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IMPROVEMENT OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS.

A survey of Aransas Pass was made in 1871, under my direction, report of which was rendered to the Chief of Engineers April 1, 1871. (See Report of Chief of Engineers for 1871, Appendix N 4, pages 528 to 530.)

A "survey of Aransas Pass and Bay up to Rockport and Corpus Christi, Tex., and Corpus Christi Pass and channel," provided for by act of Congress approved June 18, 1878, was made in that year, and report submitted to the Chief of Engineers February 1, 1879, with plans and estimates for improvement.

Thirty-five thousand dollars were appropriated for this work by act of Congress, approved March 3, 1879, with which it was proposed to commence the work of deepening the channel across the outer bar by means of jetties, according to plan set forth in my report of February 1, 1879, on survey of Aransas Pass, &c., the work to be continued until a 12-foot channel across the bar might be obtained, or until the appropriation was exhausted, and after obtaining such channel, should a sufficient balance of the appropriation remain, it will be applied to the protection of the head of Mustang Island.

It was proposed to let the work out at contract.

By order of the Chief of Engineers, dated June 3, 1879, all matters relating to this work were submitted to a Board of Engineers for consideration. This Board convened in New York City on July 1, 1879, and its report has not yet been rendered.

The work is located in the collection-district of Corpus Christi, and the nearest light-house is at Aransas Pass.

* Original estimated cost	$186,845 00
Amount appropriated	35,000 00

Money statement.

Amount appropriated by act approved March 3, 1879	$35,000 00
July 1, 1879, amount available	35,000 00
Amount (estimated) required for completion of existing project	151,845 00
Amount that can be profitably expended in fiscal year ending June 30, 1881	151,845 00

SURVEY OF ARANSAS PASS AND BAY UP TO ROCKPORT AND CORPUS CHRISTI, TEXAS, AND CORPUS CHRISTI PASS AND CHANNEL.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 1, 1879.

GENERAL: The "survey of Aransas Pass and Bay up to Rockport and Corpus Christi, Tex., and Corpus Christi Pass and Channel," as provided for by act of Congress approved June 18, 1878, being completed, I have the honor to submit the following report.

Corpus Christi and Aransas Passes present conditions, to govern treatment, very much like the conditions presented at the entrance to Galveston Bay and Harbor, as I have described them in previous reports.

The passes connect large bays with the waters of the Gulf of Mexico.

* Only estimated cost for outer bar and protection of head of Mustang Island. Other estimates held to await action of Board of Engineers convened in New York City, July 1, 1879, for consideration of projects for this work of improvement.

The streams tributary to these bays are inconsiderable in volume of discharge and area of drainage, and do not have any perceptible effect on the passes and the bars separating the passes from the Gulf. These bars are beyond question the creatures (for they are ever changing) of but two of the several causes of obstruction to harbor entrances. These two are the tides and winds. In other words, the bars are purely drift and tidal; they are formed of a sand easily moved by currents of water passing over them, in or out, and the adjacent coast line is of the same material, easily moved and carried by the winds into the channels.

The passes are each several miles in length and have their axis nearly due north and south. This is in the general direction of those off-shore winds and storms which during the autumn and winter months frequently drive water from the bays out through the passes with great velocity. This feature is noticeable all along that part of the Texas coast which trends toward the southwest, as I have indicated on Plate 1, Fig. 1.

The only point of difference in this respect between Galveston entrance and Cavallo, Aransas, and Corpus Christi Passes is that the old ship channel (at the former place), the direction of which is given on Fig. 1, was outside of the coast line, while the others lie between the sand islands and the mainland.

The prevailing on-shore winds and storms are from the southeastward, and striking the coast more or less obliquely, create a movement of sand along the coast toward the south, and this traveling wetted sand, together with the dry sand driven from the surface of the islands and peninsulas into the passes, constitutes the material of which the bars at the Gulf ends of the passes are formed.

The tidal currents, as influenced by the winds and storms, have controlled the arrangement of this material and the variations in depth of the channels across the bars formed by it.

They have also, by their joint action, caused a somewhat regular change in the location of the channels across the bars by wearing away the southern shore of the entrance to the passes, and prolonging the northern shore so as to maintain a quite uniform width of channel between the two headlands.

This double effect has been shown on charts of the entrance to Galveston Harbor, which I forwarded before commencement of the work now in progress for improvement of that entrance, and is also well shown on the large-scale chart of entrance to Aransas Pass, accompanying this report.

The passes Cavallo, Aransas, and Corpus Christi, while keeping a nearly north and south direction so long as sheltered by the sand islands and peninsulas between them and the Gulf, on making connection with the Gulf turn sharply to the southeastward, so that the channels across their Gulf bars are nearly in the general or prevailing direction of the on-shore winds and storms. This has been observed of the Mississippi River, viz, that its main stem prolongation is in the face of the prevailing on-shore winds.

It has also been observed at Galveston that, as protection is given, the channel across the outer bar works to the eastward.

I will not attempt to account for this, but will now present views as to plans for improving the entrance to the ports of Rockport, in Aransas Bay, and Corpus Christi, on Corpus Christi Bay.

The port of Corpus Christi has two channels of communication with the Gulf of Mexico, viz:

1. Through Aransas Pass and a dredged channel connecting the latter with Corpus Christi Bay.
2. Through Corpus Christi Pass.

The latter-named channel appears to be gradually filling up, and it is perhaps not unreasonable to think that at no very distant day it will become to Corpus Christi Bay what West Bay and San Luis Pass is now to Galveston Bay, viz, a navigable outlet of the past, a mere safety-valve for the future. A man of ordinary stature can wade it now at several points.

In view of this it is recommended that it be closed by a dam having its crest at the level of mean low tide, its location to be as shown on Plate I, Fig. 2—the construction of the dam as shown on Plate II, Fig. 1. The effect of this proposed artificial closure, it is thought, will be improvement of the navigable channel between Corpus Christi Bay and Aransas Pass, inasmuch as under ordinary conditions of winds and tides it will force the tidal filling and emptying of Corpus Christi Bay through Aransas Pass, thus improving the connection between Corpus Christi and Aransas Bays, and possibly increasing the normal depth over the bar of Aransas Pass.

By leaving the crest of the dam no higher than the plane of mean low tide the pass will be available as a safety-valve in case of violent storms filling or emptying the bay.

The suggested dam, it is thought, will improve the channel connecting Corpus Christi Bay with the Leguna Madre to the southward. This bay is of importance, as it furnishes the salt required by the beef-packers along that portion of the coast. It is also of importance, as it will furnish the stone for the works I recommend in this report. (See report of Assistant Engineer Collins appended, and the report of Assistant Engineer Polhemus, in Report of Chief of Engineers for 1874.)

The channel connecting Corpus Christi Bay with Aransas Pass is partly natural and partly dredged. Its width at the narrowest point is 80 feet, and its minimum depth at low tide of the spring and summer months is 8 feet; this is sometimes reduced to 7 feet by northers, which lower the surface of the bays.

This depth and width is considered sufficient until such time as a 12-foot channel may be available across Aransas Bar. The artificial portion of the channel has been excavated by a private corporation acting under charter which permits them to levy tolls on all freights passing through the cuts. From the best information I have been able to obtain, it appears probable that the amount of money expended on this channel is less than $50,000.

I submit an estimate for deepening this channel to 10 feet and widening to 100 feet at bottom.

What amount it would be necessary to pay the company for relinquishment of its rights could not be ascertained. As there are other cuts that may be made without using any portion of the present channel, estimates are submitted for such along the line H I M L and K I, Plate I, Fig. 2. Were either of these made the company channel would be valueless.

The most important work and the first that should be undertaken is no doubt that for the protection and deepening of the entrance to Aransas Pass.

The work at Galveston, I think, furnishes a fair precedent for general treatment of this entrance, but we fortunately have a better one in the attempt at improvement of Aransas Bar, which was made in 1869, the general plan being the same as that now pursued for the improvement of the bar at entrance to Galveston Bay.

In 1869 the citizens of Rockport and Corpus Christi, by subscription, raised about $10,000, which they placed in the hands of a Mr. Halliday for the purpose of improving the channel across Aransas Bar. With this money Mr. Halliday proceeded to construct a crib-work extending from the shore-line of Saint Joseph's Island out into the Gulf.

As nearly as can be ascertained this work was built into the Gulf a distance of about 600 feet.

From my remembrance of a verbal description of the work given me by Mr. Halliday in 1869 or 1870, and from accounts given Mr. H. C. Collins, assistant engineer, while engaged upon the recent survey, the following description may be given, viz:

The cribs were triangular in cross-section (dimensions not known), and their parts were very imperfectly fastened together, and besides seem to have been made of any timber and lumber that came handy—some live-oak, but mostly yellow pine scantling 4 inches by 6 inches. Some of these cribs were filled with brush and stone when sunk in place, but it is said that others were simply ballasted so as to sink them.

During the work of construction some of the cribs near the shore were broken up and washed away.

When the work was suspended it is said there was a 12-foot channel across the bar which was maintained for several months, possibly until the teredo and the waves had destroyed a considerable part of the frail crib-work.

In 1871, when the late Lieut. E. A. Woodruff, Corps of Engineers, made, under my direction, a reconnoissance of the pass he was unable to find any trace of the work. It is said that as the work gradually disappeared the channel across the bar gradually returned to its normal depth.

I consider my information reliable as to the above-described work and its effects, and shall therefore recommend a work similar in plan but substantial in character.

The location of the work designed for improvement of the channel across the bar is shown on Plate I, Fig. 2. The line is marked A B. It starts from the shore-line of Saint Joseph's Island, and extends out into the Gulf to the 5-foot curve, a distance of 4,000 feet.

The details of construction are shown on Plate II, Fig. 2. Estimate will be given further on.

The next work to be undertaken will be the protection of a portion of the end of Mustang Island (south shore of pass) from erosion. The portion to be protected is marked C D on Plate I, Fig. 2.

The protection proposed will consist of a matting or carpeting of fascines ballasted with stone, extending from the water's edge along the slope of the bank to the blue clay which underlies the sand at a depth of 30 feet.

Details are shown on Plate II, Fig. 3, and estimate is submitted at close of report.

In order to give 10 feet navigation through Aransas Pass up to Rockport (there is now a good 8-foot navigation), it will be necessary first to prevent the drifting into the shoal portion of the pass of sand swept off the lower portion of Saint Joseph's Island by on-shore winds and storms. It is proposed to do this by thickly planting the mid line of this portion of the island (about 2 miles in length) with water oaks and cedars, a course of treatment which is now being carried out on the Gulf front of Galveston City at but slight expense. Only an approximate estimate for this is submitted.

The next step will be the dredging of the pass along the line O P V, Plate I, Fig. 2; but it is evident that effect of dredging cannot reason-

ably be considered permanent until after the cause of shoaling, viz, the sand driven from the island into the pass, is provided against.

MATERIALS FOR CONSTRUCTION.

These are to be had in abundance and at reasonable cost, within a convenient distance of the proposed works.

Such piles as may be required for temporary service as guides in construction, and swamp cane (fish-pole cane) for the fascinage, may be readily obtained along the small streams near the head of Aransas Bay.

The cane makes a most excellent material for fascinage, for when freshly cut and its joints opened so as to admit water it requires but little ballast to sink it; its bushy tops become embedded in the sand, thus giving each fascine a firm anchorage, and, so far as known, the teredo does not attack it.

Stone.—About 15 miles of the coast of the upper portion of the Laguna Madre is lined with limestone bowlders of various sizes suited for the work. The channel leading from Corpus Christi Bay to these deposits is nowhere less then 28 inches in depth.

Galvanized iron wire and marline for tying fascines and for forming them into rafts is better and cheaper than any other suitable material, besides being very durable, and may be readily supplied by manufacturers.

It will be seen from the above that I have so shaped my plans for construction as to make the best use of the material near at hand.

ESTIMATES.

1st. For deepening channel across outer bar of Aransas Pass, line A B, Plate I, Fig. 2, and Plate II, Fig. 2:

24,000 fascines, 1 foot diameter, at 50 cents	$12,000 00
Labor on fascines	6,000 00
9,135 cubic yards rock, at $2	18,270 00
Labor	9,135 00
Plant, viz, towboats, barges, quarters, &c., and contingencies of engineering	15,000 00
Total	60,405 00

2d. Protection of head of Mustang Island, line C D, Plate I, Fig. 2, and Plate II, Fig. 3:

40,000 fascines 20 feet long, at 50 cents	$20,000 00
Labor on fascines	10,000 00
31,480 cubic yards rock, at $2	62,960 00
Labor	31,480 00
400 piles, 15 feet long, at $5	2,000 00
Total	126,440 00

Plant, &c., no additional expense, as that provided for in estimate No. 1 will be available.

3d. Dam across Corpus Christi Pass, line R S, Plate I, Fig. 3, and Plate II, Fig. 1:

4,680 fascines, 15 feet long, 1 foot in diameter, at 50 cents each	$2,340 00
Labor making	2,340 00
2,000 cubic yards of rock delivered at work, at $2	4,000 00
Labor sinking and ballasting fascines	2,000 00
Total	10,680 00
Contingencies of engineering 10 per cent	1,068 00
Grand total	11,748 00

4th. Approximate estimate for protection of southern end of Saint Joseph's Island, along line A E, Plate I, Fig. 2. The protection simply to arrest drifting sand $2,000 00

5th. Estimate for dredging in Aransas Pass a channel 10 feet deep and 100 feet wide at bottom, along line O P V, Plate I, Fig. 2. All material dredged to be carried off in scows:

122,222 cubic yards, at 25 cents $30,555 50

The total includes engineering contingencies.

6th. For dredging present channel between Corpus Christi Pass and Aransas Pass to a depth of 10 feet with bottom width of 100 feet. All material dredged to be deposited on side of cut, line P N L K I, Plate I, Fig. 2:

207,406 cubic yards, at 15 cents $31,123 40

Total including engineering contingencies but not purchase of the rights now enjoyed by the company controlling the channel.

7th. To dredge channel from Turtle Cove (Aransas Pass) to Corpus Christi Bay 10 feet deep and 100 feet wide at bottom; material dredged placed on side of cut, along line M L K I, Plate I, Fig 2.

1,114,814 cubic yards, at 15 cents $167,222 10

Including engineering contingencies.

8th. To dredge channel as above, along line H I, Plate I, Fig. 2:

1,325,925 cubic yards, at 15 cents $198,888 75

Including engineering contingencies.

As I have before stated, the works for which estimates Nos. 1 and 2 are offered are of the first importance. The results obtained from it will govern all the other work for which plan and estimate are submitted.

For this reason I recommend that the amount estimated for Nos. 1 and 2, viz, $186,845, be appropriated, and in doing so I beg leave to present two statements, viz:

1st. I have estimated closely.

2d. The importance of the improvement proposed appears to warrant appropriation, at one time, of the whole amount estimated. The most economical accomplishment of the work can only be secured by such action.

COMMERCIAL STATISTICS.

These were overlooked in the hurry of completing and forwarding report and charts. When called to mind it was too late to obtain them in time for report.

The commerce of the two ports of Rockport and Corpus Christi is, however, well known to be very considerable in beef-cattle, sheep, packed meats, hides, wool, &c.

The trade has been sufficiently important to sustain a quite regular steamship service between these ports and New Orleans, and justify the construction or projection of lines of railroad into the interior of the State.

One great benefit which Gulf commerce will derive from the deepening of Aransas Bar will be in its having available one more harbor of refuge along this dangerous coast, and I do not think that, on this account alone, leaving out all other considerations, I can too earnestly urge improvement.

The work is located in the collection-district of Corpus Christi, and the nearest lighthouse is at Aransas Pass.

Appended will be found the report of Mr. H. C. Collins, assistant engineer, who ably conducted the survey, and who gives in his report not only an account of the conduct of the survey, but many interesting

personal observations, and much valuable information obtained by him from prominent citizens of that part of the country.

With this report I send three large scale charts, covering the field of survey for file, and one index chart; also Plates Nos. I and II, for publication with the report.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers.

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

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

NEW ORLEANS, *December* 30, 1878.

SIR: I have the honor to submit the following report of the survey of Aransas and Corpus Christi Passes and Bays:

In accordance with instructions, I hired a schooner in Galveston, Texas, and took on supplies for a month and sailed to Aransas Pass. The party consisted of Messrs. H. S. Douglas and W. H. Hoffman, assistants, and two leadsmen, besides the captain and crew necessary for navigating the schooner, and myself.

We arrived at Aransas Pass July 19, 1878. A gale was blowing at the time, and we took a pilot in over the bar. Signal-stations were put up next day for locations of soundings in the harbor and channel and on the outer slope of the islands for several miles.

The north side of Aransas Pass is formed by Saint Joseph's Island, and south of it is Mustang Island. These islands have ranges of sand-hills 20 to 60 feet high, affording excellent positions for stations; a single pole, 16 feet high, with a large flag, being as conspicuous on the top of a high sand-mound as a large tripod would be on a level coast. Angles were read at all signal-stations to all points in sight for the triangulation, with a transit reading to minutes, and a base-line 2 miles long was measured with a steel tape-line on the sand-beach of Saint Joseph's Island. A tide-gauge was placed in the harbor, and one of the pilots employed to take hourly readings through the day for the whole time of the survey. Bench-marks were established on Mustang Island and connected with the gauge. The mean low-tide of the whole time was used for reduction of soundings of the survey. The tide-record, with the record of the self-registering gauge at Galveston for the time plotted on it, is also submitted with the charts. It shows that the low-tide used at Aransas Pass is almost exactly the same as that at Galveston.

Soundings were taken from the schooner while sailing and located by reading simultaneously two angles between three signal-stations on shore with sextants, Mr. Douglas and myself using the sextants and Mr. Hoffman recording. The schooner was sailed in whatever direction the wind would permit, covering the surface outside the 5-foot curve as well as possible, and running the shore-line and measuring base-line at such times as there was not wind enough to sail. We had sufficient soundings at Aransas Pass by August 1, and sailed by way of Corpus Christi Bay to Corpus Christi Pass. Here we placed signal-stations and measured base-line, as at Aransas Pass, but took the soundings with a yawl-boat, as there was not water enough for the schooner to sail or to cross the bar. The gulf slope was sounded for 3 miles out to 30 feet depth, and the pass out to as near shore as the yawl-boat, drawing 1½ feet, could sail. A tide-record was kept at Corpus Christi Pass during the time of sounding there. We then erected signal-stations and sounded the bay of Corpus Christi, running lines of soundings at as frequent intervals as necessary to show the bottom of the bay, but shore-lines only at points where the signal-stations were erected. The shore of Corpus Christi Bay from Flour Bluff to Corpus Christi City is high clay bluffs, nearly vertical except at Oso signal, which is at the entrance of Oso Bay (a shoal salt bay several miles long). West of Corpus Christi the bay connects with a very large shoal bay called Nueces Bay. From Indian Head around past Ingleside to McGloin's Bluffs the vertical clay walls are again found, with very large sand dunes at McGloin's and Flour Bluffs. At the passes shore-line was run for several miles near the channel to show the approaches to it. We then sounded the channel connecting Corpus Christi Bay with Aransas Bay. This was partly an old bayou connecting the bays, and partly a dredged channel in the shoal part of the northeast end of Corpus Christi Bay. Some dredging had also been done in shoal places in the old bayou and at its entrance from Aransas Bay. This channel belongs to a stock company having a charter from the State of Texas, and a charge is made

for all freight passing through it. There is at present a channel of 8 feet through at summer low-tide. It is at some points very narrow, but for most of the distance it is 80 to 100 feet wide. To increase this to a 10-foot channel would require an average cut of 2 feet for 10,500 feet from Lydia Ann Channel to the Aransas Bay entrance of the bayou, if Lydia Ann Channel was used, or of 16,500 feet if the ship-channel was used, with the same average cutting. From Aransas end of the bayou to Hog Island, 4,000 feet, would require a cut of not over 2 feet in any place in the present channel, unless it was widened, and from Hog Island to the point where Corpus Christi Bay is 10 feet deep 13,000 feet of the present dredged channel would require deepening from 1 to 2 feet to get a 10-foot channel through to Ransame Point, and thence to the deep water of the bay, 15,000 feet, has less than 10 feet, 9 or 9½ feet most of the way.

From deep water in Corpus Christi Bay to deep water in the lower harbor, straight across Harbor Island, is 22,000 feet, a small portion of which is a foot above mean low-tide, but very much of it is shoal ponds and bayous.

Harbor Island is nearly all mud, with very little sand in places and some shell reefs.

The banks of the present dredged channel where thrown up above water in Corpus Christi Bay are of blue clay, quite hard, and do not wash. The channel depth is within half a foot of what it was at first, and we found the bottom to be of soft mud for this half-foot, so that a steamship drawing 7½ feet found no impediment in it. *No sand bottom was found in this portion of Corpus Christi Bay;* but the bottom in Aransas Bay from the head of the bay down to Lydia Ann and ship channels is sand.

The whole shoal at the lower end of Aransas Bay is sandy in places, but the deep portion of the bay and of Corpus Christi Bay has blue clay bottom, except the shell reefs, which run out from shore in many places into each bay. They are so situated as not to impede navigation for any one knowing the channel, and could be easily buoyed out if necessary.

The immediate vicinity of the wharves of Corpus Christi, Rockport, and Fulton *would require more or less dredging to be available for any decided deepening of the bay channels,* as there is but 8 or 9 feet at any of the wharves at present. *The owners of these wharves will have the necessary dredging done to enable vessels drawing* 10 *feet to land as soon as they can get up through the bay.*

Soundings were taken in the shoal portion of Corpus Christi Bay, each side of the dredged channel, as far up as the schooner could sail.

In Aransas Bay the two channels connecting the bay with the lower harbor were sounded, and also that portion of the bay used in sailing up to Rockport and Fulton, but not the part of the bay above Fulton or northeast from Rockport towards Espirito Santo Bay. There is a navigable channel from this bay through to Matagorda Bay with 3 feet on shoalest places.

Of the two channels connecting Aransas Bay with the harbor, Lydia Ann Channel follows Harbor Island and is over 10 feet for nearly its entire length, but has a bar at its upper end of 7½ feet, while the ship-channel has 8 feet for more than half its length.

To connect Aransas Bay with this channel by a 10-foot cut would require an excavation for 14,000 feet nowhere more than 2 feet, and running off to nothing at the upper end. The shape of the shore-lines and the soundings indicate that Lydia Ann Channel is now increasing in depth and width from the effect of the violent current prevailing during northers. Pilots had noticed the same thing, and say that at the end of a norther the water in Aransas Bay is a foot lower than mean low tide in summer. The northers come only during the colder half of the year, and there were none during our survey. They are said to be preceded by easterly winds, which raise the water in all the back bays a foot or more above the usual height; then the water above the lowest level is blown down from Espirito Santo Bay and upper Aransas; some small portion of it finds its way through the bayous down to Corpus Christi Bay, but the greater part passes down Ship and Lydia Ann channels through the lower harbor and strikes the head of Mustang Island, which is cut away 200 feet or more each year. The Coast Survey charts of 1858 and 1868, and Lieutenant Woodruff's survey of 1871, when compared with each other and with the charts of this survey, show that this wearing away varies from 210 to 230 feet per year, Saint Joseph Island increasing as fast. Information received as to the position of the pass during the Mexican war would make the cutting of Mustang Island from 1846 to 1853 several times as great as it has been during the interval between any surveys and is not considered reliable.

The middle of August, 1878, there was a 3-day gale from eastward. The water in the lower harbor rose 3½ feet. It was 1½ feet above the prevailing summer height at Rockport and Corpus Christi wharves. There was a strong current up both passes during the time. The water covered nearly all of harbor island ½ a foot to 1 foot deep. The current was so broken by the ridges, ponds, and bayous that it made little addition to the amount passing in by way of the channels, but a stream enters Corpus Christi Bay over the flats of Turtle Cove ½ of a mile wide and nearly the whole height of the rise above mean low-tide at such times.

Current measurements were taken at any time in the bays or channels when the winds were too light to sail, or when it was too rough for other work, so that currents were found under various circumstances at many places in bays and channels; but all our information about northers and their effects comes from pilots who live there, and what we could see was plainly due to them in comparing different charts.

The field-work of the survey was finished September 17, when we returned to Galveston, and were unable to get to New Orleans on account of the quarantine, and began the charts there.

While making the survey the current ran down the coast to west of south, and there were breakers along the beach even with the lightest wind, and in any fair breeze from eastward there did not appear any break in the line of white foam in front of the bar.

The Texas coast is without an available harbor for vessels caught in the easterly gales so common on that coast during a great part of the year.

The sea-fronts of Saint Joseph, Mustang, and Padre Islands are strewn with wrecks. Some lives are lost with nearly every wreck, and in many instances all on board are lost. In a gale there is no harbor to run for, and if it increases so as to be too violent for the vessel to ride out, the only resource is to run on to the beach and be wrecked, with a view of saving as many lives as possible by loss of vessel and cargo. The currents at such times on the surface take anything up to the beach, the return being by undertow. This accounts in part for such quantities of drifts as are found along the coast—oak, pine, and cypress from the Mississippi and other rivers to eastward, and palm, mahogany, Spanish cedar logs, and bamboo canes and cocoa-nuts from tropical regions to southward.

In Aransas Harbor the bottom is blue clay through all the deep part and down as far towards the bar as 27½ feet depth abreast the head of Mustang Island, and outside the bar at 30 feet depth blue clay is again found. Between these points the bar is sand on the surface—how near the surface the clay comes at its highest point we had no means of determining, but it evidently forms the nucleus of the coast range of islands. The surface of these islands is sand, blown up from the beach into rounded mounds, forming ranges parallel with the coast line, and from 250 to 1,000 feet distant from the low-tide line. There are several of these ranges of mounds, the tops rising 20 to 60 feet. The ranges are not continuous. There are narrow gullies in the line, through which the wind blows the fine dry sand, making at the inshore end of the gully large flat mounds, quite different from the shore line mounds.

The shore range is evidently the newest, as those farthest inland are covered with a large growth of yucca, cedar, and other bushes, with grass, while the shore range has only grass, and the grass on all these islands is fast being destroyed by large numbers of cattle which nearly starve on it.

All navigation in the back bays, and any chance for a harbor along the coast, depends on the permanence of the coast islands and their line of dunes, which are fast being carried inland by the destruction of their protective coating of grass by cattle. *This grass is worth so little for pasturage and so much for protection of the hills, and indirectly of the navigation, that it would be well to exclude all but a very limited number of cattle from the coast islands, and to form plantations of the cedar for greater protection of the coast.*

The burning of some pile of drift, or some slide started by cattle, at times starts an old hill, and the whole of it is blown away, to be added to others further inland or spread over the lower inner part of the island, and in the bay back of it.

The area of these back bays is very great *and for nine or ten months in the year no fresh water runs into them.* The evaporation is so great that salt is formed in the shoal water far back from the Gulf, and in Laguna Madre, which is part of Corpus Christi Bay.

During our stay the water at flood tide ran in at Aransas Pass between Saint Joseph Island and the wreck of the *Saint Mary*, over a wide 3-foot shoal, on which, even in a quiet day, the Gulf continually breaks, and on stormy days it is very high. The water coming in from the Gulf runs on top of the bay water already in the channel.

Flood-tide currents were found only at the surface and to about mid-depth of the passes, the water for at least half its depth having no current in at flood.

Where the water coming in over this flat reaches the channel abreast the head of Mustang Island it is gray with sand, but as it reaches the light-house, a mile above, it has dropped its load of sand and is again the clear green water of the gulf. It remains entirely distinct from the bay water up through Lydia Ann and ship channel, slowly mixing with the heavier bay water.

Our current measures show that at ebb tide the current in the channel abreast the head of Mustang Island was about as strong near the bottom as at the top, and that none of it runs out over the flat where it came in, but follows the channel to southward of the wreck, and as it runs over the bar runs under the gulf water. On the surface it is clear bay water, entirely distinct from gulf water until it is lost under the latter. We had no draw-bucket to take samples from the bottom, but the fact that so large a quantity of sand is deposited each day at flood tide on this mile of channel,

and that the channel does not fill but remains 25 to 35 feet deep, proves that the sand brought in at flood is carried out at ebb tide over the bar, and really is the cause of the bar itself. All sand drifted in by winds from the islands must come out the same way with that cut from the head of Mustang Island. No mud or sand comes down the bay from above to help form outer bar.

In 1869 a pier about 600 feet long, of crib-work and brush loaded with rock, was built out on the sand-spit seaward from the south end of Saint Joseph Island. It was not water-tight, but for a time it stopped a part of this current of sand and water into the pass, giving a 12-foot channel while it was perfect.

The shore of Saint Joseph Island soon advanced to the outer end of the cribs, and the head of Mustang Island cut away, moving the channel further away from the pier, but it was 2 years before the pass had shoaled to its old depth of 7½ feet.

The curves of equal depth are pushed out off the channel 1,000 to 1,500 feet, but as the channel is moved southward the slope soon becomes the same as before, that of Mustang Island, 2 miles south from the wreck, being almost exactly the same as Saint Joseph Island, 3 miles to northward. The sand-dunes do not reach the south end of Saint Joseph by about 2 miles; the sand which would form them, were there some nucleus given, is now blown over and is dropped into the harbor to be carried out by ebb-tide. A line of cane hurdles just strong enough to offer protection against the wind would soon extend this line of sand hills to the pass.

An inspection of the charts will show a great similarity between Aransas and Corpus Christi passes in many respects, but Corpus Christi Pass appears to be very much older than Aransas Pass. It has cut its way for 8 miles from its head, while Aransas is yet but 3 or 4 miles from a similar connection with Aransas Bay. Corpus Christi Pass is now very shoal and narrow—too narrow for vessels to beat anywhere in the pass—and it has at its head less than 3 feet of water over a large quicksand bar. The sand blown at the south end of Mustang Island was much greater in quantity when we were there than on Saint Joseph Island.

August 16, the sand deposited on deck of the schooner in the pass was ⅛ of an inch in depth; and, of course, as much on the entire water-surface of the pass and of the extreme lower end of Corpus Christi Bay, which will account for the shoaling of this pass, which is said to have decreased to about half the size it had in 1846. It is now much shoaler and narrower than at the time of Lieutenant Woodruff's survey in 1871.

The distance from Corpus Christi to Corpus Christi Pass is but 10 miles less than from Corpus Christi to Aransas Pass; but were the channel cut straight through Harbor Island, there would be no great difference. The fact of the greater specific gravity of the bay water makes the improvement of the channel depend on shutting off the surface current coming in over the shoal at the south end of Saint Joseph Island, and on the protection of the head of Mustang Island. Were there a pier running out the length of this shoal, and to water so deep at its outer end as to be below reach of the agitating effect of the waves, the flood-tide current would run in clear on top of the bay water in the channel, and have no load of sand to drop, while the scouring effect of the ebb-tide would remain as at present, and resting as it does on the bottom, and running out under the gulf water, no bar could form in front of it so long as the pier did stop the sand current and the head of Mustang Island keep the channel up to its position. There might, after a long time, be a new coast line of reef, which is probably forming outside the coast range of islands; but it would only be a matter for the distant future. The opening of a channel of 20 feet or more at this point, to make the present fine harbor available for shipping, would not benefit the commerce of West Texas alone, but would make a place of refuge for vessels caught anywhere in the western part of the gulf. In a single year the saving in property alone might be more than the whole cost of the works necessary, and it would afford permanent reduction of freights by lowering the present ratio of loss. Wood-work of oak or pine will last but 3 or 4 months when exposed to ravages of the teredo; but they do not eat the palmetto logs or the bamboo cane. Rock is found in inexhausitble quantities on navigable waters of the bays and in Laguna Madre, and is at present delivered in small quantities at Corpus Christi at $2.50 per ton, and would probably cost even less in large quantities at the pass. Lumber is brought from Sabine and Calcasieu, and costs at Corpus Christi $2 or $3 per 1,000 more than Galveston. Cane is found on the rivers running into the bay east of Aransas, and connected with it by an inland navigable pass.

Three charts on a scale $\frac{1}{5000}$ show Aransas Pass, Corpus Christi Pass, and the channel connecting Aransas and Corpus Christi bays, and one chart, scale $\frac{1}{20000}$, shows the entire survey, passes, and bays.

To the most efficient assistance of Mr. Douglass and Mr. Hoffman, and to the intelligent co-operation of all the men employod, is due the success of the survey in covering so large a tract with soundings, and the other work of the survey with so small an allotment, as only with such help could it have been done.

Yours, respectfully, H. C. COLLINS, *Assistant Engineer.*

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Corps of Engineers, U. S. A.