CONCLUSIONS.

In conclusion, it seems appropriate that I should state that the topography was executed by Mr. R. B. Talfor, and that Mr. W. H. Hoffman and Mr. J. O'Connell were employed principally on the level-lines, the greater part of which was executed by them In addition to these special duties to which each assistant was assigned, all assisted in the hydrographic work, base-line measurements, &c., where more than one observer was required.

Very respectfully, your obedient servant,

H. C. RIPLEY,
Assistant Engineer.

Capt. C. E. L. B. DAVIS,
Corps of Engineers, U. S. A.

The act of Congress under which the above-reported survey was made also provides for a survey of "the bar at the mouth of the Brazos River, Texas, including a report as to the capacity of the harbor at the mouth of the Brazos, and its adaptability as a harbor of refuge and naval station." This is evidently explanatory of the act directing survey of the river and bar, so I assumed that the report called for may properly be made in continuation of the report of survey and not as a separate report.

In previous reports I have urged the importance of improvement of harbors along the coast of Texas, both on the ground of commercial importance and on the ground of importance of providing harbors of refuge at intervals along this very dangerous coast.

According to the best information I have obtained there are many coasting vessels and many lives lost each year along the Texas coast, and in many cases, perhaps, because the coast does not afford a harbor safe to enter during continuance of a severe onshore storm.

The Brazos River appears well situated to form one of a chain of harbors that may be made safe of entrance at all times.

I have described its bar and have given plans and estimates for its improvement in previous reports, to which I beg leave to refer. (Report of the Chief of Engineers for 1875, Appendix S 8, pp. 929–941)

The work recommended in these reports, or work of the same general plan, will make the Brazos River a good harbor of refuge for coasting vessels caught by storms and within reaching distance of it. It will also probably answer for the present or immediate future the commercial prospects of the place.

For a naval station more elaborate and expensive works must be undertaken. In addition to securing a sufficiently deep water channel across the Gulf bar, it will be necessary to deepen the river-bed by dredging as far upstream as the point where it may be decided to locate the necessary basins and docks. The harbor proper, that is to say, the lowest portion of the river in which vessels might find security during storms, begins at a distance of 5,000 feet from the first depth of 12 feet inside the bar. This harbor is 3,000 feet long and has an average width, for 12 feet in depth, of about 300 feet, the maximum width being 350 and the minimum 280. The depth is generally from 12 to 24 feet, the slope from the 12-foot curve being very abrupt for the deeper portions. The bottom is of clay, and the banks, which are of a material not subject to rapid abrasion, are at a distance apart of about 560 feet.

Above this, so far as our survey extended, the river maintains a quite unform width and a 12 foot channel, with depths of 20 feet or more in the bends.

The harbor capacity indicated above may be indefinitely increased by deepening and widening the river-bed by means of dredging and by excavating in the almost level prairie on either side large basins.

The material excavated from the river-bed and from the basins can be used in building up the adjacent lands above the level of storm-tides, and I think it would not be necessary to shut off connection between the river and basins by locks or tide-gates.

It is my opinion that enterprise and capital could in a very few years make this one of the most thriving ports on the coast of Texas, and if a naval station should be required on this coast, this is the best place to establish it.

In reports to which I have referred I have submitted estimates for improvement of the Gulf bar at the mouth of the Brazos, the total being $286,484.

I now present the following estimates for widening and deepening the channel of the river inside the bar for specified widths, depths, and distances:

	Width of channel.	Depth of channel, mean low tide.	Length from inside of bar.	Number of cubic yards to be excavated.	Excavation and placing on bank.	
					Estimated cost per cubic yard.	Total cost.
	Feet.	*Feet.*	*Feet.*			
1	300	12	8,000	48,210	$0 25	$12,052 50
2	300	18	12,000	616,592	.....	154,148 00
3	500	12	12,000	724,130	.....	181,032 50
4	500	18	12,000	1,692,402	.....	423,100 50
5	500	24	8,000	1,986,126	.....	496,531 50
6	500	24	12,000	2,948,052	.....	737,013 00
7	500	30	8,000	2,875,351	.....	718,837 75
8	500	30	12,000	4,248,388	.....	1,062,097 00
9	500	18	20,000	2,782,290	.....	695,572 50
10	500	24	20,000	4,871,089	.....	1,217,772 25
11	500	30	20,000	7,050,303	.....	1,762,575 75

The following estimate for a basin 1,000 by 500 by 30 feet on the plateau, which lies to the westward of that portion of the river for which improvement has been estimated, is submitted:

The average height of the plateau above mean low-tide is about 4 feet, and all the work of excavtion can be done by dredgeboats.

$1{,}000' \times 500' \times 34' = 17{,}000{,}000$ cubic feet $= 629{,}629$ cubic yards, at 25 cents per cubic yard $= \$157{,}407$.

The material excavated from this basin will raise to a height of 10 feet above mean low-tide an area surrounding the basin of over 2,500,000 square feet, thus placing this area above overflow and forming a safe embankment for protection of the basin and ample room for buildings. Smaller embankments in the immediate neighborhood, viz, one of the material excavated from the Brazos canal, and one a redoubt thrown up during the late war, successfully resisted the great storm of 1875.

The work is located in the collection-district of Galveston, and the nearest lighthouse is at entrance to Galveston Harbor.

The work is considered susceptible of permanent completion in one sense of the word, viz: It is thought that at times after completion it will be necessary to dredge some portion of the river-bed, and also necessary to make additions to the jetties projected for improvement of the outer bar. At present we have no data from which to base estimates for cost of such work, for its extent, or for times at which it may be

required. Data can only be obtained during a considerable period of actual test. Should the work of improvement suggested, or any part thereof, be undertaken by the United States, the act of Congress providing for it will possibly be explicit enough, as to extent of work designed, to enable the engineer to estimate for amounts required each year for carrying on the work to advantage.

K 14.

SURVEY OF TANGIPAHOA RIVER, LOUISIANA.

A preliminary report on this survey was forwarded to the Chief of Engineers February 12, 1879, as follows:

PRELIMINARY REPORT.

UNITED STATES ENGINEER OFFICE,
New Orleans, February 12, 1879.

GENERAL: I have the honor to submit the following preliminary report on a survey of the Tangipahoa River, as provided for by act of Congress approved June 18, 1878.

The survey was commenced on the 27th of January last, at the town of Amite, in the State of Louisiana, and concluded on the 7th of February, at the mouth of the river.

The stream was meandered with transit and stadia, and obstructions to navigation located, where of special importance, by use of the same instruments. Other obstructions were approximately located, and the character of all was ascertained.

The length of that portion of the stream surveyed is 53½ miles.

Throughout the upper portion covered by the survey the stream flows through a heavily-timbered bottom-land, averaging about 2 miles in width, and bordered by what is known as "piney-woods lands," which is above overflow.

The lower 10 miles of the stream runs through the swamp bordering Lake Ponchartrain, also heavily timbered.

The bed of the stream is composed of sand and gravel, and the bars which obstruct low-water navigation are formed of this material. As the survey was made at a quite low stage of the river, it was possible to examine these bars well, and it was found that most of them were due to sunken logs and snags that had formed a nucleus for the bars. It is thought that removal of these logs, &c., will cause the bars to disappear.

There are 1,856 snags and fallen trees in this section of the river which serve to obstruct navigation; also 660 overhanging trees and 1 bridge, which it would be necessary to convert into a draw-bridge to accommodate steam or sail navigation. There is one island chute that it would be desirable to have closed.

The stream averages about 100 feet in width, and it is thought can be given a least depth (low-water) of about 3½ feet, which would be sufficient for all purposes and as much as can be carried across the bar at its mouth. It is estimated that to effect this improvement would cost about $200 per mile, or a total of $10,700.

The trade to be benefited is very considerable. The timber along the valley of the stream is very valuable, and, even in the present obstructed condition of the stream, quantities of it are rafted to the New

Orleans market. Lumber, cotton, poultry, vegetables, and fruits form important items of production along the stream, and its opening to navigation would greatly cheapen the cost of getting these to market.

In 1871, by order of Congress, and under direction of the War Department, there was made a survey of the lower portion of this stream (see Report of the Chief of Engineers for 1871, Appendix N 10), which resulted in appropriation and in contract for improvement.

This improvement is said to have been of great benefit (comparatively), but since, other obstructions have been brought down into this portion of the river in the shape of snags and cypress logs. The cost of the work was very little, the amount of work done considered, and this was owing to the interest taken in it by those who most desired it done, and done well. (See Report of the Chief of Engineers for 1873, Appendix Q 5.)

The same interest is manifested above this portion of the river, as shown by the cheerful and volunteered assistance given to the survey party.

This office sent out on the survey one assistant engineer and the necessary instruments; parties in Amite and along the river provided for all other assistance and expense. Mr. H. S. Douglas, assistant engineer, who had charge of the survey, reports that he was everywhere treated in the most hospitable manner and provided with all the assistance he desired.

Charts of the survey will be forwarded with my final report at the close of the fiscal year. The report of Assistant Douglas will also be forwarded, giving details.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers.

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

Report of Assistant Engineer H. S. Douglas, who had charge of the survey, is now given in addition and charts forwarded.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
New Orleans, April 24, 1879.

CAPTAIN: In obedience to your orders, I left New Orleans January 27, and proceeded to Amite, La., for the purpose of making a survey of a portion of the Tangipahoa River, and have the honor to submit the following report:

I arrived at Amite on the 27th, and thanks to the valuable assistance tendered by Mr. B. D. Gullett, I was enabled to organize my party, complete my outfit, and commence field operations the day of my arrival. My party and outfit consisted of 4 men and 4 boats.

The initial point of the survey was taken at what is known as Connor's Bridge, a point on the river about 1½ miles from the town of Amite. From this point the stream was meandered with transit and stadia, and all important obstructions were located with these instruments. The method of operations was as follows: A suitable position was selected for stadia No. 1, the transit was placed in a position to sight both forward and back, and set up on magnetic meridian; the distance and bearing to stadia No. 1 were then read; also the distance and bearing to stadia No. 2, which was in a convenient position ahead of the transit. The transit was then moved to a point beyond stadia No. 2 and set up in the same manner as before; the readings and bearings then taken back to stadia No. 2 and forward to stadia No. 1 (meantime sent on ahead), and so on, repeating the same operations every time the instrument was moved. Soundings were taken from the boat while moving from station to station and put down at their location on the field plat. None were taken below Wells' Ferry, as there is everywhere more water than on the bar at the mouth of the river.

The length of that portion of the river surveyed from Connor's Bridge to its mouth at Lake Pontchartrain is 53¼ miles. The time occupied was 12 days, from January 27 to February 7, inclusive.

The river remained at ordinary low-water during the survey, and in consequence a great many obstructions were observed and noted that otherwise would have escaped observation. Average high-water is from 16 to 18 feet above the plane of reference used on the survey. During low-water the river is fed almost entirely by springs, which keep it up to an average stage even during long droughts.

The stream meanders a heavily-timbered valley, or bottom-land, subject to overflow at high-water, which is terminated on either side by high "piney-woods" lands, not subject to overflow. This valley varies from 1 to 2 miles in width.

The bed of the river is composed almost entirely of sand and gravel, clay bottom occurring in but two places, noted on the accompanying chart.

The bars are a mixture of sand and gravel, which would probably wash out but for the presence of numerous sunken snags. The removal of these snags will allow the bars to wash out to a much greater depth than they now have. Except where the land has been cleared for cultivation the banks are heavily-timbered to the water's edge, and most of the obstructions occur in the bends where the banks cave, and allow the trees to fall in.

The fall of the valley to tide-water is very rapid, and in consequence the stream is quite crooked, thereby dividing the fall through a longer distance, lessening the current, and making it practicable for navigation. The greatest current velocity observed did not exceed 2 miles per hour. The average width of the stream is about 100 feet.

Tide-water reaches as far up as Wells's Ferry, and from that point to its mouth, at Lake Pontchartrain, the river partakes more of the character of a bayou. It is deep from bank to bank, and at low-water the current is scarcely perceptible. For the last 10 miles of its course the river flows through the cypress swamp bordering Lake Pontchartrain.

Cut-offs have been tried in several places with the intention of shortening the river, and so improving the navigation; but in this they have had rather a contrary effect, as the increased velocity of the current causes the banks to cave and the river to fill with obstructions. The accompanying table shows that in those miles where cut-offs have been made the number of snags is greatly increased.

In several places island chutes, or "little rivers," as they are called, leave the main stream, and sometimes flow independently for nearly a mile before returning. Whenever this occurs the number of obstructions in the main river is greatly increased and, of course, the depth of water decreased.

The closure of the majority of these "little rivers," or island chutes, will be necessary to the permanent improvement of the river.

Under the head "Miscellaneous," in the table, are given some obstructions requiring a fuller description. At ¼ of a mile below Connor's Bridge is a "fish-trap," consisting of 2 parallel rows of light piles, from 4 to 6 inches in diameter and placeda bout 5 feet apart. They can easily be removed, being driven into sand and gravel.

There is another "fish-trap" at the end of the second mile, which can be removed as easily as the first.

On the tenth mile a "little river" leaves the main stream, carrying off fully ⅓ of its volume. This, as well as all others like it, it would be absolutely necessary to close.

On the eleventh mile are the remains of the Independence Bridge, consisting of two clusters of piles. These it may not be necessary to remove, as there is an open channel 50 feet wide between them.

On the twentieth mile are 7 large trees standing in the channel, which it would be necessary to either remove or cut a channel around; also, a place where a raft of snags and drifts have collected, allowing a clear channel of but 18 feet in width.

On the twenty-second mile is Dunnington Bridge, which would either have to be removed or converted into a draw.

On the thirtieth mile is a sunken flatboat, with 42 inches of water over it at low-water. Its removal is not absolutely necessary.

Owing to the nature of the river-bed, the removal of the snags will not be difficult. They would yield easily to the power of a snagboat, as there is no tenacious clay to hold them.

In the column of "least depths," the figures given indicate the least depth on the shoalest bar, and these are generally of small extent.

The closure of the "little rivers," or island chutes, can best be accomplished by running into them the snags, overhanging trees, &c., removed from the main river. It would be desirable, also, to close such cut-offs as have not already become the main channel.

It may not be necessary to convert Dunnington Bridge into a draw, as parties interested in it state that in case the stream is improved for navigation they, themselves, will remove the bridge.

The following estimate of removing the obstructions to navigation in the Tangipahoa River will give a navigable channel with a least depth of 42 inches to Dunnington Bridge, and a channel with a least depth of 24 inches to Connor's Bridge. Forty-two inches is all that can be carried over the bar at the entrance to the river.

Snags, at $120 per mile	$6,420
Overhanging trees, at $30 per mile	1,605
Drawbridge	700
Closure of island chutes	500
Two fish-traps, at $50 each	100
Standing trees	50
Contingencies	625
Total	10,000

The total number of snags is 1856 and of overhanging trees, 660. The greater part of these will be found in the first 38 miles of river, as the last 15 are almost clear.

If a smaller amount than that asked for is appropriated, I would respectfully suggest that it be expended on that portion of the river below the remains of the Independence Bridge. An inspection of the accompanying chart will show the advisability of this. In 1871 a schooner was built near this bridge, the dimensions of the boat being, length, 60 feet; breadth of beam, 18 feet; and draught, 18 inches. This boat was taken down the river from this point without difficulty, except from snags at low-water.

The trade to be benefited is important, and would be materially increased by the opening of the stream to navigation. Valuable timber, principally cypress and pine, abounds in the valley of the stream, and a large business is done in rafting this to the New Orleans market. This rafting is, however, confined to the lower portion of the river, as it cannot be carried on above on account of the obstructions.

Large quantities of cotton, sugar, vegetables, fruits, and poultry are produced in the country bordering the stream. Sugar-raising has lately become a prominent industry. The cost of getting these products to a market would be greatly lessened by the improvement of the river.

The greatest interest is taken by the residents of the country in the proposed improvement, and every assistance in making the survey was cheerfully volunteered. Your assistant and his party were everywhere treated in the kindest and most hospitable manner.

Further information will be found on the two charts accompanying this report, which are plotted on a scale of 1 to 5,000. That portion of the river from Wells's Ferry to the mouth was reduced from the survey of 1871 and corrected to date.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. C. W. HOWELL,
Corps of Engineers, U. S. A.

Miles.	Snags.	Overhanging trees.	Sand and gravel bars.	Least depth.	Least width.	Island chutes and bayous.	Cut-offs.	Miscellaneous.
				Inches.	*Feet.*			
0	50	38	3	12	50	1	.....	Fish-trap.
1	39	21	1	12	60	.....	.....	
2	68	13	1	12	80	1	1	Fish-trap.
3	45	20	.....	24	90	1	.....	
4	50	13	.....	24	100	.....	.....	
5	71	17	2	12	50	1	1	
6	45	28	1	18	90	1	.....	
7	48	15	1	12	90	.....	.....	
8	54	31	.....	36	100	.....	1	
9	75	26	5	12	40	1	1	River almost impassable.
10	60	31	2	12	50	.....	.....	Old Independence Bridge.
11	62	8	2	12	90	1	.....	
12	35	12	.....	24	90	.....	.....	
13	30	10	2	12	60	.....	.....	
14	64	1	1	12	60	.....	1	Cut-off; now main channel.
15	45	10	2	18	90	.....	.....	
16	24	2	1	12	70	.....	.....	
17	24	1	1	18	100	.....	.....	