek, California.
8. Mare Island Strait, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 3, 1897.

GENERAL: I have the honor to transmit herewith my annual reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

P P 1.

IMPROVEMENT OF SAN LUIS OBISPO HARBOR, CALIFORNIA.

At the commencement of the present fiscal year work was continued under contract with Patrick O'Neil.

The original contract, approved February 5, 1895, called for the delivery of 15,695 tons of stone, the date of completion being October 31, 1895. This date was extended three times, viz, to December 31, 1895, to July 31, 1896, and to November 30, 1896, or an extension of thirteen months in all.

Up to and including the month of September but 2,758.2 tons had been delivered during the present fiscal year, or a total of 10,282.4 in all. As it was evident the contract could not be completed within the specified time, Mr. O'Neil was, by direction of the Engineer Department, notified that his contract was annulled on November 30, 1896.

The river and harbor act of June 3, 1896, appropriated $40,000 for continuing the improvement, but Mr. O'Neil's contract under a former appropriation having been extended to November 30, 1896, nothing was done under the new appropriation until 1897, when on March 20 bids were opened. Six bids were received, ranging from $3.20 to $2.10 per gross ton of rock delivered in place. These bids having been rejected by direction of the Chief of Engineers, the work was readvertised and bids again opened June 12, 1897. Seven bids in all were received, ranging from $2.70 to $1.99 per ton, and on June 21, 1897, the contract was awarded to the lowest bidder, the City Street Improvement Company, of San Francisco, Cal., for $1.99 per ton.

During the fiscal year the breakwater has been extended 190 feet, 40 feet of which has been brought up to high water and 150 feet to mean low water.

The present status of the work is as follows: Total length of breakwater when completed will be 1,981 feet. Of this 1,091 feet, including Whaler Island, has been completed up to grade, 6 feet above high water, 40 feet up to high water, and 150 feet up to mean low water.

Future appropriations will be applied to extending the breakwater.

The total amount expended, including outstanding liabilities, is $122,643.95.

Money statement.

July 1, 1896, balance unexpended	$61,680.55
June 30, 1897, amount expended during fiscal year	9,300.40
July 1, 1897, balance unexpended	52,380.15
July 1, 1897, outstanding liabilities	24.10
July 1, 1897, balance available	52,356.05
Amount (estimated) required for completion of existing project	393,660.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for the work.

August 11, 1888	$25,000
September 19, 1890	40,000
July 13, 1892	30,000
August 17, 1894	40,000
June 3, 1896	40,000
Total	175,000

Abstract of bids for continuing construction of breakwater at San Luis Obispo Harbor, California, called for by advertisement of February 17, 1897, and opened March 20, 1897, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Name and address of bidder.	Price per ton of 2,240 pounds.	Total number of tons.
A. A. Polhamus, San Diego, Cal	$2.68	16,791.04
James Simpson, Eureka, Cal	3.20	14,062.50
William H. Healy, San Francisco, Cal	2.33	19,313.30
Charles Erickson, San Luis Obispo, Cal	2.50	18,000.00
John Ross, San Francisco, Cal	2.10	21,428.57
J. H. Bingham, San Francisco, Cal	2.75	16,363.63

By order of the Chief of Engineers all of the foregoing bids were rejected and the work readvertised.

Abstract of bids for continuing construction of breakwater at San Luis Obispo Harbor, California, called for by advertisement of May 12, 1897, and opened at 11 a. m. June 12, 1897, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Name and address of bidder.	Price per ton of 2,240 pounds.	Total number of tons.
City Street Improvement Co., San Francisco, Cal	$1.99	22,613
Patrick O'Neil, San Francisco, Cal	2.49	18,072
William H. Healy, San Francisco, Cal	2.24	20,089
J. H. Bingham, San Francisco, Cal	2.20	20,455
Albert A. Polhamus, San Diego, Cal	2.04	22,059
Charles Erickson & Co., San Luis Obispo, Cal	2.63	17,110
James Simpson, Eureka, Cal	2.70	16,667

COMMERCIAL STATISTICS.

[Statistics furnished by the Pacific Coast Railway Company.]

	Year the improvement began (1888).		Year ending December 31, 1897.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam	603	603	461	461
Sailing	34	34	6	6
Total	637	637	467	467
Tonnage	452,149.34	452,149.34	432,025	432,025
Draft, greatest ... feet	18		21	21
Merchandise, general ... tons	8,802	5,669	4,926	
Coal ... do	2,985		368	
Lumber ... feet	8,884,400		1,311,800	
Grain ... tons		23,305	144	23,832
Bituminous rock ... do		15,342		4,866
Dairy produce ... do				1,575
Live stock ... do			5	894
Miscellaneous freight ... do			3,694	4,412

	Tons.
Total amount of freight entered and cleared in 1888	68,425
Total amount of freight entered and cleared in 1896	46,535
Decrease	21,890

No new lines of transportation have been established during the year.

P P 2.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

No appropriation had been made for this harbor since 1892 until the river and harbor act of June 3, 1896, which appropriated $50,000 for improving the harbor in accordance with the project submitted February 7, 1895, and authorized the Secretary of War to enter into contracts for such materials and work as might be necessary to complete the project, not to exceed in the aggregate $342,000, exclusive of the $50,000 appropriated, but no such contracts were to be entered into until the Board provided for in the same act to determine the location of a deep-water harbor for commerce and of refuge as between Port Los Angeles, in Santa Monica Bay, and San Pedro had made its report to the Secretary of War, and not at all if such report should be in favor of San Pedro as the location of the harbor.

Owing to the proviso mentioned, no work has been done during the fiscal year ending June 30, 1897.

The total amount expended to June 30, 1897, including outstanding liabilities, is $952,893.43.

Money statement.

July 1, 1896, balance unexpended	$52,867.99
June 30, 1897, amount expended during fiscal year	721.42
July 1, 1897, balance unexpended	52,146.57
July 1, 1897, outstanding liabilities	40.00
July 1, 1897, balance available	52,106.57

Amount and date of all appropriations for the work.

March 3, 1871	$200,000	July 5, 1884	$50,000
June 10, 1872	75,000	August 5, 1886	75,000
March 3, 1873	150,000	August 11, 1888	90,000
March 3, 1875	30,000	September 19, 1890	34,000
June 18, 1878	20,000	July 13, 1892	51,000
March 3, 1879	12,000	June 3, 1896	50,000
June 14, 1880	35,000		
March 3, 1881	33,000	Total	1,005,000
August 2, 1882	100,000		

Commercial statistics for the year the improvement began (1871).

	Incoming.	Outgoing.
Vessels:		
Steam	160	160
Sailing	65	65
Total	225	225
Freight ... tons	25,313	9,575
Lumber ... feet	10,938,336	....

Statistics of commerce for the year ending December 31, 1896.

[Furnished by the collector of customs at Los Angeles, Cal.]

	Foreign commerce (outer harbor).		Domestic commerce.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam	....	....	176	176
Sailing	2	....	138	137
Total	2	....	314	313
Tonnage	82	....	107,611	107,470
Draft, greatest ... feet	10	....	18½	14
Merchandise, general ... tons	6	....	6,904	3,744
Lumber ... feet	....	....	61,432,000	....

There was no revenue collected at the port during the year ending December 31, 1896.

The rates upon freights have been reduced since the first expenditure for the improvement of this harbor from $7.50 to 62½ cents per 1,000 feet on lumber and from $5 to 75 cents per ton on general merchandise from the outer harbor.

	Tons.
Total amount of freight entered and cleared in 1871	50,059
Total amount of freight entered and cleared in 1896	95,888
Increase	45,829

No new lines of transportation were established during the year.

P P 3.

IMPROVEMENT OF SAN DIEGO HARBOR, CALIFORNIA.

The river and harbor act of June 3, 1896, appropriated $50,000 for continuing the improvement of this harbor, and projects for extension of the jetty and repairs of the dike were submitted and approved.

A contract was entered into with Goodbody & Roesner, of San Diego, Cal., November 9, 1896, for repairing the levee or dike across the mouth of the old river to divert its waters into False Bay. The work was to be completed in three months, and was actually completed February 6, 1897, at a cost of $4,217.61, paid the contractor.

For jetty construction a contract was entered into November 12, 1896, with Waldo S. Waterman, of San Diego, Cal., the work to be completed in eight months. Work was completed April 25, 1897, a total of $39,843.37 being paid the contractor, who placed 14,930 gross tons of stone in the jetty, built 637.5 feet of railway trestle, and put down 1,523.9 cubic yards of brush mattress for foundation.

The jetty has now been brought up to high-tide level for a distance of 3,347 feet, and a foundation course of brush and stone laid 645 feet farther, or to a distance of 3,992 feet from shore. The spur and shore revetment are in the same condition as last year. Since the last annual report the jetty has settled in places 6 to 8 inches, but on the whole the work stands well.

No complete survey of the bar has been made since 1887, but recent surveys of the jetty show some changes in the shore line of Coronado Island near the jetty, the east or sea side building out and the west or channel side cutting. On the shoal there has been a scour of from 3 to 12 feet for about 1,000 feet in advance of the jetty, increasing the cross section of the jetty wall and the cost very materially.

A complete survey will be made in the fall, covering the bar, the channel, and the middle ground, so as to note the changes effected by the works.

The total amount expended to June 30, 1897, including outstanding liabilities, is $289,715.10.

Money statement.

July 1, 1896, balance unexpended	$51,976.20
June 30, 1897, amount expended during fiscal year	49,191.30
July 1, 1897, balance unexpended	2,784.90
Amount (estimated) required for completion of existing project	184,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	184,400.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for the work.

March 3, 1875	$80,000
March 3, 1879	1,000
August 11, 1888	1,000
September 19, 1890	60,500
July 13, 1892	50,000
August 17, 1894	$50,000
June 3, 1896	50,000
Total	292,500

Abstract of bids for repairing levee at San Diego Harbor, California, called for by advertisement of September 21, 1896, and opened October 22, 1896, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Name and address of bidder.	Earth filling (2,680 cubic yards).		Cobble stones (400 cubic yards).		Revetment (600 cubic yards).		Total.
	Per cubic yard.	Total.	Per cubic yard.	Total.	Per cubic yard.	Total.	
William Osburn, San Diego, Cal....	$0.23	$616.40	$1.40	$560.00	$3.95	$2,370.00	$3,546.40
Simpson & Pirnie, San Diego, Cal ..	.65	1,742.00	2.10	840.00	5.20	3,120.00	5,702.00
Goodbody & Roesner, San Diego, Cal	.18	482.40	1.45	580.00	3.48	2,088.00	3,150.40
John Engelbret, San Diego, Cal	.38	1,018.40	.71	284.00	4.48	2,688.00	3,990.40
Wm. H. Healy, San Francisco, Cal..	.20	536.00	1.68	672.00	4.28	2,568.00	3,776.00
Cotton Bros. & Co., Oakland, Cal ...	.23	616.40	1.90	760.00	4.80	2,880.00	4,256.40

Abstract of bids for continuing construction of jetty at San Diego Harbor, California, called for by advertisement of September 21, 1896, and opened October 22, 1896, by Maj. Chas. E. L. B. Davis, Corps of Engineers.

Name and address of bidder.	Per linear foot of trestle.							Total cost per linear foot.	Total amount (620 linear feet).
	Trestle work with double railway track.	Repair work (one-seventh of a pile).		Brush mattress (2 cubic yards).		Stone (24 tons).			
	Per linear foot.	Per pile.	Per one-seventh.	Per cubic yard.	Total.	Per ton.	Total.		
Waldo S. Waterman, San Diego, Cal.................	$5.00	$10.00	$1.43	$2.50	$5.00	$2.20	$52.80	$64.23	$39,822.60
California Construction Co., San Francisco, Cal	6.50	10.00	1.43	1.90	3.80	2.35	61.20	68.13	42,240.60
William H. Healy, San Francisco, Cal.................	6.50	12.00	1.72	2.40	4.80	2.28	54.72	67.74	41,998.80
Cotton Bros. & Co., Oakland, Cal.........................	7.40	12.00	1.72	2.98	5.96	2.86	68.64	83.72	51,906.40

Commercial statistics for the year the improvement began.

	Vessels.	Freight.
	Number.	*Tons.*
Entered..	201	24,809
Cleared	195	11,647

The vessels, including 109 steamers, had an aggregate tonnage of 122,311 tons.

Commercial statistics for the year ending December 31, 1896.

[Furnished by collector of customs at San Diego, Cal.]

	Incoming.	Outgoing.
Vessels:		
Steam..	233	233
Sailing..	134	131
Total	367	364
Tonnage..	196,851	194,893
Draft, greatest..feet..	24	24
Merchandise, general...tons..	30,358	12,503
Coal ....do...	46,352	....
Lumber..feet..	14,768,000	....

Amount of revenue collected at the port during the year ending December 31, 1896, $44,466.26.

	Tons.
Total amount of freight entered and cleared in 1876	36,456
Total amount of freight entered and cleared in 1896	109,696
Increase	73,240

No new lines of transportation were established during the year.

P P 4.

PRELIMINARY EXAMINATION OF COLORADO RIVER, ARIZONA.

[Printed in House Doc. No. 118, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying report of September 11, 1896, by Maj. Charles E. L. B. Davis, Corps of Engineers, of the results of a preliminary examination of Colorado River, Arizona, made in compliance with the requirements of the river and harbor act of June 3, 1896.

In the opinion of Major Davis, the Colorado River is not worthy of improvement by the General Government, and this opinion is concurred in by Col. Charles R. Suter, Corps of Engineers, the division engineer, and by me.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 11, 1896.

GENERAL: I have the honor to submit the following report upon the preliminary examination of the Colorado River, Arizona, required by the river and harbor act of June 3, 1896:

The Colorado River has had so many examinations and surveys, commencing in 1857–58 with that of Lieut. J. C. Ives, of the Topographical Engineers, and extending up to the last examination by Lieutenant Potter in 1895, that it is considered that enough information is at hand to make a report without any further field work.

The river and harbor act of June 18, 1878, provided for an examination or survey, or both, of the Colorado River from Yuma to Eldorado. The examination was made by Lieut. A. H. Payson, Corps of Engineers, and his estimate of the cost of removal of obstructions, protection of banks, and contraction of channel was $97,269. This plan was not recommended by Lieutenant-Colonel Stewart, under whose direction the examination was made.

Lieutenant Payson stated in his report that no plan would give any permanent change for the better unless it provided for the entire confinement and control of over 200 miles of river, and that there was at that time no justification for so vast an expenditure as the execution of such a project would entail.

Lieutenant-Colonel Benyaurd, in his report upon this river in 1888, gave his opinion to the effect that there was no likelihood in the immediate future of any such great development of the country as to call for additional transportation facilities commensurate with the probable cost of improvement.

This same officer, reporting again upon this river in 1890, stated that the commerce of the river had been constantly decreasing and there appeared to be no prospect of any change for the better in the near future, and he regarded the Colorado River as not worthy of improvement by the General Government.

The most recent examination of this river was made by Lieut. Charles L. Potter, Corps of Engineers, in the fall of 1895, the report of which was published as House Ex. Doc. No. 101, Fifty-fourth Congress, first session. The river and harbor act of August 17, 1894, calling for this examination, directed it to be made "above Yuma to the highest point of navigation." This point is the mouth of the Virgin River, which Lieutenant Potter made an effort to reach, but failed, and then returned to the Needles, inspecting the river from the latter point to Yuma in a skiff. He concluded, as the result of his examination, that the present steamboat service seemed to be all that was actually required for all points except the mines of Eldorado Canyon above the Needles, but owing to the character of the river, both in the canyons and the flats, he thought the cost of improvement would be so great as to be out of all proportion to any benefit resulting from such improvement, and he considered the river between the mouth of the Virgin River and Yuma unworthy of improvement by the General Government.

As will be seen by the above brief synopsis of conclusions reached by various officers who have examined this river, there is a general consensus of opinion that the cost of any permanent improvement of the river is entirely incommensurate with the amount of commerce to be benefited, and in this opinion I fully concur.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., September 12, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the opinion of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

P P 5.

PRELIMINARY EXAMINATION OF SUISUN CREEK, CALIFORNIA.

[Printed in House Doc. No. 107, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated September 17, 1896, by Maj. Charles E. L. B. Davis, Corps of Engineers, of the results of a preliminary examination of Suisun Creek, California, made in compliance with the requirements of the river and harbor act of June 3, 1896.

Major Davis states that, while not committing himself to the opinion that the creek is worthy of improvement by the General Government, he does think it worthy of further examination to determine whether any improvement within reasonable limits of cost can be made, and estimates the cost of a survey for the purpose at $600.

The views of Major Davis are concurred in by Col. Charles R. Suter, Corps of Engineers, the division engineer, and by me.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 17, 1896.

GENERAL: I have the honor to submit the following report upon the preliminary examination of Suisun Creek, California, called for by the river and harbor act of June 3, 1896.

Suisun Creek is a tidal estuary of Suisun Bay, and is about 18 miles in length from the town of Suisun, at the head of navigation, to its mouth in the bay. It has no fresh-water streams entering it and is consequently not subject to freshets. At ordinary tides the rise is about 6 feet.

The examination was made on September 16, 1896, by means of a naphtha launch, and numerous soundings were taken at various places, both in and out of the channel, to within 4 miles of the mouth in Suisun Bay, about 14 miles from the town of Suisun, and some 2 miles below the point at which the United States Coast and Geodetic Survey chart stops. The examination shows a tolerably wide and deep slough, with several shoal places, generally at bends. The river is navigated by small flat-bottomed sailing vessels of about 80 tons, carrying bulky freight, and drawing about 5 feet of water, which depth can be carried all the way to the docks in the town at high tide, though in front of the town wharves the flats are bare at low tide, and the naphtha launch on her return trip was unable to make a landing. The vessels beat up the creek, and this fact shows that the creek is tolerably wide and deep to enable them to do so, but at some points there are sharp turns, and a sailing vessel under headway is liable to run aground by getting out of the channel, particularly where the latter is narrow, and may have to wait twelve hours for a rising tide to float off. Those interested in improving the stream think they would be satisfied with a practicable navigable depth of 8 feet and that this depth could be secured at slight cost by dredging a few shoal places, widening a few narrow portions of the channel, cutting off one point, and making a cut-off through a bend. Of course, something more than a preliminary examination will be necessary to determine the cost.

The competition of railroads has become so severe that sailing vessels of 80 tons can hardly compete, and the three previous attempts to run steamers on the creek have resulted in failure, the railroad in each case having either bought out the companies or put down the rates from Vacaville and places above to such a point that the steamers could not pay expenses; but the merchants claim that if the creek is improved to an available depth of 8 feet they will run two steamers of their own and will guarantee that the competition of the railroad company will not run their boats out of the business, though it is difficult to see how they can prevent the producer shipping his merchandise over the cheapest route, however shortsighted such a policy may be.

The town has been bonded for $42,000 for the construction of waterworks and the contract has been let for the work. When this work is completed and the supply of water ample for the purpose, it is claimed that a beet sugar factory will be started, some successful experiments in raising the sugar beet having already been made, the analyses of which were shown to me and seemed to be quite promising. It is also claimed that a cannery will be started, and in case an improvement of the creek is made an electric road built to Elmira and Vacaville.

The following statistics were furnished me by Mr. Edward Hilborn, jr.:

From January 1, 1896, to September 1, 1896, the following amounts of freight have been received by water at Suisun:

Lumber	feet..	2,207,802
General merchandise	pounds..	1,500,000

The freight shipments to local markets from Suisun for the season of 1896–97, based on the amounts already shipped and stored in the warehouse, will be—

	Pounds.
By water:	
Grain	20,000,000
Hay	1,200,000
By railroad:	
Grain	240,000
Green fruits	2,000,000
Dried fruits and nuts	5,760,000

The above does not include the amount of green fruit shipped to Eastern markets.

The town council prepared the following statement:

Average amount of freight in pounds transported via Suisun River for points in Solano County during the year 1895.

	Pounds.
For Suisun City and vicinity	24,035,699
For Winters, Capay Valley, and vicinity	2,463,293
For Vacaville, Vaca Valley, and vicinty	4,983,726
For Elmira and vicinity	752,983

Amount of freight and produce that would be transported via Suisun River if said river were dredged to accommodate larger vessels.

	Pounds.
Suisun	26,239,687
Vacaville	25,761,235
Winters	12,059,872
Dixon	34,669,116
Elmira	9,274,361

This report does not include the figures of about 2,000 car-loads of fruit for Eastern markets, and freight that is received into the county from other points that are not directly connected with the river.

These figures being in pounds seem large, but converted into tons the prospective commerce of Suisun Creek would be about 50,000 tons, an amount which seems to warrant further examination.

While not committing myself to the opinion that the creek is worthy of improvement by the General Government, I do think it worthy of further examination to determine whether any improvement within reasonable limits of cost can be made, and respectfully recommend a survey at a cost not to exceed $600.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., September 19, 1896

Respectfully forwarded to the Chief of Engineers, U. S. A., with the views of the district officer concurred in.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

P P 6.

SURVEY OF ALVISO CREEK, CALIFORNIA.

[Printed in House Doc. No. 145, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 24, 1896.

SIR: I have the honor to submit the accompanying copy of letter, dated December 11, 1896, together with copy of report transmitted therewith, by Maj. Charles E. L. B. Davis, Corps of Engineers, upon the results of a survey of Alviso Creek, California, made in compliance with the requirements of the river and harbor act of June 3, 1896.

The plan of improvement presented in the report provides for a channel depth of 7 feet at low tide from beyond the mouth of the creek up to the town of Alviso. As the tide rises from 7 to 11 feet, this would give a navigation of from 14 to 18 feet at high tide. On this basis the approximate quantity of material to be removed is 206,700 cubic yards, and the estimated cost of the work is $47,855, provided appropriations permit the whole or a greater part of the work to be done under one contract, otherwise the ultimate cost would much exceed this estimate.

For reasons given by Major Davis in his letter of transmittal, he does not think that the present commerce of Alviso Creek justifies the expenditure of public funds for its improvement. This opinion is concurred in by Col. Charles R. Suter, Corps of Engineers, the division engineer, and by me.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

LETTER OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 11, 1896.

GENERAL: I have the honor to transmit herewith my report of the survey of Alviso Creek, California, and to state my opinion as to the worthiness of the proposed improvement, and whether the same is justified by the interests of commerce involved, as called for by Department letter of September 5, 1896.

The shores of San Francisco, San Pablo, and Suisun bays are studded with creeks or sloughs, which are tidal estuaries whose lower portions, flowing through marsh land generally flooded at spring tides, are generally wide and deep, but whose upper portions narrow rapidly and are very tortuous, presenting many difficulties to navigation, particularly by sail, owing to the risk of grounding in following the crooks and turns of the slough. It is on these upper narrower portions of the slough that the town, if there is any, is situated, as it is only there that land of sufficient firmness can be found to build upon. At such towns considerable local commerce springs up, and it is only a question of time when an increase of channel depth is found necessary and Congress is petitioned to do the work.

I am of the opinion that Alviso Creek ought not to be improved by the General Government, as it is impossible to improve it within reasonable limits of cost so that commerce would leave its old course to any extent, and the creek will remain simply as at present, the outlet of the Santa Clara Valley region. Its foreign commerce is practically limited to exports of farm produce, which must be brought to tide water by rail in any case, and it would be far cheaper to build the tracks a few miles farther to where the water is deep naturally than to go to the great expense of dredging a channel, which after completion will require a considerable annual expenditure for maintenance.

I do not think the present commerce of Alviso Creek justifies the expenditure of public funds for its improvement.

The river and harbor act of September 19, 1890, required a preliminary examination of this creek, as did also the act of July 13, 1892. Both of these examinations were made by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, and in each instance he reported that in his opinion he did not consider Alviso Creek worthy of improvement by the General Government, and in this opinion I fully concur.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., December 12, 1896.

Respectfully forwarded to the Chief of Engineers, U. S. A.

For the reasons given, I concur in the opinion of the district officer that Alviso Creek is not worthy of improvement by the General Government.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 11, 1896.

GENERAL: I have the honor to submit the following report of a survey of Alviso Creek, California, and the estimated cost of improvement, as called for by the provisions of the river and harbor act of June 3, 1896.

Alviso Creek, or Slough, is situated at the upper end of San Francisco Bay and forms an outlet for a portion of the commerce of the city of San José, distant 9 miles. The village of Alviso, consisting of a few houses and stores and some warehouses and a population of 200, is situated at the head of navigation, 3½ miles from the bay.

The land immediately at Alviso is above tide water, but a short distance below the marsh land commences and extends to the bay, and is overflowed at spring tides.

Alviso is now the receiving point for lumber, coal, and like commodities for San José and Santa Clara, to which places all articles are hauled by teams.

The survey, the chart of which is shown on the accompanying tracing,* covers the creek from its mouth up to the South Pacific Coast Railroad crossing and a portion of the approach channel. The available depth at present in the creek is about 3 feet at low water, but the channel is narrow and crooked and can not be navigated by vessels of much length. The available depth beyond the mouth of the creek is about 7 feet at low tide, and the cost of the improvement has been based on an estimate of carrying this depth to the town of Alviso. As the tide rises from 7 to 11 feet, this would give a navigation of from 14 to 18 feet at high tide. To increase the depth beyond this would greatly increase the amount of dredging, particularly of hard material, and consequently the cost of improvement. The depth decided upon for the

* Not printed.

improvement is also that which the board of trade of San José in a letter addressed to this office thought would be sufficient to meet the demands of commerce.

On this basis the approximate quantity of material to be removed is 206,700 cubic yards, and the estimated cost of its removal $47,855.

The cross section assumed is 7 feet deep at zero of the gauge, with a bottom width of 60 feet, with varying side slopes to suit the character of the material. Along the face of the wharves the channel width has been increased to 80 feet, so as to leave a width of 60 feet past vessels lying alongside these wharves, while a V-shaped area has been estimated for at the head of the old Guadalupe Slough as a turning basin.

A cut-off is proposed at the sharp bend where vessels have had trouble in making the turn. This cut is of 1,000 feet radius which will afford much relief in making the turn.

With regard to the estimated cost of this improvement the unit figures given are ample, provided Congress appropriates enough money to do the whole or the greater part of the work under one contract, but should the amounts be but a small fractional part of the estimated amount the ultimate cost would much exceed the estimates, as has been found to be the case in many similar harbors of this class.

The report of Mr. F. C. Turner, assistant engineer, who conducted this survey, is appended herewith, to which attention is respectfully invited for details.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. F. C. TURNER, ASSISTANT ENGINEER.

SAN FRANCISCO, *December 10, 1896.*

MAJOR: I have the honor to submit the following report upon the survey of Alviso Creek, California:

The survey includes the creek from its mouth up to the crossing of the trestle bridge of the South Pacific Coast Railroad and the approach channel in the bay from the mouth of the creek to Beacon 11. In the upper half of the creek the soundings were taken on lines about 200 feet apart; in the lower creek and bay the sounding lines are at about 300-foot intervals. Only enough soundings to develop the approach channel and its limiting depth in the bay have been platted, the rest being omitted to save time.

Soundings have been reduced to a plane of reference of zero of a tide gauge at the town of Alviso, which is said to have been placed by Mr. Boschke in 1889. As compared with the Coast Survey tide-table predictions, using the tidal constant given for Ravenswood, the gauge appears to be 0.5 foot too low.

The limiting depth in the creek at present is about 3 feet at zero of the tide gauge, but the channel is narrow and crooked and unavailable for vessels of much length. The limiting depth in the bay beyond the mouth of the creek is about 7 feet, and this has been taken as marking the extent to which improvement might be carried, and estimates are made on that basis. As the tide rises from 7 to 11 feet on this gauge, this would give a navigation of from 14 to 18 feet at high tide. To increase the depth beyond this would necessitate dredging in the bay itself, increase the quantities to be removed in the creek above, and would greatly increase the percentage of the hard material. At the depth assumed of 7 feet no work is required in the lower half of the creek except at one small lump about a mile above the entrance.

The estimated quantity of material to be removed to obtain the proposed channel is 206,700 cubic yards.

The assumed cross section has a depth of 7 feet at zero of the gauge, a bottom width of 60 feet, side slopes of 1 on 3 up to 8 feet above the plane of reference, and vertical banks above that to the top of the marsh, which is about 10 feet above zero. The steepest existing slope observed was 1 on 2¼ at a deep hole at the lumber wharf. In the hardpan the sides will stand vertical and, it is thought, would remain stable at 1 on 1; but the softer material on top takes low slopes of from 1 on 4 to 1 on 12, few places being as steep as 1 on 3. The banks for the most part are vertical and from 1 to 3 feet high. Redredging of cuts in this material, even if not filled by detritus brought down from the upland but only from the degradation of the banks, will have to be done some years after they are made; but the assumed section of estimate is thought to approximate fairly close to that of the newly dredged channel, the slopes being steeper below and flatter above, if anything, in nature.

The channel width of 60 feet has been increased to 80 feet along the face of the wharves for a distance of 1,600 feet. This addition is about the width of the vessels likely to tie up here, leaving a 60-foot channel past them. If commerce increases this will have to be widened still farther and a wide, deep basin be built, with a low-water depth of 17 feet, or a depth equal to the high-water depth in the channel, so that deep-draft craft will not ground as the tide falls. It is said that one schooner opened her seams and filled by grounding on the hard bottom as the tide lowered. But no estimate is made for this at present, and it is doubtful if making deep berths at private docks be the province of the General Government. Some provision should be made for turning long vessels around, and an estimate is included for dredging a V-shaped area in the head of the old Guadalupe Slough opposite the town, extending 80 yards beyond the edge of the channel.

A cut-off is proposed at a sharp bend about a third of the way down toward the mouth. At this place are two sharp bends making a reverse curve difficult for vessels of much length to navigate. The lower bend has a radius of curvature in the channel of about 600 feet. The upper bend has a radius of curvature of 300 feet and a total curvature of 124 degrees, and is the bend complained of by shipping men. The cut proposed is on a curve of 1,000 feet radius, and is so placed as to allow of good alignment in case a second cut be made at the lower bend at some future time. At present the dredging at the lower bend is on the side of the existing channel, easing off the curve somewhat without cutting into the high bank very much. To make a cut-off at this and at other slighter bends to cut off the points so as to ease all curves to a radius of 1,000 feet would increase quantities by about 55,000 cubic yards.

No estimates are made for dredging beyond the upper lumber wharf. There are some old wooden warehouses there. Alviso is a town of erstwhile great expectations and disappointed hopes, and these old buildings are the relics of the days when produce of the Santa Clara Valley was carried by schooners before the advent of the railroad, but it would be cheaper to buy land downstream and move them than to dredge out the channel in front, while if the creek required turning they would be cut off anyway. The channel is so narrow and both banks being occupied, the sides might require bulkheading if the depths be increased greatly.

The material to be dredged consists of a stratum of soft, blue mud overlying hard, yellowish, sandy clay, a tough, tenacious hardpan that sticks to the buckets of bucket dredges and is difficult, slow, and expensive to handle. The same material is met with in places at Redwood Creek and Oakland Harbor. There are occasional patches of shells, but for far the greater amount the upper material is soft clay or marsh mud, easily handled by any kind of dredge. The hardpan probably can be handled by scoop, heavy ladder, or suction dredges, if the latter have mechanical cutters, but it would be desirable to have material placed well back from the edges of the banks, so as to not force them down by the superincumbent weight. For the purpose of estimate prices are assumed of 40 cents for hardpan and 15 cents for soft material per cubic yard. About a fourth of the dredging will be hardpan. The character and quantities of material of the two kinds are based on borings made with a roughly pointed bar of three-fourths inch iron at intervals of from 100 to 300 yards, and are only roughly approximate.

The projected channel has an area of cross section materially larger than that of the natural one in the upper part of the creek, and the present tidal prism is too small to maintain it by scour. To even approximate to the degree of permanence likely to be attained by the cuts would require far longer time for observation and study than is available. It is said that Guadalupe Creek or River does not carry much detritus in freshets and, in fact, many years ago was purposely turned into the head of Alviso Slough by means of an artificial cut and a wooden dike across the old channel, with the result that the winter freshets scoured out and deepened the channel very considerably. It may be pertinent to inquire whether this artificial cut is still held in private ownership before the work of improvement be carried up through and above it.

The limit of depth obtainable by creek scour was reached long ago, and its effect on a deeper channel is likely to be harmful rather than beneficial. It is thought that after the first redredging the artificial channel will not tend to refill very quickly; but general impressions are unsafe guides, and, considering the experience at other places on the bay, at Redwood Creek near by, for instance, which are similarly circumstanced, it seems likely that the enlarged channel will close up again in time. Part of the refilling material will be contributed from the degradation of the banks by their sliding to lower slopes and by the wave wash of passing vessels; part will be sediment brought down from the upland.

If after trial it be found that the dredged cuts fill up too quickly, three plans for securing a greater degree of permanence might be considered: First, to cut off the upland drainage by turning the Guadalupe back into its old course, thus turning the slough into a tidal canal or ditch; second, to enlarge the tidal prism by putting a dam across the lower part of the Guadalupe, say at a point where its natural channel cross section was fully equal to or greater than the area of the artificial section of the cuts, and third, to put in flushing gates, say at the trestle of the railroad, thus turning the stream above into a long scouring basin. The tide runs up some 2 miles above this point.

The last plan is likely to be the most costly, and unless carefully adjusted might result in spasmodic rushes that would attack and injure the banks and cause the formation of shoals in the lower, wider reaches. With the first plan the channel would be a purely artificial cut, and after the banks had taken their slopes could be increased indefinitely. The second plan of forcing the tide in the Lower Guadalupe up through Alviso Creek on its face would appear to be the most promising, as it would cost very little, would leave an open channel above, and could easily be removed, if necessary, on the adoption of other plans. But a first trial should be made of dredging alone.

All this provided that Alviso Creek be deemed worthy of improvement by the General Government.

Very respectfully,

F. C. TURNER.

Maj. C. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

Estimated amount of dredging in the proposed improvement of Alviso Creek.

	Mark on map.	Cubic yards.
Lump a mile above mouth	A.	2,000
Channel crossing	B–C.	9,800
Channel below cut-off	D–E.	8,300
Cut-off	E–F.	64,100
Channel above cut-off to lumber wharf	F–G.	89,600
Additional width in front of wharves		20,200
Turning V	H.	12,700
Total		206,700

Material:
- Hardpan (say 50,000) .... cubic yards.. 48,200
- Soft mud and clay, shells and sand .... do.... 158,500

Total .... do.... 206,700

Estimated cost:
- 50,000 cubic yards of hardpan, at 40 cents $20,000
- 156,700 cubic yards of soft material, at 15 cents 23,505

43,505

Expenses and contingencies, 10 per cent 4,350

Total 47,855

P P 7.

SURVEY OF REDWOOD CREEK, CALIFORNIA.

[Printed in House Doc. No. 87, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated October 28, 1896, with map,* by Maj. Chas. E. L. B. Davis, Corps of Engineers, giving the results of a survey of Redwood Creek, California, made to comply with the requirements of the river and harbor act of June 3, 1896.

The estimated cost of the work outlined in Major Davis's report is $8,400.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 28, 1896.

GENERAL: I have the honor to submit the following report of a survey of Redwood Creek, California, and the estimated cost of improvement, as called for by the provisions of the river and harbor act of June 3, 1896.

Redwood Creek, under the name of Redwood Harbor, has already been improved by the General Government. From 1884 to 1890 a total of $23,400 has been appropriated for this harbor, and 103,445 cubic yards of material has been dredged from the creek or slough.

In the preliminary report in 1882 it was stated that dredging would have to be repeated periodically every few years as deposits would accrue, and such has been found to be the case.

The tracing accompanying this report is from a detail sheet of the United States Coast and Geodetic Survey, the changes and additions being in red. The limits of the dredging were between the points A and B of the tracing; that is, from the town to the junction with the larger slough. As the upper third, or from the town to the tannery, is now bare at low water and the remaining two-thirds has an available depth of less than 2 feet, it would seem to be useless to do any more dredging in this stretch of channel.

The town of Redwood has built a wharf at the point marked B, where the smaller slough empties into the larger one, and a planked roadway leads from the town to the wharf, at which there is a depth of between 2 and 3 feet at low tide. This wharf, being about three-fourths of a mile from the center of the town of Redwood, will sufficiently

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*Not reprinted. Printed in House Doc. No. 87, Fifty-fourth Congress, second session.

serve the needs of the general public, the only parties to be benefited by the deepening of the upper smaller slough being the owners of the lumber yard and the tannery. In view of this state of affairs it is deemed inadvisable to expend any more money in deepening this portion of the creek.

As will be seen by an examination of the tracing, the slough, at a point about halfway to the Bay of San Francisco, widens out, forming the middle ground, with two channels and a mud bank between. To the westward of this middle ground there is a deep semicircular slough, with a bar of 2 feet at its upper end, which can be navigated by the class of sailing vessels using the slough, but with some difficulty, owing to its peculiar course. By closing this slough by means of a dike, and improving either channel around the middle ground, a 5 foot channel might be obtained. The westernmost channel is the one to be preferred, on account of its being straighter, though the amount of material to be removed is somewhat greater.

The estimate of the cost of this work is as follows:

Dike	$3,000
Dredging	5,400
Total	8,400

This dredging includes about 3,000 cubic yards to be dredged in front of the wharf built by the town of Redwood.

The Frank Tanning Company, of Redwood, has furnished me a statement of the annual traffic of the company:

	Tons.
Bark, 5,500 cords	6,600
Hides	1,875
Supplies, oils, etc	400
Coal	250
Leather	1,200
Offal (hair, glue stock, etc.)	700
Total	11,025

Hanson & Co., lumber dealers, have furnished me with the following statement of their annual traffic:

	Tons.
To Redwood City by water:	
1,000 barrels lime	100
500 barrels cement	100
1,417,590 feet of lumber	1,966
From Redwood City by water:	
1,600,000 shingles	160
3,000 tons of hay	3,000
Total	5,326

The main body of this report was written October 28, 1896, and the delay in forwarding has been occasioned by not receiving the statistics as soon as anticipated.

The report of Mr. F. C. Turner, assistant engineer, in charge of the field work, is appended herewith.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

REPORT OF MR. F. C. TURNER, ASSISTANT ENGINEER.

SAN FRANCISCO, CAL., *October 24, 1896.*

MAJOR: In accordance with your instructions I have made an examination of Redwood Creek, and respectfully submit the following report:

Difficulties in the way of navigation were reported at but two points, viz, in the upper slough between points A and B on the map which is appended hereto, and at the point C, known as the middle ground.

The upper slough, A to B, is about a mile in length from the bridge in the town to its mouth, and is the portion to which work heretofore done by the Government has been confined. A cut 50 feet wide and 3 feet deep at low tide was last made up its full length in 1892, the dredging amounting to 53,900 cubic yards. At present the channel is completely bare at low tide for about a third of its length, i. e., above the tannery; while in the lower two-thirds, from the tannery to the junction with the large slough, there is a narrow channel with ruling depths of from 1¼ to 1½ feet at low tide. This filling is caused by a creek bringing down sediment from the uplands during the winter. A small amount of mud, also, has sloughed into the channel from the banks. This upper stretch, as has been repeatedly stated in the reports by Lieutenant-Colonel Benyaurd, Corps of Engineers, can not be kept open permanently, but will require periodical dredging, as it is impracticable to turn the creek away from it at a cost at all commensurate with resulting benefits, while there is no current to keep the channel scoured.

Recently the town of Redwood City built a wharf on the larger slough at the mouth of this smaller one and connected it to high ground by means of a planked roadway. There is about 2 to 3 feet of water at this wharf at low tide, and, as it is but three-fourths of a mile to the center of town, it would appear that it answers the necessities of the general public. The only interests benefited by deepening the upper slough appear to be those of a lumber yard and a tannery. In both places the material unloaded from schooners is reloaded and repiled, so that the extra expense of going to the deep water at the city wharf would seem to be that of the extra haul of about a mile in case of the lumber yard, and of about 700 yards in case of the tannery, the cost of handling not being materially affected as regards loading and unloading. From these considerations it would seem that there is little to justify the expenditure of more money on the upper slough by the General Government.

The middle ground is a wide portion of the slough from 900 to 1,200 feet between the banks, with two channels separated by a low mud bank covered with tules. There is a deep horseshoe-shaped slough around to the west of the middle ground which can be taken, having a bar depth at its upper end of 2 feet and from 9 to 12 feet for the major portion of its course; but it is said to be difficult to follow this course, owing to the prevailing direction of the winds and the set of the tidal currents at the entrance. Of the middle ground channels the western is closed and bare at about a foot of tide, while the eastern, the one in use, has ruling depths of 2 feet at low tide, but is narrow and difficult for scow schooners to navigate. Either channel could be improved by shutting off the other, and also the deep channel around the bend by means of dikes; and it is thought that a 5-foot channel at low water could be thus maintained. The western channel would require the largest volume of dredging, but gives a straighter and somewhat better alignment than the eastern. Some dredging will be needed at the city wharf to give 5 feet at low tide. As the tide rises from 7 to 9 feet, this would allow coasting vessels to come to the wharf.

The dikes would have little pressure to withstand, and a single line of sheet piling would do, backed up with dredgings from the cut. That closing the deep bend would be about 320 feet long, and that on the middle ground 550 feet. The spur dike would require an apron of brush and stone at the end.

The material to be dredged would be mostly mud, with some shells and sand. To cut through the west side of the island would take about 24,000 cubic yards, while the east channel would require about 16,000 cubic yards. At the wharf about 3,000 cubic yards would have to be dredged.

ESTIMATES OF COST.

Closing deep channel of bend:	
34 piles 34 feet long, at 14 cents	$162
3 waling pieces, 6 by 8 inches, 300 feet, at $15	54
300 feet sheet piling, 3 by 12 inches, 28 feet, at $15	378
Bolts and spikes	12
Labor	150
	756
Machine, profits of contractor, and contingencies	244
	1,000

Spur dike:

Sheet-pile dike, freight, etc		$1,100
Brush mat, 50 cubic yards, at $3		150
Stone, 150 tons, at $2		300
		1,550
Profits, contingencies, etc		450
Total		2,000
Dredging:	Cubic yards.	
West channel	24,000	
Wharf	3,000	
	27,000, at 20 cents.	5,400
East channel	16,000	
Wharf	3,000	
	19,000, at 20 cents.	3,800

	West channel.	East channel.
Dikes	$3,000	$3,000
Dredging	5,400	3,800
Total	8,400	6,800

Very respectfully,

F. C. TURNER.

Maj. CHAS. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

P P 8.

SURVEY OF MARE ISLAND STRAIT, CALIFORNIA.

[Printed in House Doc. No. 134, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 19, 1896.

SIR: I have the honor to submit the accompanying copy of report, dated November 19, 1896, with map,* by Maj. Charles E. L. B. Davis, Corps of Engineers, giving the results of a survey of Mare Island Strait, California, provided for by the river and harbor act of June 3, 1896.

The plan of improvement recommended by Major Davis and by Col. Charles R. Suter, Corps of Engineers, the division engineer, is the dredging of a channel 30 feet deep, 800 feet wide across the outer bar, and 600 feet wide through the main channel. The estimate submitted as the cost of this work is $318,950, but the division engineer states that if, as seems entirely probable, hydraulic dredges can be employed and the dredged material be pumped ashore, the estimate of cost can probably be reduced 30 per cent or even more.

As bearing upon the question there is also submitted herewith a copy of a letter, dated December 16, 1896, from the Acting Secretary of the Navy, in which it is recommended by him that the channel in Mare Island Strait be dredged to a depth of 30 feet and to a width of 800

*Not reprinted. Printed in House Doc. No. 134, Fifty-fourth Congress, second session.

feet over the outer bar, 600 feet wide abreast of Commission Rock, and 1,000 feet wide above Commission Rock.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

LETTER OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 19, 1896.

GENERAL: In accordance with instructions contained in Department letter of September 5, 1896, I have the honor to transmit herewith my report upon the survey of Mare Island Strait, California.

I think that the importance of having a channel of sufficient depth to enable all classes of naval vessels to reach the naval establishment at Mare Island can not be overstated, and in my opinion the work of improvement is worthy of being undertaken by the General Government. I respectfully recommend the dredging of a channel 800 feet wide and 30 feet deep across the outer bar and 600 feet wide and 30 feet deep through the main channel, and, if possible, that the entire amount of the estimate be appropriated, so that the whole work may be let under one contract.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the views and recommendations of the district officer. If, as seems entirely probable, hydraulic dredges can be employed and the dredged material be pumped ashore, the estimate of cost can probably be reduced 30 per cent or even more.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 19, 1896.

GENERAL: I have the honor to submit the following report of a survey of Mare Island Strait, California, and the estimated cost of improvement, as called for by the provisions of the river and harbor act of June 3, 1896.

The United States Coast and Geodetic Survey having made a survey of the strait in June and July, 1896, application was made for a copy of the chart of this survey and a blue-print copy was obtained. The shore line and hydrography were copied from this blue print on the tracing which accompanies this report. Being a hydrographic survey simply, the character of the bottom was that given by the sounding lead, and it therefore became necessary to determine whether any rock or hard material would be met with at depths to which the dredging should be carried in case it be decided to deepen the channel.

A party was sent into the field in October with instructions to make borings distributed over the area of channel that would require dredging, the borings to extend to at least 30 feet below the plane of reference of the United States Coast and Geodetic Survey. The locations of the borings are shown on the tracing by small circles, the number inside the circle being the number of the boring. Thirty-one of these borings were made, and in no case was rock met with except in the immediate vicinity of Commission Rock.

A comparison of this last chart with the United States Coast and Geodetic Survey chart of San Pablo Bay, the hydrography of which was executed in the years from 1851 to 1859, shows that considerable shoaling of the strait has taken place. The character of the bottom revealed by the lead and determined by the borings seems to indicate that most of the deposited material is "slickens," brought down by the Sacramento River from the mines on its upper tributaries. The shoaling from this cause will probably be less in the future than in the past; still, a gradual silting up and shoaling of the strait must be anticipated, and redredging will be necessary from time to time.

On both sides of the strait there are long flats and shoals where, if dikes or levees were built, behind which the material excavated from the channel could be deposited by the hydraulic method, the expense would be greatly reduced, and it is possible that the contractor might make satisfactory arrangements with the riparian owners to permit this. Below the navy-yard there is a stretch of low land covered with tule grass, well adapted for filling in, but the fear of malaria arising from the drying out of the large quantities of freshly deposited material might deter the naval authorities from granting the privilege. I have therefore estimated the cost of dredging at 15 cents per cubic yard, on the supposition that the dumping grounds would have to be somewhere on the shoals in San Pablo Bay. As the amount of material to be dredged is large, if a sufficient appropriation is made to let the work under one contract, it is thought proposals might be obtained at a much lower figure.

In the following estimates the width of channel on the outer bar has been kept at 800 feet for all depths:

ESTIMATES.

	Cubic yards.	
For channel 24 feet deep and 600 feet wide:		
Outer bar (800 feet wide)	40,000	
Main channel	691,000	
Total	731,000, at 15 cents	$109,650
Contingencies, 10 per cent		10,965
		120,615
For channel 26 feet deep and 600 feet wide:	Cubic yards.	
Outer bar (800 feet wide)	99,000	
Main channel	963,860	
Total	1,062,860, at 15 cents	159,429
Contingencies, 10 per cent		15,943
		175,372

For channel 28 feet deep and 600 feet wide:

	Cubic yards.	
Outer bar (800 feet wide)	138,000	
Main channel	1,279,040	
Total	1,417,040, at 15 cents	$212,556
Contingencies, 10 per cent		21,256
		233,812

For channel 28 feet deep and 800 feet wide:

	Cubic yards.	
Outer bar	138,303	
Main channel	1,721,225	
Total	1,859,528, at 15 cents	278,930
Rock excavation at Commission Rock, 16,000 cubic yards, at $10		160,000
		438,930
Contingencies, 10 per cent		43,893
		482,823

For channel 30 feet deep and 600 feet wide:

	Cubic yards.	
Outer bar (800 feet)	232,800	
Main channel	1,700,233	
Total	1,933,033, at 15 cents	289,955
Contingencies, 10 per cent		28,995
		318,950

As will be seen, the channel 30 feet deep and 600 feet wide, by avoiding the expensive rock cutting near Commission Rock, is much cheaper than the 28-foot channel 800 feet wide, and is probably wide enough to accommodate the largest type of naval vessels, while the depth is none too great for the requirements of a first-class navy-yard.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

LETTER OF THE ACTING SECRETARY OF THE NAVY.

NAVY DEPARTMENT,
Washington, December 16, 1896.

SIR: I have the honor to acknowledge the receipt of your letter of the 3d instant, transmitting a copy of a report from Maj. Charles E. L. B. Davis, Corps of Engineers, giving the results of a survey of Mare Island Strait, California, made pursuant to the river and harbor act of June 3, 1896, and inviting suggestions from this Department as to the width and depth of the proposed channel.

In reply I have to recommend that the channel referred to be dredged to a depth of 30 feet below plane of reference and have a width of 800 feet over outer bar, 600 feet abreast Commission Rock, and 1,000 feet above Commission Rock.

I have the honor to be, sir, very respectfully,

W. MCADOO, *Acting Secretary.*

The Honorable the SECRETARY OF WAR.

APPENDIX Q Q.

IMPROVEMENT OF SAN JOAQUIN AND SACRAMENTO RIVERS AND TRIBUTARIES, AND OF RIVERS AND HARBORS IN CALIFORNIA NORTH OF SAN FRANCISCO.

REPORT OF CAPT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. San Joaquin River, California.
2. Mokelumne River, California.
3. Sacramento and Feather rivers, California.
4. Napa River, California.
5. Petaluma Creek, California.
6. Humboldt Harbor and Bay, California.

EXAMINATIONS.

7. Napa River, California.
8. Petaluma Creek, California.
9. Humboldt Harbor, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 12, 1897.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1897.

Very respectfully,

CASSIUS E. GILLETTE,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Q Q I.

IMPROVEMENT OF SAN JOAQUIN RIVER, CALIFORNIA.

A description of this stream, its original condition, and the plan for its improvement are given in the Annual Report of the Chief of Engineers for 1896, p. 3189.

Report of operations for the fiscal year ending June 30, 1897.—During this year $10,197.44 has been expended. The dredge worked from August 10 to September 30, inclusive, at Dutchmans Reach, and in Stockton Slough from October 1, 1896, to February 3, 1897. Forty-three thousand one hundred and fifty-nine cubic yards of material was removed at Dutchmans Reach and 138,741 cubic yards from Stockton Slough, the total cost of which was $9,889.25, or 5.4 cents per cubic yard. The dredging done has maintained a channel to Stockton, so that there has been no interruption to navigation to that point during the year.

In May, 1897, some snags were removed by blasting in the upper river, at a cost of $45.25.

Future operations.—Extensive annual dredging will be required in Stockton Channel until some provision is made for the disposal of the waters at Mormon Slough in some other manner than, as at present, into the still waters of the dredged channel. It is estimated that the sum of $10,000 will be necessary to continue the dredging during the fiscal year ending June 30, 1899, and that $1,000 will be required for snagging and analogous work in the upper river. Funds are available for enlarging the cuts at Head Reach and Twenty-one Mile Slough, which work will be done during the coming fiscal year.

Money statement.

July 1, 1896, balance unexpended	$78,943.57
June 30, 1897, amount expended during fiscal year	10,197.44
July 1, 1897, balance unexpended	68,746.13
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899	11,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Appropriations for improving San Joaquin River, California.

August 14, 1876	$20,000	September 19, 1890	$75,000
June 14, 1880	20,000	July 13, 1892	65,000
March 3, 1881	40,000	August 17, 1894	50,000
August 2, 1882	40,000	June 3, 1896	57,750
July 5, 1884	20,000		
August 5, 1886	18,750	Total	431,500
August 11, 1888	25,000		

STATISTICS OF COMMERCE ON THE SAN JOAQUIN RIVER, CALIFORNIA.

The following is a statement of the business done by the California Navigation and Improvement Company on the San Joaquin River, California, during the year ending May 31, 1897, which was furnished by Capt. H. J. Corcoran, manager of the company.

	Tons.	Tons.
Lower San Joaquin River:		
Grain	129,398	
Mill stuffs	72,241	
Lumber	56,772	
Coal	17,416	
Produce	28,500	
Merchandise	44,728	
Miscellaneous	11,000	
		360,055
Upper San Joaquin River:		
Grain	10,574	
Merchandise	1,747	
Lumber	1,350	
		13,671
Total		373,726
Passengers ... number		13,671

The following is a statement of the freight carried by the Union Transportation Company during the year ending May 31, 1897.

	Tons.
General freight	58,010

Small scow schooners also carry a large amount of freight on this river, but it is impossible to obtain a statement of the amount.

* Indeterminate.

Q Q 2.

IMPROVEMENT OF MOKELUMNE RIVER, CALIFORNIA.

A description of this stream, its original condition, the plan for its improvement, and the results obtained are given in the Annual Report of the Chief of Engineers for 1896, page 3193.

Report of operations for the fiscal year ending June 30, 1897.—No work has been done on this river during the fiscal year; $3.43 was expended.

Remarks.—During the year there has been little or no navigation above New Hope Landing, to which point one stern-wheel steamer, the *Constance* (385 tons), runs regularly, making three round trips per week. No other steamer now runs on this river, although a few scow schooners make irregular trips there.

Future operations.—There is no impediment to navigation between the mouth of the Mokelumne River and New Hope Landing. Above that point there is about 3 miles of river from the banks of which the trees might be cut with advantage to navigation, but as there is little, if any, navigation there, no necessity for this exists at present. Should the necessity arise the funds on hand are sufficient for the purpose.

Money statement.

July 1, 1896, balance unexpended	$891.77
June 30, 1897, amount expended during fiscal year	3.43
July 1, 1897, balance unexpended	888.34
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899	(†)

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of appropriations for improving Mokelumne River, California.

July 5, 1884	$8,500
August 5, 1886	2,500
August 11, 1888	2,000
July 13, 1892	2,500
August 17, 1894	2,500
Total	18,000

COMMERCIAL STATISTICS.

The following statement of the trade of the Mokelumne River for the year ending May 31, 1897, was supplied by Capt. N. Anderson, secretary of the California Transportation Company:

Freight (merchandise and produce) ... tons	38,051
Passengers	4,263

The above freight and passengers were carried on one stern-wheel steamer, the *Constance* (385 tons), which makes from one to three round trips per week, and is the only steamer plying into the river. Several scow schooners also make occasional trips into this river, but no estimate of their business can be obtained.

* Indeterminate

† Sufficient on hand.

Q Q 3.

IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

A description of this stream, its original condition, and the plan for its improvement are given in the Annual Report of the Chief of Engineers for 1896, page 3195.

Report of operations for the fiscal year ending June 30, 1897.—During the year $37,909.52 has been expended. The snag boat *Seizer* was run from July 1 to December 15, 1896. She removed 1,294 snags and destroyed most of them by chopping and blasting, and cut and put ashore from the banks of the river 263 trees. One thousand one hundred and thirty-nine blasts were fired, using 5,121 pounds of No. 1 giant powder; 3 wing dams of an aggregate length of 703 feet were built; 274 piles were driven, and the boat traveled 2,047 miles. From April 19 to June 26 the boat was given general repairs, involving new timbers and planking in most of the forward part of the boat. These new timbers and repairs cost $6,372.79. The boat is now in first-class condition.

During the low water of 1896 the river was carefully surveyed from Red Bluff to Princeton, about 90 miles. This work was done for the Board of Engineers appointed under the act of Congress of June 3, 1896.

The work at Parrott Bend to prevent the threatened cut-off has been completed, was twice damaged by high water, and has twice been repaired. The work was done by hired labor, and the total cost has been $6,555.16. On account of the difficulty in procuring rock, such structures are likely to require frequent repairs, and these prove somewhat expensive, but the cost of the present experiment has been, thus far, very much less than the cost of snagging, etc., which would certainly result should the river break through the neck of land.

During November, 1896, a small wing dam was built on the Yuba River near Deguerre Point, to confine the river to its old channel, the cost of which was $1,582.87.

There are inclosed herewith gauge readings showing the stages of the Sacramento River from June 1, 1896, to May 31, 1897.

Engineering methods.—No change in the method of snagging has been made since that described in the last annual report.

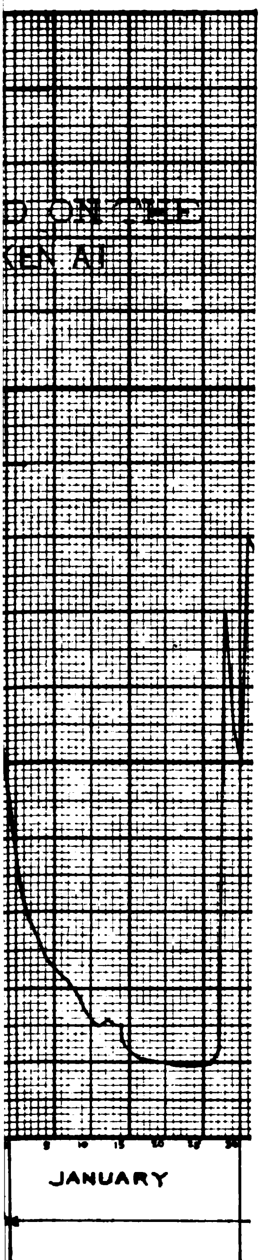
Future operations.—The amount now on hand is sufficient to carry on the work of snagging, etc., as heretofore, to the close of the fiscal year ending June 30, 1899.

The act of Congress passed June 3, 1896, provides for the construction of restraining barriers for the protection of the Sacramento River by the California Débris Commission, and also provides for placing the improvement of these rivers under a board of three engineer officers. For these reasons no estimate of funds to carry on the present project, beyond snagging, is submitted.

Money statement.

July 1, 1896, balance unexpended	$118,683.81
June 30, 1897, amount expended during fiscal year	37,909.52
July 1, 1897, balance unexpended	80,774.29
July 1, 1897, amount covered by uncompleted contracts	6,372.79
July 1, 1897, balance available	74,401.50
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899	(†)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

* Indeterminate. † Sufficient on hand.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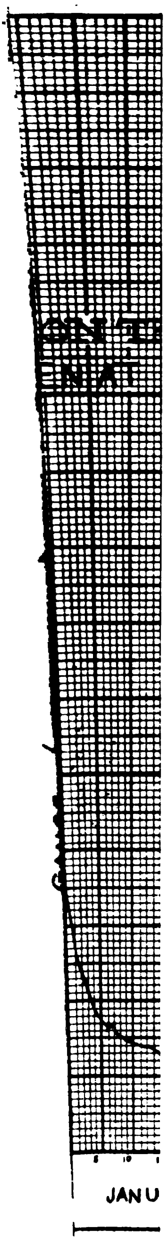
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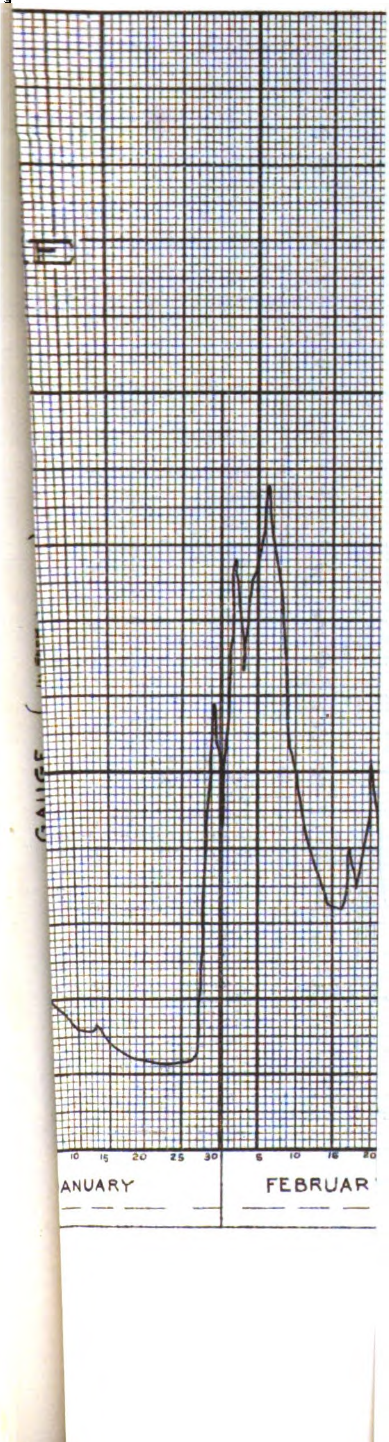
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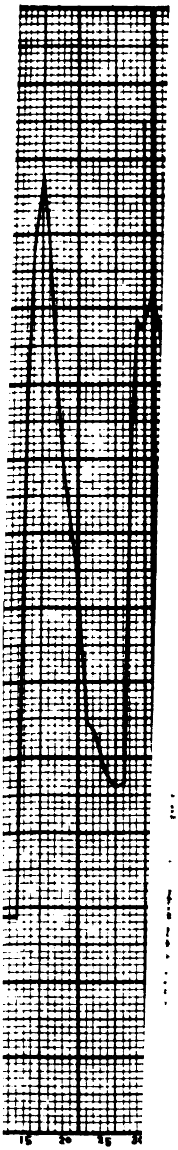

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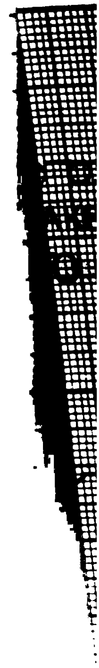

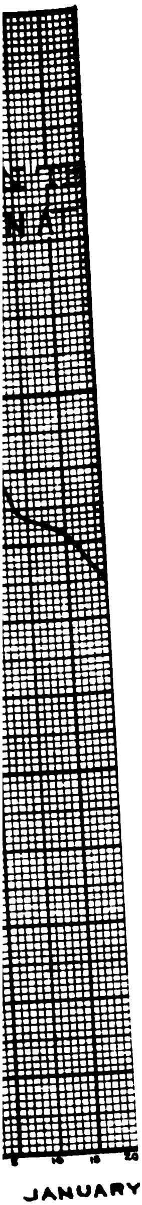
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Amount and date of all appropriations for improving Sacramento and Feather rivers, California.

March 3, 1875	$15,000	August 11, 1888	$20,000
June 18, 1878	15,000	September 19, 1890	30,000
March 3, 1879	20,000	July 13, 1892	150,000
June 14, 1880	45,000	August 17, 1894	115,000
March 3, 1881	60,000		
August 2, 1882	250,000	Total	760,000
July 5, 1884	40,000		

Abstract of bids for repairing United States snag boat Seizer, in answer to advertisement dated February 27, 1897, received and opened at San Francisco, Cal., by Capt. Cassius E. Gillette, Corps of Engineers, April 1, 1897.

California Navigation and Improvement Company, Stockton, Cal.:	
Hauling out and launching boat and use of ways	$125.00
50,000 feet clear Oregon pine, surfaced, edged, and seamed, at $26 per M feet	1,300.00
1,000 feet Oregon pine blocking. (No charge.)	
500 Oregon pine wedges, at $1 per 100	5.00
2,000 feet clear redwood, surfaced and edged, at $23 per M feet	46.00
1,000 feet clear redwood, surfaced, tongued, and grooved, at $21 per M feet	21.00
1,000 feet No. 1 sugar pine, at $50 per M feet	50.00
1,500 feet oak, at $110 per M feet	165.00
1,000 feet laurel, at $70 per M feet	70.00
3 Oregon pine knees, 7-inch face, at $5.95 each	17.85
1,000 pounds white lead, at 5¼ cents per pound	52.50
200 pounds red lead, at 5¼ cents per pound	10.50
20 pounds black lead in oil, at 6 cents per pound	1.20
2 barrels Portland cement, best quality, at $3 per barrel	6.00
30 gallons raw linseed oil, at 39 cents per gallon	11.70
30 gallons boiled linseed oil, at 39 cents per gallon	11.70
6 rolls tarred felting, 32 inches wide, at $1.20 per 25-yard roll	7.20
9 bales oakum, at $3.50 per 50-pound bale	31.50
30 kegs galvanized ship spikes, ½ by 8 inches to 5/16 by 5 inches, at $3.50 per keg	105.00
5 kegs cut nails, at $2.25 per keg	11.25
2,000 carriage bolts, ⅜ by 6 inches, at 1 cent per bolt	20.00
300 screw bolts, ⅝ by 12 inches, at 3 cents per bolt	9.00
200 screw bolts, ⅝ by 24 inches, at 6 cents per bolt	12.00
150 screw bolts, ½ by 13 inches, at 3 1/10 cents per bolt	4.65
2,500 pounds round iron, ⅝ inch, at 2 cents per pound	50.00
150 pounds round iron, ⅞ inch, at 1 9/10 cents per pound	2.85
200 pounds round iron, ¼ inch, at 2 1/10 cents per pound	4.20
100 pounds clinch rings, ⅜ inch, at 12 cents per pound	12.00
800 days, ship carpenter, at $3.50 per day	2,800.00
20 days, blacksmith and helper, at $6 per day	120.00
300 days, laborer, at $2.50 per day	750.00
50 days, calker, at $3.50 per day	175.00
Total	6,008.10
Hay & Wright, San Francisco, Cal.:	
Hauling out and launching boat and use of ways	175.00
50,000 feet clear Oregon pine, surfaced, edged, and seamed, at $20 per M feet	1,000.00
1,000 feet Oregon pine blocking, at $12 per M feet	12.00
500 Oregon pine wedges, at $200 per hundred	10.00
2,000 feet clear redwood, surfaced and edged, at $22 per M feet	44.00
1,000 feet clear redwood, surfaced, T. and G., at $20 per M feet	20.00
1,000 feet No. 1 sugar pine, at $60 per M feet	60.00
1,500 feet oak, at $100 per M feet	150.00
1,000 feet laurel, at $80 per M feet	80.00
3 Oregon pine knees, 7-inch face, at $6 each	18.00
1,000 pounds white lead, at 5½ cents per pound	55.00
200 pounds red lead, at 6 cents per pound	12.00
20 pounds black lead in oil, at 8 cents per pound	1.60

Hay & Wright, San Francisco, Cal.—Continued.	
2 barrels Portland cement, best quality, at $3 per barrel	$6.00
30 gallons raw linseed oil, at 43 cents per gallon	12.90
30 gallons boiled linseed oil, at 45 cents per gallon	13.50
6 rolls tarred felting, 32 inches wide, at $1.40 per 25-yard roll	8.40
9 bales oakum, at $3.50 per 50-pound bale	31.50
30 kegs galvanized ship spikes, $\frac{1}{2}$ by 8 inches to $\frac{5}{16}$ by 5 inches, at $3.90 per keg	117.00
5 kegs cut nails, at $2.15 per keg	10.75
2,000 carriage bolts, $\frac{5}{8}$ by 6 inches, at 1 cent per bolt	20.00
300 screw bolts, $\frac{5}{8}$ by 12 inches, at 4 cents per bolt	12.00
200 screw bolts, $\frac{5}{8}$ by 24 inches, at 10 cents per bolt	20.00
150 screw bolts, $\frac{1}{2}$ by 13 inches, at $3\frac{1}{2}$ cents per bolt	5.25
2,500 pounds round iron, $\frac{5}{8}$ inch, at 2 cents per pound	50.00
150 pounds round iron, $\frac{3}{4}$ inch, at $1\frac{3}{4}$ cents per pound	2.63
200 pounds round iron, $\frac{1}{2}$ inch, at 2 cents per pound	4.00
100 pounds clinch rings, $\frac{5}{8}$ inch, at $12\frac{1}{2}$ cents per pound	12.50
800 days, ship carpenter, at $4 per day	3,200.00
20 days, blacksmith and helper, at $6 per day	120.00
300 days, laborer, at $2 per day	600.00
50 days, calkers, at $4.50 per day	225.00
Total	6,109.03

Fulton Engineering and Shipbuilding Works, San Francisco, Cal.:	
Hauling out and launching and use of ways	550.00
50,000 feet clear Oregon pine, surfaced, edged, and seamed, at $32 per M feet	1,600.00
1,000 feet Oregon pine blocking, at $17 per M feet	17.00
500 Oregon pine wedges, at 50 cents per hundred	2.50
2,000 feet clear redwood, surfaced and edged, at $27.50 per M feet	55.00
1,000 feet clear redwood, surfaced, T. and G., at $24 per M feet	24.00
1,000 feet No. 1 sugar pine, at $66 per M feet	66.00
1,500 feet oak, at $110 per M feet	165.00
1,000 feet laurel, at $110 per M feet	110.00
3 Oregon pine knees, 7-inch face, at $7.25 each	21.75
1,000 pounds white lead, at $6\frac{1}{2}$ cents per pound	65.00
200 pounds red lead, at $6\frac{1}{2}$ cents per pound	13.50
20 pounds black lead in oil, at 12 cents per pound	2.40
2 barrels Portland cement, best quality, at $3.50 per barrel	7.00
30 gallons raw linseed oil, at 46 cents per gallon	13.80
30 gallons boiled linseed oil, at 48 cents per gallon	14.40
6 rolls tarred felting, 32 inches wide, at $1.40 per 25-yard roll	8.40
9 bales oakum, at $3.90 per 50-pound bale	35.10
30 kegs galvanized ship spikes, $\frac{1}{2}$ by 8 inches to $\frac{5}{16}$ by 5 inches, at $4.80 per keg	144.00
5 kegs cut nails, at $2.60 per keg	13.00
2,000 carriage bolts, $\frac{5}{8}$ by 6 inches, at $1\frac{1}{4}$ cents per bolt	25.00
300 screw bolts, $\frac{5}{8}$ by 12 inches, at $5\frac{1}{2}$ cents per bolt	16.50
200 screw bolts, $\frac{5}{8}$ by 24 inches, at $9\frac{1}{8}$ cents per bolt	18.25
150 screw bolts, $\frac{1}{2}$ by 13 inches, at 4 cents per bolt	6.00
2,500 pounds round iron, $\frac{5}{8}$ inch, at $2\frac{1}{4}$ cents per pound	56.25
150 pounds round iron, $\frac{3}{4}$ inch, at $2\frac{1}{10}$ cents per pound	3.15
200 pounds round iron, $\frac{1}{2}$ inch, at $2\frac{1}{3}$ cents per pound	4.67
100 pounds clinch rings, $\frac{5}{8}$ inch, at $12\frac{1}{2}$ cents per pound	12.50
800 days, ship carpenter, at $4.50 per day	3,600.00
20 days, blacksmith and helper, at $12.50 per day	250.00
300 days, laborer, at $3 per day	900.00
50 days, calker, at $5.50 per day	275.00
Total	8,094.67

Contract in force on account of improving Sacramento and Feather rivers, California (dated April 26, 1897, for repairing U. S. snag boat Seizer).

Name of contractor.	Date of approval.	Work commenced.	Expiration.
California Navigation and Improvement Co.	July 2, 1897	Apr. 26, 1897	Work was completed June 26, 1897

STATISTICS OF COMMERCE OF THE SACRAMENTO AND FEATHER RIVERS, CALIFORNIA, FOR THE YEAR ENDING MAY 31, 1897.

The following freight was carried by the boats of the California Transportation Company between San Francisco and Clarksburg, a distance of 110 miles:

	Tons.
Produce and coal	77,364
Lumber	11,380
Total	88,744
Passengers .... number	11,608

The following is a statement of the freight carried by the boats of the Southern Pacific Company between San Francisco and Sacramento, including all way freight:

	Tons.
Freight north	50,163
Freight south	65,748
Total	115,911

The following is a statement of the freight carried by the Sacramento Transportation Company, the only company running boats on the Sacramento River above the city of Sacramento:

	Tons.	Tons.
From San Francisco to Sacramento:		
Lumber	20,000	
Merchandise	16,000	
Coal	15,000	
From Sacramento to San Francisco:		
Brick	22,000	
Merchandise	2,500	
Miscellaneous	1,200	
Total freight between San Francisco and Sacramento		76,700
River above Sacramento:		
Down-river freight—	Tons.	
Wheat and barley	104,096	
Cord wood	10,000	
Broom and Indian corn	1,700	
Potatoes	3,000	
Hogs and cattle	240	
Dried fruit	250	
Miscellaneous	5,500	
Up-river freight:		
Merchandise to points below Redbluff	8,800	
Merchandise to Redbluff	7,200	
Total freight of upper river		140,786
Total freight carried		217,486

The commerce of the Sacramento River is carried on 8 steamers, 16 grain barges, and 7 brick barges belonging to the Sacramento Transportation Company, 5 steamers and 7 barges belonging to the California Transportation Company, and 2 steamers belonging to the Southern Pacific Company. The steamers vary in size from 183 to 619 tons and the barges from 118 to 800 tons. The larger of the steamers only go a short distance up the river, the commerce of the upper river being carried on barges towed by light-draft steamboats.

On the Feather River, a small steamer, 247 tons gross tonnage, belonging to the Southern Pacific Company, makes one round trip per week, with a barge, and takes all the freight that offers. The following is a statement of the freight carried during the year ending May 31, 1897:

	Tons.
Freight north	1,143
Freight south	6,976
Total freight	8,119

This includes all way freight.

Q Q 4.

IMPROVEMENT OF NAPA RIVER, CALIFORNIA.

[This work was in the charge of Maj. Chas. E. L. B. Davis, Corps of Engineers, until April 23, 1897.]

A description of this river, its original condition, the plan for its improvement, and the results obtained are given in the Annual Report of the Chief of Engineers for 1896, page 3177.

Report of operations for the fiscal year ending June 30, 1897.—No work has been done on this river during the fiscal year. Seventy dollars was expended.

Remarks.—Permanent improvement of this stream is impracticable, as a channel dredged one year is liable to be obliterated by the detritus brought down by the floods of the succeeding winter. It has therefore been considered that to keep the river in good navigable condition dredging should be continued from year to year, and as the ordinary tides rise 5 feet and the spring tides 7 feet a comparatively small amount of work is necessary to keep navigation in good condition for the class of boats that ply on this river.

Future operations.—As the river has again filled up in certain places, and there is $4,162.70 available for work on it, it is intended to dredge such bars as obstruct navigation; but as the winter floods are liable to again fill the river with detritus the improvement will be only temporary, and it is estimated that $5,000 can be profitably expended on this river during the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$4,232.70
June 30, 1897, amount expended during fiscal year	70.00
July 1, 1897, balance unexpended	4,162.70
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899	5,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving Napa River, California.

August 11, 1888	$7,500.00
September 19, 1890	10,000.00
August 17, 1894	4,000.00
June 3, 1896	4,000.00
Total	25,500.00

COMMERCIAL STATISTICS.

Articles.	1884.	1896.
Merchandise, general, received and shipped ... tons	22,800	10,700
Coal received ... do	5,000	11,000
Hay shipped ... do	2,000	4,550
Grain received and shipped ... do	3,000	14,250
Wine received and shipped ... do	7,500	9,350
Lumber received ... do	18,333	10,000
Miscellaneous freight received and shipped ... do	5,936	6,520
Total ... do	64,569	66,370
Steamers	2	2
Tonnage	176	527
Trips by steamer	....	Daily.

No new lines of transportation were established during the year.

* Indeterminate.

Q Q 5.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

Description.—The improved portion of Petaluma Creek is an estuary about 16 miles long, extending from San Pablo Bay to the town of Petaluma.

Original condition.—In its original condition it was very crooked, and in places dry at low water, navigation depending almost entirely on the tide. Its length was then 18.5 miles.

Plan of improvement.—In 1880 a project was made and adopted for the improvement of this stream by straightening it by cut-offs and dredging it so as to obtain a channel 50 feet wide and 3 feet deep at low water. In 1892 the project was increased to make the channel as deep as funds would permit.

Report of operations for the fiscal year ending June 30, 1897.—No work has been done during the fiscal year. Four dollars and eighty-eight cents was expended. The channel obtained by the last dredging has slightly deteriorated, owing to the amount of detritus brought down by Petaluma Creek, but navigation has been in no way interfered with.

Remarks.—This creek is the water outlet of one of the richest valleys in California, which is in a high state of cultivation and produces large quantities of fruit, grain, and other agricultural products. The town of Petaluma has a population of a little over 4,000 people, and is particularly flourishing, containing as it does several important manufactories, the establishment of which is said to be due in a large measure to the existence of cheap water transportation to San Francisco. The freight rates by rail from all points within one day's haul of Petaluma Creek show the beneficial effect of water competition.

Future operations.—As long as the water of Petaluma Creek empties into the navigable channel frequent dredging will be necessary, as it brings down large quantities of detritus, which are deposited in the channel.

It is estimated that $4,000 can be advantageously expended on this stream during the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$44.34
July 30, 1897, amount expended during fiscal year	4.88
July 1, 1897, balance unexpended	39.46
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1899	4,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

Appropriations for improving Petaluma Creek, California.

June 14, 1880	$8,000	July 13, 1892	$10,000
March 3, 1881	8,000	August 17, 1894	15,000
August 2, 1882	14,000		
August 11, 1888	2,000	Total	61,000
September 19, 1890	4,000		

* Indeterminate.

STATISTICS OF COMMERCE OF PETALUMA CREEK.

The following statement of the trade of Petaluma Creek during the year ending May 31, 1897, was compiled from information collected by Dr. Thomas Maclay, city clerk of Petaluma:

	Tons.		Tons.
Grain	16,550	Wool	350
Farm produce	34,015	Live stock	11,550
Dairy produce	1,035	Merchandise	6,590
Fruits, dried and fresh	2,100	Mill stuff	21,550
Hides and pelts	235	Wine	200
Building material	3,890	Paving blocks	5,000
Coal	2,700	Miscellaneous	970
Lumber	7,000		
Salt	2,500	Total	116,235

The commerce is carried on one stern-wheel steamer, the *Gold*, 294 tons, and many scow schooners, which carry the heavier freight.

Q Q 6.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

A description of this bay, its original condition, and the plan for its improvement are given in the Annual Report of the Chief of Engineers for 1896, page 3207.

Report of operations for the fiscal year ending June 30, 1897.—During the year $273,507.37 was expended.

North Jetty.—At the beginning of the fiscal year this jetty was being built up with rock and a spur at Bent 392 being constructed. The enrockment of the jetty was suspended on July 27, and the spur at Bent 392 was completed about the middle of the month. On September 2, 1896, rock delivery was resumed and carried on until April 17, 1897, when the jetty was completed and work upon it closed. The amount of rock delivered during the fiscal year on this jetty amounted to 80,001 tons. It was found impracticable to build the jetty up to full height and maintain it at that height with rock that can be obtained under the present contract. The indications are, however, that the jetty will retain sufficient height to fully accomplish the purpose for which it was constructed.

South Jetty.—The extension of the jetty seaward was suspended on July 25 at Bent 341, giving sufficient extension for the probable rock delivery during the balance of the season. Enrockment was continued to September 1, 55,181 tons having been used since the beginning of the fiscal year. This left the height of the rock in the jetty as follows: From the beginning to Bent 198, 10 feet above low water; from Bent 198 to bent 234 it averaged $+4\frac{1}{2}$; from 234 to 242, $-3\frac{1}{2}$; from 242 to 284, +2; from 284 to 321, −1, and from 321 to 341, the outer end, it sloped from −3 to −19, averaging −10 feet. The outer end of the trestle was strengthened and work stopped. During the winter the south trestle from Bent 244 to Bent 341, the last bent built last season, was all carried away by the winter storms. On March 15, 1897, work was resumed. The wharf, apron, and shore approaches, requiring renewal, were rebuilt at a point farther south and the shore track moved to correspond. This was on account of the encroachment of the sea on the spit in the vicinity. On April 19 delivery of rock on the shore protection was begun. At the close of the fiscal year 16,844 tons of rock had been delivered. The repairs to the trestle were completed by May 20, when jetty extension was resumed and continued to Bent 294. At the close of the fiscal year 27,244 tons of rock had been delivered, making the total rock delivered on the south jetty during the year 82,425 tons. In this jetty the rock is now practically up to full height, +10 feet, from shore to Bent 225, thence slopes to 0 at Bent 255, thence to —9 feet at Bent 260, thence to —12 feet at Bent 320, thence to about —20 feet at the end, which is 5,451 feet from shore.

A complete survey of the entrance to the bay was made in October, 1896, and another in May, 1897. A copy of the latter is sent herewith.

During the fiscal year the contractor delivered 179,272 tons of rock, constructed 858.8 cubic yards of brush mattress, and erected 1,159.2 linear feet of trestle with double-track railway thereon.

Engineering methods.—During the present season it has been necessary, in rebuilding the south trestle, to drive piles into the previously constructed foundation consisting mostly of small rock with the interstices filled with sand. Pile driving was quite difficult, but the result has been satisfactory, an average penetration of 9 feet having been obtained. The piles were shod with one fourth-inch steel plate made into the frustum of a cone, having diameters of 12 inches and 5 inches and a slant height of 13 inches.

Remarks.—First. Lieut. Herbert Deakyne, Corps of Engineers, was in local charge of the work from the beginning of the fiscal year to September 12, 1896; Mr. D. E. Hughes, assistant engineer, from September 12, 1896, to March 18, 1897; and First Lieut. James J. Meyler, Corps of Engineers, from that date to the close of the fiscal year. Lieutenant Meyler's report for the last working season is herewith.

Future operations.—It is expected during the present working season to continue work on the south jetty. The balance now available for the work is $348,884.66. This will probably last until June 30, 1898, and will leave a surplus of about $125,000. In addition to this it is estimated that $100,000 can be advantageously expended during the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended		$410,145.51
Amount appropriated by sundry civil act approved June 4, 1897		350,000.00
		760,145.51
June 30, 1897, amount expended during fiscal year		273,507.37
July 1, 1897, balance unexpended		486,638.14
July 1, 1897, outstanding liabilities	$137,753.48	
July 1, 1897, amount covered by uncompleted contracts	348,884.66	
		486,638.14
Amount (estimated) required for completion of existing project		243,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Amount and date of all appropriations for improving Humboldt Harbor and Bay, California.

March 3, 1881	$40,000	March 3, 1893	$522,000
August 2, 1882	40,000	March 2, 1895	225,000
July 5, 1884	62,500	June 11, 1896	225,000
August 5, 1886	75,000	June 4, 1897	350,000
August 11, 1888	125,000		
September 19, 1890	80,000	Total	1,894,500
July 13, 1892	150,000		

NOTE.—Of the above amounts appropriated $80,884.69 was expended for dredging and forms no part of the present project.

List of all contracts in force on account of improving Humboldt Harbor and Bay, California.

CONTRACT DATED DECEMBER 16, 1892, FOR JETTY WORK AT THE ENTRANCE TO HUMBOLDT HARBOR, CALIFORNIA.

Name of contractor.	Date of approval.	Work commenced.	Expiration.
John C. Bull, jr	Dec. 29, 1892	Apr. 15, 1893	This contract is continuous.

CONTRACT DATED DECEMBER 28, 1896, SUPPLEMENTAL TO THE ABOVE.

Name of contractor.	Date of approval.
John C. Bull, jr	By Chief of Engineers, Jan. 8, 1897; by Secretary of War, Jan. 9, 1897.

STATISTICS OF COMMERCE OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

The following statement of the trade of Humboldt Bay for the year ending May 31, 1897, was supplied and collected by Mr. George A. Kellogg, secretary of the Humboldt Chamber of Commerce.

Exports.

Articles.	Weight.	Value.
	Tons.	
Lumber	158, 380	$1, 320, 000
Miscellaneous products	10, 445	1, 227, 225
Total	168, 825	2, 547, 225

A correct statement of the imports of Humboldt Bay could not be obtained owing to the large number of small coasting vessels which bring freight into this port.

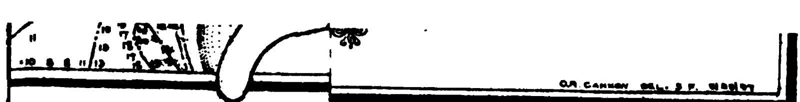
Movement of vessels, tonnage, and passengers.

	Arriving.	Departing.	Total.
Number of sail vessels	185	181	366
Number of steam vessels	353	355	708
Total number of vessels	538	536	1, 074
Total tonnage	194, 109	193, 400	387, 509
Number of passengers	6, 653	6, 599	13, 252

Included in the lumber shipments are 26 cargoes, aggregating 15,209 tons and valued at $130,175.22, which were taken directly to foreign ports; 3,619 tons, valued at $41,711.14, sent to San Francisco for reshipment.

The following is a statement of the business done by the Pacific Coast Steamship Company between San Francisco and Humboldt Bay during the year ending May 31, 1897:

	Received at Humboldt Bay.	Delivered at Humboldt Bay.
Freight ... tons	33, 485	13, 450
Treasure	$206, 013	$364, 962
Passengers	5, 241	4, 595


O.R. CANNON DEL. S.F.

The following is a statement of the business done by the steamer *North Fork* between San Francisco and Humboldt Bay during the same period:

	Received at Humboldt Bay.	Delivered at Humboldt Bay.
Lumber ....tons..	25,140	....
Merchandise........do ..	391	8,635
Passengers	278	394

REPORT OF FIRST LIEUT. JAMES J. MEYLER, CORPS OF ENGINEERS.

HUMBOLDT BAY, CALIFORNIA, *June 1, 1897.*

CAPTAIN: I have the honor to submit the following report of operations for the improvement of Humboldt Bay, California, during the working season beginning in March, 1896, and ending in April, 1897:

The general plan of this work contemplated the construction of two jetties, one on either side of the entrance to the bay, and, in addition, such spurs and shore protection work as might be necessary to protect either or both jetties or shores from injurious erosion.

The close of the previous working season, in October, 1895, found the two jetties in the following condition: The north jetty trestle had been extended to bent 503, having a total length of 8,059.6 feet, and mattresses had been sunk to 8 feet beyond that point, thus having a length of 8,068 feet. The jetty, from its initial point on shore to bent 310, had at one time or other been built up to the full height of 10 feet above mean low water, though in many places the top had been lowered by the sea. From bent 410 to bent 490 the rock had been built up to an average height of about 3 feet above 0, and from 490 to bent 503, the outer end, it sloped down to about —12 feet. Cross sections taken at the end of the season showed that on the ocean side the sand had accumulated up above low-water level as far out as bent 180, and that from there to the outer end the depth at a distance of 65 to 70 feet from the center line of the jetty varied from 2 to 19 feet, the greater depth being near bent 490. On the channel side the deepest water was 43 feet, found opposite bent 90 and about 80 feet distant from the center line of the jetty.

The south jetty trestle had been extended to bent 251, having a total length of 4,025.5 feet, and mattresses had been sunk to 10 feet beyond, having a length of 4,030 feet. The jetty had been completed to its full height of 10 feet above mean low water out to bent 180. From bent 180 to bent 220 the rock had been raised to about 4 feet above 0, and from 220 outward it sloped to about —22 feet at bent 251. Cross sections taken at the close of the season showed the deepest water to be on the channel side, it being 31 feet deep at about 70 feet distant from the center line of the jetty opposite bent 250.

During the winter of 1895–96 the heavy seas and rough weather did much damage to the trestles of both jetties. The north jetty trestle was destroyed from bent 484 to the outer end, and over 150 piles were broken out between bents 253 and 484. The trestle of the spur at bent 468 had 19 bents carried away, leaving 4 standing; 18 bents of the trestle of spur at 430 were destroyed, leaving 5 standing; and 5 bents of trestle of spur at 207 were destroyed, leaving 18 bents standing. The outer 13 bents of the trestle of south jetty were carried away, leaving the outer end of the trestle at bent 238, and, in addition, 14 piles were broken out between bents 177 and 238.

Such was the condition of both jetties at the beginning of the present working season. During the season the work has been done by Mr. J. C. Bull, jr., under a contract dated December 16, 1892.

The first work of the season was done on the south jetty, on March 24, 1896. On that date the contractor started in on the preparatory work of clearing the shore tracks of sand and getting the pile drivers ready for use. The wharf and apron were repaired and the scales were cleared of sand. Repairs to the trestle were started on March 27. On the same day work was begun on the north jetty, this being also of a preparatory nature. The shore tracks on that side were cleared of sand and the pile driver made ready for work. The wharf and apron were repaired, and on the 31st repairs on the trestle were started.

On April 1 rock delivery began on the north jetty, the first rock being used to build up that jetty near its shore end and in building up the revetment along and near the sharp curve. Rock delivery began on the south jetty on April 9, its delivery on the north jetty having been suspended the previous day, as there was little or no further use for small rock there, and the contractor could not deliver large rock. The repairs to the trestle were continued at both jetties during the month, and at its close the north jetty trestle had been repaired to bent 393. The south jetty trestle had been extended to bent 248, but during April 28 and 29 heavy seas destroyed bents 242, 244, 245, 246, 247, and 248, leaving 243 the last bent standing at the end of the month. During April the old track on south jetty trestle, from bent 10 to bent 55, was moved to the left about 10 feet to a firmer part of the trestle, and from bent 47 to bent 125 an additional track was laid, leaving a single track from shore to bent 47 and a double-track railway from that point to the outer end.

The rock delivered at the south jetty during April was used in building up the incomplete jetty near the outer end. The weather during the month was very stormy and unfavorable to the progress of the work, and greatly retarded the extension of the south jetty.

May was another very unfavorable month on account of the large amount of rain and the rough condition of the sea. Work was done on both jetties, though on the north it consisted entirely of repairs to the trestle, which had reached bent 393 at the close of the previous month. During this month repairs were carried to 484, the last bent standing after last winter's storms, and the trestle was rebuilt to bent 503, thus restoring it as completed last year. Near the outer end of the trestle there had been much scour, as one pile of the last bent was driven in 28 feet of water where the rock had been built up to —4 feet last season.

On the south jetty repairs to the trestle were continued, though this work was frequently interrupted by storms. On the 19th the trestle was repaired to bent 251, the last bent reached at the end of the previous season. New trestle was then started and at the close of the month had reached bent 272. The depths of water along the new work varied from 11 to 17 feet, averaging about 14 feet throughout the 21 bents. On the 11th of the month a severe storm again carried away a few of the outer bents of this trestle. The repairs had reached bent 247, which was partly completed, but the seas destroyed bent 243 and everything outside of that bent. The wreckage that came ashore from these bents showed that there can be but little dependence placed on piles driven into the rock, as many of them had broomed up instead of penetrating the rock. It may be noticed here, in connection with the difficulty of holding, even for a short time, the outer end of the south jetty trestle, that so far the piles in bents 243, 244, 245, 246, and 247 have been driven and capped and that part of the trestle completed four times. The first mattress was sunk this season on the south jetty at bents 252 and 253, on May 21, and at the end of the month mattress work had reached to 8 feet beyond bent 261. The average scour between the time piles were driven and the time mattresses were sunk was 3½ feet.

During May a survey of the entrance was made, showing a channel of 21 feet on the bay and a channel of 19 feet between the sharp curve of the north jetty and the deep water along the south jetty. The channel leading into South Bay showed a depth of 25 feet, and Bucksport Channel a depth of 9½ feet.

On June 1 a new spur to north jetty was begun, at bent 392. This was of the usual length of 23 bents, the piles of which were all driven in from 3 to 15 feet of water, and the trestle completed by the end of the month. The mattress work of the spur was not finished until July 7. On the south jetty the regular jetty extension was continued, and at the end of the month the trestle had reached bent 308 and mattress work had been extended to bent 299. The depths of water varied considerably, being about 14 feet at bents 280 and 290, about 21 feet at 300, and 17 feet at bent 308. The average scour during the month between the times of pile driving and mattress sinking was about 5 feet On account of the scour, and probably more because of the distortion by storms, the trestle became unsteady in some places near the outer end, and it became necessary to strengthen it in many bents by driving a fifth pile. Diagonal braces of wire cable were also used in places, they having the advantage over wooden braces of offering very little additional surface for the sea to act on. Heavy storms damaged the end of the trestle repeatedly, and on the 12th of the month a complete mattress and three bents of the trestle, Nos. 283, 284, and 285, were carried away by the rough seas. Besides, the outer 10 remaining bents were much distorted. Rock delivery was continued at both jetties during the month.

On the north jetty it was found necessary to do considerable repair work to the trestle again. On the 13th of the month three piles were broken out of the trestle. The broken piles, which were cast up on the beach, showed that in each case the break had occurred at an elevation of about 1 foot below low water, and that the piles at that point were completely honeycombed by teredo. Settlement of the trestle had occurred in other places, and it was feared that the ravages of the teredo had badly damaged a considerable portion of it. Many of the old piles were therefore tested by the contractor by striking with the pile-driver hammer, weighing about 4,600 pounds. At first a fall of 6 feet was used, but later the height of fall was reduced to 2 or 3 feet, and all piles that would not stand this blow were replaced by new piles. Only the north track of the trestle was repared in this way and made serviceable for further stone dumping. The contractor had to make the repairs at his own expense as they had become necessary during the working season. In all, he drove 74 piles in 51 bents between bent 159 and bent 262. All of the piles which failed to withstand the test applied by him were found to be honeycombed by teredo.

Work on both jetties was continued during July. On the north jetty it consisted of the enrockment of the spur at "392" and of the main jetty. The rock in spur, when finished, stood at +7 feet at bent 5; sloped to 0 at bent 10, and thence to —10 feet at the end of the spur. The length of the spur trestle was 368.7 feet, measured from the throw of the switches on the jetty to the center of cap 23. The outer edge of the last mattress is 314 feet from the center of the jetty. During the construction of this spur a scour of 1 foot took place between the time of driving piles and the time mattresses were sunk.

The south jetty trestle was finished out to bent 341 on July 25. Here the extension of this trestle was stopped, as there was no prospect of securing sufficient rock to justify any further construction during the season. Mattress work did not follow the trestle closely, owing principally to retardations by rough weather, and the last mat was not sunk until July 29. This was at bents 341 and 342 in 27 feet of water. The scour along this portion of the jetty was so small, averaging only 1¼ feet, that there was no objection to allowing mattress work to fall behind the trestle work, as when far apart they interfere much less with each other than when close. The length of the trestle to center of cap 341 was 5,451.5 feet, the mattress work extending to 5,462 feet.

On July 17 the first fatal accident since the beginning of this improvement happened, on the south jetty. While a carload of rock was being dumped it suddenly became unbalanced and fell off the trestle, taking with it another car and two men. The men were not seen after they fell; they were probably carried down under the falling cars and rock and drowned. The cars were recovered the next day, but nothing was ever seen of the bodies. Another man was injured in the same accident by being thrown to the trestle from one of the cars that went overboard. Though his injuries were not considered fatal at the time, he died on July 19.

Operations on the north jetty were suspended on July 27, as the contractor preferred to deliver rock during the remainder of the season at one jetty at a time. He then confined rock delivery to the south jetty, continued it throughout the month of August, and finished rock work there on September 1. August weather was the best of the season and work on the south progressed very fairly. Most of the rock was used near the outer end of the jetty and when the delivery for the season was completed, on September 1, the enrockment of the south jetty was left standing as follows: The jetty had been built to full height of 10 feet above mean low water out to bent 198; from 198 to bent 234 the height varied from 0 to 10 above low water, averaging +4¼ feet; from 234 to 242 (under a cross-over) the height averaged but —3¼ feet; from 242 to 284, +2 feet; 284 to 321, —1 foot. and from 321 to 341, the last bent, the rock sloped from —3 feet to —19 feet, averaging —10 feet.

The gallows frame of the south spit apron gave way August 15, owing to the fact that the piles supporting its south end had been greatly weakened by teredo. The damage was quickly repaired by the contractor, and as similar signs of weakness had been noticed on the north spit wharf and apron, he decided to make repairs there before resuming rock delivery in September. During August he drove 17 piles in the wharf, apron, and approaches on the north spit.

During the latter part of August the outer 20 bents of the south jetty trestle were strengthened. Stiffeners were made of the largest 64-foot piles obtainable at the jetty. They, breaking joints every two bents, were boxed and secured to the caps with screw bolts just outside of the outside stringers. Along the south side of the trestle, which near the end is subjected to a tensile strain in rough weather, each joint of the stiffeners was given a certain amount of tensile strength by a piece of 4 by 6 inch timber, 16 feet long, overlapping the joint and spiked to the two abutting pieces. Diagonal braces of 1-inch wire cable were placed horizontally above the caps.

Soundings were taken August 18 and 19 in order to ascertain the condition of the channel leading from the bay to the sea. It was found that the depth on the shoal in the inner part of the entrance, which was 19 feet in May, had increased to 23 feet, and that the thread of the channel on this shoal had moved 200 feet to the southeastward. On the bar there had occurred no appreciable change in either depth or position of the channel, though the bay itself had been pushed seaward by the outflowing current.

From September 2 to the close of the season, which was on April 17, 1897, work was confined to the north jetty. During this period the weather was generally bad and the seas rough; heavy storms did much damage to both trestles and interfered considerably with the progress of the work. Stone delivery was frequently interrupted because of heavy rains in the quarry, and the amount delivered during some months was very small, being only about 5,000 tons per month for November, December, and February. Most of the rock was used on the outer part of the jetty, building it up to completion from the outer end inward, as it was contemplated to abandon this jetty at the close of the season. Much of this outer end was raised twice to the full height of 10 feet above low water, but was again beaten down by the seas, until before the close of the season it was down below low water again. Cross sections taken during the latter part of the season showed that this portion of the jetty attained great width with very gentle slopes, and also that a shoaling had occurred along both sides of it and at the end.

During September it was again found necessary by the contractor to repair that part of the north jetty trestle under the north track because of the ravages of the teredo. He drove 78 new piles to reenforce badly eaten teredo piles between bents 169 and 265.

The rough seas during September broke off three piles in bents 311, 476, and 498 of the north jetty trestle, and during the following month 14 piles were carried away beyond bent 467 from a completed part of the jetty, and the outer 10 bents of spur 392 were lost. There were also 22 scattering piles lost between bents 318 and 352, and the contractor was obliged to replace them at his own expense.

The south jetty trestle during the month lost its outer 54 bents and a half dozen scattering piles besides, and during November some of this wrecked trestle (beyond bent 287) was cut away, and additional bolts were placed in the outside stringers from bent 272 to bent 287.

In the same month 14 outer bents and many scattering piles were lost from the north jetty trestle, and in December all the trestle beyond bent 457 was carried away and about 80 scattering piles besides. On the south jetty, bent 249 and all beyond bent 250 were destroyed, and in January bent 250 of south trestle and all beyond bent 12 of spur 207, north jetty, were carried away. On the north jetty several scattering piles were lost. During the remainder of the season three more bents were carried away from the outer end of the south jetty trestle, leaving bent 245 the last one standing at the close of the season. On the north jetty several more scattering piles were lost, leaving bent 457 the last one standing on April 17, with many scattering piles gone between the outer end and bent 165.

During January the contractor drove 32 piles in the north jetty trestle to repair and strengthen it, and also 18 piles in the north spit wharf. In February he drove 73 repair piles in the trestle, in March, 30, and in April, 9, all at his own expense, as he is required to keep the trestle, wharves, etc., in repair during the working season.

In the latter part of October the high-water line on the point of south spit began to recede, and the rock of the shore-protection work for several bents near the main jetty became exposed for the first time in five or six years. In the following month the high-water line had reached the shore-protection work from the jetty around nearly to the wharf, and at the wharf the beach began building out toward Red Bluff. This erosion along the shore-protection work and building up of the beach at the wharf continued until the close of the season. On February 1 the high-water line crossed the shore protection for a length of 500 feet, and went southward beyond it in one place about 130 feet. At the close of the season the enrockment of the shore protection between bents 25 and 50 had been torn down and driven southward over the beach, leaving the clay foundation bare. This clay is about 2 or 3 feet above low water. On December 31 a storm tide of about 10 feet accompanied by heavy swells took away the walls and undermined the foundation of the south spit scales pit (the scales had been removed to a place of safety the day before). Heavy breakers at the wharf tore off many plank and a few stringers, and the shore end of the apron was lifted out of its hinges and carried southward about 8 feet. The accumulation of sand continued at this point until the close of the season, at which time a spit, bare at low water, extended from the wharf 150 feet toward Red Bluff. At the same time the destruction of the wharf and apron continued, leaving them at the close of the season in a perfectly worthless condition.

The fall survey of the entrance was made during November and December. The weather was very rough most of that time and it was only with the greatest difficulty that some of the lines of soundings were obtained. The channel between the jetties showed marked improvement since the spring survey. The channel over the bar had shoaled some, giving a least depth of but 17 feet, and though 19 feet could be carried northward past the end of north jetty, it was hardly a practicable channel, except with a comparatively smooth bar, as the vessel would not be heading the seas. The bar itself had moved farther in.

During the month of June a box tide gauge was placed on the east pile of bent 20 of spur 392, with the object in view of obtaining information as to the relation between the tides there and at the light-house wharf on north spit. The gauge consisted of a 3-inch pipe having a ½-inch hole near the bottom, 7 feet below low water, the readings being taken from a bottle suspended by a tape. During July tide records were obtained simultaneously at two gauges, giving the first definite information regarding the difference in the times of the same stage of tide at the two points. The records obtained were forwarded to the San Francisco office, and they showed the tides at the spur gauge were thirty minutes earlier, and that the ranges at that gauge were somewhat greater than at the light-house wharf.

During the season the contractor in the construction of the south jetty trestle was permitted to use stronger fastenings, as follows: The head of each pile was secured against splitting by a ⅜-inch by 2½-inch ring, 14 to 18 inches in diameter, driven on the head of the pile by the pile driver hammer, and each pile was fastened to its cap by a ⅞ by 24 inch round iron driftbolt and a 1 by 28 inch screw bolt with nut set in a mortise in the pile. The stringers were secured to the caps by 1 by 28 inch screw bolts. On many of the outer bents, as the construction of the trestle progressed, temporary braces were used, consisting of wire cables placed in a vertical plane, running from the ends of the cap diagonally downward to the outside piles at the level of the sands.

During the previous season, in the construction of spur 127, south jetty, six bents were built without mattress foundation, with the view of determining the value of or necessity for brush foundations. During this season those bents have been compared very closely with the adjacent bents on either side having mattress bottom, and it has been impossible to discern that there has been any advantage in the use of the mattress as far as settlement of the jetty is concerned. On the other hand, considering the great compression of the mattress by the rock upon it and the comparative cost of rock and mattress, the latter is much more expensive here than would be a corresponding volume of rock.

In July some experiments were made by Mr. Hughes, the assistant engineer, having an important bearing on the subject of testing teredo-eaten piles. Specimens of green fir timber, obtained from the sawed-off tops of piles used in the work this season, were subjected to two kinds of tests—one to determine the resistance under certain conditions to a crushing blow by a pile-driver hammer, and the other to determine resistance to a crushing force slowly applied. In the first test a pile was driven into the ground until it gave the same penetration per blow as do the piles actually in the jetties, and then was sawed off 26 feet below the top, the stump, about 4 feet high, being used as an anvil and the sawed-off part (26 feet long) being used as a follower between which the specimens were crushed. This plan was adopted to approximate as closely as possible the conditions obtaining when testing trestle piles where the teredo-eaten section is generally below low-water mark; that is, over 24 feet below the top. The specimens were struck by a 3,990-pound hammer falling through known heights. They were 4 by 4 inches, 5 by 5 inches, and 6 by 6 inches in cross section, with larger end sections to receive the pressure. The results of twenty experiments showed that for specimens of this kind and size, tested under these conditions, each foot of fall of the 3,990-pound hammer gave a blow sufficient to crush 5 square inches of wood, which under the second test was found to require 3,200 pounds per square inch to crush.

The practical application of the tests is this: Knowing the loads which pass over the trestle, the number of pounds that any pile may have to bear may be calculated from its position with regard to the stringers and other piles; then the number of square inches of sound wood necessary to bear the load with any particular factor of safety may be calculated, and the height of fall of hammer necessary to show that the pile has this number of square inches of sound wood is known. In this way any pile suspected of being weakened by teredo can be quickly subjected to proper test.

I submit herewith a statement of the items of work done by the contractor during the season. Rock delivered: Large, 72,250 tons, 1,820 pounds; small 117,182 tons, 10 pounds; total, 189,432 tons, 1,830 pounds. Rock rejected, 4,673 tons, 840 pounds.

Brush mattresses	cubic yards	8,812.2
Trestle with double-track railway	linear feet	1,735.7
Single-track railway built	do	1,242.0
Moving track on trestle	do	726.0
Piles driven	number	361
Caps placed	linear feet	1,358.0
Stringers placed	do	2,043.2
Rails laid	do	2,015.7
Extra labor amounted to		$481.51

The total earnings of the contractor for the season were $291,271.54.

I inclose herewith in separate package a drawing showing profile and cross section of the north jetty shortly after the close of the season (May, 1897), and also a diagram indicating the total amount of rock dumped in each bent of that jetty. The profile shows the bottom of the mats when laid, and the top of the rock in May, 1897, shortly after the cessation of work there. The cross sections show the same, and also, in a rather forcible manner, the extent to which the jetty has been widened in places by the sea.

I wish to state that since assuming charge of the work in March of this year I have received the most able and heartfelt cooperation of my assistant, Mr. D. E. Hughes, who has been the assistant engineer on this work since 1893. I also make my acknowledgments to Messrs. Floyd Moulton and Alexander L. Lucas for their zeal and close attention to their duties.

JAMES J. MEYLER,
First Lieutenant of Engineers.

Capt. CASSIUS E. GILLETTE,
Corps of Engineers, U. S. A.

Q Q 7.

PRELIMINARY EXAMINATION OF NAPA RIVER, CALIFORNIA, TO STRAIGHTEN CHANNEL FROM NAPA TO A POINT SOUTH OF CARRS BEND AND TO MAKE A CUT THROUGH CARRS BEND.

[Printed in House Doc. No. 117, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of September 10, 1896, by Maj. Charles E. L. B. Davis, Corps of Engineers, of the results of a preliminary examination of "Napa River, California, to straighten channel from Napa to a point south of Carrs Bend and to make cut through Carrs Bend," made to comply with the requirements of the river and harbor act of June 3, 1896.

Major Davis considers the locality to be worthy of improvement by the General Government within certain limits of cost, and his views are concurred in by Col. Charles R. Suter, Corps of Engineers, the division engineer.

I concur in the opinion of these officers to the extent of advising a survey of the river, estimated to cost $500, upon the results of which a more reliable opinion can be formed as to the scope of the improvement justified by the commerce involved.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF MAJ. CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 10, 1896.

GENERAL: I have the honor to submit the following report upon the preliminary examination of "Napa River, California, to straighten channel from Napa to a point south of Carrs Bend and to make a cut through Carrs Bend," provided for in the river and harbor act of June 3, 1896.

This examination was made by me September 9, 1896.

Napa River is a tidal stream draining a basin of some 400 square miles. At Napa City the tides vary from 5 to 7 feet, and it is this feature which gives the river a permanent value for navigation.

During the rainy season or season of floods the river brings down trees and snags and much detritus, the last mostly gravel, which, by settling, forms the shoals. The general low-water depth of the upper river is about 5 feet, with a reduction on the bars to about 1 foot, so that at low tide the river is not navigable at all and the times of arrival and departure of the steamers and sailing vessels have to be regulated by the tide.

The approved project for the improvement of this river (for the river has been under improvement by the United States since 1888) has consisted in clearing the river of snags and the banks of overhanging trees and dredging a channel through the bars between Carrs Bend and Vernon Mills, in the immediate vicinity of Napa City. As the channel dredged one year is liable to be filled up during the next winter floods, no permanent improvement of the river can be anticipated.

The preliminary examination was directed to the question of straightening the river from Napa to a point south of Carrs Bend and cutting through the latter. A point south of Carrs Bend is rather vague, as there are many points south of that bend, but I directed my examination particularly to Jacks Bend, Carrs Bend, and Lone Tree Bend, the last just above Suscol Ferry. This portion of the river is extremely crooked, and would be much improved by cutting through all of the points of these bends, were such cutting practicable within reasonable limits of cost.

The river is worthy of improvement by the General Government, for the United States has been improving it since 1888; so, while conceding the advisability of the improvement called for by the examination, I recommend a survey for the purpose of determining the question of the cost of this improvement.

The cost of the survey is estimated not to exceed $500.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., September 11, 1896.

Respectfully forwarded to the Chief of Engineers, United States Army.

I concur in the recommendation of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

Q Q 8.

PRELIMINARY EXAMINATION OF PETALUMA CREEK, CALIFORNIA, WITH A VIEW TO STRAIGHTENING CHANNEL FROM RAILROAD BRIDGE TO DONOHUE LANDING.

[Printed in House Doc. No. 209, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated the 2d instant, by Capt. Cassius E. Gillette, Corps of Engineers, of the results of a preliminary examination of Petaluma Creek, California, to straighten channel from the railroad bridge to Donohue Landing, made to comply with the provisions of the river and harbor act of June 3, 1896.

For reasons given, Captain Gillette is of opinion, which is concurred in by the division engineer, Col. Charles R. Suter, Corps of Engineers, and by me, that Petaluma Creek is not worthy of improvement by the United States in the manner indicated in the act.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 2, 1897.

GENERAL: I have the honor to submit the following report on a preliminary examination of Petaluma Creek, California, required by act of Congress of June 3, 1896, and your letter of June 16, 1896:

The language of the act is: "Petaluma Creek; straighten channel from railroad bridge to Donohue Landing." This creek has been under improvement by the United States since 1880. A total of $61,000 has been expended in dredging and making short cut-offs which removed long bends near the upper end of the stream. This work has maintained navigation up to the present time.

A map* showing the entire creek from Petaluma to its mouth is transmitted herewith. This map was prepared from the notes of a survey made some years ago, only a small portion of which has been heretofore platted. An examination of this map shows that the straightening mentioned in the law could be made in a variety of ways by cutting off the long bends, none of which cuts would afford a shortening of the channel in anything like the same proportions as those heretofore made. Apparently the most advantageous cuts that could be made would be from point A to B and from C to D on the map. This would shorten the channel 6,600 feet, but to give a channel 60 feet wide at the bottom and 6 feet deep at low water would require the removal of 496,207 cubic yards of material, which, at an estimated cost of 10 cents per cubic yard, would require the expenditure of about $50,000.

The commerce that seeks the river is carried on one steamer, which makes a round trip to San Francisco daily, except Sundays, and numerous scow schooners which carry the heavier freight. It is not believed that the improvement mentioned would cause any increase in the number of trips made by the steamer or the schooners, or any saving in the expense of each trip commensurate at all with the expense of making the improvement.

In my opinion, therefore, the locality is not worthy of improvement by the United States in the manner indicated by the act.

Very respectfully,

CASSIUS E. GILLETTE,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

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*Not printed.

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., January 5, 1897.

Respectfully forwarded. I concur in the views of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

Q Q 9.

PRELIMINARY EXAMINATION OF HUMBOLDT HARBOR, CALIFORNIA, WITH A VIEW TO DREDGING SAME ALONG CITY (EUREKA) FRONT.

[Printed in House Doc. No. 84, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 9, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated June 30, 1897, by Capt. Cassius E. Gillette, Corps of Engineers, upon the results of a preliminary examination of Humboldt Harbor, California, with a view of "dredging same along city front," made in compliance with the provisions of the river and harbor act of June 3, 1896.

It is assumed by Captain Gillette that Eureka is the city referred to in the provisions of the act, and he is of opinion, which is concurred in by the division engineer, Col. Charles R. Suter, Corps of Engineers, and by me, that the locality is worthy of improvement by the United States.

No survey is necessary for the purpose of preparing plan and estimate of improvement.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., June 30, 1897.

GENERAL: I have the honor to submit the following report on a preliminary examination of "Humboldt Harbor, dredging same along city front," provided for by act of Congress of June 3, 1896:

It is assumed that the city referred to is Eureka. This place is the principal shipping point of the territory mainly benefited by the improvements at present going on at the entrance to Humboldt Harbor. The bulk of the commerce which seeks this harbor goes to Eureka. The available depth on the bar at present is 22 feet, whereas vessels drawing 15 feet or less have difficulty in making a landing on account of lack of depth immediately in front of the wharves. The improvement under consideration is, therefore, one that should undoubtedly be made.

The only question which arises is whether it should be made at the expense of the United States or by the owners of the wharves. The facts bearing on this question are as follows: Eureka is located mainly on a narrow and rather shallow channel between Indian Island and the mainland. Commerce seeking the upper end of the bay need not go through this channel. The wharves are built practically in contact along the water front, there being no slips to speak of. This water front appears to have been originally owned by the State, ceded by the State to the city, and by the city sold at auction for small amounts, and the entire water front now in use is owned or claimed as private property. The improvement proposed is, therefore, directly beneficial to a number of private individuals. On the other hand, the improvement will undoubtedly be of great benefit to the general commerce of the country. Then, too, the harbor lines are located along the edges of the wharves, and the Government has heretofore spent about $80,000 in dredging along this water front and up to the towns of Arcata and Hookton. These latter facts, together with the established custom of the Government to dredge in front of the wharves in such cases, leaving private owners to dredge the slips, make it appear that the locality under consideration is "worthy of improvement by the United States," and it is so recommended.

No survey of the work is necessary, as an estimate of the cost can be prepared from information now on file.

Very respectfully,

CASSIUS E. GILLETTE,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., July 1, 1897.

Respectfully forwarded. I concur in the views of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

APPENDIX R R.

IMPROVEMENT OF RIVERS AND HARBORS IN OREGON, AND OF LOWER COLUMBIA RIVER, OREGON AND WASHINGTON.

REPORT OF CAPT. W. L. FISK, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Port Orford Harbor, Oregon.
2. Coquille River, Oregon.
3. Coquille River, Oregon, between Coquille City and Myrtle Point.
4. Entrance to Coos Bay and Harbor, Oregon.
5. Harbor at Coos Bay, Oregon.
6. Coos River, Oregon.
7. Umpqua River, Oregon.
8. Mouth of Siuslaw River, Oregon.
9. Alsea River, Oregon.
10. Yaquina Bay, Oregon.
11. Nestugga River, Oregon.
12. Tillamook Bay and Bar, Oregon.
13. Mouth of Columbia River, Oregon and Washington.
14. Columbia River, Oregon, below Tongue Point.
15. Columbia and lower Willamette rivers below Portland, Oregon.
16. Columbia River between Vancouver, Washington, and mouth of Willamette River.
17. Canal at the Cascades, Columbia River, Oregon.
18. Operating and care of canal and locks at the Cascades, Columbia River.
19. Columbia River at Three Mile Rapids, and boat railway from The Dalles Rapids to Celilo Falls.
20. Willamette River above Portland and Yamhill River, Oregon.
21. Gauging waters of Columbia River, Oregon and Washington.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 17, 1897.

GENERAL: I have the honor to submit herewith annual reports on the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1897.

Very respectfully, your obedient servant,

W. L. FISK,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

R R 1.

IMPROVEMENT OF PORT ORFORD HARBOR, OREGON.

The river and harbor act of June 3, 1896, contains the following item:

Improving Port Orford Harbor, at Grave Yard Point, Oregon, according to plan recommended by Captain Thomas W. Symons, of the Corps of Engineers, as per House Document Numbered Three hundred and thirteen, Fifty-third Congress, third session, January thirtieth, eighteen hundred and ninety-five, to cost not to exceed two hundred and three thousand three hundred and thirty-six dollars, and the unexpended balance of the appropriation heretofore made, March third, eighteen hundred and seventy-nine, for the establishment of a harber of refuge on the Pacific Coast is hereby transferred to be expended on this improvement, if, in the opinion of the Secretary of War the interests of commerce demand such expenditure.

This act also provides for a survey of "Port Orford Harbor, Oregon, with estimate of cost of improvement and importance to shipping and commerce."

Money statement.

Amount appropriated by act of June 3, 1896, being unexpended balance of appropriation of March 3, 1879, for harbor of refuge on Pacific Coast.	$140,858.52
July 1, 1897, balance unexpended	140,858.52
Amount (estimated) required for completion of existing project	62,477.48
Amount that can be profitably expended in fiscal year ending June 30, 1899	62,477.48
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

R R 2.

IMPROVEMENT OF COQUILLE RIVER, OREGON.

GENERAL IMPROVEMENT.

Original condition.—The entrance to the Coquille River was originally by a narrow and tortuous channel skirting the south headland for some distance outside the bar at the mouth. This channel, both outside the bar and for a distance of one-half mile inside, was studded with rocks, while the portion across the bar was constantly shifting in position. The low-water depth was but about 3 feet, being increased to a little over 7 feet at mean high tide.

At long intervals the channel would break through the north spit and run directly out to sea just south of Rackcliffe Rock, making the entrance comparatively safe; but this most favorable condition was of short duration.

Approved project.—The original project for improvement contemplated the construction of two nearly parallel high-tide jetties, to be 800 feet apart at their outer ends, and to extend out to sea a sufficient distance to open and maintain a low-water channel with a depth of 8 feet across the bar, the north jetty to start from Rackcliffe Rock and the south jetty from the left bank inside the entrance. In 1891 the project was changed to provide for an entrance width of 600 feet instead of 800 feet. The cost of the improvement was estimated in 1878 at $164,200. A revised estimate made in 1892 places the cost of completing the improvement at mouth of the river at $180,000, making the total estimated cost $285,000. These figures, however, include $6,883.90 expended from the allotments of 1888 and 1890 for snagging between Coquille City and Myrtle Point.

Amount expended to June 30, 1896.—The sum expended to June 30, 1896, exclusive of the amount expended for snagging as above, was $141,162.69.

Results obtained to June 30, 1896.—At this date the north jetty had a length of 510 feet and the south jetty a length of 2,116½ feet, the result being to secure a straight channel across the bar with a low-water depth varying from 4 to 10 feet, this instability being due to shifting sands which are driven in by storms after each deepening of the channel from the effect of the jetties.

Work done during the fiscal year 1897.—A contract for extending the south jetty was made December 26, 1896, with Mr. Daniel Kern, work to begin on or before May 1, 1897, and to be completed not later than December 31, 1897. By the terms of this contract the use of a double-track tramway for extending the jetty similar to that built at Coös Bay is required, the work prior to fiscal year 1896 having been carried on by means of a single-track tramway on a trestle of close piling. It is also required that brush mattresses be used as a foundation for the additional enrockment. The contractor is permitted the use of a pile driver, one locomotive, two hoisting engines, and twelve dump cars, together with some minor articles of plant belonging to the United States, for which a monthly rental of $150 is to be paid.

In May the contractor began to prepare for work. During June active operations were fairly started, and progress has been satisfactory.

It was decided to work under the present contract on the south jetty, because this tramway was in such condition it was judged it would be unsafe by the time work could begin under the next contract.

The north tramway is already in bad condition and will probably have to be rebuilt before it can be used.

The depth on the bar has not been materially increased during the year, and no substantial improvement is anticipated in advance of the proposed extension of the north jetty.

APPROPRIATIONS.

Act of—		Act of—	
July 14, 1880	$10,000	July 13, 1892	$25,000
August 2, 1882	10,000	August 17, 1894	20,000
July 5, 1884	10,000	June 3, 1896	20,000
August 5, 1886	20,000		
August 11, 1888*	25,000	Total	170,000
September 19, 1890†	30,000		

Money statement.

July 1, 1896, balance unexpended		$21,953.41
June 30, 1897, amount expended during fiscal year		952.57
July 1, 1897, balance unexpended		21,000.84
July 1, 1897, outstanding liabilities	$3,017.31	
July 1, 1897, amount covered by uncompleted contracts	7,784.69	
		10,802.00
July 1, 1897, balance available		10,198.84
Amount (estimated) required for completion of existing project		115,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		115,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

* Five thousand dollars of this appropriation was allotted for snagging between Coquille City and Myrtle Point.

† Not to exceed $3,000 of this appropriation was to be expended between Coquille City and Myrtle Point.

Abstract of proposals for extending the south jetty at Coquille River, Oregon, opened at Portland, Oreg., on the 22d day of December, 1896, by Capt. W. L. Fisk, Corps of Engineers.

No.	Bidders.	Piles (6,000 feet), per foot.	Lumber (32,000 feet), per M.	Driftbolts (2,500 pounds), per pound.	Bolts with nuts and washers (600 pounds), per pound.	Wrought spikes (300 pounds), per pound.	Railroad spikes (300 pounds), per pound.	Mattresses (900 cubic yards), per cubic yard.	Stone (15,000 tons), per ton.	Total.
		Cts.		Cts.	Cts.	Cts.	Cts.		Cts.	
1	Patrick O'Neil, San Francisco, Cal	14	$18.00	6	8	5	5	$2.10	74	$14,634.00
2	Lorenzo D. Smith, Marshfield, Oreg	9½	14.75	6	7	8	6	.55	64½	11,546.00
3	Noble & Saunders, Marshfield, Oreg	15	15.00	5	15	8	8	1.40	53	10,853.00
4	William Henry Button, Bandon, Oreg	19	14.00	4	5¾	3¾	3	1.00	80	14,642.75
5	Paquet & Smith, Portland, Oreg	12	15.00	4	18	6	6	.90	69	12,604.00
6	McCubben & Nickum, Portland, Oreg	8	9.50	3	3	8	3	.40	75	12,505.00
7	G. O. Nolan, Tillamook, Oreg	20	20.00	10	10	10	10	.95	90	16,565.00
8	Daniel Kern, Portland, Oreg	8½	9.00	3	5	5	4	.35	63	10,695.00
9	R. M. Riner, Portland, Oreg	17½	13.00	4	5	4	4	.35	67½	12,042.00
10	Wakefield & Jacobsen, Portland, Oreg	10	12.50	4	5	5	5	.57	72	12,473.00
11	Louis H. Hazard, Empire City, Oreg	6	8.50	3	8	8	8	.35	68	11,258.00

Contract awarded to Daniel Kern, and executed under date of January 7, 1897.

The only contract in force on this work was made with Daniel Kern, approved January 7, 1897, work to be begun March 1 and finished December 31, 1897.

COMMERCIAL STATISTICS.

The Coquille River is in the collection district of southern Oregon. Empire City on Coos Bay, is the port of entry. The nearest light-house is at Rackcliffe Rock, on the north side of the entrance.

The following statistics have been compiled from the monthly reports of J. A. Laughead, watchman in charge of Government property. They are for the calendar year 1896.

Arrivals and departures.

Coastwise steam and sailing vessels.	Number.	Aggregate tonnage.
Arrivals	91	9,323
Departures	88	9,500
Total	179	18,823

Classification of vessels: 87 schooners, 3 steamers, 1 tug.

Receipts and shipments.

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS—continued.	
General merchandise	2,128	Match wood	813
Wool	117	Laths	83
Brick	25	Broom handles	273
Salmon	14	Salmon	63
Machinery	25	Wool and woolen goods	21
		Hides	4
Total	2,309	Agricultural products	22
		Live stock	77
SHIPMENTS.		Miscellaneous	12
Lumber and logs	15,289	Total	18,797
Coal	2,140		

R R 3.

IMPROVEMENT OF COQUILLE RIVER, OREGON, BETWEEN COQUILLE CITY AND MYRTLE POINT.

Original condition.—The Coquille is a tidal river, navigable by small coasting vessels from its mouth to Coquille City, 25 miles, and thence by river craft to Myrtle Point, a farther distance of 13 miles. Navigation in this upper stretch has always been much obstructed by shoals and snags, the latter being brought in at each freshet by the various forks which drain densely timbered basins.

Approved project.—The project contemplates the removal of obstructing snags between Coquille City and Myrtle Point and deepening the channel by means of contracting dikes, the effect of the latter to be supplemented by dredging wherever necessary to secure a low-water channel depth of 4 feet and a minimum width of 50 feet. The original estimate of cost, made in 1891, was $26,000. A revised estimate, based on a survey made in 1894, places the cost of completing the improvement at $43,176.48. This sum, together with expenditures previously made, increases the estimate to $50,980.77.

The amount expended ($6,883.90) from the allotments of 1888 and 1890 for snagging between Coquille City and Myrtle Point is not included in the above estimate.

Amount expended to June 30, 1896.—The amount expended on the present project to June 30, 1896, was $8,437.04.

Results obtained to June 30, 1896.—Up to this date many snags had been removed by a snag boat especially fitted up for the purpose, and deflecting dikes had been built at Roberts Landing and at Rackcliffe Bar, the effect being to greatly benefit navigation. The work done, however, was mostly of a temporary character, and, as the river has continued to shoal since the survey of 1891, but little progress had been made toward completion of the project for permanent improvement.

Work done during the fiscal year 1897.—A contract was made May 1, 1897, with Noble & Saunders, of Marshfield, Oreg., for dredging, snagging, repairing existing wing dams and beginning dike construction, the work to be done below Rackcliffes Landing, and to be completed by December 1, 1897. Under this contract preparations for the work were made in May and June, and the snagging begun June 18, 1897.

APPROPRIATIONS.

Act of—	
July 13, 1892	$5,000
August 17, 1894	5,000
June 3, 1896	12,000
Total	22,000

Money statement.

July 1, 1896, balance unexpended		$13,562.96
June 30, 1897, amount expended during fiscal year		122.60
July 1, 1897, balance unexpenned		13,440.36
July 1, 1897, outstanding liabilities	$357.50	
July 1, 1897, amount covered by uncompleted contracts	12,252.50	
		12,610.00
July 1, 1897, balance available		830.36
Amount (estimated) required for completion of existing project		28,980.77
Amount that can be profitably expended in fiscal year ending June 30, 1899		28,980.77

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for dredging, constructing dikes, etc., in Coquille River, Oregon, opened April 12, 1897, by Capt. W. L. Fisk, Corps of Engineers.

Name and address of bidders.	35,000 lin. feet piles, (per lin. foot).	30,000 feet B.M. lumber (per M).	3,000 pounds spikes (per pound).	2,100 cords brush (per cord).	3,000 pounds wire (per pound).	2,000 tons stone (per ton).
	Cents.		*Cents.*		*Cents.*	
Wakefield & Jacobsen, Portland, Oreg..	11	$12.00	3½	$2.35	4	$0.75
Noble & Saunders, Marshfield, Oreg....	12½	12.50	7½	2.25	7½	1.00
G. O. Nolan, Tillamook, Oreg..........	20	10.00	1	1.00	1	.75
Joseph Paquet, Portland, Oreg..........	9½	8.50	4	2.20	3½	.60
Chas. A. Gray, Salem, Oreg............	9½	14.49	9.49	1.49	18	1.04

Name and address of bidders.	7,000 sand bags (each).	5,500 cubic yards excavation, sand (per cubic yard).	3,200 cubic yards excavation, gravel (per cubic yard).	20 days' snagging, plant (per day).	Total.
	Cents.	*Cents.*	*Cents.*		
Wakefield & Jacobsen, Portland, Oreg..	13	35	55	$40.00	$16,265.00
Noble & Saunders, Marshfield, Oreg....	12	10	15	25.00	14,295.00
G. O. Nolan, Tillamook, Oreg..........	10	40	50	10.00	15,660.00
Joseph Paquet, Portland, Oreg.........	15	31	36	60.00	14,732.00
Chas. A. Gray, Salem, Oreg............	14½	29	34	199.00	17,471.40

Contract awarded to Noble & Saunders and executed under date of May 28, 1897.

The only contract in force on this work was made with Noble & Saunders, of Marshfield, Oreg., approved May 28, work to be begun June 1 and finished December 1, 1897.

COMMERCIAL STATISTICS.

The traffic on Coquille River between Coquille City and Myrtle Point for the year ending December 31, 1896, was accommodated by the steamers *Cumtux*, of 2.25 tons capacity, and the *Myrl*, of 7.43 tons capacity, the freight carried being as follows:

Articles.	Up.	Down.
	Tons.	*Tons.*
General merchandise, machinery, etc	650	....
Butter and cheese	....	500
Bacon	....	40
Live hogs	....	30
Apples and potatoes	....	295
Oats and barley	....	140
Hay	....	350
Milk	....	1,200
Total	650	2,555

Passengers, up and down, 3,500.

R R 4.

IMPROVEMENT OF ENTRANCE TO COOS BAY AND HARBOR, OREGON.

Original condition.—The entrance to Coos Bay was originally obstructed both by the outer bar of shifting sand and by the inner shoals caused by sands driven in during the prevalence of northwesterly winds. The north spit was advancing under the influence of these winds and contracting the navigable channel near the southern headland to a very narrow width, and causing the channel across the bar to follow in a tortuous course along the west side of the spit. The low-water depth on the bar was sometimes as little as 10 feet.

The channel had at times broken through the north spit nearly on the range from Fossil Point to Coos Head, making a nearly straight line of entrance. At such times the greatest depth was found and vessels could enter or leave the port without difficulty. The mean rise of tide above the plane of reference was 5.6 feet.

Approved project.—The original project, adopted in 1879, but since abandoned, was to construct a jetty starting from a point 250 yards below the northern extremity of Fossil Point and extending westerly toward Coos Head, the line curving slightly so that at its outer end it would be directed to or a little north of this headland, the object being to prevent further encroachment on the channel by the north spit, and to permanently open a direct channel across the bar. The estimated cost of this project was $600,000.

The present project, which was adopted in 1889 (Board of Engineers, October 27, 1889), contemplates the construction of two high-tide jetties of stone, the north jetty to extend seaward from the southern end of the north spit, and the south jetty to start from Coös Head, the two jetties to converge so that the outer entrance shall have a width of about 1,500 feet. The project also includes reclaiming the sands of the north spit so as to prevent their being blown into the channel. The cost of this improvement was estimated at $2,466,412.20.

Amount expended to June 30, 1896.—The amount expended under the present project to June 30, 1896, was $429,409.42. Including the amount ($213,750) expended on the project of 1879, the total expenditures to that date were $643,159.42.

Results obtained to June 30, 1896.—Up to the close of the last fiscal year the tramway for the north jetty had been completed and the mattress foundation for the enrockment had been laid and ballasted with small rock for its entire length of 10,368 feet. For a length of 5,000 feet the enrockment had been raised to high-tide level; for a further distance of 4,500 feet, and also at the outer end, it was at about the level of low water. The high-water depth across the bar at this time was about 25 feet.

Work done during the fiscal year 1897.—During last winter's storms the crest of the enrockment was somewhat beaten down, and it was decided to use all the present appropriation in raising the north jetty, and a contract for this work was made October 30, 1896. Under this contract the Government plant was rented to the contractors, and they commenced to place it in repair during November. About the middle of December the delivery of rock from the Government quarries was begun, and has continued since at a rate averaging about 14,000 tons per month.

Heavy weather during the winter and spring months carried away 25 bents (about 400 feet) of trestle and tracks, leaving bent 613 the last now standing.

There has been a least low-water depth on the bar varying from 18 to 22 feet, and nothing less than the former has been reported. The channel has shifted a little to the southward (away from the jetty), and it is possible the soundings were not in the best water.

The increase in height of the jetty under the existing contract will probably easily restore the greater depth.

The climate is very severe on plant, and, although given the best possible care, it will have to be very extensively repaired if the Government is to get any benefit from it under the next contract.

The teredo has seriously damaged the piles of the tramway, and it also will have to be largely rebuilt before it can be used with safety for future work.

From the above remarks regarding the tramways and plant it will be seen that an increased amount will be necessary in order to make any material progress under the next appropriation.

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1879	$40,000	September 19, 1890	$125,000
March 3, 1881	30,000	July 13, 1892	210,000
August 2, 1882	30,000	August 17, 1894	95,000
July 5, 1884	30,000	June 3, 1896	95,000
August 5, 1886	33,750		
August 11, 1888	50,000	Total	738,750

Money statement.

July 1, 1896, balance unexpended		$95,590.58
June 30, 1897, amount expended during fiscal year		35,866.95
July 1, 1897, balance unexpended		59,723.63
July 1, 1897, outstanding liabilities	$7,365.09	
July 1, 1897, amount covered by uncompleted contracts	43,784.51	
		51,149.60
July 1, 1897, balance available		8,574.03
Amount (estimated) required for completion of existing project		1,941,412.20
Amount that can be profitably expended in fiscal year ending June 30, 1899		600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for furnishing rock and placing same on the north jetty at entrance to Coos Bay, Oregon, opened at Portland, Oreg., on the 29th day of October, 1896, by Capt. W. L. Fisk, Corps of Engineers.

No.	Name and address of bidder.	80,000 tons (per ton).	Total.
1	Wakefield & Jacobsen, Portland, Oreg	$0.52½	$42,000
2	Noble & Saunders, Marshfield, Oreg	.73½	58,800
3	Hugh Foy, Seattle, Wash	1.15	92,000
4	William H. Healy, San Francisco, Cal	1.07	85,600
5	Paquet & Smith, Portland, Oreg	.73	58,400
6	Daniel Kern, Portland, Oreg	.57	45,600
7	Robert A. Graham, Marshfield, Oreg	.90½	72,400
8	Dickinson & McLean, Tacoma, Wash	.69½	55,600
9	Patrick O'Neil, San Francisco, Cal	1.25	100,000

Contract awarded to Wakefield & Jacobsen, and executed under date of October 30, 1896.

The only contract in force on this work was made with Wakefield & Jacobsen, of Portland, Oreg., approved November 7, 1896, work to be begun on November 20, 1896, and finished December 1, 1897.

COMMERCIAL STATISTICS.

Coos Bay is in the collection district of southern Oregon. Empire City, on Coos Bay, is the port of entry. The nearest light-house is at Cape Arago, on the south side and west of the entrance.

The following statistics have been compiled from the monthly reports of J. S. Polhemus, assistant engineer, in local charge of works; they are for the calendar year 1896:

Arrivals and departures.

	Steamers.		Sailing vessels.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Arrived	346	121,267	69	13,557	415	134,824
Cleared	349	121,252	76	14,884	425	136,136
Total	695	242,519	145	28,441	840	270,960

Number of passengers arrived by sea	2,100
Number of passengers departed by sea	2,109

Vessel built.

The four-masted barkentine *Echo*, to carry 1,000,000 feet of lumber, was launched in August at North Bend shipyard.

Receipts and shipments.

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS—continued.	
Miscellaneous freight	9,695	Railroad ties	405
		Chittim bark	20
Total	9,695	Pickets	11
		Apples and potatoes	1,764
SHIPMENTS.		Butter and cheese	314
		Cattle and hogs	80
Coal	89,960	Fish	465
Lumber (22,893,024 feet)	34,340	Woolen goods	114
Laths	1,840	Miscellaneous freight	2,233
Firewood and match wood	2,548		
Piles, poles, and spars	1,121	Total	135,239
Ship knees	24		

R R 5.

IMPROVEMENT OF HARBOR AT COOS BAY, OREGON (DREDGING).

Original condition.—In the upper portion of Coos Bay and its tributary sloughs there are a number of shoals which interfere with navigation, the principal shoal being just below Marshfield, at the extreme upper end of the bay. Another shoal in Isthmus Slough obstructs navigation to the Bay City mill. As shown by the survey of 1891, the former of these shoals had a least depth of but 5 feet and the latter of but 8 feet at low water.

Approved project.—The project submitted in 1891 contemplates the construction of a dredge and two scows and the opening of channels 10 feet deep through the shoals named, at an estimated cost of $27,390. In furtherance of this project an appropriation of $13,000 was made by the act of August 17, 1894, but this sum being insufficient for constructing the proposed dredging plant, operations were delayed awaiting adequate provision for its construction and operation.

The remainder of the estimate was appropriated by act of June 3, 1896.

Since the preparation of the project of 1891 conditions have changed so materially as to require new plans and a revised estimate of cost. The low-water depth at the entrance to the bay has now been greatly increased from the effect of the works of improvement in progress, and the proposed low-water depth of 10 feet across the shoals is evidently insufficient to accommodate vessels of the increased draft which now cross the bar without difficulty.

Amount expended to June 30, 1896.—The amount expended on this improvement to June 30, 1896, was $500.

Results obtained to June 30, 1896.—Bids for dredging machinery were opened January 24, 1895, but the money available being insufficient, action was suspended awaiting further appropriations.

Work done during the fiscal year 1897.—The law as it stands requires the building of a dredge and two dump scows. With a view to carrying out this requirement proposals for machinery for a dredge were again opened on November 10, 1896. The dredge hull and dump scows it was proposed to build at Coos Bay, but it was found that their cost, added to that of the machinery, would leave little money with which to operate, especially as it would be necessary to hire a tug for towing the scows. Furthermore, the locality is such that to properly dispose of the material in this manner would require such an excessive length of tow that two dump scows could not keep the dredge at work. A considerable amount of dredging is badly needed, and as it seemed, all things considered, that contract work would give much greater actual improvement with the amount of money available than could be attained by building and operating a dredge, it was decided to request Congress to so change the law as to allow the Department the option of contracting for the work, and it is understood a joint resolution to that effect is now before Congress.

APPROPRIATIONS.

Act of—	
August 17, 1894	$13,000
June 3, 1896	14,390
Total	27,390

Money statement.

July 1, 1896, balance unexpended	$26,890.00
June 30, 1897, amount expended during fiscal year	15.08
July 1, 1897, balance unexpended	26,874.92

R R 6.

IMPROVEMENT OF COOS RIVER, OREGON.

The river and harbor act of June 3, 1896, contains the following item:

Improving Coos River, Oregon: Completing improvement in accordance with plans submitted January nineteenth, eighteen hundred and ninety-five, five thousand dollars.

The plans to which reference is made provide for removing snags and bowlders and cutting through bars where necessary to secure a channel 50 feet wide from the mouth of the river to the head of navigation on the north and south forks, including 5½ miles on the main river and about 8½ miles on each fork. The average range of tide is about 5 feet for the entire distance, giving ample depth for navigation. (See Report of the Chief of Engineers for 1895, part 5, p. 3502 et seq.)

Amount expended to June 30, 1896, nothing.

Results obtained to June 30, 1896, none.

Work done during the fiscal year 1897.—In order to get rock for the jetty at the entrance to Coos Bay from the Government quarries on the river it was necessary to remove a number of snags in February and March, which was done by arrangement with the contractors for the jetty work at a cost of $130. Some débris from the Government quarries was also placed as a training dike at a cost of $35 for hired labor.

The remainder of the snagging will be done during the low water season with Government plant belonging to other works and which is now being prepared for that purpose.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	130.00
July 1, 1897, balance unexpended	4,870.00
July 1, 1897, outstanding liabilities	60.00
July 1, 1897, balance available	4,810.00

COMMERCIAL STATISTICS.

The traffic on Coos River for the calendar year ending December 31, 1896, was accommodated by the steamer *Coos River*, of 8.30 tons capacity; *Butcher Boy*, of 2.50 tons capacity; *Milton*, of 11.94 tons capacity, and the *Alert*, of 40 tons capacity, and the freight carried was as follows:

Articles.	Down.	Up.	Articles.	Down.	Up.
	Tons.	*Tons.*		*Tons.*	*Tons.*
Butter and cheese	62	....	Milk	91	....
Hogs	23	....	Logs	8,800	....
Potatoes	900	....	Miscellaneous freight	150	....
Beef	77	....	Stone	7,449	....
Hay	500	....	General merchandise, loggers' supplies, seed, powder, tools, implements, etc	....	1,000
Fruit	100	....			
Hides	11	....			
Honey	3	....			
Vegetables	80	....	Total	18,683	1,000
Salmon	437	....			

Besides the above, about 970 tons of milk was transported from the various landings to the creamery and was finally shipped out as butter.
Passengers carried on the river by the boats, about 4,500.

R R 7.

IMPROVEMENT OF UMPQUA RIVER, OREGON.

Original condition.—Just below Scottsburg, the head of navigation, the Umpqua River is obstructed by five sandstone bars or ledges, separated by pools of about 150 feet. These bars, which have a width of from 12 to 15 feet, are submerged but from 1 to 2 feet at the lowest stages of tide and river.

Approved project.—The project adopted in 1885 and extended in 1890, contemplates securing a channel way having a minimum width of 50 feet and a low-water depth of 4 feet from Scottsburg to its mouth, a distance of 26 miles. The cost of completing the improvement, which involved the removal of ledges and bowlders in the wharf basin at Scottsburg and of obstructions below this point, was estimated in 1890 at $9,000, making a total estimated cost of $15,685.89.

Amount expended to June 30, 1896.—The total amount expended to June 30, 1896, was $33,500, of which $17,814.11 pertaining to the appropriation of March 3, 1871, was expended under previous projects and $15,685.89 under the project of 1885–1890.

Results obtained to June 30, 1896.—The improvement had been completed, with the exception of the removal of ledges in the wharf basin at Scottsburg, where 700 cubic yards of the 1,200 cubic yards of rock obstructions to be removed, according to the estimate, had been taken out, leaving 500 cubic yards still to be removed.

Work done during the fiscal year 1897.—No work was done during the fiscal year ending June 30, 1897, but a contract was made May 1, 1897, for removal of rock at $8 per cubic yard, work to be completed by November 1, 1897. Active operations will begin in July.

A supplemental estimate of $6,000 for completing the improvement, made necessary on account of certain difficulties attending its prosecution, for which sufficient allowance had not been previously made, was submitted by Capt. Thomas W. Symons, Corps of Engineers, in his annual report for 1894 (Report of the Chief of Engineers for 1894, p. 2571), and this amount was appropriated in the act of June 3, 1896.

APPROPRIATIONS.

Act of—	
March 3, 1871	$22,500
August 11, 1888	2,000
September 19, 1890	9,000
June 3, 1896	6,000
Total	39,500

Money statement.

July 1, 1896, balance unexpended	$6,000.00
June 30, 1897, amount expended during fiscal year	29.98
July 1, 1897, balance unexpended	5,970.02
July 1, 1897, outstanding liabilities	4,000.00
July 1, 1897, balance available	1,970.02

Abstract of proposals for rock excavation in Umpqua River, Oregon, opened April 12, 1897, by Capt. W. L. Fisk, Corps of Engineers.

No.	Name and address of bidder.	Rock excavation (500 cubic yards), per cubic yard.	Total.
1	Normile & Fastabend, Astoria, Oreg	$8.00	$4,000.00
2	Joseph Paquet, Portland, Oreg	18.00	9,000.00
3	G. O. Nolan, Tillamook, Oreg	20.00	10,000.00
4	Noble & Saunders, Marshfield, Oreg	9.25	4,625.00
5	Charles A. Gray, Salem, Oreg	9.24	4,620.00
6	Perry Hinkle, Portland, Oreg	10.95	5,475.00

Contract awarded to Normile & Fastabend, and executed under date of May 30, 1897.

The only contract in force on this work was made with Normile & Fastabend, of Astoria, Oreg., approved May 20, work to be begun July 1, and finished November 1, 1897.

COMMERCIAL STATISTICS.

Umpqua River is in the collection district of southern Oregon. Empire City, Coos Bay, is the nearest port of entry. The nearest light-house is one-half mile south of the entrance to the river.

The following statistics for tue year ending December 31, 1896, have been furnished by Mr. O. B. Hinsdale, of the Gardiner Mill Company:

Vessels arrived and cleared.

The number of coastwise vessels arriving and clearing during the year was 81; of these, 38 were steamers and 43 sailing vessels. The maximum draft of loaded vessels was 14.6 feet.

Receipts and shipments.

Articles.	Received.	Shipped.
	Tons.	*Tons.*
General merchandise	1,500	
Agricultural implements	10	
Cannery supplies	60	
Lumber (10,000,000 feet)		15,000
Laths (2,000 M)		600
Salmon		350
Grain		125
Cattle		250
Miscellaneous freight		58
Total	1,570	16,383

Estimated value of imports	$103,500
Estimated value of exports	151,450

Umpqua River traffic.

Steamer *Juno*, propeller, 22.28 tons, made triweekly trips between Gardiner and Sulphur Springs. Business during the year: Freight, 500 tons; passengers, 1,490.

Steamer *Eva*, stern wheel, made daily trips between Gardiner and Scottsburg. Business during the year: Freight, 1,000 tons; passengers, 2,600.

R R 8.

IMPROVEMENT OF MOUTH OF SIUSLAW RIVER, OREGON.

Original condition.—The Siuslaw River enters the ocean through a shifting sand beach without headland or other fixed point to mark the entrance. The channel across this outer bar has a range of about 1 mile in location and varies in depth from 5 to 12 feet at low water, the latter being equal to the controlling depth inside.

Approved project.—The project for improvement, adopted in 1891 and modified in 1892, contemplates the construction of two high-tide stone jetties so located as to direct the currents upon the ocean bar in a direction practically perpendicular to the coast; the jetties to converge so as to give an entrance width of 600 feet on the crest of the bar. The north jetty, to start from the mainland about half a mile north of Cannery Hill, is to have a length of 4,500 feet; the south jetty, to extend from the end of the sandy peninsula, is to have a length of 3,200 feet. The approximate location of these jetties is shown on the map published in the Annual Report of the Chief of Engineers for 1893 (p. 3346). The estimated cost of the improvement is $700,000.

Amount expended to June 30, 1896.—The amount expended on this improvement to June 30, 1896, was $94,179.30.

Results obtained up to June 30, 1896.—Up to the beginning of the fiscal year 1896 the work done had been mostly of a preliminary character. It included the construction and assemblage of the necessary plant and the construction of a receiving wharf, of a railway trestle along the beach from this wharf to the root of the north jetty, and of the requisite buildings. A contract for continuing the improvement under the appropriation of 1894 was entered into on April 4 with Daniel Kern, the contractor to pay a monthly rental of $200 for use of the Government plant. The contract provided for the necessary repairs to the existing wharf and tramway, which had been partially destroyed by winds, waves, and landslides, and for extending the jetty as far as practicable with available funds. A mattress foundation was placed wherever the enrockment was upon the deep sand of the bar. This work was completed October 29, 1895, the jetty having been extended 500 feet and the enrockment partially completed on the channel side of the tramway. This tramway had a total length of 3,029 feet and was in good condition generally, although it had settled in some places so that repairs were necessary.

Work done during the fiscal year 1897.—A contract was made February 3, 1897, for extending the north jetty, and under it work was commenced in May. Considerable repairs to the tramway were necessary and some to the wharf; the plant also required repairs, so that the actual work of extending the jetty was not begun until June 1. The extension of the jetty is in deep water and directly across the existing channel, so it will be necessary to work with care. Work is progressing satisfactorily under the existing contract.

All work so far has been on the north jetty, but progress on the project has not yet been sufficient to produce any material effect on the bar.

APPROPRIATIONS.

Act of—

September 19, 1890	$50,000
July 13, 1892	20,000
August 17, 1894	25,000
June 3, 1896	27,000
Total	122,000

Money statement.

July 1, 1896, balance unexpended		$27,820.70
June 30, 1897, amount expended during fiscal year		1,148.07
July 1, 1897, balance unexpended		26,672.63
July 1, 1897, outstanding liabilities	$1,011.99	
July 1, 1897, amount covered by uncompleted contracts	11,224.34	
		12,236.33
July 1, 1897, balance available		14,436.30
Amount (estimated) required for completion of existing project		578,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899		100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for extending jetty at Siuslaw River, Oregon, opened January 22, 1897, by Capt. W. L. Fisk, Corps of Engineers.

No.	Name and address of bidder.	Piles (8,800 linear feet), per foot.	Lumber (56,500 feet B. M.), per M.	Drift-bolts No. 450 (2,610 pounds) per pound.	Bolts with nuts and washers (200 pounds No. 30), per bolt.	Brush mattresses (1,000 cubic yards), per cubic yard.	Stone (20,000 tons), per ton.	Total.
		Cents.		*Cents.*	*Cents.*		*Cents.*	
1	Wm. Kyle, Florence, Oreg	6	$6.00	3	5	$0.65	81	$17,796.90
2	Wakefield & Jacobsen, Portland, Oreg	10	11.00	3	21	.20	51½	12,086.10
3	Daniel Kern, Portland, Oreg	7	8.50	4	15	.22½	61	13,630.15
4	Noble & Saunders, Marshfield, Oreg.	10	8.00	3½	25	.70	59	13,930.85
5	G. O. Nolan, Tillamook, Oreg	4	6.00	1	1	.10	92	19,217.40
6	Minsinger & Smith, Portland, Oreg.	12	15.00	4	6	1.10	75	18,109.70

Contract awarded to Wakefield & Jacobsen, and executed under date of February 27, 1897.

The only contract in force on this work was made with Wakefield & Jacobsen, of Portland, Oreg., approved February 27, work to commence May 1 and be finished December 31, 1897.

COMMERCIAL STATISTICS.

The Siuslaw River is in the collection district of Yaquina, on Yaquina Bay. The nearest light-house is at Heceta Head, 8½ miles north of the river entrance.

The following statement of traffic for the year ending December 31, 1896, has been compiled from the monthly reports of J. W. Eldridge, of Florence, Oreg.

Arrivals and departures of vessels.

Coasting vessels.	Number.	Aggregate tonnage.
Arrivals	65	4,608
Departures	68	4,703
Total	133	9,311

Classification of vessels: Steamers, 8; tugs, 35; schooners, 25.

Receipts and shipments.

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Flour and feed	472	Salmon	612
Cannery supplies	430	Lumber (3,284,000 feet B. M.)	4,926
General merchandise	537	General merchandise	207
Total	1,439	Total	5,745

R R 9.

IMPROVEMENT OF ALSEA RIVER, OREGON.

The river and harbor act of June 3, 1896, contains the following item:

Improving Alsea River, Oregon: Completing improvement in accordance with plans submitted January nineteenth, eighteen hundred and ninety-five, three thousand dollars.

The plans to which reference is made propose the improvement of the downstream navigation of the river at the higher stages from the forks to the head of the tide by the removal of rocks and other obstructions. The length of river to be thus improved is 31 miles. (See Report of the Chief of Engineers for 1895, part 5, p. 3505 et seq.)

Work done during the fiscal year 1897.—A contract for this work, which can only be done during low water, was made February 10, 1897, and the contractor has just commenced active operations.

Money statement.

July 1, 1896, balance unexpended		$3,000.00
June 30, 1897, amount expended during fiscal year		29.19
July 1, 1897, balance unexpended		2,970.81
July 1, 1897, outstanding liabilities	$5.60	
July 1, 1897, amount covered by uncompleted contracts	1,475.00	
		1,480.60
July 1, 1897, balance available		1,490.21

Proposals for removing obstructions from Alsea River, Oregon, opened January 22, 1897, by Capt. W. L. Fisk, Corps of Engineers.

No.	Bidder.	Address.	Price.
1	Willis Vidito	Alsea, Oreg	$1,890.00
2	G. O. Nolan	Tillamook, Oreg	2,100.00
3	W. H. Millhollen	Oakville, Oreg	1,889.00
4	Oscar Tom	Alsea, Oreg	2,480.00
5	Charles P. Church	Portland, Oreg	1,475.00

Contract awarded to Charles P. Church, and executed under date of February 10, 1897.

The only contract in force on this work was made with Charles P. Church, of Portland, Oreg., approved February 26, work to be begun as early in 1897 as the condition of the river will permit and finished October 15, 1897.

R R 10.

IMPROVEMENT OF YAQUINA BAY, OREGON.

Original condition.—Prior to improvement there were three channels across the entrance bar, the south channel being most used, although seriously obstructed by rocks. The middle channel was free from rock obstructions, but was too shoal for general use, while the north channel was so crooked and rocky as to be considered unnavigable. The prevailing depth over the bar was from 7 to 8 feet at low water, with a mean tide of 7.1 feet.

Owing to the shifting character of the bar, the channels across it were constantly changing both in location and in depth.

Approved project.—The original project, adopted in 1881, was to build a jetty starting near low-water line on the south side and running seaward 2,500 feet, its top to be 2 feet above low-water level, the object being to close the south channel and to permanently increase the depth in the middle channel to at least 17 feet at high tide.

In course of construction it was found necessary to build a tramway for transporting the rock to place, instead of dumping it from barges, as originally planned, while, owing to the instability of banks, the jetty had to be started at the high-water line, thus increasing its projected length to 3,700 feet; this projected length was increased in 1884 by a further shoreward extension of 316 feet, necessary to close a gap washed out by the sea.

The project was amended in 1888 (file reference not known) to provide for raising the south jetty to full high water, with a length of 3,748 feet, and to construct a mid-tide jetty on the north side of the entrance, to extend in a southwesterly direction from the headland about 2,300 feet to a point opposite the outer end of the south jetty, so as to give an entrance width of 1,000 feet. The plan was modified in 1892, approved by Chief of Engineers July 9, 1892, to provide for raising the north jetty to high-water level and for the construction of five groins or spurs on the channel side of the south jetty to prevent undermining.

An estimate submitted in January, 1890, placed the cost of completing the project at $370,000, making the total cost $755,000.

Amount expended to June 30, 1896.—The amount expended to June 30, 1896, was $683,768.80.

Results obtained to June 30, 1896.—Up to this time the tramways of both jetties had been extended to full length, and the enrockment completed except about 15,000 tons on the north jetty; the groins of the south jetty were also completed. The depth on the bar had been increased from 12 feet to 15 feet at mean lower low water, completing the project as to channel depth.

Work done during the fiscal year 1897.—No work was done during the fiscal year 1897, except to care for the plant and make minor repairs to north jetty tramway from time to time.

On November 16, 1896, project for continuing this work according to the act of Congress and as outlined in the report of the Board mentioned below was forwarded, but no notification of action thereon has been received, nor was any appropriation made for this work in the sundry civil bill of June 4, 1897.

The channel has remained in good condition throughout the year.

A survey by the Board of Officers of the Corps of Engineers, appointed by the President pursuant to the sundry civil act of March 2, 1895, to make an examination of the bar in Yaquina Bay with a view to a project for deeper water, was completed in August, 1895, and in its report of October 11 (Annual Report Chief of Engineers for 1896, pp. 3284–3309) this Board proposed the parallel extension of the north and south jetties, the former for 2,100 and the latter for 2,200 feet; groins of about 100 feet in length to prevent undermining to be built at intervals of 300 feet on the channel side of the south jetty, each to run from grade level at the main jetty to mean low water at its free end; and an additional spur 800 feet long to be built from the south jetty near its root with a view to deepening the water on the inner bar. The removal of two detached rocks in the path of vessels, about 2,000 feet outside the ends of the present jetties, was also recommended. The estimated cost of this proposed extension, including contingent expenses, was $1,025,800.

Pursuant to the above report the river and harbor act of June 3, 1896, appropriates $25,000 for continuing the improvement, and provides that contracts may be entered into for its completion as recommended by the Board, the total liabilities incurred not to exceed $1,000,000 "exclusive of amount herein and heretofore appropriated."

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$40,000	September 19, 1890	$165,000
March 3, 1881	10,000	July 13, 1892	85,000
August 2, 1882	60,000	August 17, 1894	50,000
July 5, 1884	50,000	June 3, 1896	25,000
August 5, 1886	75,000		
August 11, 1888	150,000	Total	710,000

Money statement.

July 1, 1896, balance unexpended	$26,231.20
June 30, 1897, amount expended during fiscal year	1,190.16
July 1, 1897, balance unexpended	25,041.04
July 1, 1897, outstanding liabilities	55.00
July 1, 1897, balance available	24,986.04
Amount (estimated) required for completion of existing project	1,000,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

COMMERCIAL STATISTICS.

Yaquina Bay is in the collection district of Yaquina. Yaquina City is the port of entry. The nearest light-house is at Yaquina Head, 4½ miles north of the entrance.

The following statistics have been compiled from the monthly reports of J. G. Holcombe, assistant engineer, in local charge of work at Yaquina Bay. They are for the calendar year 1896.

Arrivals and departures.

Steam vessels.	Tonnage.	Draft.	Arrivals.	Departures.
Homer	331.04	17	2	2
Farallon	365.55	18.5	31	31
Manzanita	450	11.5	3	3
Alcatraz	202.06	10.3	8	8
Tonquin	18.61	......	2	2
Robarts	24.15	6.5	30	31
Tillamook	208.57	......	1	1
W. H. Harrison	52.86	......	2	2
Augusta	40.90	......	1	1
Total	......	......	80	81

Total aggregate tonnage of arrivals and departures, 48,106.04.

Receipts and shipments.

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS—continued.	
General merchandise	1,829	Flour and feed	2,720
Lumber	5	Oats	3,295
Iron	5	Lumber	197
Malt	63	Cord wood and bark	82
Salt	95	Salmon (canned)	265
Salmon	261	Building stone	3,600
Sugar	200	Potatoes	178
Bark	6	Hay	12
Tin and lead	36	Staves	390
		Ship knees	16
Total	2,500	Household goods	92
		General merchandise	626
SHIPMENTS.			
Wheat	3,309	Total	15,383

Passengers arrived by sea	448
Passengers departed by sea	495

R R 11.

IMPROVEMENT OF NESTUGGA RIVER, OREGON.

The river and harbor act of June 3, 1896, contains the following item:

Improving Nestucca River, Oregon, from town of Woods to the ocean, in accordance with plans submitted January eighteenth, eighteen hundred and ninety-five: Completing improvement, six thousand dollars.

The plans to which reference is made propose the removal of a rocky reef which forms a dangerous obstruction at the entrance to Nestugga Bay. (See Report of the Chief of Engineers for 1895, Part V, p. 3509 et seq.)

Work done during the fiscal year 1897.—A contract for the removal of rock from the reef was made May 1, 1897, work to be completed by December 1, 1897. The price to be paid is $3.75 per cubic yard, place measurement.

A careful survey was made the latter part of May and will be repeated when the work is done. Active work begun the last of May and will probably be completed July 15 or 20.

No commercial statistics for this river can be obtained.

Money statement.

July 1, 1896, balance unexpended	$6,000.00
June 30, 1897, amount expended during fiscal year	82.78
July 1, 1897, balance unexpended	5,917.22
July 1, 1897, amount covered by uncompleted contracts	3,750.00
July 1, 1897, balance available	2,167.22

Abstract of proposals for rock excavation in Nestugga River, Oregon, opened April 12, 1897, by Capt. W. L. Fisk, Corps of Engineers.

No.	Bidder.	Address.	Rock excavation (1,000 cubic yards) per cubic yard.	Total.
1	Normile & Fastabend	Astoria, Oreg	$3.75	$3,750.00
2	Joseph Paquet	Portland, Oreg	4.75	4,750.00
3	G. O. Nolan	Tillamook, Oreg	4.90	4,900.00
4	Noble & Saunders	Marshfield, Oreg	4.00	4,000.00
5	Perry Hinkle	Portland, Oreg	5.20	5,200.00

Contract awarded to Normile & Fastabend, and executed under date of May 20, 1897.

The only contract in force on this work was made with Normile & Fastabend, of Astoria, Oreg., approved May 20, work to be begun on June 1 and finished December 1, 1897.

R R 12.

IMPROVEMENT OF TILLAMOOK BAY AND BAR, OREGON.

Original condition.—Tillamook Bay is an indentation of the Oregon coast, having a tidal area of about 13.5 square miles, and lies 50 miles south of the mouth of Columbia River. The mean tide at this place is about 6.5 feet. At low water the bay presents a succession of sand and mud flats traversed by four channels of fair depth at the entrance, but which shoal to a low-water depth of but 1 or 2 feet near the head of the bay. These channels are designated as follows: Bay City Channel, Garibaldi Channel, Middle Channel, and Old South Channel. The usual bar exists at the entrance of the bay.

Tillamook City, the principal town of the region, is located on Hoquarten Slough, above the head of the bay, and can only be reached by light-draft vessels at high tide, the route being by way of the main or Garibaldi Channel. The only other places of importance are located on the north shore of the bay and are reached by way of the north or Bay City Channel. As the only navigable connection between these two channels is near the entrance of the bay, vessels going up to points on the north shore must retrace their course nearly to the entrance in order to proceed to Tillamook by way of the main or Garibaldi Channel.

Approved project.—The project, approved in 1892 and revised in 1895, is to make a navigable pass from the north to the main channel, so as to provide a direct route by way of these channels between Tillamook City and the north shore points. This involves the improvement of Junction Bar by a dike extending across the head of the Old South Channel to deflect the current into the main channel, and a dike across the head of the Middle Channel at its junction with Garibaldi Channel to direct the current northward by way of the latter channel, with a view to its cutting through the narrow intervening sands and joining the north or Bay City Channel, and thus forming the desired navigable pass between these channels. It also includes the improvement of Dry Stocking Bar in Hoquarten Slough by a dike to close one of the two channels at this point; the removal of log jams in the north fork of Trask River, which deflect the waters of this stream into the south fork, which enters Hoquarten Slough below Dry Stocking Bar; and to construct dikes to concentrate the flow in the north fork, and to enlarge the existing artificial channel between Trask River and Hoquarten Slough so as to aid in deepening the channel at this bar. Estimated cost, $100,000.

Under a former project the sum of $5,700 was expended on this improvement.

Amount expended to June 30, 1896.—The amount expended under the present project to June 30, 1896 was $29,363.63.

Results obtained to June 30, 1896.—Up to this date the dike at Dry Stocking Bar, 900 feet long, had been completed, the dike at Junction Bar had been extended to a length of 3,202.5 feet northward from Dicks Point; dike and shore protection, 2,350 feet in length, had been constructed across the head of Middle Channel; dike 505 feet long built across the southern pass of Wilson River, and a dike 1,850 feet long to deflect the waters of Kilchis River into the north or Bay City Channel.

The Junction Bar Dike had increased the depth somewhat on that bar, but there were no perceptible results on Dry Stocking Bar.

Work done during the fiscal year 1897.—A contract for this work was made October 9, 1896, and work began the next month Under this contract the following work was to be done, viz: (see map, p. 3248, Annual Report Chief of Engineers for 1896):

Making necessary repairs to all existing dikes and shore protection.

Constructing 800 feet of single-pile dike across the channel to the south of Junction Island Flat, 1,000 feet of single-pile wing dike in the main channel below Junction Island Flat, 2,000 feet of flat protection between the last named and the north end of Middle Channel Dike, excavating a channel across the mud flat between North and Main channels in the vicinity of Bay City, constructing a double-pile dike across the head of the south fork of Trask River, one across the north fork below the head of Stillwell Ditch, and enlarging the Stillwell Ditch to carry the water of Trask River into Hoquarten Slough above Dry Stocking Bar.

Of the work outlined above the channel across the flat near Bay City and the enlargement of Stillwell Ditch were to be completed December 31, 1896. Unusually heavy weather, however, kept the contractors from getting their plant out over the Columbia bar and in at Tillamook, so it was necessary to extend the time for doing this part of the work until February 28, 1897. For the remainder of the work the contract allowed until October 1, 1897, but everything was completed in good shape by the middle of June.

In addition to the contract work some troublesome trees were cut along the banks of Hoquarten Slough, and about 300 pounds of high explosives used in removing snags found embedded in Dry Stocking Bar, with a resulting increase of depth of about 1 foot.

For additional details relating to the work of construction, attention is invited to the annexed report of Mr. J. G. Holcombe, assistant engineer in local charge during active operations.

APPROPRIATIONS.

Act of—		Act of—	
August 11, 1888	$5,200	June 3, 1896	$17,000
September 19, 1890	500		
July 13, 1892	15,000	Total	53,700
August 17, 1894	16,000		

Money statement.

July 1, 1896, balance unexpended	$18,636.37
June 30, 1897, amount expended during fiscal year	17,158.23
July 1, 1897, balance unexpended	1,478.14
July 1, 1897, outstanding liabilities	23.95
July 1, 1867, balance available	1,454.19
Amount (estimated) required for completion of existing project	52,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	52,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

Abstract of proposals for constructing dikes, etc., in Tillamook Bay, Oregon, opened October 8, 1896, by Capt. W. L. Fisk, Corps of Engineers.

	Bidders.	Piles (12,400 linear feet), per foot.	Lumber (8,000 feet B. M.), per M feet.	Bolts (100), each.	Spikes (700 pounds), per pound.	Brush (2,200 cords), per cord.	Wire (3,400 pounds), per pound.	Stone (8,200 tons), per ton.	Excavation Bay City Flat (4,000 cubic yards), per cubic yard.	Excavation Trask River (12,500 cubic yards), per cubic yard.	Total.
		Cents.		*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	*Cents.*	
1	G. O. Nolan, Tillamook, Oreg	8	$7.50	5	2	$2.40	2	54	60	51	$16,922.00
2	Paquet & Smith, Portland, Oreg	9½	15.00	15	6	2.50	4	59	37½	37½	15,066.50
3	Wakefield & Jacobsen, Portland, Oreg	8¼	10.00	18	4½	2.30	4	50	25	25	12,104.50

Contract awarded to Wakefield and Jacobsen and executed under date of October 16, 1896.

The only contract in force on this work was made with Wakefield & Jacobsen, of Portland, Oreg., approved October 16, work to be begun November 1, 1896, and finished October 1, 1897.

The work was all completed during June, 1897.

REPORT OF MR. J. G. HOLCOMBE, ASSISTANT ENGINEER.

TILLAMOOK, OREG., *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report of operations on the improvement of Tillamook Bay and Bar, Oregon, for the year ending June 30, 1897.

In compliance with orders from you, I assumed charge of the work, leaving Newport, Oreg., on October 26, 1896, reaching Tillamook on the 28th, and during the entire season I have been in personal charge of operations.

Contract.—A contract had been made with Wakefield & Jacobsen, of Portland, Oreg., under date of October 9, 1896, for the work, at the following unit prices for material in place: Piles, 8¼ cents per foot; lumber, $10 per M feet B. M.; bolts, with nuts and washers, 18 cents per bolt; spikes, 4½ cents per pound; wire, 4 cents per pound; brush fascines, $2.30 per cord; stone, 50 cents per ton of 2,000 pounds; excavation, 25 cents per cubic yard.

Time.—Under this contract work was to be commenced at once and completed not later than October 1, 1897. It provided for the excavation of Trask River ditch, the cut across the mud flats in the vicinity of Bay City, and the repairs to all the existing dikes on or before December 31, 1896, but on account of the very stormy weather during November and December, 1896, the time for completion of this work was extended to February 28, 1897.

Plant.—Upon the signing of the contract the contractors began to assemble their plant, which consisted of a derrick scow and grapple to be used for dredging; a pile driver with small tools was towed from the Columbia River, reaching here November 28, 1896; three brush scows and one rock scow were rented here, all of which are small and old, but were the only scows that could be had on the bay. On the completion of driving piling for the flat protection the driver was dismantled and the scow used as a rock scow.

The works completed during the season and the order in which they are undertaken are as follows:

Trask River ditch.—Commenced November 5, 1896; finished May 30, 1897.

Dike south of Junction Islands.—Commenced December 20, 1896; finished April 15, 1897.

Cut across the Mud Flats in the vicinity of Bay City.—Commenced January 15, 1897; finished February 25, 1897.

Flat protection from north end of Middle Channel Dike.—Commenced December 29; 1896; finished June 2, 1897.

Dike north of Junction Island.—Commenced March 16; finished June 2, 1897.

Dike North Fork Trask River.—Commenced May 21; finished June 3, 1899.

Dike South Fork Trask River.—Commenced May 23; finished June 12, 1897.

Repairs to existing dikes.—Commenced February 18; finished June 4, 1897.

Trask River ditch.—This ditch was built for the purpose of improving Dry Stocking Bar, by concentrating the flow of Trask River over the bar, through Hoquarten Slough, in place of passing the major flow of the Trask into the Tillamook without crossing Dry Stocking Bar, and to improve the junction of the North Fork of the Trask with Hoquarten Slough. It is located on the lines of the old Stillwell ditch, leaving the North Fork of the Trask on practically a straight continuation of the river above the ditch and at a very bad bend in the river. It joins at its lower end, in a similar way, Hoquarten Slough, near Ox-Bow Bend. The ditch is 652 feet long, 43 feet wide at the bottom, 2.5 feet below low water or datum, and has side slopes of 1 to 1. The cube of excavation, 12,585.63 cubic yards; cost, $3,146.41.

Work was begun on November 5 with wheelbarrows and scrapers. By this means an average of 4 feet of the total depth was removed. On December 10 the dredge began work; this continued until January 17, 1897, when the dredge was removed to the Bay City Cut. Hand work continued until February 28 with a small force, when it was suspended. The dredge again going to work on that date, continued until May 5, when the excavation was practically completed. By the end of May the dumps had been trimmed back, leaving a 10-foot berm on both sides and completing the work.

This ditch has taken about two months longer than allowed by the contract, because the plant (consisting of a derrick scow working a grapple, something like the *Lancaster*, of one-half yard capacity, not capable of removing over 30 buckets per hour and which could not be worked except at the lower stages of the tide) was not suitable for working in the stiff clay at the required rate of progress. The contractors did all they could with the plant and facilities at hand to complete the ditch at the earliest moment. The work was not more difficult than specified, and an examination of the location would indicate this. The ditch has slopes somewhat steeper than 1 to 1 and the full top width, consequently the cross section is somewhat larger than they were paid for. The bottom of the ditch, as excavated, was about 2 feet lower than the bottom of the Trask at that point; so, by the Trask River seeking to modify its slope, the ditch has shoaled for about two-thirds of its length with river débris. Until the winter storms come on I think this action will stop where it now is; just what will take place then is difficult to foresee, because of the large amount of logs and débris that may reach the ditch.

Cut across the mud flats in the vicinity of Bay City.—It was the intention to dig this cut before beginning the Trask River ditch, but delay in shipping the pile-driver engine rendered it impossible to place the guide piles. These were driven January 15; they are 8 in number and are 35 feet long each, making a total of 280 feet, and costing $23.80. On the 17th of January the dredge began work and continued until February 25, on which date the cut was completed and opened to navigation. It is 815 feet long, 20 feet wide at 4 feet below low water, with side slopes of 1½ to 1 in depth. It contains 3,921 cubic yards, and cost, including guide piles, $1,004.05. It connects the main to the south channel in the vicinity of Bay City. It was dug through a stiff black mud, which is very heavy. Little or no scour has taken place; neither has it shoaled. It is used by all boats coming to or leaving Tillamook City, none having used the main channel since its completion. It is considered by the citizens as one of the most important works on the bay.

The cost and material used were as follows:

8 guide piles, 4 each side, 35 feet long, total 280 feet, at 8½ cents	$23.80
3,921 cubic yards of excavation, at 25 cents	980.25
Total	1,004.05

Junction Island Dike south.—This dike connects Junction Island on the south to the mainland, and closes a cross channel, diverting the waters down the main channel over Junction Island Flat. It is a single-pile mean-tide dike, 896 feet long, of which 96 feet on the south is shore protection, built without piles. In the main dike across the old channel the piles are 8 feet center to center, driven to not less than 12 feet penetration, and cut off at a grade of 6 feet above low water. In this dike were used 103 piles, of which 5 are guide piles 35 feet long. The depth of water over the main dike varied from 0 feet at the ends to 6 feet at the center of the channel. No difficulty was experienced in driving the piling to the required depth. The mattress work was built of fascines 16 feet to 20 feet long, depending on the depth of water. Each fascine was wrapped in two places with No. 12 wire. All the mats are from 4 to 9 fascines thick. Pile driving was commenced December 20, 1896, and completed December 28. Mattress work commenced on February 24, and was completed March 27. It was finally finished April 15, 1897. The cost and material used were as follows:

Piles, 2,187 feet, at 8½ cents	$185.90
Brush fascines, 522.5 cords, at $2.30	1,201.75
Wire, 1,720 pounds, at 4 cents	66.80
Stone, 937.26 tons, at 50 cents	468.63
Total	1,925.08

Cost per foot, $2.15 for contract material and labor only.

Flat protection from north end of Middle Channel Dike.—This dike joins the Middle Channel Dike on the south with the North Junction Island Dike on the north. It is 2,012 feet long and located near low water along the flat to the west of the channel. It is a single-pile mid-tide dike, piles 10 feet center to center, cut off at a grade of 6 feet above low water. All piles were driven to a penetration of not less than 12 feet. Two hundred piles were used, of which 6 are guide piles 35 feet long. The mattress work is made of 16-foot fascines, 4 to 7 fascines thick, bound with No. 12 wire around each fascine. Because of the soft nature of the mud it was found necessary to go back and thicken out the first 300 feet of mattresses below Middle Channel Dike. This dike prevents the waters from spreading out over the mud flats and helps to direct it against the mud flat in front of Bay City. Pile driving was commenced on January 3 and completed on the 14th of the same month. The mattress work was begun on January 17 and carried on whenever 16-foot fascines were at hand. It was finally completed June 2, 1897. The cost and material used were as follows:

Piles, 3,996 feet, at 8½ cents	$339.66
Brush fascines, 701.8 cords, at $2.30	1,614.14
Wire, 1,650 pounds, at 4 cents	66.00
Stone, 1,690.46 tons, at 50 cents	845.23
Total	2,865.03

Cost per foot, $1.42.

This dike, together with the South Junction Island dikes, is making quite a change in Junction Island Flat. It is believed that in a very short time the channel will pass directly through the island channel scoured out last year.

North Junction Island Dike.—This dike joins the above flat protection and projects out into the main channel for 1,000 feet in the direction and on the enlinement of the Bay City Cut, across the mud flats. It is a single-pile mid-tide dike, piles 8 feet center to center, cut off at a grade of 6 feet above low water. All piles were driven to a penetration of at least 12 feet. One hundred and twenty-nine piles were required, of which 6 are guide piles 35 feet long. A dolphin of three 35-foot piles was built at the end. Excepting immediately at the end, where it joins the flat protection, it was built in water 4 feet deep. The mattress work is built of fascines 16 feet to 20 feet long, depending on the depth of water, most of them being 18 feet. The mattresses are from 11 to 13 fascines thick and are bound with 3 wires.

The dike was built for the purpose of controlling the current at this place and to force it against the flats and through the cut in the vicinity of Bay City. This it has done. It has also caused a remarkable shoaling behind the dike, but as yet the main flow of the bay is in the main channel, as stated above. Little or no change is noted in the cut proper, but the time has been short since this dike was available, and a few months may cause quite a change in it. The pile driving was commenced on March 16 and completed April 16. Mattress work was commenced on April 10 and completed May 31. The dike was completed June 2. The cost and materials used were as follows:

Piles, 3,080 feet, at 8½ cents	$261.80
Brush fascines, 1,113.75 cords, at $2.30	2,561.62
Wire, 2,620 pounds, at 4 cents	104.80
Stone, 1,678.21 tons, at 50 cents	839.10
Total	3,767.32

Cost per foot, $3.77.

Dike North Fork of Trask River.—This dike is a double-pile dike, built in the river immediately below the Trask River Ditch. It is 90 feet long and 6 feet above low water of the river. It was built for the purpose of diverting the waters through the ditch. The piles are 6 feet center to center, and in two rows 6 feet apart. The banks of the river are steep. Thirty-two piles were used. All except two were driven 12 feet or more, the exceptions striking logs before that depth was reached.

The cost and materials used were as follows:

Piles, 718 feet, at 8½ cents	$61.03
Brush fascines, 51.35 cords, at $2.30	118.11
Wire, 150 pounds, at 4 cents	6.00
Stone, 152.37 tons, at 50 cents	76.19
Lumber, 1,776 feet, at $10	17.76
Spikes, 296 pounds, at 4½ cents	13.32
Bolts, No. 32, at 18 cents	5.76
Total	298.17

Cost per foot, $3.20.

Dike South Fork Trask River.—This dike is a double-pile dike, built in the South Fork of the river immediately below where it leaves the North Fork, or main river. It is built for the purpose of diverting the main flow down the North Fork, through the Trask River Ditch, and over Dry Stocking Bar. The South Fork formerly flowed into the Tillamook. The dike proper is 75 feet long, with a very heavy shore protection 35 feet long. The piling, 24 in number, were driven at least 14 feet below the bottom, the water at low stage being 14 feet deep. The piles are 6 feet center to center, and in two rows 6 feet apart. The elevation of the water on the upper side of the dike above that on the lower at ordinary low tide is 4 feet, hence at this stage of the tide there is considerable pressure on the dike. The grade is 6 feet above the former low water of the river, and because of its location and being in 14 feet of water it was the most difficult and costly dike built.

The material used, and the cost, were as follows:

Piles, 786.5 feet, at 8½ cents	$66.85
Brush fascines, 146.11 cords, at $2.30	336.05
Wire, 200 pounds, at 4 cents	8.00
Stone, 231.11 tons, at 50 cents	115.55
Lumber, 1,516 feet, at $10 per M	15.16
Spikes, 250 pounds, at 4½ cents	11.25
Bolts, No. 24, at 18 cents	4.32
Total	557.18

Cost per foot, $5.06.

The above is all new work constructed under contract. The repairs under the contract were as follows:

Junction Bar Dike.—The only repairs made to this dike consisted in replacing bracing and a short length of waling.

The material used, and the cost, were as follows:

Lumber, 1,663 feet, at $10 per M	$16.63
Spikes, 129.5 pounds, at 4½ cents	5.83
Bolts, No. 6, at 18 cents	1.08
Total	23.54

Middle Channel Dike.—Here the repairs were more extensive. The dike required raising over its entire length.

The cost and materials used were as follows:

Brush fascines, 120.83 cords, at $2.30	$277.91
Wire, 203 pounds, at 4 cents	8.12
Stone, 487.49 tons, at 50 cents	243.75
Lumber, 2,959 feet, at $10 per M	29.59
Spikes, 382 pounds, at 4½ cents	17.19
Total	576.56

The above is all the work done under contract.

The total cost of the season's work was as follows:

New construction	$13,563.24
Repairs	600.10
Total	14,163.34

The total dike constructed was 3,908 feet of single-pile dike and 200 feet of double-pile dike. The average material used per foot of dike was:

2.68 feet of piling, cost	$0.2278
0.62 cord fascines, cost	1.426
1.54 pounds of wire	.0616
1.13 tons of stone	.5650

Average cost per foot, $2.2804.

This does not include the lumber used on the two short dikes in the Trask River, nor does it include superintendence; the prices given in this report are in every case the contract prices.

Miscellaneous.—Besides the above work done by contract, there has been, by day labor, a small amount of other work, which consisted in felling and removing overhanging trees from along the banks of Hoquarten Slough, 38 trees being removed at a cost of $64. By blasting and other means there were also removed from Dry Stocking Bar 29 large snags, being from 1 foot to 2 feet in diameter, all of which were more or less buried in the sand. This has caused a deepening of the water on the bar of about 1 foot.

The contractors have done everything they could, under the circumstances, to push the work to completion at the earliest moment. But for the unfortunate fact that the arrangements for towing were made with the one towboat on the bay, the master of which seemed only willing to keep material on the work when it suited his convenience, I am confident the works would have been completed fully thirty days earlier.

Future operations.—It is rather soon after the completion of this season's work to judge just what works will be needed in the near future, but a study of this bay during eight months, winter and summer, has shown me the necessity of additional work at some places.

The Bay City Ditch, as stated above, is dug through a very heavy black mud, upon which the scouring action of the current seems to have little effect. As this ditch is used by all boats coming or leaving Tillamook City, I would suggest that it be widened out to a bottom width of 50 feet and deepened to 6 feet at low tide, and that this 50 by 6 foot channel be continued to the west Bay City wharf. Also that a short dike be built from a point just below the west bank of the present Bay City Ditch into the main channel, for the reason that the current in the main channel runs close to concave of the flat through which this ditch is cut. It is believed that a short dike will intercept and turn the current down the ditch toward Bay City, and keep it from shoaling.

Junction Island Flat.—It is hoped that the present works will remedy this place, but if it does not, a mid-tide dike should be built up stream, parallel to Middle Channel Dike, from the north half of Junction Island. The flat should also be examined for buried snags.

Junction Bar.—This bar is said to be shoaling, and for its improvement I would suggest that the Wilson River, which carries a very large amount of sediment during floods, be turned at the island, about one-half mile above the present dike, into the Kilchis River. By this means it would spread out and deposit its sediment over the flat before reaching the channels.

Shoal in front of Bakers Landing.—This shoal is located where formerly, it is said, the deepest water was found, and that the wreckage of a scow load of stone, together with the landing of snags, have formed the shoal. I would suggest that a single-pile mid-tide dike be built from opposite Bakers Landing downstream to contract the channel, and that the rocks and snags from Memaloose Point to the quarry be removed and cause the channel to follow the concave of the shore on the south.

Dry Stocking Bar.—This has been, and is now, one of the worst places on the route from the ocean to Tillamook, and where less improvement than any other on the bay has taken place. I have spent a great deal of time in studying it, and am of the opinion that the present channel is best and safest to improve, and if this place, which is fan shaped, be contracted by a parallel dike extending from a point about 400 feet below Revetment Point, parallel to Dry Stocking Island and the present dike, so that the bar will correspond in width to Hoquarten Slough, I believe that the shoal will scour out. The removal of snags that will be found buried in shoal will aid this place very materially. The present dike should be raised by solid filled-in cribbing to an elevation of 8.5 feet above datum to prevent logs and débris finding lodgment on it. If this is done, I am confident that Dry Stocking Bar will be a thing of the past.

Hoquarten Slough.—Tillamook City, the most important in the county, is located at the head of this slough. All the work undertaken is for the purpose of rendering navigation to this city safe and easy for vessels of light draft. The works below the slough bid fair to do all that is expected of them, but there still remains the slough to consider. This slough above Trask River Ditch is from 50 to 80 feet wide, and has a number of very sharp bends; its banks slope almost vertically, and are timbered with heavy growth. The slough is tidal, having little or no fresh water flowing into it; it is full of snags and drift buried in the mud bottom. These logs are rapidly raising the bottom and decreasing the depth of water; in fact, just below the city of Tillamook, small boats can not get over at low run-outs, while if these snags were removed, the sharp bends eased up, banks trimmed of the heavy timber growth, the slough would be vastly improved, and carry at least 8 feet at low tide. Knowing that the slough is the most important element in the improvement that now remains, I would respectfully recommend that the removal of these snags be given special attention under the next appropriation.

Trask River, North Fork.—Now that the South Fork has been diverted, the jams in this river should be removed, banks trimmed, and sunken logs removed to permit it to carry the flood waters without flooding the farm lands.

Future maintenance.—One of the most serious troubles with this bay is caused by the large number of snags and fallen trees that are carried on in the floods, and which eventually sink on the shoals and become buried in the same. In order to maintain the channel clear of these logs, I would recommend that a good substantial derrick scow be built and sent over the channel at stated periods to remove them, and if they are once removed, and others taken out before they sink, I think that further improvements other than those covered by the present project will not be required for a long time.

In conclusion I would recommend that the amount asked for in your last report ($52,000) be requested, so that the works can be completed as soon as possible.

Very respectfully, your obedient servant,

J. G. HOLCOMBE, *Assistant Engineer.*

Capt. W. L. FISK,
Corps of Engineers.

COMMERCIAL STATISTICS.

Tillamook Bay is in the collection district of Oregon. Astoria, near the mouth of the Columbia River, is the nearest port of entry. The nearest light-house is at Cape Meares about 4 miles south of the entrance.

The following statistics for the calendar year ending December 31, 1896, were furnished by J. H. Bridgeford, inspector of customs at Bay City, Oreg.

Shipping.—The number of vessels arriving at and clearing from Tillamook Bay during the year was 114, all steamers. Maximum draft of loaded vessels, 15.5 feet.

Receipts and shipments.

Articles.	Received.	Articles.	Shipped.
	Tons.		*Tons.*
General merchandise	6,600	Lumber (11,000,000 feet)	16,500
Agricultural implements	740	Butter	490
Flour and feed	730	Eggs	46
		Salmon	455
Total	8,070	Cheese	416
		Total	17,907

Passengers arrived by sea during the year 923
Passengers departed by sea during the year 842

River and bay traffic.—The steam launches *Louisa* and *Gertie* ply on the waters of the bay and do a general freight and passenger business. No vessels have been built on the bay during the year.

R R 13.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON.

Original condition.—Prior to commencing the work of construction in 1885, there were from one to three channels across the bar at the mouth of the Columbia River, and these varied both in location and depth, the latter being usually from 19 to 21 feet, while the location shifted through nearly 180° from Cape Disappointment to Point Adams.

Approved project.—The project for improvement was adopted in 1884, and contemplated securing and maintaining a low-water channel depth of 30 feet across the bar at the mouth of the river by the construction of a jetty to extend from the shore near Fort Stevens across Clatsop Spit in the direction of a point about 3 miles south of Cape Disappointment, the ultimate length and height of the work to be determined from the effect produced during construction. The jetty was to be built of rubble and random blocks of stone of large size resting upon mattresses of brush.

In March, 1893, the success of the project having been practically assured, the question as to the length and height of the completed jetty was referred to a board of engineers, who concluded that the then existing length of 4½ miles was sufficient, but recommended that the work be raised at its inshore end (Station 25+80) to a height of 12 feet above the mean level of the lower low waters, that it slope thence to a height of 10 feet at Station 122+00, 1.8 miles from shore, and thence to 4 feet above this datum at its outer end. This board also recommended the construction of four low groins or spurs on the channel side of the jetty to accelerate the accumulation of sands and thus add to its stability—one groin (No. 4) to start near Station 52+00 and to have a length of 1,000 feet; one (No. 3) to be of the same length and to start near Station 88+00; one (No. 2) to be 600 feet long, starting near Station 151+00, and the outer groin (No. 1), 500 feet long, starting near Station 228+00; all to slope on the top from datum level at the jetty to the bottom of the river at the outer end.

Amount expended to June 30, 1896.—The amount expended on this improvement to the close of the fiscal year ending June 30, 1896, was $1,958,602.09.

Results obtained to June 30, 1896.—The work was completed on October 17, 1895, in accordance with the recommendations of the above-mentioned board of engineers and remained in excellent condition. During the year, between the surveys of June, 1895, and June, 1896, a material change was found in the channel from the inner bar buoy to deep water outside, it having forced its way out in an almost direct line instead of turning to the south as theretofore. This change in location was not effected without some decrease in depth, but it was much less than might have been anticipated, as it amounted to only 1 foot—that is, the new channel had a depth of 29 feet at mean lower low water for a width of over three-fourths of a mile, with a narrow 30-foot channel, while the year before there was 30 feet for about the same width, with a narrower 31-foot channel.

Work done during the fiscal year 1897.—No work has been done except to care for the plant when it was not employed on other work and make a survey of the channel over the bar. The jetty itself remains practically intact, as reported last year. (Annual Report of the Chief of Engineers for 1896, p. 3251.)

The tramway is standing to Station 217 + 00, as last year, but the rails of the jetty tramway have been taken up for other use, only one-third, however, being in sufficiently good condition for use in tracks. The stringers of the shore revetment and inner groin tracks were also taken up for other use. The survey of this year shows the channel in nearly the same position as last year, but the 30-foot depth at mean lower low water is now 2,000 feet in width. It seems probable that the channel is now established, or very nearly so, in what should be its permanent position.

The 24 and 30 foot curves on the south side of the channel some distance beyond the end of the jetty have moved slightly to the southward, and the depth over the south spit is somewhat greater. To the southward and westward of the jetty the shoaling has been considerable, the breakers being a much greater distance seaward than a year ago, but as no soundings were taken there the actual amount can not be told.

Peacock Spit, on the north side of the entrance, shows practically no change, while Republic Spit, immediately southwest of Sand Island, has moved a little to the northward and increased considerably in height.

The southern portion of Clatsop Spit follows closely the lines of last year, but the part of it north of the jetty has decreased in area on its western side.

Between Peacock and Republic spits there is reported to be a very narrow channel carrying 10 to 12 feet at low water into Bakers Bay, but there was no favorable opportunity of verifying this during the survey. It is, however, of no importance so far as the main channel is concerned.

APPROPRIATIONS.

Act of—		Act of—	
July 5, 1884	$100,000	July 13, 1892	$350,000
August 5, 1886	187,500	August 17, 1894	338,180
August 11, 1888	500,000		
February 22, 1890	75,000	Total	2,025,680
September 19, 1890	475,000		

Money statement.

July 1, 1896, balance unexpended	$17,077.91
June 30, 1897, amount expended during fiscal year	2,657.90
July 1, 1897, balance unexpended	14,420.01
July 1, 1897, outstanding liabilities	445.83
July 1, 1897, balance available	13,974.18

R R 14.

IMPROVEMENT OF COLUMBIA RIVER BELOW TONGUE POINT.

The river and harbor act of June 3, 1896, makes appropriation for this improvement as follows:

Improving Columbia River below Tongue Point, by way of the south channel, in front of Astoria, Oregon, in accordance with project submitted in the Annual Report of the Chief of Engineers for eighteen hundred and ninety-five, fifty thousand dollars of the balance on hand to the credit of the mouth of the Columbia River improvement is hereby authorized to be expended on this work, in the discretion of the Secretary of War.

The project referred to in this act contemplates the removal of the wreck of the steamer *Sylvia de Grasse* and the outer portion of the ledge upon which it rests; this work to be supplemented by dredging to open a waterway in front of Astoria 25 feet deep and 250 feet wide at the bottom, in accordance with the general project for improving the Columbia and lower Willamette rivers from Portland to the sea. Estimated cost, $121,550.

Amount expended to June 30, 1896.—Nothing.

Work done during the fiscal year 1897.—The river having risen to a height at which the United States dredge *W. S. Ladd* could not work to advantage above Tongue Point, she was sent to widen and straighten the south channel below Tongue Point in the vicinity of the Sylvia de Grasse reef.

Since beginning this work, April 25, 1897, the dredge has taken out 103,231 cubic yards of sand and has materially improved the channel. The presence of this reef, however, makes a very bad place in the channel, and it should be removed as soon as possible; in order to do so, it will require the remainder of the money estimated for it in the plan referred to. In addition to improving the south channel in the immediate vicinity of this work, it is hoped the enlarged upper end of the channel will allow the entrance to it of more water from the river and effect some improvement lower down in front of the city of Astoria.

Money statement.

July 1, 1896, balance unexpended	$50,000.00
June 30, 1897, amount expended during fiscal year	2,781.66
July 1, 1897, balance unexpended	47,218.34
July 1, 1897, outstanding liabilities	1,178.40
July 1, 1897, balance available	46,039.94
Amount (estimated) required for completion of existing project	71,550.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	71,550.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

R R 15.

IMPROVEMENT OF COLUMBIA AND LOWER WILLAMETTE RIVERS BELOW PORTLAND, OREGON.

Approved project.—The original project, adopted in 1877, for improving the channel of these rivers from Portland to the sea, covering 12 miles on the Willamette and 98 miles on the Columbia River, contemplated increasing the depth in the shoalest places, where there was but from 10 to 15 feet at low water, to secure a minimum depth of 20 feet at this stage. In 1891 (Board of Engineers, October 14, 1891) this project was extended to provide for a low-water channel depth of 25 feet.

Amount expended to June 30, 1896.—The amount expended by the United States under the projects of 1877 and 1891 to the close of the fiscal year ending June 30, 1896, was $854,414.86.

Results obtained to June 30, 1896.—Work was carried on under the original project for a 20-foot channel until 1891, at which time a depth of 19 feet had been attained by the construction in the Willamette River of dams to close the chute at Swan Island, the entrance to Willamette Slough and other lesser sloughs near the mouth of the river, and by bank revetments in the vicinity of these works; also by the construction in the Columbia River of a dike at St. Helens and of dams to close Burke Slough and Martin Slough; the effect of these works being supplemented by dredging in both rivers.

Since the extension of the project to provide for a 25-foot channel, dikes have been built by the Port of Portland at St. Johns and at Post-Office Bar, in the Willamette River, and at Walkers Island and Cathlamet Bay, or Snag Island, in the Columbia River. The dike at St. Helens, previously built, has also been strengthened, and a dike has been constructed by the United States at Martin Island Bar.

Dredging has also been continued by the United States and by the Port of Portland.

At the close of the year, by taking advantage of the tides, vessels drawing 23 feet or more could navigate the river from Portland to the sea.

Work done during the fiscal year 1897.—Operations during the year were carried on by hired labor and were confined to dredging to aid in creating and maintaining channels of the depth required by the project, the removal of obstructions found in these channels, and the making of special surveys to determine the conditions of same.

Before placing the hydraulic dredge *W. S. Ladd* in commission it was discovered that the furnaces were in a dangerous condition, and they were replaced by new ones of corrugated steel, which have proven satisfactory and more economical than the old ones.

Two new pumps were also obtained, the old ones being badly worn, and two new 12-foot lengths of 15-inch rubber suction pipe, those on the dredge being nearly worn through. The machinery was overhauled, everything put in good order, and work was begun October 12 on the turn in the channel at Martin Island, where the San Francisco steamships were having difficulty in making the turn. The old channel was near the middle of the river at this place, but a new one having partially developed close in to the Washington shore, it was cut through by the dredge belonging to the Port of Portland, taking out 50,400 cubic yards. The work done by the *Ladd* consisted in cutting 57,128 cubic yards off the point of the shoal, leaving a least low water depth of 23 feet, and making the turn much easier, so the ships now have no trouble.

From Martin Island the dredge proceeded to Walker Island Bar and removed 90,045 cubic yards, leaving a low-water depth of 23 feet where there had been only 17 feet.

The next work done was at Pillar Rock Bar (two shoals), where the depth was increased from 17 feet to 23 feet at low water by removing 134,109 cubic yards.

Dobelbower Bar, the last place in the upper river where trouble was experienced, was then dredged from 19 feet to 23 feet depth at low water by taking out 85,506 cubic yards. By the time this work was completed the river had risen to such a height that dredging to advantage could no longer be done, and the *Ladd* was sent below Tongue Point to widen the upper end of the south channel opposite the Sylvia de Grasse reef; at this place she had dredged to June 30, 103,231 cubic yards, making the total amount dredged from October 12 to June 30 a little over 470,019 cubic yards. The work done below Tongue Point belongs to appropriation for improving mouth of Columbia River below Tongue Point, and is mentioned here only to show total work of dredge for the year.

Dredging on Columbia River below mouth of Willamette River during the fiscal year by dredge W. S. Ladd.

Date.	Location.	Excavated.
		Cubic yds.
October 12 to November 14, 1896	Martin Island	57,128
November 15, 1896, to January 1, 1897	Walker Island	90,045
January 2 to March 3, 1897	Pillar Rock	134,109
March 4 to April 24, 1897	Dobelbower Bar	85,506
Total		366,788

In addition to the work done by the *Ladd*, the *Port of Portland* expended $6,984.33 and dredged 90,200 cubic yards in the Willamette and Columbia rivers, as shown in the following table.

Dredging during the year by the city dredge as reported by the *Port of Portland:*

	Cubic yards.
In the Willamette River:	
At mouth of Willamette River	11,500
At Post-Office Bar	28,300
In the Columbia River:	
Near Martin Island	50,400
	90,200

The *Port of Portland* has purchased the right to use the Bowers patents on the Columbia and Lower Willamette rivers and have had plans prepared for a pump dredge with pipes for disposing of the material. It is proposed to build this dredge very shortly.

Special surveys have been made during the year to determine the condition of the channel in the Columbia River at Hunters Point Bar, and both before and after the dredging at Martin Island, Dobelbower, Walker Island, and Pillar Rock bars.

Minor repairs were made on the boiler of the tug *Lincoln* and four dolphins were driven, marking and protecting the passage through the inner dam in the Willamette Slough.

While the present hydraulic dredge in use on these rivers may possibly suffice to maintain a low-water depth of 20 feet below Portland, it is wholly inadequate to secure a depth of 25 feet, as proposed by the existing project, or even to make any appreciable progress in this direction. The construction of an additional dredge of much greater capacity is therefore urgently recommended, and it is in view of this necessary addition to the plant that an estimate of $300,000 is submitted as the amount which can be profitably expended during the year ending June 30, 1898.

The report of Mr. Robert Warrack, assistant engineer, in immediate charge of the work during the year is herewith, and reference to it is made for interesting details.

APPROPRIATIONS.

Lower Willamette, act of—		
June 23, 1866	$15,000	
March 2, 1867	30,000	
July 25, 1868 (allotted)	21,000	
April 10, 1869 (allotted)	13,365	
July 11, 1870	31,000	
June 10, 1872	50,000	
		$160,365
Lower Willamette, from Portland to the sea, act of—		
March 3, 1873	20,000	
June 23, 1874	20,000	
March 3, 1875	20,000	
August 14, 1876	20,000	
June 18, 1878	30,000	
March 3, 1879	45,000	
		155,000
Lower Willamette and Columbia, from Portland to the sea, including bar at the mouth of the Columbia, act of—		
June 14, 1880	45,000	
March 3, 1881	45,000	
August 2, 1882	100,000	
		190,000

Columbia and Lower Willamette, below Portland, Oreg., act of—

July 5, 1884	$100,000	
August 5, 1886	75,000	
August 11, 1888	100,000	
September 19, 1890	100,000	
July 13, 1892	150,000	
August 17, 1894	50,000	
June 3, 1896	100,000	
		$675,000
Total		1,180,365

Money statement.

July 1, 1896, balance unexpended	$104,169.68
June 30, 1897, amount expended during fiscal year	27,128.97
July 1, 1897, balance unexpended	77,040.71
July 1, 1897, outstanding liabilities	59.85
July 1, 1897, balance available	76,980.86
Amount (estimated) required for completion of existing project	472,464.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

REPORT OF MR. ROBERT WARRACK, ASSISTANT ENGINEER.

PORTLAND, OREG., *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report of operations on improving Lower Willamette and Columbia rivers for the year ending June 30, 1897:

Dredging.—The work done has consisted mainly in dredging with the suction dredge *W. S. Ladd* at the various points where trouble has been experienced by reason of shoal water.

The bars improved were—

	Cubic yards.
Martin Island Bar, 34 miles below Portland	57,128.32
Dobelbower Bar, 44 miles below Portland	85,506.25
Walker Island Bar, 53 miles below Portland	90,044.85
Pillar Rock Bar, 85 miles below Portland	134,109.43
Total	366,788.85

No improvement was carried on by the United States in the Willamette River below Portland, this portion being cared for during the year by the Port of Portland Commission.

The first point improved was Martin Island Bar, where a new channel was opened at the lower end of the island, and close to the Washington shore, the former channel across the bar having shoaled to 15 feet at low water. The *Ladd*, on being put in commission, went to work on October 12 in the new channel, which had already been begun by the Port of Portland Commission's dredge. This was completed by the *Ladd* on November 14, the amount of material removed being 57,128.32 cubic yards. The work accomplished was the widening and straightening of a narrow natural channel, the width obtained being 250 feet with a depth of 23 feet at low water, the depth over a portion of the area added to the channel having been as shoal as 15 feet at low water.

Walker Island Bar was the next point to be improved, where 90,044.85 cubic yards was removed between November 15, 1896, and January 1, 1897. A freshet, followed by a freeze-up in the river, caused about a week's delay at this point. The bar at Walker Island is now located below the lower end of Walker Island on the Washington side, and before dredging was begun had but 17 feet over it at low water. The least depth in channel left by the *Ladd* was 23 feet at low water.

At Pillar Rock Bar the dredge removed, between January 2 and March 3 134,109.43 cubic yards. The depth on the two shoals at this point, both being in the channel between Pillar Rock and the Washington shore and to the east and west of the rock, was but 17 feet at low water before work was begun, with 23 feet at low water on the completion of operations. It became necessary while at this point to renew the stern bearing, which required the beaching of the dredge at Astoria, with the loss, however, of but one day to the work of dredging.

Dobelbower Bar was the last point at which work was done on this division of the river. The dredge began operations at this point on March 4, and finished on

April 24, removing during this time 85,506.25 cubic yards and increasing the depth from 19 to 23 feet at low water. Some delay was also occasioned at this point through the brass sleeve having become loose on the shaft, thereby damaging the stern bearing and causing a loss of three days' time from the work.

On the completion of the work at Dobelbower Bar the dredge was transferred to Astoria (see "Improving Columbia River below Tongue Point"), as the river above its estuary was then in its annual flood, rendering dredging impracticable.

Repairs.—Before putting the *Ladd* in commission an examination was made of the boilers, which disclosed the fact that the furnaces were in bad condition, exhibiting in a marked degree a tendency to collapse. It was considered the most economical plan to remove the old furnaces and replace them with four corrugated steel furnaces, 3 feet by 7 feet 6 inches by $\frac{7}{16}$ inch thick. This was done at a total cost of $1,580. These furnaces have proved eminently satisfactory, and have, it is believed, through their greater heating surface effected a considerable saving in coal.

Two new centrifugal pumps were constructed in Portland and put in place during the year when required, their cost being $1,240. The rubber sections of the suction pipes having shown signs of giving way, two new sections 15 inches by 12 feet were purchased and put in place when needed, their cost being $336. The renewals of stern bearing and sleeve have during the year cost $147.87.

These are the main repairs carried out during the year.

A vertical boiler 2 feet 6 inches by 5 feet 6 inches was added to the dredge's equipment, for use in washing the main boilers, operating capstans, etc.; the cost of this boiler, $167, was paid from appropriation for improving Willamette River above Portland, this appropriation having the use of a hoisting engine and boiler belonging to lower Willamette and Columbia rivers.

Surveys.—Local surveys were made before and after dredging at Martin Island, Dobelbower, Walker Island, and Pillar Rock bars, also at Hunters Point Bar, at which place, however, no dredging was done.

General.—The boiler of the tug *Lincoln*, built in 1881, gave out on April 24 through the wasting of iron around the legs. Repairs were carred out at a cost of $475.

The snag boat *Willamette* was dismantled and the house and machinery transferred to the new snag boat *Mathloma* belonging to the upper Willamette River.

The *Osgood* dredge, inspected and condemned by the inspector-general, Pacific district, on October 8, 1895, was sold by public auction on November 27, 1896, for the sum of $400.

Four dolphins were driven, marking the passage through the inner dam at Willamette Slough. These dolphins were each of five 60-feet piles, and cost, for the lot, $132.

The following table shows the cost of operating the *Ladd* from July 1, 1896, to April 24, 1897:

Cost of dredging by W. S. Ladd, 1896–97.

Amount of material removed .... cubic yards..		366, 788. 85
Operating expenses, including current minor repairs, wages, and subsistence		$11, 872. 03
Coal, $77\frac{1920}{2240}$ tons Franklin, at $5.50	$426. 03	
Coal, $696\frac{730}{2240}$ tons Wallsend, at $5	3, 471. 54	
—— $773\frac{8}{10}$ tons		3, 897. 57
Total cost of operating		15, 769. 60

Cost per yard as above, 4.30 cents.

Total cost of operating dredge, including all repairs	$18, 935. 60
Total cost per yard for the year .... cents..	5. 162
Cost per yard for coal* .... do....	1. 065
Tons of coal per yard* (.0021 ton) .... pounds..	4. 7
Yards dredged per ton of coal .... cubic yards..	474
Number of days dredging .... days..	140
Cubic yards per day dredging .... cubic yards..	2, 626 34

The dredge has been in the able charge of Capt. George A. Pease, assisted by Chief Engineer Madison Welch, to whose skill and care is due in no small measure the efficiency of the dredge.

Respectfully submitted.

ROBERT WARRACK,
Assistant Engineer.

To Capt. W. L. FISK,
Corps of Engineers, U. S. A.

*It is to be noted that this includes a proportion of all coal consumed by the dredge, both while actually dredging and in going to and from moorings and all other movements incident to the work.

COMMERCIAL STATISTICS.

This work is in the collection district of Willamette and Oregon. The ports of entry are Portland and Astoria, Oreg. The nearest light-house is at the mouth of Columbia River.

Arrivals and clearances of vessels at Astoria, Oreg., during the year ending December 31, 1896.

[From collector of customs at Astoria.]

Vessels.	Coastwise.		Foreign ports.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Arrived	512	346,302	127	184,516	639	530,818
Cleared	484	340,446	135	184,398	619	494,844
Total	996	686,748	262	338,914	1,258	1,025,662

Commerce for year ending December 31, 1896.

Value of exports	$395,634
Value of imports	380,517
Duties collected	160,001

The exports included 2,189 tons of wheat and flour, 1,219 tons of salmon, and 8,137 tons of lumber.

The principal items of import were 4,343 tons of tin and 7,280 tons of railroad iron.

Arrivals and clearances of vessels at Portland, Oreg., during the year ending December 31, 1896.

[From collector of customs at Portland.]

Vessels.	Coastwise.		Foreign ports.		Total.	
	Number.	Tonnage.	Number.	Tonnage.	Number.	Tonnage.
Arrived	254	283,168	27	41,152	281	324,320
Cleared	182	159,605	97	212,873	279	372,478
Total	436	442,773	124	254,025	560	696,798

Commerce for year ending December 31, 1896.

Value of exports to foreign countries	$7,235,109
Value of imports from foreign countries	1,111,715
Duties collected	264,495

Comparative statement of shipments of wheat and flour from Portland for the past ten years.

Year ending—	Wheat.	Flour.	Total.
	Tons.	*Tons.*	*Tons.*
July 31—			
1887	187,709	52,168	239,877
1888	223,119	64,411	287,530
1889	162,482	65,503	227,985
1890	104,828	52,343	157,171
1891	207,561	63,889	271,450
1892	227,406	52,907	280,313
1893	190,907	57,906	248,813
December 31—			
1893	207,327	56,202	263,529
1894	244,405	45,454	289,859
1895	275,573	65,399	341,972
1896	243,248	77,822	321,070

Statement of principal articles shipped from and received at Portland by deep-sea vessels during the year 1896.

Articles.	Tons.	Articles.	Tons.
SHIPMENTS.		RECEIPTS—continued.	
Flour	77,822	Tin and tin plate	894
Wheat	243,248	Glass	661
Barley	921	Hemp and jute	892
Bran	62	Tea	200
Canned salmon	49	Coffee	76
Timber	7,000	Soda, soda ash, and caustic soda	294
Total	329,102	Sulphur	1,945
		Sugar	1,155
RECEIPTS.		Iron	4,886
		Raw and waste silk	29
Cement	11,616	Chloride of lime	35
Coal and coke	20,355	Tea*	1,907
Salt	3,758		
Rice and rice flour	813	Total	49,011

* Entered at Portland for transportation to other points.

Registered tonnage over Columbia River Bar.

INWARD TO ASTORIA AND PORTLAND.

Year.	Deep-sea sailing vessels.						Coasters.		Total.	
	American.		British.		Other flags.					
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
1889	5	7,739	50	75,621	4	3,976	370	357,373	439	444,709
1890	8	11,568	46	64,028	2	3,038	387	333,690	443	412,324
1891	7	9,954	95	124,837	7	7,826	393	332,374	502	474,991
1892	15	21,834	84	114,485	6	7,699	344	252,170	449	393,188
1893	19	20,585	62	94,108	3	3,528	251	188,107	335	306,328
1894	22	17,239	69	114,102	9	14,470	190	206,005	290	350,816
1895	31	22,673	122	201,042	20	30,115	589	473,433	762	727,263
1896	12	8,816	107	165,850	8	10,850	512	346,302	639	531,638

OUTWARD FROM PORTLAND AND ASTORIA.

Year.	American No.	American Tonnage.	British No.	British Tonnage.	Other flags No.	Other flags Tonnage.	Coasters No.	Coasters Tonnage.	Total No.	Total Tonnage.
1889	5	7,104	62	77,842	4	3,976	378	368,452	444	451,374
1890	9	14,155	51	71,679	2	3,038	384	334,225	446	423,115
1891	7	10,849	73	94,490	6	6,619	381	331,963	467	443,921
1892	12	18,165	99	130,405	6	7,332	351	252,734	468	408,636
1893	17	23,046	64	96,658	5	6,397	225	182,076	311	308,177
1894	25	19,244	68	109,893	9	9,703	144	159,227	246	298,067
1895	31	22,246	122	209,973	14	22,776	546	478,037	713	733,032
1896	20	13,863	108	154,419	12	16,116	484	340,446	619	524,844

The following statement of traffic on the Columbia and lower Willamette rivers has been compiled from reports of the various steamers and transportation companies doing business on these rivers during the calendar year 1896. It includes freight carried in coasting vessels to and from Portland, but not that transported in deep-sea sailing vessels.

	Tons.		Tons.
Grain	26,009	Merchandise	213,759
Piles (2,538,800 linear feet)	38,082	Fish	23,325
Lumber (7,811,488 feet B. M.)	11,717	Passengers	13,511
Logs (148,431,145 feet B. M.)	621,078	Sand	118,916
Cattle and horses	3,610	Stone	51,072
Sheep and hogs	2,880	Shingles	700
Coal	2,599		
Wool	2,415	Total	1,129,673

List of steamers plying on the Upper Willamette, Lower Willamette, and Columbia rivers, Oregon and Washington, during the calendar year 1896.

Name of vessel.	Tons.	Depth.		Name of vessel.	Tons.	Depth.	
		Ft.	*In.*			*Ft.*	*In.*
Augusta	40.90	7	0	Ione	213.40	2	0
Albany	401.29			Ilwaco	62.03	6	0
Alliance	213.52	12	0	Joseph Kellogg	272.12	2	2
Alice V	41.28	4	0	James B. Stephens	26.40	5	4
Alice A	3.24			J. Ordway	194.74	4	0
Alice Blanchard	396.11			Kehani	85.41	4	0
Annarinne	3.35			LaCamas	19.48	4	0
Annie	125.22			Lorelei	18.78		
Argonaut	20.35	10	9	Louise Vaughn	21.64	6	0
Astorian	234.24	2	6	Lurline	338.38	6	0
Altona	189.68	2	3	Maria	184.58	3	0
Alarm	16.08	5	0	Mascot	199.45	3	0
Bailey Gatzert	444.32	8	0	Mayflower	23.90	8	0
Brazee	4.99			Modoc	337.55	5	0
Brisk	1.06			Monmouthshire	1,870.89		
Bismark	144.40	4	0	Naiad	8.04		
Buffalo	2.15			Northwest	301.98	1	3
C. M. Belshaw	8.12	5	8	Ocean Wave	507.34	9	0
C. W. Rich	17.07	5	2	Occident	2.95	6	4
Chilkat	106.45			Ocklahama	394.19	6	0
Columbia	1,746.14	20	0	Olympian	1,083.20		
Cygnet	2.86			O. K.	47.76	4	6
Dispatch	13.47			Oswego	21.43		
D. S. Baker	566.22	5	0	Queen	28.75	6	2
Dalles City	296.38	7	0	Rowena	4.50		
Edith	37.01	7	6	Pilgrim	28.26		
Edyth	1.37			R. Miler	41.39	6	2
Electric	20.03	4	7	R. P. Elmore	57.24		
El Hurd	26.26			Ramona	208.76	5	0
Elmore	467.60			Regulator	334.88		
Enterprise	137.41	3	8	R. R. Thompson	912.06	10	6
E. L. Dwyer	26.88	5	9	Ruth	388.02		
Escort No. 2	72.92	12	0	Sadie B	33.30		
Emma Hayward	456.67	7	5	State of California	1,260.06	24	4
Elwood	420.54	7	0	Sea Foam	9.77		
Egalite	82.38	4	0	Sarah Dixon	278.84	6	5
Eclipse	25.03	5	2	Salem	240.81	1	8
Eugene	271.88			Swift	1.80		
Fannie	276.41	5	0	Telephone	443.24	4	0
Felida	3.46			Tacoma	1,311.81	11	7
George W. Shaver	276.15	2	4	T. J. Potter	589.60	9	0
Gertie	3.18			Tonquin	18.61		
Gov. Newell	184.43	1	6	Undine	280.48	3	0
G. M. Walker	125.91			Vancouver	157.14		
Grey Eagle	162.88			Victorian	809.17		
Gypsy	154.44			Volga	48.18		
Hassalo	350.85	6	0	Vulcan	219.72	4	0
Hattie	2.92			Wallowa	92.05	11	6
Hattie Bell	129.49	4	5	W. H. Harrison	52.86	6	8
Harvest Queen	697.04	6	0	Wm. M. Hoag	431.18	1	6
H. C. Grady	244.04	2	0	W. S. Mason	252		
Hustler	129.58	7	0	Wauna	3.10		
Hoo-Hoo	16.19			Wenona	34.67	6	4
Iralda	36.84	6	0	Young America	42.10	4	5

R R 16.

IMPROVEMENT OF COLUMBIA RIVER BETWEEN VANCOUVER, WASHINGTON, AND MOUTH OF WILLAMETTE RIVER.

Original condition.—The principal obstruction to navigation in this portion of the river consists in a shoal on the north side of Hayden Island, opposite the city of Vancouver, upon which there is low-water depth of but 9 feet.

Approved project.—The project for improvement adopted in 1892 provides for the construction of a dam connecting the head of Hayden Island with the Oregon shore, the dam to be built to the height of 4 feet above low water to stop the flow behind the island during the low-water stages, at which time about 36 per cent of the river volume was carried by this channel, anticipating that by the increased current the depth upon the bar in the main channel opposite the island would be increased so that vessels drawing 20 feet or more might be able to ascend the river to Vancouver.

Amount expended to June 30, 1896.—The amount expended on the improvement, as above reported, to June 30, 1896, was $32,994.80.

Results obtained to June 30, 1896.—The construction of the dam was commenced in 1892, and was completed, except a portion 60 feet long next the island, when the work was submerged in the spring of 1893 by a rise in the river. When the water had subsided sufficiently to again expose the work, it was found that the gap between the dam and the island had been increased during the high water to 470 feet by scour from the head of the island. The incomplete portion of the dam had also been destroyed, and the depth of water in the gap had increased from 30 to 39 feet.

In 1894 an attempt was made to secure the work from further injury by revetting the head of the island and laying a sill or foundation across the gap to arrest the scour. With this end in view, the revetment was completed, but further work was made impracticable by the high water of that year, which carried away the revetment, together with a considerable portion of the head of the island. As the funds remaining on hand were altogether insufficient to justify the continuance of work on the dam, temporary relief was given to navigation in 1895 by dredging the channel on the north of the island. The construction and repair of the dam were done under contract and the work of dredging by hired labor.

Pursuant to instructions from the Chief of Engineers, a survey was made in September, 1895, to determine the condition of the channel and to ascertain what further improvements, if any, were needed.

In the report on this survey (Senate Ex. Doc. No. 54, Fifty-fourth Congress, first session), a project was submitted for completing the improvement by extending the dam 1,500 feet, passing the head of Hayden Island, and turning downstream at its outer end; the effect of the dam to be supplemented by dredging in the main channel. The cost of the work was estimated at $67,000, and this sum was appropriated by the river and harbor act of June 3, 1896.

Work done during the fiscal year 1897.—Nothing was done during the fiscal year ending June 30, 1897, as the river during that time did not reach a stage sufficiently low to permit working on the dam to advantage.

It is hoped the water will be low enough this season to allow the dam to be built, and if this does not remove the bar it will be assisted by dredging.

APPROPRIATIONS.

Act of—	
July 13, 1892	$33,000
June 3, 1896	67,000
Total	100,000

Money statement.

July 1, 1896, balance unexpended	$67,005.20
July 1, 1897, balance unexpended	67,005.20

COMMERCIAL STATISTICS.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 17 miles distant by river, 5 miles by land. The nearest coast lighthouse is at the mouth of Columbia River, 103 miles distant.

The following statement of traffic on the Columbia River between the mouth of the Willamette River and Cascade Locks has been compiled from reports of the various steamers and transportation companies doing business on this part of the river during the calendar year 1896:

	Tons.		Tons.
Sand and gravel	1,266	Fish	3,600
Grain	2,875	Wool	1,250
Lumber	225	Passengers (190,177)	11,886
Cattle and horses	2,548		
Sheep and hogs	2,717	Total	45,595
General merchandise	19,228		

RR 17.

CONSTRUCTION OF CANAL AT THE CASCADES, COLUMBIA RIVER, OREGON.

Original condition.—The Cascades of the Columbia River are located at the head of a narrow gorge, some 4½ miles in length, through which the river crosses the Cascade Mountain Range. In the first 2,500 feet of this gorge, known as the Cascades, there is a fall of 24 feet at low water, and below this are rapids which extend throughout its length.

Approved project.—The project for improving this locality, adopted in 1877 and modified in 1880 (Board of Engineers, November 13, 1880, E. D. 3772, R. and H. 80) and 1886 (E. D. 3395, R. and H. 1885), provides for the construction of a canal for the passage of the Cascades and for the improvement of the rapids below to secure a low-water channel depth of 8 feet. This canal, which is nearing completion, has a length of 3,000 feet and is provided with a lock 521 feet long between hollow quoins 90 feet wide, and having a lift of 24 feet.

The canal was originally designed for the passage of boats, at stages not exceeding 20 feet above low water below the Cascades, it being assumed that this was the maximum stage at which they could ascend the rapids to its lower entrance. The improvement of the rapids was completed in 1885, and it having been clearly demonstrated since that date that their navigation is practicable at much higher stages, a modification of the project to provide for the utilization of that portion of the canal between the upper gates of the lock and the upper guard gate as a second lock, by putting in a concrete floor and side walls, thus making the canal available for all stages up to 42 feet above low water on lower gauge, was recommended by the Board of Engineers constituted by Special Orders, No. 51, Headquarters Corps of Engineers, September 21, 1894. This Board also recommended certain modifications in the details of the protection works of the canal, the level of which had been based on the flood of 1876, the highest water known previous to 1894, to make them conform to the flood height of this latter year, which was 6 feet above that of 1876. (See Annual Report of the Chief of Engineers for 1895, page 3575 et seq.)

Pursuant to the above-mentioned report, the river and harbor act of June 3, 1896, appropriates $50,000 for maintaining and protecting existing works, and for modifications required to increase the navigable capacity of the canal, $20,000 of this sum to be immediately available for expenditure, in the discretion of the Secretary of War, in constructing on the land and river sides of the canal, between the upper lock gate masonry and the upper guard gate masonry, such portions of the walls proposed in the modified project presented by the Board as it may be necessary to construct in advance of the opening of the canal to commerce.

Amount expended to June 30, 1896.—The total expenditure on account of this improvement to June 30, 1896, was $3,303,550.81; of which sum $1,877,500 had been appropriated prior to the act of 1892, which authorized the making of contracts for completing the canal at an estimated cost of $1,745,500, as above stated.

Results obtained to June 30, 1896.—By the river and harbor act of July 13, 1892, the Secretary of War was authorized to enter into contract for the completion of the canal, upon which work had been previously carried on by hired labor; the liability thus incurred not to exceed $1,419,250, exclusive of the amount ($326,250) appropriated by the act in question, or the total sum of $1,745,500, this latter sum being the estimated cost of the work.

Pursuant to this authority a contract for completing the canal was entered into with J. G. & I. N. Day, on December 27, 1892, and was approved under date of January 24, 1893. This contract provided that so much of the Government plant as might be needed by the contractors for the prosecution of the work should be turned over to them for that purpose, and that the amount then available for the improvement should be earned within one year from the date of the contract; also that the amount of each subsequent appropriation should be earned within one year from the date of its approval. The contractors having failed to carry out the provisions of their contract as to the time at which the appropriations should be earned, three extensions of time were granted upon their application, viz, to March 3, 1895, to March 3 and to November 30, 1896. The excavation for the canal and lock was completed, except for 100 feet at the upper and 150 feet at lower entrance. For the remaining 100 feet at the upper entrance the channel had been dredged to nearly its full width and to within 4 feet of bottom grade.

The masonry of the canal and lock, as originally designed, including the concrete flooring in the upper and lower bays of the canal provided for by the supplemental contract of July 15, 1895, was practically completed.

The gates and the main culvert valves had been set, and the machinery for operating both was in position and ready for service. The pipe line to supply water for operating the maneuvering machinery was also laid and tested. The cover plates for valve and engine pits and some minor pieces of metal work were yet to be placed.

The estimate for completing the improvement in accordance with the modified plans submitted by the Board in its report of October 18, 1894, is as follows:

For repair and preservation of existing work:		
Paving outer slope of fill, including top and both sides of protection wall and berm between toe of inner slope and coping of canal wall, 25,240 cubic yards, at $5	$126,200.00	
Repairing paving on land side of canal, 2,500 cubic yards, at $5	12,500.00	
Repairing paving on land side of canal, 810 cubic yards, at $2.50	2,025.00	
Additional paving, 6,890 cubic yards, at $2.50	17,225.00	
Concrete floor in upper bay, 3,824 cubic yards, at $6.25	23,900.00	
Concrete floor in lower bay, 832 cubic yards, at $6.25	5,200.00	
Iron stairs and steps	2,190.00	
Movable dam on top of upper guard gate masonry	2,638.00	
Movable dam above upper guard gates	3,220.00	
		$195,098.00
For modifications required to increase navigable capacity of canal:		
Concrete, 11,174 cubic yards, at $6.25	69,837.50	
Face stone, 1,982 cubic yards, at $32	63,424.00	
Dimension stone, 1,008 cubic yards, at $36	36,288.00	
Iron, 12,600 pounds, at 9 cents	1,134.00	
		170,683.50
Lock keepers' houses		10,000.00
Contingencies, expenses of engineering and inspection, about 10 per cent.		37,578.50
Total		413,360.00

The estimate covers the cost of constructing suitable walls, connecting the upper gate masonry of the lock with the upper guard gate masonry, to provide a second lock chamber between these gates, and thus make it practicable to navigate the canal at all stages up to 42 feet above low water at the foot of the canal, and of raising the existing protection works to reference (148), to secure the improvement against damage in case of the future occurrence of a flood equaling that of 1894.

It should be added that the concrete flooring in the upper and lower bays of the canal, the cost of which was estimated at $29,100, had been completed.

Work done during the fiscal year 1897.—All the remaining work under the contract was completed and the return of the United States plant in the hands of the contractors was begun.

Congress formally sanctioned the additional work recommended by the Board before mentioned and appropriated $50,000 toward it, but practically directed an earlier opening of the canal and locks than the Board had contemplated.

Careful consideration led to the conclusion that if the north wall between the upper lock gate and the upper guard gate masonry were built to a height of 34 feet (ref. 122.0, six-tenths foot above the highest stage at which the last boat reached the canal during the high water of 1896), and the portion of the south wall in rear of the filling culvert to a height of 12 feet (ref. 100.0), to prevent the south bank from caving, the locks could be safely operated to very nearly the highest stage at which boats could reach them through the rapids at the foot of the Cascades.

This recommendation was made July 20, 1896, and approved by the Secretary of War August 1, 1896.

Circumstances being such that an agreement supplemental to the existing contract could not be made, the Secretary of War authorized an open-market agreement with the Messrs. Day at the following prices, viz, $40 per cubic yard for the cut stone; snubbing hooks of Norway iron, at 9 cents per pound; concrete, $6.25 per cubic yard, and anchors of American iron, at 6 cents per pound.

In order to do the work required and leave in hand some money for protection against another possible great flood, the north wall differs from those before built, as follows: The lower four courses of cut-face stone (those below low water) were replaced by concrete and payment for the remainder of the face stone was to be made on the basis of 12-inch beds instead of 24-inch, but about alternate stretchers were to be anchored to the concrete backing by cramps of ½-inch by 2½-inch iron 3 feet long. As a matter of fact, there are very few stones in this wall that are not larger than those in the other walls because the contractors had plenty of stone available, and it was cheaper for them to put it in large than to cut it down. The stone in excess of the agreed thickness was paid for as concrete only. Notification of approval of project was received August 13, 1896. The contractors were notified on the same day that their offer was accepted, and on August 17 they began cutting stone. On September 21 stone setting was begun, and on October 10 the north wall was completed to the proposed height of 34 feet (ref. 122.0). The portion of the south wall to be built (of concrete) was begun September 15 and completed September 19 to the proposed height of 12 feet (ref. 100.0).

Derricks, bridges, etc., were cleared away, the channels from the river to the canal were dredged out, and on November 5 the locks were thrown open to navigation. At the first formal lockage there were in the lock 3 stern-wheel steamboats of good size and 3 small propellers.

A statement of the traffic passing the canal from the opening to June 30, 1897, is appended to report on operation and care of the canal.

As a precaution against damage by high water, a considerable amount of large rock was hoisted by derricks from the point outside canal and placed as revetment along the river side of the canal embankment as proposed in project submitted from this office July 20, 1896. The price under the contract for work of this class was $2 per cubic yard while the cost by hired labor has been about $1, including cost of setting derricks, and each additional yard of work will diminish the average cost.

This work was resumed late in June, when the water had fallen sufficiently, under instructions to lay aside such stone as would be useful in completing the walls between the upper-lock gate and upper-guard gate masonry with a view to completing them as soon as money is available.

The random revetment is in lieu of the revetment recommended by the Board to be laid in cement (see project of July 20, 1896, approved August 1, 1896.)

In addition to the revetment, and in view of the fact that a majority of people anticipated an extraordinary flood again this year on account of excessive amounts of snow in the mountains, a temporary timber dam was framed ready to be placed at a moment's warning on the upper-guard gate masonry to confine the overfall to the gate itself, and prevent cutting down the revetment. The high water season, however, passed without notable incident of any kind.

Experience with the pumps used by the contractors during construction having proved conclusively that a single 12-inch pump would be insufficient to empty the lock in a reasonable time, authority was obtained for the purchase of an additional 12-inch pump, but it arrived too late to have it set by the contractors before high water shut them out of the power pit. It will be placed this season.

It is earnestly hoped the amount necessary to complete the additional work sanctioned by Congress may be appropriated at its next session.

Assistant Engineer William E. Morris was in local charge until May 8, 1897. Since that date Transitman W. G. Brown has been in local charge, and his report herewith will be found of much interest as to details.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1876	$90,000	September 19, 1890	$435,000
June 18, 1878	150,000	June 13, 1892	326,250
March 3, 1879	100,000	March 3, 1893 (sundry civil act)	1,239,653
June 14, 1880	100,000	June 3, 1896	50,000
March 3, 1881	100,000	June 11, 1896 (sundry civil act)	179,597
August 2, 1882	265,000		
July 5, 1884	150,000		
August 5, 1886	187,500		
August 11, 1888	300,000	Total	3,673,000

Money statement.

July 1, 1896, balance unexpended	$369,449.19
June 30, 1897, amount expended during fiscal year	165,603.90
July 1, 1897, balance unexpended	203,845.29
July 1, 1897, outstanding liabilities	163,661.64
July 1, 1897, balance available	40,183.65
Amount (estimated) required for completion of existing project	334,260.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	334,260.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

REPORT OF MR. W. G. BROWN, TRANSITMAN.

CASCADE LOCKS, OREG., *July 1, 1897.*

SIR: I have the honor to submit the following report of operations for improving Columbia River at Cascades, Oreg., for the fiscal year ending June 30, 1897.

The work during the year by the contractors has been done under the terms of the contract, dated December 27, 1892, with Messrs. J. G. and I. N. Day, for the completion of the canal as authorized by the act of Congress approved July 13, 1892, and a supplemental agreement dated August 25, 1896. In addition to this, protection of the river side of embankment north of canal was begun in April, 1897, by day labor and carried on when the stage of water permitted for the rest of the year, and a timber dam to be used if water should rise above upper guard gate was framed ready to be set up when needed.

At the beginning of the year the usual summer freshet had raised the water to a height of 45 feet above adopted low water at lower entrance which prevented any work being done in canal, but a force of men was kept at work grading above top of paved slope, and hydraulic capstan and other metal work on gate walls was completed during this time.

By August 17 the river had fallen sufficiently to allow dredging to commence, and soon after work on walls of upper lock, riprap, etc., was begun, and by the end of October the walls were completed as far as contemplated and canal was formally opened for traffic on November 5. Up to this time the weather had been favorable for work, and the river below the average height, so that dredging could be advantageously carried on, but from the middle of November the weather was as a whole unfavorable. Several rapid rises of the river and a freeze up for a week about the end of November greatly delayed the work. On March 31 the river had risen so high that dredging was stopped for the season and very little other work was done by contractors after that time.

On May 8 the property was turned over to me by Mr. William E. Morris, and I assumed local charge of the work on May 9.

Excavation.—With the exception of some small slides in upper lock, a little excavation on slopes for riprapping, and some necessary excavation in leveling up to grade above top of paved slopes, all the excavation during the year was done by dredges. On making soundings for estimating amount of excavation before commencing dredging it was found that a very large amount of sand was deposited in upper entrance, averaging 5 feet in depth at station 2+50 and sloping to 1 foot at station 9, and half a foot at the upper guard gate. A great deal was also deposited below lower guard gate, but this was all washed out by water discharged through valves, and no dredging was done between the lower guard gate and station 28. The greater part of the work was done by a dipper dredge built by the Marion Steam Shovel Company, but a ladder dredge built here by the contractors was put to work about the 1st of December and found to work very well in soft washed-in material in the upper entrance. Both dredges continued to work from this time, with numerous stops for repairs, bad weather, or high water until February 8, when the ladder dredge was tied up, having taken out all the loose material deemed necessary in the upper entrance. The dipper dredge continued to work until stopped by high water. During the winter a great deal of material was washed from the banks above and deposited in the upper entrance. When measured by cross sections this showed as dry excavation (above reference 96), but as it had been actually dredged from below 96 after having washed from banks, most of it was credited in estimate as subaqueous excavation.

The channel at lower entrance would have been improved had it been possible to continue longer at work in removing bowlders, but a sufficiently wide channel is excavated to grade, and at extreme low water dangerous bowlders on each side can be marked with buoys or broken up. The total amount of excavation during the year was 17,721.8 cubic yards of loose material, 30,483 cubic yards of subaqueous material, 345 cubic yards of rock, and 3,385 cubic yards of subaqueous rock, distributed as follows:

	Cubic yards.
Dredging in upper entrance:	
Loose	6,593
Subaqueous, loose	24,435
Rock	45
Subaqueous, rock	52

	Cubic yards.
Dredging at lower entrance:	
Loose	5,451
Subaqueous, loose	5,674
Rock	281
Subaqueous, rock	3,333

Excavation for riprap at upper entrance, north side, 558 cubic yards loose; excavation above reference 142 at upper entrance, 1,088 cubic yards loose; slides in upper lock, 425 cubic yards loose, and 19 cubic yards rock; not paid for in previous estimates since beginning of contract, 3,606.8 cubic yards loose and 374 cubic yards subaqueous loose.

Grading.—Three thousand nine hundred and fifty-five cubic yards of gravel was hauled from gravel pit and filled in opposite upper guard gate on south side, partly completing grading near mess house.

Masonry.—Two stones of coping around power capstan on upper guard gate that had been omitted until capstan was placed were set on July 31, and several stones that had been omitted on 3-foot coping at boat landing were set on September 23. This was all the stone set under original contract during the year, but on checking over all stone work done since beginning of contract a balance was found in favor of contractors, which was credited in December estimate.

Concreting walls of upper lock under terms of open-market agreement of August 25, 1896, was begun September 15, and stone setting began September 28. The portion of wall on south side was finished September 19, and on October 31 north wall was completed to reference 122, which ended stone setting for the year.

On August 31 riprapping slope from reference 142 to 148, above old Government riprap on north side above upper guard gate was commenced, and on September 22 work was begun on riprap on two-thirds slope at upper entrance on north side. On November 19 all riprap work done by contractors was finished.

On April 2 work was begun by day labor protecting slope on river side of embankment north of canal and carried on until stopped by high water on May 18; on June 15, the water having dropped sufficiently, work was again begun and carried on until end of year. This slope is protected by covering it to an average depth of 3 feet with rock of all sizes from a cubic yard or more to small spalls. The rock is quarried from large bowlders near United States powder house just north of slope, being run to foot of slope on cars and from there hoisted to place by derricks. All stone suitable for ashlar or dimension stone is laid aside to be used in completing walls of upper lock.

Metal work.—During the month of July the power capstan and dydraulic engine for operating it were placed in position on wall at upper guard gate, and geared hand wheel and shaft for operating turbine-culvert valve at upper end of turbine culvert were placed in position. Cover plates over gate and valve-engine pits were placed during October, November, and December. In March and April turbine wheel, one pump and connections, were placed in power pit.

The total amount of work of the different classes accepted during the year is as shown in the following summary of the estimates submitted for the period of July 1, 1896, to June 30, 1897:

Items.	Quantity.	Price per unit.	Total.
Excavation, dry .... cubic yards..	17,721.8	$0.50	$8,860.90
Excavation, subaqueous, dry .... do....	30,483	1.00	30,483.00
Rock excavation, dry .... do....	345	1.35	465.75
Rock excavation, subaqueous .... do....	3,385	2.50	8,462.50
Stone cut and laid:			
Granite dimension .... do....	15.79	63.50	1,002.67
Basalt dimension .... do....	44.53	36.00	1,603.08
Basalt face .... do....	56.21	32.00	1,798.72
Basalt quarry face .... do....	5.08	28.00	142.24
Basalt dimension .... do....	106.20	40.00	4,248.00
Basalt face .... do....	443.28	40.00	17,731.20
Stone laid:			
Granite or basalt .... do....	106.20	5.00	531.00
Rubble masonry .... do....	3,169	2.00	6,338.00
Paving slopes .... do....	1,041	2.50	2,602.50
Concrete .... do....	603.60	6.25	3,772.50
Concrete* .... do....	6,828.30	6.25	42,676.87
Grading .... do....	3,955	.25	988.75
Other connections:			
Wrought iron .... pounds..	475	.15	71.25
Snubbing hooks in masonry .... do....	5,248	.09	472.32
Snubbing hooks in masonry* .... do....	6,401	.09	576.09
Anchors and dowels* .... do....	3,665	.06	219.90
Maneuvering machinery:			
Forged steel .... do....	2,622	.17½	458.85
Wrought iron .... do....	6,137	.15	920.55
Cast iron .... do....	43,268	.09	3,894.12
Brass .... do....	530	.26	137.80
Hydraulic wrought-iron pipe .... do....	2,778	.06	166.68
Gates .... do....	700	.13	91.00
12-inch centrifugal pump .... number..	1	980.00	980.00
Power capstan .... do....	1	505.00	505.00
Turbine water wheel .... do....	1	338.00	338.00
Cover plates:			
Steel plates .... pounds..	64,319	.13	8,361.47
Cast iron .... do....	2,845	.09	256.05
Labor	....	....	422.35
Total	....	....	149,579.11

The items marked thus (*) show work done under written agreement dated August 25, 1896.

In protection of river side of embankment north of canal 1,700 cubic yards of rock paving was placed on slope and 420 cubic yards of earth added to embankment, the cost of same being as follows:

Labor	$2,434.44
60 cords wood, at $2	120.00
Oil, waste, etc	20.00
Total	2,574.44

Cost of timber dam and cover for power pit.

Materials	$329.15
Labor	214.00
Total	543.15

General repairs to property and plant and preparing for high water (moving derricks, etc.) $328.56

The inclosed table gives a summary of the meteorological and gauge record for the year.

Very respectfully, your obedient servant,

W. G. BROWN, *Transitman.*

Capt. W. L. FISK,
Corps of Engineers, U. S. A.

Meteorological and gauge record for the year.

Months.	Rainfall.	Days on which rain or snow fell.	Average temperature at 12 m.	Highest reading of gauges.		Lowest reading of gauges.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1896.	*Inches.*		*Degrees F.*				
July	0.00	0	79	130.6	117.8	114.4	99.7
August	.65	4	72.8	113.8	98.5	104.8	85.1
September	1.66	5	69.8	104.8	85.2	99.9	77.6
October	3.85	6	61	99.6	77.4	97.3	73.9
November	23.65	21	39.3	105.8	86.5	97.3	73.9
December	14.85	20	41.8	106	86.9	99.3	76.6
1897.							
January	6.18	15	38	101.5	80	99	76.2
February	14.37	21	43.3	102.8	81.9	99	76.1
March	11.39	22	42.8	105.8	86.5	97.9	74.8
April	4.04	9	62.3	120	106.2	102.7	81.8
May	1.33	7	70.2	130.9	117.6	117.3	103.2
June	2.75	11	68.6	128.8	115.6	116.8	102.8
Total	84.72	141	57.3	....	....	....	....

Highest reading at head of canal during the year	130.9
Highest reading at foot of canal during the year	117.6
Lowest reading at head of canal during the year	97.3
Lowest reading at foot of canal during the year	73.9

NOTE.—Reading of adopted low water at head of canal is 96; reading of adopted low water at foot of canal is 72.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 65 miles distant by river, 45 miles by land. The nearest light-house is at the mouth of Columbia River, 156 miles distant.

Statement of traffic over the Oregon State Portage Railway at the Cascades of the Columbia River.

	1892.	1893.	1894.	1895.	1896.
Miscellaneous freight .... tons..	9,724	8,712	6,276	8,122	2,639
Passengers .... number..	6,071	6,949	6,261	10,676	3,371

The State Portage road was only operated five months during the year of 1896 and was entirely abandoned upon opening of the canal to navigation.

R R 18.

OPERATING AND CARE OF CANAL AND LOCKS AT THE CASCADES OF THE COLUMBIA RIVER, OREGON.

The canal and locks at the Cascades of the Columbia River were formally opened to navigation November 5, 1896, and have been in use since, except as follows:

Machinery frozen up, one day, November 27, 1896.

Canal frozen over, eight days, November 28 to December 3, 1896.

Closed for repairs, seven days, March 1, 2, 3, 6, 10, 11, and 12, 1897.

Water too high, twenty-six days, May 16 to June 10, 1897.

Everything worked smoothly until about the end of December, when both lower culvert valves began to give trouble, although it was possible to get enough service from them to operate the canal. It was finally necessary to send down a diver, and then it was discovered that on the north side the cotter block which holds the trunnions of the valve in the bearings had moved forward until the valve, which was necessarily a close fit, wedged against it in turning so it could only be partly opened. The south valve had become immovable, and it was found to be very much damaged—just how badly can not be told until the culvert can be pumped out and the valve gotten at. This can be done, however, without closing the canal.

The north valve was fixed by removing the cotter and the adjoining block and fastening them together by a piece of scantling projecting through them into a groove on the cap of the bearing.

It had been noticed from the beginning that when the valve was in a horizontal position the water rushing by caused it to vibrate considerably, and this, it is believed, caused the wedge to work forward. After finding the condition of the south valve the south culvert was closed and the lock operated with the north valve only. Even in this crippled condition, however, a boat has been passed in eight minutes from time of entering to leaving the lock.

When the water reaches a low stage the south culvert will be pumped out, the valve removed, and a special estimate for its repair submitted.

A small dynamo to furnish a light for the diver was purchased, and is run by a small water motor attached to the pipe furnishing power to the gate and valve engines.

The following allotments for this work have been made from the general appropriation for "Operating and care of canals and other works of navigation:"

November 4, 1896	$2,500
May 21, 1897	350

A detailed account of expenditures follows; also a statement of traffic passing through the canal from the opening, November 5, 1896, to June 30, 1897.

Money statement.

Amount appropriated by act approved July 5, 1884:	
Allotment of November 4, 1896	$2,500.00
Allotment of May 21, 1897	350.00
	2,850.00
June 30, 1897, amount expended during fiscal year	2,434.72
July 1, 1897, balance unexpended	415.28
July 1, 1897, outstanding liabilities	260.00
July 1, 1897, balance available	155.28

Itemized statement of disbursements on operating and care of canal at Cascades, Oreg., during the fiscal year 1897.

Month.	Labor.	Material.	Supplies.	Total.
1896.				
December	$345.00	$20.77	$91.65	$457.42
1897.				
January	284.50		3.90	288.40
February	224.00	9.00	1.50	234.50
March	302.50			302.50
April	493.50	72.40		565.90
May	249.00			249.00
June	260.00	77.00		337.00
Total	2,158.50	179.17	97.05	2,434.72

Canal at Cascades, Oreg.—Summary of business November 5, 1896, to June 30, 1897.

Month.	Average gauge readings, 12 m.		Number of lockages.	Locks operated.		Number of passages.				Registered tonnage.	Freight carried.	Passengers.
	Upper.	Lower.				Stern wheel.	Propeller.	Barge or sail.	Total.			
1896.				h.	m.						Tons.	No.
November	100.5	78.6	38	15	41	41	1		42	13,492.14	551.33	1,783
December	103.1	82.4	17	7	41	18			18	5,989.34	608.75	502
1897.												
January	100.1	77.8	24	17	50	24			24	8,037.12	467.57	530
February	100.7	78.6	32	19	53	26	6		32	8,736.82	490.97	665
March	99.6	77.1	45	13	41	38	17	2	57	9,479.50	863.17	1,116
April	110.7	93.5	64	18	15	53	17		70	17,340	792.78	1,784
May	124.5	111	22	5	35	22			22	6,943.86	379.50	789
June	120.5	106.7	37	9	25	37			37	11,967.40	787.08	1,912
Total	859.7	705.7	279	108	1	259	41	2	302	81,985.68	4,941.15	9,081
Average	107.4	88.2	34.8		38	32.3	5.1	2	37.7	10,248.20	617.64	1,135.1

Statement of traffic passing through canal at Cascades, Oreg., November 5, 1896, to June 30, 1897.

Month.	Bound up.										Bound down.	
	Miscellaneous grain.	Hay.	Cattle.	Horses.	Sheep.	Miscellaneous live stock.	Lumber.	Miscellaneous merchandise.	Total cargo.	Passengers.	Wheat.	Flour.
1896.	Lbs.	Tons.	No.	No.	No.	No.	Ft. B. M.	Tons.	Tons.	No.	Lbs.	Lbs.
November		2.50	27	18		28		217.95	248.95	862		35,000
December	6,000		4	7				123.25	133.50	254	757,000	20,000
1897.												
January				20				132	147	290	365,500	20,000
February			5	35	13	8	12,000	180.75	228.05	386		20,000
March			99	65		2	22,000	454.43	534.93	714		25,900
April			10	115		6	31,370	483.65	625.32	1,147	1,375	4,900
May			1	53			13,600	248.00	309.25	465		20,000
June			2	74			11,000	530.53	603.03	1,186	44,820	9,605
Total	6,000	2.50	148	387	13	44	89,970	2,370.56	2,830.03	5,304	1,168,695	155,405

Statement of traffic passing through canal at Cascades, Oreg., etc.—Continued.

Month.	Bound down.											
	Cattle.	Horses.	Sheep.	Miscellaneous live stock.	Wool.	Berries and fruit.	Lumber.	Miscellaneous merchandise.	Wagons.	Logs.	Total cargo.	Passengers.
1896.	*No.*	*No.*	*No.*	*No.*	*Lbs.*	*Lbs.*	*Ft.B.M*	*Tons.*	*No.*	*No.*	*Tons.*	*No.*
November	90	49	852	2	222,850	11,050	....	54.58	2	.....	302.38	921
December	2	14	....	80	94,500	15,000	....	16.00	.....	.....	475.25	248
1897.												
January	1	21	....	2	164,350	3,000	....	27.20	.....	.....	320.57	240
February	69	12	....	107	238,500	36,950	....	49.75	.....	.....	262.92	279
March	3	16	167	......	63,102	6,800	....	242.75	.....	15	328.24	402
April	3	54	....	......	68,309	2,500	....	64.50	.....	.....	167.46	637
May	2	33	....	......	33,860	....	....	18.50	.....	.....	70.25	324
June	2	57	....	2	132,021	....	2,000	34.00	.....	.....	184.05	726
Total	172	256	1,019	193	1,017,492	75,300	2,000	507.28	2	15	2,111.12	3,777

R R 19.

IMPROVEMENT OF COLUMBIA RIVER AT THREE MILE RAPIDS, AND THE CONSTRUCTION AND EQUIPMENT OF A BOAT RAILWAY FROM THE FOOT OF THE DALLES RAPIDS TO THE HEAD OF CELILO FALLS.

Approved project.—The project for this improvment, which was adopted in 1894, contemplates the construction of a boat railway on the Oregon shore from the foot of The Dalles Rapids to the head of Celilo Falls, said boat railway to be provided at each terminus with hydraulic lifts and other necessary appliances for the purpose of raising and lowering the boats on suitable cars to and from its tracks, and to be equipped for the passage of eight boats of 600 tons each in each direction in twelve hours; also the improvement of Three Mile Rapids below the lower terminus of the boat railway, to render the same navigable by boats of like tonnage. The cost of the improvement was estimated in 1893 at $2,264,467.

In pursuance of this project, the line of the railway has been definitely located, its lower terminus being at Big Eddy and its upper terminus a short distance above Celilo Falls.

The railway has a total length of 9 miles, with a maximum grade of 13.2 feet per mile, the line being straight throughout except at four points, where there are curves of one-half degree each. The low-water lifts at the upper and lower terminals are 62 and 72 feet, respectively.

For the right of way and for the terminal and other facilities of the boat railway a total area of 297.08 acres is required, and an additional area of 26.75 acres is required to provide for changes in the track of the Oregon Railroad and Navigation Company necessary to accommodate the line of the boat railway, or a total of 323.83 acres.

Of this area, 5.1 acres owned by the United States at the time the project was adopted has been withdrawn from sale by the Interior Department, and from that time to June 30, 1896, title to 67.58 acres and right of way over 1.9 acres had been acquired by purchase, at a total cost of $109.47. The remaining lands required were owned by corporations and individuals, as follows: 40.49 acres by the Oregon Railroad and Navigation Company (of which 24.44 acres are required for the boat railway and 16.05 for changes in the company's track); 94.3 acres by the Seufert Bros. Company; 84.20 acres by The Dalles Packing Company; 0.16 acre by James Wesley; 17 acres by I. H. Taffe; a two-thirds interest in 13.1 acres by William Michell, and a one-third interest in the same 13.1 acres by Leopold F. Schmidt.

It having been found impracticable to arrange for securing right of way, etc., across lands owned by the Seufert Bros. Company, The Dalles Packing Company, William Michell, and I. H. Taffe, at reasonable cost, suits for condemnation of the desired right of way across said lands were filed by the United States district attorney in the United States circuit court at Portland, Oreg., and verdicts in these cases were returned in favor of the defendants, as follows: Seufort Bros. Company, $25,087.50; The Dalles Packing Company, $2,000; William Michell, $552, and I. H. Taffe, $14,200.

Work done during fiscal year 1897.—New trials were granted in the cases of Seufert Bros. Company and I. H. Taffe, resulting in verdicts for $35,000 and $17,500, respectively, each being greater than at the first trial. The Dalles Packing Company judgment of $2,000, with $57.10 court costs, has been paid and the decree of the court duly recorded. In the Michell case the papers were in the hands of the Department of Justice for some months for opinion as to title, and were received back June 16, 1897. This judgment of $575 and court costs of $75.40 for two-thirds interest in 13.1 acres will be paid very shortly. The remaining one-third interest in this parcel of 13.1 acres will be purchased from Leopold F. Schmidt for $131, as authorized.

The 0.16 acre belonging to John Wesley was also purchased at a cost of $5.

Therefore, on June 30, 1897, the right of way stands as follows:

Owner.	Area required.	Cost.	Remarks.
	Acres.		
United States	5.1		Withdrawn from sale by United States.
State of Oregon	67.58	$84.47	Title acquired by purchase.
J. C. Willmon	1.9	25.00	Right of way acquired by purchase.
The Dalles Packing Co.	84.20	2,057.10	Amount of judgment rendered in proceedings for condemnation of right of way (verdict, $2,000; costs, $57.10). Judgment satisfied.
James Wesley	0.16	5.00	Title acquired by purchase.
William Michell (undivided two-thirds interest).	13.1	650.40	Amount of verdict rendered in proceedings for condemnation (verdict, $575; costs, $75.40).
Leopold F. Schmidt (undivided one-third interest).		131.00	Proposal received for purchase and authority granted for payment.
I. H. Taffe	17	17,500.00	Amount of verdict returned December 13, 1896, in second trial for condemnation of right of way. Application for retrial filed in behalf of the United States and granted. Since then a stipulation has been signed leaving the case to the decision of the United States judge.
Seufert Bros. Co	94.3	35,000.00	Amount of verdict rendered December 9, 1896, in second trial for condemnation of right of way. Application for retrial, filed in behalf of the United States, has been granted.
Oregon Railroad and Navigation Co.	24.44	Undetermined.	Right of way, etc., to be acquired in connection with negotiations for surrender of such portions of the company's right of way, etc., as are needed for purposes of the boat railway.
Do	16.05	1,030.66	Amount expended by the Oregon Railroad and Navigation Co. for purchase of lands required for changes in its track necessary to accommodate line of boat railway. Reimbursement authorized by the Secretary of War, under date of Oct. 17, 1896, and payment made May 3, 1897.
Total	323.83		

New trials were again granted in the cases against Seufert Bros. Company and I. H. Taffe, the court holding the judgments excessive.

About the same time Mr. Taffe, and the district attorney, on the part of the United States, signed a stipulation leaving the case to the decision of the United States judge who had tried the cases. No decision has yet been rendered in this case, nor has the time for the third trial of the Seufert Bros. Company case been set.

The report of Mr. Olaf Pihl, assistant engineer, engaged on the plans for this work, is herewith, and describes some of the details of the work.

There are also forwarded three tracings,* which are referred to in his report, as follows:

1. General plan of transport car.
2. Details of transport car.
3. Plan and details of switches.

Amount expended.—The amount expended on surveys for location, in negotiating for titles to land, and in the preparation of plans for the boat railway to June 30, 1896, was $6,063.47. The total expenditure on this account, including the purchase of land as reported, to end of the fiscal year 1897, has been $11,182.40.

APPROPRIATIONS.

Act of—	
August 17, 1894	$100,000
June 3, 1896	150,000
Total	250,000

Money statement.

July, 1, 1896, balance unexpended	$243,936.53
June 30, 1897, amount expended during fiscal year	5,118.93
July 1, 1897, balance unexpended	238,817.60
July 1, 1897, outstanding liabilities	931.40
July 1, 1897, balance available	237,886.20
Amount (estimated) required for completion of existing project	2,114,467.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

REPORT OF MR. O. R. PIHL, ASSISTANT ENGINEER.

PORTLAND, OREG., *June 30, 1897.*

CAPTAIN: I have the honor to submit the following report on the project for improving the Columbia River at Three Mile Rapids and the construction and equipment of a boat railway from the foot of The Dalles Rapids to the head of Celilo Falls.

In conformity with the final location of the railway between the foot of The Dalles Rapids and the head of Celilo Falls, located in October–November, 1894, the necessary right of way has been secured from the following owners:

By purchase from—	Acres.
J. C. Willmon	1.9
James Wesley	.16
The State of Oregon	64.68
L. F. Schmidt, one-third interest (the remaining two-thirds interest being acquired through condemnation proceedings from W. Michell) in	13.1

* Not printed.

	Acres.
By condemnation proceedings:	
From The Dalles Packing Company	84.20
Between I. H. Taffe and the Government an agreement has been drawn leaving it to the United States district judge to determine the value of the required right of way for	9.7
From the United States Government is required	4.6
(This land has been withdrawn from sale.)	
Total acreage right of way acquired or agreed upon for transfer to the United States Government	178.34
From the Oregon Railroad and Navigation Company is required	24.44
(Owned by this road in fee simple, the settlement for which is pending the adjustment for settlement of changing the company's track.)	
From the Seufert Bros	94.3
(The acquiring of which is pending a third trial for condemnation of right of way and granted by the United States district judge.)	
Right of way necessary but not yet secured	118.74
Acreage right of way acquired or agreed upon for transfer to the United States Government (transferred from above)	178.34
Total acreage required for boat railway proper	297.08
The Oregon Railroad and Navigation Company, whose track is to be moved at 6 different places, has already secured for themselves	16.05
(This land has been paid for by the Government.)	
The railroad company requires in addition	7.3
through Mr. I. H. Taffe's land, the purchase of which has been provided in the agreement with Mr. Taffe for the purchase of the right of way required for the boat railway.	
Also land owned by the Government, but to be transferred to the railroad company	3.4
(2.9 acres of which has been bought of the State of Oregon, and 0.5 acre belong to the public lands, but withdrawn from sale.)	
Additional acreage required by the Oregon Railroad and Navigation Company, for necessary changes in the company's track	26.75

Lifts, the details for which are still under study, will have a vertical reach, the one at the foot of The Dalles Rapids of 77 feet and the one at Celilo of 62 feet. Each lift is designed with two sets of parallel towers placed on each side of the platform or cradle built for supporting the boat car. The towers, 12 in number, or 6 on each side, are built up of channels, angles, and plates. They are each 8 by 10 feet with 27 feet clear space between each other in the same row, and 42 feet clear space between the two rows, each side of the cradle.

The cradle, which is 40 by 180 feet, is provided with a track for the boat car; it is suspended by cables placed in sheaves resting on girders between the towers each side of the lift; the other ends of the cables are attached to steel water tanks, 5 on each side, and placed between the towers on each side of the cradle; their size is each 26 by 14 feet by 9 feet deep.

In the sidehills, close to the lifts, are to be built water reservoirs, from which the lift tanks can be filled through a pipe line from the reservoir, and to each side of the lift. For operating the lift with a light or heavy load, the tanks are correspondingly filled and a balance of weight given to either the tank or platform with its load, depending upon which way it is desired to move the load.

In each tower is placed a hydraulic brake for the purpose of regulating the speed and stopping the platform when desired; these brakes are attached to the platform with steel cables independent of the tank cables; they are designed so as to be able to hold 50 per cent of the greatest load that may ever come on the platform, and provisions have been made that through disabling of parts of the brake mechanism its load may be taken up by the rest.

The arrangement provides also for automatically stopping the lift when the cradle shall reach the proper level at the upper end for discharging the car with the boat, and at the lower end for discharging the boat.

The design under study provides for a boat with its cargo weighing 800 tons.

The necessary water supply for the reservoirs can be had most economically by direct dumping from the river, but for a greater demand on the capacity of the boat railway water may be had by a gravity pipe line from about 8 miles up the Des Chutes River, or a distance of 10 miles from the proposed reservoir at Celilo, and then further alongside the boat railway, 9 miles to The Dalles Rapids reservoir. A preliminary survey for this pipe line was made in November, 1895.

The car.—Owing to the maximum curvature on the finally located line having been reduced to 30 minutes against a maximum curvature of 2 degrees on the preliminary line, and according to which a car was designed, it will, with this reduced maximum curvature, be possible to use a car with fewer movable parts, thus simplifying the construction and making a lighter car than was at first thought possible. The accompanying plans (1 and 2) of the car show a length over all of 175 feet; the platform is 171 feet 6 inches, and built rigid its whole length against any horizontal movement.

The maximum grade being 0.25 per cent and the grades being connected by long vertical curves, the vertical movement of the car will be very small and taken up by the flexibility of the platform, which has a comparatively small depth to its length. The wheels for the central 81 feet of the car have their bearings attached directly to the platform, and of these only the three rows of wheels at each end are provided with flanges.

It will be noticed that the platform is supported at each end by trucks, consisting each of a frame with 32 wheels, the bearings of which are directly attached to the truck frame. The trucks are coupled to the central body of the platform in a way so as to allow the trucks to adjust themselves to the curves of the line without causing any lateral movement of the rigidly braced platform, which is carried on the moving truck frame by nests of rollers placed on the top of the truck frame between bearings of wheels.

It is estimated that one locomotive of 60 tons weight will easily pull the car with its load, and for convenience the central rails have been placed apart equal to the standard gauge.

The versine on a 30-minute curve for a chord of 81 feet, the length of the central rigid wheel base is seven-eighths inch, and considering curves in opposite direction the combined deflection will be 1¾ inches, which is provided for by a wheel tread of 6 inches in the central portion of the car.

Switching arrangement.—Plan 3 indicates in detail the switching arrangement proposed to be located on the railway nearly midway between the two lifts. The curves in the arrangement are all of 30-minute. The throw of the switch, which is taken at 6 inches, gives a length of switch of 75.6 feet, and by an arrangement of levers and the stops of the chairs it is possible, by operating the switch stand, to give the switch rails an even curve.

The frogs, of which there are 6 for each turn-out, are an application of the pioneer frogs in railroad work. These, as, in fact, the whole track arrangement for switches, rest on chairs, for the purpose of obstructing the sand as little as possible and to give smooth surfaces for the switch and frog rails to move on.

Through an arrangement of levers and cables it is intended to move all the frogs at once from a frog stand of similar construction to the switch stand, and, for facility of operating, placed near it.

Very respectfully, your obedient servant,

OLAF R. PIHL, *Assistant Engineer.*

Capt. W. L. FISK, *Corps of Engineers.*

R R 20.

IMPROVEMENT OF WILLAMETTE RIVER ABOVE PORTLAND, AND THE YAMHILL RIVER, OREGON.

Original condition.—Prior to improvement the mouth of the Yamhill River, 40 miles above Portland, was the head of low-water navigation on the Willamette River, with a draft of 2½ feet. A draft of but 1 foot could be carried above and the channel was greatly obstructed by snags, rocks, and gravel bars.

Approved project.—The project for improvement, adopted in 1878, contemplated the removal of snags and other obstructions and the contraction of the river in wide places, with a view to securing a navigable channel for light-draft boats from Portland to Eugene, a distance of 172 miles. In 1892 the project was extended to include the removal of obstructions in the Yamhill River from its mouth to McMinnville (approved August 12, 1892), a distance of 17 miles. (Annual Report of Chief of Engineers, 1896, p. 3309 et seq.)

The present project proposes the improvement of the Willamette River from Portland to Eugene by the removal of obstructions and the building of controlling works, with a view of obtaining a depth of 12 feet or more from Portland to the foot of Clackamas Rapids (11 miles); of 3 to 3½ feet thence to Corvallis (107 miles), and of from 2 to 2½ feet from Corvallis to Eugene (53 miles). Estimated cost, $131,697. On the Yamhill River the project contemplates the construction of a lock and dam near Lafayette and the removal of obstructions, to provide a draft of 3½ feet throughout the year from the mouth of the river to McMinnville. Estimated cost, $69,000.

The total amount appropriated to and including the appropriation of June 30, 1896, was $288,500. Of this sum, $5,000 was allotted to the Yamhill River and $8,000 to the improvement of the Willamette River (construction of bank revetment) at Corvallis.

Amount expended to June 30, 1896.—The total amount expended to June 30, 1896, was $247,747.51. Of this sum, $71,373.75 was expended under former projects to June 30, 1878, and $164,972.28 under the project of 1878–1892, as follows: On the general improvement of Willamette River, $165,780.29; on the improvement of Willamette River at Corvallis, $7,382.17, and in removing obstructions in Yamhill River, $3,211.30.

Results obtained to June 30, 1896.—The expenditures to the end of the last fiscal year were principally confined to the removal of obstructions from time to time as required by the immediate necessity of navigation, and it can not be claimed that, with the exception of the bank revetment at Corvallis, any considerable progress was made toward the radical improvement of the river.

WORK DONE DURING THE FISCAL YEAR.

General.—The wreck of the old snag boat *Corvallis* was sold at auction where it lay on the gravel bar in the Willamette River, a few miles below Eugene, for $450.

The plans for a new hull, 134 feet long and 33 feet beam, were prepared as early in the year as possible and a contract let for building it, transferring to it and placing in good order the machinery from the old snag boat *Willamette*, and furnishing and placing on the new boat a 10 by 12 inch double cylinder, double drum hoisting engine. The total cost of the boat, the *Mathloma*, with equipment, supplies, etc., complete, was $6,781.23.

The *Mathloma* was in commission sixty-six days from the date of approval of the contract, has been almost constantly at work since, and has been most satisfactory in every way. Provided with ample power for running and for snag pulling, she has proven vastly superior to the old boat.

Willamette River.—Snagging has been done at many places on the river below Harrisburg, as none of the steamboats have cared to go above that place, even when there was ample water for them. One thousand and twenty-seven snags have been removed from the channel and 239 overhanging trees from the banks. In addition to the snagging, work was begun on the permanent part of the project by rebuilding 130 feet of the dike at Weston Bar with piles and brush held in place by sacked gravel. The cost of this repair work was $2.41 per running foot, and it was done from October 6 to 16, 1896, before the completion of the snag boat. A dike at the mouth of East River was begun early in May and finished about the middle of June. It consists of a single row of piles in front of which were placed brush fascines, held in place by sacked gravel. This dike has already proven its value, for where there was a depth of 14 to 18 inches on the bar before the work there is now a depth of 4 to 5 feet. It is 714 feet in length and was built by the crew of the snag boat, with some outside assistance, for $1.27 per linear foot (this does not include the expenses of the boat, which were estimated separately in the report on which the existing project was based). At the close of the year the improvement of Black Dog Bar had just been begun.

Yamhill River.—A landslide just below Dayton during the winter carried into the channel 41 snags, which were removed by the *Mathloma.*

A careful examination of existing circumstances led to the conclusion that the $69,000 which was named as the limit of a continuing contract for the construction of a lock and dam on the Yamhill River to carry slack-water navigation up to McMinnville would hardly suffice for the use of concrete, as was contemplated in the report upon which the project is based. Plans were submitted for a lock and dam of crib work, but the Department held that the letter of the law must be followed and returned the plans with instructions to submit them for a concrete lock. These plans are nearly completed ready to advertise the work, but the question of land has now come up and will have to be first settled. Another question to be settled is regarding the small water power at Lafayette, which will be submerged by the lock and dam.

The location for the lock and dam was so selected, after a personal examination, as to make the cost of the work a minimum. If placed at Lafayette, the water-power question would be solved, but this would require the removal of some 40,000 cubic yards of material, most of which is soft rock, to carry a channel 50 feet wide up to the lock, and would require a considerably larger amount of money than is available.

APPROPRIATIONS.

Act of—	
March 3, 1871	$16,000
March 3, 1873	3,000
June 23, 1874	7,500
March 3, 1875	25,000
August 14, 1876	20,000
June 18, 1878	20,000
March 3, 1879	12,000
June 14, 1880	12,000
March 3, 1881	15,000
August 2, 1882	5,000
July 5, 1884	10,000
August 5, 1886	10,000
August 11, 1888	29,000
September 19, 1890	$11,000
July 13, 1892 (of which $3,000 was allotted to Yamhill River)	30,000
August 17, 1894 (of which $2,000 was allotted to Yamhill River)	23,000
June 3, 1896 (Willamette and Yamhill rivers)	40,000
June 4, 1897 (Willamette and Yamhill rivers)	160,000
Total	448,500

Money statement.

July 1, 1896, balance unexpended	$40,752.49
Amount appropriated by sundry civil act approved June 4, 1897	160,000.00
	200,752.49
June 30, 1897, amount expended during fiscal year	18,206.23
July 1, 1897, balance unexpended	182,546.26
July 1, 1897, outstanding liabilities	732.62
July 1, 1897, balance available	181,810.64

Abstract of proposals for constructing a snag boat for use on Willamette River, Oregon, opened August 20, 1896, by Capt. W. L. Fisk, Corps of Engineers.

No.	Name and address of bidder.	Amount.
1	John F. Steffen, Portland, Oreg	$6,095
2	Honnes & Nelson, Portland, Oreg	4,850
3	Joseph Paquet and Benjamin F. Smith, Portland, Oreg	8,250

Contract awarded to Honnes & Nelson, and executed under date of August 27, 1896.

The only contract in force on this work was made with Honnes & Nelson, of Portland, Oreg., approved September 4, 1896, work to be begun on or before September 10 and finished November 9, 1896.

The work was all completed on November 2, 1896.

COMMERCIAL STATISTICS.

These rivers are in the collection district of Willamette. The ports of entry are Portland and Astoria, Oreg. The nearest light-house is at the mouth of Columbia River.

The following statement of traffic on the Willamette River above Portland has been compiled from reports of the various steamers and transportation companies doing business on this part of the river during the year ending December 31, 1896:

	Tons.		Tons.
Grain	21,793	General merchandise	62,918
Lumber	14,171	Fish	99
Logs	188	Sand and gravel	117,915
Cattle and horses	206		
Sheep and hogs	172	Total	218,480
Coal	658		
Wool	360	Passengers carried ....number..	48,465

R R 21.

GAUGING WATERS OF COLUMBIA RIVER, OREGON AND WASHINGTON.

The self-registering gauge at Astoria, Oreg., has been maintained during the year, and the daily readings of this gauge have been publicly exhibited in Astoria for the benefit of commerce.

In view of the importance of this work, it is recommended that an additional appropriation of $1,000 be made for its maintenance during the fiscal year 1899.

APPROPRIATIONS.

Act of—		Act of—	
August 2, 1882	$500	August 17, 1894	$1,000
July 5, 1884	1,000	June 3, 1896	1,000
August 5, 1886	1,000		
August 11, 1888	2,500	Total	7,000

Money statement.

July 1, 1896, balance unexpended	$1,244.00
June 30, 1897, amount expended during fiscal year	445.65
July 1, 1897, balance unexpended	798.35
July 1, 1897, outstanding liabilities	48.00
July 1, 1897, balance available	750.35
Amount that can be profitably expended in fiscal year ending June 30, 1899	1,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPENDIX S S.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN WASHINGTON, IDAHO, AND MONTANA.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS, OFFICER IN CHARGE FOR THE FISCAL YEAR ENDING JUNE 30, 1897, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Willapa River and Harbor, Washington.
2. Grays Harbor and Bar entrance, Washington.
3. Chehalis River, Washington.
4. Puget Sound and its tributary waters, Washington.
5. Olympia Harbor, Washington.
6. Waterway connecting Puget Sound with Lakes Union and Washington.
7. Everett Harbor, Washington.
8. Swinomish Slough, Washington.
9. Columbia River from Rock Island Rapids to Foster Creek Rapids, Washington.
10. Upper Columbia and Snake rivers, Oregon and Washington.
11. Cowlitz River, Washington.
12. Clearwater River, Idaho.
13. Kootenai River, Idaho.
14. Flathead River, Montana.

EXAMINATIONS.

15. North Fork of Lewis River, Washington.
16. North River, Washington.

SURVEYS.

17. Lewis River, Washington.
18. Bellingham Bay, Washington.
19. Kootenai River, Montana.

HARBOR LINES.

20. Olympia Harbor, Washington.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., July 17, 1897.

GENERAL: I have the honor to forward herewith * * * annual reports * * * of the river and harbor works in my charge for the year ending June 30, 1897, as follows:

* * * * * * *

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

S S 1.

IMPROVEMENT OF WILLAPA RIVER AND HARBOR, WASHINGTON.

(For previous history, see page 508, Annual Report of the Chief of Engineers for 1897.)

Plan of improvement.—The plan of improvement adopted consists in building a dike of piles, brush, and stone across the head of Mailboat Slough, in order to concentrate the ebbing and flooding currents into the main channel, and thereby produce as great a scour as possible on the shoals at the head and foot of the slough. Also to dredge a channel 100 feet wide and 8 feet deep at low water through the reef just below Willapa City, and to close Louderback Slough with a pile, brush, and stone dike, with the object of compelling the currents to scour a channel through the bar in the river at its lower end. The estimated cost of the work is $31,350.

The project of August 29, 1894, approved by the Chief of Engineers, also provides for cutting a channel through the log jam of North River, a tributary of Willapa Harbor.

Results obtained during the fiscal year ending June 30, 1897.—The work called for by the project had been completed during the previous fiscal year. During August and September, 1896, some needed repairs to the dikes were made, and they were refilled with brush and stone where settlement had occurred. A pile driver was employed for two weeks pulling snags, and some troublesome snags which had been the cause, to a very large extent, at least, of the shoal near Louderback Slough were removed.

A channel 50 feet in width had been cut through the jam on the North River. The logs and drift forming the jam were cut up into short lengths in the line of the selected channel during low water, with the expectation that at high water the channel would be cleared out. But long sticks caused the jam to re-form, and no benefit resulted from the work done until the fall of 1896, when an unusually high freshet occurred and the greater part of the jam in the selected channel went out. The settlers living along the river above the jam assisted the movement of the jam by dislodging the keys at the time of the high water.

Recommendations and remarks.—It is believed that the effect of the Mailboat Slough dikes has been about as great as can be expected. Willapa Harbor has a comparatively easy entrance, with a depth of about 21 feet at mean lower low water. The average rise of the tide is 8 feet. The harbor entrance is thus sufficient for the general class of coasting vessels, but, owing to the shoals below South Bend, they can not reach the city, and the commerce of the harbor suffers. In order to make the inner harbor depths correspond with the bar depths, a channel 20 feet deep at mean lower low water would have to be dredged through two shoals below South Bend.

The dikes already built will probably need occasional repairs, but the funds already appropriated will be sufficient to maintain them for several years. Some further work may be necessary to keep an open passage through the log jam in the North River, and if the balance of the appropriation, or so much thereof as might be necessary, could be made available for the purpose, the work could be done without further appropriations.

The funds already appropriated being sufficient to complete the project, no recommendation for future appropriations is made, but it is recommended that the balance remaining after completing the Willapa River and Harbor work, or so much thereof as may be necessary, be made available for opening a channel through the North River jam.

Future operations.—The dikes will be repaired from time to time as may be necessary.

Money statement.

July 1, 1896, balance unexpended	$4,971.61
June 30, 1897, amount expended during fiscal year	1,394.41
July 1, 1897, balance unexpended	3,577.20

APPROPRIATIONS.

Act of—	
July 13, 1892	$18,000
August 17, 1894	13,350
Total	31,350

COMMERCIAL STATISTICS.

Willapa Harbor is in the collection district of Puget Sound. The nearest lighthouse is on Toke Point, at the north side of the entrance.

The following statistics relative to the commerce of Willapa Harbor and River were furnished by John L. Harris and George H. Webber, deputy collector of customs. They are for the calendar year ending December 31, 1896.

SHIPPING.

Arrivals and departures of vessels.

Steam and sail vessels.	Number.	Maximum draft of water.	Average gross tonnage.
		Ft. In.	
Steamers arrived, coastwise	24	13 8	367
Sail vessels arrived:			
Coastwise	31	14	386
Foreign	2		1,088
Steamers departed, coastwise	24	13 8	367
Sail vessels departed:			
Coastwise	31	14	386
Foreign	1		637

Maximum draft of loaded vessels, 14 feet.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		Tons.	
Fruit	5	$250		
Fish, salmon, oysters, etc	5,450	174,000		
Lumber and products	20,986	110,975	50	$1,000
Merchandise			1,141	64,950
Total	26,351	285,225	1,191	65,950

S S 2.

IMPROVEMENT OF GRAYS HARBOR AND BAR ENTRANCE, WASHINGTON.

(For previous history see page 509, Annual Report of the Chief of Engineers for 1897.)

Plan of improvement.—The proposed plan of improvement is to control, by means of a single jetty extending out to sea from the point on the south side of the harbor throat, a distance of about 3½ miles, the ebbing and flooding waters to a sufficient extent to concentrate and direct upon the bar a much greater portion thereof than would naturally go there. It is expected that a depth across the bar of 24 feet at mean lower low water will be obtained.

The jetty is to be of rubblestone built above high-tide level. The estimated cost of the work is $1,000,000.

A full description of this work with plan is published in the Report of the Chief of Engineers for 1895, pages 3517–3528.

In accordance with the authority granted by the act making the first appropriation for this work it is proposed to let one contract for the entire work.

Results obtained during the fiscal year ending June 30, 1897.—Specifications for the work were prepared and advertisements issued.

Report of operations.—Specifications were prepared for the work to be done and advertisements were issued under date of May 10, 1897. On account of the importance of the work, and to give prospective bidders ample time to thoroughly investigate it, the advertisement is to run two months so that the bids will not be received and opened until July 9, 1897.

Recommendations and remarks.—As one contract is to be let for the entire work it is hoped that the work will be carried on with such rapidity that the contractor will earn the full amount allowed by law each year, thus completing the work in about three years. The minimum amount required to be earned by the specifications, after the work is fairly started, is $250,000 a year and with favorable conditions this may be exceeded.

An appropriation of $400,000, the full amount permissible by law is recommended for the fiscal year ending June 30, 1899.

Money statement.

July 1, 1896, balance unexpended	$20,000.00
Amount appropriated by sundry civil act approved June 4, 1897	350,000.00
	370,000.00
June 30, 1897, amount expended during fiscal year	1,271.76
July 1, 1897, balance unexpended	368,728.24
July 1, 1897, outstanding liabilities	42.80
July 1, 1897, balance available	368,685.44
Amount (estimated) required for completion of existing project	630,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	400,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of June 3, 1896	$20,000.00
Act of June 4, 1897	350,000.00
Total	370,000.00

COMMERCIAL STATISTICS.

Grays Harbor is in the collection district of Puget Sound. Aberdeen is the sub-port of entry. The nearest light-house is at Tokio Point, Cape Shoalwater, 14½ miles south of the entrance. A new light-house is now being constructed on the south side of the entrance to Grays Harbor.

The following information relative to the commerce of Grays Harbor for the calendar year, 1896, was furnished principally by Mr. A. P. Stockwell, of Aberdeen, Wash., and Mr. R. E. Dawdy, of Hoquiam, Wash.:

SHIPPING.

Arrivals and departures of vessels.

Steam and sail vessels.	Number.	Maximum draft of water.	Average tonnage.
		Feet.	
Steamers arrived, coastwise	27	13	525
Sail vessels arrived:			
Coastwise	86	17	
Foreign	2		

The departures were the same.
Maximum draft of loaded vessels, 17 feet.
No vessels were built during the year.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Basket stock	1,400	$15,000		
Lumber and products	108,186	494,085		
Machinery			157	$53,000
Merchandise	37	3,725	968	63,867
Total	109,623	512,810	1,125	116,867

S S 3.

IMPROVEMENT OF CHEHALIS RIVER, WASHINGTON.

(For previous history, see page 510, Annual Report of the Chief of Engineers for 1897).

Plan of improvement.—The plan of improvement contemplates the removal of snags, overhanging trees, jams, drift heaps, shoals, and other obstructions to navigation which may from time to time accumulate in the portion of the river regularly used by boats.

The cost of the work is indefinite.

Results obtained during fiscal year ending June 30, 1897.—The river was cleared of most of the obstructions which had accumulated during the preceding year, during which time no work had been done.

Report of operations.—From September 29 to October 26, 1896, snagging operations were carried on on the river with an ordinary stern-wheel boat fitted up with a derrick and hoisting engine. During this time the river was cleared of all the most dangerous snags below a point about 5 miles above Montesano.

Recommendations and remarks.—From the nature of the country through which the Chehalis River runs, it is liable to be blocked with snags after every freshet. To keep it open and tolerably free from obstructions to navigation it is necessary to go over it at least once a year. Heretofore the work has been almost entirely confined to the portion of the river below Montesano, and for the next 4 or 5 miles above, as this portion of the river is that principally navigated. A branch of the Northern Pacific Railroad parallels the river, and there is but little demand for any navigation farther up the river than where the work has been done. Even were the river entirely clear of snags above that point, its navigation would be difficult and dangerous on account of the swift current and shallow water. Future work will therefore be confined as heretofore to the lower part of the river. An appropriation of $3,000 is recommended as the amount which can be profitably expended on this improvement during the fiscal year ending June 30, 1899.

Future operations.—The river will be gone over and the dangerous snags removed as often as the necessity demands and funds permit.

Money statement.

July 1, 1896, balance unexpended	$3,000.00
June 30, 1897, amount expended during fiscal year	1,481.99
July 1, 1897, balance unexpended	1,518.01
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
August 2, 1882	$3,000
July 5, 1884	2,500
August 5, 1886	2,500
August 11, 1888	2,000
September 19, 1890	$3,000
June 3, 1896	3,000
Total	16,000

COMMERCIAL STATISTICS.

The commercial statistics of Chehalis River have heretofore been reported in connection with the reports for Grays Harbor and Chehalis River.

The export and import traffic (not given separately) for the Chehalis River for the calendar year 1896 was furnished by A. P. Stockwell, Aberdeen, Wash.

Table of comparative statistics.

	1895.*a*		1896.*a*		1896.*b*	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
Exports and imports	4,354	$233,691	2,841	Not given.	2,561	$246.498

a Fiscal year. *b* Calendar year.

SS 4.

IMPROVEMENT OF PUGET SOUND AND ITS TRIBUTARY WATERS, WASHINGTON.

(For previous history see page 511, Annual Report of the Chief of Engineers for 1897).

Plan of improvement.—The plan of improvement contemplates the removal of snags, logs, trees, and other obstructions to navigation.

For this purpose a snag boat with an outfit of tools and appliances has been provided. This boat passes from one river to another, doing service in each as far as the necessities of its commerce require and as the amount of the funds appropriated will admit.

With the funds that have been appropriated this snag boat and outfit have been provided, and a large number of snags, jams, overhanging trees, and other obstructions to navigation removed. These, with the trees that from time to time fall into the rivers, will furnish constant employment for the snag boat for an indefinite period.

Results obtained during fiscal year ending June 30, 1897.—The snag boat was rebuilt and a large amount of work done in the principal rivers tributary to Puget Sound in removing snags and other obstructions, and navigation thereby greatly benefited.

Report of operations.—On August 19, 1896, a contract was let for the rebuilding of the snag boat, transferring the machinery from the old to the new boat, and housing same. The new boat was completed and turned over to the United States on December 15. On December 22 the new boat left Seattle for the Skagit River to commence work. From that time to the end of the fiscal year the boat was continuously at work. Work was carried on on the Skagit River from December 24, 1896, until January 10, 1897; from January 14 until January 18, and from January 25 until June 14, except two days, which were spent on the Stillaguamish. Work was carried on on the Duwamish River from January 18 until January 24, 1897; on Hat Slough from January 11 to January 13, and on the Snohomish River from June 14 to June 30, 1897.

The following is a summary of the operations of the snag boat during the year:

Snags and drift removed:	
Skagit River	1,816
Snohomish River	216
Stillaguamish River	99
Duwamish River	25
Hat Slough	36
Total	2,192
Largest diameter ... feet	10
Smallest diameter ... inches	10
Total length ... feet	49,394
Trees chopped:	
Skagit River	217
Duwamish River	53
Snohomish River	78
Total	348
Largest diameter ... feet	5
Smallest diameter ... inches	6
Total length ... feet	27,477

A project for the improvement by a cut-off of one particularly bad bend in the Skagit River was submitted and approved during the year. The settlers in the vicinity agreed to furnish the right of way required. Up to the end of the year they had not done this, and no work had been done on the cut-off. Further details of the snag boat's operations are given in the report of the master, E. H. Jefferson, which is herewith.

Recommendations and remarks.—The work which has been done on the rivers flowing into Puget Sound has been confined to those which flow into it from the east. These streams all have their sources in the mountains, which are covered with a heavy snow fall in the winter. The upper parts of the streams are in the nature of mountain torrents, subject to rapid fluctuations. The lower parts of the rivers have a flat slope, run through a country which was formerly completely, and is still partially, covered with heavy forests, and they generally empty into Puget Sound through a number of mouths, forming wide deltas. These conditions favor the rapid accumulation of snags and drift in the lower parts of the rivers. It is of great importance to keep these snags out for the safety of navigation and to prevent the outlets becoming completely blocked and causing disastrous overflows. To do this it is necessary that the snag boat should be kept steadily at work. Previous to this year there has never been sufficient money to permit of this being done, and the work accomplished has simply been to remove those snags which most interfered with navigation. During the past year, the available funds having been sufficient to permit it, the snag boat has been kept continuously at work since she was rebuilt, with the result that the rivers worked on are now in better condition than they have been for many years. There is still work enough in sight to keep the snag boat busy for a couple of years, and with what new snags come in it will be an indefinite time before the rivers will be entirely clear. Had it not been for the snag boat's work during the past year navigation on the Skagit River, at least, which is the most important river flowing into Puget Sound, would have been entirely suspended part of the year and carried on at great risk the remainder. This would have had an important effect on the freight rates, and so on the prosperity of the country surrounding it.

A complete survey of the navigable part of the Skagit River was also made, and the notes are now being plotted. Surveys of the other streams will be made as soon as possible. Based upon these surveys, plans will be developed for their further improvement. For the snagging operations alone an appropriation of $25,000 is necessary, and this amount is recommended.

Future operations.—Snagging operations will be continued and such other work done as appears advantageous and the funds permit.

Money statement.

July 1, 1896, balance unexpended	$79,853.57
June 30, 1897, amount expended during fiscal year	19,827.44
July 1, 1897, balance unexpended	60,026.13
July 1, 1897, outstanding liabilities	25.00
July 1, 1897, balance available	60,001.13
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
June 14, 1880	$2,500
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	10,000
August 11, 1888	15,000
September 19, 1890	12,000
July 13, 1892	$15,000
August 17, 1894	14,000
June 3, 1896	75,000
Total	173,500

Abstract of proposals.

No.	Name and address of bidder.	Rebuilding snag boat, etc.	Time required to do the work.
			Days.
1	Thomas C. Reed and Lemual E. Shephard, Ballard, Wash	$8,124.05	75
2	J. F. Steffen, Portland, Oreg	8,240.00	75
3	Moran Bros. Co., Seattle, Wash	12,446.00	75

COMMERCIAL STATISTICS.

The following statistics were furnished by Mr. S. G. Yerkes, of Seattle, Wash., and are for the calendar year 1896.

SHIPPING.

Five river and sound steamboats are engaged in traffic on the Skagit River, with an average tonnage of 211.2 tons and an average depth of 5 feet.

Exports and imports (Skagit River).

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Grain	5,300	$106,000		
Hay	9,800	68,600		
Merchandise			3,000	$144,000
Salmon (fresh)	500	40,000		
Total	15,600	214,600	3,000	144,000

On the Snohomish and Snoqualmie rivers 6 steamboats are engaged in traffic. During the past year they carried 1,910 passengers and 7,905 tons of freight, consisting of general merchandise and farm produce.

REPORT OF E. H. JEFFERSON, MASTER OF SNAG BOAT "SKAGIT."

SNOHOMISH, WASH., *July 12, 1897.*

SIR: I have the honor to submit the following annual report of operations of the United States snag boat *Skagit* at improvement of Puget Sound and tributary waters for the fiscal year ending June 30, 1897:

During the first part of this year the snag boat was not put in commission, on account of her hull being old, rotten, and unsafe for hard work, and because it was contemplated building a new hull. During this period, though, two or three trips were made by me to the mouths of the Stillaguamish and Skagit rivers with small boat, and a number of complained-of obstructions removed by blasting. Several dangerous overhanging trees were also disposed of in Steamboat Slough, Skagit River.

Plans and specifications for building new hull, placing the old machinery in it and housing the same, were prepared, and on August 19, 1896, the contract was awarded to Reed & Shephard, of Ballard, Wash.

On August 20 the old snag boat and property was turned over to the contractors and their receipt taken for the same. On September 3 the old boat was towed from her Duwamish River moorings to Ballard.

On September 6 the contractors, with a small force, commenced the work of constructing the new hull, which they lingered along with till December 15, when the contract was practically completed and the new boat accepted, although some of the small details, such as painting, were not finished.

A crew was shipped, property from the old boat transferred to the new one, supplies taken on board, and on December 22, 1896, the new boat left Seattle via the Stillaguamish for the Skagit River to commence work. Part of the 22d, 23d, and 24th was spent clearing obstructions from the mouth of the Stillaguamish River.

On the 24th work was commenced on the Skagit, and continued there until January 10, 1897. On January 11 a trip was made to Hat Slough, and that stream made safe for navigation. On January 14 returned to the Skagit and worked until the 18th, on which date the snag boat left the Skagit for the Duwamish River, working there under unfavorable conditions until the 25th, on which date the boat returned to the Skagit River, the water in the Duwamish being too high for profitable work. On the way to the Skagit one day's work was done at the mouth of the Stillaguamish River, after which work was prosecuted on the Skagit until March 31, when another trip was made to the Stillaguamish for the purpose of clearing the channel at its mouth of snags and stumps recently deposited there.

On April 2 work was again resumed on the Skagit, and continued there until June 14, when the boat left for and arrived at the Snohomish River, where operations were conducted to the end of the month and the fiscal year.

During the period accounted for above a great deal of effective work has been done. During the winter months, when the water was very low, the Skagit River, as far up as passenger boats ply, was pretty thoroughly cleared of old and dangerous snags that can only be seen and removed at extreme low stages. Complaints from steamboat men were less numerous on account of the good work done by the snag boat. During the spring high water the upper river as far up as Lyman was greatly improved for the benefit of the log-towing business. Above this point there does not appear to be any present necessity of doing work, as there are no boats running above there.

A great many trees along the banks of the Skagit, in the bends that are continually washing, have been chopped and trimmed and cut in sections when practicable. This work was generally done when the river was too high for other work. Several drift jams have also been pulled off and floated away with the current or cut and blasted up so that they will float away on next high water.

The general impression with river men is that the Skagit River is now in better shape than they ever knew it to be, but there is lots of work that can profitably be done there yet.

The channel at the two mouths of the Stillaguamish has been cleared of large stumps several times. Work can be found there most any time the snag boat passes that way, owing greatly, I think, to operations of the logging boom at that point.

Hat Slough, a tributary of the Stillaguamishal River, has been thoroughly cleared of some very large stumps and roots that almost blocked the entrance to it.

On the Snohomish River some very effective work has also been done at points between Everett and The Forks.

The new boat works very satisfactorily, steers and handles well, and shows no evidence of weakness.

Following is a summary of the snag boat's operations for the period stated:

Snags and drift removed:		
Skagit River		1,816
Snohomish River		216
Stillaguamish River		99
Duwamish River		25
Hat Slough		36
Total		2,192
Largest diameter	feet..	10
Smallest diameter	inches..	10
Total length	feet..	49,394
Trees chopped:		
Skagit River		217
Duwamish River		53
Snohomish River		78
Total		348
Largest diameter	feet..	5
Smallest diameter	inches..	6
Total length	feet..	27,477

Additional operations consisted of the usual amount of work required to properly care for the boat and machinery, and to keep the tools, gear, and other property in good condition.

Although I have not heard of any reduction this year in the rates charged for freight and towage by reason of the snag boat's operations on these rivers, I have heard the steamboat men say they don't know how they would get along without her

On the Skagit River there are two regular boats running, one from Seattle to Mount Vernon and Avon via Stanwood, on the Stillaguamish, making three trips per week and carrying freight and passengers; the other one doing a log-towing business from the upper river, when stage of water is favorable.

Jobbing boats frequently make trips to the Skagit and neighboring sloughs when the crops of hay and grain are being moved to market.

The Skagit River boats generally do the business for the Stillaguamish as well.

The Snohomish River has four regular boats plying on its waters, one of them making triweekly trips from Seattle, one making three trips daily between Everett and Snohomish, carrying passengers and small freight, and one making two trips per week between Snohomish and Snoqualmie river points, and the other one doing a log towing and jobbing business. Other boats make occasional trips to the river with or after freight.

The Duwamish River has no regular steamer on its waters; an occasional one goes up a short distance and freights out some hay and other produce.

I have no means at hand of getting any commercial statistics for these rivers, and have always heretofore found it a very difficult matter to obtain any accurate figures representing the amount of business done by these boats, as they do not appear to keep any record of it except in dollars and cents.

If statistics are required, I think that the figures contained in my report of last year can be found with perhaps a little variation. I do not think there has been much change in the business for this year. If so, it is in my opinion very slightly increased.

Very respectfully, your obedient servant,

E. H. JEFFERSON,
Master of Snag Boat.

Capt. HARRY TAYLOR,
Corps of Engineers, U. S. A.

S S 5.

IMPROVEMENT OF HARBOR AT OLYMPIA, WASHINGTON.

(For previous history, see page 512, Annual Report of the Chief of Engineers for 1897.)

Plan of improvements.—It is proposed by the plan of improvement adopted to dredge a channel 250 feet wide and 12 feet deep at the mean of the lower low waters from the vicinity of the Fourth Street Bridge to deep water in Budd Inlet. Near its inner end the channel is to be widened out to 500 feet, so as to provide a turning basin for boats using it.

The estimated cost of the work was $275,000.

Results obtained during the fiscal year ending June 30, 1897.—The turning basin and channel were enlarged to the full size proposed by the project, the basin deepened to 10 feet at extreme low water throughout, and the outer end of the channel, for a distance of 1,500 feet, deepened to 8 feet at extreme low water.

The turning basin was also slightly enlarged by dredging a triangular piece near its inner end on the side next the main part of the city, along one of the principal docks, where it was for the manifest public interest to do so.

Report of operations.—Under a contract with the New York Dredging Company, dredging was commenced November 9, 1896, and completed March 10, 1897. During this time the dredge removed 192,485 cubic yards of material, enlarging the basin and channel to their full contemplated widths, and deepening the basin from 6 feet to 10 feet at extreme low water, and part of the channel from 6 feet to 8 feet at extreme low water. The Capitol waterway was closed at Fourth street by a bulkhead, and a large part of the dredged material was deposited behind this bulkhead, making a solid fill. This bulkhead cuts off the Capitol waterway at Fourth street and turns the water of the Deschutes River, which formerly emptied through the Capitol waterway into the excavated basin through the Deschutes waterway, and prevents the deposition of sediment from the river in the basin and channel.

Recommendations and remarks.—The importance of Olympia lies in the fact that it is the capital of the State. The only commerce carried on by water is the local commerce between Olympia and other cities on Puget Sound. This local traffic is carried by the ordinary light-draft stern-wheel boats, and as the depth and width of channel and basin already secured are ample for the accommodation of this class of boats, the project is completed, as far as the main and immediate benefit to the city is concerned. The projected depth is 12 feet at "mean lower low water." The datum used in the determination of the depths obtained by dredging is "extreme low water." The relation between these two planes does not seem to have been established at the time the project was made, but recent observations indicate that "extreme low water" is about 2 feet below "mean lower low water." Such being the case the project is completed, so far as the basin is concerned. There are practically no boats plying in these waters, except possibly tow boats, with a draft between that of the boats now running to Olympia and that of the deep-draft coasting vessels, 20 feet or more. If the latter class of vessels is to be accommodated, for which there appears to be no reason at present, the projected depth should be increased. If not, the depths already obtained in the basin and in the outer end of the channel will serve practically every purpose which depths 2 feet, greater will. It might, however, be of some slight advantage to increase the depth throughout the part of the channel now 6 feet deep to 8 feet, so as to have all parts of the channel of a uniform depth. It is also probable that there will be some shoaling of the depths already obtained, and as it is important to maintain these depths, an appropriation of $20,000 is recommended as the amount that can be profitably expended during the fiscal year ending June 30, 1899.

Future operations.—Future work will depend upon the funds appropriated.

Money statement.

July 1, 1896, balance unexpended	$32,091.55
June 30, 1897, amount expended during fiscal year	29,017.43
July 1, 1897, balance unexpended	3,074.12
Amount (estimated) required for completion of existing project	168,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—

July 13, 1892	$35,000.00
August 17, 1894	40,000.00
June 3, 1896	32,000.00
Total	107,000.00

Abstract of proposals.

No.	Name and address of bidder.	Cubic yard.	Total.
		Cents.	
1	Bowers Dredging Co., Seattle, Wash	19½	$29,250.00
2	New York Dredging Co., New York, N. Y	12⅞	19,312.50

COMMERCIAL STATISTICS.

Olympia Harbor is in the collection district of Puget Sound.

The returns were furnished by Mr. L. Willey, manager S. Willey Steamship and Navigation Company, and are for the calendar year 1896.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Grain			500	$10,000
Hay	400	$4,000		
Live stock	40	1,000	40	1,000
Lumber and products	20,025	57,000	12,300	22,500
Merchandise	609	42,800	2,183	53,000
Total	21,074	104,800	15,023	86,500

S S 6.

IMPROVEMENT OF WATERWAY CONNECTING PUGET SOUND WITH LAKES UNION AND WASHINGTON.

(For previous history, see page 513, Annual Report of the Chief of Engineers for 1897.)

The river and harbor bill of September 19, 1890, contained an item directing the appointment of a board of three officers of the Corps of Engineers upon whom should devolve the duty of selecting and surveying the most feasible location and of estimating the expense of constructing a ship canal to connect the waters of Lakes Union, Washington, and Sammamish with Puget Sound, and appropriating $10,000 for the necessary expenses.

Plan of improvement.—The plan outlined in the report of the Board consisted in dredging a channel through the flats of Shilshole Bay from deep water in Puget Sound to the mouth of Salmon Bay, and there building a lock to overcome the differences of elevation between the Sound and Lake Union.

The lock with a dam would bring the waters of Salmon Bay to the elevation of Lake Union.

The plan further provided for dredging in Salmon Bay to give the requisite depth for a deep-sea harbor, and for the dredging of a canal to connect Salmon Bay with Lake Union, and the necessary dredging in Lake Union to reach the head of the lake. Communication between Lakes Union and Washington was provided for by a canal with a lock to overcome the difference of elevation between the lakes, and by dredging through the shallows of Lake Washington to deep water.

A variation of the plan was to throw a dam across the outlet of Salmon Bay and dig a canal from Salmon Bay to Smiths Cove, and there dredge a channel to deep water in Elliott Bay, building a lock to overcome the difference of level between the waters of Elliott Bay and Lake Union.

The total length of the waterway from the inner end of the lock nearest Lake Washington to the outer end of the lock nearest Puget Sound will be about 6.2 miles by the Shilshole Bay route and somewhat less by the Smiths Cove route.

The estimated cost of a double-track canal, with masonry locks, and including the necessary right of way, was $2,900,000 by the Shilshole Bay route, or $3,500,000 by the Smiths Cove route; and of a single-track canal, with composite locks, and exclusive of any right of way, was $1,781,167 by the Shilshole Bay route, or $2,316,167 by the Smiths Cove route.

Amount expended during fiscal year ending June 30, 1897.—No money has been available for expenditure on this improvement during the past fiscal year, and nothing has been done by the United States.

Report of operations.—In accordance with the authority granted him by the river and harbor act of June 3, 1896, under date of September 22, 1896, the Secretary of War designated the Smiths Cove route as the one to be followed from the head of Salmon Bay to Puget Sound.

The act of August 17, 1894, making the first appropriation for this improvement contained the proviso that—

> No part of said amount shall be expended on the improvement of the waterway connecting the waters of Puget Sound with Lakes Union and Washington until the entire right of way and release from all liability to adjacent property owners have been secured to the United States free of cost and to the satisfaction of the Secretary of War.

It having been decided by the Comptroller of the Treasury that none of the money appropriated could be used in surveying and defining the right of way and lands and interests from which releases would be required, the act was amended by a clause in the sundry civil bill approved March 2, 1895, authorizing the expenditure of $5,000 for the purpose.

Under date of March 8, 1895, Capt. T. W. Symons, Corps of Engineers, was directed to proceed with the survey thus provided for. Captain Symons's report was submitted under date of August 29, 1895, and is published in the Report of the Chief of Engineers for 1896, pages 3356 et seq.

The maps and other data submitted with Captain Symons's report having been approved by the Secretary of War, the county commissioners undertook to procure the lands and releases required. Condemnation proceedings were inaugurated and the necessary land condemned and damages awarded for the part of the canal from Lake Washington to the head of Salmon Bay, but the title has not yet been transferred to the United States.

As the river and harbor act of August 17, 1894, provided for the improvement of the "waterway connecting the waters of Puget Sound with Lakes Union and Washington," and the only "waterway" was the one into Shilshole Bay, the survey authorized by the act of March 2, 1895, was limited to this route. This survey cost the full $5,000 authorized.

When the Smiths Cove route was designated by the Secretary of War as the route to be followed, the county commissioners had the route surveyed from the head of Salmon Bay to Smiths Cove, and obtained the same data for this part of the route as was obtained for the remainder. The maps and data furnished by them were forwarded June 25, 1897. It is the intention of the county commissioners to proceed with the condemnation of the remaining land needed as soon as these maps are approved by the Secretary of War. If such approval is given, the title to all the required land will undoubtedly be transferred to the United States before the end of the fiscal year ending June 30, 1898.

Recommendations and remarks.—As no money has been available for work on detailed plans, no consideration has been given them. It is probable that the title to all the required land will be transferred to the United States within a few months and actual construction can be commenced as soon as proper detailed plans are prepared. This will be an undertaking of some magnitude and, if work is commenced in advance of the completion of such plans, there is a possibility of a change being required during the construction, making unnecessary expense and eventually delaying the completion of the work. Such consideration as I have given the project in a general way induces me to believe that a complete revision of the project and estimated cost should be made before work is commenced.

Future operations.—As soon as the money becomes available detailed plans will be prepared. The amount of money that can profitably be spent upon this improvement during the next fiscal year depends upon the time actual construction can be commenced. If it is commenced early in the year, $200,000 can be profitably expended in addition to the amount on hand.

Money statement.

July 1, 1896, balance unexpended	$170,000.00
July 1, 1897, balance unexpended	170,000.00
Amount (estimated) required for completion of existing project	2,141,167.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—	
August 17, 1894	$25,000
June 3, 1896	150,000
Total	175,000

S S 7.

IMPROVEMENT OF EVERETT HARBOR, WASHINGTON.

(For previous history, see page 515, Annual Report of the Chief of Engineers for 1897.)

Plan of improvement.—The plan of improvement adopted for this work may be generally described as follows:

First, to excavate a harbor basin in the shallows and tide lands adjoining deep water near the river's mouth; second, to dredge a channel from this through the tide flats and the Old River mouth to deep fresh water in Snohomish River, this channel being designed to bring fresh water to the harbor basin and to afford facilities for navigation about the peninsula and into the deep water bounding the peninsula on the east; and, third, to protect and maintain this harbor and channel across the tide flats by a bulkhead interposed between them and the open waters of the sound, the bulkhead to act as a retaining wall for the material dredged from the harbor.

The proper conduct of the work required that the bulkhead for retaining the dredged material should be built previous to doing any dredging. A map of Everett Harbor showing the plan of improvement was published in the Report of the Chief of Engineers for 1895, opposite page 3434.

The estimated cost of the improvement is $372,000.

Results obtained during the fiscal year ending June 30, 1897.—The retaining dike, which had been previously built for a distance of 7,980 feet, was extended a distance of 6,456 feet along the bulkhead line, and a channel 50 feet wide at the bottom and 6 feet deep at mean low water was dredged from the deep water outside in toward the deep water in the river, for a distance of 2,885 feet.

Report of operations.—Work on the retaining dike was commenced on October 20, 1896, under contract with Messrs. Savage & Scofield, and completed on March 1, 1897. During this time there was built 6,456 linear feet of dike, containing 63,807 linear feet of piles, 4,102 cords of brush, 2,410 tons of stone, 107,600 feet B. M. lumber, and 10,200 pounds of spikes. The total cost of the contract work amounted to $11,612.27, or $1.80 per linear foot of dike constructed. Repairs to the part of the dike previously built were also made, involving the use of 405 linear feet of piles, 412 cords of brush, 658 tons of stone, 4,806 feet B. M. lumber, and 600 pounds of spikes.

Dredging was commenced, under contract with the New York Dredging Company, on March 13, 1897, and completed March 28, 1897. The amount of material removed was 32,143 cubic yards.

Recommendations and remarks.—No material benefit has resulted from the work done thus far, and none will result until the channel has been dredged through the flats from deep water outside to deep water inside. Until the dike is backed up with the dredged material, repairs will be necessary with every appropriation. Therefore, the longer the work is in completing the longer will the benefits to be received from it be delayed and the more the work will cost.

The cost of the materials used in the dike was about the same as heretofore, but owing to the greater average depth of water in which the dike was built the cost per linear foot of dike was considerably greater. This year, as last, the work was done in a very satisfactory manner, at very reasonable prices. Last year in my annual report I referred to the fact that all the low bids for the work were by local firms, and spoke of it as an evidence of the earnestness of the people of Everett in regard to the prosecution of the improvement of their harbor. This year the contract went to an outside firm, but local bidders were close competitors, and the scale of prices set last year, I believe, had much to do with the low bids received this year.

In the collection of the commercial statistics for the various works in this district, the more statistics there are to furnish and the greater amount of commerce there is to report the less trouble has been experienced, as a rule, in the collection. The commercial statistics for Everett, which were furnished principally by Mr. F. H. Brownell, vice-president Everett Land Company, were obtained with as little trouble to my office as any in the district, and the relative estimated cost of the improvement and the commerce of Everett certainly makes a very good showing.

An appropriation of $150,000 is recommended as the amount which can be profitably expended on the project during the fiscal year ending June 30, 1899.

Future operations.—The dike will be repaired and added to from time to time as may be necessary, and the dredging continued, so as to give such relief to shipping as the funds will permit.

Money statement.

July 1, 1896, balance unexpended	$20,012.01
June 30, 1897, amount expended during fiscal year	19,220.24
July 1, 1897, balance unexpended	791.77
Amount (estimated) required for completion of existing project	342,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Act of—	
August 17, 1894	$10,000
June 3, 1896	20,000
Total	30,000

Abstract of proposals.

No.	Name and address of bidder.	Piles (per linear foot).	Lumber (per M feet B. M.).	Spikes (per pound).	Brush (per cord).	Stone (per ton).	Total for dike work.	Dredging (per cubic yard).
		Cents.		*Cents.*		*Cents.*		*Cents.*
1	Savage & Scofield, Olympia, Wash	5	$7.50	3	$1.30	82	$11,074.00	....
2	Pacific Dredging Co., Tacoma, Wash	5¾	8.25	3	1.45	75	11,965.00	23
3	Everett Terminal Co., Everett, Wash	5	7.70	3	1.35	93	11,567.60	....
4	New York Dredging Co., New York, N. Y	7¾	11.00	4	2.49	88	17,330.00	a 29
5	J. J. Maney, Everett, Wash	5¼	8.00	3½	1.35	95	11,882.00	....

a Fourteen cents if awarded contract for dredging at Olympia Harbor.

COMMERCIAL STATISTICS.

Everett is in the collection district of Puget Sound and is a subport of entry. The following returns were principally furnished by Mr. F. H. Brownell, vice-president of the Everett Land Company, and are for the calendar year 1896:

SHIPPING.

There are five seagoing steamers, of the propeller type, with an aggregate tonnage of 9,261 tons, and 20 Sound and river steamers, mostly of the stern-wheel class, with an aggregate tonnage of 2,596 tons, that are engaged in the Everett commerce. The maximum draft of the steamers is 24 feet.

Exports and imports (water shipments).

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Bullion	8,000	$10,500,000	....	....
Coal and coke	....	....	9,300	$53,220
Fish	275	13,750	....	....
Fruit and vegetables	250	3,000	5,260	52,600
Grain and feed	650	13,000	2,500	50,000
Hay	700	6,650	900	8,100
Lime rock	....	....	12,228	24,456
Lumber and products	12,494	64,059	....	....
Machinery and implements	....	....	1,112	51,152
Merchandise, general	....	....	13,650	682,500
Miscellaneous	700	7,000	70,640	706,400
Nails, wire	3,164	221,480	....	....
Ore	....	....	68,342	2,575,434
Paper	3,250	270,000	....	....
Sulphur	....	....	300	8,750
Wire rods	....	....	1,832	73,280
Total	24,483	11,098,939	186,064	4,285,892

The Everett smelter ships all of its bullion by steamer to the refinery at San Francisco, Cal. That item of export includes the total bullion realized from ore shipped to the smelter from all sources, namely, Monte Cristo, Rossland, Idaho, British Columbia, Montana, and from all points from which ore comes by rail as well as that received by vessel from Alaska and Mexico. As much the larger amount of the smelter's ore comes to it by rail the export of bullion realized far exceeds the import of ore.

NEW INDUSTRIES.

Three sawmills and one shingle mill were erected during 1896.

S S 8.

IMPROVEMENT OF SWINOMISH SLOUGH, WASHINGTON.

(For previous history see page 516, Annual Report of the Chief of Engineers for 1897.)

Plan of improvement.—The plan of improvement adopted is to dredge a channel 4 feet deep and 100 feet wide from deep water in Saratoga Passage across Skagit Flats, through the shoals of the slough proper, and across the flats of Padilla Bay to deep water, and to build dikes in Skagit and Padilla bays to direct the ebbing and flooding waters through the dredged channels.

The estimated cost of the work is $122,000.

A report of a survey of Swinomish Slough, upon which the plan of improvement is based, is printed with a general map in House Ex. Doc. No. 31, Fifty-second Congress, first session, and reprinted without map in the report of the Chief of Engineers for 1892, pages 2753–2762.

Maps showing parts of the improvement are also published in the Report of the Chief of Engineers for 1894, opposite page 2615, and for 1896, opposite page 3377.

Results obtained during the fiscal year ending June 30, 1897.—The wattled dike in Skagit Bay has been repaired; a pile, brush, and stone dike connecting McGlinns Island and Gallahers Point built, and a channel dredged across the flat just inside the "Hole in the Wall."

Report of operations.—Work on the dikes was commenced under contract with Mr. David Rutherford on October 19, 1896, and completed June 21, 1897.

The first work undertaken was the repair of the Skagit Bay dikes. By the time the work was fairly started bad weather set in causing a suspension of the repair work on the outside dikes until spring. The construction of the dike connecting McGlinns Island and Gallahers Point was then taken up, but owing to delays caused by stormy weather, unfavorable tides, loss of plant, and other causes, the inside dike was not completed until June 13, 1897. Work on the outside dikes was carried on during favorable weather in the spring. During the continuance of this contract there was received and placed in the various dikes 45,596 linear feet of piling, 4,351.2 cords of brush, 7,120.9 tons of stone, 110,260 feet, B. M., lumber, 12,242 pounds of spikes, and 5,986 pounds of wire. The length of the new dike built between McGlinns Island and Gallahers Point was 2,745 feet, and the total cost of the contract work upon it was $11,869.28, or $4.32 per linear foot. This dike at first was built so as to entirely close the passage to the east of McGlinns Island, but it was found that at certain stages of the tide there was a difference of level in the surface of the water on the two sides of the dike of about 2 feet. This exerted a very heavy pressure on the dike, endangering its existence and causing a tremendous current through the "Hole in the Wall." A gap about 80 feet in length was made in the dike near the northern end and the bottom of the gap protected with a mattress. This relieved the pressure on the dike and reduced the current through the "Hole in the Wall."

Of the old dike which was repaired, 2,129 linear feet were replaced by a new dike consisting of two rows of piles filled in between with brush and stone, as it was found that the old form, consisting of a single row of piles wattled with brush, was not sufficiently strong to stand the exposure at certain points.

Dredging was commenced across the flats inside the "Hole in the Wall" under contract with the New York Dredging Company on April 1, 1897, and completed on April 18, 1897. The amount of material removed was 36,017.95 cubic yards. The dredged channel was nearly parallel to the dike extending from McGlinns Island to Gallahers Point, and the material taken from the channel was deposited on the outside of the dike. The dimensions of the channel when completed were 100 feet wide and 4 feet deep at mean low water. The currents are directed by the dike through this channel, and since the dredging was completed this channel has scoured out so that for the greater part of the distance it is 7 feet or more deep at mean low water and 200 feet or more wide. At the end near the "Hole in the Wall" the depth has not increased any, but the action which has thus far taken place indicates that this will also soon deepen to the same depth as the remainder of this channel.

Recommendations and remarks.—The work done the past year completes the work contemplated by the project as far as Laconner, the principal town on Swinomish Slough, and considerable immediate benefit is derived from the work already done; but as all the work so far done has been on the southern half of the slough, no benefit is derived by boats having their destination north of Laconner.

The route through Deception Pass and around the west side of Fidalgo Island is a particularly dangerous one, as the island is high and cuts off the wind to such an extent that a severe wind may be blowing outside and but little intimation of it felt on the inside. At certain stages the tide running through Deception Pass resembles a mountain torrent more than a tidal flow. On the ebb this tide running into a west wind raises a dangerously heavy sea. A boat once started through the Pass can not turn back, but must go through and meet whatever sea there may be on the outside.

It is therefore very desirable that the slough be fully opened with the least delay practicable, and it is recommended that the full amount to complete the project be appropriated.

Future operations.—Work in accordance with the project will be extended north of Laconner as fast as available funds permit.

Money statement.

July 1, 1896, balance unexpended	$29,075.26
June 30, 1897, amount expended during fiscal year	26,905.51
July 1, 1897, balance unexpended	2,169.75
Amount (estimated) required for completion of existing project	47,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	47,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS

Act of—	
July 13, 1892	$25,000
August 17, 1894	25,000
June 3, 1896	25,000
Total	75,000

Abstract of proposals.

No.	Name and address of bidder.	Piles (per linear foot).	Lumber (per M feet B. M.).	Spikes (per pound).	Wire (per pound).	Brush, per cord of fascines.	Stone (per ton).	Total for dike work.	Dredging (per cubic yard).	Total for dredging.
		Cents.		*Cents.*	*Cents.*				*Cents.*	
1	Pacific Dredging Co., Tacoma, Wash	6	$8.75	3	3	$2.35	$0.70	$13,471.00	24	$9,000.00
2	J. J. Maney, Everett, Wash	6½	9.50	3½	3½	1.75	.75	11,971.25		
3	Everett Terminal Co., Everett, Wash	6	8.00	3	3	1.70	.75	11,454.00		
4	David Rutherford, Tacoma, Wash	7	10.50	3½	3½	1.74	.55	11,372.00		
5	New York Dredging Co., New York, N. Y.	8	12.00	4	4½	2.79	.66	15,789.50	[a] 20 29	8,000.00 11,600.00
6	P. Gibbons, Renton, Wash	11	12.25	4½	4½	1.65	1.85	17,697.75		

[a] If awarded contract for dredging at Olympia Harbor.

COMMERCIAL STATISTICS.

Swinomish Slough is in the collection district of Puget Sound. The nearest port of entry is Port Townsend.

The following statistics were furnished by Mr. R. O. Welts, of Laconner, Wash., for the calendar year 1896:

SHIPPING.

Seventeen steamboats are engaged in traffic with this port, the maximum draft being about 7 feet.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Butter	100	$30,000		
Cabbage seed	25	10,000		
Coal			100	$1,000
Eggs	50	6,664		
Fish	3,100	206,000		
Fruit	15	500	20	1,000
Grain	30,100	602,000		
Hay	15,000	140,000		
Hides	10	2,000		
Hops	100	20,000		
Live stock	100	5,000	50	2,500
Lumber and products	4,000	21,000	8,625	58,000
Merchandise			1,160	103,000
Meats, dressed	500	60,000		
Machinery			600	60,000
Vegetables	1,700	17,000		
Wool	20	2,000		
Total	54,820	1,122,164	10,555	225,500

No new industries have been reported.

REPORT OF MR. E. L. CARPENTER, INSPECTOR, IN CHARGE OF WORK OF IMPROVING SWINOMISH SLOUGH, WASHINGTON.

SEATTLE, WASH., *June 26, 1897.*

CAPTAIN: I have the honor to submit the following report of operations improving Swinomish Slough, Washington, for the fiscal year ending June 30, 1897.

The operations contemplated under the appropriation of $25,000 by the river and harbor act of June 3, 1896, were the straightening of the channel between the Hole-in-the-Wall and LaConner, by building a pile, brush, and stone dike from McGlinns Island to Gallihers Point, dredging a channel through the flats to the west of this dike, and repairing the old wattled dike in Skagit Bay.

Dike building.—On October 9, 1896, a contract was entered into with David Rutherford, of Tacoma, Wash., to make the necessary repairs to the wattled dike and to build the dike from McGlinns Island to Gallihers Point.

Repairs to the wattled dike.—On October 19 work was begun repairing the wattled dike and was continued until November 11, 1896, when it was suspended on account of the winter weather. Operations were resumed on April 20, 1897, and brought to a close on June 21, 1897.

Three dikes, respectively, 804, 905, and 420 feet long were built. For the first two of these dikes the wattling, where there was any, was pulled off the piles, and wherever possible these piles were used, but where they they were badly out of line or too low they were pulled out or cut off and new ones driven in their place. A row of piles, 6 feet apart and 4 feet from the old piles, were driven and a dike of brush and stone, similar to the Gallihers Point dike, constructed; a mattress 32 feet wide and three fascines thick being used for the first dike, and a mattress 16 feet wide and three fascines thick for the second dike. In the third dike, 420 feet long, the wattling was in good condition, but the bottom had cut away leaving the wattling hanging up on the piles from 5 to 7 feet from the bottom. The wattling was left on and a row of piles driven 4 feet from the wattled dike and 6 feet apart, the space between the rows of piles being filled with brush and stone up as far as the bottom of the wattling, a brush mattress being sunk on the channel side of the dike.

The number of piles driven for the three dikes was 463; the average penetration, 19 feet; the weight of the pile driver hammer, 3,760 pounds; the average number of blows per pile, 16; the greatest number 54 and the least number 4.

Marker piles were driven on the channel side of the dike 100 feet apart and 16 feet from the dike. They have an average elevation of 20 feet above high water.

The following table shows the quantities of materials used and the cost:

1,072.9 cords brush, at $1.74 per cord	$1,866.85
1,343.23 tons stone, at 55 cents per ton	738.78
2,072 pounds wire, at 3½ cents per pound	72.52
17,972 linear feet piling, at 7 cents per foot	1,258.04
5,060 pounds spikes, at 3½ cents per pound	177.10
46,900 feet B. M. lumber, at $10.50 per M	492.45
Making total cost, exclusive of inspection	4,605.74

And the cost per linear foot, $2.16.

McGlinns Island—Gallihers Point Dike.—The construction of this dike was begun November 21, 1896, and finished June 16, 1897. Its length is 2,745 feet.

Where the dike crossed the Swinomish Slough channel the piles were driven 6 feet apart each way, but where it crossed the flats the distance between the two rows of piles was decreased to 4 feet and the distance between the piles in the rows increased to 8 feet.

The length of the flat section is 1,506 feet, the north channel section 530 feet, and the south channel section 709 feet.

At first mattresses two fascines thick and 16 feet wide were used, but these were found insufficient, and for the flat section and north channel section the thickness was increased to 3 fascines, and the width to 32 feet on the south channel section, where great difficulty was experienced in holding the dike, as on the ebb tide the water would bank up on the east side of the dike and cut under the mattress. It was finally found necessary to increase the mattress width to 48 feet.

The damming off of the channel between McGlinns Island and the mainland caused a very swift current through the Hole-in-the-Wall and on the flood tide a difference in the height of the water on the two sides of the dike of from 8 inches to 2 feet. On April 16, when the difference in the height of the water on the two sides of the dike was 2 feet, a break 78 feet long occurred 72 feet from the north end of the dike. To reduce the current through the Hole-in-the-Wall, this break was not repaired, and as the mattress did not break up it was loaded heavily with stone and left as a sill. There is 20 feet of water in this gap at mean lower low water.

The number of piles driven for the dike was 820; the average penetration, flat section 16 feet, channel sections 23.5 feet. The weight of the pile-driver hammer was 3,760 pounds; the average number of blows per pile 19, greatest number 172, least number 6.

Quantities of materials and cost:

3,278.3 cords brush, at $1.74 per cord	$5,704.24
5,777.67 tons stone, at 55 cents per ton	3,177.72
27,624 linear feet piling, at 7 cents per foot	1,933.68
3,914 pounds wire, at 3½ cents per pound	136.99
7,182 pounds spikes, at 3½ cents per pound	251.37
63,360 feet B. M. lumber, at $10.50 per M	665.28
Making total cost of dike, exclusive of inspection	11,869.28

And the cost per linear foot, $4.32.

Dredging.—A contract was entered into with the New York Dredging Company on October 16, 1896, to dredge a channel across the flats from deep water in the Hole-in-the-Wall to deep water off Gallihers Point, at 20 cents per cubic yard.

The dredger arrived March 31 and began work April 1, 1897, at the south end of the cut, working north.

Considerable difficulty was experienced during the ebb tide by the channel filling in around and behind the dredge. After every ebb tide the dredge was compelled to set back from 40 to 100 feet to maintain the required depth.

The length of the cut was 1,925 feet and required width on the bottom 100 feet, with a depth at mean lower low water of 4 feet. The cut as made by the dredge was from 105 to 125 feet wide on the bottom, and for 1,200 feet north from the south end was from 4½ to 5½ feet deep, the remaining 725 feet being 8 feet deep. The cut was finished April 18, 1897.

Previous to the arrival of the dredge a survey was made to determine the amount of material to be excavated, as all of the cut except the extreme ends went bare at low water the channel was cross sectioned every 20 feet by instrumental or water levels. The amount of excavation was found to be 36,017.95 cubic yards. Owing to the continual refilling of the channel and the extra depth and width cut the amount of material removed was probably not far from 65,000 cubic yards. The excavated material was deposited against the dike on the east side, the fill being carried up to the waling. The material removed was sand and weighed 2,260 pounds per cubic yard.

The cost of the dredging, exclusive of inspection, was $7,203.59.

Present condition.—As soon as the channel was cut it began to widen and deepen and at present it is from 200 to 250 feet wide and 7 feet deep. The sand washed out in this widening process settled in the Hole-in-the-Wall where it has formed a bar. This bar first formed about 200 feet north of the south end of the dredged channel, it slowly moved south, and at present is in the Hole-in-the-Wall about midway between the point of rocks on the Fidalgo Island side and the red light on McGlinns Island. It has about 2 feet of water on it at mean lower low water.

Condition of previous work.—Upon a recent examination of the dredged channel between Laconner and the Seattle and Northern Railroad Bridge it was found to be in good condition, no shoaling being noticed.

The pile dike between Goat and Ika islands is also in good condition, no drift has collected, but the small channels crossing its line have filled up.

The dredged channel in Skagit Bay shoaled up considerably, caused by the breaks in the wattled dike. Now that these breaks have been repaired, it is probable that the old depths will be regained.

Surveys.—In April a survey was made of the dredged channel and the Hole-in-the-Wall.

In May a survey of Skagit Bay was made between the end of the wattled dike and deep water in Saratoga Passage.

The notes of neither of these surveys have as yet been platted.

Completion of project.—The original plan for the improvement of Swinomish Slough provided for a channel 100 feet wide at the bottom and 4 feet deep at mean lower low water, extending from deep water in Skagit Bay across Skagit Bay Flats, through Swinomish Slough, and across Padilla Bay Flats to deep water in the latter bay. Under the appropriations of July 13, 1892, August 17, 1894, and June 3, 1896, the project has been completed to the extent of dredging 21,745 feet of channel, building 6,200 feet of wattled dike in Skagit Bay, putting in a pile dike between Goat and Ika islands, and building a pile, brush, and stone dike between McGlinns Island and Gallihers Point.

I estimate to complete the project the following amounts of dredging and dike building will be required:

Dredging:		
Skagit Bay ... cubic yards..	$42,000	
Padilla Bay ... do....	104,000	
Swinomish Slough ... do....	32,000	
Total ... do....	178,000, at 16 cents =	$28,480
Dike building:		
Brush dike, Padilla Bay, 5,400 feet, at $1 ...		5,400
Pile, brush, and stone dike—		
Telegraph Slough, 485 feet ...		1,000
Skagit Bay, 3,770 feet ...		10,400
		45,280
Contingencies, etc., 10 per cent ...		4,528
Total ...		49,808

Future operations.—I would recommend that the next appropriation that becomes available be spent in dredging a channel through Padilla Bay Flats and cutting off the point near Whitney's barn.

There is still about 700 feet of the wattled dike that needs repairing. The wattling is badly broken up and a good deal of it has gone out, leaving the average height of the wattling for this 700 feet only about 2 feet above mean lower low water. I estimate to repair this, by putting in a pile, brush, and stone dike, would cost $1,850.

Very respectfully, your obedient servant,

E. L. CARPENTER, *Inspector.*

Capt. HARRY TAYLOR,
Corps of Engineers.

S S 9.

IMPROVEMENT OF COLUMBIA RIVER FROM ROCK ISLAND RAPIDS TO FOSTER CREEK RAPIDS, WASHINGTON.

Description of original condition.—This portion of the river is 80 miles in length. It flows through a deep canyon with an average fall of 2.2 feet per mile. The river has sufficient water for all purposes of navigation, and the only difficulties in the way of navigation are:

1. The generally swift currents;
2. Rocks here and there which occupy dangerous positions; and
3. The rapids at the Methow, Entiat, and Wenatchee rivers.

The river is navigated from the mouth of the Okanogan, which is practically at Foster Creek Rapids, down to Wenatchee, where connection is made with the Great Northern Railroad.

Plan of improvement.—A survey with project for improvement of this portion of the river has been made and was the subject of a special report by Capt. T. W. Symons, Corps of Engineers, May 22, 1895, but has not yet been finally adopted.

In the meanwhile a temporary project of improvement was made, based upon a preliminary examination. The project contemplated the removal of obstructive rocks at Rocky Reach and Methow Rapids and at such other places as may be found necessary. Also, to put in "dead men" or other suitable anchorages as points of support for lining up at Entiat and Methow Rapids and to put in a timber boom at Entiat Rapids. This boom was designed to enable boatmen to carry a line to a "dead man" located on an island conveniently situated for boats lining up over the rapids.

The work done under the temporary project was carried on in accordance with the authority granted by the river and harbor act of August 17, 1894, which authorized the use of the unexpended balance of the appropriation for the improvement of the Columbia River between the head of Rock Island Rapids and the foot of Priest Rapids, Washington.

The money available at the time the above authority was granted having all been expended prior to June 30, 1896, and no further appropriation having been made, no work has been done during the past year.

Recommendations and remarks.—The funds available for this work have been exhausted, and as it has been the subject of a special survey and report and no appropriation has since been made it is not considered necessary to make any recommendation in regard to future appropriations, and no more reports will be submitted unless further appropriations are made.

Money statement.

July 1, 1896, balance unexpended	$2.00
June 30, 1897, amount expended during fiscal year	2.00

Appropriation.—The river and harbor act of August 17, 1894, contained the following item:

The Secretary of War may, in his discretion, expend the unexpended balance, eight thousand two hundred and ten dollars and ninety-two cents, of the appropriation heretofore made for the improvement of the Columbia River between the head of Rock Island Rapids and the foot of Priest Rapids, Washington, for the building of a snag boat for use on the Columbia River between Rock Island Rapids and Foster Creek Rapids, and for such other work as may be necessary for the improvement of navigation of said river within the above-named limits.

At the time of the passage of the bill this amount had been reduced to $8,005.20.

COMMERCIAL STATISTICS.

The following information relative to the commerce of this portion of the Columbia River was furnished by Mr. W. R. Prowell and E. L. Hallenbeck, secretary of the Columbia and Okanogan Steamer Line.

The new line now extends from Wenatchee to Johnson Creek, on the Okanogan River.

The transportation during the past fiscal year was as follows:

Freight carried	tons..	5,500
Number of passengers carried		1,300

The freight consisted of general merchandise, grain, and ore.

The amount of freight carried during the previous year was 6,000 tons.

NEW INDUSTRIES.

Two stamp mills and a cyanide plant have been erected in the district tributary to this portion of the river during the past year.

The Palmer Mountain Tunnel Company is pushing work on the tunnel through Palmer Mountain, and general mining development has been far greater than in any previous year.

S S 10.

IMPROVEMENT OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON.

(For previous history see page 518, Annual Report of the Chief of Engineers for 1897.)

Plan of improvement.—Previous to 1877 $120,000 had been appropriated for the work of improvement and had been expended in surveys and rock removal at the principal rapids.

In 1877 Maj. J. M. Wilson made a project for the improvement of the upper Columbia and Snake rivers, which consisted in the removal of rock bowlders and rocky reefs and the scraping of gravel bars in the Columbia and Snake as far up as Lewiston. The estimated cost of this work was $132,000.

The present project or plan of improvement consists in the removal of bowlders, gravel bars, and rock ledges and the construction of such contraction works as may be necessary.

The estimated cost of the work has not yet been accurately determined because of the lack of full and continuous surveys and because, from the nature of things, it can not be, as many of the obstructions which it is necessary to remove are continually recurring.

Results obtained during the fiscal year ending June 30, 1897.—The dikes at Log Cabin Rapids, 38 miles below Lewiston, and at Wild Goose Island Rapids, 73 miles below Lewiston, were completed and the parts previously built were repaired.

Report of operations.—Work on the dike at Log Cabin Rapids was carried on during September and the early part of October, 1896, and on the dike at Wild Goose Island during the latter part of October and November, 1896. During the time work was in progress at Log Cabin Rapids 480 feet of dike was built and 120 feet repaired and strengthened. The amount of rock used in the new work was 1,505 tons and in the repair work 200 tons. At Wild Goose Island 80 feet of dike was built and 141 feet repaired, with a total of 602 tons of stone. Navigation at these points was materially benefited by the work done during the year.

Full details of the work as to methods, cost, and results are given in the accompanying report of Assistant Engineer J. M. Clapp, who had charge of the work.

Recommendations and remarks.—The importance of the navigation of the Snake River between Riparia and Lewiston is continually increasing. The high plateaux along the banks of the Snake are magnificent grain fields, and this grain naturally finds its way to market by the river. Along the bottom lands of the river valley are some of the finest fruit orchards in the Northwest. It is, of course, an absolute necessity that the fruit from these orchards should be shipped without delay, at the proper time, and the boats which ply on the river are the only means by which this can be accomplished. These orchards are increasing in number every year, and the fruit shipped out in the last few years has been an important part of the freight carried.

Some additional dike work is required, and besides this work, which may be considered fairly permanent, there is, and always will be required on this river, work of a temporary character, consisting of the removal of water and ice-borne bowlders which lodge in the shallowest parts of the channel and become dangerous obstructions, which, even if known and avoided, limit materially the loads that can be carried on the steamboats plying on the river. The work done on the river between Lewiston and Asotin in removing these bowlders has doubled the carrying capacity of the steamers employed.

The dikes should be completed as soon as practicable, and it is recommended that an appropriation of $20,000 be made for the upper Columbia and Snake, as this amount can be profitably expended during the fiscal year ending June 30, 1899.

Future operations.—It is contemplated to repair the dikes at Wild Goose Island and Log Cabin Rapids as often as they may need it, to build such other dikes and to do such other work in accordance with the project as there may be funds for.

Money statement.

July 1, 1896, balance unexpended	$6,666.97
June 30, 1897, amount expended during fiscal year	3,898.92
July 1, 1897, balance unexpended	2,768.05
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

APPROPRIATIONS.

Upper Columbia River, act of—	
June 10, 1873	$50,000
June 23, 1874	20,000
March 3, 1875	35,000
Total	105,000
Upper Columbia and Snake rivers, act of—	
August 14, 1876	15,000
June 18, 1878	20,000
March 3, 1879	20,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	6,000
July 5, 1884	20,000
August 5, 1886	10,000
August 11, 1888	10,000
September 19, 1890	20,000
July 13, 1892	15,000
August 17, 1894	5,000
June 3, 1896	5,000
Total	176,000
Aggregate	281,000

COMMERCIAL STATISTICS.

The commercial statistics for this improvement were furnished by Mr. E. J. Rathbone, superintendent of water lines, Oregon Railroad and Navigation Company, for the calendar year 1896.

SHIPPING.

Three boats ply on the river between Riparia and Asotin at times, engaged in freight and passenger traffic. They are of the stern-wheel class, and their registered tonnage is 673.38, 513.92, and 502.35, respectively; draft of water fully laden is 4 feet 6 inches; light, 1 foot 9 inches.

The total number of passengers carried during the year 1896 was 2,445. Up to April 1, 1897, the passenger business showed an increase of 100 per cent over 1896.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Fruit	1,500	$40,000		
Grain	15,846	316,927		
Live stock	862	34,480		
Lumber			4,250	$18,000
Merchandise			1,272	127,250
Wool	142	28,400		
Total	18,350	419,807	5,522	145,250

REPORT OF MR. J. M. CLAPP, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., December 29, 1896.

CAPTAIN: I have the honor to submit the following report of operations "improving upper Columbia and Snake rivers, Oregon and Washington," during September, October, and November, 1896:

Briefly stated, the original project under which this work was done called for a channel in the Columbia River, 5½ feet deep at low water, between the mouth of Snake River and Celilo, and a channel in the Snake River, 4½ feet deep at low water, from its mouth to Asotin. Since the completion of the Oregon Railroad and Navigation Railway Line between Portland and Spokane, the rivers below Riparia, Wash., have not been navigated to any great extent, navigation having been confined to that part of Snake River between Riparia, Wash., and Asotin, Wash. Since 1890 this stretch of river has been the only part which has received aid from the General Government.

Work during the past season was confined to the building and repairing of stone dikes at two points in the Snake River between Lewiston and Riparia. One of these points is known as Log Cabin Rapids, situated about 38 miles below Lewiston; the other as Wild Goose Rapids, and is situated about 7 miles above Riparia. The two points are distant from each other about 35 miles.

LOG CABIN ISLAND DIKE.

History.—The object of the construction of this dike was to close up one of the two steamboat channels at this point and concentrate the flow of water at low-water season in the other channel with the hope that this increased flow would scour out this channel to the desired depth and adjust it in a more direct line.

Work was first commenced on this dike December 11, 1892, and continued until December 21, when the river began to freeze up and operations ceased. During this time 50 feet of dike was constructed, the amount of rock used being 305 tons.

On March 7, 1893, the ice having disappeared from the river, work was resumed and again suspended April 25, 1893, on account of high water. During this time 70 feet of dike was constructed, the amount of rock used being 1,296 tons.

No other work was done on this dike until September, 1896, when operations again started, and the dike was completed October 21, 1896. During this time 480 feet of new dike was built besides the stopping up of several gaps in the old work and a general crowning of the whole structure. The amount of rock used was 1,705 tons.

Detail of operations, 1896.—The plant used for this work was the property of the United States and consisted of 1 quarters scow, 1 stone scow, and the necessary equipment of wheelbarrows, hammers, blacksmith shop, cooking outfit, etc.

The work was done by hired labor.

On September 16, 1896, I left Seattle, Wash., for Log Cabin Island, Washington, under your instructions to take charge of the work of improving the Upper Columbia and Snake rivers, Oregon and Washington, at that point. On September 21 I relieved Mr. E. W. Baughman, overseer, of the charge of this work.

On September 2 a crew of men was hired and were engaged until September 5 in outfitting. On this date the crew with the plant left Lewiston for Log Cabin Island, floating thither with the current, at which place they arrived September 8. On September 9 several deadmen were planted at different points where needed to fasten lines used in manipulating the stone scow.

On this date the first load of about 40 tons of stone was taken to the dike.

Quarry.—The rock used for the construction of this dike was obtained from a natural quarry located about one-half mile above the dike and on the opposite side of the river. Angular rock of sizes varying in weight from 20 to 800 pounds was found here in abundance, which had dropped from the high, basaltic bluffs which flank the river at this point. No blasting was done other than to break some of the larger rocks into pieces, which were readily loaded on wheelbarrows and grain trucks.

Loading the scow.—The stone scow was moored at the quarry several feet from the shore line, whereby danger of grounding was overcome. Three large gang planks, 18 feet long and 2 feet wide, were made from the 4 by 12 inch lumber used for launching purposes last spring. These strong planks were used as runways for the wheelbarrows and grain trucks to carry the rock from the quarry to the scow. Rocks from 20 to 200 pounds weight were loaded by the wheelbarrows, while those weighing over this were loaded with the aid of a grain truck. Rocks of 1,000 pounds weight (estimated) were loaded by this means.

Moving the scow from quarry to dike and return.—The scow load of rock was swung across the river by means of a bowline, one end of which was made fast to a deadman located on the same side of the river and upstream from the quarry, and the other end made fast to the bow timber head on the starboard side. With the aid of a long oar or sweep the scow was kept at an angle with the current, which forced her toward the other shore, where the end of the swing line was made fast to a deadman and there freed from the scow. From this point to a point within about 1,000 feet of the dike the scow was towed by the workmen. A strong line was made fast to a deadman planted here and the scow dropped by slacking away on the line (which was passed round the bitts of the scow) to a point within about 250 feet of the dike, where another deadman was planted. The strong line was made fast to this deadman and the scow dropped into the proper position by slacking away as before, care being taken that a strain was always kept on this line. After discharging the cargo the scow was returned to this last-mentioned or lower deadman with the aid of the capstan. From this point to the deadman, where the swing line was made fast, the scow was towed by the workmen. The empty scow was then swung to the quarry by means of the swing line which had been taken aboard and passed round the bow timber head on the port side in the same manner as the loaded scow was crossed

By September 21, 1896, 7 scow loads, aggregating 295 tons, had been placed into this dike.

The work was continued in the same general manner until October 21, on which date the dike was completed.

The crest of the dike had a general elevation of about 2 feet above low water. The width on top averaged from 2 to 3 feet with a side slope toward the channel of about 1 on 1, the slope on the reverse side being about 1 on 2.

The difference of elevation between the water surfaces above and below the dike varied from 4 feet at the upper end to 1½ feet near the lower end.

The greatest depth of water crossed by this dike was about 7 feet, the average depth about 3½ feet.

Brush work.—About 1,600 square feet of shore surface at the root of the dike was covered about 8 inches deep with loose brush, which was securely weighted with rock. There was used for this purpose about 10 cords, the total cost of which in place was $13.25, or $1.32 per cord.

Results, changes, etc.—Since the closing of the north channel the currents in the south channel have become stronger and more direct. The channel used by the steamboats is much farther north than formerly. The water has been raised over 1 foot on the rapids since the dike was constructed. No lining was done by the steamboats during the past season. Reports of navigators are all of a character to indicate that a great amount of benefit has resulted.

On October 22, the outfit was transferred to Wild Goose Island, drifting thither with the current, a distance of about 35 miles. Next day the work of repairing the dike at this point was begun.

WILD GOOSE ISLAND DIKE.

History.—The object of this dike was to close a very crooked channel, called the south channel, and thereby concentrate the flow of water (below a 2-foot stage) in a straight middle channel, with the hope that it would scour it to a greater depth, lengthen the rapid at this point, and lessen the current.

Work was begun on this dike in August, 1892, and suspended on account of lack of funds July 30, 1893. Between these dates work was suspended twice; once on account of very low water and again on account of very high water. The total length of dike constructed was about 570 feet.

Work done in 1896.—The work done during 1896 consisted of the refilling of several small shallow gaps in the dike itself, which had been made by the ice, and the construction of a stone dike in prolongation of the old work across a channel which had cut round the upper or Goose Island end of the dike.

When work began, October 23, 1896, there were seven gaps in the dike itself, ranging from 10 to 40 feet wide, and having a depth of water pouring through them varying from 2 to 5 feet, besides a channel at either end of the dike.

The dike was repaired and raised so that its crest stood at an elevation of about 2 feet above low water, its full length, with exception of the channel at the lower end and one of the gaps, which is located about 150 feet from the lower end. The former has a width of about 15 feet, and a channel depth of about 1½ feet at low water. The latter has a width of about 40 feet and a low-water depth of about 5 feet.

On account of shoal water in the vicinity of these gaps, it was impossible to transport stone to them, and they were left unrepaired.

Seven gaps, combining a length of about 140 feet, were refilled to the proper elevation, using therefor 140.71 tons of stone.

The dike built across the channel at the upper end of the dike was built in water averaging 6½ feet in depth. Its length is 80 feet. Eleven scow loads of stone, aggregating 460.72 tons, were used in its construction. In cross section it is similar to the old dike, having a width on top of about 2 feet, a slope on its upper side of about 1 on 1, and on the reverse side about 1 on 2.

Brush work.—A shore protection of brush fascines was laid at the upper end of the dike and securely weighted with rock. A similar protection was laid at the lower end of the dike and weighted with coarse gravel.

Quarry.—The stone used was obtained from the south shore of the river in the vicinity of the dike. Desirable pieces were very scarce, the quarry extending along the shore a distance of about 1,200 feet. The basaltic bluffs which flank the river at this point contained only a small amount of suitable rock that was handy enough to be loaded at a reasonable expense. About half the rocks used were large angular pieces obtained from these bluffs, the remainder being the beach bowlders found along the shore. The quarried pieces were used in the bottom of the dike as a foundation behind and upon which the bowlders were placed.

Moving the scow.—The scow of rocks were moved from the quarry to the dike in about the same manner as at Log Cabin Dike, with the exception that the capstan was used to a greater extent, made necessary on account of the rapid current at this point, which made the work more laborious and slow. On account of shoal water the loads carried were small, averaging about 40 tons.

Results, changes, etc.—After filling up the several gaps and the channel at the upper end the surface of the water on the upper side of the dike was about 2½ feet above the water surface on the lower side. The water over the rapids in the middle channel was raised about 1 foot.

The steamboats ascended the rapids at this point without lining.

On November 13 the quarters scow and all the equipment except some mooring lines, which were left on the stone scow, started for Lewiston in tow of the steamer *Lewiston*, arriving there at 1.30 p. m. November 14. The stone scow was towed to Lewiston later in the month.

The property was all overhauled, checked up, stored, and turned over to the charge of Nicholas Smith, watchman, November 20, 1896.

The weather throughout the whole time was most suitable for field work. No time was lost. What rain there was, fell nights and Sundays. The water of the river remained at a practically uniform stage. On one occasion only did it rise a few inches.

Summarized statement.

Expenditures.	Log Cabin Dike.	Goose Island Dike.
Labor	$1,146.06	$581.23
Supplies:		
Subsistence	336.87	129.19
Hardware, powder, etc	58.96	29.00
Traveling expenses	32.55	27.00
Towing scows to Lewiston	20.00	20.00
Freight, storage, etc	104.10	61.87
Engineering, superintendence, etc	250.00	150.00
Total cost	1,948.54	998.29

SUMMARY OF WORK.

Log Cabin Dike.

Work began September 1, 1896.
Work ended October 21, 1896.
Length of dike built, 480 feet.
Amount of rock used, 1,505 tons.
Amount of rock used per foot, 3.14 tons, nearly.
Cost per ton of rock in place, $1.15, nearly.
Cost per foot of dike, $3.61.
Average depth of water, about 3½ feet.
Length of dike repaired, 120 feet.
Amount of rock used, 200 tons.
Amount of rock used per foot, 1⅔ tons.
Cost per ton of rock in place, $1.15, nearly.
Cost per foot of repairs, $1.92.

Goose Island Dike

Work began October 22, 1896.
Work ended November 20, 1896.
Length of dike built, 80 feet.
Amount of rock used, 466 tons.
Amount of rock used per foot, 5.76 tons.
Cost of dike per foot, $9.60.
Cost per ton of rock in place, $1.66.
Average depth of water, 6½ feet.

Repair work.

Length of dike repaired, 141 feet.
Amount of rock used, 141 tons.
Amount of rock used per foot, 1 ton.

Cost of repairs per foot, $1.66.
Average height of fill, 2 feet.
All labor was hired by the hour and board furnished.

Disregarding the miscellaneous items of expense and taking into consideration only the cost of subsistence, labor, and engineering, the cost per ton of rock in place in Log Cabin dike was as follows:

In September	$1.53
In October	.78

The cost per ton of rock in place in Goose Island dike was $1.11. The total amount of rock used altogether in the construction of Log Cabin dike is as follows:

	Tons.
From December 11, 1892, to September, 1896	1,601
From September, 1896, to October 21, 1896	1,705
Total	3,306

Total length of dike, 600 feet.

The total amount of rock used altogether in the construction of Wild Goose Island dike is as follows:

	Tons.
Prior to October 22, 1896	3,734
From October, 1896, to November 20, 1896	602
Total	4,336

Total length of dike, 650 feet.

FUTURE OPERATIONS.

The project for 1894 recommended the building of three dikes as follows:

(1) At Wild Goose Island, estimated cost	$8,078.50
(2) At Log Cabin Rapids, estimated cost	5,810.00
(3) At Diamond Crossing, estimated cost	9,330.75
(4) The extension of the crib at Log Cabin Rapids, estimated cost	1,016.63

One and 2 are now completed, save some repairs to No. 1, and a possible extension of the Log Cabin dike after another high water, the combined cost of which should not be more than $1,500.

No. 3 is a troublesome place, but has always been an easier place to navigate than either Nos. 1 or 2.

No work has been done at No. 3 as yet. The proposed extension of the Log Cabin Crib I am of opinion is unnecessary. Since the construction of Log Cabin dike the channels have so changed that steamers now run several hundred feet away from the crib. A marked improvement in the channel over these rapids has already taken place.

Since this project was outlined, I am of opinion the topography of Wild Goose Island has so changed as to necessitate a change in the plan of improvement at this point. The channel to the south of the island has gradually increased in width and depth until now at very lowest water there is a channel of 4 feet (the bottom of which is covered with large and small bowlders), where several years ago it was easily forded with a team and wagon at the same stage of water.

The location of the steamboat channel should be kept to the north of the island. To insure this and also to maintain a deeper channel over the rapids I respectfully recommend the construction of a stone trailing dike closing the south or slough channel at its head. Such a dike would have a length of about 1,200 feet, in water averaging about 3½ feet deep, and would require about 4,000 tons of rock, which could be put in place at a cost not to exceed $1 per ton.

RECAPITULATION.

To recapitulate, I would respectfully recommend that the following work of improvement be done on that part of Snake River between Riparia, Wash., and Lewiston, Idaho, for the improvement of its channels at the following estimated cost:

Repairs to existing dikes	$1,500
Stone dike to close South Channel, Goose Island	4,000
Stone dike at Diamond Crossing	9,330
Care of plant two years	2,000
Engineering, superintendence, etc., 10 per cent	1,683
Total	18,513

In addition to the above, I believe it will be necessary from time to time to remove bowlders which lodge at different points in the channel, brought thither by ice, high water, etc.

It is difficult to estimate about how much would be necessary to keep the channel clear of these bowlders, but I should think that $2,500 spent every two years would be ample for this purpose.

The bottom of the river at Log Cabin and Goose Island rapids is a hard gravel of various sizes, compactly bedded. It is difficult to remove a single piece of this gravel from the bed, so firmly is it imbedded with sand, which appears to cement the whole mass. It is not a cement gravel, however.

The currents would be aided in their work at these points if a heavy iron drag or scraper were dragged down over the rapids sufficiently to stir up this hard bottom which would then wash away. I should think a steamer supplied with such a contrivance could be employed with great benefit to the channel at these and perhaps other points for a period of about thirty days.

There is a drag of this character now at Lewiston, the weight of which is several thousand pounds, and which has been used before with success on the rapids of Snake River.

Thirty days work of steamer, at probably $40 per day, $1,200.

The total amount which could be profitably expended on the improvement of Snake River, Oregon and Washington, between Lewiston, Idaho, and Riparia, Wash., is as follows:

Dike building and repairing	$18,513
Care of plant and office expenses for two years	2,000
Rock removal (bowlders)	2,500
Bar scraping	1,200
Total	24,213

Very respectfully, your obedient servant,

J. M. CLAPP, *Assistant Engineer.*

Capt. HARRY TAYLOR,
Corps of Engineers.

S S 11.

IMPROVEMENT OF COWLITZ RIVER, WASHINGTON.

The first appropriation for this work was made in the river and harbor bill approved June 14, 1880.

Description of original condition.—The Cowlitz is a northern tributary of the Columbia, and joins the latter river 64 miles above its mouth. The lower part of the river was seriously obstructed by snags and bars, with but little water on them during the low-water season. Many of the bars were the results of the accumulation of snags and drift.

Plan of improvement.—The original project adopted in 1878 contemplates the removal of sand bars, snags, rocks, and other obstructions for a distance of 50 miles above the mouth of the river. The cost of the work was estimated to be $5,000, with an additional annual expenditure of $2,000.

Results obtained during the fiscal year ending June 30, 1897.—The snags which have lodged in the channel after every rise in the river have been removed as thoroughly as possible.

Report of operations.—A small party consisting of three or four men has been kept at work on the river during the greater part of the year, when the stage of the water has been favorable. The party worked with rowboats and removed the snags by blasting. In this manner 129 large snags and a great number of small ones were removed from the river during the year, besides the leaning trees which were cut from the banks and which threatened to fall in and become obstructions. In August, 1896, the revetment below Toledo was repaired and every visible snag in the river below Toledo removed. In November, 1896, an extraordinary freshet occurred, and besides bringing in a large number of snags completely changed the channel in many places. All the work since done on the river has been below Toledo, in an endeavor to get the river back into as favorable a condition for navigation as before the November freshet.

A survey of the part of the river above Toledo included in the limits of the original project was made in September, 1896.

Recommendations and remarks.—The work on the river below Toledo the past year has been of great benefit to the commerce of the river, although the net result is to leave the river at the end of this year in little or no better condition than at the end of last year. But had it not been for the work done this year navigation of any sort at any time would have been impracticable. As it is, navigation is fairly easy, except at extreme low water and at a few places. As the November freshet caused such extensive changes in the channel, the survey of the upper part of the river made previously has no very great value except in a general way. In a general way it shows there is too much slope to the river surface and too little depth for the greater part of the stretch surveyed to permit of its ever being made navigable. The bottom was generally gravelly and there were no snags to interfere with navigation. Therefore no attempt will be made to improve the river above Toledo at present, but, as heretofore, the funds will be used in keeping the channel as clear as possible below that place.

An appropriation of $3,000 is recommended as the amount which can be profitably expended on this improvement during the fiscal year ending June 30, 1899.

Future operations.—The lower part of the river will be kept cleared of obstructions as thoroughly as practicable.

Money statement.

July 1, 1896, balance unexpended	$3,326.25
June 30, 1897, amount expended during fiscal year	2,014.75
July 1, 1897, balance unexpended	1,311.50
July 1, 1897, outstanding liabilities	151.00
July 1, 1897, balance available	1,160.50
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1899	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$2,000	September 19, 1890	$8,000
March 3, 1881	1,000	July 13, 1892	3,000
August 2, 1882	1,000	August 17, 1894	3,000
July 5, 1884	2,000	June 3, 1896	3,000
August 5, 1886	2,000		
August 11, 1888	3,000	Total	28,000

COMMERCIAL STATISTICS.

The following commercial statistics for the calendar year 1896 were furnished by the J. Kellogg Transportation Company:

SHIPPING.

There are five steamers engaged in traffic on the Cowlitz River, whose maximum draft is 4 feet and whose aggregate tonnage is 1,521 tons.

The tonnage for 1896 is much less than heretofore, but is explained by the fact that tonnage for logs is not given.

The number of passengers carried during the year was 8,385.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Coal	346	1,038		
Fish	123	9,840		
Grain	642	12,840		
Hay	1,093	6,558		
Live stock	1,070	64,200		
Lumber	566	3,200		
Merchandise			4,000	$200,000
Potatoes	2,100	21,000		
Shingles	4,819	50,000		
Total	10,759	168,676	4,000	200,000

S S 12.

IMPROVEMENT OF CLEARWATER RIVER, IDAHO.

Description of original condition.—The only portion of the Clearwater River upon which navigation has been attempted is the portion extending from Kamai, on the Middle Fork, to the mouth of the river at Lewiston, a distance of 69 miles. This stretch of the river has an average fall of 7 feet to the mile, and was obstructed by many rocks scattered throughout the upper portion, and by bars of bowlders and large gravel on the lower portion. The controlling low-water depth on many of the bars was but a few inches.

Plan of improvement.—The original project adopted in 1879 provided for the improvement of the river so as to obtain a low-water depth of 4½ feet to the North Fork and of 3 feet from the North Fork to the South Fork by the removal of rock bowlders, gravel bars, and ledges, and the construction of such contraction works as might be necessary.

The estimated cost of this improvement was $34,424.

In 1883 another examination of the river was made, and it was found that the original estimates of the quantities to be removed to obtain the projected depths, as well as the unit costs of the same, were too low, and a revised estimate was submitted (published in Report of the Chief of Engineers for 1884, p. 2280), placing the cost of the work remaining at that time to obtain the projected depth as far as the North Fork at $87,000. No revised estimate was made of the cost of the work above the North Fork.

In the fall of 1896 a complete survey of the river from the junction of the Middle and South forks to the mouth of the river was made. As a result of the information obtained by the survey, the project for obtaining a low-water navigation was abandoned, and a project for obtaining a high-water navigation substituted.

The amount required to complete the improvement needed in accordance with the project for obtaining a high-water navigation was estimated to be $35,000.

Results obtained during fiscal year ending June 30, 1897.—A survey of the river from the junction of the Middle and South forks to the mouth was made, and a number of rocks which obstructed high-water navigation removed.

Report of operations.—During the months of October, November, and December, a survey of the river was made, and rock removal was carried on in accordance with a temporary project which was submitted under date of August 25, 1896, and approved by the Chief of Engineers, September 8, 1896. During the time active operations were in progress work was scattered over about 25 miles of river, attention being paid only to the worst rocks at the worst places. In this manner a general improvement of the river was effected, but without completing the improvement at any one particular place. The work was much interfered with by floods and cold weather.

Recommendations and remarks.—While a low-water navigation would be very convenient for the people living in the country tributary to the river, a high-water navigation will accomplish the main object of the improvement along the banks of the river. This improvement can be carried on advantageously only during the fall of the year, and from the isolation of the work and its character it will necessarily be expensive, considering the amount to be done, and the expense may vary within wide limits, depending on whether the conditions of weather and water are favorable or unfavorable. The length of time to complete the improvement is also uncertain, but with favorable conditions all the work required can be done in two or three seasons if the money is available.

As it is impossible to tow quarter boats up against the current in this river, and the work can not be carried on economically without them, each season's work must be inaugurated by the construction of such boats, and there is but one place on the upper part of the river where such boats can be constructed.

In order that advantage may be taken of any favorable conditions which may develop, it is recommended that the balance of $10,000 necessary to complete the project be appropriated in one sum.

Future operations.—Rock removal will be carried on as may be advantageous.

Money statement.

July 1, 1896, balance unexpended	$25,000.00
June 30, 1897, amount expended during fiscal year	7,170.83
July 1, 1897, balance unexpended	17,829.17
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1899	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	

APPROPRIATIONS.

Act of—

March 3, 1879	$5,000
June 14, 1880	5,000
August 2, 1882	5,000
June 3, 1896	25,000
Total	40,000

COMMERCIAL STATISTICS.

The following statistics were furnished by Mr. E. J. Rathbone, superintendent of water lines, Oregon Railroad and Navigation Company, for the calendar year 1896:

SHIPPING.

There are two boats which ply on the Clearwater River at times, carrying freight and passengers. They are of the stern-wheel class, and their registered gross tonnage is 539.92 and 502.35, respectively. Their draft of water, fully laden, is 4 feet 6 inches; light, 1 foot 9 inches.

The total number of passengers carried during the year 1896 was 697.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Grain	800	$15,500		
Live stock	250	15,000		
Merchandise			850	$35,000
Wood	1,500	2,000		
Total	2,550	32,500	850	35,000

No previous statistics for this work have been collected.

S S 13.

IMPROVEMENT OF KOOTENAI RIVER, IDAHO, BETWEEN BONNERS FERRY AND THE INTERNATIONAL BOUNDARY LINE.

The appropriation for this work was made in the river and harbor act of June 3, 1896.

Description of original condition.—The portion of the Kootenai River for which this appropriation is available is about 60 miles in length, has a gentle current, and a depth sufficient for navigation, but was obstructed by many snags, which had lodged in the river.

A description of this part of the river is published in the Report of the Chief of Engineers for 1893, pages 3456–3458.

Plan of improvement.—The plan of improvement is to remove the snags in the river and the leaning trees on the banks which are liable to fall in and become obstructions.

The estimated cost of the improvement is $5,000.

Results obtained during fiscal year ending June 30, 1897.—The worst snags were removed from about one-half of the stretch of river to be improved.

Report of operations.—In October, 1896, an examination of the river showed that there were over 200 snags in the river at that time. It was also found that there were no American boats on the river adapted for use in snag pulling. Arrangements were therefore made for the hire of a barge, which was to be specially built and fitted up with hoisting machinery for the purpose of pulling the snags. Before the boat could be completed an enormous rise in the river, followed by severe cold weather, caused work to be suspended until spring. Snag pulling was commenced on March 31, 1897, as soon as the river was free from ice, and continued until May 6, 1897, at which time the river had risen too high to permit of advantageous work. During the time active work was in progress there were removed from the 33 miles of river next below Bonners Ferry 159 snags, ranging in length from 12 feet to 104 feet and in average circumference from 5 inches to 3 feet.

Recommendations and remarks.—As more than half the part of the river to be improved has been gone over and more than half the total number of snags which were visible last fall removed and considerably less than half the appropriation expended, it is certain that the river can be thoroughly cleared of the snags in it at present. It is probable, however, that other snags will lodge in the river, and that in the course of a few years the work will have to be done over again. As the appropriation amounts to the estimated cost of improvement, no recommendation is made in regard to future appropriations.

Future operations.—The remaining snags in the river, and any new snags coming in, will be removed as long as there are funds available.

Money statement.

July 1, 1896, balance unexpended	$5,000.00
June 30, 1897, amount expended during fiscal year	2,163.03
July 1, 1897, balance unexpended	2,836.97

APPROPRIATION.

Act of June 3, 1896	$5,000

COMMERCIAL STATISTICS.

The following returns for the commerce on the Kootenai River were furnished by Capt. Frank M. Lucas, of Bonners Ferry, Idaho.

Exports and imports.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Fruits and vegetables	377	$11,000		
Furs	1	9,000		
Grain	200	4,000		
Hay	800	3,000		
Lumber	105	600		
Miscellaneous			10	$565
Wood, cord	300	450		
Total	1,590	42,250	10	565

No previous statistics have been collected for this work.

The number of entries of vessels was 112, and number of vessels cleared was 112.

The number of passengers carried was 500.

Two stern-wheel and three propeller steamers ply on the river, the maximum draft of which is 6.5 feet. Their average tonnage is 119 tons net.

S S 14.

IMPROVEMENT OF FLATHEAD RIVER, MONTANA.

The first appropriation for this work was made in the river and harbor act of June 3, 1896.

Description of original condition.—The portion of the Flathead River included within the limits for which this appropriation is available is about 27 miles in length. This portion of the river is of very gentle slope, running with many turns through a large area of low-lying lands, and has a minimum depth of about 10 feet, but is obstructed by a large number of snags which have accumulated in the river.

Plan of improvement.—The plan of improvement is to remove the snags. The language of the act making the appropriation is as follows:

Improving Flathead River, Montana, ten thousand dollars, which sum shall be expended in snagging from Demersville to the Flathead Lake, in accordance with the plan submitted in the Annual Report of the Chief of Engineers for eighteen hundred and ninety-five.

No estimate of the cost of this improvement has been made, and from its nature and a lack of information concerning the amount of work to be done, none can be made.

A description of this work is given in the Report of the Chief of Engineers for 1895, pages 3480–3484.

No work has been done, and nothing has been spent on this improvement.

Recommendations and remarks.—On account of the local conditions, the only season of the year when the work required by this improvement can be carried on advantageously is the fall. It was planned to begin work in the fall of 1896, but on account of floods, which were unprecedented at the season of the year when they occurred, and severe cold weather much earlier than usual, the plans were not carried out. Work will be started as early in the fall of 1897 as the stage of water will permit. Unless there should be much greater difficulty met with in the removal of the snags than is anticipated, the available funds will suffice to thoroughly clear the river of all snags in it at the present time, and therefore no recommendation is made in regard to future appropriations.

No commercial statistics were collected. When application was made to persons interested in this improvement for commercial statistics it was claimed in the replies that no records were kept which would enable them to make any estimate of the commerce. It seems to be a general rule in this district that the more commerce there is to be carried the more complete are the records kept of it and the easier it is to obtain full information in regard to it.

Future operations.—The portion of the river to be improved will be cleared of snags.

Money statement.

July 1, 1896, balance unexpended	$10,000.00
July 1, 1897, balance unexpended	10,000.00
Amount (estimated) required for completion of existing project	Indefinite
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

APPROPRIATION.

Act of June 3, 1896	$10,000

S S 15.

PRELIMINARY EXAMINATION OF NORTH FORK OF LEWIS RIVER, WASHINGTON, TO HEAD OF NAVIGATION, OR ETNA.

[Printed in House Doc. No. 80, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of November 19, 1896, by Capt. Harry Taylor, Corps of Engineers, of preliminary examination of the North Fork of Lewis River, Washington, to head of navigation, or Etna, made in compliance with the requirements of the river and harbor act of June 3, 1896.

It is the opinion of Captain Taylor that this locality is worthy of improvement by the General Government, and his views are concurred in by Col. Charles R. Suter, Corps of Engineers, the division engineer, and me.

A survey is not considered necessary to ascertain the character or cost of the improvement required.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., November 19, 1896.

GENERAL: I have the honor to submit the following report relative to the "North Fork of Lewis River to head of navigation or Etna," Wash., for the examination of which provision was made in the river and harbor bill of June 3, 1896, and which was assigned to my charge by your letter of July 31, 1896.

In September, 1892, acting under the direction of Maj. T. H. Handbury, Corps of Engineers, I made a personal examination of the Lewis River from Speliah Creek to its mouth. Speliah Creek being about 12 miles above Etna, my examination included all of the part which I am now directed to examine, as well as part not now included, and I have not thought it necessary to make any personal examination at the present time.

Major Handbury's report of the examination is published in the Report of the Chief of Engineers for 1893, page 3533, and also printed in House Ex. Doc. No. 144, Fifty-second Congress, second session. My report to Major Handbury of my personal examination was published with his report. The following is quoted from my former report:

Lewis River empties into the Columbia about 14 miles below the mouth of the Willamette, or 25 miles from Portland, Oreg. Three miles above its mouth it separates into two branches, the North Fork and the East Fork. Speliah Creek runs into the North Fork about 28 miles from the junction of the two branches.

* * * * * * *

From Speliah Creek down to within about 3 miles of Woodland the Lewis River is almost entirely free of snags and overhanging trees. It has a general width of from 100 to 150 feet, and is a succession of deep, still pools and shallow, gravelly bars, over which the water runs with a swift current. In the first 12 miles below Speliah Creek there are no less than thirty-one of these gravelly bars. Almost all the fall in the river is at these bars. The fall at the various bars varies from 6 inches to 7 feet, and the distance in which this fall occurs varies from 75 feet to half a mile, but as a rule the fall is from 1 foot to 2 feet in a distance of from 50 to 100 yards. The total length of the river covered by these bars in these 12 miles is approximately 2¼ miles, and the total fall 55 feet.

The lower ends of the bars are almost always of a steep slope, and run diagonally from one bank to the other. The water runs over this slope all along from one side of the river to the other, gradually concentrating toward the bank at which is the upper part of the lower end of the bar, and near to which the channel is generally found. At the stage at which the river was when I visited it, almost all the water in the river ran through this channel. The water in the channel varied from 1 foot to 2 feet deep and the width of the channel was generally not more than 50 feet. The current over these bars was very swift. With a rise of 2 feet in the river there would appear to be no obstruction to a steamboat ascending this part of the river except the naturally extremely swift current due to the great fall. At the lower stage navigation might possibly be helped by wing dams at a few of the worst bars, but at most of them the river is contracted as much in the natural channel as would ever be desirable.

Twelve miles below Speliah Creek is Etna. From Etna down for 10 miles the character of the river is much the same as between Speliah Creek and Etna, except that the gravel bars are much fewer and have less fall, and the pools are larger. About 10 miles below Etna, or 3 miles above Woodland, the character of the river changes. From this point to the mouth the banks are sandy or muddy, the gravel bars change to sand bars, and the river is full of snags. If the snags were removed and a few short wing dams put in to straighten and deepen the channel on the sand bars this part of the river could be easily and safely navigated. The entrance to the Lewis River from the Columbia River is obstructed by a shoal sand bar, but this difficulty would be largely or wholly removed by closing a chute, by which a considerable part of the water from the Lewis River is drawn off to the Columbia. Just above this chute is a boom operated by the Lewis River Boom Company, and through the chute logs are floated to the main boom in the Columbia.

* * * * * * *

The country around Woodland is a good farming country, and large quantities of hay and potatoes are shipped to market. The principal industry up the Lewis River has been lumbering, but the lumber is being rapidly cleared off, and farms are growing along the valley. I was informed at Speliah Creek that there were more than 100 settlers farther up the river than that. The freight on ordinary merchandise to Speliah Creek from Woodland depends upon the condition of the roads, and runs from 75 cents per hundred up. If steamboats could run regularly up to Etna this rate would be very much reduced, for, besides giving water transportation more than halfway, the worst part of the roads, which are between Woodland and Etna, would be avoided.

The Lewis River is crossed by three ferries with overhead wire ropes. One of these is at Woodland, one about half a mile above Woodland, and the third at Etna. The line of the railroad from Portland to the Sound, which crosses the Columbia near Vancouver, Wash., crosses the Lewis River about 1 mile from its mouth. This road has been partially graded, but at present no work is being done on it.

In view of the great benefit the improvement of the Lewis River would confer on the people in its vicinity and the small cost of the improvement, it is respectfully recommended as "worthy of improvement" from its mouth to Etna.

The approximate amount of freight and passengers carried by boats running between Portland and points on the Lewis River during the year 1895 was as follows: Grain, 1,550 tons; general merchandise, 3,775 tons; cattle and horses, 700 head; sheep and hogs, 550 head; lumber, 100,000 feet B. M.; passengers, 19,446.

In a letter transmitting a statement of the business done by his boats during the year, Mr. Charles T. Kamm, superintendent Lewis River Transportation Company, says:

The location and opening of a number of mines on the North Fork, and also in the Cascade Mountains, about 25 miles from La Center, on the East Fork, will undoubtedly increase the amount of business which will be carried on this river. The company which I represent have just completed the removal of a number of the worst snags between Woodland and Brattens Bend, having had a steamer and crew there four days of the past week, and, while we have not fully completed the work, yet the improvement is such that we have greatly benefited navigation to that place. The safety of our boats made it absolutely necessary that we do this work ourselves at once.

The amount of traffic carried with the last year has been smaller than in former years, owing to the low price of agricultural products and the consumption and demand for same being greatly reduced. Also, the water in both forks in the river having been very low for a greater period than usual, the transportation lines were unable to move the crop until after the roads were in very bad condition; then it became next to impossible for the farmers and others wishing to ship to haul their products to the river, and such articles as hay and grain they fed to their stock, afterwards driving same to market, rather than ship it.

Since my examination in 1892 was made the valley of the Lewis River has been still further settled, and I regard the river as no less worthy of improvement by the General Government now than it was then. * * * On account of the nature of the obstructions it is not thought that a survey would add any definite knowledge to that already obtained of the character or cost of the improvement required, as a survey made one year might be entirely valueless the next on account of the shifting of the obstructions, and no survey is recommended.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., November 24, 1896.

Respectfully forwarded to the Chief of Engineers, U. S. A.

I concur in the views of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

S S 16.

PRELIMINARY EXAMINATION OF NORTH RIVER, WASHINGTON.

[Printed in House Doc. No. 91, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 3, 1896.

SIR: I have the honor to submit the accompanying copy of report of September 11, 1896, by Capt. Harry Taylor, Corps of Engineers, of the results of a preliminary examination of North River, Washington, made to comply with provisions of the river and harbor act of June 3, 1896.

It is the opinion of Captain Taylor, concurred in by the division engineer, Col. Chas. R. Suter, Corps of Engineers, and by me, that North River, from its mouth for 25 miles upward, is worthy of improvement by the General Government.

No survey is necessary to determine the character and extent of improvement required.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., September 11, 1896.

GENERAL: I have the honor to submit the following report relative to North River, Washington, for the examination of which provision was made in the river and harbor bill of June 3, 1896, and which was assigned to my charge by your letter of July 31, 1896.

There is a North River, Washington, which flows into Willapa Harbor and which is the only one I have been able to find on any map of the State. An examination of this stream was made in 1895 under the direction of Capt. T. W. Symons, Corps of Engineers, U. S. A., whose report is published in the Report of the Chief of Engineers for 1895, pages 3485 et seq. Captain Symons' report is accompanied by that of Mr. J. M. Clapp, United States assistant engineer, who made the examination, and also by a map of the river.

In June, 1896, Mr. Clapp made another examination of the "Big Jam" in the North River, where some work was done during the summer of 1895, in accordance with a provision in the river and harbor bill of August 17, 1894, attached to the appropriation for the completion of the improvement of Willapa River and Harbor, which permitted $2,500 of the amount appropriated for Willapa River and Harbor to be used in removing obstructions in North River.

Mr. Clapp's report of his last examination accompanied my annual report for the year ending June 30, 1896.

In view of the reports which have already been submitted upon this stream, it does not seem that a further examination would add any material information to that which has already been published in regard to it, nor is any survey necessary to determine the character and extent of improvement required.

Captain Symons's opinion, as stated in his report referred to above, was "that the North River, from its mouth for 25 miles upward, is worthy of improvement by the General Government." In this I concur.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., October 31, 1896.

Respectfully forwarded to the Chief of Engineers, U. S. A.

I concur in the opinion of the district officer.

CHAS. R. SUTER,
Colonel of Engineers, Division Engineer.

S S 17.

SURVEY OF LEWIS RIVER, WASHINGTON, FROM COLUMBIA RIVER TO LACENTER.

[Printed in House Doc. No. 64, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 5, 1897.

SIR: I have the honor to submit the accompanying report of May 12, 1897, with map,* by Capt. Harry Taylor, Corps of Engineers, giving the results of a survey of Lewis River, Washington, from Columbia River to Lacenter, authorized by the river and harbor act of June 3, 1896.

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* Not reprinted. Printed in House Doc. No. 64, Fifty-fifth Congress, first session.

The improvement proposed by Captain Taylor is to secure an increased depth in the river by the construction of training dikes, and by dredging, as indicated in his report, and a limited amount of snagging on the lower river.

The cost of the improvement is estimated at $20,460.

In view of the nature of the material forming some of the shoals to be improved, I have to suggest the possible desirability of changing the character of the dikes and their location and direction at the time when work on this stream shall be actually undertaken.

In the opinion of Captain Taylor, concurred in by Col. C. R. Suter, Corps of Engineers, division engineer, the improvement is a worthy one and is justified by the interests of commerce involved.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., May 12, 1897.

GENERAL: I have the honor to submit the following report of a survey of the Lewis River, Washington, from the Columbia River to Lacenter, as required by your letter of September 5, 1896.

The Lewis River empties into the Columbia River about 14 miles below the mouth of the Willamette, or 25 miles from Portland, Oreg. No railroad touches the Lewis River, and as the natural trading point for the people living along this river is Portland, the business is all carried on by means of the boats plying between Portland and points on the river.

At a distance of 3¾ miles from the Columbia the Lewis River separates into two branches, known as the North Fork and the East Fork. Of these, the North Fork is the larger stream. Lacenter is situated on the East Fork, 3⅛ miles from the junction. The general width of the river below the forks is from 400 feet to 600 feet, narrowing to less than 200 feet near the forks, and widening to over 700 feet at Lindsleys Bar. The general width of the East Fork, as far as Lacenter, is from 150 feet to 200 feet.

Boats running from Portland can ascend the Lewis River and the East Fork as far as Lacenter, except at low water. At low water a transfer to a smaller steamer is made at the forks, and at extreme low water it is necessary to use a rowboat above the forks. Below the forks there is only one shoal where any difficulty is experienced.

The material forming all the bars, except the ones in the East Fork near the main river, is of an exceedingly light yielding material, apparently pure pumice, easily carried by a current, as is shown by the fact that the bars are continually changing in shape. The material forming the shoal near the mouth of the East Fork is clay.

At the time the survey was made, in March, 1897, the least depth found in the river below the forks was 4 feet, and in the East Fork above the forks was 2 feet. Two gauges are kept by the Lewis River Transportation Company—one at Lacenter and one at the forks. Calling the stage of the river at the time the survey was made normal, the record of the gauges for the year 1896 shows that the river was above the normal for a period of 324 days at the forks, and at or below it for 42 days, and that it was above the normal for 277 days, and at or below it for 89 days at Lacenter.

The lowest stage reached during the year was $2\frac{1}{2}$ feet below the normal at the forks and $3\frac{1}{2}$ feet below at Lacenter. That the river could fall $3\frac{1}{2}$ feet at Lacenter below the stage at which depths of only 2 feet were found below is explained by the fact that the shoalest place in the river is about halfway between the forks and Lacenter, and a fall in the main river below the forks, due either to a fall in the Columbia or in the North Fork, would increase the slope of the water surface from the shoal to the junction of the forks without causing much change in the slope above the shoal, while a fall in the East Fork would decrease the slope from Lacenter to the shoal without causing a corresponding change below the shoal. The total fall in the water surface from Lacenter to the forks was at the time of the survey $3\frac{1}{2}$ feet. The number of days during the year during which the river was at different stages is shown by the tables accompanying the report of my assistant who made the survey, which is forwarded herewith.

An increase of depth so that steamboats could ascend to Lacenter the year round would be of very material benefit to the commerce of the river. It is believed that great relief would be afforded, even if an all-the-year-round navigation was not obtained, by the construction of training dikes at one place on the main river and at three places on the East Fork, and by dredging in the East Fork near the junction. It is proposed by these to secure a depth of 6 feet in the main river and 4 feet from the forks to Lacenter at the stage of water at which the river was when the survey was made.

The estimated cost of this improvement is as follows:

Dike, 4,150 linear feet, at $4	$16,600
Dredging 6,000 cubic yards, at 25 cents	1,500
Snagging	500
Total	18,600
Contingencies	1,860
Aggregate	20,460

Accompanying this report are a map of the Lewis River from Lacenter to the Columbia, a copy of the report of Asst. Engineer P. G. Eastwick, who was in immediate charge of the survey, and commercial statistics for the year 1896.

The commercial statistics were collected Mr. Charles T. Kamm, superintendent Lewis River Transportation Company. In his letter forwarding them to me Mr. Kamm says:

* * * * * * *

There is at present one wood flume in operation, which exports about 10,000 cords of fir wood per year. There is under construction another of this same class, and they expect to export possibly the same amount. There is also another one under consideration, which, should the parties decide to build, they anticipate exporting about 5,000 cords.

The failure of the fruit, potato, and hay crops the past year has materially reduced the amount of exports for that time.

The benefit to the section of country drained by that fork of Lewis River, should it be improved, will be very great. I might add, should it not be improved, the commerce which goes through this natural channel must necessarily, owing to the extreme difficulty, the uncertainty of navigation, and the cost of transportation during low water, being about eight months in the year, seek another outlet, and it is sincerely hoped by all parties interested that Congress will make a sufficient appropriation to fully improve same at a very early day.

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Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. PHILIP G. EASTWICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., April 24, 1897.

SIR: Complying with your instructions I have made a survey of Lewis River, Washington, from the Columbia River to Lacenter, and have the honor to report as follows:

The field work was commenced March 6, and closed March 16. The length of river embraced in the survey comprises 3¼ miles of the Lewis River extending from the Columbia to the junction of the North and East forks, and 3⅛ miles of the East Fork extending from the forks to Lacenter, a total length of river surveyed of 6⅞ miles. Maps of the survey—one to a scale of 1 inch to 100 feet, and one to a scale of 1 inch to 500 feet, are herewith submitted:

At the time of the survey the water in the river reached a stage below which it falls during the driest season of the year, as ascertained from the records, kept by the Lewis River Transportation Company, of gauges at Lacenter and at the forks. Soundings were reduced to the plane of lowest water observed during the survey. In the latter part of August the water falls below that plane and remains low until the rains of October fill the stream. During that period the East Fork is not navigable, nor is it susceptible to improvement for navigation except by canalization.

The North Fork of the river carries a much larger volume of water than the East Fork, and the river below the forks presents fewer obstacles to navigation than does the East Fork. This lower reach flows between banks of alluvial deposit, flanked, with little exception, by extensive plains, the former flood plains of the river. These plains are subject to overflow by the backwater of the Columbia, and by excessive floods in the Lewis River. The banks are generally quite precipitous, and from 12 to 15 feet high, with narrow beaches at their bases. This is interrupted by several low sand bars of considerable extent. The bed of the river consists of a shifting sand of coarse but light material probably overlying a clay substratum. The sand consists largely of pumice brought down the river from the volcanic beds.

The general width of this reach is from 400 to 600 feet, narrowing to less than 200 feet at one point near the forks and widening to 700 feet at Lindsleys Bar. Excepting at the shoal at Lindsleys Bar the river carries a depth of more than 6 feet. The course of this reach is direct and has no abrupt bends.

The East Fork passes for most of its length between Lacenter and the forks through a narrow valley flanked by steep hills, which at places come close to the river, the rock bases encroaching upon the stream at three places. In the vicinity of Lacenter is an extensive bottom, and near the forks the valley merges into the flat plain of the lower river. The fall of the river over the reach of 3⅛ miles is 3.5 feet, an average of 1.12 feet per mile. This fall varies from a minimum of six-tenths foot per mile to a maximum for a short distance of 1.7 feet per mile. The general width of this reach is from 150 to 200 feet. At a bend near Lacenter the river is contracted to 75 feet and widens for a short distance to 250 feet near Kinder Rock. Except at the shoals, hereafter named, a depth of at least 4 feet is found at the normal stage of water.

The bed of the river is of material similar to that of the lower river, except near the forks, where the material is clay.

The shoals on this reach are, at the bar near the forks, at Kinder, Shutie, and Cowley bars, with much shoal water between the last two named bars.

The improvements proposed are the deepening of the river at the bars so as to give a least depth of 6 feet at the normal stage on the lower river, and of 4 feet on the East Fork, and a limited amount of snagging on the lower river. The deepening can be effected by contraction works except at the bar above the mouth of the East Fork, where the material, being clay, will have to be removed by dredging.

The closing of three lateral channels will be necessary in connection with the improvement.

The following is the estimated cost of the proposed work:

Dike:		
Closing lateral outlet near the Columbia River	linear feet	300
Closing slough below Lindsleys Bar	do	100
Contracting channel above Lindsleys Bar	do	600
Closing slough above Kinder Bar	do	150
At Shutie and Cowley bars and at the intermediate shoals	do	3,000
Total		4,150
Dredging at shoal above the mouth of the East Fork	cubic yards	6,000

SUMMARY.

4,150 feet of dike, at $4	$16,600
6,000 cubic yards dredging, at 25 cents	1,500
Snagging	500
	18,600
Engineering, superintendence, etc., 10 per cent	1,860
Total	20,460

Very respectfully, your obedient servant,

PHILIP G. EASTWICK,
Assistant Engineer.

Capt. HARRY TAYLOR,
Corps of Engineers.

SURVEY OF LEWIS RIVER, WASHINGTON.

Duration of water elevation during the calendar year 1896 at the forks, referred to the normal plane, which is 1¾ feet above the zero of the gauge at the forks.

	Days.
More than 3½ feet above normal	186
More than 3 feet above normal	233
More than 2½ feet above normal	248
More than 2 feet above normal	275
More than 1½ feet above normal	290
More than 1 foot above normal	298
More than ½ foot above normal	308
Above normal	324
At or below normal	42
More than ½ foot below normal	32
More than 1 foot below normal	17
More than 1½ feet below normal	9
More than 2 feet below normal	6
More than 2½ feet below normal	4
More than 3 feet below normal	0

Duration of the water elevation during the calendar year 1896 at Lacenter, referred to the normal plane, which is 5 feet above the zero of the gauge at Lacenter.

	Days.
More than 3½ feet above normal	142
More than 3 feet above normal	155
More than 2½ feet above normal	169
More than 2 feet above normal	196
More than 1½ feet above normal	216
More than 1 foot above normal	239
More than ½ foot above normal	266
Above normal	277
At or below normal	89
More than ½ foot below normal	79
More than 1 foot below normal	73
More than 1½ feet below normal	64
More than 2 feet below normal	55
More than 2½ feet below normal	23
More than 3 feet below normal	16
More than 3½ feet below normal	2

COMMERCIAL STATISTICS FOR LEWIS RIVER, WASHINGTON, FOR CALENDAR YEAR 1896.

Class of goods.	Exports.		Imports.	
	Tons.	Value.	Tons.	Value.
Grain	150	$2,670	20	$350
Hay	400	4,000		
Hides	10	800		
Household goods	100	10,000	200	20,000
Live stock	214	11,500	90	6,250
Lumber and products	16,524	28,450	89	910
Merchandise	197	24,900	862	90,830
Meats, dressed	149	12,640	8	800
Poultry	45	4,500		
Salmon, fresh	50	2,000		
Vegetables	600	7,000		
Wool	5	1,500		
Total	18,444	109,960	1,269	119,140

Number of passengers, 4,212.

Six steamers are engaged in traffic on the river, with an average net tonnage of 175 and an average depth of 5 feet 8 inches.

S S 18.

SURVEY OF BELLINGHAM BAY, FROM DEEP WATER TO THE MOUTH OF WHATCOM CREEK, AT NEW WHATCOM, WASHINGTON.

[Printed in House Doc. No. 80, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 6, 1897.

SIR: I have the honor to submit the accompanying copy of report, dated June 14, 1897, with map,* by Capt. Harry Taylor, Corps of Engineers, upon the results of a survey of Bellingham Bay, from deep water to the mouth of Whatcom Creek, at New Whatcom, Wash., made to comply with the provisions of the river and harbor act of June 3, 1896.

Captain Taylor states that the wharfage facilities at New Whatcom for deep-draft vessels are fairly good for the business carried on by them. The improvement proposed is to dredge the Whatcom Creek waterway, as shown on the accompanying map, to a depth of 12 feet at mean lower low water, a channel 200 feet wide being provided as far as the existing railway bridge, and the waterway shoreward from this point to be dredged to its full size. These channel dimensions would furnish an easy, safe, and sufficient harbor for the small craft now seeking New Whatcom, and greatly facilitate their loading and unloading. The estimated cost of the work proposed is $80,000.

In transmitting the report to this office the local engineer expressed the opinion that the proposed improvement is a worthy one and justified by the interests of commerce involved, and his views were concurred in by the division engineer, Col. Charles R. Suter, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

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*Not reprinted. Printed in House Doc. No. 80, Fifty-fifth Congress, first session.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., June 14, 1897.

GENERAL: I have the honor to submit the following report of a survey of "Bellingham Bay, from deep water to the mouth of Whatcom Creek, at New Whatcom," Wash., made in compliance with the river and harbor act of June 3, 1896, and assigned to my charge by your letter of September 5, 1896.

Bellingham Bay is a portion of the great body of water to which, as a whole, the name of Puget Sound is generally applied. It reaches to within 15 miles of the international boundary line, and it opens out into that portion of Puget Sound in which are situated the islands forming the San Juan Archipelago. It is about 10 miles long from north to south and 5 miles wide from east to west. It has an average depth of about 10 fathoms, with a maximum depth, according to the Coast Survey charts, of 26 fathoms. The fact of its being generally sufficiently shallow to allow anchorage favorably distinguishes it from most of the other harbors of Puget Sound.

New Whatcom, which is situated near the northern end of Bellingham Bay, is the largest city on Puget Sound north of Seattle, and is the main distributing point for a large part of the islands constituting San Juan and Island counties and the western part of Skagit County, as well as quite an important part of the mainland surrounding the city.

Imports by water are received from other ports on Puget Sound, principally in the ordinary type of stern-wheel boat, and from San Francisco in both steamers and sail vessels. Communication between Bellingham Bay ports and the islands to the west is kept up by steamboats and small sailing vessels.

The wharfage facilities at New Whatcom for the deep-draft vessels are fairly good for the business carried on by them; but the wharfage facilities for the smaller class of vessels, which carry a very important part of the commerce, are very poor. From the nature of the business carried on by these smaller boats, its convenience demands wharf room near the business portion of the city. Mud flats extend out in front of the city from the meander line to low water, a distance of 2,400 feet; from the low-water line to the 6-foot curve, a distance of 800 feet, and from the 6-foot curve to the 12-foot curve, 200 feet, or a total distance from the meander line to the 12-foot curve of 3,400 feet. Two long wharves which were built out from the shore line to the 18-foot curve accommodated the vessels which found business at New Whatcom for a number of years, but these wharves were very costly to maintain and have been allowed to gradually fall into such a bad state of repair as to be useless. About the only place for the business which is now available is the slip between the railway dock and the mill yards, which is 1½ miles from the business part of the city and inconvenient of access.

The relief that is desired is for a channel to be dredged from the deep water in toward the city through the mud flats.

A system of harbor lines for New Whatcom was approved by the Secretary of War June 3, 1892. This system provides for three waterways leading from deep water to the meander line. One of these, the "Whatcom Creek waterway," leads nearly to the mouth of Whatcom Creek, and it is the improvement of this waterway that is evidently contemplated by the law authorizing this survey.

The improvement proposed is to dredge the Whatcom Creek waterway, as shown on the accompanying tracing, to a depth of 12 feet at mean lower low water, a channel 200 feet wide being provided as far as the existing railway bridge, and the waterway being dredged its full size inside this bridge. This would provide an easy, safe, and sufficient harbor for the small craft now seeking New Whatcom, and would greatly facilitate their loading and unloading.

The estimated cost of this improvement is as follows:

Dredging 476,027 cubic yards, at 15 cents	\$71,404.05
Engineering, contingencies, etc	7,140.40
Total	78,544.45

Or, in round numbers, \$80,000.

Accompanying this report are commercial statistics of Bellingham Bay for the calendar year 1896, the report of Assistant Engineer J. M. Clapp, who was in immediate charge of the survey, and one tracing showing the results of the survey.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

REPORT OF MR. J. M. CLAPP, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., June 10, 1897.

CAPTAIN: I have the honor to submit the following report of a survey of Bellingham Bay, in the vicinity of New Whatcom, Wash., made in January, in accordance with your instructions.

The language of the act authorizing this survey is as follows: "Bellingham Bay, from deep water to the mouth of Whatcom Creek."

The field work began January 16 and was completed January 27. That part of the bay included in this survey lies in front of the city of New Whatcom, and extends from the high-water line to the 30-foot curve.

Whatcom Creek, which drains a very pretty inland body of water called Lake Whatcom, has a length of about 3 miles and a fall of nearly 300 feet from its source to its junction with Bellingham Bay, near the center of the city of New Whatcom.

Method of work.—A base line 5,500 feet long was carefully measured along the Great Northern Railway track. From this base a number of stations were located, as well as numerous natural objects, such as mill stacks, towers of buildings, and peaks of houses, by triangulation.

The wharves, mills, and other improvements, as well as the shore lines, were located by stadia observations from triangulation stations. A thorough hydrographic survey was made, the soundings being located by sextant observations.

Two hundred and nine observations were made and 2,624 soundings taken, covering an area of about 2 square miles. The plane of reference adopted was the same used by the Coast and Geodetic Survey in 1888.

Accompanying this report are the following drawings: One map, scale 400 feet=1 inch; 1 tracing, scale 400 feet=1 inch.

Soundings are expressed in feet and tenth, and indicte the depths at mean lower low water.

The wharfage facilities at New Whatcom are poor, being limited to the Bellingham Bay and British Columbia Railway wharf, located at the foot of Dock street, and the Bellingham Bay Improvement Company's mill wharf, in the same vicinity. The former has a length along the face of about 600 feet, with a slip, the length of which is about 400 feet; the latter has a frontage of about 650 feet and affords accommodations only to such vessels as are engaged in the business of the company.

Two long wharves which were built out from the shore line at a great cost to deep water (18 feet) accommodated the vessels which found business in New Whatcom for a number of years; but they are now in a bad state of repair and are dangerous for use even for light loads. One of them is now tumbling down and has been condemned.

About the only harbor afforded craft at New Whatcom is the slip between the railway dock and the mill yards. This space is limited to an area about 600 feet by 100 feet. This harbor and the wharf are located about 1½ miles from the business part of the city.

The mud flats in front of the city extend from the meander line a distance of 2,400 feet toward the bay to low-water line, 3,200 feet to the 6-foot curve, and 3,400 feet to the 12-foot curve.

On June 3, 1892, the Secretary War approved a system of harbor lines for New Whatcom. This system provides for three waterways from the bay to the meander line, as follows:

1. Whatcom Creek waterway.
2. I and J streets waterway.
3. Squalicum Creek waterway.

The first two lie within the corporate limits of the city.

The improvement proposed is the dredging of Whatcom Creek waterway to a depth of 12 feet at mean lower low water, thereby providing a safe harbor and dock facilities for the many small steamers plying between New Whatcom and the different ports of the island counties and other sound ports. The only means of communication which the island counties enjoy with the mainland is by boat.

The following is the estimated cost of the proposed improvement:

Dredging 476,027 cubic yards sand and silt, at 15 cents	$71,404.05
Engineering, office expenses, and other contingencies, 10 per cent	7,140.40
Total	78,544.45

or, in round numbers, about $80,000.

The character of the material to be dredged consists of light volcanic sand, fine gravel, and silt on top of coarse sand.

Borings made toward the shore end of the proposed harbor show this character to extend to a depth of 12 feet below mean lower low water.

New Whatcom is the third largest city in western Washington and is the distributing point for a large area of surrounding agricultural and logging country.

Very respectfully, your obedient servant,

J. M. CLAPP, *Assistant Engineer.*

Capt. HARRY TAYLOR,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS FOR BELLINGHAM BAY.

[The commercial statistics for Bellingham Bay were furnished by Albert E. Jones, secretary of Board of Trade of New Whatcom, Wash., and are for the calendar year 1896.]

EXPORTS AND IMPORTS.

Class of goods.	Exports.		Imports.	
	Quantity.	Value.	Quantity.	Value.
	Tons.		*Tons.*	
Fish, fresh	105	$6,300		
Flour and feed			2,122	$71,087
Grain	1,000	18,000		
Hay			1,410	11,280
Iron ore	1,200	3,600		
Live stock	40	1,000	100	2,400
Lumber and products	31,243	181,984		
Merchandise	1,680	102,350	3,972	217,190
Salmon, canned	359	41,272		
Total	35,627	354,506	7,504	301,957

SHIPPING.

Arrivals and departures of vessels.

Steam and sail vessels.	Arrived.	Departed.
Steamers, coastwise	1,107	1,107
Sail vessels:		
Coastwise	24	24
Foreign	7	7

Number of passengers arrived by sea	14,000
Number of passengers departed by sea	14,500
Maximum draft of loaded vessels ...feet..	26

S S 19.

SURVEY OF KOOTENAI RIVER, MONTANA, FOR REMOVAL OF OBSTRUCTIONS ABOVE JENNINGS.

[Printed in House Doc. No. 73, Fifty-fifth Congress, first session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., June 15, 1897.

SIR: I have the honor to submit the accompanying copy of report dated June 1, 1897, with map,* by Capt. Harry Taylor, Corps of Engineers, upon the results of a survey of Kootenai River, Montana, for removal of obstructions above Jennings, made to comply with the provisions of the river and harbor act of June 3, 1896.

At the higher stages of the river there is but one point between Jennings and the international boundary line where difficulty to navigation is met with, this being at a canyon, or gorge, about 5 miles above Jennings.

It is the opinion of Captain Taylor that the danger and difficulty of navigating this canyon can be very materially reduced by the removal of the projecting points of rocks at B, and the breaking up and scattering of the large bowlders on the point C, shown on the map, and possibly at some other places near by. The cost of the work is estimated at $5,000.

In transmitting the report to this office Captain Taylor expressed the opinion that the proposed improvement is a worthy one and justified by the commerce interested, and his views were concurred in by the division engineer, Col. Chas. R. Suter, Corps of Engineers.

Very respectfully, your obedient servant,

JOHN M. WILSON,
Brig. Gen., Chief of Engineers, U. S. Army.

Hon. R. A. ALGER,
Secretary of War.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., June 1, 1897.

GENERAL: I have the honor to submit the following report of a survey of the "Kootenai River, for removal of obstructions above Jennings," Mont., made in compliance with the river and harbor act of June 3, 1896, and assigned to my charge by your letter of September 5, 1896.

Under date of August 5, 1895, Capt. T. W. Symons, Corps of Engineers, submitted a report of a preliminary examination of the Kootenai River above Jennings. His report is published in the Report of the Chief of Engineers for 1895, pages 3489–3491. Captain Symons states that—

> The river between Jennings and the international boundary line, 65 miles in length, is a fairly good river for purposes of navigation, with some slight exceptions. At the higher stages of the river there is but one point where difficulty is met with, and this is at a canyon, or gorge, about 5 miles above Jennings. Here the rock walls of the river approach each other, causing an engorgement and considerable fall when the river is up. Large rocks are scattered about here and there in and below the

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* Not reprinted. Printed in House Doc. No. 73, Fifty-fifth Congress, first session.

gorge. These rocks are the principal sources of danger to boats running downstream, while the heavy fall and swift currents render the ascent of boats difficult, time-consuming, and laborious.

It was understood that the survey was ordered in accordance with this preliminary report, and it was accordingly limited to the canyon referred to.

The results of the survey are shown on the tracing herewith.

At the time of Captain Symons's preliminary examination the chief obstructions to navigation were the rocks in the river at the point marked A on the tracing. These rocks stood well up above low water, and obstructed the high-water flow to such an extent that the water was backed up in the canyon above them, and a considerable fall produced as the river flowed past them. This made the upstream navigation a difficult operation, requiring "lining," and the downstream navigation extremely hazardous on account of the narrow passages between the rocks and the shores on either side and the swift currents caused by the backing up of the water. Last July one of the steamers plying on the river was carried onto these rocks and completely wrecked, breaking in pieces and turning bottom up in a few minutes after striking. It was only by the fortunate arrival of another steamer that happened to be near when the accident occurred that a large loss of life was prevented.

During the early spring of 1897 these rocks were removed by private enterprise, so that at the time the survey was made in April, 1897, these rocks were found to be about 6 inches below low water. On account of sand bars and shallow water the river is not navigated at the low stage, so that the danger from these rocks is almost entirely done away with.

The removal of the rocks at A, however, causes the current to strike violently against the projecting ridges of rock at B and cross diagonally to the point C.

The point C is a low bar covered by enormous bowlders, and is now scarcely less dangerous to navigation than the rocks at A were before their removal.

On May 7, 1897, two steamers were wrecked within a few minutes of each other near the point C. It was reported that the first steamer caught a log in her rudders and was forced onto the rocks by the cross current spoken of. The cause of the wreck of the second boat was also said to be the cross current. The passengers from these two boats were obliged to spend the night on the rocks.

A new boat is now being built to run on this part of the river, which, in view of the fact that three boats have been wrecked in this canyon within less than a year, is pretty good evidence that the river traffic must be of considerable importance.

The danger and difficulty of navigating this canyon can be very materially reduced by the removal of the projecting points at B and by breaking up and scattering out the large bowlders on the point C, and possibly at some other places near by. At the time the survey was made there was still considerable snow and ice in the canyon, and an exact estimate of the amount to be blasted up was not made, but it is believed that the entire cost of the work will not exceed $5,000.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

S S 20.

MODIFICATION OF HARBOR LINES AT OLYMPIA HARBOR, WASHINGTON.

SIR: We respectfully request that a narrow strip of tide flats in front of Percival's dock, and between the dock and channel already opened, be dredged and removed as part of the improvement of the harbor of Olympia undertaken by the United States Government.

It is bare at low tide, blocking all approach to the wharf. It is situated directly opposite the basin which has been excavated to enlarge the area of deep water. Its removal would more than double the present available wharfage and would considerably increase the deep-water basin.

Very respectfully,

A. H. CHAMBERS,
Chairman Board of Trade,
And 31 others.

Captain TAYLOR,
Engineer Corps, U. S. A.

Nothing in the State constitution or laws to prevent dredging and removing a tide flat adjacent to but on the shore side of the outer or sea harbor line. The outer line was established as a barrier against encroachment upon the harbor by wharves or other structures. There is no reason why the harbor area should not be extended beyond the harbor line if navigation or business can be promoted thereby. In fact, the constitution expressly provides for making docks, and consequently of channels and basins leading to them, as well as wharves, in the area reserved between the outer and inner harbor lines.

Unquestionably a party leasing a portion of this reserve from the State would have the right to improve it by dredging, docks, basins, and water approaches, as well as by building wharves.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
February 1, 1897.

Respectfully submitted to the Secretary of War.

Application is made by citizens of Olympia, Wash., for a change in the plan of improvement of the harbor, so as to have certain dredging done along Percival's dock.

This will necessitate a change in the harbor lines which were established by the Secretary of War June 3, 1892.

The subject has been given careful consideration by Capt. Harry Taylor, Corps of Engineers, and attention is respectfully invited to the within report by that officer, in which he recommends certain dredging in front of the dock, and that the harbor line be modified accordingly. This recommendation meets the approval of the division engineer, and is concurred in by me.

A tracing, showing in green the proposed change in the harbor line, is submitted, and I recommend that the Secretary place his approval thereon.

A. MACKENZIE,
Acting Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *February 3, 1897.*

Approved, as recommended by the Acting Chief of Engineers.

By order of the Secretary of War.

JOHN TWEEDALE, *Chief Clerk.*

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Seattle, Wash., January 19, 1897.

GENERAL: I have the honor to submit the following report, in answer to your telegram of the 15th instant, asking if there is any objection to drawing in harbor line in front of Percivals Dock and dredging triangular area between the dock and the harbor line of Olympia Harbor, Washington:

Upon receipt of your letter I wrote my inspector at Olympia to consult with the citizens of Olympia, and he reports that he has seen Col. F. D. Huestes, Gen. Hazard Stevens, Mr. C. H. Ayer, late mayor of Olympia, and other prominent citizens, all of whom strongly favor the plan of dredging along the front of the dock. From my own knowledge of the sentiment in Olympia, I know that it is generally very strong in favor of doing this dredging. There seems to be little question but that it will be decidedly to the advantage of the shipping and commercial interests of the city, and I believe that there will be no objection to it on the part of anyone there.

Percivals Dock is the only one generally used, and all steamboats plying between Olympia and other points on Puget Sound land there. Considerable inconvenience is experienced by them on account of the lack of deep water along the dock at low water, as at such times the only available portion of the dock is a short stretch near the inner or south end of the dock.

I inclose herewith a tracing, upon which are shown part of the harbor lines of Olympia Harbor as they now exist, Percivals Dock, and the proposed change in the harbor lines to bring the eastern line in along a portion of the dock. The outer end of the dock is little used, and there seems to be no advantage at present in carrying the dredging farther than is indicated on the tracing.

The present contract was for an estimated amount of 150,000 cubic yards to complete the project for the enitre width of the channel and basin to a depth of 6 feet. Upon sounding the area to be dredged over, it was discovered that under previous contracts the dredging had evidently exceeded 6 feet, and that by increasing the estimated amount to 174,000 cubic yards the entire basin could be dredged to a depth of 10 feet and the outer end of the channel to a depth of 8 feet. As the adopted project contemplates a depth of 12 feet throughout the entire area, I directed the dredging company to excavate to the depths above mentioned, i. e., 10 feet in the basin and 8 feet in the outer end of the channel.

To dredge the area indicated in front of Percival Dock to a depth of 10 feet will require an additional amount of dredging of about 20,000 cubic yards, making the total amount 194,000 cubic yards. This amount will still leave a balance of the appropriation of about $5,000.

As this seems to be to the general benefit of the community and in accordance with the general desire, I would respectfully recommend that the harbor lines be changed as indicated upon the tracing herewith, and that I be allowed to have the dredging done under the present contract. As the work now contemplated is well advanced and will probably be completed within ten days or two weeks, I would respectfully request to be informed by telegraph if this recommendation is approved.

Very respectfully, your obedient servant,

HARRY TAYLOR,
Captain, Corps of Engineers, U. S. A.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through the Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., January 22, 1897.

Respectfully forwarded recommended.

CHAS. R. SUTER,
Colonel of Engineers, U. S. A., Division Engineer.

APPENDIX T T.

PRELIMINARY EXAMINATION OF PORTLAND CHANNEL (CANAL), ALASKA.

[Printed in Senate Doc. No. 19, Fifty-fourth Congress, second session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., November 14, 1896.

SIR: I have the honor to submit the accompanying copy of letter of November 3, 1896, from Capt. D. D. Gaillard, Corps of Engineers, inclosing his report of results of preliminary examination of Portland Channel (Canal), Alaska.

The duty assigned Captain Gaillard has been performed in a prompt and very satisfactory manner, and his unusually interesting report is submitted for such action as may be deemed proper in the judgment of the Secretary of War.

Very respectfully, your obedient servant,

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

LETTER OF CAPT. D. D. GAILLARD, CORPS OF ENGINEERS.

OFFICE OF THE WASHINGTON AQUEDUCT,
Washington, D. C., November 3, 1896.

GENERAL: I have the honor to submit the following report, in duplicate, upon the preliminary examination of Portland Channel (Canal), Alaska, and the construction of the storehouses on its west bank, as directed by Department letter of August 17, 1896.

United States Coast and Geodetic Survey chart No. 8100 covers the localities mentioned in the report. Two copies of this chart,* on each of which have been platted the locations of the storehouses, are forwarded by the same mail.

Very respectfully, your obedient servant,

D. D. GAILLARD,
Captain, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,
Chief of Engineers, U. S. A.

PRELIMINARY EXAMINATION OF PORTLAND CHANNEL (CANAL), SOUTHEAST ALASKA.

GENERAL DESCRIPTION.

Portland Canal, named by Vancouver in 1793, forms a part of the boundary line between British Columbia and southeast Alaska and extends in a generally northerly direction for a distance of about 96

*Not reprinted. Printed in Senate Doc. No. 19, Fifty-fourth Congress, second session.

miles, measured along the axis of the channel. For about 25 miles from its mouth the average width is about 3½ miles, and the average mid-channel depth about 244 fathoms. For the remaining distance of 71 miles to the head of the canal the width is remarkably uniform, and varies but little from about 1½ miles, while the average mid-channel depth is about 137 fathoms. The least mid-channel depth at any point of the canal until the head is reached is 52 fathoms.

Tidal observations taken by parties under charge of Lieut. Commander C. M. Thomas, U. S. N., in 1888, and furnished through the courtesy of the Superintendent of the United States Coast and Geodetic Survey, show that the mean range of tide along Portland Canal is as follows:

	Feet.
Somerville Bay, British Columbia	13.23
Halibut Bay, southeast Alaska	15.30
Fords Cove, British Columbia	14.03

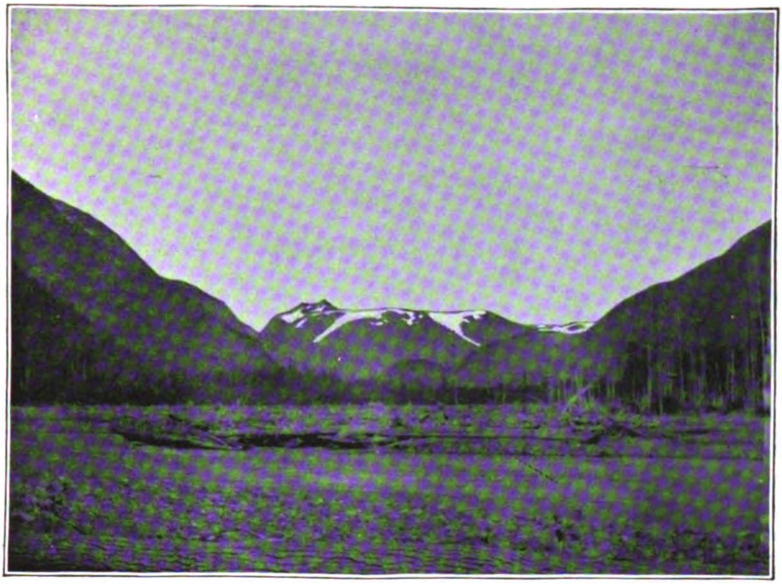
But a single island (Hattie Island) and no rocks are found in the channel, and except at the mouths of the larger creeks deep water extends close inshore.

From Lion Point to the head of the canal, on September 14, 1896, the surface water tasted perfectly fresh, and for several miles below Lion Point it was but slightly brackish.

The temperature of the surface water 10 miles south of Halibut Bay, on September 2, was 54° F., and of that midway between the mouths of Bear and Salmon rivers, on September 15, 41° F., the temperature of the air at the same time being 56° F. The water at the head of the canal has a very peculiar milky-white appearance, given it by the waters of Bear and Salmon rivers, two very swift streams draining considerable extents of country and frequently branching into several channels, but when confined in a single channel having at low water, in the case of the former, a width of about 60 feet and maximum depth of about 4 feet, and in the latter a width of about 50 feet and depth of about 3 feet, with velocities in each case of from 6 to 9 feet per second. At times of flood they bring down large quantities of sediment, and have formed extensive flats at their mouths. A reconnaissance of about 6 miles up Bear River Valley, and the view obtained from the most northerly point reached on the reconnaissance, showed that for a distance of 12 or 14 miles north of the head of Portland Canal the valley of Bear River is but a prolongation of the same glacier-formed gorge which constitutes Portland Canal. At 12 or 14 miles above the mouth of Bear River the valley seems to separate into two branches, one of which apparently passes on each side of Mount Gordon, the name given by us, in honor of the hero of Khartoum, to the prominent glacier-capped peak shown in the background of the view up Bear River Valley taken from the vicinity of parallel 56 degrees, and which appears to have been unnamed previously.

The banks are in general steep and rocky, and the entire canal on both sides is bordered by mountains which vary in height from about 1,500 to 7,600 feet, the summits of the higher peaks being covered with snow and ice from which are formed numerous glaciers, generally terminating at an altitude of 3,000 to 4,000 feet above sea level.

From the scorings observed on the rocks and from other indications it seems probable that Portland Canal itself was once the bed of an enormous glacier, fed by tributary glaciers, which occupied the ravines and valleys on either bank, and that these tributary glaciers were in turn fed by smaller glaciers, some of which yet remain. All indications



VIEW OF BEAR RIVER VALLEY FROM VICINITY OF PARALLEL 56°—MOUNT GORDON IN THE BACKGROUND.

MOUNTAINS AT HEAD OF PORTLAND CANAL, ON BRITISH COLUMBIA SHORE.

TIMBER TORN UP BY "AVALANCHE," WEST SIDE OF BEAR RIVER VALLEY, NEAR HEAD OF PORTLAND CANAL.

FOREST ON NORTH BANK OF SALMON RIVER, SOUTHEAST ALASKA, NEAR HEAD OF PORTLAND CANAL.

point to the fact that at the present time the climate of this portion of Alaska is becoming gradually milder, and that the glaciers are receding at a rate geologically rapid. From the water's edge up to an elevation of 3,500 to 4,000 feet, the shores are covered with a dense growth of hemlock, spruce, and pine, mingled in some localities with red and yellow cedar. Huge bare scars, frequently extending from the snow line down to the water's edge, mark the paths of numerous avalanches which have swept away every vestige of timber in their downward course. While not comparable with the timber of Washington, Oregon, or of some parts of Alaska, much of it compares favorably in size with that of the Atlantic States, and on account of its great abundance and its proximity to deep water, the day will yet come when the immense forests of Alaska will be called upon to furnish lumber for use in other parts of the United States.

A dense growth of underbrush and a perfect tangle of fallen trees cover the ground in the forests. Of soil proper, except in the valleys of streams, there is but little. What supplies its place is a spongy mass of decayed wood and vegetation from 2 to 5 feet in thickness, which seems as tremulous under foot as does an ordinary salt marsh, and which, when thoroughly dried by artificial heat, generally contained sufficient organic matter to burn readily.

SETTLEMENTS.

There are no permanent settlements on the Alaska shore of Portland Canal, and only about a dozen Indians in all were encountered there, engaged temporarily in catching and drying salmon, hunting, and trapping. These Indians, without exception, had come from the British Columbia side of the canal and were semicivilized. Several unoccupied Indian huts and two or three substantial log huts, built by white men—hunters, trappers, and prospectors—but unoccupied at the time, were observed.

In that part of southeast Alaska adjacent to Portland Canal—i. e., the area included between Dixon Entrance, Clarence Strait, the west branch of Behm Canal, Bell Arm, the fifty-sixth parallel of north latitude, a small part of Bear River, and Portland Canal—the United States has established three post-offices, one at each of the following points: United States custom-house, Mary Island; Ketchikan, Tongass Narrows; and Loring, Naha Bay, Behm Canal. Another is soon to be established at Metlakahtla, Annette Island.

The United States custom-house which was established at Tongass, Tongass Island, in 1869 was abolished toward the close of the year 1888, and by act of Congress approved March 3, 1891, Mary Island was constituted a subport of delivery. On April 29, 1868, a military post, Fort Tongass, was established at Tongass and garrisoned by about 3 commissioned officers and 50 enlisted men of Battery E, Second Regiment of Artillery, until October 7, 1870, when the post was abandoned.

The largest settlement in the region under discussion is at New Metlakahtla (Port Chester), where there is a store, a cannery, a sawmill, and about 850 Christian Indians who, in 1887, to obtain greater religious liberty, abandoned their village in British Columbia and followed their devoted missionary, Mr. William Duncan, to their present abode, upon arrival at which it is said that they hoisted the United States flag and formally transferred their allegiance from Canada to the United States. By act of Congress, approved March 3, 1891, the body of lands known as Annette Islands was set apart as a reservation "for the use of the Metlakahtla Indians and those persons known as Metlakahtlans who have recently emigrated from British Columbia to Alaska, and such other Alaskan natives as may join them," etc.

This settlement affords a striking example of the results attained by one man by a judicious blending of industrial with moral and religious instruction during a period of about forty years.

At Loring there are, besides the post-office, a store, a cannery, and a few resident Indians. On Neets Bay is a cannery.

At Ketchikan there are about 100 Indians, a store, and an establishment for salting fish.

At Gavina, Tongass Narrows, there is a sawmill owned and operated by Indians.

At Tongass there is a trading store, an establishment for salting fish, and a settlement of about 50 Indians. One and a half miles below Ketchikan, on Tongass Narrows, a new Indian mission has recently been established.

There is said to be a cannery near the head of Behm Canal, at the mouth of the Klaheena River, and another on Boca de Quadra.

So far as could be ascertained, the preceding list comprises all of the principal settlements in southeast Alaska within the limits previously described.

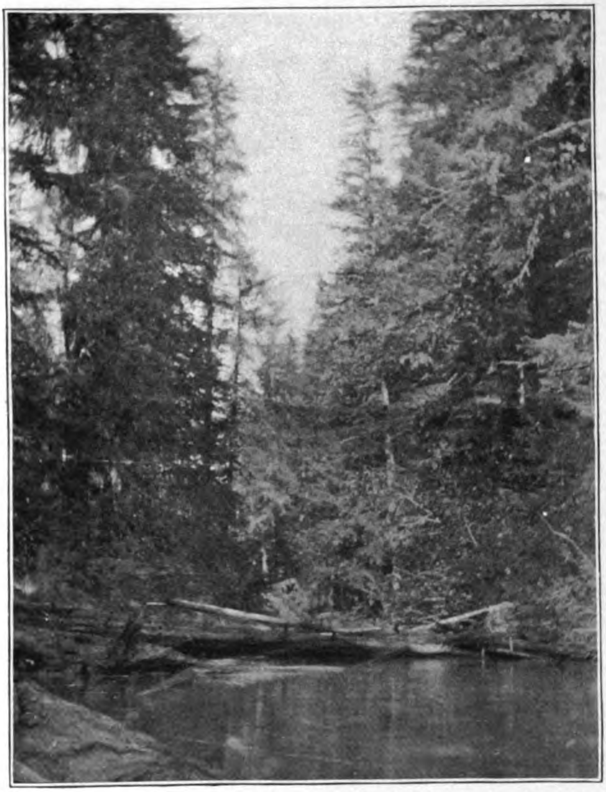
On the British Columbia side of Portland Canal by far the most important settlement is Port Simpson, near the mouth of the canal, a trading post established by the Hudson Bay Company sixty or eighty years ago and still controlled by them. The total settlement comprises some 800 to 1,000 persons, employees of the company, and a large number of Indians. The town presents rather an attractive appearance, and many of the Indians own comfortable frame houses. From Port Simpson, a small but powerful stern-wheel steamer, the *Caledonia*, makes constant trips during the summer to the company's subposts in the interior of British Columbia to collect furs, which are then baled at Port Simpson and shipped abroad. A few days before our arrival a single shipment of 100 bales, valued at $50,000, had been made.

The other settlements on the British Columbia side of Portland Canal consist of a mission and an Indian village on Nass River, and some canneries on this river and on Observatory Inlet.

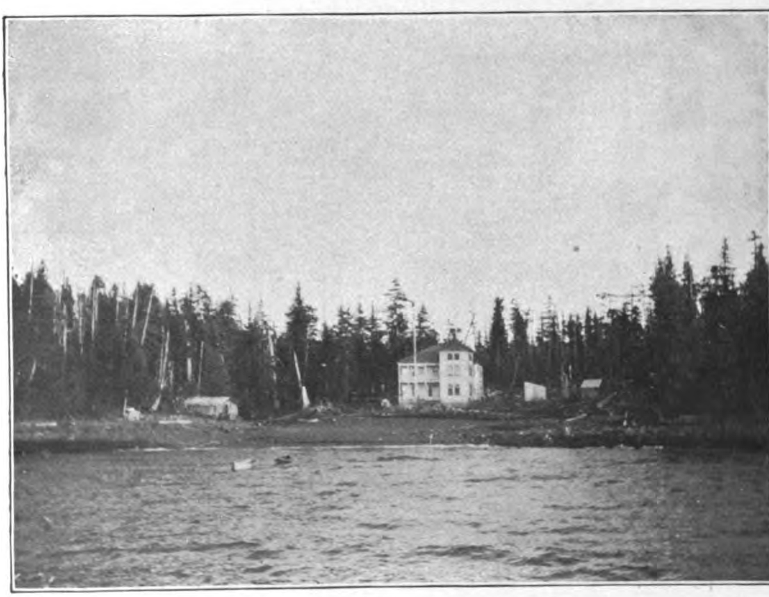
RESOURCES OF THE REGION ADJACENT TO PORTLAND CANAL.

Unquestionably the principal food supply of this portion of Alaska is now and always will be fish, and of all the different species found in Portland Canal and adjacent waters by far the most numerous are the salmon, which in the summer months and until the middle of September swarm up every stream emptying into Portland Canal for the purpose of depositing their spawn. Apparently taking no food while spawning is in progress, and weakened and bruised by their struggles in rapids and against rocks in their efforts to reach the spawning ground, their strength lasts but a short time after the spawn is deposited, and few live to return to deep water.

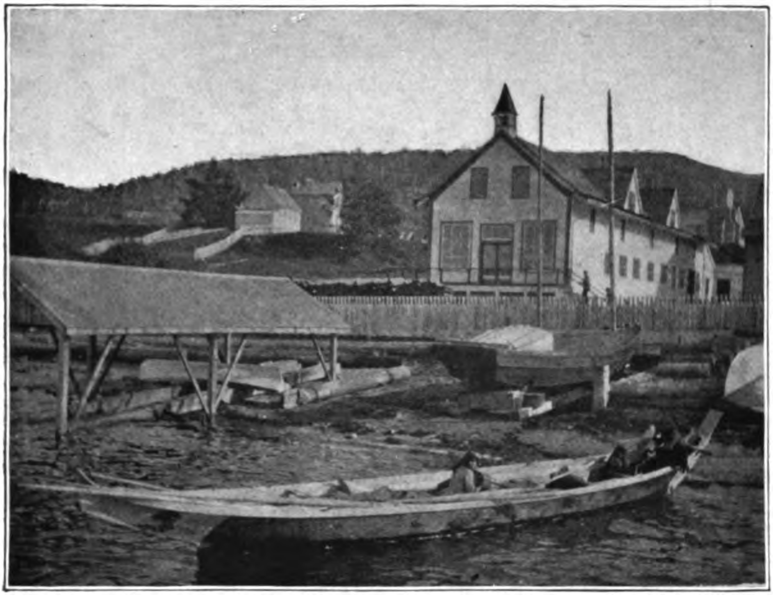
Certain favorite creeks seemed almost alive with them, and on one section, about half a mile long, 12 feet wide, and 8 inches deep, of a creek emptying into Halibut Bay, an attempt was made to estimate the number of salmon by counting those in a typical portion 25 feet in length and 12 feet in width. In this small area were 54 salmon, and in the half mile of stream there were probably between 5,000 and 6,000



VIEW ON SMALL CREEK, NEAR STOREHOUSE No. 4, PORTLAND CANAL.



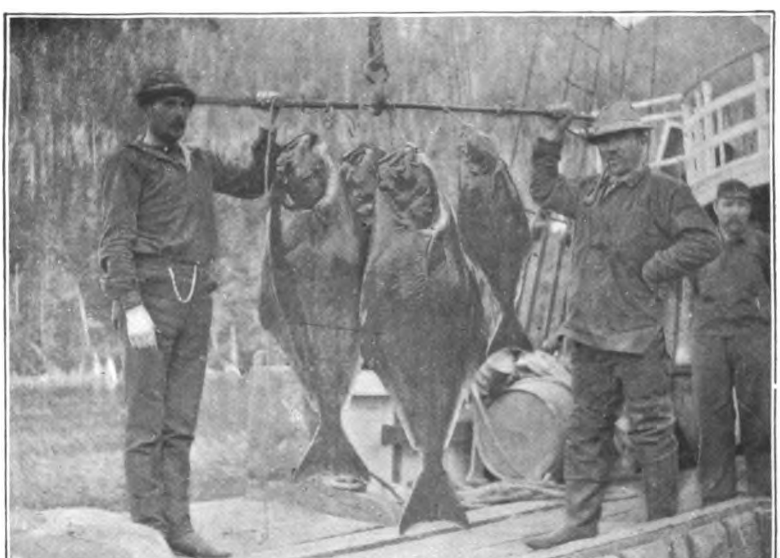
U. S. CUSTOM HOUSE, MARY ISLAND, SOUTHEAST ALASKA.



HUDSON'S BAY COMPANY'S STORE, PORT SIMPSON, BRITISH COLUMBIA.

SALMON ASCENDING CREEK, HEAD OF HALIBUT BAY.

SALMON ASCENDING CREEK, HEAD OF HALIBUT BAY.



HALIBUT CAUGHT IN MANZANITA COVE, NEAR STOREHOUSE No. 1.

fish. When the "run" is almost over the stench from the dead fish is sickening. In a stream about 14 feet wide and 8 inches deep, which flows within a few yards of Storehouse No. 4, 1,379 dead salmon were counted in a stretch of 800 feet of stream. This did not include the very large number which had previously floated downstream into Portland Canal.

On Salmon River, near Storehouse No. 4, on September 19, although the "run" had almost ended, a single Indian with a "salmon hook" took 250 salmon in less than two hours. It is doubtful if there are many places outside of Alaska where a man can secure a year's supply of meat in less than three hours and with no risk or uncertainty, and but little exertion. The salmon already described were apparently confined to three varieties, "hook-nose," "humpback," and "steelhead," but as our observations extended only between September 2 and 25, other varieties may have made their "runs" previous to the former date.

In addition to salmon, our parties caught brook trout, codfish, rock cod, halibut, flounders, and crabs. Fine clams were obtained in front of Storehouse No. 1, and numerous hair seals were seen at the head of Portland Canal and a few in Halibut Bay. Porpoises were seen in all parts of the canal, and whales in "Manzanita Cove" and Wales Passage.

The animals seen at various times by members of the party were the bear, wolf, mountain goat, porcupine, mink, squirrel, and muskrat. In addition to these, it is known that the deer, marten, wolverine, otter, and marmot are also found along portions of Portland Canal.

Among the birds noted were geese, ducks of various kinds, coots, loons, bald eagles, an owl, ravens, gulls, jay birds, pheasants (rough-legged grouse), two species of hawk, blue herons, kingfishers, dippers, woodpeckers, wrens, sparrows, humming birds, and one or two other small birds whose names were not known to us.

In general, however, considering the density and extent of the forests, one can not help being struck at this season by the scarcity of birds of all kinds, and especially by the absence of song birds.

A single lizard and several toads constituted the sole representatives of the reptile and batrachian families.

At all points along the canal on still days sand flies and mosquitoes were very troublesome, the former, however, largely outnumbering the latter.

The principal forest trees are hemlock, spruce, pine, and red and yellow cedar. Along the larger water courses cottonwoods, willows, and red-berry alders are plentiful.

Huckleberries and red currants were very abundant and of large size. Salmon berries, raspberries, and cranberries were frequently seen, as were also strawberry plants, but no strawberries, the season probably having passed. Several other kinds of berries were noted, but whether or not they were edible could not be determined. In general, all of the berries were rather insipid, due, probably, to the large amount of moisture and to the fact that on account of the density of the forests overhead they were but little exposed to the direct rays of the sun.

Of cultivable land there is very little in the vicinity of Portland Canal, but at Port Simpson some vegetable gardens and a few beautiful flower gardens were seen. Carrots, turnips, beets, parsnips, radishes, onions, pease, lettuce, and celery are said to do well. Potato plants appeared very flourishing. It is stated that cauliflower does well, but that cabbage does not head well, if at all. A flourishing potato plant was observed in front of a trapper's deserted cabin at Lion Point, British Columbia, near the head of Portland Canal, and another in front of a similar cabin on Halibut Bay.

It is not known at the present time that any valuable mineral deposits exist in the vicinity of Portland Canal, but the region is very rugged and the forests so dense and the adjoining territory so inaccessible on account of the entire absence of navigable streams, of roads, and of trails that but little prospecting in the interior has yet been done.

CLIMATE.

During our stay of twenty-eight days in Portland Canal rain fell on nine days, and on one day fog hung down to the water, while on several days fog banks which obscured objects at some height above the water were observed in the early morning, but these were generally dissipated by the sun by 9 or 10 o'clock. As regards rain, sunshine, and temperature the weather was practically the same at the sites of all of the storehouses, but while there was but comparatively little wind at any of them, its velocity generally increased from the head toward the mouth of the canal. The highest observed temperature was 69° F., on September 15, and the lowest 32° F., on September 26, at Lizard Cove, when thin ice formed. Very heavy white frosts were of constant occurrence during the latter part of the month.

A table showing the direction of the wind and the temperature at 6 a. m., 12 noon, and 6 p. m., taken on board of the *Manzanita*, is given in Appendix A, in which is also given some data in reference to the same subjects for Port Simpson, British Columbia, at the mouth of Portland Canal, obtained from the Pacific Coast Pilot, 1869.

CONCLUSIONS.

It may be stated, in summing up the results of the preliminary examination of Portland Canal, that it is a beautiful sheet of water, with bold, well-defined shores, and a least mid-channel depth of 312 feet, and is remarkably easy to navigate, but the depth of water is so great that there are but few safe anchorages available.

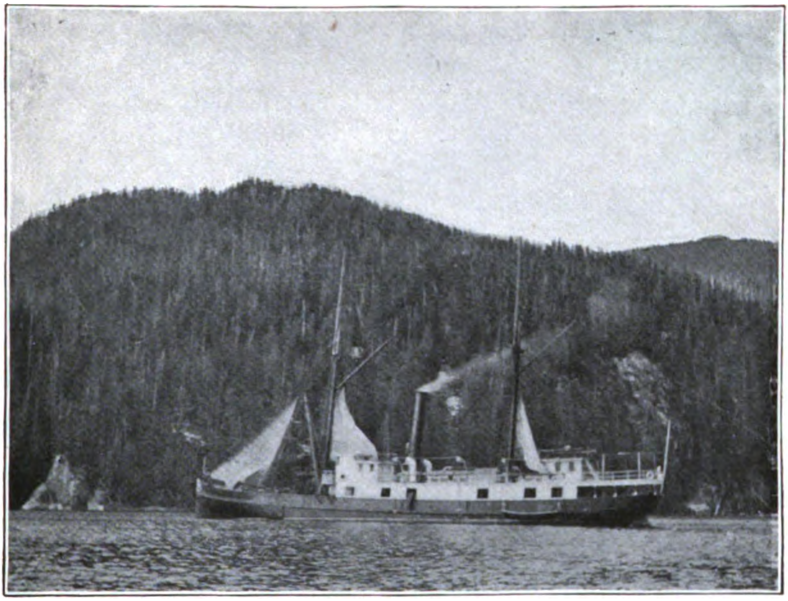
No United States vessels except those connected with surveys now navigate Portland Canal.

There are no permanent inhabitants on the Alaska shore of the canal, and the only industries carried on there are hunting, trapping, and the smoking of a comparatively small number of salmon, principally by Indians. The latest chart issued by the United States Coast and Geodetic Survey of Portland Canal and its vicinity was entirely satisfactory for all purposes of navigation, although neither the captain of the *Manzanita* nor the pilot had ever navigated the canal before. The description of triangulation stations along Portland Canal and their geographical positions, kindly furnished by the Superintendent of the United States Coast and Geodetic Survey, were so complete that no trouble, except in a single instance, was found in recovering any desired station, although some of them had been established over eight years and were now marked only by a small cross cut in the rocks.

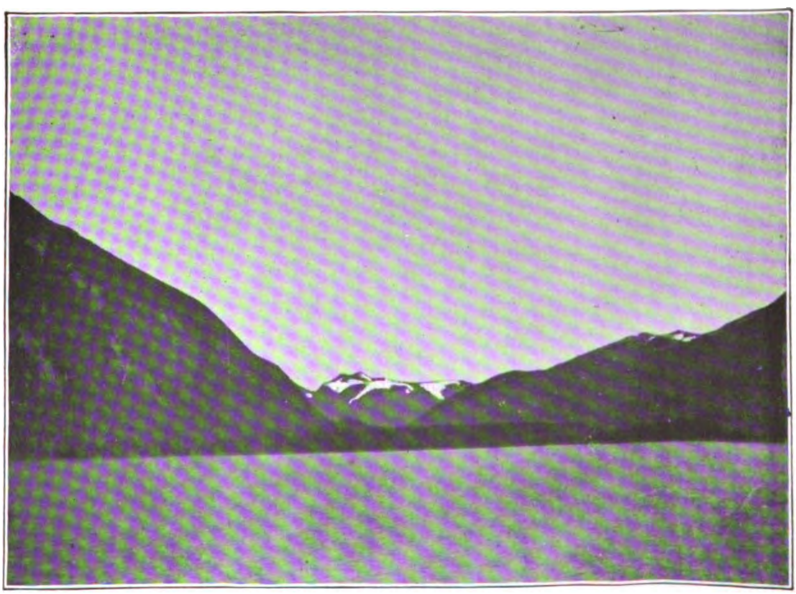
REPORT UPON THE CONSTRUCTION OF STOREHOUSES ON PORTLAND CHANNEL (CANAL), SOUTHEAST ALASKA.

Orders and instructions directing me to proceed to Portland Channel (Canal), Alaska, for the purpose of making a preliminary examination of the same and of constructing four storehouses on its western

FOREST ONE-FOURTH OF A MILE WEST OF STOREHOUSE No. 4.



U. S. L. H. TENDER "MANZANITA" IN HALIBUT BAY, PORTLAND CANAL, ALASKA.



HEAD OF PORTLAND CANAL, SHOWING MOUNT GORDON IN THE BACKGROUND.

LANDING STORES AT LIZARD COVE, PORTLAND CANAL, ALASKA.

LANDING STORES AT LIZARD COVE, PORTLAND CANAL, ALASKA.

bank, were received just before noon on August 17, 1896, and I left Washington, D. C., that night for Seattle, Wash., via Portland, Oreg., the stop at the latter place being necessary to consult with Capt. W. L. Fisk, United States Corps of Engineers, engineer of the Thirteenth light-house district, in reference to the light-house tender *Manzanita*, which had been ordered to be placed at my disposal at Seattle, Wash., for the transportation of myself, laborers, and materials from that point to Alaska and return.

I arrived in Portland on the morning of August 24, 1896, conferred with Captain Fisk, and left on the afternoon of the same day for Seattle, where I arrived at midnight and found the *Manzanita* awaiting me, provisioned for the trip and with her coal bunkers filled. Conversation with her efficient commander, Capt. William E. Gregory, and inquiries made in Seattle showed that unless enough coal for the entire trip could be carried from Seattle serious inconvenience and delay would result, as no coal could be purchased in Alaska nearer than Juneau, distant about 400 miles from the head of Portland Canal.

By advice of Captain Gregory I purchased 500 sacks, which were filled with coal and stored in the stern and along the gangways. This, with the coal in the bunkers and an extra supply carried in the hold and on the forward deck, gave a total supply of 135 tons, which was judged sufficient for the round trip, and was all that could be taken.

The period from August 25 to 28, inclusive, was spent in securing the services of a skillful pilot for the inland route between Seattle and Portland Canal, a transitman to assist in the supervision of operations and to assume charge in case I should be disabled from any cause, an assistant quartermaster (for a part of the time only), four masons, four carpenters, four cooks, four mason's assistants, and eight laborers, subsistence stores, medicines, tentage, cooking and table utensils, tools, and building materials (cement, lumber, shingles, nails, etc.), for the four storehouses to be constructed on the Alaska side of Portland Canal.

All stores were loaded on board the *Manzanita* on the afternoon of August 28, and at 6.15 a. m. on the 29th, in a heavy fog, she sailed for Portland Canal, at the mouth of which she arrived at 7 p. m. on September 1, having anchored during the nights of August 30 and 31 in order to give the pilot much-needed rest.

The head of Portland Canal was reached at 5 p. m. on September 2, and the site of storehouse No. 4, at Eagle Point, northeast of the mouth of Salmon River, on the west bank of Portland Canal, was selected on the same afternoon.

The regular working party, consisting of one mason, one carpenter, one cook, one mason's helper, and two laborers, provided with tentage and tools, was landed on the following morning in a pouring rain, and by noon the tents were pitched and ready for occupancy, much clearing of brush and cutting of timber having been found necessary before they could be erected. Building materials and subsistence stores were landed during the afternoon and stored in the tents without injury from the rain.

We left the head of Portland Canal at 6 a. m. on September 4 and arrived at Halibut Bay at 11.30 a. m., selected the site of storehouse No. 3, on the west side of the bay, north of the mouth of a creek, and erected tents for the party in a pouring rain on the same afternoon. The working party, materials, and provisions were landed on the following morning, and excavation for the foundation of the storehouse was at once begun.

Previous investigation having shown that there was little probability of finding sand for use in the construction of the masonry of storehouses

Nos. 1 and 2 near their sites, September 5 and 7 were spent in filling 357 sacks with sand, carrying them about 1½ miles in small boats to the *Manzanita*, and loading them on board.

We left Halibut Bay at 5 a. m., September 8, and arrived at Lizard Cove, Pearse Island, at 7.45 a. m., selected the site of storehouse No. 2, at the head of the cove just south of Lizard Point, Pearse Island, landed party, pitched tents, excavated foundation for storehouse, landed building materials, provisions, and 135 bags of sand, and sailed for "Manzanita Cove," north of Red Cliff Point, Wales Island, at 4.30 p. m., arriving there at 6 p. m., and selecting the site for storehouse No. 1, at the head of a small cove opening into "Manzanita Cove," about 250 yards west of Red Cliff Point.

We landed the working party for storehouse No. 1 at 6.30 a. m., September 9, in rain, and during the day pitched tents and landed materials, provisions, and 222 bags of sand. The storehouses were located with the view of permitting the safe approach of a small boat to the vicinity at high tide, except in severe storms, and of affording anchorage at a reasonable distance under ordinary conditions of weather to large vessels, from which stores could be discharged. This latter condition, however, could not be fulfilled at Lizard Cove nor at any other point to be found on the east side of Pearse Island.

DESCRIPTION OF STOREHOUSES.

Storehouse No. 1.—This storehouse is situated on "Manzanita Cove," Wales Island, about 250 yards west of Red Cliff Point. The walls are of rubble masonry, laid with Portland cement mortar. The foundation walls are 24 inches thick and the side walls 18 inches. Its interior dimensions are 10 by 15 feet by 7 feet 5 inches in the clear, and it is surmounted by a gable roof with a pitch of 2 on 3, covered with cedar shingles. At one end of the building is a door 3 by 6½ feet in the clear, and at the opposite end a window 2 by 3 feet in the clear. The floor is of 1-inch boards. On the corner of the house, to the left of the door and about 3 feet above the foundation, is a dressed stone with a face 8 by 24 inches, set flush with the wall, on which is neatly cut the inscription:

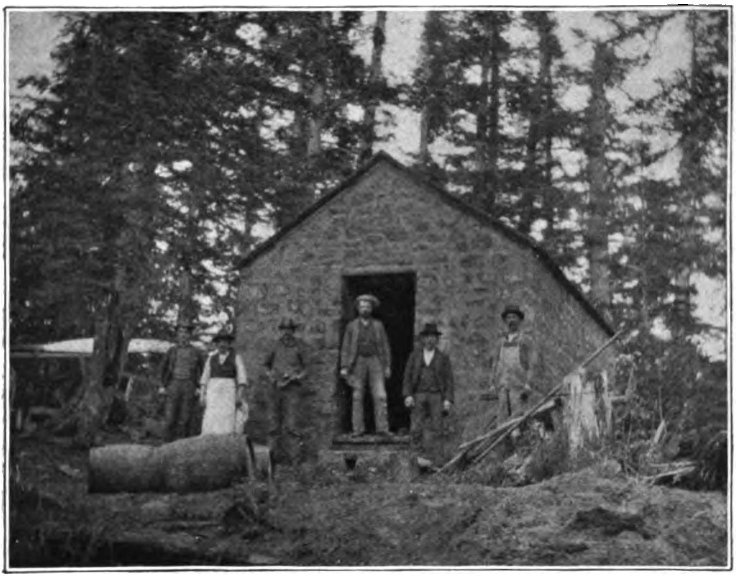
U. S. PROPERTY.
DO NOT INJURE.

This storehouse contains 31.6 cubic yards of masonry. It was commenced on September 9 and completed on September 28. About 60 feet to the right of the storehouse is a flagstaff 60 feet in height and 18 inches in diameter at the base, made by trimming and dressing a straight spruce tree. On this staff is carved—

U. S.
SEPT.
12th,
1896.

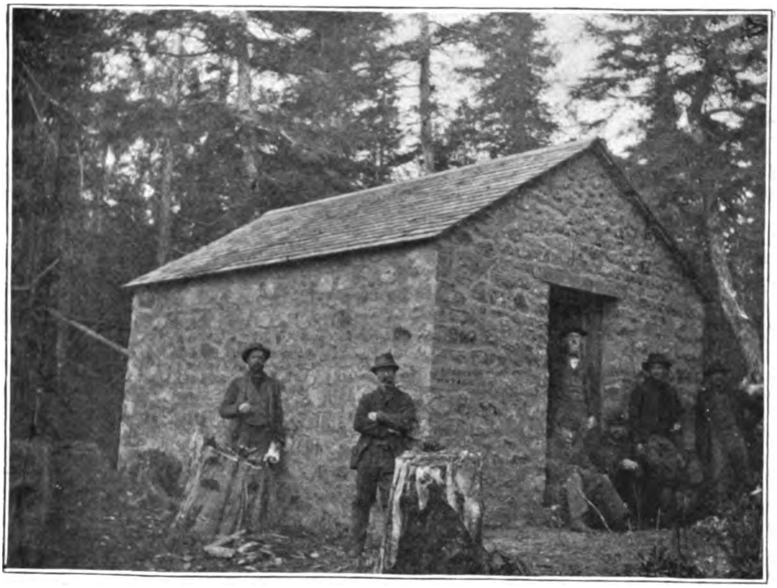
the date on which the United States 4-foot 9-inch by 8-foot "storm flag" was first hoisted, which was done with a salute, three cheers, and uncovered heads. This flag was kept flying during the day until the party left on September 28.

Storehouse No. 2.—This storehouse is situated at the head of the cove just south of Lizard Point, Pearse Island, southeast Alaska. The walls are of rubble masonry laid with Portland cement mortar. The foundation walls are 24 inches thick and the side walls 18 inches. Its interior

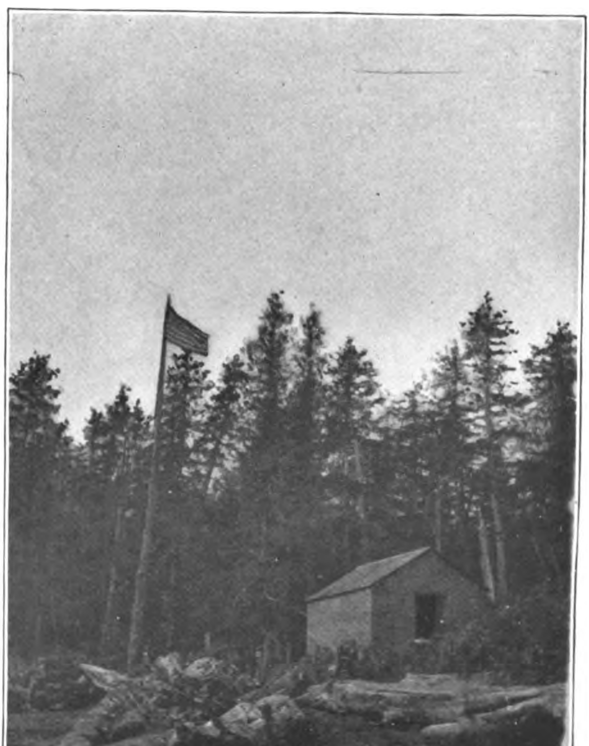


STOREHOUSE No. 1, MANZANITA COVE, WALES ISLAND, ALASKA.

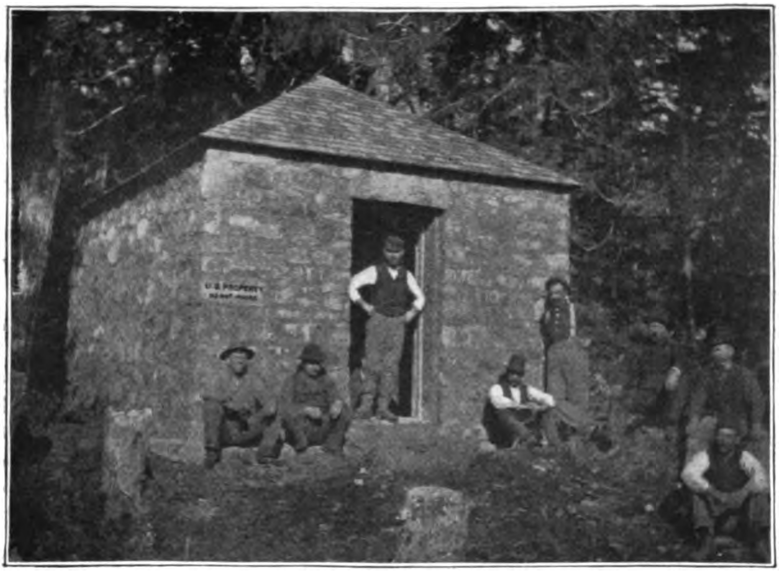
STOREHOUSE No. 1, MANZANITA COVE, WALES ISLAND, ALASKA.



STOREHOUSE No. 2, LIZARD COVE, PEARSE ISLAND, ALASKA.



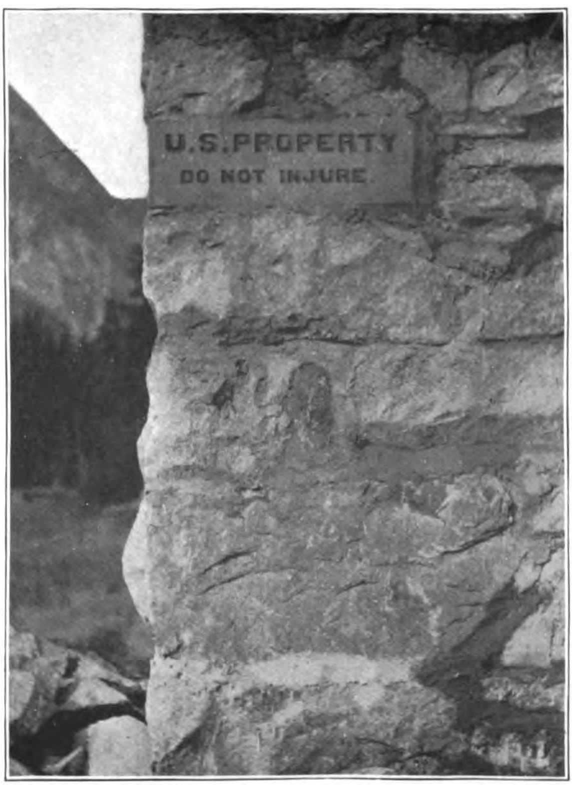
STOREHOUSE No. 2, LIZARD COVE, PEARSE ISLAND, ALASKA.



STOREHOUSE No. 3, HALIBUT BAY, PORTLAND CANAL, ALASKA.

STOREHOUSE No. 3 HALIBUT BAY, PORTLAND CANAL, ALASKA.

CONSTRUCTING STOREHOUSE No. 4, EAGLE POINT, NEAR MOUTH OF SALMON RIVER, PORTLAND CANAL, ALASKA.



INSCRIPTION STONE BUILT INTO STOREHOUSES, 1, 2, 3, AND 4.

STOREHOUSE No. 4, EAGLE POINT, NEAR MOUTH OF SALMON RIVER, PORTLAND CANAL, ALASKA.

dimensions are 10 by 15 feet by 7 feet 5 inches in the clear, and it is surmounted by a gable roof with a pitch of 2 on 3, covered with cedar shingles. At one end of the building is a door 3 by 6½ feet in the clear, and at the opposite end a window 2 by 3 feet in the clear. The floor is of 1-inch boards. On the corner of the house, to the left of the door and about 3 feet above the foundation, is a dressed stone with a face 8 by 24 inches, set flush with the wall, on which is neatly cut the inscription:

U. S. PROPERTY.
DO NOT INJURE.

This storehouse contains 31.8 cubic yards of masonry. It was commenced on September 8 and completed on September 28. About 15 feet to the left of the storehouse and the same distance in the rear is a flagstaff, about 60 feet in height and 14 inches in diameter at the base, made by trimming and dressing a straight spruce tree. On the staff is carved—

U. S.
SEPT.
14,
1896.

the date on which the United States 4-foot 9-inch by 8-foot "storm flag" was first hoisted, which was done with a salute, three cheers, and uncovered heads. This flag was kept flying during the day until the party left "Lizard Cove" on September 28.

Storehouse No. 3.—This storehouse is situated on the west side of Halibut Bay, and is of rubble masonry laid with Portland cement mortar, with foundation walls 24 inches in thickness, and side walls 18 inches thick. Its interior dimensions are 10 by 15 by 8 feet in the clear, and it is surmounted by a hip roof with a pitch of 2 on 3 and a 5-foot ridge. This roof is covered with cedar shingles. At one end of the building is a door 3 by 6½ feet in the clear, and at the opposite end a window 2 by 3 feet in the clear. The floor is of 1-inch boards. On the corner of the house to the left of the door and about 3 feet above the foundation is a dressed stone, with a face 8 by 24 inches, set flush with the wall, on which is neatly cut the inscription—

U. S. PROPERTY.
DO NOT INJURE.

This storehouse contains 38.3 cubic yards of masonry. It was commenced on September 5 and completed on September 26, 1896. About 40 feet in front of the storehouse is a flagstaff of cedar 50 feet in height and 9 inches in diameter at its base, on one side of which is carved "U. S." and on the other "Sept. 7, 1896," on which date a 4-foot 9-inch by 8-foot United States "storm flag" was first hoisted, which was done with a salute, three cheers, and uncovered heads. This flag was kept flying during the day until the party left Halibut Bay on September 26.

Storehouse No. 4.—This storehouse is situated at Eagle Point, near the head of Portland Canal, and is of rubble masonry laid with Portland cement mortar, with foundation walls 18 inches in thickness and side walls 12 inches thick. Its interior dimensions are 10 by 15 by 8 feet in the clear, and it is surmounted by a hip-roof with a pitch of 2 on 3 and a 5-foot ridge. This roof is covered with cedar shingles. At one end of the building is a door 3 by 6½ feet in the clear, and at the opposite end a window 2 by 3 feet in the clear. The floor is of 1-inch boards. On the corner of the house to the left of the door, and about 3 feet above the foundation, is a dressed stone, with a face 8 by 24 inches, set flush with the wall, on which is neatly cut the following inscription:

U. S. PROPERTY.
DO NOT INJURE.

This storehouse contains 23.2 cubic yards of masonry. It was commenced on September 4 and completed on September 21, 1896. About 25 feet to the left of the storehouse is a flagstaff formed by trimming and dressing a spruce tree 35 feet in height and 12 inches in diameter at the base. On this staff is carved

U. S.
SEPT.
14,
1896.

on which date a United States "storm flag" 4 feet 9 inches by 8 feet was first hoisted, which was done with a salute, three cheers, and uncovered heads. This flag was kept flying during the day until the party left Eagle Point on September 21.

The four storehouses are neatly and strongly built, and would make comfortable quarters for small parties.

From inquiries made on the subject it seems probable that they are the first buildings of stone masonry ever erected in Alaska.

The doors and windows are of double thickness of inch boards, the inner course vertical and the outer diagonal.

In each of the buildings are stored cement, tools, rope, cooking utensils, etc., for the use of future parties, and in each, except No. 4, a 4-foot 9-inch by 8-foot United States "storm flag." The plates, pans, cups, knives, forks, spoons, etc., necessary for the use of the employees on the return voyage from Alaska were stored with Capt. Harry Taylor, United States Corps of Engineers, at Seattle, Wash., with whom was also left one complete set of storehouse keys, the other set being here in my possession.

Sand for Storehouse No. 1 was obtained from a point 40 miles distant, and for No. 2 from a point 30 miles distant. That for No. 3 was loaded on rafts in the vicinity at low tide and floated near the site of the storehouse at high tide.

Stone for Storehouses Nos. 1, 2, and 3 was obtained by breaking up bowlders, loading them on rafts, and floating them as near as possible to the sites of the storehouses. Stone for Storehouse No. 4 was quarried from a ledge of excellent granite in the immediate vicinity.

All building materials, provisions, etc., amounting to a total of about 270 tons, had to be carried in handbarrows over ground which generally afforded bad footing.

By 5.15 p. m. on September 28 the parties were all once more on board of the *Manzanita*, which left for Mary Island for the purpose of getting mail at 5 a. m. September 29 and arrived there at 9.40 a. m. the same day. Here the first newspapers seen in over a month were received and much enjoyed.

September 29 to October 4 were spent en route to Seattle, which was reached at 10 a. m. on the latter date with the entire party in good health from start to finish—a source of great satisfaction, as I had experienced much anxiety regarding the health of the 50 persons (including the crew of the ship) under my charge, knowing that no physician could be obtained within several hundred miles of Portland Canal.

The party was disbanded at Seattle on October 4, and paid off on the next day.

I left Seattle for Washington, D. C., on October 10, and arrived in Washington on October 17, exactly two months from the date of leaving the latter place, and after a total journey of over 9,000 miles.

In conclusion, I beg to acknowledge my great indebtedness to Capt. William E. Gregory, the efficient commander of the *Manzanita*, who, with his officers and the entire crew, did everything to facilitate work and to render my party comfortable.

To Capt. J. E. Lennan, pilot, and to Mr. A. G. Mosier, instrument man, I am indebted for efficient and cheerful performance of their respective duties.

Respectfully submitted.

D. D. GAILLARD,
Captain, Corps of Engineers.

WASHINGTON, D. C., *November 3, 1896.*

APPENDIX A.

Survey of Portland Channel, Alaska.

[Extract from log of U. S. light-house tender *Manzanita*.]

Date.	Hour.	Wind.		Thermometer.	Weather.	Locality.
		Direction.	Force.			
				°F.		
Sept. 1	6 a. m.	Calm.	0	56	Fine	Fitzhugh Sound.
	Noon	S.	3	59	Rain	Grenville Channel.
	6 p. m.	SE.	4	56	Cloudy	Port Simpson.
Sept. 2	6 a. m.	S.	2	50	Rain	Portland Canal.
	Noon	S.	3	51	....do	Do.
	6 p. m.	S.	1	50	....do	Do.
Sept. 3	6 a. m.	S.	1	52	....do	Do.
	Noon	S.	1	59	....do	Do.
	6 p. m.	S.	1	60	....do	Head Portland Canal.
Sept. 4	6 a. m.	Calm.	0	50	Fog	Do.
	Noon	Calm.	0	60	Cloudy	Alexander Bay, Portland Canal.
	6 p. m.	Calm.	0	61	Rain	Halibut Bay, Portland Canal.
Sept. 5	6 a. m.	S.	4	51	Cloudy	Do.
	Noon	SE.	5	52	Rain	Do.
	6 p. m.	S.	4	56	....do	Do.
Sept. 6	6 a. m.	SW.	4	49	Cloudy	Do.
	Noon	SW.	4	51	Rain	Do.
	6 p. m.	SW.	4	49	....do	Do.
Sept. 7	6 a. m.	NW.	1	49	Fine	Do.
	Noon	NW.	1	60	....do	Do.
	6 p. m.	NW.	1	52	....do	Do.
Sept. 8	6 a. m.	Calm.	0	48	....do	Do.
	Noon	NE.	2	51	....do	Lizard Cove, Portland Canal.
	6 p. m.	NW.	4	49	....do	"Manzanita Cove," Portland Canal.
Sept. 9	6 a. m.	NW.	2	51	Overcast	Do.
	Noon	NW.	2	56	....do	Do.
	6 p. m.	NW.	3	55	....do	Do.
Sept. 10	6 a. m.	SW.	3	54	Rain	Do.
	Noon	NW.	3	61	Fine	Mary Island.
	6 p. m.	NW.	2	59	....do	Do.
Sept. 11	6 a. m.	NW.	1	49	....do	Do.
	Noon	N.	2	61	....do	Port Simpson.
	6 p. m.	Calm.	0	62	....do	"Manzanita Cove," Portland Canal.
Sept. 12	6 a. m.	N.	6	52	....do	Do.
	Noon	N.	6	55	....do	Winter Harbor, Pearse Island.
	6 p. m.	NW.	4	58	....do	Do.
Sept. 13	6 a. m.	NW.	3	54	....do	Do.
	Noon	NW.	4	60	....do	Do.
	6 p. m.	NW.	1	59	....do	Do.
Sept. 14	6 a. m.	N.	2	58	Overcast	Do.
	Noon	N.	1	62	Fine	Portland Canal.
	6 p. m.	Calm.	0	61	....do	Salmon River, Portland Canal.

Survey of Portland Channel, Alaska—Continued.

Date.	Hour.	Wind.		Thermometer.	Weather.	Locality.
		Direction.	Force.	° F.		
Sept. 15	6 a. m.	NW.	3	59	Fine	Salmon River, Portland Canal.
	Noon	NW.	2	69	....do	Do.
	6 p. m.	NW.	1	67	....do	Do.
Sept. 16	6 a. m.	Calm.	0	56	....do	Do.
	Noon	Calm.	0	67	....do	Do.
	6 p. m.	Calm.	0	60	....do	Do.
Sept. 17	6 a. m.	Calm.	0	51	....do	Do.
	Noon	Calm.	0	62	....do	Do.
	6 p. m.	Calm.	0	59	....do	Do.
Sept. 18	6 a. m.	Calm.	0	52	....do	Do.
	Noon	Calm.	0	64	....do	Do.
	6 p. m.	Calm.	0	59	....do	Do.
Sept. 19	6 a. m.	Calm.	0	56	....do	Do.
	Noon	Calm.	0	63	....do	Do.
	6 p. m.	Calm.	0	60	....do	Do.
Sept. 20	6 a. m.	Calm.	0	53	....do	Do.
	Noon	Calm.	0	64	....do	Do.
	6 p. m.	Calm.	0	69	....do	Do.
Sept. 21	6 a. m.	Calm.	0	54	....do	Do.
	Noon	SW.	1	60	....do	Do.
	6 p. m.	S.	3	59	Overcast	Halibut Bay, Portland Canal.
Sept. 22	6 a. m.	SE.	3	57	Squally	Do.
	Noon	S.	4	58	....do	Do.
	6 p. m.	SW.	5	56	....do	Do.
Sept. 23	6 a. m.	SW.	3	51	Cloudy	Do.
	Noon	W.	2	58	Fine	Do.
	6 p. m.	NW.	1	52	....do	Do.
Sept. 24	6 a. m.	NW.	3	51	....do	Do.
	Noon	NW.	4	58	....do	Do.
	6 p. m.	NW.	1	57	....do	Do.
Sept. 25	6 a. m.	NW.	1	50	....do	Do.
	Noon	S.	2	56	....do	Do.
	6 p. m.	W.	1	51	....do	Do.
Sept. 26	6 a. m.	NW.	2	46	....do	Do.
	Noon	Calm.	0	59	....do	Do.
	6 p. m.	SW.	4	51	....do	"Manzanita Cove," Portland Canal.
Sept. 27	6 a. m.	S.	4	48	Rain	Do.
	Noon	SW.	4	54	....do	Do.
	6 p. m.	S.	5	52	....do	Do.
Sept. 28	6 a. m.	SE.	6	58	....do	Do.
	Noon	S.	4	54	Cloudy	Start Point, Portland Canal.
	6 p. m.	S.	1	53	Rain	"Manzanita Cove," Portland Canal.
Sept. 29	6 a. m.	SE.	3	49	....do	Do.
	Noon	SE.	4	52	....do	Mary Island.
	6 p. m.	SE.	4	50	....do	Chalmers Harbor, British Columbia.

NOTE.—In explanation of the preceding table it should be stated that the temperatures were obtained from a thermometer hung in a position where it was somewhat sheltered by the upper deck of the vessel, which lay at anchor during most of the time in water varying in temperature from 41° to 54° F., consequently the diurnal variations are less than on the adjacent shores.

Mean temperature of the air and approximate direction of the wind, Port Simpson, British Columbia, near mouth of Portland Canal.

[Extract from Pacific Coast Pilot, 1869.]

Month.	Temperature.	Prevailing direction of wind.
	° F.	
January	29.8	North.
February	35.2	Do.
March	28.1	Do.
November	45.9	Southeast.
December	31.8	North.

APPENDIX U U.

SUPERVISION OF THE HARBOR OF NEW YORK.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1897—SUPERVISORS, LIEUT. COMMANDER DANIEL DELEHANTY AND LIEUT. JOHN F. PARKER, UNITED STATES NAVY.

WAR DEPARTMENT,
OFFICE OF THE SUPERVISOR OF THE
HARBOR OF NEW YORK,
New York, July 19, 1897.

GENERAL: I have the honor to submit the following report of the operations of this office for the fiscal year ending June 30, 1897, also an estimate of amount required for the fiscal year ending June 30, 1899.

As I did not assume charge until April 5, 1897, I can only submit a report of the operations of the office as shown by the records thereof and personal observation since that date.

The steam tugs *Scout* and *Daniel S. Lamont* are in excellent condition. The steam tugs *Nimrod* and *Argus* are in fair condition; both, however, need a general overhauling to make them effective and preserve them for future service.

These steam tugs are employed in patrolling the bay and harbor day and night; one on patrol duty outside the Narrows, not only to prevent the illegal deposit of refuse and to insure the deposit of material outside the harbor at the proper point of deposit as designated on the permits, but to prevent the deposit of stone or other ballast from incoming vessels; another stationed inside the Narrows to collect the permits, note the condition of the scows passing in an out, and follow tows with scows returning loaded or partially loaded, which, owing to defective machinery or refractory material, fail to fully discharge their loads at the designated point of deposit, and to see that the doors of such dumpers are wound up as far as practicable, thus insuring the return of the material to the point where it was dredged. Considerable difficulty was at first experienced in enforcing this order, every advantage being taken of adventitious circumstances by the masters of tows to get the scows clear before reaching the dredge. However, under the method of patrol and the system of checking loaded and light scows now in operation it is almost impossible for this material to be illegally deposited without detection.

The inside tug also performs the duty of keeping the main channels clear of small fishing craft and reporting any violations of the act of Congress dated August 17, 1894.

Of the other two steam tugs, while one is off duty the other is utilized in making special inspections within the harbor, in Long Island Sound, or in the Hudson River.

The steam launches *Active* and *Alert* require extensive repairs, and much patching will be required to keep them serviceable during this summer. I doubt if their present condition would warrant an expenditure sufficient to put them in permanent efficient condition. They are, however, exceedingly useful in many ways, especially so in detecting and preventing violations of the law by the deposit of refuse and waste material of all kinds from the piers and wharves along the water front, being employed during the daytime and at night when deemed advisable. They make daily reports as to the condition of the scows at dumping boards. It would be desirable to use these boats continuously on patrol duty, and it would therefore be of great advantage if they could be replaced by others large enough to quarter the crews on board.

Arrests have been made during the past year by the deputy inspectors on these launches of persons violating the law in their presence by throwing refuse from the piers into the tidal waters of the harbor, the guilty parties being turned over to the United States district attorney for the southern district of New York for his action and placed under bail to await the action of the courts. These arrests have had a salutary effect.

The small naphtha launch is stationed in the Kills to watch the waters around Staten Island, the entrance to Newark Bay, and the Passaic and Raritan rivers.

From observation I am satisfied that many of the injurious deposits which find their way to the channels of the harbor are due to the deposit of refuse material from shore, and the necessity of preventing the promiscuous throwing of waste material into the North and East rivers being so apparent, special efforts are being made by this office to prevent the defilement of the harbor from this source. Upon investigation in this direction I found that the authorities of Blackwells and Wards islands, inhabited principally by occupants of city hospitals, prisons, poorhouses, and lunatic asylums, with their staffs of surgeons, nurses, and employees, were in the habit of depositing their refuse in holes on the islands, where it was washed out into the East River by the action of the tides. Wells with sluice gates had been built for the reception of this refuse, the gates being raised at high tide to permit the waste to escape into the river, implements being at hand to facilitate the discharge of the material when the tide was not strong enough to carry it off. The departments having charge of these islands were immediately advised that this method of disposing of refuse was in violation of law, and arrangements are now completed for the disposition of this material, aggregating some 13 tons daily, by sanitary methods.

The question of disposition of ashes from the vast number of steam vessels plying this harbor and tributary waters is a most important one. They consume daily many tons of coal, yielding thousands of cubic yards of ashes, which if deposited in the tidal waters of the harbor would in a very short time injure the channels; that a large quantity of these ashes is still illicitly deposited in the waters of the harbor I have no doubt, and I shall continue to direct every effort of this office to correct the evil.

Through the efforts of my predecessor the following sections were introduced in the Greater New York charter:

CERTAIN SUBSTANCES NOT TO BE DUMPED IN PORT OF NEW YORK.

SECTION 880. The placing, discharging, or depositing, by any process or in any manner, of refuse, dirt, ashes, cinders, mud, sand, dredgings, sludge acid, or any other refuse matter, floatable or otherwise, in the tidal waters of the port of New York as defined by this act, except under permit of the United States supervisor of the harbor, is hereby strictly forbidden, and every person violating the foregoing provisions shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine of not more than two hundred and fifty dollars nor less than five dollars, or imprisonment for not more than six months nor less than ten days, one-half of said fine to be paid to the person or persons giving information which shall lead to the conviction of such misdemeanor.

SCOWS TO RECEIVE ASHES, ETC., FROM STEAM TUGS AND VESSELS.

SECTION 881. The various scows employed by the city of New York, or by the contractors for removing ashes, garbage, and refuse of said city, while moored at the various dumping boards of said city are hereby designated and required to receive directly any and all ashes or rubbish from any steam tug or steam vessel in the harbor, and in addition to the foregoing provisions two or more scows shall be located at such points within the harbor as the supervisor of the harbor may direct for the special use of boats and vessels wishing to discharge ashes or rubbish.

It is hoped that section 880 will promote the work of the office by insuring prompt trial of minor offenders when the Federal court is congested, and the added facilities provided by section 881 will much lessen the temptation for small craft to dispose of their refuse material illegally.

Much of my time since assuming charge has been directed to enforce the law in relation to the contracts for work now going on under the department of docks of this city. I refer to the extension of the pierhead lines as approved by the Secretary of War, to extend the piers 100 feet into the North River. The present plan of the dock department contemplates the removal and rebuilding of about 2½ miles of crib work along the water front. The contract for the first section of this work went into effect about April 5, the contractors being required to dispose of the dredged material, which consisted of foundation spiles, crib logs, and other dredging spoils, in accordance with law. The regulations of this office positively forbid the deposit of spiles or logs of any kind in any of the tidal waters of the harbor, and the contractors experience much difficulty in disposing of them, permitting them to get adrift from the work to become a serious menace to navigation, or attempting to dump them at sea from mud dumpers in direct violation of the permits granted by this office for the deposit of material at sea. Some idea may be had of the vast amount of worthless timber to be disposed of when it is estimated that the contracts for the first section now under operation involve the removal of about 81,000 cubic yards of crib work, 20 per cent of which is worthless timbers and about two thousand foundation spiles. It has required the utmost vigilance to insure a strict compliance with the law in relation to the deposit of this material.

The reduction plant erected on Barren Island for the final disposition of the city's garbage commenced operations in November last, the garbage of both Brooklyn and New York cities being now successfully disposed of by this method, amounting to upward of 59,930 cubic yards since the commencement of operations. Permits are issued in accordance with law for its transportation over the waters of the harbor, an average distance of 25 miles, but strict supervision has to be exercised by the patrol boats on duty to prevent loss of material in transit, due to improper trimming or careless handling.

The result is a very marked improvement in the condition of the lower bay, and the reports of the shore inspectors of the Brooklyn board of health show a decided improvement in the condition of the beaches.

The remainder of the city's waste, consisting of street sweepings, ashes, etc., is at present deposited outside Sandy Hook light-ship. I am assured, however, that the city will within a few weeks dispose of this material by placing it behind bulkheads on Riker Island, and this, in my judgment, is the only proper method.

The deposit of what is technically known as "cellar dirt," being débris from city improvements and private contracts, also takes place outside Sandy Hook light-ship, which is deemed as far from the coast as the character and type of boats used for the transportation of this material can venture with safety.

This, although entirely objectionable, is the only disposition which can be made of this material until the deposit of material of any kind in the tidal waters of this harbor is absolutely prohibited by law. Cellar dirt, ashes, and other inoffensive refuse will then be utilized for filling in bulkheads and reclaiming land.

It will be readily seen from the foregoing that a constant and vigilant patrol of the bay and harbor by the boats of this office is imperative to protect the channels from probable violations of the law involved in the movement of the enormous amount of refuse of all kinds, averaging yearly about 10,000,000 cubic yards. The effect of this supervision is shown by the marked abatement of illicit deposits.

There has been moved and deposited into the waters outside the harbor at properly designated places and behind bulkheads in the neighborhood of New York during the fiscal year ending June 30, 1897, the amount of 9,932,644 cubic yards of material, mud, city refuse, garbage, cellar dirt, ashes, lime, and other material, as per the following recapitulation:

Place of deposit.	Kind of material.	Amount.
		Cubic yds.
Mud buoy	Mud, etc	5,394,332
One-half mile southeast mud buoy.	City refuge, etc	1,114,925
Sandy Hook light-ship	do	1,510,749
Scotland light-ship	Mud, etc	117,135
Long Island Sound	do	602,441
East River	Stone, etc., in deep hole	33,148
Do	Dirt, ashes, etc., behind bulkheads and on shore for filling	812,905
North River	do	220,241
New York Bay	do	141,242
Harlem River	do	85,705
Passaic River	do	11,200
Hackensack River	do	300
Shrewsbury River	do	1,254
Raritan River	do	84,550
Jamaica Bay	do	8,396
Flushing Bay	do	3,450
Shoal Harbor, N. J	do	7,500
Staten Island Sound	do	172,120
Barren Island	Garbage on shore for reduction	59,930
Do	Dead animals, etc., on shore in store	51,130
Total		9,932,644

Permits issued, 10,408.

From the foregoing statement it will be seen that 8,137,132 cubic yards of mud, city refuse, cellar dirt, etc., was deposited near the mouth of the harbor; 1,048,863 cubic yards of cellar dirt, ashes, and other inoffensive material, was used for filling in behind bulkheads, reclaiming land, etc., and 111,060 cubic yards of garbage, dead animals, offal, etc., was deposited on Barren Island for reduction.

The following is a statement of the appropriation for "prevention of deposits, New York Harbor, 1897."

For pay of crews and maintenance of 4 steam tugs and 3 launches		$48,740.00	
Expended to June 30, 1897	$44,930.94		
Outstanding liabilities	3,622.02		
		48,552.96	
			$187.04
For pay of inspectors, deputy inspectors, office force, and expenses of office		10,260.00	
Expended to June 30 1897	$9,449.70		
Transferred to "expenses of buoyage, 1897"	52.60		
Outstanding liabilities	112.64		
		9,614.94	
			645.06
Balance			832.10

The following is an estimate of appropriations required for service of the fiscal year ending June 30, 1899, by the supervisor of the harbor of New York:

Detailed object of expenditure, and explanations.	Estimated amount that will be required for each object.	Amount appropriated for fiscal year ending June 30, 1898.
Prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City:		
For pay of inspectors, deputy inspectors, office force, and expenses of office	$10,260	$10,260
For pay of crews and maintenance of 4 steam tugs and 3 launches	48,740	48,740
Total	59,000	59,000

Very respectfully, your obedient servant,

JNO. F. PARKER,
Lieutenant, United States Navy, Supervisor.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

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