

In order to determine this difference a second tide-gauge was set up at Bridge street. From simultaneous observations made at the two gauges I found that while there is a mean rise and fall of tides at the mouth of the river of 4.7 feet the variation is but 3.4 feet at Bridge street. On account of the limited amount available for the survey no line of levels was run between the two gauges. The levels of the city survey of Elizabeth, however, as well as observation of the current at the time of high-water, which happens at about the same time at both gauges, when little or no current is perceptible, seem to indicate that at the time of high-water the river-surface is nearly horizontal, while the elevation of low-water at the upper gauge depends more upon the quantity of fresh water coming down the river than upon the elevation of low-water at the lower gauge, and is on an average 1.3 feet higher than at the latter place. A verification of these observations is found in the fact of the long duration of low-water stand at the upper gauge, no rise of tide taking place until the tide at the lower gauge has risen to about 1.3 feet above mean low-water, when the tide continues to rise nearly uniformly at both gauges until high-water. An inspection of the map shows the cause of this phenomenon to be due to a gradual rise of the river bottom as we go up stream. In the vicinity of the gas-works the river-bed rises to about the level of low-water at the lower gauge, and continues to rise until in the reach above the last drawbridge it is 2.5 feet above this plane.

It is stated by old residents of Elizabeth that 20 years ago market-vessels, drawing from 5 to 6 feet of water, had no difficulty in coming up the river as far as Broad street at the time of high-water, which would indicate a shoaling up in the upper part of the stream since that time of from 2 to 3 feet.

The probable causes of this shoaling are to be found in a number of circumstances. About 1 mile above Broad street bridge a dam has been thrown across the river by the Elizabeth Water Company, where, according to the statement of Mr. Battin, the superintendent of the works, about 2,000,000 gallons of water are diverted from the stream per day. He further states that on an average about 6,000,000 gallons per day fall over the dam. According to this statement the fresh-water discharge of the river has been reduced by about one-fourth by the construction of the dam. This reduction must make itself felt in a diminution of the strength of the ebb-current, and a corresponding increase of the flood-current, the resultant action being a decreased ability of the ebb-current to carry the detritus brought down from the upper parts of the river to the deep waters of Staten Island Sound, and a consequent shoaling up of the river.

Another cause is to be found in the discharge of the sewage matter of a large portion of the city of Elizabeth into the river, there being 4 main sewers emptying into it at different points of its course. These sewers bring down solid matter of all kinds, especially during heavy rain-falls, which the currents of the river are not strong enough to carry out. In addition to this, as these sewers all strike the course of the river nearly at right angles, their discharge interferes with the currents of the river, thereby causing the formation of shoals.

The building up of the city along the course of the stream, and the grading of new streets, has also resulted in carrying solid matter of all kinds, organic and mineral, into the stream. The refuse matter of the gas-works discharged into the stream likewise has a detrimental action upon it. The coal-tar adhering to the banks and river bottom holds any solid matter brought into contact with it, forming a viscous mass which the currents will not cut, thus probably forming the nucleus of new shoals.

As these causes will continue to act in the future as heretofore, it is probable that deepening the channel by means of dredging will afford only temporary relief, and that the improvement will not be of a permanent character, but that the dredging will have to be repeated from time to time. Still no other mode of improvement seems practicable. To increase the current of the river would necessitate the construction of a large tidal basin above Broad street, which would be a very expensive undertaking, as this part of the river passes through valuable improved lands, and the river banks rise very rapidly, making heavy excavation necessary. A resort to slackwater navigation by the construction of a lock at the mouth of the river would likewise meet with serious objections, as it would prevent a free discharge of the sewers emptying into the river. The water stagnating would produce malaria and pestilence. Aside from these sanitary considerations it is probable that the river would shoal up so rapidly that in a few years dredging would become necessary under any circumstances. The only practicable plan of improvement then appears to be the deepening of the present channel by dredging. All that seems to be required by the present interests of navigation is to deepen the channel to a uniform depth of about 7 feet at mean high-water, beginning at a point at which the depth becomes less than this and continuing the excavation up-stream as far as Broad street. To dredge a channel 60 feet wide and 7 feet deep at mean high-water would require the removal of 44,400 cubic yards of sand, gravel, mud, and small stones. As it will be difficult to find a suitable place to deposit the dredged material without handling it at least twice, and as the shoal water in the river will make it possible to work only from half-tide to

half-tide, the cost of dredging will be high, not less than 50 cents per cubic yard, which would make the cost of dredging \$22,200. Add 15 per cent. for contingencies and engineering, and we have for total cost of obtaining 7 feet at high-water \$25,530. To produce a channel of a uniform depth of 8 feet at mean high-water and 60 feet wide would require the removal of an additional amount of 20,000 cubic yards, making a total of 64,400 cubic yards, which, at 45 cents per cubic yard, would amount to \$28,980. Add 15 per cent. for contingencies and engineering, and we have for total cost of improvement, obtaining 8 feet at mean high-water, \$33,327.

I am, very respectfully, your obedient servant,

A. DOERFLINGER,  
Assistant Engineer.

Col. J. N. MACOMB,  
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

ELIZABETH, N. J., January 4, 1879.

DEAR SIR: It is a difficult matter to get at the exact tonnage of the Elizabeth River for the past year, but I have been able to obtain the following, which I believe to be accurate:

Messrs. Thompson, lumber, coal, lime, cement, 3,500; Mulford & Sons, ditto, 3,000; John Curtis, stone, sand, and brick, 2,500; Heidrieter & Sons, coal and wood, 7,000; Irwin & Spencer, coal, 6,000; Elizabeth Gas Company, coal, 3,300; Lindner, lime and shells, 1,500; Hatfield, merchandise, 2,000; Union County Manufacturing Company, timber, 3,000; miscellaneous, 5,000; total, 36,800.

A great deal of building material and general merchandise, in addition to the above, has been assigned to parties throughout the city that I have been unable to reach; but a fair estimate of this tonnage would probably run the total up to 45,000.

I have ascertained further that the total tonnage in 1870, in coal, lumber, building material, clay, pottery, ice, stone, wood, and street contractors' materials, oil-cloth, oils, paints, and general merchandise, &c., amounted to 125,000 tons.

Coal and lumber dealers along the line or adjacent to the river say that they are compelled to unload vessels at the mouth of the river and lighter up to their docks, as there is but 3 and 4 feet of water at high-tide now, where a few years ago there was 6 and 7 feet.

Potteries and other manufactories, including extensive oil-cloth works, have been obliged to suspend operations entirely, owing to the lack of navigation in the river.

I have endeavored to ascertain the value of the tonnage, but find it would take more time than I have at my disposal.

Yours, truly,

H. F. J. DRAKE.

Hon. MILES ROSS.

E 24.

SURVEY OF RAHWAY RIVER, NEW JERSEY.

UNITED STATES ENGINEER OFFICE,  
Philadelphia, Pa., December 27, 1878.

GENERAL: I have the honor herewith to forward, with my approval, report and tracing of the survey of Rahway River, New Jersey, made under my direction by Mr. A. Doerflinger, assistant engineer.

The proposed method of effecting the desired improvement is that which appears the most feasible and economical and promises the best result.

The amount of business to be facilitated by the proposed improvement is very large, as is shown by the commercial exhibit appended to the report.

Very respectfully, your obedient servant,

J. N. MACOMB,  
Colonel of Engineers.

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



REPORT OF MR. A. DOERFLINGER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,  
Philadelphia, Pa., December 18, 1878.

COLONEL: I have the honor to make the following report upon the survey of Rahway River, New Jersey:

The survey embraced the course of the river from its entrance into Staten Island Sound to the head of navigation at Main street in the city of Rahway, a distance of 5 miles. Its course is generally through low marsh and meadow lands, the average level of which is about that of mean high-water. Rahway, at the head of navigation of the river, is a thriving city of about 15,000 inhabitants, where many manufacturing and other interests more or less dependent on water transportation are centered.

The field-work of the survey was executed between the 10th and 25th of September, 1878. A triangulation was extended over the area embraced by the survey, and the soundings and points of the shore-lines were located by means of two transits stationed on the trigonometrical points. Mean high and low water were established at the Long Branch Railroad bridge, by means of simultaneous tidal observations made at the latter place, and on the gauge at the entrance to Elizabeth River. From these observations the mean rise and fall of tide at the railroad bridge, Rahway River, was found to be 5.3 feet. A second gauge was set up at Milton avenue draw-bridge, 3 miles farther up stream, and observed simultaneously with the gauge at the railroad bridge. These observations developed the fact that while the rise and fall of tide at the latter place is 5.3 feet, it is but 4 feet at Milton avenue bridge. On account of the limited amount available for the purposes of the survey, no line of levels was run between the two gauges. It appears, however, from the fact that high-water happens at nearly the same time at the two gauges, and that little or no current is then perceptible, that the elevation of high-water at the two points is about the same, while low-water at the upper gauge is 1.3 feet higher than at the lower gauge. Further evidence in support of this indication is found in the fact that low-water at the upper gauge seems to depend more upon the fresh-water stage of the river than upon the elevation of low-water at the lower gauge, there being little difference in low-water at the upper gauge, no matter how much low-water may fluctuate at the lower gauge, and no rise of tide at the upper gauge until the tide has risen about 1.3 feet above mean low-water at the lower gauge.

The tidal relations between the upper and lower part of the stream appear to be much the same as those between the upper and lower parts of the Elizabeth River, and the cause is to be found in the same circumstance, viz, a gradual rise in the river bottom from the mouth upward. This rise in the river-bed is especially marked in the section of the river between Bricktown and the head of navigation. Little difficulty is said to be experienced by the vessels navigating the river to reach the former point at an ordinary high-water; but to reach the docks above Milton avenue bridge, the general point of discharge of most of the vessels, they are often obliged to wait several days for a tide high enough to carry them up, or else to transfer part of their cargo to flat-boats, and thus lighten sufficiently to proceed farther. Freights and the expenses of vessels are enhanced by the delays incident to this restricted depth of water, and as a necessary consequence much freight comes by rail at the increased rates due to such a mode of transportation. To obviate this state of affairs the shipping and industrial interests of Rahway desire the deepening of the channel from Bricktown to the head of navigation. The most practicable means of attaining this end will be dredging. To excavate a channel 8 feet deep at mean high-water and 125 feet wide from Bricktown to Milton avenue bridge, and 100 feet wide from this point up to Main street bridge, would require the removal of 65,642 cubic yards of sand, gravel, mud, and stone. Above Milton avenue bridge the river bottom is quite hard, the material being tightly packed. Some bowlders also occur, varying from 1 to 4 feet in length, and projecting from 1 to 2 feet above the bottom; none of these bowlders, however, seem to be too large to be taken out by an ordinary dredge. The dredging can probably not be done for less than 50 cents per cubic yard, which would give for cost of dredging 65,642 cubic yards, at 50 cents per cubic yard, \$32,821. In addition to this there are two large bowlders, one in the channel about 70 feet from the bulkhead at Bricktown, the other in the channel about 650 feet above the Long Branch Railroad bridge, the soundings on which are shown in red on the map. These bowlders form dangerous obstructions, as they lie directly in the channel and have good water about them. They could be easily broken up by a few surface-blasts and the broken stone taken up by a dredge. The cost of removal would not exceed \$200 for the one at Bricktown, and \$300 for the

one above the railroad bridge, which is the larger of the two. The total estimated cost to obtain 8 feet at mean high-water would therefore be—

For dredging .....	\$32,821 00
Removing bowlders from channel .....	500 00
	<hr/>
	33,321 00
Contingencies and engineering, 10 per cent. of the above.....	3,332 00
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Total estimated cost of improvement .....	36,653 00

The subjoined statement, kindly furnished by Mr. William Chamberlain, of Rahway, shows the amount of commerce, &c., that will be benefited by the contemplated improvements.

I am, very respectfully, your obedient servant,

A. DOERFLINGER,  
Assistant Engineer.

Col. J. N. MACOMB,  
Corps of Engineers, U. S. A.

Rahway River commerce.

Names.		Tons.	Value.
Coe & Co.....	Poudrette.....	6,000	\$100,000
H. Cutter.....	Coal and lime-kiln.....	5,000	25,000
Charles Steele.....	Clay.....	4,000	12,000
Brokaw & Co.....	Shippers of timber, &c.....	10,000	100,000
Citizens of Rahway.....	Public dock.....	10,000	100,000
E. Pierson.....	Coal, &c.....	4,000	20,000
Edgar Dock.....	Everything.....	5,000	25,000
M. Frieze.....	Coal and stone.....	3,000	15,000
Bricktown Dock.....	Everything.....	25,000	300,000
E. T. Tappan.....	Coal and stone.....	3,000	15,000
R. Tice.....	Coal, &c.....	2,500	10,000
H. Spier, dock.....	do.....	1,000	5,000
M. Brewster.....	Coal, lumber, &c.....	10,000	50,000
William Chamberlain.....	Coal, brick, &c.....	10,000	50,000
Samuel Ayres.....	Coal.....	1,000	5,000
George W. Hall.....	Coal, &c.....	2,000	10,000
Ayres & Lufley.....	Lumber and timber.....	10,000	100,000
Rahway Gas Company.....	Gas coal.....	9,000	45,000
Total.....		120,500	987,000

RAHWAY, October 17, 1878.

We would increase considerably in commerce if we had the depth of water; a steamboat would run to New York. Three parties have run a steamboat, but had to haul her off as the delay was so long by getting aground. Parties will put a steamboat on as soon as the river is deepened.

Respectfully,

WM. CHAMBERLAIN.

E 25.

SURVEY OF DELAWARE RIVER BELOW LEAGUE ISLAND.

The act of June 18, 1878, having directed a "survey of the Delaware River below League Island" without establishing a lower limit, alternative estimates were submitted July 19, 1878, as follows:

- 1st. For a survey to the capes, \$12,000 to \$15,000.
- 2d. For a survey to the head of the bay, assumed at Reedy Island, \$6,000 to \$7,000.
- 3d. For a survey only of such points as were known to require improvement, \$2,300.

The amount that could be ultimately allotted for this survey made it impossible to do more than cover those portions of the river below



League Island that were known to be in most pressing need of examination.

These were:

- 1st. From League Island to Marcus Hook, including Mifflin Bar, Chester Island, Marcus Hook Bar, and Schooner Ledge.
- 2d. The Cherry Island Flats.
- 3d. The vicinity of Reedy Island Ice Harbor.
- 4th. The Dan Baker Shoals below Reedy Island.
- 5th. The wreck of the Addie Walton above Cross Ledge Light.

A survey of the Cherry Island Flats by Mr. Junken of the Coast Survey in August and September, 1878, for and at the expense of the Light-House Establishment, abbreviated our work to that extent.

Special examinations were made of Schooner Ledge and the Addie Walton, and reports submitted which are hereunto appended for incorporation.

Local surveys were also made of Mifflin Bar and Bulkhead Shoals in connection with the improvement of these localities.

The city of Philadelphia has had in progress, under charge of the Coast Survey, a survey of the river from Bridesburg to League Island, about 13½ miles. It is understood that this survey is completed, although the charts are not yet available.

A survey to connect this with the light-house survey from Old Man's Point to Deep Water Point, 9½ miles, was desirable, the existing charts dating from 1843.

A base-line of 2 miles was therefore measured on the New Jersey shore below Marcus Hook and the triangulation carried up to include the Schuylkill Ranges and the Red Bank Hotel, a distance of about 15 miles.

The shore topography and the hydrography followed the angulation. This work was done in April and May, 1879, and has been plotted on one sheet on a scale of  $\frac{1}{100000}$ .

The three surveys (when that of the city shall have been obtained) will together cover the river from Bridesburg to below Deep Water Point, a distance of 38 miles, and constitute a chart invaluable to the commerce of the river and indispensable to its future improvement.

During the ensuing year it is proposed, with the approval of the department, to complete the work already projected, viz: The surveys at Reedy Island Harbor and Dan Baker Shoals, and, if possible, to connect these with the lower limit of the light-house survey at Deep Water Point.

This would have the effect of charting an additional 20 miles of river covering Bulkhead and Dan Baker Shoals and the Reedy Island Ice Harbor.

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## APPENDIX F.

### ANNUAL REPORT OF MAJOR WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS, FOR THE FISCAL YEAR END- ING JUNE 30, 1879.

UNITED STATES ENGINEER OFFICE,  
*Baltimore, Md., July 12, 1879.*

GENERAL: I have the honor to forward herewith the annual report for the year ending June 30, 1879, for works of improvement of rivers and harbors, and of surveys which have been in my charge.

Efforts have been made to procure full statistics as to the commerce of each improvement, as required by instructions from the Chief of Engineers and in compliance with law. These efforts have not been entirely successful.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,

*Major of Engineers, Bvt. Lieut. Col., U. S. A.*

Brig. Gen. H. G. WRIGHT,

*Chief of Engineers, U. S. A.*

#### F 1.

##### IMPROVEMENT OF SUSQUEHANNA RIVER, NEAR HAVRE DE GRACE, MARY- LAND.

At the request of Prof. S. F. Baird, made to the Secretary of War, May 23, 1879, some dredging was done in the latter part of May and the early part of June, near Spesutic Island, to aid the movement of boats engaged in the business of the United States Commission of Fish and Fisheries. The funds for the work, \$500, were derived from the general appropriation for examinations and surveys and contingencies of rivers and harbors for which no specific appropriation had been made. The assistant commissioner states that more work is necessary. It is recommended that a specific appropriation of \$5,000 be made for this purpose.

##### *Money statement.*

July 1, 1879, amount expended during fiscal year.....	\$500 00
Amount (estimated) required for completion of existing project .....	5,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881..	5,000 00

#### F 2.

##### IMPROVEMENT OF HARBOR OF QUEENSTOWN, MARYLAND.

Queenstown is situated in Queen Anne's County, on Queenstown Creek, a tributary of the Chester River, about 10 miles from the mouth of the latter. It is almost directly opposite to Baltimore across Chesapeake Bay, being about 36 miles distant from that city.