

The work is located in the collection-district of Indianola, Tex., and near Matagorda light-house.

Original estimated cost.....	\$715,325 00
Amount appropriated.....	70,000 00
Amount expended.....	2,331 41

Money statement.

July 1, 1878, amount available.....	\$45,000 00
Amount appropriated by act approved March 3, 1879.....	25,000 00
	\$70,000 00
July 1, 1879, amount expended during fiscal year.....	2,331 41
	67,668 59
July 1, 1879, amount available.....	600,325 00
Amount (estimated) required for completion of existing project.....	150,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881.....	

SURVEY OF PASS CAVALLO INLET TO MATAGORDA BAY, TEXAS.

UNITED STATES ENGINEER OFFICE,
New Orleans, December 17, 1878.

GENERAL: The recent survey of Pass Cavallo Inlet to Matagorda Bay, Texas, ordered by the Chief of Engineers, U. S. A., to determine the advisability of applying to protection of the head of Matagorda Island the appropriation now available for improvement of this pass, being now completed, and reports of assistants, together with charts placed before me, I have the honor to make the following report thereon:

INTRODUCTORY.

In the beginning of this report I beg leave to submit a memorandum of events that have led up to the present survey.

I will only go back to 1870, when Congress ordered a survey of this pass, the expense of the survey to be paid from such allotment as could be made from the general appropriation for surveys of rivers and harbors.

Survey planned to suit a necessarily small allotment was made under my direction and report forwarded. (See Report of Chief of Engineers for 1871, pp. 51-53.) From considerations to be found reported in the Report of the Chief of Engineers above cited, it was recommended that no attempt at improvement of the pass be made.

So the matter rested until 1873, when by act of Congress approved March 3, 1873, survey was ordered "at the entrance of Matagorda Bay and channel to Indianola, Texas."

Report of this survey was rendered January 24, 1874. The plan of improvement recommended in report of second survey was similar to that now in operation for improving Galveston Harbor, viz, to construct two submerged jetties with cement-covered gabions, as described in my report of December 30, 1873, on Galveston Harbor.

The first work recommended was the closure of Decrow and Elizabeth Channels, which it was thought might increase the depth across the bar to 12 feet.

Such being the effect of the closure, the improvement to be continued by further contracting the entrance by the formation of shoals on the lines Y. E. and Z. B. (on chart) which would probably insure a single

channel across the bar of from 18 to 20 feet in depth, and 500 to 1,000 feet in width.

To perform this work it was estimated the cost would be \$291,167. (See Report of Chief of Engineers for 1874, Part I, Appendix R 12, p. 760.)

In 1876 Congress, by act approved August 14, 1876, appropriated \$20,000 for improvement of the pass.

This amount being too small for commencing work, it was recommended, and the recommendation approved by the Chief of Engineers, U. S. A., and the honorable Secretary of War, that this appropriation be held to await the future action of Congress.

By act of Congress approved June 18, 1878, an appropriation of \$25,000 for the work was made, making \$45,000 the total amount available.

In letter to the Chief of Engineers, dated June 29, 1878, on the subject of applying this amount, authority was requested to have an examination made of the pass to ascertain what changes had taken place since last survey, before finally considering the suggestion that the money be expended in protecting the end of Matagorda Island from further abrasion.

Authority for examination was given in Engineer Department letter of July 10, 1878.

On the 10th of August I instructed my assistant, Capt. C. E. L. B. Davis, Corps of Engineers, on duty in Galveston, to organize, dispatch, and direct a party to make this survey, being unable to attend to the matter in person on account of the strict State and local quarantine throughout Texas.

Following this memorandum I submit the following report of Captain Davis, supplemented by the report of Assistant Abram Cross, who had charge of the field and office work, and by the report of Assistant H. C. Ripley, who had charge of the survey of 1873, and in consequence was detailed to report on changes that had occurred between 1873 and 1878. Mr. Cross would have been assigned this latter duty had he not completed his work before tracing of survey of 1873 could be got to Galveston. This tracing was duly forwarded, but was detained in the post-office for several months because of quarantine of mail-matter.

REPORT OF CAPTAIN CHARLES E. L. B. DAVIS, CORPS OF ENGINEERS.

GALVESTON, TEX., November 22, 1878.

SIR: I have the honor to submit the following report of the survey of Pass Cavallo Inlet to Matagorda Bay. This survey was made under telegraphic instructions received from you dated August 10, 1878.

In accordance with your instructions, I placed a survey party in the field in charge of Mr. Cross, with orders to conduct the survey according to your directions.

I transmit herewith the report of Mr. Cross upon the survey work and a tracing of the chart.

As stated by Mr. Cross, the plane of mean low-water is probably too high, though I doubt if it is as much as one foot higher than the true plane.

I thought it better to use the mean low-water plane as actually determined, stating the method of determination in the report, than to attempt to assume, approximately, the true plane.

As the bays on the Texas coast resemble each other closely in the configurations of the land, I can determine the plane of mean low-water from the tide record at Bolivar Point for the period covered by Mr. Cross's survey, and the proper correction can be made at some future time if you think necessary.

To determine the extent of the caving of the west bank a comparison with Mr. Ripley's chart is absolutely necessary. Should the changes be very material, I think the plan of improvement suggested by Mr. Cross would prove inadequate; if, however, the washing is but superficial, as he thinks, his plan would answer very well. Not

having Mr. Ripley's chart, I hardly feel justified in submitting any plan, and will therefore forward Mr. Cross's report without further remark.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

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

LETTER OF CAPTAIN CHAS. E. L. B. DAVIS, CORPS OF ENGINEERS.

GALVESTON, TEX., December 2, 1878.

CAPTAIN: I have the honor to transmit herewith a special report of Mr. H. C. Ripley, relating to the resurvey of Pass Cavallo Inlet to Matagorda Bay.

In my letter of November 22 I stated that a comparison of Mr. Cross's chart, with that of the original survey was absolutely necessary in order to determine the extent of the changes.

Since the date of that, letter of August 5, inclosing tracing of Mr. Ripley's chart, has been received.

As the original chart of Mr. Cross's survey was over at Bolivar, I sent a note to Mr. Ripley inclosing the tracing, with request to make a comparison at his leisure, and to let me know the result, and the inclosed report was sent in reply, which is so full and explicit I have concluded to forward it in full to you.

Very respectfully, your obedient servant,

CHAS. E. L. B. DAVIS,
Captain of Engineers.

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

REPORT OF MR. H. C. RIPLEY, ASSISTANT ENGINEER.

BOLIVAR POINT, TEXAS, November 27, 1878.

CAPTAIN: I have the honor to acknowledge the receipt of your letter of the 25th instant, containing a tracing of the survey of Pass Cavallo Inlet to Matagorda Bay made in 1873, and have compared it with the chart just finished by Mr. Cross.

The changes are greater than I should have anticipated under any probable circumstances.

Pelican Island has moved nearly one mile in a southerly direction. Redfish Spit and the shoal extending southeast from it have disappeared, the present channel passing through where the center of this shoal was in 1873. On the west side of the pass the end of Matagorda Island has been washed away more or less all the way from above the fort to the Gulf.

At one point near the old light-house, the shore-line is driven back 1,300 feet. The sight of the old light-house is gone. At another point (near A on the chart) it has been driven back only 200 feet (as is shown by the bluff line) and has advanced again about 600 feet. Near the fort the shore-line has been pushed back about 600 feet, carrying away the fort, Nichol's house, and the house next below.

On the bar great changes have occurred. A general deepening all over the bar has taken place. The 18-foot curve outside has not materially changed, neither has the 12-foot curve west of the line A B; but east of this line it moves abruptly north and continues parallel with its former position and about 2,000 feet from it.

Inside of the bar the 12-foot and 18-foot curves have entirely changed until we reach a point nearly abreast of the "Range Stake," the "Veto" and "Old" channels having merged into one channel in the prolongation of the channel above, but curving slightly to the eastward. North of the "Range Stake" the channel has widened about 200 feet, both between the 12-foot and 18-foot curves, and at one point (about 500 feet below the fort) the 12-foot curve has moved toward the shore, in a short bend, a distance of 300 feet. Aside from this and the movement due to the widening of the channel, which has taken place equally on both sides, there has been no movement of either the 12-foot or 18-foot curves towards Matagorda Island.

Below the "Range Stake" both of these curves have moved to the eastward, reaching a maximum distance (near Redfish Spit) of 1,600 feet.

These changes seem truly remarkable, and, I think, could have resulted only through a series of changes, the successive steps of which have almost entirely disappeared.

With regard to the abrasion of Matagorda Island, there are two inferences which can be made; first, that the washing has been superficial; second, that it was deep, the channel having encroached upon the bank, even to its very bottom, and that it

has since receded and an accumulation has been formed which gives it the appearance of only a superficial scour.

The first of these inferences is the one which Mr. Cross has made, and has submitted plans and estimates for preventing its further progress, which, if the inference be correct, will most likely accomplish that result, yet they seem rather expensive, considering the value of the property to be protected. But if the second inference be correct, then his plan of protection is entirely inadequate, if, indeed, any protection at all be needed; for, if needed, any structure like the one proposed would soon be undermined and entirely disappear. It is important, therefore, to know in what way the abrasion actually took place.

The land is high (that is, above the highest tides except in times of great storms) and is covered with grass. The soil, although sandy, is yet quite compact and capable of cultivation. It is quite similar to the soil of Bolivar Peninsula, if I remember rightly. At any rate it is suitable for growing sweet potatoes and other vegetables.

The surface soil, therefore, is not that shifting sand that is found immediately on the beach. Then, too, the bank is greatly protected from the sea by Pelican Island and shoals lying seaward, so that any abrasion taking place would be effected by undermining and caving, as in the case of a river bank. If this abrasion has been accomplished in any other way, or if it was only superficial, it is contrary to anything I have ever observed.

The shelf or flat along the channel face of the island is, I think, of the nature of a batture, which always indicates a formation. Such are some of the objections to the truth of the first inference. Against the truth of the second inference there is no evidence except the negative evidence that the successive steps have not been observed, while there is positive evidence of its truth in the re-formation before referred to, shown at A on the tracing.

A reasonable explanation for the abrasion, which also shows the process, is as follows:

The opening of the Veto Channel and closure of the Old Channel introduced a bend in the pass, which moved westward, in consequence causing the bank to cave, as is always the case in rivers with a similar bend. The movement of the outer end of Veto Channel southward, followed by Pelican Island, carried the apex of the bend down and consequently caving.

Finally the channel becomes straightened, caving ceases, the channel moves back to its original position, and a batture is formed such as now exists. If such be a correct explanation of the process of abrasion and re-formation, either no protection is needed, or, if needed, it should be of such a nature as to resist the undermining action to which it will be subjected.

Very respectfully, your obedient servant,

H. C. RIPLEY,
U. S. Assistant Engineer.

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

REPORT OF MR. ABRAM CROSS, ASSISTANT ENGINEER.

BOLIVAR POINT, TEXAS, November 9, 1878.

CAPTAIN: In obedience to your orders of the 19th of August, 1878 (a copy of which is hereto attached), directing me to make a survey of "Pass Cavallo Inlet to Matagorda Bay," I have the honor to report as follows:

On Wednesday, August 21, 1878, I left Galveston on the schooner Julia (chartered for the purpose), and arrived at Pass Cavallo on the evening of the Saturday following. Monday, August 26, I commenced operations, and on the 23d of September completed the field work. Next day started for Galveston, and arrived on the night of the 25th, since which time I have been at work on the accompanying chart, which, with the following exceptions, will, I think, explain itself.

The plane of mean low tide used is probably about 1 foot higher than it should be, having been calculated from the observations of only 29 days, during which time, on account of the prevalence of easterly winds, the tides were unusually high, consequently gave a result higher than the true level of mean low if calculated from a sufficiently extended series of observations.

The current measurements all show the directions and velocities of ebb tide only, and on the surface. It being impracticable to get any correct measurements of flood tides, for the reason that during the time I was making the survey the tide was invariably running out during the day and in at night, and I was not prepared to take observations except by daylight. I would more particularly call your attention to the line A B, as it shows the divide between the tide ebbing through the main or

what is known as the "Veto" channel and that passing out between Pelican Island and the small sand island southwest of Decrow's Point.

While taking the observations from which this line has been plotted, the float followed almost exactly the dividing line of these currents, and at times showed very clearly, by revolving rapidly from west to east, that the west current was much the more rapid of the two.

As to the extent of damage to Matagorda Island from washing I have no data from which to estimate, but am of the opinion that it has been somewhat exaggerated, and I believe that by far the greater part was done by the storm of September, 1875, since when the general tendency has been to assume its former shape.

The wash has been, I think, only superficial, and to a casual observer would appear much more extensive than it really is, more especially as it has not been confined to the immediate shore, there having been several small bayous and lakes found between the pass and the bay to the westward of this part of Matagorda Island. It (the island) being mostly of light shifting sand, and not more than from 5 to 7 feet above ordinary high tide, is easily affected by overflow or wind.

For example, the sand island southwest of Decrow's Point (a similar formation), and which I have been told has been formed since last May, was washed off on the north end between 50 and 60 feet in 21 days, from the 1st to the 21st of September. The immediate cause of this washing was the current produced by northeastwardly winds.

As to the cheapest and most practicable plan for protecting this shore and guarding against future washing, I would respectfully suggest the construction of jetties from its several salient points in a southeastwardly direction to about the line of mean low tide.

These jetties might be constructed of wood as far as the line of ordinary high tide, and from there to their outside ends be built of concrete.

The concrete part of the work might be done in the following-described manner, viz:

Construct wooden caissons of the required size and shape, place them in position, then fill with concrete and sink them to the desired depth, forcing the sand from beneath by means of a force-pump with attachments similar to those used for sinking piles in quicksand, then as the caisson is lowered it could be built onto and filled until the desired depth and height shall have been attained.

The wooden part might be constructed by driving a double row of piles about 6 feet apart in the direction of the jetty and inclined towards its center line, so that each pair can be bolted or otherwise fastened together at top, making an angle of about 60 degrees with each other. Then spike on 3-inch plank from about 2 feet below the surface of the ground to where the piles come together.

The work to be carried up to about the general level of the island, or to about 7 feet above the level of ordinary high tide at the inside or shore end, and sloped to 1 foot above the level of ordinary high tide at its outer end.

As to the cost, I am not prepared to make an accurate estimate; but from my knowledge of the adjacent country, I am of the opinion that the ingredients necessary for the concrete could be procured for prices nearly the same, or perhaps somewhat higher (there being less competition here) than paid by you in Galveston, except cement, to which should be added freight from Galveston.

The "caissons" or "mould-boxes" would cost about \$3 per linear foot in position, and should be built of heart red cypress. The wooden part of the jetty or wing-dam would cost about \$4 per linear foot. For this the piles should be red cedar and the plank red heart cypress. Wrought nails should be used exclusively.

APPROXIMATE ESTIMATE OF COST OF "JETTIES" OR "WING-DAMS."

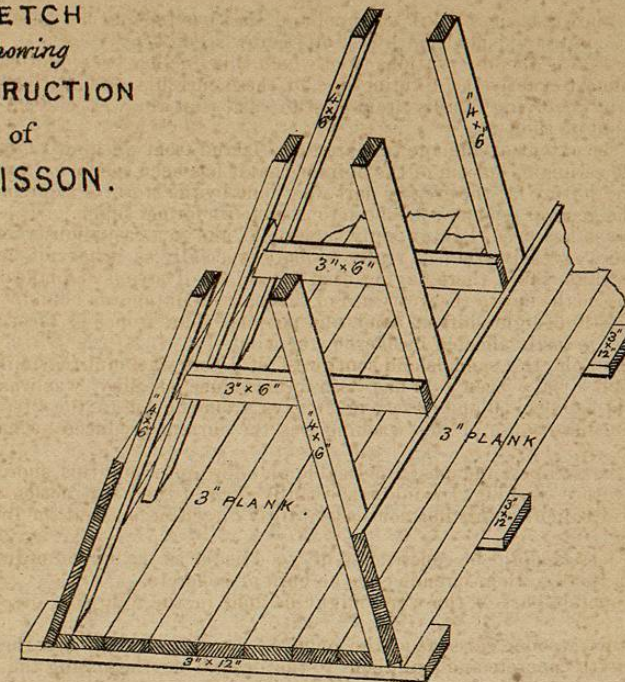
Concrete, per linear foot, 1½ cubic yard.....	\$10 00
Caisson, per linear foot.....	3 00
Total, per linear foot, for concrete work.....	13 00
1,700 feet of pile work, at \$4.....	6,800 00
3,000 feet of concrete work, at \$13.....	39,000 00
Total cost.....	45,800 00

I have the honor to be, very respectfully, your obedient servant,

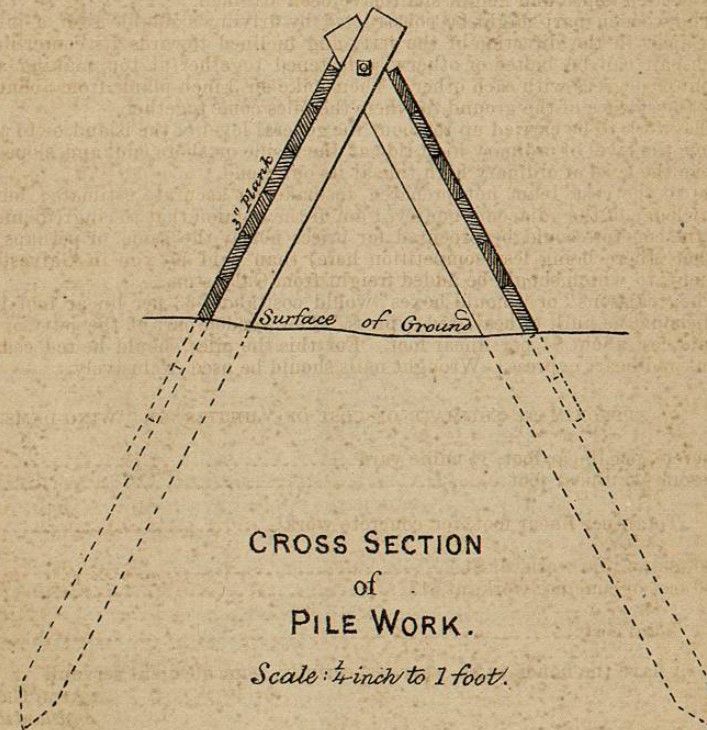
ABM. CROSS,
Assistant Engineer.

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

SKETCH
showing
CONSTRUCTION
of
CAISSON.



Scale: ¼ inch to 1 foot.



CROSS SECTION
of
PILE WORK.

Scale: ¼ inch to 1 foot.

I will now present my own views:

1st. As to the character and effects of abrasion of the head of Matagorda Island.

1. The head of the island is exposed to abrasion, near the surface, by the action of the Gulf waves during the hurricane season; that is, during the season when the coast of Texas is visited by those cyclones which come up from the Caribbean Sea almost every year and in passing into Texas do so much damage along the low-lying portions of that coast. From this cause of abrasion the head of Matagorda Island is protected in some measure by the shoals, of which Pelican Island is the largest portion above more than ordinary high tides.

2. During the season of northers, owing to the direction of the main body of the pass, the water from the greatest expanse of Matagorda Bay is driven out with great velocity, and, no doubt, judging from the shape of the pass, scours out from the Matagorda Island side of the pass to much greater depths than those affected by the waves during storms.

3. Now, considering these two most potent causes of change, leaving minor yet important causes out altogether, it appears that the spur-dikes proposed by Mr. Cross, being projected approximately parallel to the axis of the cyclones, cannot protect the upper portion of the Matagorda Island from abrasion by the Gulf waves, nor can they protect the lower and channel portions from abrasion by the ebb currents due to northers; they would rather serve to produce injurious eddies.

4. There is no other plan for protection suggested that would warrant commencement with the means at command, nor do I think that the protection is desirable, except as a possible necessity, in connection with improvement of the channel across the outer bar of the pass, the necessity to be ascertained after the more important work is well under way.

The channel across the bar is now better than in 1873, and I think the normal conditions that have made it so should not be interfered with until the engineer who ventures upon the duty of changing those conditions has enough money to carry out his plans.

The estimate submitted by Mr. Cross exceeds the total appropriation, and yet makes no allowance for contingencies, for which a liberal allowance of not less than 20 per cent. should be made.

After deducting cost of survey the balance of appropriation is less than \$45,000.

I have therefore to recommend that the present appropriation for improving Pass Cavallo, Texas, be held to await the further action of Congress, with the hope that by the cumulative system so far carried out, in the course of time enough may be appropriated to justify commencement of work for the improvement of this important pass, upon the plan already approved, viz, that of first connecting and solidifying the shoals between Decrow's Point and the head of Matagorda Island, thus better protecting this island from the wash of waves during storms, and cutting off the deleterious currents found between Decrow's Point and Pelican Spit.

The amount that can be profitably expended in the commencement year of this work, is stated in my last annual report. (See Report of Chief of Engineers for 1878, Appendix J, p. 613.)

An appropriation of \$100,000 in addition to that now available would justify commencement of the work.

I inclose tracing from chart of Mr. Cross's survey of this year, also comparative tracing taken from charts of 1873 and 1878.

Very respectfully, your obedient servant,

C. W. HOWELL, *Captain of Engineers.*

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

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