73

ANNUAL REPORT

OF THE

MISSISSIPPI RIVER COMMISSION

FOR THE

FISCAL YEAR ENDING JUNE 30, 1893;

BEING

APPENDIX Y Y

OF THE

ANNUAL REPORT OF THE CHIEF OF ENGINEERS FOR 1893.

C. B. COMSTOCK, Colonel, Corps of Engineers, Bvt. Brig. Gen., U. S. A., *President*,
CHARLES R. SUTER, Lieut. Colonel, Corps of Engineers, U. S. A.,
O. H. ERNST, Major, Corps of Engineers, U. S. A.,
MR. HENRY L. WHITING, Assistant, U. S. Coast and Geodetic Survey,
MR. B. M. HARROD,
MR. ROBERT S. TAYLOR,
MR. HENRY FLAD,
Commissioners.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1893.

The Miss River Comm

[EXTRACT FROM THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., September 19, 1893.

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MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission, constituted by act of Congress of June 28, 1879, is in charge of the improvement of Mississippi River between the mouth of Ohio River and the head of the Passes and of surveys of the entire river.

The commissioners during the past year were Col. C. B. Comstock, Corps of Engineers, president; Lieut. Col. Charles R. Suter, Corps of Engineers; Maj. O. H. Ernst, Corps of Engineers; Henry L. Whiting, assistant, U. S. Coast and Geodetic Survey; B. M. Harrod, Robert S. Taylor, and Henry Flad.

The report of the Commission upon the operations under its charge for the fiscal year ending June 30, 1893, is submitted as Appendix Y Y.

Estimates for the fiscal year ending June 30, 1895.—The following estimates of funds required for carrying on the works under its charge for the year ending June 30, 1895, are submitted by the Commission:

For improving Mississippi River from head of the Passes to the mouth of Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$2,665,000
For improving harbors at—	
New Madrid, Mo	75,000
Memphis, Tenn	100,000
Greenville, Miss	200,000
Vicksburg, Miss. (Delta Point)	150,000
Natchez, Miss., and Vidalia, La	400,000
New Orleans, La	300,000
For improvement at head of Atchafalaya and mouth of Red River, Louisiana	350,000
Total	4,240,000

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APPENDIX Y Y.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

ARMY BUILDING,
New York City, June 28, 1893.

SIR: The Mississippi River Commission has the honor to submit its annual report for the fiscal year ending June 30, 1893.

The act approved July 13, 1892, appropriated the following sums to be expended under the Commission:

Improvement of—	
Memphis Harbor, Tennessee	$25,000
Vicksburg Harbor, Mississippi	80,000
Greenville Harbor, Mississippi	100,000
Natchez Harbor, Mississippi } Vidalia Harbor, Louisiana }	80,000
Atchafalaya and Red rivers	80,000
Mississippi River	2,000,000

The last-named sum was distributed as follows:

Levees	$1,500,000
Channel works (construction)	333,000
Channel works (dredging)	35,000
Plant	110,000
Surveys, gauges, and observations	22,000

Details of allotments are shown in the financial statements.

Transfers of allotments and of previous balances have been made as follows:

The levee system having been redistricted balances of previous allotments for levees was transferred to the new titles. From Plum Point $25,000 has been transferred to rebuilding the steamer *Mississippi*, $15,000 to dredging experiments, and $2,000 to surveys, gauges, and observations.

First and second districts: From the balance for Memphis Harbor has been transferred $7,431.78 to Hopefield Bend. From Ashbrook Neck has been transferred $25,000 to plant for the third district. From the general service its remaining balance of $46,345.33 has been transferred to surveys, gauges, and observations under the secretary.

The act approved March 3, 1893, appropriated the sum of $2,665,000, to be available July 1, 1893.

From this distribution has been made as follows:

Levees	$1,500,000
Channel works (construction)	455,000
Dredging experiments	40,000
Plant	292,000
Surveys, gauges, and observations	132,000
Expenses of Mississippi River Commission	40,000

leaving unallotted $206,000, of which $150,000 is held awaiting the results of the dredging experiments.

Since the last report of the Commission five meetings have been held, as follows: In New York on June 22, August 2, 1892, and June 26, 1893; on the steamer *Mississippi* November 5, 1892, and on the steamer *Gen. Barnard* on May 6, 1893. The two last-mentioned meetings have included inspections of the works.

OFFICE AND SURVEYS, GAUGES AND OBSERVATIONS.

Triangulation.—At the date of the last annual report the triangulation party on May 31, 1892, had reached Fairport, Iowa. Subsequently this work has been extended upstream a distance 116 miles, and to within 9 miles of Dubuque, Iowa, by August 26. This is, at present, the northern limit of the triangulation of the general survey which the Commission is directed to extend from the Head of the Passes to the headwaters of the Mississippi River. This survey, complete in its triangulation, topography, and hydrography, is now finished from the head of the Des Moines Rapids to Donaldsonville, La., 79 miles above New Orleans. The leveling and triangulation is finished to the Head of the Passes.

The survey down to Donaldsonville, done by the Commission in 1883, connected with a survey in 1879, extending up to Donaldsonville from the Head of the Passes, by the U. S. Coast and Geodetic Survey. It was considered advisable, in order to obtain the information which is best given by comparative surveys and to secure uniformity of method and detail, to extend the survey of the Commission from Donaldsonville down to the Head of the Passes. Accordingly a party entered the field at Donaldsonville on December 13, 1892, to make such triangulation as might be found necessary, from lapse of time, in a region which had already been triangulated by the Coast and Geodetic Survey, and to mark the stone lines which form part of our system. Descriptions of triangulation of located points were furnished by the Coast and Geodetic Survey, and enough of them were found to render secondary triangulation unnecessary.

This party reached Kennerville, La., 62 miles below Donaldsonville and 17 miles above New Orleans, on January 12, 1893, and completed the triangulation to the Head of the Passes, an additional distance of 94 miles by the river, on March 15.

Precise leveling.—The foregoing party was sufficiently strengthened at Kennerville to add to its duties the extension of the line of precise levels which the Commission had already run from Duluth and Chicago, on the Great Lakes, across to and down the Mississippi River to New Orleans (with a branch line to tidal level of the Gulf of Mexico at Biloxi, Miss.) down to the Head of the Passes.

The practicability of this extension, as it enters the low and marshy tracts bordering the river near the Gulf, has generally been considered doubtful on account of the instability of the soil. The experience of this party still leaves the work with an uncertain value, and it will be most important to rerun this line, after sufficient time has elapsed to give comparative results, in order to prove the permanence of the bench marks or ascertain the causes of their instability.

Topography and hydrography.—On September 1, 1892, a party entered the field at Hannibal, Mo., to continue the upstream extension of the topography and hydrography of the Commission's survey. By the end of the working season, on November 10, a river distance of 69 miles was covered, and the work was suspended at a point near the head of the Des Moines Rapids, 10 miles above Keokuk, Iowa.

Maps, publications, etc.—The condition and progress of the publication of the charts of this survey may be stated as follows:

The map of the alluvial region, reaching from the Gulf of Mexico up to Cape Girardeau, Mo. (scale 1 inch to 5 miles), is complete in 8 published sheets.

The 1 inch to the mile map is complete from the Head of the Passes to Grafton, Ill., 1,289 miles by river, in 41 sheets.

The charts on a scale of 1:20000 are now complete from Donaldsonville, La., to Grafton, Ill., 1,116 miles by river, in 84 sheets. Four sheets have been issued since the last report.

The charts on a scale of 1:10000 are now complete from Donaldsonville, La., to just above Quincy, Ill., a distance by river of 1,235 miles. Seven have been completed since the last report.

During the year 25 gauges have been maintained in good order by the Commission and daily observations read. The collection, tabulation, and publication of these gauge records, together with others kept by Majors Mackenzie and Allen and by Captains Willard and Taber, of the Corps of Engineers, and by the Weather Bureau, aggregating 32 on the main river and 26 on the tributaries, has been brought down to include the year 1892. An improvement in the construction of gauge bulletins, designed by Assistant Engineer Ockerson, adding materially to their strength and durability, is being made as fast as reconstruction is required.

The publication of the gauging of the main river and of its tributaries, made under the direction of the Commission at different points and stages, has been continued to include the year 1892.

An exhibit, consisting of various maps, observations, and methods of the Commission, has been prepared and placed in the World's Columbian Exposition.

An interesting study and report on eighteenth century maps of the Mississippi River has been made by Captain Palfrey, secretary of the Commission. These show great topographical ability on the part of the authors, and indicate that the constant and rapid changes observed in the river are local, and of detail, and mainly caused by cut-offs, and that the great features of curvature are permanently characteristic.

During the year the steamer *Mississippi* lost her upper works by fire, and the *Pete Kirns* was crushed in an ice gorge. The former is being rebuilt and the latter replaced by purchase.

Diligent efforts have been made this year by the secretary and the district officers to collect commercial statistics of the river, and much greater success has been obtained than in previous years. The analysis of the information received from the Mississippi Valley Transportation Company, by the secretary, shows in a clear light the importance of improved low-water navigation. The result of their labor will be found in their several reports and appendices.

Further details of the transactions of the Commission and of its office will be found in the report of Captain Palfrey, secretary, and the several reports of assistant engineers and the appendices attached thereto.

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky., 21 miles below Cairo.—This work is intended to protect the front of the town against erosion. It covers 2,200 linear feet of bank and was completed in 1891. It has accomplished its purpose, and, at present, requires neither repairs nor extension.

Hickman, Ky., 36 miles below Cairo.—At this point the hills reach the river, and on and below them the city is located. For several years caving of the alluvial bottom lands, both above and below the bluff, had been going on rapidly, while the harder hill formation has successfully resisted the attack of the current. At one time there was a railway terminus above the bluff, but this was abandoned before appropriations for the improvement were made. Therefore, from the small value of the land above the hill, from the great extent of work which would have been required to protect it, and because the bluff made a safe head for the work, a project was adopted for starting a revetment there, extending 1,000 feet downstream. This work was built in 1890 and has accomplished its purpose. It is possible that an extension both in width and length may be required as the floods have damaged the lower end and increased the depth along its outer edge. The repairs so far necessary at the lower end have been made and additional ballast placed on the shore mats.

New Madrid, Mo., 71 miles below Cairo.—The project for this improvement consists of a revetment along the front of the town, from Dry Slough downstream, to protect it against erosion. The stone for the work has been delivered on the bank, and construction will commence as soon as the water has fallen sufficiently to make it practicable.

Plum Point Reach, 147–186 miles below Cairo.—This reach has a length of about 40 miles. The several works designed for its improvement are detached and consist of continuous and interrupted revetments of spurs, dikes, and training walls. These are all intended to coöperate in confining and directing the channel throughout the limits of the reach. Reference is here made, in detail, to each of these works and its present condition, in geographical order, beginning at the upstream end.

Daniels Point revetment.—This revetment was commenced in 1888, to maintain the conditions and direction in which the river entered the reach. At that time about one mile was built, with the intention of extending it upstream, in subsequent years, as far as might prove necessary. Slight repairs were required during the fiscal year ending June 30, 1892, and others of a more extensive character have been necessary during the past year. The work is in a very exposed position and, owing to the short length of bank covered, is liable to serious attack on either flank. All repairs were repeated on March 1, 1893, and the work is now in good order. Preparations are made to extend it 1,000 feet upstream during the early summer.

Ashport Bend revetment.—At the date of the last report this revetment had been extended downstream to a point 6,750 feet below Ashport. Its extension has been actively pushed during the working season of the past year, and by February, 1893, when work was suspended by high water, 8,504 additional feet of bank had been covered. This leaves only about 4,000 feet to complete this part of the project. Considerable difficulties were encountered on this work, in some parts owing to the unstable nature of the soil and in others from the great number of cypress stumps, both of which added much to the time and cost of grading. The mats below low water range in width from 200 to 240 feet.

Gold Dust dikes.—These dikes remain as they were described in the report of 1891. No further work is now contemplated, as the projected dikes in Elmot and Island 30 chutes will better accomplish the results that would be gained by their maintenance.

Fletchers Bend revetment.—This work, commenced in 1884, had reached at the time of our last report a continuous development of 12,900 linear feet. Below this was three detached pieces, aggregating about 3,300 feet, practically giving a length of 17,400 feet of protected bank. It is proposed to connect these detached pieces as soon as circumstances will permit, and an allotment is made for that purpose. The repairs required during the past year have been unimportant.

Elmot and Island 30 chutes.—It has been necessary to postpone so far the construction of the dikes across Elmot and Island 30 chutes. This work is now proposed as part of the operations of the coming season. These will be low-water dams, intended to turn the low-water flow from these by-ways, and divert it into the main channel, for the improvement of Fletchers and Elmot crossings. An allotment has been made for the purpose and the required amount of stone has been delivered on a convenient part of the bank. The object of these dikes has been to a certain extent anticipated by sinking mats, heavily ballasted with stone, over the drift racks accumulated in the chutes.

Plum Point revetment and dikes.—No work has been done or is at present intended here.

Osceola revetment.—At the date of last report this work had a length of 5,500 feet, which is apparently sufficient for protecting the bar.

Osceola and Bullerton dikes.—No work has been done or is at present intended here.

Bullerton revetment.—This is one of the earliest revetments built by the Commission. It had a width of only 100 feet. It has done good service, but recent changes in the channel have subjected it to a strain which makes it necessary that it should be largely if not entirely rebuilt with greater width and strength.

Levees.—The only levees at present in this engineer district are in the vicinity of Plum Point, in connection with the channel improvement.

An allotment of $264,000, under the provisions of the act of July 13, 1892, has been made for the levees of the lower St. Francis Basin, from Point Pleasant to Helena, with a frontage of 228 miles. Surveys and contracts will be made as soon as practicable after the overflow, to commence the construction of the levees of this district, beginning at Bear Bayou and extending upstream as far as the allotment will permit.

Surveys, gauges, and observations.—During the year the usual surveys were made in this district in connection with the works of channel improvement and with levees. Special surveys were made of a shoal crossing near New Madrid, and of the lower portions of the Wolf and Caloosahatchie rivers, in connection with Memphis Harbor. Also special examinations, by soundings, have been made of the revetments of this district, with the view of ascertaining the condition of such work, and the cause of such defects as might be detected. The results of this and similar examinations made in the other districts will be discussed in another part of this report. All details of these examinations with an important discussion, as well as of all other transactions in this district will be found in the appended report of Capt. S. W. Roessler, in charge of the district, and in the reports of his assistant engineers.

High or low water discharge measurements were made at Columbus, Ky.; New Madrid, Mo.; Fulton, Tenn., and Helena, Ark.

SECOND DISTRICT (ISLAND 40 TO MOUTH OF WHITE RIVER, 180 MILES).

Hopefield Bend, Ark., 225 miles below Cairo.—The revetment built in this bend is intended to coöperate with the local work along the front of Memphis Harbor. It was commenced in 1882, and has, year by year, except when revetment work was interdicted by Congress, been carried to a completion in 1889. Such injuries have been caused by floods and such repairs made as have been described in previous reports. After the flood of 1892 repairs aggregating 4,200 linear feet and the strengthening of about 1,300 feet were found necessary. This was done during the past low-water season, but other breaks, four in number and aggregating 1,600 feet in length, have occurred during the past flood.

Memphis Harbor, 230 miles below Cairo.—Without the holding of Hopefield Bend by the revetment just reported on the harbor of Memphis by this time would have been largely obstructed by the extension of the sand bar below Old Hen Island. As it is this bar has encroached on the front so as to overlap the paved landing about 150 yards. The other harbor works, consisting of 7,500 feet of revetment and 2,000 feet of spur protection, have accomplished their object and continue in good order.

Nonconnah Rocks, 236 miles below Cairo.—Contract has been made for the removal of this obstruction to the channel on the left of Presidents Island, to a depth of about 8 feet below low water, during the coming season.

Helena Harbor, 306 miles below Cairo.—This work remains in the condition described in the last report of the Commission. It consists of 600 linear feet of revetment and five spurs, covering a frontage of about 3,000 feet, which includes the most important part of the harbor. The lower end of this work is still incomplete, but the objects sought seem fairly established and no further work is in contemplation at present.

Levees.—In this district are included the lower part of the lower St. Francis Basin, to which allusion has been made in the report on the first engineer district, also the Upper Yazoo levee district, 244 to 365 miles below Cairo, and the levee districts in the White River Basin, 306 to 385 miles below Cairo. The levees of the Upper Yazoo levee district, about 120 miles long, are in a higher state of efficiency than those of most other parts of the system. They have generally grades 3 or 4 feet above the highest recorded water, full crowns and sections, and banquettes where the height makes it advisable. No crevasse has occurred in this district for the last two years. The work of the past year has been an enlargement of section over 5 miles, and the construction of a new levee about 1½ miles long at a point threatened by caving. The proposed work for the coming year is a further enlargement of about 10 miles and the construction of a new levee about 3,500 feet long.

The work done in the past year by the General Government was 503,448 and by the local authorities 439,106 cubic yards.

The White River Basin, extending from Helena to the mouth of White River, about 78 miles of frontage, comprises a projected system of levees throughout its length. Work on these has been commenced on both the upper and lower ends, as giving the most immediately valuable results in protection from overflow. At the date of the last report the upper section extended about 21 miles below Helena and the lower section was about 19 miles long, leaving a gap of about 24 miles. During the year this gap has been reduced about 4 miles, and a long section of existing levees has been raised and strengthened. These levees, as far as built, are generally of fair grade and section. It is proposed during the coming year to reduce the intervening gap as much as the allotment will permit.

Surveys, gauges, and observations.—The surveys necessary for information concerning several works and the condition of the river in the district have been made during the year, and also many borings to gain information concerning the character of the soil at depths to which the channel reaches and to which revetments must necessarily extend. Special surveys of revetments such as were described in the first district were everywhere made and will be discussed hereafter.

Full accounts of the operations of this district will be found in the reports of Capt. S. W. Roessler and of his assistant engineer, and in their appendices.

THIRD DISTRICT (FROM WHITE RIVER TO WARRENTON, MISS., 220 MILES.)

Lake Bolivar front, 417 miles below Cairo.—This work, consisting of 4,400 linear feet of revetment, intended to protect the Lake Bolivar levee and its site, was completed in 1889. It has accomplished its purpose. During the coming year it is proposed to make the necessary repairs, which are slight.

Ashbrook Neck revetment, 446 miles below Cairo.—This important work had in view the prevention of a cut-off at the upper end of the narrow necks, formed by the remarkable series of reverse curves in the river just above Greenville, and known as "The Bends." It was apprehended that a cut-off at this point would, by shortening the local length, so increase the slope and velocity of the river that the rate of caving would be much augmented, other cut-offs would occur, the harbor of Greenville be destroyed, many miles of levee lost, and a general disturbance induced of the conditions of this part of the river which are now tolerably stable and quite favorable for navigation. The work was designed to consist of a continuous revetment 8,000 feet long with a width of 300 feet below low water, or as near that as is practicable. Work was commenced in 1890, during which season 2,820 feet were laid. During the next year, besides the repairs which were necessary at the lower end of the previous season's work, an extension of 2,500 feet downstream and 1,500 upstream was made. During the past season the work was completed by a further upstream extension of 2,610 linear feet. To assist in the same object a spur dike or levee was built down the axis of the point to obstruct the overflow across the neck. Although this part of the work was badly damaged by the floods it accomplished an important result by accumulating a large quantity of drift and sand. No further work is now contemplated at this point.

Greenville Harbor, 478 miles below Cairo.—The object of this improvement is the protection from caving of the bank on which the city of Greenville is built. The first project proposed only the construction of a series of spurs along the city front. This was accomplished in the years 1887, 1888, and 1889. They gave an immediate local result, but it was soon recognized that the caving in the bend above was so rapid that, to preserve the existing work and the city, it was necessary to extend a revetment upstream until a stable bank was reached. This was commenced in 1891, during which year 6,600 linear feet of mat work, similar to that at Ashbrook Neck, was laid. During the past season 4,450 feet have been added. It is proposed to continue the work as fast as circumstances will permit.

Lake Providence Reach, 512–572 miles below Cairo.—The reports of the last and previous years have given full details of the various works of channel improvement comprised in the system for the rectification of this reach. At the date of the last report the revetment of Louisiana Bend, commenced in 1889, had a length of 11,024 feet, all in good order. During the past year 5,835 feet have been added, making a total length of 3¼ miles. Notwithstanding the destruction of many of the earlier works built in this reach, and the failure of the continued operation of others by the extensive caving in bends opposite the contraction works, which it was not in the power of the Commission to prevent, partly from lack of funds and partly from legislative restrictions, the beneficial results secured for navigation are not lost. It is not proposed to continue any work in this reach during the coming season for reasons that will be given hereafter.

Vicksburg Harbor and Delta Point, 599 miles below Cairo.—Since the cut-off of the point opposite Vicksburg in 1876 a persistent and successful effort has been made to prevent the caving of Delta Point. Any further recession of this point would not only add to the commercial disadvantages under which this city rests as the result of the cut-off, but would also very materially increase the cost and difficulty of any plan, that can be devised for the improvement of the harbor. The maintenance of this point has therefore been regarded as the key of the situation to which all other features were subordinate. Besides this work at Delta Point the dredging of a canal of navigable width and depth at the lowest stages, leading from the main channel of the river into the east end of the lake formed by the cut-off and along the commercial front of the city, was undertaken in 1887. To protect it against silt-bearing currents in higher stages a dike is being constructed, with excavated material across the lake at the head of the canal, and has now reached a height of 25 to 35 feet above the zero of the Vicksburg gauge.

The Delta Point revetment has been successful and is now in efficient order. Its permanence is, however, threatened by a very considerable increase of depth from scour along its outer edge. It is therefore proposed, during the coming working season, to increase the width and take all other necessary precautions for the preservation of this mat work.

The results of dredging in the canal have not been encouraging, more particularly in the last two years, during which 559,721 cubic yards have been excavated and a refill of 298,000 yards, or over 53 per cent, has occurred. The total excavation since 1887 should have given a prism with a contents of 1,416,165 cubic yards, of which only about 1,000,000 yards, or 70 per cent, can now be found. It will be observed that the fill has occurred at an increasing rate as the excavation has been deepened.

The river and harbor bill of July 13, 1892, adopted the plan of Capt. J. H. Willard, Corps of Engineers, for an improvement of Vicksburg Harbor, and made an appropriation for its execution. This project contemplates the diversion of the Yazoo River from its present outfall into the east end of Centennial Lake and along the city front. When this plan is put in execution the dike under construction by the Commission, across the head of the canal to protect it against silt-bearing currents, will be an obstruction which it will be necessary to remove. But, in view of the past experience in dredging, it is evident that an exclusion of the sediment-charged flow is necessary to the success of the canal. The Commission therefore recommends that no further work be done upon the dike across the head of the canal, and, also, in view of the importance of this dike to the successful completion and maintenance of the canal, that further dredging be suspended.

Levees, Lower Yazoo district.—This district is on the left bank, with a river frontage of 215 miles and a development of levee line of about

190 miles. With that of the Upper Yazoo district it completes the protection of the Yazoo Basin. The levees of the district have generally comparatively fair grades, crowns, and slopes, with banquettes on the land side where the heights are great. They have successfully withstood the great floods of 1892 and 1893 without a break. During the last fiscal year the Government work has consisted in raising and strengthening about 20 miles of the line to standard grade and dimensions. Similar work will be prosecuted under the allotment for the coming working season over about 30 miles.

Upper Tensas district.—This district is on the right bank of the river, extending from the Arkansas River down to the Louisiana line. It has a length of about 85 miles. The head of the system rests on moderately high land on the bank of Amos Bayou, about 7 miles back from the Mississippi at Lucca Landing. This location gives fair protection to the Tensas Basin against flood coming exclusively down the Mississippi, but when the Arkansas is in flood at the same time a large volume escapes around the head of those levees into the Tensas Basin. This overflow in 1892 amounted to 300,000 cubic feet per second. The Commission has now under advisement plans of extension to prevent this condition of affairs. The general condition of this line of levees is very far inferior to those heretofore described on the Yazoo Basin front. While the levees recently built both by the General Government and by the State authorities of Arkansas and Louisiana are of standard grade and section, yet many old-time levees are still remaining which were topped during the last two floods and have very weak sections. The length of these deficient parts was estimated during the flood of 1892 at about 40 miles. This has been materially reduced during the past year by the placing of 1,203,000 cubic yards of earth by the General Government. Similar work will be prosecuted during the coming low-water season by the building of about 1,100,000 cubic yards. Even with these expenditures there will still remain in this district about 25 miles of low-grade and weak levees, which are an annual source of danger and expense. During these same periods about 250,000 cubic yards have been placed and undertaken by the State organizations.

There have occurred in this district from the flood of 1893 four crevasses.

Middle Tensas district.—This levee district is on the right bank and is continuous with the Upper Tensas, from the Louisiana State line down to a point opposite Warrenton, Miss., 10 miles below Vicksburg. It has a levee length of 87 miles. While the grades and sections of these are generally rather better than those of the Upper Tensas, yet many of them require very material improvements to make them safe, and many more are threatened with caving in the very near future, and large expenditures will be required within the next two or three years, if not sooner, to preserve the continuity of the line. This caving is graphically shown in the plate accompanying the report of Assistant Engineer Ockerson (Appendix 4 F, Report 1892) on the relative rate of caving in different parts of the river.

During the past year the General Government has built 460,000 and the State organizations 258,000 cubic yards of levee in this district.

During the present flood there has occurred one crevasse at Wylys. This is a most disastrous one, having an observed discharge of 200,000 cubic feet per second. This, with the crevasses in the Upper Tensas district, all discharge into the Tensas Basin, and the overflow is collected and returned into Lower Red and reaches the Gulf through the Mississippi and Atchafalaya rivers. In this emergency the General Government has rendered efficient assistance in the supply of labor and material and in inspection, patrolling, and other services which could be best rendered by the steamboats and barges under the control of the district officer.

Surveys, gauges, and observations.—Full surveys have been made during the year of all the works of channel improvement in this district, also many levee surveys. Discharge observations have been taken at Arkansas City and Wilsons Point, on the Mississippi, and also on the Arkansas and White rivers.

As in the first and second districts, special examinations have also been made here into the condition of the revetments of the district. The results of these, with important discussions, are presented in the appendices containing the reports of Captain C. McD. Townsend and his assistant engineers. In these appendices full details will be found of all the transactions in this district. The results of the special examination of revetment work will receive consideration in another part of this report.

FOURTH DISTRICT (WARRENTON, MISS., TO HEAD OF PASSES, 484 MILES).

Natchez, Miss., and Vidalia, La., Harbors, 700 miles below Cairo.—This improvement will consist mainly of bank revetment, intended to avert a cut-off through the point above the harbors in question, by which the Vidalia bank would be badly eroded, and a sand bar formed in front of Natchez. As the appropriation was entirely insufficient to undertake a very large amount of revetment required, it was determined by the Commission to confine the year's operation to the construction of a spur levee, to prevent the injurious and dangerous flow in high water across the point. Surveys for this have been completed and the work will be done as soon as the high water sufficiently subsides.

Rectification of the Red and Atchafalaya rivers, 764 miles below Cairo.—The condition of affairs remains the same at this point as was described in the last report of the Commission. The project for improvement has also been set forth in full detail in previous reports.

At the approach of low water and during September, 1892, three dredges were employed in maintaining the channel from the Mississippi, through lower Old River, into the Red and Atchafalaya. Notwithstanding every effort navigation was entirely suspended from October 1 until early in November and was not freely reopened until the 19th of that month.

During the year the Commission has contracted for the building of a dredge boat specially designed for work in upper Old River on the adopted project for meeting the requirements of several acts of Congress on the subject. This boat will be completed before the low-water season, when dredging will be commenced in upper Old River. The balance of the appropriation on hand, after paying for this dredge, may not be more than sufficient for temporary work in maintaining navigation during the low-water season through lower Old River. As soon as sufficient funds are available for the completion of the dam it is proposed to take advantage of the expressed willingness of the steamboat men of the Red, Atchafalaya, and Ouachita rivers, mentioned in our last report, to relinquish the use of the old channel and suspend their trade for the time during which it will be necessarily obstructed by the raising of the dam to a sufficient height to divert a large part of the low-water discharge to the north of Turnbulls Island, and thus coöperate with the dredging operations in opening that channel.

New Orleans Harbor, 963 miles below Cairo.—The project for the improvement of this harbor contemplates, almost exclusively, the protection against caving of the banks of the river, by spurs and revetments. The condition of the river and its banks within the limits of this harbor is one of comparative stability, when compared with the extraordinary changes which occur above and below Vicksburg. But, owing to the valuable improvements located immediately on the banks of the harbor and the enormous commerce to which they minister, any change which, in other localities, would be of slight importance, becomes here a most serious matter, involving the loss of wharves, warehouses, public streets, factories, and other valuable real estate, as well as restricting and impeding both interstate and foreign commerce.

It may also be observed that the methods of improvement which have been applied to this harbor have proved generally effective, as far as the limit of appropriations have permitted their application. There exists great need for the early extension of similar work of improvement down the Carrollton Bend to Audubon Park, from St. Ann to Esplanade street, for an increased number of spurs in the Third Municipal district, and for work at the Algiers Point. In all these places, where valuable properties and interests are located, erosion, more or less rapid, but always destructive, is going on. In some cases the damage in one year of erosion has exceeded the cost of permanent improvement.

During the past year work has been confined to the placing of continuous bank revetment in the intervals between the completed dikes in the Carrollton Bend at Southport, at which point the short radius of curvature makes the attack of the current so direct and the slope of the bank so abrupt as to render this additional precaution advisable.

A part of the appropriation of $80,000 (for two years) was necessarily expended in new barges and repairs to the plant.

Levees.—The levee work in this engineer district has largely increased during the past year, and a redistribution of the levee districts within its limits has been found convenient. The titles of the several allotments have been accordingly changed. A detailed description of the season's operations will be found in the reports of Capt. J. Millis and of his assistant engineers.

Several improvements have been made in the methods of construction, which are described therein.

The titles, lengths, and limits of the levee districts, as rearranged within the engineer district, are as follows:

Lower Tensas, right bank, from Warrenton to Red River, 146 miles of river, of which 130.5 are leveed.

Atchafalaya, right bank, from Red River to the Lafourche, 121 miles, entirely leveed.

Lafourche, right bank, from Lafourche to New Orleans, 78 miles, entirely leveed.

Barataria, right bank, from New Orleans to the Head of Passes, 80 miles, of which 70 is leveed.

Pontchartrain, left bank, from Baton Rouge to New Orleans, 124 miles, entirely leveed..

Lake Borgne, left bank, from New Orleans to Head of Passes, 90 miles, of which 80 miles is leveed.

The work done during the past year, including contracts under way, but not completed, by the General Government in rebuilding and raising and enlarging to standard grade and section is as follows:

District.	Miles of levee length.	Miles improved this year.	Cubic yards.
Lower Tensas	130.5	23.90	590,350
Atchafalaya	121	5.72	677,290
Lafourche	78	5.91	461,711
Barataria	70	12.28	782,806
Pontchartrain	124	11.43	415,646
Lake Borgne	80	8.72	361,346
Total	603.5	67.96	3,289,149

It will be seen that within the past year's operations over 11 per cent of the levees of the district have been improved by the General Government. The work of the State organizations in the same limits during the year 1892 has comprised the raising and enlargement of 101.5 miles, or about 17 per cent, of the several lines, all to standard grade and dimensions except 24 miles, which were temporarily improved.

The flood of 1892 caused twenty-five breaks in this engineer district, all of which were below Red River, and all of which, except five, were promptly closed. Belmont and Sarpy were disastrous crevasses in the Pontchartrain levee district. Anchor, in the same district, did but little additional damage, while Story and Villere, in the Lake Borgne district, were quite local in their effects.

From the flood of 1893, of equal magnitude to that of the previous year, there is but one crevasse remaining open, viz, at Rescue. This will probably prove disastrous in part of the Pontchartrain district.

Much improvement and success were attained in 1892 in closing crevasses; but the art has not yet reached a point of sufficient certainty and economy to justify its application except where the conditions are very favorable.

During the floods of 1892 and of this year the General Government has rendered much assistance by the supply and transportation of materials to threatened points in the line as well as by the rapid and careful inspection of levees which the district officer was best able to make with the towboats and barges under his control.

During the past year the levees of this engineer district have been substantially improved, from the efficient coöperation of the General and State authorities, but much remains to be done to bring them to a condition of safety for more than an average flood.

Surveys, gauges, and observations.—During the year usual high and low-water discharge observations have been made at Carrollton, and Red River, on the Mississippi, and on the Red and Atchafalaya rivers. Surveys are being made at and below Belmont and Sarpy crevasses of 1892, with a view of ascertaining, by duplicating these surveys after the present flood, the effect upon the bed of the main river caused by the loss of volume through these crevasses. The usual harbor and levee surveys have been made during the year, while special surveys, directed by the Commission, have been made between Warrenton and Grand Gulf, Rodney, and Coles Creek, and back of Lake Bruin and St. Joseph.

Reference for further information concerning the operations of this engineer district is made in the report of Capt. J. Millis, and the reports of his assistant engineers.

REVETMENTS AND DREDGING.

During the past year special examinations have been made of all the bank revetments in each of the districts where they have been built to ascertain defects of construction or change of condition caused by them. These surveys have disclosed the fact of a general deepening from scour along the outer edges of the mats. In some cases the mat has adjusted itself to the new condition, as was intended, while in others the test of its flexibility has been too great and faults have occurred. In some places, also, there has been settlement in the middle of mats rather than along their edges, indicating that greater thickness or density is required in very exposed situations. Defects have also been found between the low-water mats and those built on the graded bank. Under the strain of the long-continued floods of recent years the injury suffered by the revetment work has been sufficient to require a modification of some of the details of construction of bank protection.

The history of this work, under the Commission, is one of progressive increase in size and strength of structures employed as the necessity for such increase has been developed and as, by invention and the skill which comes from experience, the building and handling of larger and stronger structures has become possible. The mattresses used in the lower Mississippi for five years past have been the heaviest and widest ever made for like purpose in the history of engineering. To build and sink them in the deepest and swiftest stream upon which such improvement has been attempted is an undertaking of extreme difficulty. It could not have been done successfully in the earlier stages of the improvement.

These works have always accomplished the results intended in their construction. The holding of a caving bank has always contributed to the improvement in the channel. The one open question of the whole problem of low-water improvement upon the lines hitherto followed is the permanence of the works employed for bank protection. In this respect there is more to be desired than has been attained.

Upon careful consideration of the subject the Commission believes it advisable to further modify the construction of mattresses used in revetment work with a view to securing more flexibility and greater density in certain parts that are particularly exposed, and a better connection between the mats above and below low water, at the same time retaining the strength and general methods of construction and handling. This will involve additional cost. But, believing it to be warranted by the importance of the work, the engineers in charge have been directed to adopt methods to secure these ends in the work of the coming season. With these modifications of structure other and additional safeguards will be introduced.

In view of these facts and conclusions it has been recommended that, during the coming working season, new revetment work be confined to Plum Point Reach and Hopefield Bend.

These considerations, and the recommendation to which they lead, may involve a delay in the present methods of channel improvement which the rapidly increasing demand for better low-water navigation can not stand. The Commission has therefore had under consideration for the past year the subject of temporarily dredging such bars as may, during each low-water season, limit the navigable depth between Cairo and Red River. After very full study they have devised a plan and are building an experimental dredging plant on the lines which they think are most likely to accomplish this purpose. This will be large enough to demonstrate satisfactorily the feasibility or otherwise of affording relief to commerce by this class of work. It is recognized that to be at all efficient this dredging must be done on a scale rarely, if ever, previously attempted. The character of dredge to be used, the manner and possible speed of working, and above all the best method of disposing of the dredged material, are points of great importance which must be settled before the great cost of the final plant required should be incurred. The experimental dredge now building is designed to throw light on these points as far as possible. It is expected that it will be completed in time to be used during the low water of the present season. The Commission has, therefore, also reserved from other allotments a sum sufficient to construct a dredge boat of sufficient size and capacity to fully apply the results of these experiments on the practicability of the temporary improvement of navigation by such means.

HIGH WATER OF 1893 AND LEVEES.

The volume of discharge of the flood of 1893 was of very much more than average magnitude and it is possible in this respect, after the discharge measurements are prepared, that in some parts of the river it may rank among the very great floods. The volume contained between levees was greater than ever before. The following dates and stages at different localities on the main river and its tributaries show clearly the sources from which the contributions were received:

	Feet.
Cincinnati, May 2	50.6
Chattanooga, May 6	28.2
Nashville, May 9	19.9
St. Louis, May 3	31.5
Cairo, May 9	49.3
Little Rock, May 3	25.2
Alexandria, May 27	24

The northern tributaries of the Ohio, the St. Francis, White, and Yazoo were also excessively high during the month of May. It will thus be seen that very large discharges combined from all flood-making sources, except the Tennessee and the Cumberland, which did not rise much above a half-flood stage.

The high water resulting from these sources in 1893 was in many respects similar to that of the previous year. Both came exceedingly late in the season, and later in 1893 than in 1892.

The resemblance between the floods is also noticeable in the fact that between Arkansas City and Vicksburg and below Red River greater absolute heights were reached than were ever recorded before, and greater relative heights than were observed in either year above Arkansas City.

The greater heights of these floods in the parts of the river above mentioned is to be mainly if not entirely attributed to the larger volume of discharge held between the levees by their improved condition.

Notwithstanding the substantial equality in the flood heights of the past and present high water the number of crevasses in 1893 have been less than ever before whenever any such stage prevailed, and several districts have entirely escaped overflow. The number of unclosed crevasses in 1892 was ten, with an aggregate open length of 10,982 feet, or about one in 550 miles. During the present flood there have been six unclosed crevasses. The aggregate length of these is not yet ascertained, nor is the information yet in the possession of the Commission to prepare a complete statement of the area of land overflowed, as compared with previous years, although the indications are that it will be less. It may be well, in connection with this review of the high water of 1893, to briefly describe the existing levee system, its conditions, results, and requirements. Below the junction of the Mississippi and Ohio the hills crowd closely to the left bank and prevent any large escape of high water as far down as Memphis. Here no general system of levees exists or is required. On the right bank below Cairo lies the St. Francis Basin, extending from Cape Girardeau, Mo., to Helena, Ark. It is drained by the St. Francis River and Bayou St. John. This large region has never been protected from overflow, and only now are coöperative measures being taken by the General Government and the local organizations to inaugurate a system of levees. On the left bank, a short distance below Memphis, and on the right bank, at Helena, begin the existing levee systems. That on the left bank extends down near to Vicksburg and protects the Yazoo Basin. It is in good condition, generally having strong sections and grades from 3 to 4 feet above high water. It withstood the floods of the years 1892 and 1893 without a break, although the flood of 1882, when the water was from 2 to 3½ feet lower along the front of the basin, there were 149 crevasses. The levee system on the right bank, from Helena down to White River, is intended to protect the White River Basin, and is now in process of construction. When completed it will have provisionally efficient grades and sections. Below the Arkansas River, and still on the right bank, lies the Tensas Basin, extending to Red River, 330 miles, partly in Arkansas and partly in Louisiana. A line of levees extends along the entire front of this basin. These levees are by no means in a condition equal to those on the left bank and crevasses have been of annual occurrence. Much work is still required to bring them to a state to safely resist floods equaling those of the past two years.

Below Red River the levees extend on the right bank to about 70 miles below New Orleans, while on the left bank, owing to the proximity of the hills, they only commence at Baton Rouge, from which point they also extend to about 70 miles below New Orleans. Although these levees on both banks have been recently much improved, yet no year has passed without crevasses on one side or the other, and much work is still required to make them efficient.

It has appeared to the Commission to be a wise policy in levee building, owing to the extent of the work and the limited amount applicable to it in any one year, to promptly close all breaks as soon as practicable after their occurrence, in order to maintain the continuity of the line, and to build as long an extent of levee as possible, with a provisional grade and strength sufficient to resist the high waters that recur with substantial regularity, in order to give the earliest and widest protection, even if this protection is not absolute. This course commands itself rather than to build levees at present to an estimated grade and strength which will be sufficient to confine the entire discharge of the greatest future floods, and, in the meantime, to leave unimproved long stretches that will be breached by every ordinary high water. The levee authorities of all the riparian States concur in and act upon this line in their yearly work. It is believed that the wisdom of this policy has already proved itself by the increased coöperation which is coming from local sources, by the increase of acreage under cultivation and of the value of land, and also of population in many of the districts, and by a greater feeling of confidence in those who live behind levees.

The effect of such improvement as has already been made has been to confine between levees a much larger high water volume, amounting, in some localities, as at Lake Providence, to an increase of 40 per cent. Accompanying this increase of volume is, of course, an increase of flood height. The extreme instance of this is again found at Lake Providence, where the flood rise of the river has increased, since the improvement of the levees, 3.5 feet, or about 8 per cent. A statement of the same tenor applies to Baton Rouge, where the increase of flood rise has been 2.45 feet, or 7 per cent, although during the floods of 1892 and 1893 the entire discharge at Red River Landing upwards of 1,300,000 cubic feet per second has, owing to the improvement of the levees of the Atchafalaya District, been transmitted past Baton Rouge. In all previous years when any such discharge passed Red River disastrous breaks above Baton Rouge materially reduced the volume passing the latter point.

Undoubtedly greater heights will occur when a still larger proportion of high water discharge is controlled between levees and when abnormal floods, such as in 1862 or 1882, occur, but in the meantime the improvement of the levees undertaken and approaching completion in some basins, and well advanced in all, brings in sight a condition of the levee system that will give substantial relief and protection in all except years of unusual floods. The measure of prosperity thus induced will help to supply the resources for the final completion and maintenance of the work.

To any other system for the protection of these alluvial lands there are objections, both theoretical and practical, which can not be overcome. Those of a theoretical character are connected with the hydraulic law that a reduction of flood discharge in a silt-formed channel will reduce its capacity below the point of outlet. This observation has been repeated in the many local comparative surveys of the river bed made by the Commission before and after crevasses, or before and after rebuilding the levee made necessary by a crevasse. The difficulties of a practical nature consist of the necessity of continuing any outlet to the Gulf without return to the river at any intermediate point. Such return would merely transfer the danger from one locality to another lower down. The condition thus imposed upon any outlet involves great cost and danger. Any outlet intended to relieve the parts of the river where flood heights are now most dangerous would, in any case, be very long. To have an appreciable effect it would require an excavated channel of large width and depth. As it would traverse tracts of cultivated and valuable land the cost of expropriation of a right of way would be very great. The cost of the levees which would be required to control it and prevent the permanent continuation of disaster and overflow while flowing through regions which will in a few years be placed under the sufficient protection of a levee system would be very much greater.

When completed there would be two or more rivers, each presenting the same dangers and requiring the same treatment as the present single channel. The cost of efficient outlets would be greater than the cost of completion of the levee system. When constructed they would either silt up, as do many island chutes, or would enlarge and assume the tortuous type of an alluvial stream, with shifting bars and caving banks. Finally, conceived and executed in defiance of physical law, they would fail as a safe, cheap, or efficient method of abating overflow.

After a review of the progress thus far made in the improvement of a levee system and of the facts developed by the continued surveys, gaugings, and observations of the river, such as the entire absence of evidence of any rise of the bed of the river, the local tendency to shoal where volume is reduced, and the larger discharge now controlled between levees, with an increase of flood heights which does not affect the practicability of a low system, the Commission expresses its continued confidence in the reclamation from overflow of the alluvial lands of the Lower Mississippi Valley on the lines now proposed and in progress, as entirely practicable, at a cost which is amply justified by the importance of the undertaking.

LOW WATER OF 1892.

During the summer and autumn of 1892 the gauge readings were by no means so low as those of the previous year, which, generally, have not been equaled since 1879. The condition of the navigation is shown in the following abstract of bar depth between Cairo and Red River, where 10 feet or less were found:

Depth.	Number of places.
5½	2
6	2
6½	3
7	5
7½	5
8	7
8½	3
9	11
Total	38

FINANCIAL STATEMENT.

Appropriation for salaries and expenses Mississippi River Commission:	
Balance on hand May 31, 1892	$138.26
Balance on hand May 31, 1893	138.26
Appropriation for survey of Mississippi River:	
Balance on hand May 31, 1892	7.08
Balance on hand May 31, 1893	7.08
Appropriation for improving Mississippi River:	
Balance on hand May 31, 1892	986, 375.18
Appropriated, act of July 13, 1892	2, 470, 000.00
Total	3, 456, 375.18
Expended, June 1, 1892, to May 31, 1893	2, 653, 471.92
Balance on hand May 31, 1893	802, 903.26
Distributed as follows:	
Levees	194, 193.70
Channel works	81, 559.60
Harbors and bank protection	245, 199.19
Red and Atchafalaya rivers	139, 973.00
Surveys, gauges, and observations	38, 880.67
Plant, Mississippi River Commission, and miscellaneous	103, 097.10
Total	802, 903.26
Approximate outstanding liabilities and amounts covered by existing contracts	295, 492.82

Estimate of funds by the Mississippi River Commission for the fiscal year ending June 30, 1895.

For improving Mississippi River from head of the passes to the mouth of the Ohio River, including salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$2,665 000
For improving harbors at:	
New Madrid, Mo	75,000
Memphis, Tenn	100,000
Greenville, Miss	200,000
Vicksburg, Miss. (Delta Point)	150,000
Natchez, Miss., and Vidalia, La	400,000
New Orleans, La	300,000
For improvement at head of Atchafalaya and mouth of Red River, Louisiana	350,000

C. B. COMSTOCK,
Colonel of Engineers, Brt. Brig. Gen., U. S. A.,
President Mississippi River Commission.
CHAS. R. SUTER,
Lieut. Col. of Engineers.
B. M. HARROD,
R. S. TAYLOR,
O. H. ERNST,
Major of Engineers.
HENRY FLAD, C. E.,
HENRY L. WHITING,
U. S. Coast and Geodetic Survey.

BRIG. GEN. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Concurring in the inadvisability of an attempt to create new outlets from the Mississippi River which shall be large streams at all stages of the river, we do not wish to be understood as condemning the use in the levees of long waste weirs to take off the top of the flood if it shall be found that at certain places in the lower part of the river the further increase in flood flow which will come from raising the levees at points farther up the river can be controlled in whole or in part by such waste weirs more economically than by higher levees.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen. U. S. A.
President Mississippi River Commission.
O. H. ERNST,
Major of Engineers.
HENRY FLAD, C. E.,
HENRY L. WHITING,
U. S. Coast and Geodetic Survey.

The signatures of Henry Flad and Henry L. Whiting have been added at their request.

C. B. C.

LIST OF APPENDIXES ACCOMPANYING THE ABOVE REPORT.

LIST OF PLATES ACCOMPANYING REPORTS.

Sections of canal and basin, Vicksburg.
Profile of Mississippi levees.
Profile of Arkansas and Louisiana levees.
Typical section of Middle Tensas levees.
Natchez and Vidalia—survey of Cowpen Point.
Red and Atchafalaya. Improvement at Turnbull Island.
New Orleans Harbor, bank protection, Carrollton Bend.
New Orleans Harbor, survey, Southport to Exposition Wharf.
Levees, Lower Tensas and Big Black districts.
Levees, Atchafalaya, Lafourche, and Pontchartrain districts.
Levees, Barataria and Lake Borgne districts.
Levees, method of closing crevasses in.
Levees, typical sections, Fourth district.
Map of Fourth district, showing crevasses and overflowed area.

APPENDIX 1.

NOTE BY COL. C. B. COMSTOCK, CORPS OF ENGINEERS, ON "CHANGE OF PLANE" AT RED RIVER LANDING.

NEW YORK, *May 24, 1893.*

To the Mississippi River Commission:

1. In a paper by Colonel Suter, printed in the Annual Report of the Mississippi River Commission for 1891, in speaking of the Mississippi at the mouth of Red River, he states as follows, p. 3420: (1) "In December and January, 1884–'85, a very abrupt change of plane took place, as shown on both the gauge relation and the discharge curve, and this change was found to coincide with a considerable rise in Red River, the Mississippi being at quite a low stage. This change of plane or elevation of the zero of discharge curve, amounted to 5.8 feet, and inspection of Plate VIII [XI], will show that this elevation was substantially retained throughout the season and on it was superposed the changes of plane, amounting to 3.35 feet more which were transmitted down from Helena and Arkansas City."

And on p. 3422 he states: (2) "These tables show, in a general way, that in every year noted there is an abnormal elevation of the plane of flow at extreme stages, both at Carrollton and Red River. At the latter place this abnormal elevation has amounted to as much as 13 feet; at the former place to 5.4 feet. They also show that if the levee system had been perfect from Vicksburg to Carrollton, the actual mean maximum gauge reading at Red River Landing would have been increased 0.43 feet, and at Carrollton 1.11 feet, while under the same conditions, but with Red River shut out, the actual mean maximum at Red River Landing would have been reduced 7.29 feet and at Carrollton 2.09 feet. Consequently with the levees all up, the difference in mean maximum between the conditions with Red River open and closed would amount to 7.72 feet at Red River Landing and 3.20 feet at Carrollton; the actual maximum differences being 13 feet for Red River Landing and 5.4 feet for Carrollton."

The paper gives many other instances of what are called changes of plane, but it is difficult to follow or verify the discussions by which they are derived, the discussions including a large use of graphic processes in fitting assumed discharge curves to observed discharge curves, or assumed right lines to curves of equivalent gauge relation. Under such circumstances the process can best be examined by taking an instance in which a large result is obtained. That quoted in the first statement above, namely, that in December and January, 1884–'85, an abrupt change of plane of 5.8 feet took place at the mouth of Red River will be chosen.

"Change of plane" is defined as "such as might have been expected, were the whole river bodily raised or depressed so as to change its plane of flow, the gauge remaining fixed in position." As such a bodily elevation or depression would not, necessarily, change the discharge, it would appear that "change of plane" is really difference of gauge readings for two equal discharges at different times at the same place, a phenomenon which was noticed by Dupuit many years ago, and which arises mainly from changes in slope.

The evidence on which this "change of plane" of 5.8 feet at Red River mouth in January, 1885, is based may be found on Plate V and Plate XI of the paper.

2. The relation between the readings of two gauges on the Mississippi River at a distance from each other can be readily studied by plotting their simultaneous readings as an abscissa and ordinate. The succession of points thus obtained will define an irregular curve, showing, graphically, the relation in question. If the gauges are

very near each other, the curve will be a very regular one, nearly a right line inclined at 45 degrees to the axis of abscissas. For gauges widely separated the curve will be very irregular. For instance, the curve obtained in this way for the gauges at Arkansas City and Red River Landing, which are 327 miles apart, is very irregular. The time required for the crest of a flood wave that does not rise above the banks of the river to travel over this distance, is about 4½ days. Now, when the river is rising rapidly on account of the time required for transmission to the lower gauge, there may be a considerable rise at Arkansas City, and a smaller rise at Red River Landing, and this difference in rises will give a corresponding irregularity in the curve, which shows the relation between the readings at the two gauges. Thus, between December 14, and December 20, 1884, the rise at Arkansas City was 10 feet, while at Red River Landing it was but 1.5 feet, giving an irregularity in the curve of 8.5 feet. When the river begins to fall rapidly at Arkansas City, and is falling slowly at Red River Landing, a similar irregularity in the curve will occur, but in the opposite direction.

Now, if the assumption could be correctly made that the same discharge that passed Arkansas City on a given date would pass a point just above the mouth of Red River 4½ days later, it might be expected that these equal discharges would give gauge readings having a more regular relation to each other than simultaneous gauge readings would have; and, in that case, if in plotting the curve to express graphically the relation between the gauge readings at the two places, readings on the lower gauge 4½ days later than those on the upper were used, the irregularity in the curve, due to the fact that the river rises earliest at the upper station, would, in part at least, be eliminated. A curve for 1884–'85 obtained in the last way is given on Plate v, accompanying Colonel Suter's paper. It is marked "Arkansas City, Red River Landing actual gauge relation." This curve has great irregularities, and that it must have great irregularities could have been foreseen.

(*a*) The assumption that the same discharge would occur on a given date at Red River Landing as occurred 4½ days before at Arkansas City, and that the curve ought to be regular, would not be true, even if all tributary inflow were excluded, unless the river were at a stand for this distance, since wave forms vary much in descending the river.

(*b*) If the tributary inflow were excluded, and the discharges at the two places, at their respective dates, were the same, the gauge readings at the two places would not vary regularly, unless the slopes of the water surface were constant or varied regularly and slowly through long periods. From the general expression for river discharge, $D = C w r^{\frac{3}{2}} s^{\frac{1}{2}}$, where D is the discharge, C approximately a constant, r the mean depth, w the width, and s the slope, it is seen at once that, while D is constant, and w constant for moderate variations in depth, a given percentage of increase in s will produce an equal percentage of decrease in $r^{\frac{3}{2}}$, or, for constant discharge, the mean depths will vary inversely as the cube roots of the slopes. Now, at Red River and Arkansas City it is known that the slopes sometimes vary rapidly by 10 per cent or more, and the corresponding variation in the gauge reading at mid stage (the discharge remaining the same) would be 4 per cent of 40 feet or 1.6 feet, 40 feet being about the mean depth at mid stage. This gives an irregularity in the curve of "actual gauge relations," if it occurs at but one of the stations, of 1.6 feet. If it occurred at both, and in opposite directions, the amount of the irregularity would be still greater.

(*c*) It is well known that the river bed rises on bad shoals during high water, and is cut out during low water. This process affects the heighth of the gauge reading for a given discharge at low stages, and in some degree also at high stages. It may affect distant gauges quite differently.

(*d*) Thus far it has been assumed that there was no inflow between Arkansas City and Red River Landing. In fact the Red River, the Big Black, and the Yazoo are tributaries. Now as, at mid stages, at Red River Landing an increased discharge of 27,000 cubic feet corresponds to 1 foot of gauge increase, it will be seen that the tributaries may introduce very large irregularities into the gauge readings at Red River Landing as compared with those at Arkansas City. At Helena, Little Rock and Vicksburg, between December 27 and December 31, 1884, the rainfall exceeded 9 inches.

3. The general causes acting to produce marked irregularities in the curve of "actual gauge relations" have now been examined. A glance at this curve for Arkansas City–Red River Landing, on Plate v of Colonel Suter's paper, will show what great irregularities they produce. The most marked one is that which occurred between December 23 and December 30, 1884, Arkansas City dates, the corresponding dates at Red River Landing being 4½ days later. It is contained in Plate v, between the readings 16 and 24 feet on the Red River gauge. It will now be considered.

From December 23 to December 30, at Arkansas City, the gauge fell from 18.4 feet to 16.5 feet, or 1.9 feet, its lowest point being 15.3 feet on December 28, 1884.

Between the corresponding dates at Red River Landing, namely, December 27½, 1884, and January 3½, 1885, the gauge reading there rose from 16.2 to 23.3, or by 7.1 feet. Now, as the oscillations are about the same at Arkansas City and Red River Landing, a regular curve of "actual gauge relations" would have required a fall of 1.9 feet at Red River corresponding to the fall at Arkansas City. Instead there was a rise of 7.1 feet, making the aggregate irregularly 9 feet in the relative gauge readings, corresponding to an irregularity of about 8 feet parallel to the Red River Landing gauge, in the curve of "actual gauge relations." Is there anything surprising in this? Anything requiring the assumption of two parallel lines, (1) and (2) drawn 5.8 feet apart on the curve of "actual gauge relations," Plate v, giving a "change of plane" of 5.8 feet?

If the gauge curves from Cairo down be examined, it will be seen that a depression of about 3 feet, caused by a slight fall above Cairo, descending the river, interrupted the general winter rise already begun. The crest of the low wave thus formed passed Arkansas City on December 23, at 18.4 feet on the gauge, and the depression following reached 15.3 feet on December 28. In descending the river this depression gradually became less below Arkansas City, and when it reached Red River Landing caused no fall, but brought the river there for one day to a stand.

The fact that at Arkansas City, between December 23 and December 27, the river could fall 2.6 feet in five days, without producing any fall at Red River 4½ days later, shows the inaccuracy of the opinion that the same flow that passes Arkansas City on a given date will pass Red River 4½ days later, and that, without tributary inflow, it will give a regular curve of actual gauge relations.

From December 18 to December 30, at Red River Landing, the river had risen steadily, under the sole influence of the Mississippi above, since the Alexandria gauge read only 3.2 feet on December 28. But the Alexandria readings rose to 28.2 on the 31st, and this flood of about 80,000 cubic feet per second was added to the Mississippi, it being supposed that the Black supplied the Atchafalaya, since the Ouachita was high. This 80,000 cubic feet per second would cause the Mississippi to rise about 3 feet, and would reach Red River Landing December 31 to January 2. This rise began on December 29, and then was probably due to local rains.

It is thus seen that of the irregularity of 8 feet parallel to the Red River Landing gauge, in the curve of "actual gauge relation," Arkansas City, Red River, on Plate v, between December 23 and 30, Arkansas City dates, 1.0 foot is accounted for by the fall at Arkansas City coming from above Cairo, and 3 feet by the rise of the Red River, leaving 4.0 feet, which is accounted for by the general rise coming from above in the seven days at Red River between December 27½, 1884, and January 3½, 1885, a rise of but 0.6 feet per day, while from December 18 to December 27, before the Red River flood, the gauge reading had been rising 0.9 per day. It is then seen that this great irregularity is fully accounted for without the assumption of unknown causes or changes of plane and since the actual changes in the gauge readings are accounted for, the same explanation covers the irregularities in the curve of "equivalent gauge relations" which is yet to be considered, since that curve is derived from actual gauge readings by eliminating differences in discharge. It should also be noticed that of this great irregularity of 8.0 feet, only 3 feet are accounted for by tributary inflow; the rest is mainly due to the tapering out of a small wave of depression in descending the river. The effect of this wave can be separated from that of the inflow at Red River in another way by considering it before the Red River flood affected the Mississippi.

The Red River rise only began at Alexandria on the 28th, and on the 29th the stage was but 10 feet. This rise could not have affected the Mississippi seriously before the 31st December, and till that time the change in tributary inflow may be neglected as small. Now, between the 27th and 31st December, 1884, the river rose 3 feet at Red River Landing, while in the corresponding period, 4½ days earlier, at Arkansas City, it fell 2.4 feet. Under the assumption that the same flow passes Red River Landing (tributary inflow being excluded) as has passed Arkansas City 4½ days earlier, the fall of 2.4 feet should have been repeated at Red River. The river there actually rose 3 feet, giving an irregularity in the difference of gauge readings of $2.4+3.0=5.4$ feet, due mainly to the tapering out of the low wave already referred to. This irregularity of 5.4 feet simply measures the error in the assumption that gauge readings at Red River Landing can, when there is no tributary inflow, be accurately derived from those of another gauge 327 miles above at Arkansas City.

4. In the preceding sections it has been seen that the attempt to derive (on the assumption that the water passing Arkansas City on a given date passes Red River Landing 4½ days later) a regular curve which shall give, even with an approximation to accuracy, the relation between the gauge readings at the two places for dates differing by 4½ days has entirely failed. And this failure is little less conspicuous when the effect of the Red River flood is eliminated, the failure being due to error in the assumption and not to irregularities in the observations or to anything abnormal in the river.

Another method of approaching the subject would be to make the assumption that, if differences of flow at the two stations were eliminated by means of the discharge curves, then a regular curve representing the gauge relation ought to result. We have the discharge curves for Red River Landing and Arkansas City in 1884-'85. Taking the gauge readings on the two curves which correspond to a common arbitrarily selected discharge, if these two gauge readings be plotted as abscissa and ordinate, respectively, one point of a curve showing the relation between those gauge readings will be obtained. Deriving many such points in the same way, they give essentially the curve shown on Plate v of Colonel Suter's paper, and entitled "Arkansas City-Red River Landing, equivalent gauge relations." It will be noticed that this curve is very irregular. There is a great irregularity from December 27 to January 4, 1885, Red River dates; after January 4 the irregularities are not great.

In forming an estimate of the irregularities to be expected in such a curve of "equivalent gauge relations," two errors are to be considered, either of which will introduce irregularites. (*a*) Errors in the discharge observations at either Red River Landing or Arkansas City (which are arbitrarily selected) will give corresponding errors in the gauge heights. Now, irregularities of 10 per cent frequently occur in observed discharges. As the Red River Landing discharge at this time was about 400,000 cubic feet per second, 10 per cent of it would be 40,000 cubic feet per second, corresponding to an irregularity in the gauge reading of 1.3 feet, which irregularity would enter the curve of "equivalent gauge relations." An equal error in the opposite direction at Arkansas City would give an aggregate irregularity of about 2 feet in the curve of equivalent gauge relations, parallel to the Red River gauge, from this cause alone. (*b*) If the observed discharges arbitrarily selected to plot this curve were exact, in order that the curve might be regular it would be further necessary that the slope at these two stations at the times of the selected discharges should have regular values, since, as already seen, the gauge readings corresponding to a given discharge vary approximately with the inverse cube root of the slope. Slopes frequently vary by 10 per cent or more in a few days. Since the slope, as well as the mean depth, is effective in increasing discharge, if for a selected discharge the slope should be 10 per cent above its regular value the mean depth would be 4 per cent below its regular value. Since the mean depth at both places at this time was about 40 feet, the irregularity in gauge reading would be 1.6 feet. If this irregularity occurred in opposite directions at the two stations it would introduce an irregularity into the curve of equivalent gauge relations of about 2.7 feet.

It is seen, then, in advance, that from the methods by which the curve of equivalent gauge relations is derived large irregularities may occur in it, either from errors in discharge or from irregularities in slope. As instances in point, the fall from Natchez to Port Hickey, which gives approximately the slope at Red River, was on December 26, 1884, 20.6 feet, while on January 1, 1885, it was 18.1 feet, or it was 12 per cent less at the later date. Between these dates the river rose from 16.1 to 20.3 at Red River Landing, and if the slope had followed its usual course it would have increased instead by about 3 per cent. The slope was then irregular by 15 per cent. To carry the same discharge this slope irregularity of 15 per cent would require the mean depth to be increased by 5 per cent, or 2 feet. Hence, in this period, the Red River abscissas of the curve of "equivalent gauge relations" become greater by that amount in consequence of change of slope, and give a corresponding irregularity to the curve.

Between December 23 and January 1 the decrease in slope from Natchez to Port Hickey was still greater, amounting to 20 per cent, although the Red River gauge readings rose 6 feet, giving an irregularity in the slope of 24 per cent, which would produce an irregularity of 8 per cent of the mean depth, or 3.2 feet in the Red River Landing gauge readings, plotted in the curve.

Between December 22 and December 31, 1884, are found the discharges at Arkansas City used in Col. Suter's paper, which are equal to those observed between December 26, 1884, and January 1, 1885, at Red River Landing. Any irregularity in the slopes in Arkansas City between December 22 and December 31 would produce a corresponding irregularity in the corresponding gauge readings. Between these dates the fall from White River to Greenville, which gives approximately the slope at Arkansas City, increased from 23.9 to 25.3 feet, or by 1.4 feet; allowing 0.2 foot as the increase of fall due to 1.6 rise in the river, there remains 1.2 feet, or 5 per cent, as an irregular increase. This would give an irregular decrease of 0.8 in the Arkansas City gauge reading to be combined with the irregular increase at Red River Landing of 2.0, giving a resulting irregularity in the curve of equivalent gauge relations of about 3 feet. It is thus seen that from known causes irregularities in the curve of the equivalent gauge relations, Arkansas City-Red River Landing, on Plate v, of about 3 feet, may be expected. Further, if this irregular curve be examined it will be seen that the whole of it can be represented by a single continuous straight line, not deviating from any part of it by more than 2 feet. If for any reason it were desirable to use a line simpler than a regular continuous curve, such a straight line might, therefore, well be taken, although the actual curve, with all its irregularities, would be better. Instead of representing it by one straight line the paper represents it by five parallel straight lines, which are discrepant with each other by 5.8 feet, and even by 6.2 feet. This 5.8 feet is called a "change of plane," and it is suggested as a possible cause that the Red River water partly fills the channel like mud or sand, and that the Mississippi water is forced to climb on top of it. It is evident that a single straight line, not deviating from the curve anywhere by amounts greater than could have been expected in advance, is a far better representation of all the observations than a series of parallel lines, some of them 6.2 feet apart, measured parallel to the Red River gauge. Had this curve of equivalent gauge relations been plotted from the actually observed discharges, instead of from numerous arbitrarily assumed curves (Plate XI and Plate IX), it might have been represented throughout by a conic section deviating from the observations by only about 1½ feet.

The inducement to the representation by many parallel lines seems to have been the fact that the upper and lower parts of the curve can be pretty well represented by such lines, provided the middle part of the curve be rejected. No reason is assigned for such rejection, and no reason is given for assuming that the lines or the different parts of the curve should be parallel and disconnected. Neither the rejection nor the assumption is justifiable. If *G* and G^1 represent the equivalent gauge readings at Arkansas City and Red River Landing, their ratio, to give straight parallel lines for the curve of equivalent gauge relation, must be constant.

The general formula for discharge, $D = c\,w\,r^{\frac{3}{2}}\,s^{\frac{1}{2}}$ may be written $r = \dfrac{D^{\frac{2}{3}}}{C^{\frac{2}{3}}\,w^{\frac{2}{3}}\,s^{\frac{1}{3}}}$,

or if width, *w*, be considered constant, and $\dfrac{1}{C^{\frac{2}{3}}\,w^{\frac{2}{3}}} = c^1$, $r = c^1\,D^{\frac{2}{3}}\,s^{-\frac{1}{3}}$. Similarly, for

the lower station, $r = C^{11}\,D^{1\frac{2}{3}}\,s^{1\,-\frac{1}{3}}$, in which, if the gauges are so set as to read mean depths at medium stage, G being a gauge reading and G^1 another with a time

interval, $\dfrac{G}{G^1} = \dfrac{r}{r,^1} = \dfrac{c^1}{c^{11},} \dfrac{s^{1\,-\frac{1}{3}}}{s^{11\,-\frac{1}{3}}}$, since equal discharges are used.

It is seen from this that, since the slope has very wide variations in value at Red River, as compared with those at Arkansas City (varying from nearly 0 to the maximum), $\dfrac{G}{G^1}$ can not be constant as the river rises, and hence that the correct curve of equivalent gauge relations can not be one or several parallel straight lines.

It should be noticed that the part of the curve before December 30 could be well represented by a nonparallel line, which, prolonged to the gauge reading of January 6, would give at that time a "change of plane" of but 3.6 feet, instead of the 5.8 feet derived in the paper. It must be concluded that the actual irregularities of the curve, when referred to a single right line, are no greater than could have been anticipated, and that the "change of plane" of 5.8 feet arises in the main from the assumption that the curve ought to be two parallel straight lines 5.8 feet apart, which well represent separate parts of the curve, but do not represent, even approximately, the whole curve.

5. This same "change of plane" of 5.8 feet is also derived from the Red River Landing discharge curve of 1884–'85, given on Plate XI, or rather, not from the curve itself but from certain assumed curves numbered from 1 to 10, Plate XI. The interval in the direction of gauge readings between No. 1 and No. 5 of these curves is again the "change of plane" of 5.8 feet. But if the interval between No. 1 and No. 6 be taken it is 9.3 feet, and this is also a "change of plane." The reason why the discharge curves give a change of plane of 9.3 feet while the curve of equivalent gauge relations for the same place and time give only 6.2 for the change of plane is not stated.

The method by which the ten curves are derived is as follows: A regular curve, which represents well the discharge observations of 1882 at Helena (and does not represent those of 1884–'85), is taken, and is called a "standard normal curve." As previously stated, if observed discharge curves for two stations be taken, and for any chosen common discharge on the two curves the corresponding gauge readings be taken, these are called "equivalent gauge readings." Now, a so-called "normal curve" of discharge for gauge readings being known for an upper station, a "normal curve" for a lower station is obtained in this paper by plotting the discharge at the upper station to the corresponding equivalent gauge reading at the lower station. This is called a transfer by a line of gauge relations.

It is important to notice that if we start from a single continuous discharge curve at the upper station, such as the observations give, and plot its discharges to the equivalent gauge readings (derived from the actually observed discharge curve) at the lower station, since this equivalent gauge reading is the actual gauge reading at the lower station for the actual chosen discharge, by such plotting we reproduce identically the observed discharge curve at the lower station.

Now, in Plate XI, Red River discharges, 1884–'85, curve 1, from which "changes of plane" are derived, differs very widely from the observed discharge curve, and the question at once arises as to the method by which it has been obtained. The answer is that the part of it lying below 19 feet on the gauge has practically been derived from curves 1 and 2, Arkansas City discharges, Plate IX, and from line 1, Arkansas City–Red River Landing equivalent gauge relations, Plate V. The lines and curves referred to on Plates V and IX represent pretty closely, for gauge readings below 19 feet, the actual observations, and hence in Plate XI this part of curve 1 reproduces pretty closely the observed discharge curve at Red River Landing below 19 feet on the gauge. But the part of curve 1, Plate XI, above 19 feet is derived from curve 1, Arkansas City discharges, Plate IX, which does not represent actual discharges above 30 feet on the gauge, and from the prolongation of line 1, Arkansas City–Red River Landing equivalent gauge relations, above 19 feet up to 40 feet, for which distance it makes no approximation to representing actual equivalent gauge readings, but is an assumption of what it is supposed they ought to have been, which has already been discussed in section 4, and has been shown to be an unproven assumption.

As previously stated, if the curves 1 to 10, Plate XI, Red River discharges, had been derived from the things actually observed, and not from assumptions, they would have reproduced the actual discharge curve. The fact that they are widely discrepant at high stages comes mainly from assuming that the curve of equivalent gauge relations, Arkansas City–Red River Landing, Plate V, ought in high stages to be a line which differs very widely from what was actually observed. The changes of plane that these discharge curves Nos. 1 to 10 show give no additional support to the theory of "change of plane." They result mainly from the assumed changes of plane for lines 1 to 5 of equivalent gauge relations, Plate V, Arkansas City–Red River Landing.

It is stated in the paper that these changes of plane are cumulative in going downstream. That necessarily results from the way in which the upper part of curve 1, Plate IX, Red River Landing discharges, 1884–'85, is derived. The upper part of this curve (above 27 feet) is derived from the upper part of curve 1, Arkansas City discharge observations, 1884–'85, Plate IX, and from the upper part of line 1, prolonged, of Arkansas City–Red River Landing, equivalent gauge relations, Plate V. The upper part of the curve 1 at Arkansas City, Plate IX, already erroneously deviates from the observed discharge curve in such a way as to have too small gauge readings. The upper part of line 1 of equivalent gauge relations, Arkansas City–Red River Landing, Plate V, also erroneously deviates from the observations in such a way as to give equivalent gauge readings at Red River less than those observed, and the combination of the two deviations by which the upper part of curve 1, Red River Landing discharge curve, 1884–'85, is obtained adds to the deviations of curve 1 from the actual discharge curve at Arkansas City those due to the process of transfer to Red River Landing. The increasing "changes of plane" in descending the river arise in this way from the method used in determining them, and not from the river itself.

6. The following is a summary of the preceding conclusions with reference to "change of plane" between Arkansas City and Red River Landing:

The change of plane of 5.8 feet at Red River Landing in 1884–'85, deduced in Col. Suter's paper, is unproven. It results almost entirely from the assumption that the curve of equivalent gauge relations, Arkansas City–Red River Landing, 1884–'85, ought to be represented by five parallel straight lines, with an interval between two of them of 5.8 feet, (which is called "change of plane") rather than by the observed curve. No proof is given that these lines must be parallel, and the results can be largely changed by taking them inclined to each other. Hydraulic formulæ show that the curve can not be of parallel straight lines.

The whole curve can be represented, within the limits of errors to be foreseen, by a continuous conic section, so that there is no justification for assuming several straight lines to represent it, or for calling the intervals between them "change of plane."

The discharge curves add nothing to the evidence of change of plane given by the lines assumed to represent the equivalent gauge relations, since their changes of plane result from those previously assumed for the curves of equivalent gauge relations.

The fact that the changes of plane as derived are cumulative in going down the river is not due to the river, but to the assumptions under which they are obtained.

The general reasoning which has been applied to a single case would also be applicable to the other "changes of plane" given in the paper.

The conclusion that there has been an abnormal elevation of the plane of flow at Red River Landing, "which has amounted to as much as 13 feet," results from the erroneous methods used in the appendix to the paper, and this abnormal elevation did not exist.

C. B. COMSTOCK,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
President Mississippi River Commission.

APPENDIX 2.

REPORT OF COMMITTEE ON DREDGES.

ST. LOUIS, MO., *July 16, 1892.*

SIR: The committee designated at the November meeting of the Commission to investigate and report on the most suitable means of affording temporary relief to navigation at low-water stages of the river, beg leave to report that they have given the subject very careful consideration and have endeavored to avail themselves of all possible information that would throw any light on the question.

In order to make clear the conclusions reached by the committee, a short discussion of the nature of the problem considered seems necessary.

The bars which obstruct low-water navigation result from the ever-varying action of the water-flow upon the materials which compose the river's bed and upon the immense contributions of similar materials derived from the banks of the main stream and from its various tributaries. This material may all be considered as intermittently in motion, and its position with regard to the main thread of the stream determines the extent and direction of its motion. Thus, where the flow is concentrated the action is the strongest, a deep excavation results, and the material thus removed is pushed on till diminished velocity of flow brings it again to a state of rest. The depths of water thus fairly indicate the relative velocities, and those portions of the bed which receive for the longest period of time the action of the strongest current will, under ordinary circumstances, be the deepest. The well-known tendency of flowing water to take a sinuous course, even when the limiting banks are straight, sets up an inequality of flow within any given section, to which the existence of the bars as we know them is directly traceable. Immediately below the apex of each curvature the concentration of flow is at its maximum, and the deepest water is found here against the concave face of the curve. As we follow along the curved channel we find, where the width is sufficient, that a divergence of flow soon begins. Part of the water still follows the curve, while part of it takes a short cut in the direction of the curve immediately below and opposite the one we are considering. The passage from one curve to another is thus effected in a broad and more or less shallow sheet, instead of in concentrated volume; and on a line normal to this modified flow the material of the bed is more or less undisturbed, and in fact is further reënforced, especially at high stages, by the material scoured from the deeper section or swept through it. This action is repeated at each change of direction with more or less intensity, according to the degree of the curvature and to the width of the bed.

The general result is to build up a series of dam-like bars diagonally across the river bed, and the crests of these bars on the lower Mississippi attain frequently a length of many miles. Their elevation is quite irregular, often under favorable conditions, as in the cases of islands, attaining nearly to the level of the main banks. Where the width is limited, as on the river below Red River Landing, these bar crests are so deeply submerged as to be unnoticeable on the surface, though soundings still reveal their existence, but on all the other portions of the river they are the controlling factor in navigation. Above and below them lie the deep pools, characterized by concentrated flow, narrow section, and small slope; while in crossing from pool to pool a sharp slope, wide section, and small depth are met with. Additional complications are introduced by the immense variation in volume at different stages and by the varied direction of flow which frequently takes place under these conditions. As a rule, it may be stated that the closer the agreement in direction of the high and low water flow the better will be the low-water channel. At very many localities, however, there is much divergence, and at such places low-water navigation is almost invariably bad. As the river falls to the low-water stage channels break through the bar crests at various points, and as the fall of the water exposes more and more of the surface of the bars these channels become better defined and deeper. Eventually they carry the whole discharge from one pool to another. When, as is often the case, these channels are numerous, the discharge is so scattered and its energy so dissipated as to be unable to maintain anywhere a channel of adequate size and depth. Moreover, sand is still moving in considerable quantity, and, as it naturally follows the thread of greatest velocity, it tends in time to choke up the channel which carries the largest discharge. This in turn raises the head of water in the pool above till another channel is broken through, and thus in the course of a season the main channel may shift its position several times and occupy in succession a number of openings through the bar of approximately equal size. It is impossible to predict in advance where the low-water channel will be, nor in the case just mentioned how long it will remain in any one position.

In actual practice the case is much more complicated than has been sketched here, but we have only attempted to outline the principal phenomena as they occur from year to year.

It must be sufficiently obvious that the main difficulty lies in securing a sufficiently concentrated low-water discharge through the great sand deposits left by the high water. Where this concentration occurs naturally, or is brought about by proper regulating works, there is no trouble, but where this is not the case navigation is sure to be more or less impeded.

The duty imposed on this committee is to suggest some means by which these difficulties may be more or less temporarily alleviated. Our answer must necessarily be that, whether for a temporary or a permanent improvement, concentration of low-water flow is the only possible expedient. On small streams the necessary concentration is often successfully secured by cutting off or obstructing all but one channel; but this on a stream like the lower Mississippi would hardly be possible, owing to the time required to effect it, and also to the very great cost. The only other expedient is to enlarge one channel to such an extent that the main body of water will be drawn toward it, thus depleting and cutting off the discharge through the subsidiary channels. To accomplish this purpose a variety of methods have been suggested which will now be briefly recapitulated.

(1) *Movable jetties or wing dams.*—According to this plan it is proposed to anchor or sink converging lines of boats, with leeboards or of closed caissons, on or near the lines of the proposed channel, in order to gather in and direct more water through it. It is further expected that after the required deepening has been effected the plant may be moved successively to other localities. With regard to this scheme your committee would say that, while correct enough in theory, they believe it to be impracticable in actual practice, except possibly in certain special cases. If the caissons, for instance, were once sunk in place, we think it would be impracticable to raise them again in a serviceable condition, and the cost of the plant to fill out the long lines of jetties needed must necessarily be very great.

As regards the other alternative, of barges with leeboards, the great difficulty would lie in keeping the boats in place without obstructing the channel with anchors, and also in keeping the leeboards close to the bottom, failing which they would certainly be inefficient. Moreover, we think, that as in the previous case, the amount of concentration needed would require so extensive a plant as to be prohibitory on the score of cost, if for no other reason.

(2) *Scraping or stirring the bottom.*—This is a favorite scheme, and numberless devices have been brought forward to accomplish it. They all work on the same principle, viz, to stir up the bottom by some mechanical means, as water jets, harrows, plows, etc., trusting and expecting that the sand thus thrown up from the bottom will be carried off by the current. Many of these devices have been faithfully tried and after due trial abandoned. The reason is simple enough: It is a comparatively easy matter to stir up the bottom to any extent, but the current, except under very favorable conditions, is entirely inadequate to carry off the sand thus loosened. This has been the invariable experience when the stage of water has been low enough to make the work a matter of real necessity; and the only success, or partial success, ever attained under these circumstances has been with machines that were calculated to bodily drag away the sand as well as to stir it up. Your committee consider that while in certain special cases some device of this kind might prove to a limited extent useful, yet for general and extensive service, such as is apparently now contemplated by the Commission, they can not possibly be recommended.

(3) *Dredging.*—This is the last alternative, and as it is also the only one which in our opinion holds out the least chance of success, it has received very careful study. In order to clear the ground for the discussion of details, it will be well to give here our ideas as to the scope the work should be given. Taking the fall of 1891 as the type of an exceedingly low stage, it was noted on the trip made by the Commission in November, that the great majority of the crossings which could fairly be called shoal gave a depth of about 8 feet. The very shoal crossings ran down to 5 feet. It is our opinion that no very appreciable benefit would have been conferred unless the depth on these shoaler crossings had been brought up to 8 feet.

If, as is more usually the case, the stage be not so low, a greater depth should be aimed at, the object in all cases being to bring the least depths up to the average as nearly as possible, and to maintain them there. The shoal bars to be operated on extend from Cairo to the mouth of Red River, 765 miles. Last November there were thirty-one crossings having less than 8 feet depth, and as many of these crossings had shoal water for a length of over a mile, it will readily be seen that the contract to be undertaken is by no means a small one. Another point must also be considered. As the dredging proceeds, and especially after an increased flow has been set up, a great influx of sand must be expected. Just how much this will be, how long it will last, whether the current will carry it through, or whether it must be entirely or in part removed by dredging, are questions which in the absence of actual experience it is impossible to answer; but it may be asserted with full confidence that considerably more than the actual visible yardage will require removal. Another point, the permanence of the dredged channel, also requires consideration. As already mentioned in this report, the naturally formed channels are far from permanent, and it seems unreasonable to expect that artificially formed ones will offer any very different feature in this respect. It seems to your committee that the only chance lies in cutting so deeply as to lower the upper pool materially, and by this means to draw the water away from the minor channels. This will, of course, increase the original work, and even then we deem that it will be the part of wisdom to be prepared for the necessity of repeating the work several times in the course of a season. We should have been very glad to base our estimates on definite figures as to the work to be accomplished, but this has been impossible.

Immediately after receiving our instructions we arranged to have careful surveys made of several of the worst bars, but the sudden rise in the river prevented this, and no opportunity has since been presented. The committee, however, feel that it would be a difficult matter to overestimate this work, and they have approached the subject in that spirit. The time element must figure very largely in a question of this kind; the work to be worth doing at all must be done quickly. In our opinion not more than two weeks should be allowed for opening a channel as far south as may be necessary. Such an undertaking at once precludes the use of any of the common types of bucket or elevator dredges and throws us back on suction or pumping dredges as alone possessing the elements of speed and capacity required. Of these there are three types, varying with the method of disposing of the spoil. The self-loading dredges used on river-mouth and harbor bars, and of which the *Bayley* may be mentioned as a type, are out of the question here, as their draft when loaded would be too great. To use dump scows in work of this magnitude, while not impossible, would involve many delays and difficulties and would require a very considerable increase in the plant; as under these circumstances a towboat and a large fleet of dump scows would be absolutely necessary. The method of pumping the spoil through long floating pipes to deep holes or points outside the limits of the channel seems to us, on the whole, the one best adapted to this special case. The pumping machinery should be mounted on a steamer of reasonably light draft and fair power, so as to insure speedy travel from place to place and ample capacity while at work to supply steam power to the pumps used in dredging. Both in first cost, in maintenance, and in running expenses a large plant will cost much less than several small ones of the same aggregate capacity. We should, therefore, prefer a vessel of as large size as can be handled with certainty and facility, placing on this vessel as large pumps as the draft of water and the extent of the possible steam supply will justify.

Reasoning from such imperfect data as we have, the actual yardage requiring removal may be placed at from 500,000 to 1,000,000 cubic yards. These figures are liable to be increased to an uncertain extent by the causes already adverted to, but taking them as the basis of estimate and two weeks as the longest allowance of time available, it will be seen that the removal of from 36,000 to 72,000 cubic yards per day will be necessary. This will probably require at least two and possibly three outfits. There is a good deal of uncertainty regarding the proportion of sand to water which can be lifted by pumping, but 10 per cent seems to be about the lowest limit, while 20 and 30 per cent are not impossible. This question can only be settled by direct experiment. A pump discharge of 50,000 gallons per minute would, with the smaller percentage mentioned, give a capacity of about 1,500 cubic yards per hour. We further think that ten hours out of the twenty-four would be a fair average of the working time, allowing for all incidental delays due to fog, bad weather, and repairs to machinery and the loss of time involved in moving from place to place. This would make the daily capacity from 15,000 to 45,000 cubic yards, according to the percentage assumed. The power required to run the pumps would be between 300 and 400 I. H. P., and the total power provided for both boat and pumps should be about 600 I. H. P. The boat's engines should be proportioned to utilize the entire power while in transit from place to place, and a coal supply sufficient for at least a week's work should be carried on board. The full loaded draft of the boat should not exceed 4 feet.

The best method of working the dredge is a matter of great importance, but one upon which we hardly feel competent to make at present any definite recommendation. If the dredge while at work is to be kept stationary by anchors or other appliances or moved slowly by capstans along the line of dredging, the whole operation will be much simplified and will not vary materially from ordinary work of this nature. There are, however, objections to this method, which may prove serious in practice. The intrusion into the main channel of a large boat, with the necessary lines and anchors, would render the passage of boats dangerous, both for themselves and for the dredging plant, and would probably necessitate the stoppage of work and removal of the dredge whenever a steamer desired to cross the bar. If a dredge could be used which was maneuvered while at work entirely by its own power, uncomplicated by lines, anchors, and similar appliances, the difficulties above alluded to would be avoided, as such a boat could more readily be dropped out of the way of passing vessels. In such a design the use of drags on the suction pipes of a nature similar to those of the dredges used in the New York Harbor would probably be necessary, and without question the work of raising the solid material would be slower and more uncertain than by the other method, while breakages and other interruptions of work would be more frequent. The disposition of the spoil would also be more difficult. As internal receptacles are not possible, dump scows would probably be required.

There is a possibility that floating pipes might be used, or long suspended pipes projecting over the boat's sides to beyond the limits of the dredged channel, but there would be many difficulties involved in either method. None of the points adverted to can be definitely settled until by direct experiment it shall have been determined just what work is likely to be required and what conditions in a design are the most desirable. Such experiments should be made on a fairly large scale, so as to bring the whole question to a definite test; yet at the same time we do not consider it either advisable or necessary that the Commission should incur large expenditures, which might prove entirely useless. We would, therefore, recommend that the Commission procure one or two pumps of approved pattern and of a capacity of say 20,000 to 25,000 gallons per minute each. Let these pumps each be mounted in a temporary fashion on barges, old steamboat hulls, or any similar cheap structure, and let the work be done at low water in as systematic and thorough a manner as possible, so as to develop fully all the points upon which doubt now exists. With such information available, a design for permanent work can be prepared with some confidence as to its value and efficiency. If successful in operation these pumps and other machinery could probably be used in the permanent design, but in any case the amount involved would not be excessive, and would undoubtedly result in decided economy in the long run. Of course in the experiments here recommended a self-propelling machine is not contemplated, and a towboat, with possibly some dump scows, should be provided for each dredge.

Respectfully submitted.

CHAS. R. SUTER,
Lieut. Col. of Engineers.
HENRY FLAD,
Civil Engineer.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

APPENDIX 3.

REPORT OF CAPT. CARL F. PALFREY, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

ST. LOUIS, MO., *June 15, 1893.*

GENERAL: I have the honor to present the following report of operations under my charge as secretary Mississippi River Commission and assistant to construction committee from May 31, 1892, to May 31, 1893.

These works are carried on under the following allotments from the appropriations approved September 19, 1890, and March 3, 1891, made by the Commission and approved by the honorable the Secretary of War:

First. "Mississippi River Commission," applicable to salaries of three Commissioners, to expenses of offices of president and secretary, and to expenses of meetings and inspections of Commission.

Second. "Surveys, gauges, and observations," applicable to the general survey of the river, to collection and office reduction of physical data, and to general examinations and computations not confined to any one district.

Third. "General service," applicable to supply of stone, maintenance of plant, and general aid to works in the districts.

The small balances from earlier appropriations which appear in the financial statement are set off by outstanding liabilities for telegrams, which can not under existing orders be adjusted.

MISSISSIPPI RIVER COMMISSION.

The Commission has held four sessions during the period reported: At New York City, June 22 and August 2-5; on board steamer *Mississippi* from St. Louis, November 5, to New Orleans, November 19, 1892; and on board steamer *J. G. Barnard*, loaned for the purpose by Maj. A. Mackenzie, Corps of Engineers, from St. Louis, May 6, to New Orleans, May 11, 1893.

On January 16, about 9:30 a. m., the upper works of the steamer *Mississippi*, laid up at Paducah, Ky., were destroyed by fire, probably caused by a spark escaped from the breeching of the "nigger" boiler, in which steam was kept up for setting lines as the water level changed.

The fire was first seen on the under side of the boiler deck, and quickly burned through the floor of the forward cabin a little forward of the steam box of the main boilers.

The fires of the "nigger" boiler had just been drawn, and the steam pressure was only 20 pounds, insufficient for throwing water from the steamer's hose.

A barge was laid up just outside the steamer *Mississippi*, and the steamer *Eagle* was at the time lying outside the barge, taking on lumber from the shore, her deck crew crossing the decks of the *Mississippi* and the barge. The *Eagle* endeavored to assist, but her hose was small, and before it could be brought into play the flames had too great headway for it to be effective and for the position of the barge and the *Eagle* to be safe. The ice in the river, from ¼ to ¾ inch thick, rendered the buckets of little or no use. The alarm was sent to the fire department of Paducah, and was answered but the first supply of hose was insufficient, and by the time a second arrived the only service to be rendered was the quenching of some burning coal in the hold.

The progress of the fire was so rapid that little of the boat's property was saved. The two watchmen and the wife and child of one of them saved no clothing but what they had on. Some blocks in the forward hold and some blacksmith's tools which passed through the fire, a small quantity of bedding thrown on board the barge, a tin box of plated forks and spoons, badly damaged by fire, and a small iron safe, with one castor broken by fall, are all that was recovered.

Telegraphic report reached me at 2 p. m. I reached Paducah a little after midnight, and saw the wreck next morning.

The débris capable of holding fire had already been cleared away. The main deck was deeply charred all over and burned through in several places. The main boilers had still their cover of plaster and asbestos and showed no trace of injury. The main cylinders and the doctor, except its heating box, also appeared uninjured; the paint was not burned entirely off. The cylinder beams, iron "I" beams with castings of plate, were true to the eye, and showed no injury except that one plate of the casing of one of them was slightly warped. The wheel was uninjured.

Every indication was that a light offshore wind, or the draft over the bank caused by the fire, carried the flames across the boat. On the shore side the smoke stack, though fallen, appeared unscorched; that on the offside was collapsed. In the engine room two cans of oil standing near the cylinder beam on the shore side were not burned; on the offside one plate of the beam casing was slightly warped. The wheel was hardly charred at all; the barge lying alongside was badly so.

The moorings of wire cable probably saved the steel hull. The ice in the river was running rapidly; had the hull drifted beyond reach of hose from shore the coal stored therein would, in its burning, have warped the plates and bulkheads. It was promptly extinguished, and I can see no injury to the hull.

The sum of $25,000 was allotted for rebuilding the steamer *Mississippi*. She has been towed to Carondelet, hauled out, and redecked. Repairs of machinery and rebuilding of upper works are in progress.

SURVEYS, GAUGES, AND OBSERVATIONS.

Fieldwork under this allotment has been nearly continuous during the period reported. The triangulation party in the field, on board steamer *Patrol* on May 31, 1892, closed their work about 9 miles below Dubuque, Iowa, on August 26; started down the river on the same date, filled in, en route, some work prevented by high water, and reached Quincy, Ill., August 30. August 31 was occupied in preparing quarter boat *Illinois* for occupancy and towing to Hannibal, Mo., where topographical work began. This work was closed at head of Des Moines Rapids on November 10, the quarter boat was laid up in the canal, and *Patrol* reported at St. Louis on November 14. On November 17 she left St. Louis, carrying instruments and outfit for surveys below Donaldsonville, and having on board Assistant Engineer Ockerson, under orders for inspection of gauges; this inspection was closed on December 15. On December 8 the assistant engineers of the triangulation and stone-line party joined at Donaldsonville and carried work to New Orleans by January 13. On January 12 the assistant engineers, recorders, and rodmen of precise-level party joined at Kennerville, and all proceeded, January 17, to Head of Passes for work thence to New Orleans. This work was closed at New Orleans on March 15. En route, returning, the boat's crew replaced the bulletin at Arkansas City, destroyed by fire, by one of new type with iron frame.

March 27 Assistant Engineer Paige rejoined at Cairo for connection of Belmont gauge with previous benches. The *Patrol* reported at St. Louis April 4, and after slight refitting, boiler inspected, and delay by storm, left for Keokuk on April 8. En route bench marks of stone lines 81, 82, 83 situate near a railroad embankment soon to be enlarged, were relocated by Assistant Engineer French. The *Patrol* reached Keokuk on April 15 and was hauled out for repairs on April 18. The trip on the lower river had developed some weakness which, in prospect of another season there next winter, required attention. On May 2 Assistant Engineers Morrow and French left for work in the base line and closing line of last season's triangulation and for reconnoissance for that of the coming season. Repairs of *Patrol* were completed on May 17, and she reported at Dubuque on May 20 with party and equipment for triangulation.

Secondary Triangulation, and Stone-lines—On May 31, 1892, a party in the field since April 25, consisting of Assistant Engineer Charles W. Stewart, in charge, Assistant Engineers A. T. Morrow and George H. French, Recorders C. L. Ockerson, O. N. Axtell, and M. I. Powers, with boat's crew and working party of T. C. Hockridge, master and foreman, and 23 men, had carried this work to Fairport, Iowa, having then occupied 16 triangulation stations, marked 18 triangulation points, and 12 stone lines, completed work covering about 22 miles of river.

This party closed its season's field work on August 26 at a point about 9 miles below Dubuque, started down river the same night, completed en route some stone-line work near Muscatine, Iowa, left undone because of high water. Assistant Engineer Stewart turned over boat and party at Quincy on August 30 to Assistant Engineer Morrow, in charge of topographical work, and reported at office for computations and report.

Instructions for this work as to triangulation, printed in Annual Report 1891, pp. 3474–3476, as to stone lines, formerly placed by topographical party, in same report, pp. 3481–3485.

The season's work extends from Port Louisa, Iowa, to near Galena, Ill., covering about 138 miles of river by 72 triangles, and closing on a Coast Survey triangle-side, Horseshoe–Sinsinnaway; 1 base line of about 1 mile was measured along railroad track near Rapids City, Ill.; 41 stone lines, Nos. 136–176, were marked by 118 bench marks of tile and pipe.

The chain from New Boston base (9 miles below Port Louisa), measured in 1891, to Rapids City base is of 39 triangles, has a length by river of 68 miles and an axial length of 59 miles. The chain from Rapids City base to close is of 36 triangles, has a length by river of 79 miles and an axial length of 70 miles. The average error of closure of the 72 triangles of this season was 1''.88; 34 are large, with average error 2''.22 and greatest error 5''.82; 37 are small, with average error 1''.62 and greatest error 5''.21; 1 has no error.

The base at Rapids City was measured twice, with discrepancy of two measurements, 1:594917. The two observations for azimuth by Assistant Engineer Stewart were too widely discrepant and were rejected. May 9 and 11, 1893, observations for azimuth were made by Assistant Engineer Morrow, which were accepted. The results are as follows:

Computed length, 1,604.829 meters; measured length, 1,604.756 meters; discrepancy, 1:21807. Computed azimuth, 69°03' 52''.2; observed azimuth, 69°03' 47''.5; discrepancy, 4''.7.

The season's work was not closed upon a base line, the ground being unfavorable, though the customary interval was fully covered. It was closed by Assistant Engineer Stewart on what he supposed to be the side, Sinsinnawa–Horseshoe Mound, in the triangulation of the U. S. Coast and Geodetic Survey across Wisconsin in 1881. The descriptions received from the U. S. Coast and Geodetic Survey render it questionable whether he occupied the station Horseshoe Mound, and the coördinates furnished did not show this line as a side of a completed triangle.

On the reporting of the *Patrol* with full party, May 20, 1893, Assistant Engineer Morrow proceeded to occupy Stewarts Station Horseshoe, and the U. S. Coast and Geodetic Survey stations Sinsinnawa and Gratiots Grove (which were recognized beyond question), and thus joined the Mississippi River Commission work with that of the U. S. Coast and Geodetic Survey on the line Sinsinnawa–Gratiots Grove, a side of a completed triangle in both systems.

The regular triangulation has been carried on, occupying 8 stations and closing 5 triangles, with average error of closure, by field computation, of 1''.75. Favorable location of a base line has been selected; it will be measured in June.

Report of Assistant Engineer Stewart on the fieldwork under his charge, together with plat of triangulation and descriptions and geographical positions of stations as far as Rapids City, prepared in this office, is appended, marked A.

Topography and hydrography.—On September 1 a party, consisting of Assistant Engineer A. T. Morrow, in charge, with Assistant Engineers W. G. Comber, George H. French, E. L. Harman, H. Dunaway, and E. J. Thomas, and Recorders C. L. Ockerson and O. N. Axtell on topography, Recorders A. O. Wheeler and T. G. Ray on ordinary levels, T. C. Hockridge (also master of *Patrol*) and L. D. Cabanne on hydrography, M. I. Powers and H. C. Winchell on computation and platting, with boat crew and working party of forty-nine men, assembled at Hannibal, Mo.

The working season was from September 1 to November 10. The reach covered is from stone line 94, near the railroad bridge at Hannibal, Mo., to stone line 114, near head of Des Moines Rapids, 10 miles above Keokuk, Iowa, a distance of about 69 miles by river. The belt surveyed in this section is broader than the average, and includes a large amount of shore line (sloughs and islands) per mile of river. Up to and including No. 111 stone lines were placed by the topographical party. The season's work overlaps 9 miles by river upon the triangulation of 1891, in connection with which the stone lines were placed. The weather was favorable for fieldwork, and field plats were carried little beyond the instrumental lines necessary for check. Field plats were made on tracing linen for direct transfer to detail charts. (The original platting is slower; the time so lost is fully made up in the transfer, with gain of accuracy.) During work in the overflowed lowlands there was considerable sickness in the party; by temporary enlargement of the working force the work was carried on without material delay.

The instructions for this work are given in Annual Report 1891, pp. 3481-3485.

The tertiary triangulation occupied 143 stations and closed on 11 measured bases, 1 side of secondary triangulation for distance and 10 for azimuth.

Average error of closing, 1 in 9,652.

Lines of ordinary levels on both banks, with crossings near each stone line, checked each other with a greatest discrepancy of 0.145 foot, average 0.101 foot. These lines were checked at 12 points upon lines of precise levels run in 1881, with discrepancies ranging from 0.00 to 0.17 foot.

Twenty-four high-water marks of dates 1851 to 1892, whose history and accuracy appeared well established, were connected.

Soundings were taken on 402 sections, also in continuous line where channel was evident, and in several trial lines over shallows and divided channels, a total number of 25,490 soundings located by 10,674 sextant angles.

Report of Assistant Engineer Morrow is appended, marked B.

Triangulation, stone lines, and precise levels from Donaldsonville to Head of Passes.—For the extension of the surveys under the Commission from Donaldsonville, La. (where they were closed in 1883), a party took the field at that point on December 8 to make such triangulation as might prove necessary in a region already triangulated by the U. S. Coast and Geodetic Survey, and to mark the stone lines. As its work neared New Orleans it was joined by a precise level party, and both began work at the Head of Passes and carried their work to a junction with the triangulation above and the line of precise levels run from Biloxi in 1882. The work was thus broken to determine at once the feasibility of running precise levels on the soft lowlands, and to reach the levees before the rise of the river. Both works were closed at New Orleans on March 15, the precise levels connecting with the old line at three points.

Descriptions of triangulation stations and located points were furnished by the Coast and Geodetic Survey. Enough of them were found to render secondary triangulation unnecessary. In long reaches the tertiary triangulation was checked by frequent base lines and by distance measured by chain or tape as a check, though not used in computation as bases. The monuments are located to within the possibility of delineation on scale 1:10000. Stone lines besides the left bank section of No. 188, near Donaldsonville, were marked by 198 tile and pipe bench marks.

By exercising care in the placing of instrument and rods the precise levels have been kept well up to the average of this work. To test the accuracy of bench marks set in such soil advantage was taken of a delay by wind at Fort Jackson while en route from New Orleans to Head of Passes. On January 18 a bench mark was set in selected unfavorable ground, such that water was baled out of the pit before setting the tile, and carefully connected with a temporary bench on a tree. On February 3 and 5, when the line reached Fort Jackson, it was again connected. The results in the three dates differ only in the tenths of millimeters, and the mean of all is the same as the first determination.

This experimental bench mark gave a curious evidence of the elasticity of the soil of the Delta. The tile was well settled in place and its elevation taken before filling the pit. After filling the elevation was again taken through the pipe, and it was found to have settled 4.8 millimeters. After releveling, on February 3, the tile was uncovered and rose 3.8 millimeters. On refilling the pit the same settlement took place.

The time interval (January 18 to February 3) given in this experiment was all that the conditions of the work permitted. The results appear to show that these bench marks in soft springy ground are good if there is no disturbance of the ground near them, but may be affected by a turning up of the soil within a distance which would elsewhere be regarded as safe. The traditions of the former and present relations to the ground and water levels of a house near Cubitts Gap, would indicate that the soil of the Delta is raised by deposit of sediment and lowered by consolidation. It is possible that a future releveling of this line from the Metairie Ridge may determine this point.

Report of Assistant Engineer Morrow on the field work of this party, with descriptions and geographical positions of stone-line bench marks, is appended, marked C; also report of Assistant Engineer Paige on precise level work, with descriptions and elevations of permanent bench marks, marked D.

The present status of the surveys is as follows:

Triangulation and stone lines completed from Head of Passes to a little above Dubuque, Iowa; extension northward in progress.

Precise levels completed from Head of Passes to St. Paul, with side lines New Orleans-Biloxi, Savannah-Chicago, and St. Paul-Duluth; no extension projected.

Topography and hydrography complete from Donaldsonville, La., to head of Des Moines Rapids; extension northward projected for summer and autumn of 1893; completion from Donaldsonville to Head of Passes projected for winter of 1893-'94.

Manuscript charts, etc.—Detail charts, scale 1:10000: On May 31, 1892, these charts were completed to include No. 121, extending to stone line, 74.3 miles above Cap au Gris, with three in progress extending to midway between stone lines 85 and 86. They are now completed, except final retouching, to include No. 130, extending to just below Quincy, Ill., with six in progress, nearly completed, extending to stone line 114, at head of Des Moines Rapids, covering the field work of 1892.

In connection with these the sounding chart, serving also as index chart, is completed to same line. The office force for this work consists of the field topographers. All surveys and mapping have been under the direction of Assistant Engineer Ockerson.

Topographical maps, scale, 1 inch : 1 mile: On May 31, 1892, these maps were completed to Water Works, St. Louis (195 miles above Cairo), with one sheet in progress extending to mouth of Missouri River (207 miles above Cairo).

One has been redrawn, and two partly redrawn for better arrangement and execution. They are now completed to just below Grafton, Ill., 232 miles above Cairo (nine maps, numbered 101-109), with one in progress, extending to 255 miles above Cairo.

This work is in the hands of Mr. C. W. Clark.

Published charts and maps.—The charts and maps published by the Commission are the following. Except official issues under resolution of the Commission they are, in accordance with law, sold at the prices annexed:

		Cents.
Alluvial valley (scale, 1 inch : 5 miles) (completed)	per sheet..	10
Alluvial valley (scale, 1 inch : 5 miles)	per set (8 sheets)..	40
Mississippi River (scale, 1 : 20000) (in progress)	per sheet..	20
Mississippi River below Cairo (scale, 1 inch : 1 mile) (completed)	do....	5
Mississippi River above Cairo (scale, 1 inch : 1 mile) (in preparation).		

On May 31, 1892, of the charts, scale 1 : 20000, sixty-six sheets, extending from Cairo to Donaldsonville (numbered southward from 3 to 69), were published, and fourteen sheets, extending from Cairo to the southern limit of Carondelet (numbered northward from 101 to 114).

For the southward series, index charts (numbered 1 and 2) have been published, completing that series as far as surveys have been made. Of the northward series Nos. 115, 116, extending to mouth of Missouri River, have been published; final proofs of Nos. 117, 118, extending to just above Grafton, Ill., have been received.

On May 31, 1892, of the inch-mile series above Cairo, five maps were in hands of the printer. This printer failed utterly to produce satisfactory work. Eight maps, extending to mouth of Missouri River, are now in the hands of the printer. Satisfactory proofs have been received of five of them. The progress of publication has hitherto, for various reasons, lagged far behind that of preparation for it. With reasonable promptness on the part of the printer the field work of 1892 will all be published before the end of 1893.

The gauges maintained by the Commission have been sometimes under charge of the secretary and sometimes under that of the district officers. Few of them are of permanent construction, and some, owing to caving banks, have not been permanent in location. To determine their present condition and to put their location on record as accurately as the nature of the river bank leaves possible, an inspection was made during low water by Assistant Engineer J. A. Ockerson. His report, with plats, is appended, marked E.

The records for 1892 of gauges under the Commission, as well as of certain others under Majs. Mackenzie and Miller and Capts. Willard and Taber, Corps of Engineers, under the Weather Bureau, and of the Cincinnati Water Works, have been received, tabulated, and printed in pamphlet form, together with descriptions of gauges and bench marks. (Issued March 23.)

A table of high and low water, in extension of that published in Annual Report, 1891, pp. 3555–3575, is appended, marked F.

By direction of the president Mississippi River Commission the following tables have been prepared:

1. Showing, for certain selected stations and for the years 1872–'92 (except as noted in tables), the highest, lowest, mean highest, and mean lowest stages. (Appended, marked G.)

2. Showing, for certain selected stations, and for the years 1872–'92 (except as noted in tables), the mean number of days in which the stage above extreme low water was in successive intervals of 5 and 10 feet. (Appended, marked H). Since and including August, 1892, all gauges and records received weekly or monthly have been tabulated monthly and sent to Commissioners and district officers.

The office hydrographs have been kept up to date.

The discharge observations of 1892 have been recomputed and results tabulated and printed in pamphlet form. (Issued May 27.) Copy is appended, marked I.

This work has been under charge of Assistant Engineer Kivas Tully, assisted by Messrs. George H. Johnson and C. A. Bonfils.

Miscellaneous.—The exhibit of this office has been prepared and shipped to the Columbian Exposition. It consists of 1 atlas detail charts, mounted and bound; 1 atlas inch-mile maps, mounted and bound; 1 atlas survey of caving banks, blue prints; 1 atlas annual hydrographs, containing hydrographs, 1873–'92; 1 set of borings, mounted in glass tubes; 1 set of topographical sign printing apparatus (furnished by Assistant Engineer Ockerson); 1 set of "Stages," and 1 set "Discharge Observations."

A study has been made of early maps of the Mississippi River below Cairo in comparison with those published by the Commission. The maps studied are those of Lieut. Ross, Thirty-fourth Regiment, from observations taken on a journey in the latter part of the year 1765 (London, 1776); of Capt. Phillip Pitman, from observations extending probaby from 1765 to 1768 (London, 1770); and of Brig. Gen. Victor Collot, from a journey September 16–October 26, 1796 (Paris, 1826). Report of method and results with tracings of the maps, and meander lines platted for comparison, is appended, marked K.

For the privilege of tracing Ross's map I am indebted to the librarian of the Missouri Historical Society; for that of Pitman's, to Col. George E. Leighton, of St. Louis. Collot's is in my possession.

GENERAL SERVICE.

On May 31, 1892, the general service was engaged in the repair of barges and in towing stone from Apple Creek Quarry to works in the first and second districts.

On June 22 the commission, in session at New York, directed that the general service be abolished as soon as practicable after June 30, that its property be distributed to the works of the secretary and the first, second, and third districts, and that the officers in charge of those works make the distribution.

These officers met at Memphis on July 16, and assigned to the secretary the furniture in his office and the steamer *Mississippi* with outfit; to the first and second districts, the steamer *Minnetonka* with outfit, the camel docks, and one-half the barges and working tools; to the third district, the steamers *Etheridge* and *Vedette* with outfit, and one-half the barges and working tools.

In view of the importance to the first district of the repair of barges and the stone supply, this work, with control of all property, was turned over to Capt. S. W. Roessler, in charge of that district, the formal transfer of property to be completed when the requirements of this work permitted. It was completed at the end of December.

Stone supply.—The season of 1892 extended from February 21, when on notice that the barges in this district were free, the *Minnetonka* was sent out to collect them to July 20, when the work was turned over to Capt. Roessler.

The expenditures and results are tabulated below, the cost of towing, as in former reports, includes all running expenses of steamers, but not repairs others than those made en route, nor interest on value of plant.

Statement of cost of towing stone to first district, by the general service, February 21 to July 20, 1892.

Total running expenses of steamers	$12,663.58
Less applied to third district, returning empties	5,740.24
	6,923.34
6,408,437 yard miles, at $0.00107	6,923.34

Cost of stone on barges.

		Cents.
At quarry	per cubic yard..	62.50
At Daniels Point	do....	87.34
At Ashport	do....	87.34
At Keyes Point	do....	87.34+

The general service was organized in 1882, having for its functions the purchase, construction, and repair of plant, and the purchase and delivery of general supplies and materials for the districts. Of later years the stone supply and repair of plant has been almost its only service. Its plant has been held in the districts whenever required for the works, and collected by it when not so required for repair and for stone towing. It has had no permanent location and at no time the control, by purchase or lease, of any water front. Up to 1889 it was a separate charge; since that year it has been under the secretary.

Its expenditures, 1882-'92, are as follows:

Running expense of steamers, charter, etc	$358,443.89
Repairs and care of plant (labor and material)	315,121.52
Plant and outfit	189,773.03
Inspection administration and office	102,243.88
Purchase of stone	20,151.38
Raising sunken barges and property	3,219.33
Medical attendance	403.40
Miscellaneous	289.90
Total	989,646.33

"Running expense of steamers" covers the delivering in the districts of 386,788 cubic yards of stone, about 10,000 tons of coal, and about 4,000 tons of general supplies, that of the floating plant built above Cairo on Mississippi and Ohio rivers, as well as of its own plant, when required, and its collection after such service, with incidentally some moving of plant, and, in emergency, direct aid in construction in the districts.

"Repair and care of plant" includes that of the general service, that of fifty-eight barges purchased from allotment for New Madrid, of thirty barges borrowed for the Mississippi River Commission in use from May, 1884, to March, 1885, and of some belonging to the districts.

"Plant and outfit" includes part payment for building and fitting out steamer *Mississippi*, purchase of steamers *Minnetonka*, *Etheridge*, and *Vedette* with outfit, building thirty barges, three camel docks, and upper works to make a store boat of a second hand coal barge, also the necessary provision of small boats and working tools.

The office expenses, as distinct from inspection and administration, have been of late years an allotted five-twelfths of the expenses of the combined office; in the early years those of the separate office included the printing under the commission.

"Purchase of stone" includes only that directly paid for by the general service; most of that actually purchased was paid for by the district officers.

The expenditures have been distributed among the districts and the several titles of allotment, as shown in the detailed statements of expended and current allotments.

TONNAGE AND TRAFFIC.

The through traffic of the lower Mississippi River comes from the upper Mississippi and Missouri rivers and northern and northwestern railroads (reshipped from St. Louis) and from ports on the Ohio River.

From the northern rivers and railroads the most important shipment is of grain in bulk for export to European ports, much of which is sold in Europe before shipment. This traffic, entirely in the hands of the St. Louis and Mississippi Valley Transportation Company, aggregated as follows:

Corn	bushels..	5,763,187
Wheat	do....	6,662,799
Oats	do....	36,857
Total	tons..	365,859

The principal items of miscellaneous freight carried down by this line (total 42,301 tons) are white lead, flour, grain in sacks (for domestic trade), and meat products.

The principal items of return freight (total, 40,425 tons) are imported cement and rice and native lumber. Detailed statements of the "Shipments of bulk grain," and of "Shipments by N. O. boats and barges," taken from report of St. Louis Merchants' Exchange, and of return freights, furnished by the secretary of the company, are contained in commercial statistics appended, marked L.

The traffic from northern rivers and railroads to way ports (also reshipped at St. Louis) is in the hands of the "Anchor Line."

Detailed statement of it is contained in the "Shipments by Memphis, Vicksburg, and Natchez boats," taken from report of St. Louis Merchants Exchange in Appendix L.

On the estimate of this company 1 per cent is deducted for traffic between St. Louis and Cairo and 40 per cent added for return freights, giving a total of 106,813 tons.

All of the above traffic was seriously interfered with by the extreme range and the long duration of both the high and low waters. The former cut off the communication with the grain elevators at St. Louis and with many way landings, affecting both heavy and light traffic. The low water, while affecting both, tells more seriously on the heavy traffic. This is shown by the records of two trips, the best and the worst of 1892. On March 5, 4 p. m., the steamer *Hoxie* left Cairo with six barges, loaded to 8 feet 8 inches, carrying 8,843 tons of freight. Reached New Orleans March 12, 12 m. Left New Orleans March 13, 6 a. m., with six barges, carrying 790 tons of freight. Reached Cairo March 24, 2 a. m. Round trip time, and full steamer service, seventeen days sixteen hours. On November 5, 5 a. m., the steamer *Clark* left Cairo with six barges, loaded to 5 feet 1 inch, carrying 4,008 tons of freight. Had en route eight days twenty-one hours of service of an auxiliary steamer. Reached New Orleans November 19, 8 a. m. Left New Orleans November 20, 4 a. m., with six barges, carrying 1,850 tons of freight. Reached Cairo December 1, 9 a. m. Round trip time, twenty-five days, eight hours; total steamer service, thirty-four days, five hours.

The secretary of the company writes: "At low stage it is almost impossible to tow more than three barges at once between Cairo and points as low down as Helena, the channels being so close as to forbid of tows of greater width; hence we are compelled to use auxiliary or helping steamers for a part of the journey."

The *Hoxie*, the *Clark*, and the auxiliary steamer are all of the first class, representing substantially the same expense and working power. The coal expenditure is slightly less in low-water towing; the breaking of lines and wear of plant much greater. In counting the expense as proportional to the hours of steamer service I consider the low-water towing to be treated with favor. The upstream freight is not of such quantity as to make draft important. In counting the freight carried I consider the downstream freights alone to give the ratio really in question. On this analysis the cost per ton of towing on draft 5 feet 1 inch is 4.279 times that of towing on draft 8 feet 8 inches.

Taking the trip of the *Clark* as the worst of the season, and assuming a perfect combination of trips, the auxiliary steamer, working from Cairo to Helena, might give aid to three steamers of the regular line while the first was completing its round trip, thus securing from four steamers, including the auxiliary, the full work of three in the regular line. Compounding this ratio of steamers required, that of the downstream freights and that of the round trip times, the efficiency of steamers on draft 8 feet 8 inches is 4.217 times that on draft 5 feet 1 inch.

The low water usually occurs at a time when St. Louis elevators are full of grain, and certainty and promptness of transportation is important.

The Cherokee Packet Company, plying from St. Louis to Memphis, carries downstream freights of general merchandise, upstream freights of lumber, grain, and hay. Deducting deliveries above Cairo, their agent estimates the downstream freight at 21,600 tons; upstream, 12,500 tons; total, 34,100 tons.

The principal shipments from the Ohio River are of coal from Pittsburg and general merchandise from Cincinnati; the principal return freights are of sugar, molasses, and cotton products.

The secretary of the Pittsburg Coal Exchange has furnished me a statement of shipments of coal delivered in successive reaches of the river, which he has compiled from statements of shippers, the records of the exchange not containing the information in this form. The total of these shipments is 1,850,000 tons. No freight is brought back, and many of the barges are sold with the coal. (Copy in Appendix L.)

The superintendent of the Cincinnati Chamber of Commerce has furnished me with a statement of the traffic with the Lower Mississippi from that port, also made up from special inquiry, classified only as above and below Memphis. The downstream shipments are of general merchandise; the upstream are mainly sugar and molasses and cotton products. They aggregate, downstream, 28,071 tons, upstream, 27,811 tons; total, 55,882 tons. (Copy in Appendix L.)

The above comprises nearly all the through traffic on the Lower Mississippi; there remain that of a few small steamers and some small way traffic of the through steamers, of which little or no formal record is kept, and of which no trustworthy estimate is accessible to me. From the information furnished I summarize as follows:

Downstream: From the northern rivers, 499,118 tons; from the Ohio, 1,878,071 tons; total, 2,377,189 tons.

Upstream: To the north, 90,380 tons; to the Ohio, 27,811 tons; total, 118,191 tons. Aggregate, 2,495,380 tons, of which about three-fourths are carried over the whole distance Cairo to New Orleans.

As the commercial sections most nearly corresponding to the engineer districts, I take the following: First, from Cairo to and including Memphis; second, from Memphis to and including White River; third, from White River to and including Vicksburg; fourth, from Vicksburg to and including New Orleans.

The traffic by the Anchor Line of steamers is, on the estimate of the company, apportioned, one-fourth to Memphis, one-half to Vicksburg, and one-fourth to Natchez.

This gives the through-freight traffic of the districts as follows:

First. Down, 2,377,189 tons; up, 118,191 tons; total, 2,495,380 tons; of which 2,143,480 tons were in transit, 351,900 delivered or shipped in the district.

Second. Down, 2,063,571 tons; up, 79,909 tons; total, 2,143,480 tons; of which 2,083,480 tons were in transit, 60,000 tons delivered in the district.

Third. Down, 2,003,571 tons; up, 79,909 tons; total, 2,083,480 tons; of which 1,882,325 tons were in transit, 201,157 tons delivered or shipped in the district.

Fourth. Down, 1,821,292 tons; up, 61,031 tons; total, 1,882,323 tons; all delivered or shipped in the district.

I have tabulated the above so as to show, for each district, the source or destination of the above traffic, with the amounts in transit and those delivered downstream or shipped upstream, and the local traffic from information received from the district officers. It is the first statement in Appendix L.

Financial statements for May, detailed and consolidated statements up to May 31, statement of maps issued, list of civilian engineers, and approximate value of plant, are appended.

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

Carl F. Palfrey,
Captain of Engineers.

Gen. C. B. Comstock,
President Mississippi River Commission.

Secretary's office—Financial statements for the month ending May 31, 1893.

	Mississippi River Commission act Oct. 2, 1888.	Survey of Mississippi River, act Aug. 11, 1888.	Improving Mississippi River; surveys, gauges, and observations.	Improving Mississippi River; Mississippi River Commission.	Improving Mississippi River; rebuilding steamer Mississippi.	Total.	Works above Cairo, act July 5, 1884.
Balance unexpended at end of last fiscal year	$138.26	$7.08	$44,206.71	$35,560.97	....	$79,918.02	$8,600.00
Appropriated and allotted during current fiscal year	....	....	....	....	....	....	....
Gained by transfer during current fiscal year	....	....	46,345.33	....	$25,000.00	71,345.33	....
Lost by transfer during current fiscal year	....	....	....	....	....	....	....
Total available	138.26	7.08	90,552.04	35,560.97	25,000.00	151,258.35	8,600.00
Expended during current fiscal year	....	....	*59,860.70	25,610.36	649.64	86,120.70	....
Refunded during current fiscal year	....	....	....	....	....	....	....
Total disposed of	....	....	59,860.70	25,610.36	649.64	86,120.70	....
Balance unexpended	138.26	7.08	30,691.34	9,950.61	24,350.36	65,137.65	....
In treasury	57.35	....	26,077.27	13,995.97	25,000.00	65,130.59	....
On hand	80.91	7.08	4,614.07	....	....	4,702.06	8,600.00
Overdrawn	....	....	....	4,045.36	649.64	4,695.00	....
Balance as above	138.26	7.08	30,691.34	9,950.61	24,350.36	65,137.65	8,600.00
Outstanding liabilities	138.26	7.08	5,000.00	3,000.00	4,500.00	12,645.34	39.00
Amounts covered by existing contracts	....	....	....	....	....	....	....
Total liabilities	138.26	7.08	5,000.00	3,000.00	4,500.00	12,645.34	39.00
Balance available	....	....	25,691.34	6,950.61	19,850.36	52,492.31	8,561.00

*61.55 expended by Treasury settlement No. 7,977.

First and Second districts—financial statement for the month ending May 31, 1893.

	Plum Point Reach.	Plant, first and second districts.	Hickman, Ky.	New Madrid, Mo.	Improving harbor at New Madrid, Mo.	Preservation of works.
Balance unexpended at end of last fiscal year	$270,163.82	$7,976.02	$45,910.97	$226.61	....	$11,039.89
Appropriated and allotted during current fiscal year	60,000.00	60,000.00	....	....	$25,000.00	....
Gained by transfer during current fiscal year	....	....	....	....	....	....
Lost by transfer during current fiscal year	42,000.00	....	....	....	....	....
Total available	288,163.82	67,976.02	45,910.97	226.61	25,000.00	11,039.89
Expended during current fiscal year	237,322.05	53,343.16	4,113.12	208.00	6,138.97	3,289.18
Refunded during current fiscal year	....	....	....	....	....	....
Total disposed of	237,322.05	53,343.16	4,113.12	208.00	6,138.97	3,289.18
Balance unexpended	50,841.77	14,632.86	41,797.85	18.61	18,861.03	7,750.71
In treasury	62,500.00	20,000.00	31,843.17	....	25,000.00	5,000.00
On hand	....	....	9,954.68	18.61	....	2,750.71
Overdrawn	11,658.23	5,367.14	....	....	6,138.97	....
Balance as above	50,841.77	14,632.86	41,797.85	18.61	18,861.03	7,750.71
Outstanding liabilities	5,000.00	5,000.00	....	....	3,000.00	....
Amounts covered by existing contracts	8,000.00	....	....	....	....	....
Total liabilities	13,000.00	5,000.00	....	....	3,000.00	....
Balance available	37,841.77	9,632.86	41,797.85	18.61	15,861.03	7,750.71

	Surveys, gauges, and observations.	Dredging experiments.	Hopefield Bend.	Improving harbor at Memphis, Tenn.	Removal Nonconnah rock.
Balance unexpended at end of last fiscal year	$6,807.99	....	....	....	....
Appropriated and allotted during current fiscal year	....	$35,000.00	$91,000.00	$25,000.00	$6,000.00
Gained by transfer during current fiscal year	2,000.00	15,000.00	7,431.78	....	....
Lost by transfer during current fiscal year	....	....	....	....	....
Total available	8,807.99	50.000.00	98,431.78	25,000.00	6,000.00
Expended during current fiscal year	7,470.17	9,269.15	98,316.51	....	7.20
Refunded during current fiscal year	....	....	....	....	....
Total disposed of	7,470.17	9,269.15	98,316.51	....	7.20
Balance unexpended	1,837.82	40,730.85	115.27	25,000.00	5,992.80
In treasury	4,500.00	45,000.00	....	24,000.00	2,000.00
On hand	....	....	115.27	1,000.00	3,992.80
Overdrawn	3,162.18	4,269.15	....	....	....
Balance as above	1,337.82	40,730.85	115.27	25,000.00	5,992.80
Outstanding liabilities	1,000.00	40,730.85	115.27	....	992.80
Amounts covered by existing contracts	....	....	....	....	5,000.00
Total liabilities	1,000.00	40,730.85	115.27	....	5,992.80
Balance available	337.82	....	....	25,000.00	....

First and Second districts—Financial statement for the month ending May 31, 1893— Continued.

	Helena, Ark.	Upper Yazoo levee district.	Upper White River levee district.	Lower White River levee district.	Total.
Balance unexpended at end of last fiscal year	$1,502.80				$343,628.10
Appropriated and allotted during current fiscal year		$100,000.00	$50,000.00	$75,000.00	527,000.00
Gained by transfer during current fiscal year		4,548.65	790.39		29,770.82
Lost by transfer during current fiscal year					42,000.00
Total available	1,502.80	104,548.65	50,790.39	75,000.00	858,398.92
Expended during current fiscal year	6.70	97,453.80	22,229.13	65,444.62	604,611.76
Refunded during current fiscal year					
Total disposed of	6.70	97,453.80	22,229.13	65,444.62	604,611.76
Balance unexpended	1,496.10	7,094.85	28,561.26	9,555.38	253,787.16
In treasury	500.00	10,000.00		7,500.00	237,843.17
On hand	996.10		28,561.26	2,055.38	49,444.81
Overdrawn		2,905.15			33,500.82
Balance as above	1,496.10	7,094.85	28,561.26	9,555.38	253,787.16
Outstanding liabilities		500.00	5,000.00	1,000.00	62,338.92
Amounts covered by existing contracts			10,000.00		23,000.00
Total liabilities		500.00	15,000.00	1,000.00	85,338.92
Balance available	1,496.10	6,594.85	13,561.26	8,555.38	168,448.24

Third district—Financial statement for the month ending May 31, 1893.

	Lake Providence Reach.	Vicksburg, Miss.	Lake Bolivar Front.	Ashbrook Neck.	Plant, third district.	Surveys, gauges, and observations.
Balance unexpended at end of last fiscal year	$27,474.29	$40,089.82	$6,000.00	$107,245.84	$10,201.71	$75.54
Appropriated and allotted during current fiscal year	176,000.00				50,000.00	10,000.00
Gained by transfer during current fiscal year					25,000.00	
Lost by transfer during current fiscal year				25,000.00		
Total available	203,474.29	40,089.82	6,000.00	82,245.84	85,201.71	10,075.54
Expended during current fiscal year	178,749.26	34,050.20	3,377.20	81,231.26	79,520.00	9,777.12
Refunded during current fiscal year						
Total disposed of	178,749.26	34,050.20	3,377.20	81,231.26	79,520.00	9,777.12
Balance unexpended	24,725.03	6,039.62	2,622.80	1,014.58	5,681.71	298.42
In Treasury	15,000.00	5,000.00				1,000.00
On hand	9,725.03	1,039.62	2,622.80	1,014.58	5,681.71	
Overdrawn						701.58
Balance as above	24,725.03	6,039.62	2,622.80	1,014.58	5,681.71	298.42
Outstanding liabilities	4,725.03			1,014.58	5,681.71	298.42
Amounts covered by existing contracts	10,000.00					
Total liabilities	14,725.03			1,014.58	5,681.71	298.42
Balance available	10,000.00	6,039.62	2,622.80			

Third district—Financial statement for the month ending May 31, 1893—Continued.

	Lower Yazoo levee district.	Upper Tensas levee district.	Middle Tensas levee district.	Improving harbor at Vicksburg, Miss.	Improving harbor at Greenville, Miss.	Totals.
Balance unexpended at end of last fiscal year	....	....	....	....	....	$191,087.20
Appropriated and allotted during current fiscal year	$200,000.00	$310,000.00	$110,000.00	$80,000.00	$100,000.00	1,036,000.00
Gained by transfer during current fiscal year	4,091.01	3,854.12	277.47	....	....	33,222.60
Lost by transfer during current fiscal year	....	....	....	....	....	25,000.00
Total available	204,091.01	313,854.12	110,277.47	80,000.00	100,000.00	1,235,309.80
Expended during current fiscal year	179,172.03	286,374.80	92,936.28	24,187.74	94,758.46	1,064,134.35
Refunded during current fiscal year	....	....	....	....	....	....
Total disposed of	179,172.03	286,374.80	92,936.28	24,187.74	94,758.46	1,064,134.35
Balance unexpended	24,918.98	27,479.32	17,341.19	55,812.26	5,241.54	171,175.45
In Treasury	24,000.00	43,000.00	7,000.00	60,000.00	5,000.00	160,000.00
On hand	918.98	....	10,341.19	....	241.54	31,585.45
Overdrawn	....	15,520.68	....	4,187.74	....	20,410.00
Balance as above	24,918.98	27,479.32	17,341.19	55,812.26	5,241.54	171,175.45
Outstanding liabilities	9,918.98	7,179.32	7,341.19	1,000.00	....	37,159.23
Amounts covered by existing contracts	....	5,300.00	....	36,512.26	....	51,812.26
Total liabilities	9,918.98	12,479.32	7,341.19	37,512.26	....	88,971.49
Balance available	15,000.00	15,000.00	10,000.00	18,300.00	5,241.54	82,203.96

Fourth district—Financial statement for the month ending May 31, 1893.

	Lower Tensas levee district.	Atchafalaya levee district.	Lafourche levee district.	Barataria levee district.	Pontchartrain levee district.	Lake Borgne levee district.	Red and Atchafalaya rivers.
Balance unexpended at end of last fiscal year	....	....	....	....	....	....	$88,697.06
Appropriated and allotted during current fiscal year	$150,000.00	$155,000.00	$90,000.00	$60,000.00	$150,000.00	$50,000.00	....
Gained by transfer during current fiscal year	....	....	....	....	....	....	....
Lost by transfer during current fiscal year	....	....	....	....	....	....	....
Total available	150,000.00	155,000.00	90,000.00	60,000.00	150,000.00	50,000.00	88,697.06
Expended during current fiscal year	133,324.57	127,883.67	75,106.64	57,566.16	132,171.43	49,704.81	28,724.06
Refunded during current fiscal year	....	....	....	....	....	....	....
Total disposed of	133,324.57	127,883.67	75,106.64	57,566.16	132,171.43	49,704.81	28,724.06
Balance unexpended	16,675.43	27,116.33	14,893.36	2,433.84	17,828.57	295.19	59,973.00
In Treasury	15,000.00	25,000.00	15,000.00	5,000.00	20,000.00	5,000.00	58,000.00
On hand	1,675.43	2,116.33	....	....	....	....	1,973.00
Overdrawn	....	....	106.64	2,566.16	2,171.43	4,704.81	....
Balance as above	16,675.43	27,116.33	14,893.36	2,433.84	17,828.57	295.19	59,973.00
Outstanding liabilities	....	....	....	....	....	....	....
Amounts covered by existing contracts	15,319.99	....	10,725.59	....	12,991.49	....	59,973.00
Total liabilities	15,319.99	....	10,725.59	....	12,991.49	....	59,973.00
Balance available	1,355.44	27,116.33	4,167.77	2,433.84	4,837.08	295.19	....

Fourth district—Financial statement for the month ending May 31, 1893—Continued.

	Surveys, gauges, and observations.	Improving Mississippi River.	Improving harbor at New Orleans, La.	Improving Atchafalaya and Red Rivers, Louisiana.	Improving harbors at Natchez and Vidalia, Miss. and La.	Total.
Balance unexpended at end of last fiscal year	$626.42	$89,323.48				$89,323.48
Appropriated and allotted during current fiscal year	12,000.00	667,000.00	$80,000.00	$80,000.00	$80,000.00	907,000.00
Gained by transfer during current fiscal year						
Lost by transfer during current fiscal year						
Total available	12,626.42	756,323.48	80,000.00	80,000.00	80,000.00	996,323.48
Expended during current fiscal year	6,073.33	610,554.67	80,000.00		1,420.47	691,975.14
Refunded during current fiscal year						
Total disposed of	6,073.33	610,554.67	80,000.00		1,420.47	691,975.14
Balance unexpended	6,553.09	145,768.81		80,000.00	78,579.53	304,348.34
In Treasury	6,000.00	149,000.00	5,000.00	80,000.00	75,000.00	309,000.00
On hand	553.09	6,317.85			3,579.53	9,897.38
Overdrawn		9,549.04	5,000.00			14,549.04
Balance as above	6,553.09	145,768.81		80,000.00	78,579.53	304,348.84
Outstanding liabilities						
Amounts covered by existing contracts		99,010.07		9,527.00		108,537.07
Total liabilities		99,010.07		9,527.00		108,537.07
Balance available	6,553.09	46,758.74		70,473.00	78,579.53	195,811.27

Detailed statement, March 3, 1881, to May 31, 1893. (Expended allotments.)

Districts.	Balances.	Appropriations and allotments.	Applied by general service.	Total.
Des Moines Rapids to Illinois River	$12,663.38	$195,000.00		$207,663.38
Illinois River to Ohio River	9,969.15	470,000.00		479,969.15
Total	22,632.53	665,000.00		687,632.53
Survey, St. Francis Front		10,122.61		10,122.61
New Madrid Reach		200,721.86	$9,640.05	210,361.91
Columbus, Ky		41,150.92	2,599.08	43,750.00
Gauges		1,436.50		1,436.50
Observations and discharges		3,000.00		3,000.00
Surveys, examinations, and inspections		1,791.52		1,791.52
Levees—Plum Point		155,924.03		155,924.03
Survey, St. Francis Front		4,000.00		4,000.00
Survey, Helena Reach		8,000.00		8,000.00
Levees:				
Long Lake		15,000.00		15,000.00
Yazoo-Mississippi Delta		100,000.00		100,000.00
Protection of levees		1,595.55		1,595.55
Memphis Reach		147,384.47	52,696.32	200,080.79
Memphis Harbor and Reach		431,792.38	138,232.94	570,025.32
Gauges		987.50		987.50
Observations and discharges		3,000.00		3,000.00
Surveys, examinations, and inspections		1,880.11		1,880.11
Care of plant, first and second districts		84,998.64		84,998.64
Surveys, first and second districts		9,475.84		9,475.84
Levees:				
Yazoo Front		157,406.45		157,406.45
White River Basin		270,561.44		270,561.44
Upper Mississippi Levee District		139,348.90		139,348.90
Memphis		372,933.75	8,567.13	381,500.88
Total, first and second districts		2,162,512.47	211,735.52	2,374,247.99
Survey, Vicksburg Harbor		2,500.00		2,500.00
Survey, unleveed fronts		1,000.00		1,000.00
Survey, Choctaw Reach		2,679.86		2,679.86

Detailed statement, March 3, 1881, to May 31, 1893. (Expended allotments.)—**Cont'd.**

Districts.	Balances.	Appropriations and allotments.	Applied by general service.	Total.
Levees:				
Opossum Fork		$120,000.00		$120,000.00
Yazoo Front		364,878.95		364,878.95
Yazoo Front—Ben Lomond		11,386.22		11,386.22
Yazoo Front—Hughes Break		6,849.69		6,849.69
Tensas Front		566,723.00		566,723.00
Protection of levees		216,431.83		216,431.83
Protection of existing works		25,000.00		25,000.00
Repairs to floating plant		30,000.00		30,000.00
Vicksburg Harbor—Delta Point	$25,770.13	107,579.88		133,350.01
Care of plant and surveys		24,360.00		24,360.00
Lake Bolivar front		116,329.85	$8,028.19	124,358.04
Gauges		1,461.10		1,461.10
Observations and discharges		3,000.00		3,000.00
Surveys, examinations, and inspections		10,149.46		10,149.46
Greenville, Miss		348,499.02	58,144.00	406,643.02
Levees:				
Lower Mississippi levee district		289,944.54		289,944.54
Tensas Basin, Louisiana		160,072.27		160,072.27
Tensas Basin, Arkansas		399,591.09		399,591.09
Floating dock		20,000.00		20,000.00
Total, third district	25,717.13	2,828,436.76	66,172.19	2,920,379.08
Survey:				
Cubitt's Gap		137.14		137.14
Unleveed fronts		1,000.00		1,000.00
Observations at Carrollton		3,000.00		3,000.00
Bonnet Carre Crevasse		15,000.00		15,000.00
Natchez and Vidalia harbors	8,252.04			8,252.04
Mouth of Red River	90,812.40	38,405.00		129,217.40
Natchez, Miss. (survey)		1,500.00		1,500.00
Gauges		1,878.11		1,878.11
Observations and discharges		9,000.00		9,000.00
Levees—Atchafalaya front		176,800.00		176,800.00
Protection of levee—Tensas front		23,000.00		23,000.00
Protection of levees		104,000.00		104,000.00
Surveys, examinations, and inspections		4,000.00		4,000.00
New Orleans Harbor	147,670.37	389,183.86	1,527.61	538,381.86
Levees:				
Tensas Basin		1,163,477.00		1,163,477.00
Right bank below Red River		191,892.00		191,892.00
Left bank below Red River		134,116.00		134,116.00
Total, fourth district	246,734.83	2,256,389.11	1,527.61	2,504,651.55
Reduction of observations		2,500.00		2,500.00
Total, secretary's office		2,500.00		2,500.00
Grand total	295,137.49	7,914,838.34	279,435.32	8,489,411.15

Detailed statement, March 3, 1881, to May 31, 1893. (Current allotments.)

Districts.	Appropriations and allotments.	Applied by general service.	Total available.	Expended.	Total balances.
Protection near Cairo	$50,000.00	....	$50,000.00	$41,400.00	$8,600.00
Total above Cairo	50,000.00	....	50,000.00	41,400.00	8,600.00
First and second districts.					
Plum Point Reach	3,314,821.18	$364,515.50	3,679,336.68	3,628,494.91	50,841.77
Plant, first and second district	190,507.35	5,017.40	195,524.75	180,891.89	14,632.86
Hickman, Ky	85,343.17	3,288.83	89,132.00	47,334.15	41,797.85
New Madrid, Mo	1,000.00	....	1,000.00	981.39	18.61
Improving harbor at New Madrid, Mo	25,000.00	....	25,000.00	6,138.97	18,861.03
Preservation of works, first and second districts	20,680.42	3,187.47	23,867.89	16,117.18	7,750.71
Surveys, gauges, and observations	20,479.03	....	20,479.03	19,141.21	1,337.82
Dredging experiments	50,000,00	....	50,000.00	9,269.15	40,730.85
Hopefield Bend	98,431.78	....	98,431.78	98,316.51	115.27
Improving harbor, Memphis, Tenn	25,000.00	....	25,000.00	....	25,000.00
Removal of Nonconnah Rock	6,000.00	....	6,000.00	7.20	5,992.80
Helena, Ark	66,106.83	10,393.17	76,500.00	75,003.90	1,496.10
Upper Yazoo levee district	104,548.65	....	104,548.65	97,453.80	7,094.85
Upper White River levee district	50,790.39	....	50,790.39	22,229.13	28,561.26
Lower White River levee district	75,000.00	....	75,000.00	65,444.62	9,555.38
Total, first and second districts	4,134,208.80	386,402.37	4,520,611.17	4,266,824.01	253,787.16
Third district.					
Lake Providence Reach	2,975,876.34	255,046.96	3,230,923.30	3,206,198.27	24,725.03
Vicksburg, Miss	366,968.70	2,662.27	369,630.97	363,591.35	6,039.62
Lake Bolivar front	6,000.00	....	6,000.00	3,377.20	2,622.80
Ashbrook Neck	317,000.00	49,003.87	366,003.87	364,989.29	1,014.58
Plant, third district	231,331.17	17,095.54	248,426.71	242,745.00	5,681.71
Surveys, gauges, and observations	22,138.90	....	22,138.90	21,840.48	298.42
Lower Yazoo levee district	204,091.01	....	204,091.01	179,172.03	24,918.98
Upper Tensas levee district	313,854.12	....	313,854.12	286,374.80	27,479.32
Middle Tensas levee district	110,277.47	....	110,277.47	92,936.28	17,341.19
Improving harbor, Vicksburg, Miss.	80,000.00	....	80,000.00	24,187.74	55,812.26
Improving harbor, Greenville, Miss.	100,000.00	....	100,000.00	94,758.46	5,241.54
Total, third district	4,727,537.71	323,808.64	5,051,346.35	4,880,170.90	171,175.45
Fourth district.					
Lower Tensas levee district	150,000.00	....	150,000.00	133,324.57	16,675.43
Atchafalaya levee district	155,000.00	....	155,000.00	127,883.67	27,116.33
Lafourche levee district	90,000.00	....	90,000.00	75,106.64	14,893.36
Barataria levee district	60,000.00	....	60,000.00	57,566.16	2,433.84
Pontchartrain levee district	150,000.00	....	150,000.00	132,171.43	17,828.57
Lake Borgne levee district	50,000.00	....	50,000.00	49,704.81	295.19
Red and Atchafalaya rivers	657,500.00	....	657,500.00	597,527.00	59,973.00
Surveys, gauges, and observations	25,121.89	....	25,121.89	18,568.80	6,553.09
Improving harbor, New Orleans, La.	80,000.00	....	80,000.00	80,000.00	....
Improving Atchafalaya and Red rivers, Louisiana	80,000.00	....	80,000.00	....	80,000.00
Improving harbor, Natches and Vidalia	80,000.00	....	80,000.00	1,420.47	78,579.53
Total, fourth district	1,577,621.89	....	1,577,621.89	1,273,273.55	304,348.34
Mississippi River Commission	75,000.00	....	75,000.00	*65,049.39	9,950.61
Surveys, gauges, and observations	198,345.33	....	198,345.33	†167,653.99	30,691.34
Rebuilding steamer Mississippi	25,000.00	....	25,000.00	649.64	24,350.36
Total, secretary's office	298,345.33	....	298,345.33	233,353.02	64,992.31
Grand total	10,787,718.73	710,211.01	11,497,924.74	10,695,021.48	802,903.26

*Includes $4.03 disbursed by Treasury settlement No. 7130.
†Includes $61.55 disbursed by Treasury settlement No. 7977.

Consolidated statement, March 3, 1881, to May 31, 1893.

Act of—		
March 3, 1881		$1,000,000.00
August 2, 1882		4,123,000.00
January 19, 1884		1,000,000.00
July 5, 1884, less $5,000 transferred to snag-boat service		2,065,000.00
August 5, 1886, less $5,942.60 for expenses, office Chief of Engineers		1,994,057.40
August 11, 1888, less $4,859 for expenses, office Chief of Engineers.		2,840,141.00
September 19, 1890		3,200,000.00
March 3, 1891		1,000,000.00
July 13, 1892		2,470,000.00
Total specific appropriations		19,692,198.40
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42 reverted to treasury	$272,504,96	
Same for works above Cairo, under act of July 5, 1884.	22,632.53	
Total balances		295,137.49
Total available		19,987,335.89
Expended—		
Plum Point Reach		3,628,494.91
Memphis Harbor and Reach		1,150,535.77
Lake Providence		3,206,198.27
Red and Atchafalaya		726,744.40
Levees		6,090,947.64
Other works		4,381,511.64
Total		19,184,432.63
Balance May 31, 1893		802,903.26

Statement of charts issued, June 1, 1892, to May 31, 1893.

Description.	Free.	Sold.	Total.
Alluvial Valley	80	306	386
Scale 1:20 000	435	249	683
Scale 1 inch: 1 mile	2,160	1,121	3,281
Proceeds of sale deposited with assistant treasurer of the United States at St. Louis			$99.10

List of civilian engineers employed on work of river and harbor improvements in charge of Capt. Carl F. Palfrey, Corps of Engineers, July 1, 1892, to May 31, 1893.

Name and residence.	Time employed. M.	Time employed. D.	Compensation. Per Mo.	Where employed.	Work on which employed.
J. A. Ockerson, St. Louis, Mo	11	00	$250.00	St. Louis, Mo	In charge surveys, S. G. O.
Kivas Tully, St. Louis, Mo	11	00	175.00	...do	In charge computation S. G. O.
C. W. Clark, St. Louis, Mo	11	00	175.00	...do	Platting maps, S. G. O.
Chas. W. Stewart, Champagin, Ill	2	9	150.00	In the field and in office, St. Louis, Mo	Surveys and reduction of field work.
James A. Paige, St. Louis, Mo	4	13	175.00		
A. T. Morrow, Mendota, Ill	2	...	140.00		
Do	9	...	175.00		
George H. French, Milton, Ill	2	...	120.00		
O. W. Connet, Houghton, Mich	..	8	120.00		

Approximate value of plant belonging to the United States, in charge of Capt. Carl F. Palfrey, Corps of Engineers, used in works under the Mississippi River Commission.

Allotment.	Class of property.	No.	Approximate value May 31, 1893.
Mississippi River Commission	Steamboat Mississippi (hull only)	1	$20,000
	Row boats	2	40
	Books, furniture, etc		250
Surveys, gauges, and observations.	Steamboat Patrol, with outfit	1	11,000
	Quarter boat, with outfit	1	1,500
	Quarter boat (condemned)	1	
	Row boats	15	200
	Surveying instruments		10,000
	Current meters	7	1,100
	Drawing instruments		700
	General tools		500
	Printing plant		700
	Office furniture		750

APPENDIX 3 A.

REPORT OF ASSISTANT ENGINEER CHARLES W. STEWART ON SECONDARY TRIANGULATION FROM PORT LOUISA, IOWA, TO NEAR MOUTH OF GALENA RIVER, ILLINOIS (NINE MILES BELOW DUBUQUE).

ST. LOUIS, MO., *September 2, 1892.*

CAPTAIN: I have the honor to submit the following report on fieldwork of secondary triangulation from March 28, to August 30, 1892, between Port Louisa, Iowa, and near mouth of Galena River, Illinois, 9 miles below Dubuque.

A reconnaissance was made between these limits from March 28 to April 25 by myself and Assistant George H. French, and the party took the field at New Boston, Ill., on April 26, the steamer *Patrol* furnishing quarters and transportation.

The instruments furnished were T. and S., Nos. 1 and 2; Gambey, No. 2; Wurdeman, Nos. 95 and 154; a B. and B. transit and level, and Missouri River Commission tape II, and Missouri River Commission tension apparatus.

The program of observations and general method was the same as during the preceding season.

The arrangements of men and officers was as follows: In charge of party, Assistant Charles W. Stewart; observers, Charles W. Stewart, A. T. Morrow; stone lines, A. T. Morrow, O. N. Axtell; stations and clearing, George H. French, T. C. Hockridge; secondary recorders, C. L. Ockerson, M. I. Powers. A steamboat crew of 5, 1 rodman, galley force of 4, and 13 axmen completed the party.

The length and azimuth of a base line at Rapids City, Ill., was determined and connected with, and the work was closed on the U. S. C. and G. S. line △ Horseshoe Mound, Illinois, △ Sinsinawa Mound, Wisconsin, on August 25. The *Patrol* and party started for Quincy, Ill., on following day, arriving August 29, and was turned over to Assistant A. T. Morrow for topographical work, and the triangulation records forwarded to this office.

A summary of the work done is as follows:

Secondary base-azimuth	1
Secondary stations established	72
Cupolas located	3
Built stations (average height, 25 feet)	46
Ground stations	23
Secondary stations occupied	76
Secondary triangles closed	72
Stone lines located (136–176)	41
Stone line B. Ms located	120
Tertiary stone-line triangles	133
Tertiary stone-line bases measured	12

The astronomical post and meridian mark at Rock Island Arsenal were connected with.

The average error of closure of secondary triangles is 01″.88, indicating a high grade of work.

The total number of days in the field, April 26 to August 26, is 122. There were 17 Sundays and about 35 stormy days on which little or no work could be done, leaving 70 working days in which the triangulation and stone lines were carried 1 miles (channel distance).

The phaseless target designed by Assistant Engineer J. A. Ockerson was used i all secondary stations. It is an important factor in the good results obtained, a is the handiwork of Mr. Thomas Hebron, steam engineer of the *Patrol*.

Despite the many discouragements of general bad weather, fair progress has bee made.

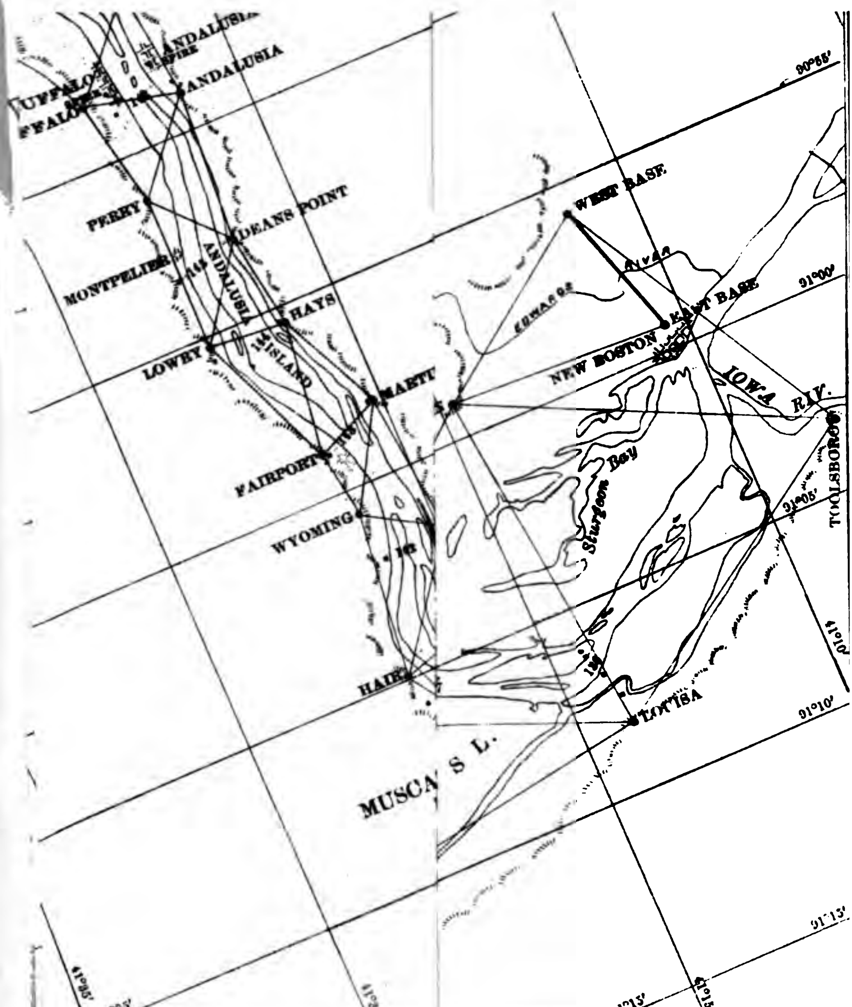
It is respectfully suggested that, if practicable, the services of the party b retained.

My thanks are due the party generally for zeal, efficiency, and cheerfulness, an especially to Assistant A. T. Morrow.

Respectfully submitted.

CHAS. W. STEWART,
U. S. Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.


ANDALUSIA
PERRY
DEANS POINT
MONTPELIER
ANDALUSIA
ISLAND
HAYS
LOWRY
FAIRPORT
WYOMING
WEST BASE
EAST BASE
NEW BOSTON
IOWA RIV.
Sturgeon Bay
TOOLSBORO
90°55'
91°00'
91°05'
91°10'
91°13'
91°05'

Geographical positions north of Keokuk, Iowa.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds, in meters.	Longitude.	Seconds, in meters.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″		° ′ ″		° ′ ″	° ′ ″		*Meters.*
△ West Base	41 10 22.84	704.6	90 59 32.62	760.5	184 30 18.8	4 30 36.8	△ Sturgeon	8,057.4
					253 18 49.1	73 21 18.1	△ East Base	5,506.4
△ East Base	41 11 14.08	482.8	90 55 46.29	1,078.9	144 18 26.5	324 16 15.3	△ Sturgeon	7,947.7
					61 01 43.3	240 56 42.4	△ Toolsboro	11,942.0
△ Sturgeon	41 14 43.22	1,333.3	90 59 05.44	126.7	25 21 36.5	205 18 52.7	do	13,548.5
					84 03 51.4	268 57 48.4	△ Louisa	12,894.2
					140 14 21.4	320 10 29.2	△ Fruitland	12,790.6
△ Louisa	41 13 59.63	1,839.6	91 08 16.18	375.6	202 29 02.4	22 31 13.6	do	12,093.2
					171 20 55.7	351 19 35.8	△ Hardtimes	18,685.2
					327 07 50.1	147 11 08.9	△ Toolsboro	12,974.1
△ Toolsboro	41 08 06.28	193.7	91 03 14.28	381.9	230 37 15.1		△ New Boston Spire	6,269.5
△ Fruitland	41 20 01.80	55.5	91 04 57.25	1,331.3	134 30 16.7	314 26 45.3	△ Hardtimes	10,418.9
					194 39 46.0	14 40 55.2	△ Muscatine	9,606.7
					247 08 24.0	67 11 35.4	△ Carruthers	7,306.1
△ Hardtimes	41 23 58.42	1,802.3	91 10 17.13	396.1	258 31 51.0	78 35 31.8	△ Muscatine	10,061.3
△ Muscatine	41 25 03.05	94.1	91 03 12.54	291.2	326 20 55.1	146 22 57.4	△ Carruthers	7,756.8
					276 05 52.5	96 08 33.2	△ Campbell	5,673.7
					237 24 12.3	57 26 22.2	△ Hair	5,413.1
△ Carruthers	41 21 33.71	1,040.0	91 00 07.62	177.1	192 57 22.9	12 58 01.2	△ Campbell	6,606.4
△ Campbell	41 24 43.44	1,340.1	90 59 09.64	223.9	162 57 56.2	342 57 25.5	△ Hair	3,681.2
					265 36 59.0	85 38 33.8	△ Hershey	3,336.3
△ Hair	41 26 37.53	1,157.8	90 59 56.09	1,302.0	306 32 06.8	126 34 11.8	do	5,482.8
					276 30 06.2	96 32 56.6	△ Wyoming	6,016.0
△ Hershey	41 24 51.68	1,594.4	90 56 46.40	1,077.5	211 21 34.7	31 22 19.6	do	3,023.5
					264 28 11.5	84 30 37.2	△ Martin	5,137.2
△ Wyoming	41 26 15.36	473.9	90 55 38.63	896.9	300 31 56.7	120 33 37.6	do	4,109.1
					261 55 52.5	81 57 00.3	△ Fairport	2,402.0
△ Martin	41 25 07.67	236.6	90 53 06.22	144.5	154 26 17.3	334 25 44.3	do	2,688.4
					244 11 28.6	64 13 14.8	△ Hays	4,143.1
△ Fairport	41 26 26.28	810.7	90 53 56.19	1,304.6	277 14 03.5	97 16 22.9	do	4,929.1
					246 42 46.7	66 45 11.6	△ Lowry	5,531.5
△ Hays	41 26 06.11	188.5	90 50 25.58	594.0	183 55 45.8	3 55 51.3	do	2,814.0
					261 08 24.5	81 10 01.3	△ Deans Point	3,435.3
△ Lowry	41 27 37.10	1,144.6	90 50 17.27	400.8	305 26 17.3	125 27 48.6	do	3,929.4
					270 35 05.6	90 37 47.6	△ Perry	5,678.6
△ Deans Point	41 26 23.23	716.6	90 47 59.87	1,378.5	228 09 06.2	48 10 16.9	do	3,326.5
					274 05 07.0	94 07 44.1	△ Andalusia	5,524.6
△ Perry	41 27 35.15	1,084.4	90 46 12.60	292.4	310 45 58.4	130 47 24.8	do	4,003.1
					257 54 33.1	77 56 22.6	△ Buffalo	3,923.3

Geographical positions north of Keokuk, Iowa—Continued.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude.	Seconds, in meters.	Longitude.	Seconds, in meters.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″		° ′ ″		° ′ ″	° ′ ″		*Meters.*
(△) Andalusia	41 26 10.40	320.8	90 44 02.02	46.9	198 12 06.9	18 12 29.8	(△) Buffalo	3,528.6
					262 23 12.1	82 25 09.0	(△) Bean	4,134.2
					200 59 48.1	21 00 15.3	△ Buffalo Spire	2,663.1
					243 25 41.9	63 26 21.1	△ Andalusia Spire	1,538.8
(△) Buffalo	41 28 01.76	54.8	90 43 27.29	633.8	311 15 45.7	131 17 19.5	(△) Bean	4,378.9
					244 51 38.2	64 54 18.1	(△) Anderson	6,187.1
					351 06 50.5	171 06 54.8	△ Buffalo Spire	960.6
					348 16 29.8	168 16 46.1	△ Andalusia Spire	2,805.6
△ Buffalo Spire	41 27 30.99	956.1	90 43 20.90	484.9			....	....
△ Andalusia Spire	41 26 32.71	1,009.1	90 43 02.73	63.4	....	....		
(△) Bean	41 26 28.12	867.5	90 41 05.50	127.7	202 44 34.9	22 45 40.9	(△) Anderson	5,980.3
					282 51 11.4	102 52 59.7	(△) Kane	3,896.0
					121 41 37.0	301 40 07.3	△ Buffalo Spire	3,693.1
					211 44 12.4	31 45 15.1	△ Kimball	4,181.6
(△) Anderson	41 29 26.88	829.3	90 39 25.84	599.5	346 54 26.7	166 55 09.0	(△) Kane	6,552.8
					264 30 12.7	84 32 54.1	(△) Beatty	5,676.2
					223 19 13.8	43 20 57.8	(△) Davenport	5,304.5
(△) Kane	41 25 59.99	1,850.7	90 38 21.91	508.8	211 02 12.8	31 04 11.8	(△) Beatty	8,082.4
					160 09 15.7	340 08 30.2	△ Kimball	4,702.9
△ Kimball	41 28 23.38	721.3	90 39 30.72	712.9	56 56 25.7	236 53 26.1	(△) Andalusia	7,515.9
(△) Beatty	41 29 44.43	1,370.7	90 35 22.25	516.1	148 48 31.4	328 47 34.0	(△) Davenport	3,877.6
					204 04 04.1	24 04 49.1	(△) School	3,854.1
					250 46 20.1	70 47 34.0	(△) Rock Island	2,742.1
					222 07 02.1	....	△ Arsenal Tower	....
					224 22 24.1	44 23 01.2	△ R. I. Spire	1,858.9
(△) Davenport	41 31 31.95	985.7	90 36 48.87	1,132.9	266 45 18.8	86 47 01.2	(△) School	3,585.7
(△) School	41 31 38.50	1,187.8	90 34 14.46	335.2	338 45 39.4	158 46 08.4	(△) Rock Island	2,806.3
					261 09 08.8	81 10 27.3	(△) McClellan	2,776.8
					322 17 31.2	142 17 54.4	R. I. Astron. Post	1,328.9
					335 22 30.4	155 22 45.9	△ Arsenal Tower	1,299.7
					258 27 30.0	78 27 53.3	△ Renwicks	829.7
					7 05 09.4	187 05 01.6	△ R. I. Spire	2,207.1
					294 03 09.6	....	△ Arsenal Stack	2,386.7
(△) Rock Island	41 30 13.69	422.4	90 33 30.62	710.2	209 34 51.8	29 35 41.1	(△) McClellan	3,499.1
					268 12 35.8	88 13 41.2	(△) Moline	2,289.7
					117 43 27.5	....	△ Davenport	....
					108 17 37.2	....	△ R. I. Spire	1,357.6
					158 47 38.6	338 47 09.6	Dav. School Flg. Stf.	2,807.1
					215 17 10.4	35 17 43.6	△ Arsenal Stack	2,013.1
					142 03 37.9	322 02 21.3	△ Davenport C. H	4,356.7
					161 40 49.1	....	△ Arsenal Tower	....
					175 48 58.8	355 48 53.0	△ Renwicks	2,789.7

R. I. Astronomical Post	41 31 04.42	186.4	90 33 39.41	913.8	180 00 44.1	....	......do	....
					64 22 38.9	244 22 31.2	△ Arsenal Tower	300.9
△ Renwicks	41 31 43.87	1,353.4	90 33 39.40	913.4	....	....	....	....
△ Arsenal Tower	41 31 00.20	6.2	90 33 51.10	1,184.9	....	....	....	....
△ R. I. Spire	41 30 27.50	848.4	90 34 26.20	607.8	....	....	....	....
△ Arsenal Stack	41 31 06.95	214.4	90 32 40.46	938.2	....	....	....	....
△ Davenport C. H	41 32 05.05	155.8	90 35 26.16	606.4	....	....	....	....
◬ McClellan	41 31 52.32	1,614.2	90 32 16.11	373.6	349 19 03	169 19 19	◬ Moline	3,024.1
					272 16 43	92 18 11	◬ Gilberttown	3,105.7
					53 52 34	233 51 31	△ Arsenal Tower	2,727.1
					82 19 11	262 18 16	△ Renwicks	1,948.5
					81 11 08	261 09 45	Davenport School flag-staff	2,775.6
					95 06 35	275 04 29	Davenport C. H	4,423.5
					21 58 29	201 58 13	△ Arsenal Stack	1,509.3
					351 09 09	171 09 21	△ Moline School	2,910.6
△ Moline School	41 30 19.10	589.2	90 31 56.80	1,317.4	....	....	....	....
◬ Moline	41 30 16.00	493.6	90 31 51.94	1,204.7	221 45 34	41 46 47	◬ Gilberttown	3,818.1
					259 37 07	79 38 50	◬ Race Track	3,654.9
◬ Gilberttown	41 31 48.30	1,490.1	90 30 02.26	52.4	334 21 09	154 21 39	......do	2,429.2
					240 59 51	61 01 30	◬ Crow	3,960.0
					43 59 47	223 58 32	△ Moline School	3,824.6
◬ Race Track	41 30 37.31	1,151.0	90 29 16.92	392.4	210 24 57	30 26 06	◬ Crow	4,765.3
					244 56 50	64 59 29	◬ Watertown	6,141.4
◬ Crow	41 32 50.50	1,558.0	90 27 32.83	760.9	295 36 24	115 37 55	......do	3,493.7
					261 00 32	81 02 31	◬ Hampton	4,211.9
					224 15 23	44 16 31	◬ Valley City	3,410.2
◬ Watertown	41 32 01.54	47.5	90 25 16.93	392.5	168 59 33	348 59 10	......do	4,026.7
					204 59 40	25 00 09	◬ Hampton	2,391.7
◬ Hampton	41 33 11.80	364.0	90 24 33.38	772.5	135 05 52	315 06 01	◬ Valley City	2,520.5
					183 42 39	3 42 44	◬ Fulton	2,621.0
					230 41 44	50 42 45	◬ Crab Island	2,794.4
					118 59 24	298 59 15	△ Hampton School	349.5
					146 38 36	326 38 29	△ Hampton Spire	448.4
◬ Valley City	41 34 09.66	298.0	90 25 50.12	1,161.3	246 54 47	66 55 43	◬ Fulton	2,118.3
△ Hampton School	41 33 17.29	533.4	90 24 46.52	1,078.2	....	....	....	....
△ Hampton Spire	41 33 23.94	738.6	90 24 43.97	1,019.0	....	....	....	....
◬ Fulton	41 34 36.57	1,128.2	90 24 26.00	602.4	292 59 23	113 00 20	△ Crab Island	2,164.5
					255 26 49	75 28 15	◬ Sycamore	3,106.8
					10 59 55	190 59 41	△ Hampton School	2,491.7
					10 31 23	190 31 11	△ Hampton Spire	2,279.1
◬ Crab Island	41 34 09.16	282.6	90 23 00.00	0.0	211 58 34	31 59 03	◬ Sycamore	1,916.6
					244 17 36	64 18 18	◬ Lower Base	1,601.1
◬ Sycamore	41 35 01.86	57.4	90 22 16.19	375.0	335 20 16	155 20 28	......do	1,024.7
					280 30 45	100 31 40	◬ Upper Base	1,959.2
◬ Lower Base	41 34 31.67	977.0	90 21 57.73	1,337.8	249 08 05	69 08 47	......do	1,604.8
◬ Upper Base	41 34 50.26	1,550.6	90 20 53.04	1,228.6	....	....	....	....

Geographical positions of tertiary points north of Keokuk, Iowa.

[Referred to the Cairo Astronomical Post.]

Name of station.	Latitude. ° ′ ″	Seconds, in meters.	Longitude. ° ′ ″	Seconds, in meters.	Azimuth. ° ′ ″	Back azimuth. ° ′ ″	To station.	Distance. *Meters.*
⊡ 138/1	41 14 21.10	650.9	91 06 07.01	163.8	67 30 39	247 30 38	⊡ 138/2	244.0
⊡ 138/2	41 14 18.08	557.8	91 06 16.69	388.7	67 26 02	247 25 39	⊡ 138/3	874.2
⊡ 138/3	41 14 07.20	222.1	91 06 51.35	1,195.8	71 57 37	251 57 10	⊡ 138/4	985.8
⊡ 138/4	41 13 57.30	1,767.7	91 07 31.60	736.0	93 58 58	273 58 28	△ Louisa	1,039.7
⊡ 137/1	41 17 05.41	166.9	91 04 58.46	1,360.5	111 12 16	291 12 05	⊡ 137/2	414.0
⊡ 137/2	41 17 10.26	316.5	91 05 15.05	350.2	111 17 51	291 17 32	⊡ 137/3	688.4
⊡ 137/3	41 17 18.37	566.7	91 05 42.62	991.8	......	......	......	......
⊡ 138/1	41 18 57.68	1,779.5	91 03 10.47	243.5	113 20 47	293 20 15	⊡ 138/2	1,205.5
⊡ 138/3	41 19 13.16	406.0	91 03 58.06	1,350.5	113 34 32	293 34 07	⊡ 138/3	975.4
					137 28 24	317 27 45	△ Fruitland	2,036.3
⊡ 138/5	41 19 25.80	795.9	91 04 36.49	848.8	156 30 39	336 30 25	do	1,210.8
					101 54 49	......	P. B. M. 26	29.1
P. B. M. No. 26	41 19 26.00	802.1	91 04 37.72	877.4	......	......	......	......
⊡ 139/1	41 21 44.89	1,384.9	91 03 13.54	314.7	99 38 34	279 38 15	⊡ 139/2	693.2
⊡ 139/2	41 21 48.65	1,500.9	91 03 42.94	998.0	99 38 47	279 38 22	⊡ 139/3	889.3
⊡ 139/3	41 21 53.48	1,649.9	91 04 20.67	480.4	100 27 59	280 27 27	⊡ 139/4	1,154.6
⊡ 139/4	41 22 00.27	8.3	91 05 09.52	221.3	355 32 12	175 32 20	△ Fruitland	......
⊡ 140/1	41 24 07.61	234.8	91 02 27.98	650.0	127 28 23	307 28 12	⊡ 140/2	486.0
⊡ 140/2	41 24 17.19	530.3	91 02 44.59	1,035.8	127 35 48	307 35 29	⊡ 140/3	828.0
					155 21 08	335 20 49	△ Muscatine	1,556.3
⊡ 140/3	41 24 33.57	1,035.7	91 03 12.84	298.2	138 33 10	318 32 51	⊡ 140/4	1,008.6
					180 26 07	0 26 07	△ Muscatine	909.4
⊡ 140/4	41 24 58.07	1,791.5	91 03 41.58	965.6	10 53 47	190 52 57	△ Fruitland	9,307.5
					257 11 12	77 11 31	△ Muscatiue	691.7
⊡ 141/2	41 25 31.24	963.8	91 00 13.13	304.9	156 51 50	336 51 34	⊡ 141/3	1,420.6
					156 52 57	336 52 36	⊡ 141/4	......
					190 57 02	10 57 13	△ Hair	2,082.9
⊡ 141/3	41 26 13.58	419.0	91 00 37.18	863.2	156 56 05	336 55 59	⊡ 141/4	501.6
					232 15 09	52 15 35	△ Hair	1,206.5
⊡ 141/4	41 26 28.54	880.5	91 00 45.64	1,059.6	......	......	......	......
⊡ 142/2	41 24 58.20	1,795.5	90 57 06.07	141.0	186 13 38	6 13 44	⊡ 142/3	2,129.3
⊡ 142/3	41 26 06.81	210.1	90 56 56.13	1,303.2	102 47 38	282 45 39	△ Hair	4,284.1
⊡ 143/2	41 25 13.09	403.8	90 53 06.46	150.0	358 09 17	178 09 18	△ Martin	167.4
					148 26 15	328 25 39	⊡ 143/3	2,396.5
					152 55 04	332 54 33	△ Fairport	......
⊡ 143/3	41 26 19.28	594.8	90 54 00.50	11.6	274 38 14	94 40 36	△ Hayes	5006.3
					330 17 27	150 18 03	△ Martin	2543.4
					204 49 55	24 49 58	△ Fairport	238.0
⊡ 144/1	41 26 12.23	877.3	90 50 23.86	542.4	171 41 28	351 41 18	⊡ 144/2	2653.8
					95 01 52	274 59 32	△ Fairport	4960.0
⊡ 144/2	41 26 59.57	1837.8	90 51 09.49	220.3	210 31 04	30 31 23	⊡ 144/2	1352.9

□ 144	41	27	37.85	1152.8	90	50	39.88	925.5	358	16	16	178	16	26	(△) Hayes 2834.5
									64	19	17	244	17	07	(△) Fairport 5056.7
□ 144	41	26	26.02	802.7	90	47	57.65	1338.5	124	05	50	304	04	18	(△) Lowry 8913.1
									228	48	50	48	49	59.6	(△) Perry 8239.4
									168	50	41	349	50	22	□ 144 2874.4
□ 145	41	27	39.95	1232.5	90	48	26.11	605.9	345	18	08	165	18	25	(△) Deans Point 2446.7
									43	46	46	223	45	27	(△) Hayes 4008.9
□ 146	41	26	15.11	466.2	90	43	42.41	984.7	172	11	12	352	11	03	□ 146 2286.5
									92	25	45	272	22	55	(△) Deans Point 5970.7
									72	17	54	252	17	41	(△) Andalusia 477.9
□ 146	41	27	28.53	880.2	90	43	55.80	1295.2	3	25	39	183	25	35	(△) Andalusia 2414.7
									70	24	34	250	21	53	(△) Deans Point 6002.1
□ 147	41	26	40.86	1245.1	90	40	22.76	528.3	120	23	55	300	21	53	(△) Buffalo 4964.8
									200	48	16	20	48	50	△ Kimball 3400.1
															□ 147 ....
□ 147	41	27	50.62	1561.7	90	40	44.75	1038.4	10	43	04	190	42	50	(△) Bean 2590.2
									55	59	27	235	57	16	(△) Andalusia 5524.9
□ 148	41	28	33.28	1026.7	90	37	36.45	845.6	135	56	30	315	56	11	□ 148 950.9
									83	26	13	263	24	58	△ Kimball 2668.9
□ 148	41	28	55.43	1710.0	90	38	04.96	115.1	144	54	49	294	54	09	□ 148 1569.5
									63	35	02	243	34	06	△ Kimball 2222.1
□ 148	41	29	16.86	520.1	90	39	06.32	146.6	18	56	39	198	56	23	△ Kimball 1744.3
□ 149	41	30	01.20	37.0	90	35	09.06	210.1	30	37	10	210	37	01	(△) Beatty 601.0
									260	24	36	80	25	41	(△) Rock Island 2315.4
															□ 149 ....
□ 149	41	31	02.87	88.5	90	36	04.76	110.4	246	48	46	66	44	59	△ School 2784.9
									292	58	58	113	00	41	(△) Rock Island 3888.2
□ 150	41	31	42.63	1315.2	90	32	16.00	370.9	87	21	44	267	20	26	△ School 2748.3
									27	16	13	207	15	57	△ Arsenal Stack 1238.3
									81	59	55				△ Court House ....
□ 151	41	30	53.05	1636.6	90	29	03.17	73.5	165	07	14	345	07	07	□ 151 1022.5
									141	11	58	321	11	34	(△) Gilbertown ....
□ 151	41	31	25.08	773.7	90	29	14.50	336.2	2	11	04	182	11	02	(△) Race Track ....
□ 152	41	32	42.74	1318.6	90	25	01.75	40.6	129	23	02	309	22	18	□ 152 2003.8
									157	19	15	337	18	43	(△) Valley City 2906.4
□ 152	41	33	23.94	738.6	90	26	08.58	198.9	132	18	45	312	18	29	□ 152 743.4
									196	52	26	16	52	38	(△) Valley City 1473.8
									334	46	51	154	47	26	(△) Watertown 2810.2
□ 152	41	33	40.16	1239.0	90	26	32.30	748.4	227	02	46	47	03	14	(△) Valley City 1335.5
									330	07	53	150	08	43	(△) Watertown 3508.5
□ 153	41	34	13.76	424.5	90	22	53.15	1231.5	188	26	51	8	26	56	□ 153 1200.4
									108	07	35	288	06	33	(△) Fulton 2263.4
									209	58	57	29	59	21	(△) Sycamore 1713.2
									48	14	27	228	14	23	(△) Crab Island 212.9
									88	14	46	268	12	49	(△) Valley City ....
□ 153	41	34	52.25	1611.9	90	22	45.54	1054.9	14	09	17	194	09	07	(△) Crab Island 1370.8
									299	49	04	119	49	36	(△) Lower Base 1276.5

DESCRIPTIONS OF SECONDARY TRIANGULATION STATIONS FROM PORT LOUISA, IOWA, TO GORDONS FERRY, IOWA, 1892.

△ Hardtimes is marked by tile and pipe on Iowa side on bluffs west of Muscatine Slough, and about 5 miles below Muscatine, Iowa. Station is 1¼ miles below schoolhouse on bluff side of wagon road; 300 meters below creek, where two houses and two large barns stand; three-fourths mile below a lone pine standing on side of bluff; 30 meters east of a wire fence along top of hill. Trees blazed with triangles; 8-inch black oak=255° 14.4 meters; 6-inch red oak = 120° 2.9 meters; 5-inch red oak = 22° 15.7 meters.

△ Fruitland: Tile and pipe on Iowa side, 6 miles below Muscatine, Iowa; 4 meters north of fence which runs west from river at a point 1,100 meters above Beatty's house; 590 meters west of levee, and 140 meters (paced) west from fence corner at crest of ridge. Elevation of pipe, 609.11; tile, 605.11 feet above Memphis datum.

△ Muscatine is center of town on residence of Mrs. Cora Weed, Muscatine, Iowa.

△ Carruthers: Tile and pipe on Illinois side on apex of hill three-fourths mile back of main road between Muscatine and New Boston; one-fourth mile below Copper Creek; 7 miles from Muscatine by road; on land of Mrs. Rachael Ann Carruthers.

△ Campbell: Tile and pipe on Illinois side in road on apex of bluff, 3 miles east of east end of Muscatine Bridge, just opposite house of Robert Campbell, and one-fourth mile west of residence of Dan M. Foster.

△ Hair: Tile and pipe on highest point of hill on land of Judge Hair, 3 miles above Muscatine, Iowa; one-fourth mile north of railroad, and about three-fourths mile above head of Island 334; 42 meters east of north and south fence running over hill opposite east end of race track at foot of bluff; 65 meters west of orchard on same hill, and one-half mile below schoolhouse.

△ Hershey: Tile and pipe on Illinois side on top of bluff opposite head of Island 331, one-fourth mile east of ravine, and about 20 meters from wagon road running up bluff from the ravine.

△ Wyoming: Tile and pipe on Iowa side on second hill north of railroad; about 1 mile below Fairport, Iowa; 300 meters below railroad bridge 73, ¾ miles above Wyoming hill; near head of ravine, on land of Hincky heirs.

△ Martin: Tile and pipe on Illinois side, at crest of bluff opposite foot of Andalusia Island; 9 meters north of an east and west fence, and 150 meters south of road at foot of bluff. Trees blazed with triangles; 10-inch black oak, 289° 5.6 meters; 23-inch white oak, 95° 3.1 meters; 14-inch white oak, 166° 14.0 meters.

△ Fairport: Tile and pipe on Iowa side on crest of hill, three-fourths mile above railroad station, Fairport; about 600 meters above upper limits of Fairport, 400 meters from river, 150 meters from railroad track, opposite a point midway between the second and third railroad bridges above Fairport, and on land of George Smith. Trees blazed with triangles; 10-inch white oak, 225° 18 meters; 10-inch white oak, 30° 8.5 meters; 5-inch white oak, 150° 10.5 meters. Bearings magnetic.

△ Hays: Tile and pipe on Illinois side on high knoll in grass field, 400 meters from river, and 300 meters north of large stock barn of Col. Hays; at edge of brush at crest of hill, 43 meters north of fence, and opposite middle of tow head in Andalusia Slough.

△ Lowry: Tile and pipe on Iowa side in yard of Wm. E. Lowry, 1 meter north and 1 meter east of northwest corner of orchard fence, and 25 meters east of east side of Lowry's house, which is a little above railroad bridge 57.

△ Dean's Point: Tile and pipe on Illinois side on wooded bluff point, just back of abandoned clearing at foot of bluff (only clearing in vicinity), and 12 meters back of highest point of bluff. Station is opposite a point 1 mile above Montpelier, Iowa trees blazed with triangles; 5-inch poplar, 150° 5 meters; 9-inch black oak, 315° 8.5 meters; 5-inch black oak, 8° 4.5 meters.

△ Perry: Tile and pipe on Iowa side, about one-half mile north from river bank, on level surface at top of hill about 300 meters north of railroad; 150 meters east of section-line fence which crosses railroad at third telegraph pole east of bridge 40; about 80 meters northeast of clump of evergreens at old graveyard, and on land of Mrs. Morehead.

△ Andalusia: Tile and pipe on Illinois side on land of Mrs. Paul Shaw, about one-half mile below limits of Andalusia, Ill., on side of bluff about 150 meters south of main road and 50 meters east of fence.

△ Buffalo: Tile and pipe on Iowa side about 1 mile back from Buffalo, Iowa, at the jog in north and south lane. Elevation of pipe, 719.54; tile, 715.54 above Memphis datum.

△ Bean: Tile and pipe on Illinois side on land of Mr. Haas, 50 feet south of south line of J. L. Bean's property; is on prominent hill about 2 miles east of Andalusia, Ill; hill is bare of timber, and a large poplar bears about E.S.E. 810 feet.

◬ Anderson: Tile and pipe on Iowa side on top of bluff, one-fourth of a mile directly back from Fairview schoolhouse, at roadside 3 meters south of fence on north side of road, 100 meters west of fence corner on north side of road, and 300 meters east of large red barn which stands on north side of road opposite a dwelling house.

◬ Kane: Tile and pipe on Illinois side on land of Robert Kane, on crest of bluff 3¼ miles below Milan, Ill., near an east and west fence, and 15 meters east of an old hedge row running north and south.

◬ Beatty: Tile and pipe in southwestern Rock Island, on land owned by the Davenport heirs and leased to one Beatty; is 302 meters west of Ninth street, 188 meters north of fence at race track, and about midway between slough and top of slope in grass field. Station is on line with ◬ school and a prominent square-topped tower in Rock Island.

◬ Davenport: Tile and pipe on top of bluff in West Davenport on property of Dr. Bickford, 10 meters west of old barn, 100 meters north of street, 300 meters below where main line of Chicago, Rock Island and Pacific Railroad enters bluffs.

◬ School: Is marked on floor in cupola of high school building in Davenport, Iowa. It is 53° 50′ 1.305 meters from center of tower.

◬ Rock Island: Tile and pipe on wooded knoll between Twenty-ninth and Thirtieth streets in Rock Island, Ill., on land of C. F. Lynde; opposite and about 40 meters south of Huber's brewery.

◬ Rock Island Astronomical Post: Stone post 24 inches long by 18 inches in width projecting 15 inches above ground, on lower end of Arsenal Island, 300 meters above the arsenal building near end of bridge, 150 meters above fence at guardhouse, and 20 meters from river. Geodetic point is marked by cross in top of stone. Elevation, 574.15 (precise levels).

◬ Arsenal Tower is point on top of arsenal side of tower on arsenal building 1865A at foot of Rock Island; in center of coping 4.04 meters from extreme southeast end of coping and 6.43 meters from northwest end of coping.

◬ McClellan: Tile and pipe on Iowa side on site of old Camp McClellan, 400 meters from the river, on land of William Grummoll, just above city limits of Davenport.

◬ Moline: Tile and pipe on wooded hill in Moline, Ill., diagonally opposite the Fourth street school; almost in line with the prolongation of Fifth avenue.

◬ Gilberttown: Tile and pipe on Iowa side 1 meter west of fence on west side of road which runs north from road at foot of bluff about one-quarter mile above the Gilberttown stone schoolhouse. Station is on second hill, 25 meters north of fence corner, and about 80 meters north of dwelling house.

◬ Race Track: Tile and pipe in small grove at top of prominent bluff back of race-track, 1 mile above Moline, Ill.; on first hill above cemetery.

◬ Crow: Tile and pipe on Iowa side, on top of bluff in middle of grass field, almost in line with road running from river to foot of bluff opposite middle of Campbell's Island.

◬ Watertown: Tile and pipe on Illinois side, 150 meters back from schoolhouse at Watertown, Ill.; on top of bluff, 40 meters above a cultivated field and 20 meters back from crest of bluff; to fence corner 355° 43 meters; to small, lone crab-apple tree 165° 15 meters.

◬ Hampton: Tile and pipe on Illinois side, on top of bluff, 100 meters north of road running east past the Methodist church in the lower part of Hampton, Ill.; 15 meters east of fence inclosing garden at house.

◬ Valley City: Tile and pipe on Iowa side, on top of bluff, 210° 150 meters from Pleasant Valley brick schoolhouse. In grass field on land of S. S. Blackman, 11 meters north of fence and 10 meters west of line fence. Station is on line with Hampton business houses and head of Island 402.

◬ Fulton: Tile and pipe on Iowa side, on top of bluff opposite foot of Fulton's Island, and 300 meters above old mill at river bank. At roadside, 1 meter northwest of fence on river side of road, 180 meters above jog in road at dwelling house, and 20 meters above fence corner at lower end of grove on opposite side of road.

◬ Crab Island: Tile and pipe on Illinois side, on land of G. W. Bowles; on top of hill in grass and scattering timber, 60 meters due west from fence corner, on top of hill, and 100 meters back of Chicago, Milwaukee and St. Paul Railroad.

◬ Sycamore: Tile and pipe on Iowa side on flat high ground half way up hill, 200 meters north of river; in cultivated field near edge of timber, 8 meters east of west edge of field, and 10 meters south from north edge of field one-half mile above schoolhouse, and 2 miles below Le Claire, Iowa.

◬ Lower Base: Tile and pipe at west end of Rapids City base line; on north side of Chicago, Milwaukee and St. Paul Railroad track, at foot of dump 1½ miles below Rapids City, and 153 meters below bridge $\overset{E}{486}$. Elevation, pipe, 587.31; tile, 583.29 feet above Memphis datum.

◬ Upper Base: Tile and pipe at east end of Rapids City base line; on south side of railroad track at top of cut, opposite brick dwelling house of Mr. Shafer; opposite third telegraph pole below wagon road and sixth pole below depot. Elevation of pipe, 600.89; tile, 596.87 feet above Memphis datum.

△ Le Claire: Tile and pipe on Iowa side on flat ground at top of hill in open field, directly back of old mill on river bank, 1 mile below Le Claire, Iowa; 80 meters back from crest of hill, 80 meters west of rail fence, and 40 meters south of fence at road side.

△ Rapids City: Tile and pipe on Illinois side at highest point of bare hill, one-half mile above Rapids City, Ill; directly back from an old abandoned frame house, and 300 meters below a prominent bare bluff point.

△ Le Boone: Tile and pipe on Iowa side in open spot in oak grove on second ridge, 100 meters north of road running back from river one block above ferry landing in upper part of Le Claire, Iowa. Trees blazed with triangles: 16-inch white oak, 180° 7.5 meters; 12-inch white oak, 25° 12.5 meters; 12-inch red oak, 330° 10 meters.

△ Port Byron: Tile and pipe on Illinois side on top of hill in upper part of Port Byron, Ill., about 200 meters back of second street and 13 meters north of road running back from river one block above steamboat warehouse.

△ Hopson: Tile and pipe on Iowa side on top of bluff point, 200 meters below a tow head near right bank of river, and two miles above Le Claire, Iowa; 15 meters north of fence at north edge of grove and 25 meters west of fence corner.

△ Woodward: Tile and pipe on Illinois side, on sandy knoll, one-half mile back from crest of bluff, and 2½ miles above Port Byron, Ill.; 90 meters west of lane leading south from county road to residence of Mr. Woodward; 200 meters northwest of house, and in center of small inclosed lot west of lane.

△ Princeton: Tile and pipe on Iowa side on top of hill in cultivated field one-half mile back from river, and 65 meters south of wagon road which runs west from lower end of Princeton, Iowa, at the brick warehouse on river bank; 26 meters west of fence and 150 meters southeast of cemetery. Station is due south from east end of barn on north side of the road.

△ Cordova: Tile and pipe on land of Jim Armstrong, and back of his house, on hill 400 meters back of Johnson's limekilns. Elevation of pipe, 704.85; tile, 700.83 feet above Memphis datum.

△ Wapsie: Tile and pipe on Iowa side in Wapsie bottoms, 3 miles northwest of Princeton, Iowa; one-fourth mile east of Clinton wagon road and one-fourth mile west of another wagon road; 2 meters east of fence at jog; one-fourth mile north of lane and 100 meters south of section corner at hedge.

△ Evergreen: Tile and pipe on Illinois side on south side of wagon road running east from river, opposite mouth of Wapsipinicon; about 1 mile east from river, 4 meters north of fence on south side of road, and 20 meters east of Chicago, Milwaukee and St. Paul Railroad.

△ Rocks: Tile and bench-mark pipe on Illinois side on highest grassy knoll on land of John Williamson, 5 miles east of Cordova, Ill. From ledges of rock outcropping in the neighborhood, it is called the "Rocks."

△ Marais D'Osier: Bench-mark tile and pipe on Illinois side on very high grassy knoll, 3 miles below Albany, where the Marais D'Osier comes close to foot of bluffs; on land of Mr. Grady, of Clinton, Iowa, near residence of Mr. Hugh Farrell; on prolongation of wagon road running south along foot of bluffs below Marais D'Osier Bridge.

△ Camanche: Tile and pipe on Iowa side on top of hill in grass field one-fourth mile north of road running west from Camanche, Iowa, in prolongation of Chicago street; on Benning estate, 100 meters west of one fence, 30 meters south of another, and about one-half mile northwest of Chicago and Northwestern Railroad main line.

△ Albany: Bench-mark tile and pipe on land of M. Freak, on apex of knoll back of and near his house and in his garden at Albany, Ill.

△ Clinton: Center of finial of cupola on school house on Eleventh avenue, between Sixth and Seventh streets, Clinton, Iowa.

△ Ferris: Tile and pipe on Illinois side on sand ridge 8 miles east of river, one-half mile north of road running east from Clinton bridges, 2 miles south of road running east out of Fulton, and one-half mile east of north and south road which leaves Fulton road just east of bridge over creek 2 miles east of Fulton. Station is in open spot in small oak timber and near south end of sand ridge.

△ Lyons: Tile and pipe on bluff point one-half mile above upper sawmills in Lyons, Iowa; in line of fence about 15 meters back from crest of bluff, and 200 meters north of a dwelling house.

△ Jack Green: Tile and pipe on Illinois side on property of Jack Green; on mound on top of bluff, 10 miles northeast of Fulton, Ill., 3 miles north of where Fulton wagon road enters bluffs and three-fourths of a mile above school house in district No. 1. Two small pines stand near top of mound 5 meters west and north of the station. The foot of bluff where the station stands is at edge of wagon road.

Below, the bluffs are farther from the road. Trees blazed with triangles: 12-inch black oak, 325° 5 meters; 8-inch black oak, 248° 5 meters.

△ Elk River: Tile and pipe on Iowa side on top of bluff about 1 mile north of mouth of Elk River and back of railroad bridge 512, 200 meters back from timber at crest of bluff, 80 meters south of head of small ravine, and 70 meters southeast of fence corner at farm house.

△ Dyson: Tile and pipe on Illinois side on crest of high wooded bluff, in front of timber, on property of Mr. Dyson, about 100 meters back of bluff road, 400 meters above a long row of elms along road across bottom 400 meters below a stone dwelling house on bluff side of road, and about 5 miles below the point where the Chicago, Burlington and Northern Railroad enters bluffs.

△ Sabula: Tile and pipe on Iowa side on top of bluff in clover field, 40 meters back from crest of bluff, 40 meters south of fence at south side of orchard which is just south of residence of R. A. Schroeder; about 1 mile below Sabula, Iowa, on property of Lou Eskelson.

△ Bristol: Tile and pipe on Illinois side on top of ridge east of bluff road, 200 meters below crossing under Chicago, Burlington and Northern, where it enters bluffs; on land of Widow Bristol, 5 meters east of fence.

△ Savanna: Tile and pipe on Illinois side about $1\frac{1}{2}$ miles north of Savanna, Ill.; 1 meter south of fence on south side of road, and 15 meters east of fence corner at junction of roads.

△ Lainsville: Tile and pipe on Iowa side on top of mound at top of bluffs in pasture on property of William F. Marr; 70 meters west of fence between pasture and small cultivated field which lies between two ravines which join opposite the station at railroad bridge, $\frac{K}{12}$ three-fourths mile above Lainsville railroad station.

△ Miller: Tile and pipe on Illinois side on brow of bluff, 4 miles above Savanna, Ill., 50 meters east of wagon road and 200 meters east of railroad; on property of Mr. Fisher, whose residence is one-half mile north. Trees blazed with triangles: 14-inch black oak, 235° 6 meters; 18-inch black oak, 145° 11 meters.

△ Apple River: Tile and pipe on Illinois side on highest point of sand ridge, three-fourths mile above mouth of Apple River; in oak timber 50 meters from river bank, 600 meters below head of island 267, and 100 meters below dyke.

△ Green Island: Tile and pipe on Iowa side on side of bluff at top of rock ledge, 3 meters back from crest of bluff; 270 meters north of wire fence at top of bluff; 100 meters northwest of small shed east of railroad track. Station is nearly 2 miles north of Green Island, Iowa, and opposite about the twentieth telegraph pole above the Maquoketa Bridge.

△ Hanover: Tile and pipe at Chicago, Burlington and Northern Railroad station, Hanover, Ill.; 2 meters east of fence at west side of right of way, and about 50 meters north of depot.

△ Harrington: Tile and pipe on Iowa side on wooded point opposite foot of Island 249, on land of Joe Harrington.

△ Blanding: Tile and pipe on Illinois side on top of bluff one-half mile below railroad station Blanding, and one-fourth mile above road crossing railroad; 30 meters from top of rock ledge and 8 meters from edge of woods.

△ Rogers: Tile and pipe on Iowa side on high ridge one-fourth mile east of the bluffs and one-fourth mile west of the river, 8 meters west from east crest of ridge; in open pasture, 200 meters southwest of the brick dwelling house of Mr. Rogers, 1 mile north of Bellevue, Iowa. Distance, 7 meters; azimuth, 10° to a double black oak. Elevation of pipe, 817.96; tile, 813.96 feet above Memphis datum.

△ Wise: Tile and pipe on Illinois side on top of bluff in open meadow one-fourth mile back from river and 20 meters north of sink hole; on property of Mrs. Wise.

△ Smith: Tile and pipe on Iowa side on top of bluff one-half mile back from river in long narrow open field between trees; three-fourths mile above Smith's siding.

△ Horseshoe is near the Coast-Survey station of the same name. Geodetic point is center of hole drilled in top of exposed rock ledge. A pipe 1 foot long and 4 inches diameter with the usual cap is centered over this mark and cemented to the rock. Station is 1 mile southeast of Galena, Ill., at northwest end of Horseshoe Mound, on top of exposed ledge of natural rock $2\frac{1}{2}$ meters wide and 5 meters from south end of ledge. Station is about 100 meters south of road running east from Galena and is on property of Samuel Roberts.

△ Gordon's Ferry: Tile and pipe on Iowa side on property of John Schenk, about 3 miles north of Gordon's Ferry, Iowa; on top of wooded point one-fourth mile back from river.

△ Sinsinnawa: Steel bolt in natural rock on Wisconsin side on highest point on wooded hill of same name, in rear of church at St. Clara's Academy, Sinsinnawa, Wis., and 20 meters westerly from a large wood cross. This station is one of the Coast-Survey points.

APPENDIX 3 B.

REPORT OF MR. A. T. MORROW, ASSISTANT ENGINEER, IN CHARGE OF TOPOGRAPHICAL PARTY FOR SEASON OF 1892.

ST. LOUIS, MO., *November 23, 1892.*

CAPTAIN: I have the honor to submit the following report on the operations of the topographical party which has been under my charge during the field season just closed:

On August 29 the steamer *Patrol* was turned over to me at Quincy, Ill., together with a small party then on board. At that point I took in tow the quarter boat *Illinois* and proceeded to Hannibal, Mo., where I spent the remaining days of August in renovating the steamer and quarter boat.

On September 1 the rest of my assistants and a number of men reported for duty, and at the same time I received an outfit of instruments and a supply of subsistence stores from St. Louis.

On September 2 the field work was begun at the Hannibal Bridge (stone line 94) with a party composed as follows: Assistant Engineer A. T. Morrow in charge; Messrs. W. G. Comber, George H. French, E. L. Harman, Horace Dunaway, E. J. Thomas, C. L. Ockerson, and O. N. Axtell, topography; A. O. Wheeler and T. G. Ray, ordinary levels; T. C. Hockridge and L. D. Cabanne, hydrography; M. I. Powers and H. C. Winchell, computations and platting. In addition to these there were the officers and crew of the steamer and a number of men, which was increased until the party numbered altogether about 63 persons.

The stage of water and the weather were favorable for the work and remained so for the entire season.

The party suffered a good deal from malaria while working on the overflowed lands, but at such times a few extra men were kept employed and the work did not suffer any serious delay.

On November 10 the work was completed to stone line 114, 10 miles above Keokuk, and was there discontinued. The quarter boat *Illinois* was laid up at Keokuk and the steamer *Patrol* brought back to St. Louis and turned over to Assistant Engineer J. A. Ockerson, there still remaining on board a small party which had been retained for work on the lower river.

With a few exceptions, which will be noticed, the fieldwork has been carried on in accordance with the printed instructions.

From Hannibal to Keokuk the secondary stations are far apart, and in most instances at a distance from the river. It therefore became necessary to carry a complete system of tertiary triangulation over the whole work. A 50-meter steel tape had been provided for the measurement of tertiary bases and proved to be a great aid to the work, and tertiary bases were measured at intervals of about 5 miles as far as Keokuk, where secondary lines were available. The azimuth and coördinates, however, were checked on secondary points at Quincy, La Grange, Canton, and Warsaw, and the azimuth was checked at secondary station Heather, about halfway between Hannibal and Quincy. An appended tabulation will show the discrepancies at these various points of connection. The entire number of tertiary triangles was 260. The longest tertiary line was 3,478 meters; the average tertiary was 1,297 meters; the shortest 485 meters.

A line of ordinary levels was carried along each bank of the river to form a basis for topographical work. These two lines were checked on each other every 3 miles by "river crossings" and as frequently as possible by connection with the precise bench marks previously established in this region. A table showing the results of these connections is appended hereto. Especial care was taken to connect with all local bench marks, water gauges, monuments of surveys, and all authentic high-water marks.

Soundings were taken in the customary manner from a cutter and located by sextant angles, section lines being sounded about every 250 meters, followed by a channel line through the deepest water found on the sections. At the Des Moines Rapids, however, that method did not seem practicable, as the water was too shallow and swift to admit of sounding from the cutter and a skiff would not carry the necessary observers to locate the soundings by sextant. A skiff was therefore used and observers placed on shore with transits and the course of the sounding skiff guided by two flagmen on opposite sides of the river. All the points occupied by the observers were afterwards located by tertiary triangulation.

Lines were thus sounded across the river at points about 200 meters apart, and above the canal three longitudinal lines were run in the channel to the extremity of the work. Total number of soundings for the season, 25,490; total number of sextant angles read, 10,674.

In the topographical work especial attention was given to instrumental checks, and all stadia lines were begun and ended either on points of triangulation or on points of other stadia lines, thus giving checks on azimuths, distances, and elevations. An attempt was made to improve the method of sketching which has heretofore been in practice. For this purpose Assistant Engineer J. A. Ockerson sent to the field a semicircular transparent pivot protractor with scale to be used in plotting stadia stakes and important points of topography, prior to the operation of sketching. Mr. W. G. Comber experimented with this protractor and soon found that it could not be used to advantage in the note books, as the protractor could not be kept in place on the loose leaves, and the size of the page was too limited to admit of the revolution of the protractor. A small sketching board and a sheet of computing paper about four times the size of a page of the note book were then substituted.

These proved satisfactory and the plan was soon after adopted by several other topographers, and in every case with satisfactory results. The little time lost in platting was more than made up by the increased facility with which the sketching could be done and by the readiness with which the topographer could lay out his work by the aid of an extended and accurate sketch. It does not seem practicable to transfer the sketches to the plats during the season of fieldwork, and a more comprehensive and accurate method seems desirable in order that the sketches may be laid over to be transferred in the office.

I am of the opinion that this method or some modification of it would be an improvement over the method heretofore practiced. These detached sketches, when they are finished or when they have been transferred, can be folded and pasted into the note books, thus becoming as completely a part of the permanent record as if they had been made on the pages of the note book.

In accordance with the suggestion of Assistant Engineer J. A. Ockerson, the party was supplied this season with field sheets of tracing linen instead of paper field sheets as heretofore. Plats made upon these can be transferred directly to the detail charts without the additional labor and the increased inaccuracies of transferring by tracings. To what extent these advantages will be offset by the difficulty of making and retaining the details of the plats on the smooth surface of the linen, can not be determined until the work shall have made further progress.

Owing to a large number of islands, several cities and towns and a large extent of bottom land filled with sloughs, the amount of topographical work required for a mile of river has been unusually large, as will be seen by the following figures: Number of miles of levees surveyed outside of limit of topography, 10; number of miles of lakes, sloughs, and rivers outside the ordinary limit of topography, 94; number of miles of bluff line, 78; number of square miles of topography, 197½. The entire distance covered by the work of the season is 60 miles by river, and the total number of working days 59, making a little more than an average of 1 mile of river per working day.

The field season has been so short that the party was not more than thoroughly organized when the work was discontinued, and as the part of the river surveyed has been a difficult one, it seems to me that the work of the party has not been unsatisfactory, a result which is due much more to the efficient services of my several assistants than to any efforts of my own.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

Table showing discrepancies in azimuth between tertiary and secondary triangulation.

Stations.	Tertiary azimuth.			Secondary azimuth.			Discrepancy.		Number of triangles.	Closure per triangle.
	°	′	″	°	′	″	′	″		″
◬ Hannibal to ◬ Heather	210	12	54	210	11	47	1	07	26	2.57
◬ Heather to ◬ Quincy	324	02	25	324	00	35	1	50	30	8.66
◬ Quincy to ◬ La Grange	242	30	40	242	30	46		06	27	0.22
◬ La Grange to ◬ Canton Univ	236	51	14	236	50	47		27	14	1.92
◬ Canton Univ. to ◬ Warsaw	137	45	42	137	45	30		12	45	0.26
◬ Warsaw to ◬ Rapids	214	39	52	214	40	05		13	13	1.00
◬ Rapids to B. M. $\frac{1}{3}^{2}$	84	53	48	84	53	54		06	5	1.20
B. M $\frac{1}{3}^{2}$ to Sandusky	113	21	13	113	20	42		31	6	5.16
◬ Sandusky to ◬ Edwards	21	31	19	21	32	12		53	4	13.25
◬ Edwards to ⊡ B. M. $\frac{1}{3}^{4}$	193	53	40	193	53	24		16	5	8.20
Mean								34	175	3.24

Table showing discrepancies between computed and measured bases and secondary lines.

Distance.	Number of triangles.	Computed base.	Measured base.	Discrepancy.	Rates.
Miles.		*Meters.*	*Meters.*	*Meters.*	
4	10	942.37	942.22	.15	1: 6,281
6	14	1,161.89	1,161.43	.46	1: 2,525
2	6	693.95	693.98	.03	1:23,133
4	12	788.93	788.71	.22	1: 3,585
4	11	613.57	613.70	.13	1: 4,721
8	23	852.17	852.27	.10	1: 8,523
5	13	547.66	547.33	.33	1: 1,658
5	19	599.64	599.42	.22	1: 2,724
4	12	1,440.35	1,439.46	.89	1: 1,600
4	11	1,031.23	1,031.30	.07	1:14,733
9	16	1,570.09	1,569.80	.29	1: 5,413
4	20	1,279.67	1,279.52	.15	1: 8,530
4	9	1,261.49	1,261.52	.03	1:42,050
60					

Average closure, 1:9,652 (regardless of length of run).

Discrepancy between precise and ordinary levels.

Between P. B. Ms.	Distance.	Error.	Leveled by—	Between P. B. Ms.	Distance.	Error.	Leveled by—
	Miles.				*Miles.*		
No. 16 and 14	11½	0.04	F. G. Ray.	No. 8 and 5	16	0.17	F. G. Ray.
No. 14 and 12	6½	0.03	Do.	No. 5 and 2	5	0.15	Do.
No. 12 and 56 McK.	8½	0.17	Do.	No. 2 and 3	½	0.00	Do.
No. 56 McK. and 10.	1	0.	Do.	No. 2 and 1	¼	0.00	Do.
No. 10 and 8	5	0.11	Do.	No. 1 and 1	2½	0.03	Do.
No. 8 and 9	½	0.00	Do.	No. 1 and 2	5¼	0.11	Do.

Discrepancies between right and left bank levels.

River crossing at—	Distance.	Discrepancy.	River crossing at—	Distance.	Discrepancy.
	Miles.			*Miles.*	
Stone line 95	3	0.145	Stone line 105	3	0.16
96	3	0.100	106	3	0.00
97	3	0.09	107	3	0.01
98	3	0.05	109	6	0.10
99	3	0.07	110	3	0.14
100	3	0.15	111	3	0.18
101	3	0.13	113	6	0.02
103	6	0.23	114	3	0.13
104	3	0.10			

Descriptions and elevations of high-water marks leveled to in season of 1892.

Description.	Year.	Eleva-tions.
On water gauge on Quincy Railroad bridge	1888	485.23
On northwest corner ◇ Jo Warehouse, La Grange, Mo	1892	487.63
On northeast corner of the "Blackwood," La Grange, Mo	1888	488.61
On southeast corner of the "Blackwood," La Grange, Mo	1851	490.93
On northeast corner of Buschman's feed mill, Canton, Mo	1888	491.89
On northeast corner of Palmer's boarding-house, Alexandria, Mo	1888	500.89
Do	1881	500.80
On southeast corner of ◇Jo Warehouse, Keokuk, Iowa	1892	503.67
On water gauge on lower lock of D. M. R. Canal	1851	505.61
Do	1888	504.29
Do	1881	503.59
On water gauge on middle lock of D. M. R. Canal (in canal)	1891	505.64
Do	1888	504.34
Do	1881	503.64
On water gauge in sluice way at middle lock (in rapids)	1888	506.65
On water gauge on upper lock of D. M. R. Canal	1888	515.74
Do	1881	515.06
Tellico Mills, Quincy, Ill	1851	487.50
Do	1888	484.58
Do	1881	484.09
On tree opposite foot of Island No. 432	1892	482.24
Vicinity of Warsaw, Ill	1888	502.08
On small culvert 4,590 meters above Keokuk bridge, on left bank	1885	505.96
On small culvert 4,060 meters above Keokuk bridge, on left bank, and 300 meters north of Ⓐ rapids	1888	506.08

APPENDIX 3 O.

REPORT OF ASSISTANT ENGINEER A. T. MORROW ON TERTIARY TRIANGULATION AND STONE LINES FROM DONALDSONVILLE TO HEAD OF PASSES, AND PRECISE LEVELS FROM NEW ORLEANS TO HEAD OF PASSES, NOVEMBER, 1892, TO MARCH, 1893.

ST. LOUIS, *April 10, 1893.*

CAPTAIN: I have the honor to submit the following report on the work done by the party which operated under my charge on the lower river during the past winter.

On November 17 the steamer *Patrol* left St. Louis under charge of Assistant Engineer J. A. Ockerson, who was engaged during the down-river trip in inspecting and repairing gauges and bulletins. On December 8, when the steamer had reached Donaldsonville, La., I joined the party and began work with a party composed as follows: A. T. Morrow in charge, with G. H. French, T. C. Hockridge, O. N. Axtell and A. O. Wheeler, assistants. There were also the crew of the steamer and 13 additional men. The work in view consisted of placing the bench marks on "stone lines" from Donaldsonville to the Head of the Passes and connecting them with the remaining marks of the old Coast Survey triangulation. This work was continued down the river till the city of New Orleans was reached on January 12. At that point the party was joined by precise-level men J. A. Paige and E. J. Thomas, recorder W. S. Williams, and two precise-level rodmen.

Two additional men were employed, a barge to carry coal was borrowed from Capt. Millis, a supply of bench marks and stones were taken on board, and on January 17 the steamer left New Orleans bound for the Head of the Passes, where the work was to be taken up in order to complete the lower portions of the river before the season of high water. At Fort Jackson the steamer was delayed two days by storms, and reached South Pass on the morning of January 20. The work from the Head of the Passes to New Orleans consisted of placing and locating bench marks and running a line of precise levels between these two points, and was prosecuted with a party composed as follows: A. T. Morrow, in charge; J. A. Paige and E. J. Thomas, precise level men, with recorders A. O. Wheeler and W. S. Williams; G. H. French, tertiary angles; T. C. Hockridge, bench marks, and O. N. Axtell, computations.

The work progressed without any serious delay until March 15, when the precise levels were closed on the precise bench marks at New Orleans and the work of placing and locating bench marks carried to the lower limit of the work of the early part of the season. On March 16 I discharged the men hired at New Orleans, placed the steamer, with the regular crew and three extra men, under the charge of T. C. Hockridge as master, with orders to proceed to St. Louis, and with the remainder of party, seventeen in number, I returned to St. Louis.

During the entire season the weather was, in the main, favorable, and no trouble was experienced from high water, except during the last two weeks of the season.

Tertiary triangulation.—At nearly all points enough of the Coast Survey triangulation stations remained to furnish good connections for the system of tertiary triangulation, which was carried along to locate the various bench marks of the survey. Of the 120 Coast Survey stations looked for 68 were found, and these were pretty fairly distributed, except on the stretch of river below Fort Jackson, where it became necessary to make a run of 18 miles between consecutive points of connection.

On this long stretch, however, the shores were flat and on one side mostly open, so that I was enabled to "chain" about half the distance with a steel tape, and the rest of the distance was favorable for triangulation, so that it is believed that the locations of the intermediate points are entirely reliable. During the entire season a good deal of difficulty was experienced in procuring reliable azimuths at the several Coast Survey stations on account of trees, buildings, and levees, which cut off the lines of sight between the consecutive points. For this reason it became necessary often to carry azimuth for long distances, but generally the coördinates could be checked at points sufficiently close to insure good results.

The atmospheric conditions were often unfavorable for observing angles, and it often became necessary to locate tertiary flags in unfavorable positions, such as on mud bars, tops of logs, stumps, docks, or buildings, and for these reasons the triangles did not always close with as much accuracy as could have been desired, but as the country was flat it was practicable to measure frequent tertiary bases, and it was considered more economical and productive of better results to devote less time to the determination of angles and give more attention to the measurement of tertiary bases than is usual in work of this kind.

The 50-meter steel tape, with which the party was provided, proved very serviceable for this work and was brought into almost daily use during the whole progress of the work. Besides the regular tertiary bases so measured there were check distances chained with a 20-meter chain, using ordinary chaining pins, but in the soft, wet ground of the region these determinations did not prove very satisfactory and in almost all instances were used for checks only. In a table which, is appended hereto, giving results of checks on tertiary triangulation, distances of this character are explained in a footnote as being used for checks only, as such determinations were used to detect mistakes in computations or other parts of the work, but did not enter the computations and thereby affect the general results of the work. As an illustration of the inexactness of ordinary chaining I have appended a small table showing the results of measurements of the same lines by tape and by chain. These measurements by tape and by chain were made by different parties, but on the same day. The measurements by tape were made with much care, a spring balance was used to insure uniform tension, and the extremities of each tape length were marked by a tack driven in the top of a stake set for the purpose. The marking of the chain lengths was by ordinary chaining pins, and no more than ordinary care was taken in the work, as the determinations were intended only for check on the work of the tape. The ground on nearly all of these lines was soft, but did not differ materially in that respect from most of the ground on which the chain was used during the general progress of the work. It is, therefore, probable that many of the discrepancies shown between measurements by chain and by computed distances, which were based generally on tape measurements, were due to inaccuracies of chaining rather than to defects in the tertiary triangulation.

As the ultimate object of the tertiary work was to determine the correct geographical positions of the various bench marks, perhaps a better test of the accuracy of the work is shown by the appended table, giving the discrepancies between the tertiary and secondary coördinates in the several runs from one secondary station to another.

Besides the permanent bench marks, a number of conspicuous objects have been located, and nearly all the intermediate tertiary points have been marked by stakes and their positions described, so that many of them will be available for connection for one or two years.

There were, all together, 502 tertiary triangles used during the season's work.

Bench marks.—In view of the lack of permanence that has attended many of the bench marks of former years, I have endeavored to keep steadily and prominently in view the importance of selecting permanent positions for the marks which we have established. For this purpose they have as often as practicable been placed by the sides of roadways and land lines and as much as possible out of way of cultivation and probable improvements. Where they have been put on plantations or other private grounds they have in most cases been so placed with the knowledge and consent of the owners or occupants and with the understanding that they were placed there as permanent and valuable marks of public surveys. They have also been placed with a view to being used as points of location as well as of elevation, and with this object in view they have been located, as has been stated, by triangulation, and, besides, have been occupied and pointings have been taken to various permanent and conspicuous objects in sight. Observations so taken will not only furnish effective means of recovering the points hereafter, but will supply azimuth lines for use in future surveys.

Full descriptions and sketches have been made, and it is believed that in most cases these points may be recovered many years hence, even if the surface marks shall have been removed.

On the extreme lower river some difficulty was experienced in planting the bench marks, owing to the close proximity of the water to the surface of the ground, and it often became necessary to bail water continuously from the holes while the work was being done. In these cases the tiles were well rammed down, and it is believed that they are as stable as any objects in those localities. Two bench marks placed in wet ground at Fort Jackson on the way down seemed not to have settled perceptibly in the two weeks that elapsed before our return to that place.

It is a question, however, in my mind whether any object in the vicinity of the Passes remains permanently at the same elevation—a question that will perhaps not be definitely settled until precise levels shall have been carried down again from above, after a lapse of years.

A table is given below showing number and kind of bench marks established.

Precise levels.—Two precise-level bench marks were established at the head of the Passes and connection was made with the U. S. Engineers' bench mark and two gauges. From that place precise levels were carried on the right bank to Fort Jackson and thence on the left bank to New Orleans, where they were connected with the P. B. M's of 1883, back of the city, and carried to the Coast Survey astronomical post in Lafayette Square. Much less difficulty was experienced on the wet ground of the extreme lower river than was anticipated, a line having been cleared out through the timber, where the roots of trees served as turning points and the uniform atmospheric conditions seemed to largely compensate for the difficulty of leveling over the soft ground.

Assistant Engineer Paige, who was placed in general charge of precise levels, will make a report on the results and methods of that work.

Very respectfully, your obedient servant,

A. T. MORROW,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.

Table showing number and character of permanent bench marks established between Donaldsonville, La., and the Head of the Passes, during the progress of the survey of the winter of 1892 and 1893.

	Number.
Ordinary bench marks of tile and pipe	198
Secondary triangulation stations used as ordinary bench marks	6
Other marks used as ordinary bench marks	4
Total ordinary bench marks	208
Precise bench marks of tile and pipe	32
Copper bolt precise bench marks	9
Ordinary bench marks used as precise bench marks	28
Other marks used as precise bench marks	7
Total precise bench marks	76
Total bench marks of all classes	256

Table showing discrepancies in tertiary triangulation.

Stations.	Distance chained or computed.	Distance computed.	Discrepancies.	No. of triangles.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
192 to 192	*791.55	791.43	.12	4	1 in 6,597
192 to 192	*882.80	883.30	.50	7	1 in 1,766
192 to St. James ch	762.88	763.07	.19	3	1 in 4,016
△ 25 to △ 24	952.84	953.07	.23	4	1 in 4,144
192 to 192	*857.48	857.50	.02	5	1 in 47,874
△ 34 to △ 36	1175.75	1175.76	.01	5	1 in 117,575
△ 39 to ware ho. cupola	752.21	752.16	.05	5	1 in 15,045
△ 44 to △ 46	671.68	671.48	.20	2	1 in 3,358
192 to 192	*852.20	852.05	.15	2	1 in 5,681
△ 44 to △ 46	671.68	671.70	.02	2	1 in 33,584
192 to △ 50	*870.74	870.67	.07	2	1 in 12,439
△ 50 to △ 48	600.32	630.87	.55	3	1 in 1,092
△ 51 to 192	*1128.33	1128.17	.16	6	1 in 7,052
(△) St. John to St. Johns ch	1692.80	1692.30	.50	7	1 in 3,360
△ 62 to △ 60	950.47	950.38	.09	15	1 in 10,561
202 to △ 67	*609.70	609.66	.04	4	1 in 15,242
202 to △ 74	*1108.80	1108.36	.56	6	1 in 1,981
202 to △ 73	*636.20	636.63	.43	7	1 in 1,481
204 to △ 81	*861.70	862.16	.46	17	1 in 1,895
204 to △ 78	*875.84	876.24	.40	17	1 in 2,189
202 to △ 82	*1024.40	1024.53	.13	2	1 in 7,881
202 to 202	*784.30	784.42	.12	2	1 in 6,536
△ 86 to 202	*713.37	713.86	.39	3	1 in 1,830
207 to △ 95	*1005.30	1006.40	.90	4	1 in 1,117
207 to △ 94	*895.14	895.26	.12	3	1 in 7,459
△ 88 to △ 90	1123.36	1123.35	.01	3	1 in 112,336
(△) Odier to Duseau S. H. Chy	648.10	648.20	.10	7	1 in 6,481
△ 102 to △ 105	1212.64	1212.54	.10	4	1 in 12,126
△ 104 to △ 106	*620.89	620.61	.28	2	1 in 2,218
△ 117 to 211	*822.40	822.14	.26	5	1 in 3,163
(△) City Park to △ 119	481.39	481.19	.20	5	1 in 2,407
212 to (△) Com. canal	582.27	582.25	.02	4	1 in 29,113
△ Donovan No. 2 to Cubits Chy	2009.64	2009.67	.03	2	1 in 66,988
244 to 244	1173.43	1173.53	.10	10	1 in 11,735
242 to △ 127	800.00	800.05	.05	8	1 in 16,000
△ 131 to △ 129	1450.00	1449.04	.96	2	1 in 1,510
△ 136 to 241	806.97	806.82	.15	7	1 in 5,380
△ 143 to △ 140	955.84	956.06	.22	2	1 in 4,345
△ 152 to 212	1056.65	1056.47	.18	9	1 in 5,780
△ 170 to △ 173	686.48	686.32	.16	11	1 in 4,280
△ 189 to △ 190	721.28	721.48	.20	27	1 in 3,606
△ 197 to (△) Union	632.65	632.57	.08	2	1 in 7,908
△ 211 to △ 212	929.61	929.39	.22	14	1 in 4,226
△ 217 to △ 219	548.95	549.07	.12	4	1 in 4,574
212 to Junior Chy	834.84	834.78	.06	9	1 in 13,914
△ 231 to △ 233	1256.10	*1254.62	1.48	4	1 in 848
222 to △ 247	712.93	713.19	.26	12	1 in 3,128
△ 236 to 222	*529.12	529.30	.18	4	1 in 2,941
△ 250 to △ 252	1067.09	1067.08	.01	11	1 in 106,709
△ 256 to (△) Bayhi	630.70	630.66	.04	6	1 in 15,737
△ 258 to 224	727.97	728.03	.06	4	1 in 12,133
△ 264 to 222	789.73	789.66	.07	8	1 in 11,267
△ 268 to △ 267	823.21	823.26	.03	5	1 in 16,465
212 to 222	*560.40	560.35	.05	6	1 in 11,208
△ 276 to 221	919.70	919.50	.20	4	1 in 4,598
△ 271 to △ 272	730.09	729.98	.11	10	1 in 6,637
△ 275 to △ 276	868.73	868.81	.08	5	1 in 10,860
△ 278 to △ 280	1057.10	1057.24	.14	5	1 in 7,551
211 to 221	747.62	747.60	.03	2	1 in 24,920
△ 281 to △ 282	739.70	739.91	.21	13	1 in 3,523
△ 288 to 210	*536.43	536.43	.00	4	1 in ∞
210 to △ 288	833.99	833.95	.04	5	1 in 20,850
△ 292 to △ 287	786.31	786.13	.18	11	1 in 4,368
(△) Magnolia to 213	1,083.09	1,083.09	.00	2	1 in ∞
△ 295 to 212	*1,040.21	1,039.72	.49	4	1 in 2,123
△ 308 to 212	985.49	985.44	.05	4	1 in 19,710
(△) Battle Ground, Refinery Chy	1,621.63	1,621.74	.11	3	1 in 14,742
△ 308 to Refinery Chy	986.01	986.00	.01	6	1 in 98,601
△ 307 to 212	1,214.73	1,214.61	.12	4	1 in 10,126
216 to Colored Church	540.64	540.60	.04	3	1 in 13,516

* Used for check only.

Table showing discrepancies between tape and chain measurements.

Stations.	Measured with tape.	Measured with chain.	Discrepancy.	Character of ground.	Proportionate discrepancies.
	Meters.	*Meters.*	*Meters.*		
$\frac{143}{2}$ to △ 127	800.06	799.84	—.22	Soft	1 in 3,637
△ 129 to △ 131	1,450.05	1,449.36	—.69	....do	1 in 2,101
△ 131 to $\frac{243}{2}$	1,640.11	1,640.21	+.10	Hard	1 in 16,402
$\frac{142}{2}$ to △ 133	980.12	980.00	—.12	Soft	1 in 8,168
$\frac{241}{2}$ to △ 139	1,062.07	1,061.50	—.57	....do	1 in 1,863
△ 139 to △ 141	1,500.12	1,499.20	—.92	....do	1 in 1,631
△ 141 to △ 143	1,370.12	1,369.30	—.82	....do	1 in 1,671
△ 143 to $\frac{242}{2}$	1,472.54	1,471.80	—.74	....do	1 in 1,981
$\frac{249}{2}$ to △ 245	1,100.00	1,099.55	—.45	....do	1 in 2,444

Discrepancies between tertiary and secondary coördinates, Donaldsonville, La., to Head of Passes.

From station.	To station.	Number of triangles.	Distance.	Discrepancy in latitude.	Discrepancy in longitude.	Proportional discrepancy.
			Miles.	*Meters.*	*Meters.*	
(△) Webre	(△) Donalson	6	2.2	0.8	0.2	1: 4,317
(△) St. James	△ St. Michael's Church	4	1.8	0.7	0.6	1: 3,133
(△) St. Emma	(△) College	7	4.7	1.0	0.0	1: 7,520
(△) Jolly	(△) Homestead	8	4.2	1.6	0.6	1: 4,188
Do	(△) Jolly	5	5.1	0.9	1.3	1: 5,100
△ White Rose	(△) Chauf	10	2.4	1.5	0.3	1: 2,560
(△) St. John	(△) Reserve	7	3.9	1.1	0.4	1: 5,200
(△) Reserve	△ Round-house	12	5.6	0.2	0.6	1:14,860
(△) Kilana	(△) Becuar	12	4.5	0.8	0.1	1: 9,000
(△) Bois Blanc	(△) Avondale	3	2.1	1.0	0.1	1: 3,360
(△) Company Canal	(△) City Park	7	1.4	1.1	0.8	1: 1,640
(△) Lee	(△) St. Maurice	5	2.5	0.3	0.2	1:11,110
(△) Orleans	(△) Battle ground	5	1.9	0.0	0.2	1:15,200
(△) Magnolia	(△) Orange Grove	2	1.6	0.4	0.5	1: 4,000
(△) Scarsdale	....do	18	4.9	0.7	1.6	1: 4,360
(△) Concessions	(△) Scarsdale	6	2.8	0.3	1.1	1: 3,345
Do	(△) Cedar	11	3.9	0.5	0.5	1: 8,910
(△) Berthaud	(△) Jesuit	8	1.4	0.6	0.3	1: 3,700
(△) Jesuit	(△) Bayhi	8	2.4	0.1	0.2	1:19,200
(△) Bayhi	(△) St. Rosalie	15	4.8	0.4	0.5	1:12,000
(△) St. Rosalie	(△) Woodland	22	9.5	3.9	1.3	1: 3,700
(△) Upper Base	(△) Union	18	5.6	0.6	0.1	1:14,930
(△) Union	(△) White	18	7.5	1.1	1.6	1: 6,320
(△) White	(△) Grand Prairie	21	8.3	0.5	0.5	1:19,000
(△) Quarantine	△ Buras Church	2	0.7	0.8	0.1	1: 1,400
(△) North	(△) Taylor	42	18.6	1.8	1.4	1:12,940
(△) H. P. Light	(△) North	3	4.2	0.3	0.5	1:12,200

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana.

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	Meters.	° ′ ″	Meters.	° ′ ″	° ′ ″		Meters.
⊡ [illegible]	30 07 14.84	457.0	90 57 35.62	953.5	14 55 52	194 55 48	⊡ [illegible]	925.4
⊡ [illegible]	30 06 45.81	1,410.7	90 57 44.52	1,191.8	14 34 51	194 34 46	△ North Base	
					80 17 51		Hermitage S. H	
⊡ [illegible]	30 08 53.01	1,632.4	90 56 17.39	465.4	74 33 34	254 33 02	△ Riverton	1,787.3
					359 56 00	179 56 00	⊡ [illegible]	757.7
					236 26 35		Donaldson Chy	
					344 28 05		Cofield Chy	
⊡ [illegible]	30 08 28.40	874.5	90 56 17.36	464.7				
⊡ [illegible]	30 07 59.83	1,842.4	90 56 14.21	380.4	335 16 24	155 16 32	⊡ [illegible]	1,016.8
					53 32 54		Hermitage Chy	
⊡ [illegible]	30 07 29.83	918.6	90 55 58.32	1,561.3	180 01 04		Cofield S. H. Chy	
					178 35 54		Cofield Stack	
					72 22 09		Hermitage Chy	
					201 36 35		Clark Chy	
⊡ [illegible]	30 06 20.34	626.3	90 53 57.58	1,541.8	77 34 33	257 34 16	⊡ [illegible]	940.2
					143 25 26		Union Stack	
⊡ [illegible]	30 06 13.77	424.0	90 54 31.87	853.4	274 10 51		St. Mary's Chy	
⊡ [illegible]	30 06 08.39	258.4	90 55 01.23	32.9	75 08 03	255 07 47	⊡ [illegible]	884.3
⊡ [illegible]	30 06 01.02	31.4	90 55 33.15	887.6	169 51 56	349 51 53	△ Lemann	925.6
					344 03 00		Salsburg Chy	
⊡ [illegible]	30 04 38.40	1,182.5	90 53 06.40	171.4	26 19 07	206 19 00	⊡ [illegible]	835.6
					108 12 49		M. E. Church	
					333 37 37		Vegas S. H.	
⊡ [illegible]	30 04 14.07	433.3	90 53 20.23	541.8				
⊡ [illegible]	30 03 45.42	1,398.6	90 53 36.42	975.5	16 35 07	196 35 02	⊡ [illegible]	990.9
⊡ [illegible]	30 03 14.58	449.0	90 58 46.96	1,258.6	147 14 14		Salsburg Chy	
					230 22 57		Zion church	
⊡ [illegible]	30 03 14.96	461.3	90 49 52.41	1,404.0	67 40 23	247 40 09	⊡ [illegible]	791.4
					33 16 40	213 16 33	△ Donnelson	
					355 10 33		St. Michael's Church	
⊡ [illegible]	30 03 05.22	160.7	90 50 19.74	528.8	303 36 52	123 36 59	△ Donnelson	446.7
⊡ [illegible]	30 02 52.16	1,606.2	90 50 47.11	1,262.1	61 04 31	241 04 17	⊡ [illegible]	856.1
⊡ [illegible]	30 02 38.70	1,191.7	90 51 15.08	404.0	99 42 57	279 42 30	△ Webre	1,489.8
					338 30 17		St. James's Church	
⊡ [illegible]	30 00 57.44	1,768.8	90 49 10.33	276.8	72 56 54	252 56 38	⊡ [illegible]	882.8
					51 55 07	231 54 54	St. Michael's Church	
⊡ [illegible]	30 00 49.03	1,509.8	90 49 41.82	1,120.7	347 38 06		do	
⊡ [illegible]	30 00 43.13	1,328.1	90 50 16.56	443.8	67 39 49	247 39 36	⊡ [illegible]	762.9
					276 44 32		St. Michael's Church	
					171 03 15		St. James's Church	
					115 46 20		La Pice S. H	

⊡ 123	30	00	33.71	1,038.1	90	50	42.89	1,149.8	106	20	36	286	20	14	⊙ St. James	1,230.0
									214	14	19				St. James's Church	
									140	17	25				La Pice S. H. Chy	
									74	50	45				Forstall S. H.	
⊡ 124 = ⊙ College	30	00	07.25	223.3	90	49	02.55	68.4	323	04	38	143	04	46	⊡ 124	744.3
⊡ 124	29	59	47.93	1,425.9	90	48	45.87	1,229.4								
⊡ 124	29	59	12.44	383.1	90	48	18.95	508.0	335	38	13	155	38	19	⊡ 124	775.6
									356	14	28				Pikes Peak Chy	
⊡ 124	29	58	49.50	1,524.3	90	48	07.02	188.3	132	41	08				College Chy	
									15	21	23				Pikes Peak Chy	
⊡ 125	30	01	37.60	1,157.8	90	46	07.46	199.9	257	24	38	77	25	28	⊙ Jolly	3,039.1
									356	08	50	176	09	00	⊡ 125	975.3
									335	21	36				Belle Alliance	
⊡ 125	30	01	06.00	184.8	90	46	05.01	134.8	248	32	55	68	33	01	do	346.7
									136	15	40				Belmont Chy	
⊡ 125	30	00	27.69	852.7	90	46	01.98	53.1	351	01	20	171	01	22	⊡ 125	537.6
									190	27	51				Belle Alliance	
									347	55	00				Felicite Chy	
									47	15	33				Oak Alley Chy	
⊡ 125	30	00	10.45	321.8	90	45	58.85	1,577.3	184	54	07				Belle Alliance	
									80	24	49				Oak Alley Chy	
⊡ 125	30	01	34.57	1,064.5	90	43	34.87	934.3	123	50	02	303	58	41	⊙ Jolly	1,354.5
									260	14	59	80	15	26	△ Chapel	1,446.7
									337	04	22	157	04	27	⊡ 125	722.4
									78	31	27				Belle Alliance	
									336	37	29				Catholic Church	
⊡ 126	30	01	12.97	399.4	90	43	24.37	653.0	170	00	29				Borgeois S. H.	
									336	14	34				Catholic Church	
⊡ 126	30	00	45.44	1,399.2	90	43	11.04	295.9	338	47	47	158	47	53	⊡ 126	857.5
									276	20	39				Iron Smokestack	
⊡ 126	30	00	19.48	599.9	90	42	59.47	1,593.9	12	07	52				Wagenspeck Chy	
									70	44	20				Dupare Bagasse Burner	
⊡ 127	30	03	14.62	450.2	90	41	01.57	42.1	323	58	03	143	58	12	⊡ 127	817.0
									62	42	43				Ross S. H. Chy	
									32	24	38				Sawmill Stack	
⊡ 127	30	02	53.16	1,637.0	90	40	43.63	1,168.8	98	52	32				Ross S. H. Chy	
⊡ 127	30	02	30.43	937.1	90	40	24.94	668.0	350	08	01	170	08	03	⊡ 127	675.7
									116	10	21				Ross S. H. Chy	
									83	49	27				Sawmill Stack	
⊡ 127	30	02	08.81	271.3	90	40	20.62	552.4	253	45	10				S. H. Chy. R. B	
									299	18	10				Tall Brick Chy	
⊡ 129	30	02	42.40	1,305.6	90	37	29.89	800.6	55	26	17	235	26	03	⊡ 128	884.7
									262	38	17				Hope S. H. Chy	
⊡ 128	30	02	26.10	803.7	90	37	57.08	1,529.4	247	18	33				do	
									223	56	03				Chauff Chy	
⊡ 128	30	02	01.06	32.6	90	38	37.83	1,013.6	63	55	13	243	54	59	⊡ 128	852.1
⊡ 128	30	01	48.89	1,505.5	90	39	06.89	171.2								
⊡ 128	30	03	36.35	1,119.3	90	36	09.08	243.2	342	33	01	162	33	07	⊡ 129	1,109.7
									64	18	38	244	18	21	⊙ Chauff	1,023.7
									268	17	03				Reserve S. H. Chy	
⊡ 129	30	03	01.95	60.1	90	35	56.65	1,517.5								
⊡ 129	30	02	38.22	1,176.9	90	35	42.47	1,187.8	337	43	40	157	43	46	⊡ 129	855.1

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	Meters.	° ′ ″	Meters.	° ′ ″	° ′ ″		Meters.
⊡ 212	30 02 12.50	384.9	90 35 30.87	813.7	61 39 50	241 39 26	△ White Rose	1,453.5
					85 38 19		Snyder S. H	
					68 19 05		Carroll S. H	
⊡ 210	30 03 31.11	958.0	90 32 54.30	1,454.4	2 41 36	182 41 35	⊡ 212	663.8
					72 05 46		St. Peter's Church	1,224.4
					34 31 48		St. John's Church	
⊡ 200	30 03 09.57	294.7	90 32 55.47	1,485.9				
⊡ 200	30 02 43.17	1,329.4	90 32 55.64	1,490.5	2 30 31	182 30 30	⊡ 200	1,025.2
					10 48 59		McBecknel Chy	
					28 08 19		Carle S. H	
⊡ 200	30 02 09.89	804.6	90 32 57.31	1,535.6	62 30 05	242 29 46	△ St. John	1,142.0
					143 52 48		St. John's Church	1,431.8
					85 11 22		Webre S. H	
					50 56 58		Carle S. H	
⊡ 201	30 04 08.41	259.0	90 30 08.86	237.3	352 15 46	172 15 48	⊡ 201	823.1
⊡ 201	30 03 41.92	1,290.9	90 30 04.73	126.7	175 03 36		Bagasse Burner	
					226 42 00		R. R. Water Tank	
⊡ 201	30 03 00.85	26.2	90 30 07.71	206.5	13 34 08	193 34 05	⊡ 201	761.6
⊡ 201	30 02 36.80	1,133.2	90 30 14.38	385.3				
⊡ 202	30 00 50.30	1,548.9	90 28 17.00	455.6	126 47 47	306 47 38	⊡ 203	588.1
⊡ 203	30 01 01.74	53.6	90 28 34.57	926.4				
⊡ 202	30 01 37.75	1,162.5	90 29 20.39	546.2	131 19 15	311 19 06	⊡ 202	610.4
					143 59 05		Lindall S. H	
					164 14 10		Chimney	
⊡ 202	30 01 50.84	1,565.6	90 29 37.50	1,004.8	71 04 16	251 03 31	△ Kennemore	2,538.7
					110 55 38		Gold Mine Chy	3,096.6
⊡ 202	30 00 27.02	832.0	90 27 08.07	216.8	11 04 54	191 04 52	⊡ 202	621.7
					292 01 31		Kilona S. H	
					59 29 24		Ross S. H	
⊡ 202	30 00 07.21	222.0	90 27 12.53	335.8	282 28 35		Providence Church	
⊡ 202	29 59 33.93	1,044.8	90 27 19.14	513.0	18 19 18	198 19 13	⊡ 202	840.1
					209 55 03		Providence Church	
⊡ 202	29 59 08.03	247.3	90 27 28.99	777.1	204 51 36		do	
⊡ 204	29 59 45.76	1,409.1	90 23 42.62	1,142.3	49 02 23	229 02 11	⊡ 204	840.5
					32 38 08		Hahnville Church	
					342 03 15		Sarpy's S. H. Cupola	
⊡ 204	29 59 27.85	857.5	90 24 06.31	169.2	277 52 21		Sarpy's S. H. Cupola	
					313 19 48		Lightning-rod	
⊡ 204	29 59 12.53	385.8	90 24 32.18	862.6	52 52 43	232 52 32	⊡ 204	750.6
⊡ 204	29 58 57.82	1,780.2	90 24 54.50	1,460.9	316 19 45		Hahnville Church	
					116 02 21		Star Church	

⊡ 295/1	29	57	47.46	1,461.2	90	22	51.72	1,386.7	33	27	41	213	27	30	⊡ 294/4	1,074.3
									338	18	19	158	18	29	Red Church	
									158	52	28				Sarpy's S. H. Cupola	
									357	04	31				Ashley's S. H. Chy	
⊡ 295/2	29	57	18.35	565.1	90	23	18.81	370.4								
⊡ 295/3	29	56	49.62	1,527.8	90	23	32.46	870.5	88	23	17	218	23	07	⊡ 295/2	826.0
									7	07	15				⊙ La Fitte	
									201	48	55				Ormond S. H. Chy	
⊡ 295/4	29	56	28.59	880.3	90	23	51.59	1,383.6	332	57	42	152	57	48	⊙ La Fitte	764.0
									207	27	54				Ormond S. H. Chy	
									307	29	14				Ashley's S. H. Chy	
⊡ 296/1	29	56	44.19	1,360.6	90	20	26.65	714.6	0	21	02	180	21	02	⊡ 295/3	784.4
									49	42	06				Alicia S. H. Chy	
									63	16	59				Ashley S. H. Chy	
⊡ 296/2	29	56	18.71	576.1	90	20	26.83	719.6	267	34	27				S. H. Chimney	
									239	27	22				S. H. down river	
⊡ 296/3	29	55	49.13	1,512.7	90	20	34.53	926.1	17	09	15	197	09	10	⊡ 296/2	856.3
									91	15	46				Alicia Chy	
									87	16	04				Ashley Chy	
⊡ 296/4	29	55	22.56	694.6	90	20	43.94	1,178.7	119	53	20				Alicia Chy	
									101	23	13				Ashley Chy	
⊡ 297/1	29	58	02.91	89.6	90	18	35.40	949.1	316	29	34	136	29	46	⊡ 297/2	944.7
									267	46	04				Price S. H. Chy	
									252	56	37				Frelson S. H. Chy	
⊡ 297/2	29	57	40.66	1,251.9	90	18	11.14	298.7	68	51	11				Ashley Chy	
									164	27	43				Price Chy	
									224	48	30				Frelson Chy	
⊡ 297/3	29	57	13.64	420.0	90	17	46.59	1,249.3	324	12	59	144	13	07	⊡ 297/4	763.3
⊡ 297/4	29	56	53.53	1,648.1	90	17	29.94	802.8	183	14	40				Frelson Chy	
									48	46	12				Louise Chy	
⊡ 298/1	29	58	57.52	1,771.0	90	15	01.63	43.7	8	54	22	188	54	19	⊡ 298/2	1,022.1
									298	23	07				Methodist Church	
									23	28	45				Oakland Church	
									87	07	48				Johnson S. H.	
⊡ 298/2	29	58	24.72	761.1	90	15	07.53	201.9	232	34	49				Catholic Church	
⊡ 298/3	29	57	58.95	1,815.2	90	15	11.43	306.4	10	43	49	190	43	47	⊡ 298/4	716.8
									343	38	39				Duseau Chy	
⊡ 298/4	29	57	36.08	1,110.9	90	15	16.41	440.0	293	52	07	113	52	18	⊙ Odier	673.8
									224	04	55				Duseau Chy	
⊡ 299/1 ⊙ Bois Blanc	29	56	46.35	1,427.1	90	12	33.77	905.5	45	36	37	225	36	23	⊡ 299/2	1,047.9
									355	26	17	175	26	21	Jefferson Church	2,797.9
									358	12	34				Soniat S. H	
⊡ 299/2	29	56	22.54	694.1	90	13	01.69	45.3	317	24	33				Soniat S. H	
									252	00	23				Frenia S. H	
⊡ 299/3	29	56	07.72	237.7	90	13	30.34	813.7	55	29	11	235	28	58	⊡ 299/4	858.5
									23	10	36				Smith Pump House	
									9	29	14				Smith S. H.	
									50	46	59				Section House Chy	
⊡ 299/4	29	55	51.92	1,598.6	90	13	56.71	1,521.0	268	07	33				Sugar House Chy	
									234	27	21				Chy. on house	

Stone line B. Ms., geographical positions, Donaldsonville to head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation ⊚'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	*Meters.*	° ′ ″	*Meters.*	° ′ ″	° ′ ″		*Meters.*
⊡ 2 1/1 2	29 56 32.02	985.9	90 11 46.63	1,250.4	315 32 55	135 33 06	⊡ 2 1/2 2	843.4
					217 12 00		Sugar House Chy	
					308 40 40		Gable Ag. Col. Barn	
⊡ 2 1/2 2	29 56 12.47	383.9	90 11 24.61	660.0				
⊡ 2 1/3 2	29 55 44.45	1,368.6	90 10 54.49	1,461.4	316 30 14	136 30 22	⊡ 2 1/4 2	605.4
					228 07 17		La Branch Chy	
					39 25 57		Avondale Chy	
⊡ 2 1/4 2	29 55 30.19	929.5	90 10 38.96	1,044.9	72 41 54	252 41 22	⊚ Avondale	1,812.5
					208 22 13		La Branch Chy	
					60 17 51		Avondale Chy	
⊡ 2 1/1 1	29 57 52.18	1,606.6	90 08 18.44	494.4	22 51 05	202 50 59	⊡ 2 1/2 1	771.7
					342 20 18		Electric-Light Tower	
					37 13 28		Water Tank	
					75 43 35		Church Spire	
⊡ 2 1/2 1	29 57 29.08	895.3	90 08 29.62	794.8				
⊡ 2 1/3 1	29 57 03.88	119.5	90 08 52.75	1,414.5	33 12 39	213 12 32	⊡ 2 1/4 1	703.6
					285 25 12		Catholic Church	
					210 25 54		Edge of Elevator	
					145 49 02		Church Spire	
					55 37 08	235 36 26	La Branch Chy	2,757.6
⊡ 2 1/4 1	29 56 44.76	1,378.1	90 09 07.12	190.9	211 37 45		Edge of Elevator	
					200 41 21		Church Spire	
⊡ 2 1/1 2 ⊚ City park	29 55 36.43	1,121.5	90 07 48.94	1,312.5	28 45 09	208 45 05	⊡ 2 1/2 2	459.7
					262 55 19		St. Charles Str. Church	
					262 00 29		Asylum	
					231 27 09		Standpipe	
⊡ 2 1/2 2	29 55 23.35	718.9	90 07 57.18	1,533.8	221 47 28		Standpipe	
					198 20 40		Church Spire	
					87 34 05		Elevator Stack	
⊡ 2 1/3 2	29 54 51.92	1,598.6	90 08 22.56	605.2	31 42 58	211 42 51	⊡ 2 1/4 2	747.6
					70 50 11	250 50 01	⊚ Company Canal	582.3
					155 53 20		Elevator Tank	
					155 26 48		Elevator Stack	
					72 30 43		R. R. Tank	
⊡ 2 1/4 2	29 54 31.27	962.8	90 08 37.21	998.1	160 33 27	340 33 24	⊚ Company Canal	471.7
					271 41 53		Brickyard Chy	
					164 07 05		Zerringer Chy	
					238 09 48		Square Tower	
⊡ 2 1/1 2	29 55 36.77	1,132.1	90 05 23.40	627.6				
⊡ 2 1/2 2	29 55 25.12	773.4	90 05 23.48	629.8	242 24 39		M. E. Church	

⊡ $2\tfrac{1}{3}{}^{3}$	29	54	22.58	695.2	90	04	55.51	1,489.3	342	55	56	162	58	00	⊡ $2\tfrac{1}{3}{}^{3}$	787.1
									284	45	26	104	45	54	◬ Gretna	1,562.5
									85	08	42				Ames S. H	
⊡ $2\tfrac{1}{4}{}^{3}$	29	53	58.14	1,790.1	90	04	46.90	1,258.8	254	31	20	74	31	44	◬ Gretna	1,528.1
									203	43	48				Brick Chy. N. O	
									148	30	48				Carrolton Av. Church	
									168	11	36				Louisiana Av. Church	
⊡ $2\tfrac{1}{1}{}^{4}$ = Astronomical Post	29	56	57.86	1,781.3	90	04	11.46	807.8								
⊡ $2\tfrac{1}{2}{}^{4}$	29	56	47.40	1,459.4	90	03	46.49	1,246.6	319	13	42	139	14	00	Tank	1,457.1
									108	48	05				1st Pres. Church	
⊡ $2\tfrac{1}{3}{}^{4}$	29	56	35.98	1,107.8	90	02	53.41	1,432.3	295	48	20	115	48	34	◬ Algiers	826.8
									32	07	27	212	07	15	Tank	887.9
									105	33	08				1st Pres. Church	
									167	28	59				St. Mary's Church	
⊡ $2\tfrac{1}{4}{}^{4}$ = ◬ Algiers	29	56	24.30	748.1	90	02	25.67	688.8	108	19	52	288	18	58	1st Pres. Church	3,089.4
									145	16	24				St. Louis Cathedral	
									150	16	37	330	16	07	3d Pres. Church	3,236.0
									307	46	09	27	46	30	Ursuline Convent	2,427.2
									156	05	13	336	04	48	St. Peters and St. Pauls Ch.	3,361.9
									159	56	00	339	55	48	Oil Works Chy	1,833.2
									161	53	58	341	53	34	German M. E. Church	3,250.8
									120	54	50	300	53	56	Christ Church	3,396.3
									159	18	26	339	18	07	White Spire	2,946.4
⊡ $2\tfrac{1}{1}{}^{5}$	29	57	59.47	1,831.0	90	01	12.09	324.1	17	11	00	197	10	54	⊡ $2\tfrac{1}{4}{}^{5}$	1,030.2
									325	58	55	145	59	10	◬ St. Maurice	1,409.8
									47	06	05				Ursuline Convent	1,149.7
⊡ $2\tfrac{1}{2}{}^{5}$	29	57	27.51	847.0	90	01	23.44	628.5								
⊡ $2\tfrac{1}{3}{}^{5}$	29	56	49.63	1,528.0	90	01	29.01	777.9	3	18	49	183	18	48	⊡ $2\tfrac{1}{4}{}^{5}$	717.8
									315	32	48	135	32	53	Church	381.1
⊡ $2\tfrac{1}{4}{}^{5}$	29	56	26.38	812.2	90	01	30.56	819.6	315	51	22	135	51	35	◬ Lee	991.9
									266	34	05				◬ Chalmette	
									214	46	42	34	46	48	Church	540.6
									131	42	13				Spire	
⊡ $2\tfrac{1}{1}{}^{5}$	29	56	37.05	1,140.7	89	58	35.50	952.0	275	11	13	95	11	35	◬ Battleground	1,200.7
									25	47	06	205	46	59	⊡ $2\tfrac{1}{3}{}^{5}$	909.0
									89	29	34				◬ Chalmette	
									4	53	23	184	58	22	Refinery Chy	1,096.4
⊡ $2\tfrac{1}{2}{}^{5}$	29	56	10.47	322.4	89	58	50.24	1,347.4	245	57	00	65	57	45	◬ Battleground	1,742.4
									122	08	31				◬ Chalmette	
⊡ $2\tfrac{1}{3}{}^{6}$	29	55	35.83	1,103.2	89	59	04.95	132.8	6	39	05	186	39	03	⊡ $2\tfrac{1}{4}{}^{5}$	899.9
⊡ $2\tfrac{1}{4}{}^{6}$	29	55	06.80	209.4	89	59	08.84	237.1	278	24	36	98	24	51	◬ Orleans	820.6
									164	12	15				◬ Chalmette	
									205	24	00	25	24	14	Refinery Chy	
P. B. M. 37	29	55	59.58	1,834.4	89	57	27.94	749.4	149	29	07	329	28	56	◬ Battleground	1,213.3
									91	51	02				Refinery Chy	
P. B. M. 36	29	54	42.26	1,301.1	89	54	23.68	635.2	152	37	50				Story S. H. Chy	
									192	40	45				Pump House Chy	
⊡ $2\tfrac{1}{1}{}^{7}$ = ◬ Du Cross	29	56	10.21	314.5	89	55	25.36	680.1	36	07	11	216	07	01	⊡ $2\tfrac{1}{4}{}^{7}$	937.1
									326	07	49				Story S. H	
⊡ $2\tfrac{1}{2}{}^{7}$	29	55	45.62	1,404.6	89	55	45.96	1,232.6								
⊡ $2\tfrac{1}{3}{}^{7}$	29	55	13.24	407.6	89	56	10.63	285.1	39	15	51	219	15	43	⊡ $2\tfrac{1}{4}{}^{7}$	681.1
									267	13	19				Story S. H. Chy	

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation △'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	Meters.	° ′ ″	Meters.	° ′ ″	° ′ ″		Meters.
⊡ $2\frac{1}{4}7$	29 54 56.11	1,727.6	89 56 26.70	716.2	193 46 30		Stanton S. H. Cupola	
					119 36 00		Jarvin S. H	
⊡ $2\frac{1}{1}8$	29 53 46.36	1,427.4	89 53 26.84	720.1	73 41 42	253 41 28	⊡ $2\frac{1}{2}8$	803.4
					7 44 39		Poydras S. H	
⊡ $2\frac{1}{2}8$	29 53 39.03	1,201.7	89 53 55.58	1,491.2	165 41 34		Tile Works Chy	
⊡ $2\frac{1}{3}8$	29 53 22.60	695.8	89 54 33.20	890.9	83 30 01	263 29 47	⊡ $2\frac{1}{4}8$	765.2
					27 54 28		12 Mile Pt S. H	
					327 53 53		Poydras S. H	
⊡ $2\frac{1}{4}8$	29 53 19.79	609.3	89 55 01.53	41.1	57 38 45	237 38 28	△ Magnolia	1,083.1
					327 54 27		12 Mile Pt S. H	
					314 38 32		Poydras S. H	
P. B. M. 35	29 52 17.45	537.3	89 53 47.10	1,264.1				
P. B. M. 34	29 52 19.99	615.5	89 56 59.14	1,587.2	295 11 51	115 12 04	Orange Grove S. H	751.5
⊡ $2\frac{1}{1}2$	29 51 35.97	1,107.5	89 56 00.81	21.7	178 56 55	358 56 55	⊡ $2\frac{1}{2}2$	707.0
					139 27 49	319 27 33	Orange Grove S. H	1,362.6
					253 51 01		Poydras S. H	
⊡ $2\frac{1}{2}2$	29 51 58.92	1,814.1	89 56 01.29	34.6	110 38 22		Orange Grove S. H	932.5
⊡ $2\frac{1}{3}2$	29 52 33.64	1,035.7	89 55 54.16	1,453.3	210 35 33	30 35 42	△ Magnolia	977.3
					55 10 08		Orange Grove S. H	
					245 56 18		12 Mile Pt S. H	
⊡ $2\frac{1}{4}2$ = △ Magnolia	29 53 00.96	29.5	89 55 35.63	956.0	271 39 42	91 40 06	do	1,302.5
					296 40 09	116 41 06	Poydras S. H	3,421.1
⊡ $2\frac{2}{1}0$	29 52 03.56	1,096.0	89 57 40.84	109.6	118 33 18	298 33 05	⊡ $2\frac{2}{2}0$	792.3
					34 30 31		Scarsdale S. H	
					86 09 58		St. Clair S. H	
⊡ $2\frac{2}{2}0$	29 52 15.86	488.3	89 58 06.77	181.7	274 23 50		Orange Grove L. Rod	
					358 34 20		St. Clair S. H	
					42 34 32		Belle Chasse S. H	
⊡ $2\frac{2}{3}0$	29 52 27.48	844.5	89 58 38.86	1,029.5	116 05 53	296 05 46	⊡ $2\frac{2}{4}0$	450.7
					16 32 47		Belle Chasse S. H. Chy	
⊡ $2\frac{2}{4}0$	29 52 33.87	1,042.8	89 58 53.44	1,434.0	4 17 34		Belle Chasse S. H	
					307 46 58		St. Clair S. H	
P. B. M. 33	29 51 02.47	76.0	89 58 27.29	732.5	130 12 54		Belle Chasse	
					37 40 41		Scarsdale S. H	
P. B. M. 32	29 49 22.02	678.0	89 59 44.47	1,194.1	159 50 53		Concession Church	
⊡ $2\frac{2}{1}1$	29 49 49.44	1,522.2	89 58 54.53	1,464.0	177 50 33	357 50 33	△ Scarsdale	704.9
					119 30 03	299 29 51	△ $2\frac{2}{2}1$	747.6
					177 32 18		Belle Chasse Chy	
					190 29 43		Scarsdale S. H	
⊡ $2\frac{2}{2}1$	29 50 01.89	42.8	89 59 18.77	504.0	241 41 17	61 41 29	△ Scarsdale	708.9
					191 19 46		Belle Chasse Chy	
					215 42 56		Scarsdale S. H	

□ 221/3	29	50	19.01	585.3	89	59	51.80	1,390.7	116	00	44	296	00	30	□ 221/4	867.2
									214	20	09				Belle Chasse Chy	
									246	34	26				Sugar House	
□ 221/4	29	50	31.43	967.5	90	00	20.79	558.1	7	46	39	187	46	36	⊗ Concessions	1,144.4
									328	14	38				Concessions Cupola	
									260	53	49				Scarsdale S. H	
□ 222/1	29	47	28.49	877.2	89	59	50.64	1,360.8	108	31	52	288	31	38	□ 222/2	809.8
									62	57	35	242	57	08	P. B. M. 31	1,641.6
									39	58	33				Greenwood S. H	
									143	12	08				Lindwood Cupola	
□ 222/2	29	47	36.85	1,134.6	90	00	19.23	516.5	34	46	50				P. B. M. 31	
									358	44	01				Greenwood S. H	
									204	22	23				Lindwood Cupola	
□ 222/3	29	47	56.77	1,747.9	90	00	48.64	1,306.8	84	48	25	264	48	12	⊗ Cedar	722.6
									116	30	39	296	30	30	□ 222/4	560.4
									202	52	47				Oak Point S. H	
□ 222/4	29	48	04.89	150.6	90	01	07.31	196.3	34	39	36	214	39	32	⊗ Cedar	383.6
									232	15	17				Oak Point S. H	
P. B. M. 31	29	47	04.25	130.9	90	00	45.07	1,210.6	285	34	49				Greenwood S. H	
									211	33	59				Lindwood Cupola	
P. B. M. 30	29	44	28.84	488.0	89	59	45.93	1,234.4	330	59	08				Belair S. H	
									161	16	16				Fanny S. H	
□ 223/1	29	45	30.22	930.4	90	00	34.79	934.6	73	16	46	253	16	38	⊗ Berthoud	469.3
									77	42	44				Jesuit Church	
									113	41	54				Live Oak S. H	
□ 223/2 = ⊗ Berthoud	29	45	25.84	795.4	90	00	51.52	1,384.1	80	03	48	260	03	32	Jesuit Church	894.0
									124	36	12	304	35	47	Live Oak S. H	1,610.7
□ 223/3	29	45	07.24	222.9	90	01	18.75	503.8	74	16	28	254	16	15	□ 223/4	710.7
									160	24	11				Jesuit Church	
□ 223/4	29	45	00.98	30.2	90	01	44.21	1,187.9	221	12	36				Jesuit Church	
									183	01	51				Live Oak S. H	
									307	58	22				Union S. H	
P. B. M. 29	29	42	14.69	452.3	89	58	26.77	719.6	175	34	33	355	34	30	□ 224/1	
									24	26	39				Sugar House	
□ 224/1	29	43	29.65	912.9	89	58	33.41	897.9	63	26	11	243	25	57	□ 224/2	855.7
									82	00	58				Belair S. H	
□ 224/2	29	43	17.22	530.1	89	59	01.89	50.8	157	57	34				Belair S. H	
□ 224/3	29	43	18.42	567.1	89	59	37.80	1,010.0	1	27	58	181	27	57	⊗ Bayhi	1,132.5
									70	56	48	250	56	36	□ 224/4	680.0
									187	37	24				Star S. H	
□ 224/4	29	43	11.22	345.4	90	00	01.72	46.2	326	00	07	146	00	18	⊗ Bayhi	1,097.8
									172	03	29				Star S. H	
□ 225/1	29	41	21.60	665.0	89	57	17.94	482.4	63	35	50	243	35	38	□ 225/2	695.2
									355	41	49				Union S. H	
□ 225/2	29	41	11.55	355.6	89	57	41.11	1,105.3								
□ 225/3	29	40	58.58	1,803.6	89	58	13.99	376.2	69	43	55	249	43	40	□ 225/4	875.0
									265	49	26				St. Luke's Church	
									301	15	21				Union S. H	
									148	44	19				Alliance L. rod	
□ 225/4	29	40	48.73	1,500.3	89	58	44.51	1,196.8								
P. B. M. 28	29	39	45.69	1,406.8	89	57	19.98	537.3	188	15	35				Union S. H	

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation Ⓐ's.]

Name of station.	Latitude. ° ′ ″	Seconds.	Longitude. ° ′ ″	Seconds.	Azimuth. ° ′ ″	Back azimuth. ° ′ ″	To station.	Distance.
		Meters.		Meters.				Meters.
⊡ [illegible]	29 39 08.95	275.6	89 56 31.83	8561.	42 36 22	222 36 15	⊡ [illegible]	541.5
					29 56 02		Wilkinson's S. H	
					317 44 54		St. Joseph Church	
					317 05 32		St. John's Church	
⊡ [illegible]	29 38 56.01	1,724.5	89 56 45.46	1,222.8	22 35 48		Wilkinson's S. H	
					284 08 45		St. Joseph Church	
					273 06 20		St. John's Church	
⊡ [illegible]	29 38 31.63	973.9	89 56 59.15	1,590.9	30 06 20	210 06 16	⊡ [illegible]	463.8
⊡ [illegible]	29 38 18.60	572.7	89 57 07.80	209.8	219 44 36		Wilkinson's S. H	
P. B. M. 27	29 38 22.26	685.4	89 55 25.75	692.7	94 09 31		do	
⊡ [illegible]	29 37 45.64	1,405.5	89 54 06.09	163.8	30 24 47	210 24 43	⊡ [illegible]	454.0
					316 43 29	136 43 49	Bellevue chy	1,539.6
⊡ [illegible]	29 37 32.94	1,014.2	89 54 14.64	393.8	299 35 02	119 35 26	do	1,479.2
⊡ [illegible]	29 37 09.36	288.2	89 54 31.14	837.8	42 38 54	222 38 44	⊡ [illegible]	842.5
⊡ [illegible]	29 36 49.24	1,516.0	89 54 52.36	1,408.8	255 01 26		Bellevue chy	
P. B. M. 26	29 37 02.65	81.5	89 53 07.37	198.3	111 11 13	291 11 03	do	559.8
⊡ [illegible]	29 37 04.19	129.0	89 51 25.49	685.8	22 26 32	202 26 27	⊡ [illegible]	776.0
⊡ [illegible]	29 36 40.90	1,259.2	89 51 36.50	982.0	10 06 01	190 05 59	⊡ [illegible]	849.0
					321 23 37	141 23 58	Celeste chy	1,841.6
					49 53 42	229 53 24	Junior chy	1,286.1
⊡ [illegible]	29 36 13.75	428.1	89 51 42.03	1,131.0	24 18 14	204 18 08	⊡ [illegible]	749.5
					294 55 34	114 56 02	Celeste chy	1,431.4
					90 30 68	270 29 53	Junior chy	834.8
⊡ [illegible]	29 35 51.57	1,587.8	89 51 53.50	1,469.7	267 09 23	87 09 52	Celeste chy	1,608.5
P. B. M. 25	29 36 11.62	357.7	89 49 58.18	1,565.6				
⊡ [illegible]	29 35 34.28	1,055.4	89 48 26.55	714.5	24 07 39	204 07 33	⊡ [illegible]	869.2
					355 09 54		St. Thomas Church	776.4
					322 55 50		Court House	
⊡ [illegible]	29 35 12.04	370.7	89 48 37.95	1,021.4	283 25 33		St. Thomas Church	
⊡ [illegible]	29 34 46.28	1,424.9	89 48 52.58	1,415.1	119 36 07	299 35 46	Ⓐ Woodland	1,267.0
					28 28 29	208 28 22	⊡ [illegible]	761.2
					43 29 44		Old chimney	
					112 02 51		Woodland S. H	
⊡ [illegible]	29 34 24.54	755.6	89 49 06.06	163.1	150 17 49	330 17 35	Ⓐ Woodland	1,490.8
					140 54 05		Woodland S. H	
					58 11 46		Old chimney	
					219 24 59		St. Thomas Church	
					254 23 33		Court-house	
P. B. M. 23	29 34 16.13	496.6	89 46 57.08	1,535.1	0 27 41		Magnolia S. H	
					359 14 31		Tower	
					354 49 45		Tank	

⊡ $^{230}_{1}$	29 34 00.72	22.2	89 46 00.45	11.8	43 54 04	223 53 54	⊡ $^{232}_{3}$	749.2
					48 55 55		Tower	
					50 17 33		Tank	
					115 57 34		Court-house	
⊡ $^{230}_{2}$	29 33 43.19	1,329.8	89 46 19.75	531.6				
⊡ $^{229}_{3}$	29 33 22.05	678.9	89 46 51.88	1,396.7	52 57 07	232 56 49	⊡ $^{232}_{4}$	1,194.7
					44 41 36	224 41 34	Tower	161.7
					151 17 37		Court-house	
⊡ $^{230}_{4}$	26 32 58.67	1,806.4	89 47 37.30	734.9	303 26 24	123 26 49	Lower base (new position)	1,623.0
					165 10 26	345 10 15	◬ Upper base	2,238.3
					234 13 59		Tower	
					231 24 50		Tank	
					172 17 34		Court-house	
Lower base (new position.)	29 32 29.62	911.7	89 46 37.00	996.3	147 47 24	327 46 48	◬ Upper base	3,614.7
					161 01 59		Tower	
					112 02 45		do.	
P. B. M. 22	29 32 48.42	1,489.8	89 45 31.71	853.7	357 56 26		Gable of red house	
⊡ $^{231}_{1}$	29 32 30.03	924.6	89 43 46.42	1,249.7	323 09 31		St. Patricks Church	
⊡ $^{231}_{2}$	29 32 11.37	350.1	89 44 06.79	182.8	295 35 20		Gable of red house	
⊡ $^{231}_{3}$	29 31 45.30	1,394.7	89 44 22.60	608.5	38 20 05	218 20 00	⊡ $^{231}_{4}$	403.1
					124 42 32		Tower	
⊡ $^{231}_{4}$	29 31 33.50	1,031.4	89 44 33.27	895.8	127 55 30		Red house chimney	
⊡ $^{232}_{1}$	29 30 05.76	177.3	89 41 59.68	1,607.5	48 27 00	228 26 49	⊡ $^{232}_{3}$	816.6
					45 23 35		Chimney	
⊡ $^{232}_{3}$	29 29 48.17	1,483.1	89 42 22.86	602.8	40 11 15	220 11 05	⊡ $^{232}_{4}$	815.5
⊡ $^{232}_{4}$	29 29 27.93	860.0	89 42 41.90	1,128.8	307 26 58		St. Patricks Church	
					297 11 56		James Church	
P. B. M. 21	29 31 21.79	670.9	89 43 03.97	106.9	147 00 19		◬ Union	
					54 06 57		Chimney	
					150 52 42		Church gable	
P. B. M. 20	29 29 13.83	425.8	89 41 16.03	431.8	57 46 02		James Church	
P. B. M. 19	29 27 57.17	1,760.2	89 39 11.30	304.5				
⊡ $^{233}_{1}$	29 28 43.80	1,348.6	89 40 12.44	335.1	40 54 18	220 54 12	⊡ $^{233}_{2}$	463.0
					23 00 27	203 00 17	St. Patricks Church	1,414.9
⊡ $^{233}_{2}$	29 28 32.44	998.8	89 40 23.69	638.2	40 53 02	220 52 52	⊡ $^{233}_{3}$	870.0
					14 41 53	194 41 49	St. Patricks Church	984.7
⊡ $^{233}_{3}$	29 28 11.07	340.8	89 40 44.83	1,207.9	39 12 19	219 12 12	⊡ $^{233}_{4}$	573.9
					184 59 01		M. E. Church	
⊡ $^{233}_{4}$	29 27 56.47	1,738.7	89 40 58.44	1,574.6	257 16 51	77 17 04	St. Patricks Church	703.6
⊡ $^{234}_{2}$	29 27 50.00	1,539.4	89 37 29.01	781.6	119 03 18	299 03 16	Wesley Church	141.2
⊡ $^{234}_{3}$	29 27 15.80	486.5	89 37 35.28	950.8	2 20 05	182 20 05	⊡ $^{234}_{4}$	407.4
⊡ $^{234}_{4}$	29 27 02.58	79.4	89 37 35.90	967.5				
P. B. M. 18	29 27 12.65	389.5	89 36 16.74	451.1				
⊡ $^{235}_{2}$	29 25 30.06	925.5	89 36 04.98	134.2	90 07 47	270 07 32	⊡ $^{235}_{3}$	792.6
⊡ $^{235}_{3}$	20 25 30.11	927.1	89 36 34.38	926.7	68 40 43	248 40 35	⊡ $^{235}_{4}$	490.4
⊡ $^{235}_{4}$	29 25 24.32	748.8	89 36 51.38	1,383.8				
P. B. M. 17	29 24 30.72	945.8	89 35 55.83	1,505.1				
⊡ $^{236}_{1}$	29 23 41.98	1,292.5	89 34 52.65	1,419.5	37 56 32	217 56 27	⊡ $^{236}_{2}$	441.9
					85 07 41		Church spire	
⊡ $^{236}_{2}$	29 23 30.66	944.0	89 35 02.72	73.3	42 52 58	222 52 47	⊡ $^{236}_{3}$	897.8
					61 52 20		◬ Decker	966.2
					132 10 34	312 10 28	◬ Darkey	441.6

Stone line B. Ms., geographical positions, Donaldsonville to Head of Passes, Louisiana—Continued.

[Latitudes and longitudes are derived from C. and G. S. triangulation ◬'s.]

Name of station.	Latitude.	Seconds.	Longitude.	Seconds.	Azimuth.	Back azimuth.	To station.	Distance.
	° ′ ″	Meters.	° ′ ″	Meters.	° ′ ″	° ′ ″		Meters.
⊡ $\frac{236}{3}$	29 23 09.29	286.0	89 35 25.38	684.4				
P. B. M. 16	29 22 52.82	1,626.3	89 34 03.86	104.1	149 24 56	329 24 55	◬ Grand Prairie	116.3
⊡ $\frac{237}{3}$	29 22 18.91	582.2	89 32 37.73	1,017.6	18 02 12	198 02 07	⊡ $\frac{237}{3}$	897.9
					324 46 35	144 46 49	Buras Church	1,368.7
					259 01 21		◬ Quarantine	
⊡ $\frac{237}{3}$	29 21 51.19	1,576.1	89 32 48.03	1,295.4				
P. B. M. 14	29 21 41.54	1,279.0	89 30 47.22	1,273.5				
⊡ $\frac{238}{3}$	29 21 10.63	327.3	89 29 50.26	1,355.8	22 08 20	202 08 14	⊡ $\frac{238}{3}$	
⊡ $\frac{238}{3}$	29 20 44.67	1,375.3	89 30 02.32	62.6	133 34 14		◬ Quarantine	
P. B. M. 13	29 21 03.07	94.5	89 28 28.89	779.3	33 06 18	213 06 06	◬ Taylor	1,248.1
⊡ $\frac{232}{3}$	29 21 54.99	1,693.1	89 27 41.15	1,109.8	333 50 51	153 50 58	⊡ $\frac{232}{3}$	855.8
					180 21 45	0 21 45	NE. cor. Ft. St. Philip	1,132.5
					321 06 45	141 06 46	SE. cor. Ft. St. Philip	50.4
					69 05 10	249 05 04	Flagstaff Ft. St. Philip	350.4
⊡ $\frac{232}{3}$	29 21 30.04	924.9	89 27 27.16	732.5	168 59 01	348 58 55	NE. cor. Ft. St. Philip	
					132 23 19	312 23 06	Flagstaff Ft. St. Philip	953.9
Monument S. E. cor. Ft. St. Philip	29 21 53.72	1,654.0	89 27 39.98	1,078.3	334 38 32	154 38 38	⊡ $\frac{232}{3}$	
					178 48 32	358 48 32	NE. cor. Ft. St. Philip	1,171.8
					76 33 10	256 33 03	Flagstaff Ft. St. Philip	
Monument N. E. cor. Ft. St. Philip	29 22 31.77	978.1	89 27 40.88	1,102.4	14 53 28	194 53 22	do	
Monument southwest corner Fort Jackson	29 20 58.09	1,788.5	89 28 00.82	22.1	187 07 29		Flagstaff Fort St. Philip	
					198 10 37		Southeast corner Fort St. Philip.	
					196 50 51		⊡ $\frac{232}{3}$	
⊡ $\frac{240}{3}$	29 21 18.08	556.7	89 24 45.70	1,232.8				
⊡ $\frac{240}{3}$	29 20 50.26	1,547.4	89 25 03.45	93.1				
P. B. M. 8	29 19 55.79	1,717.7	89 23 52.53	1,417.3				
⊡ $\frac{241}{3}$	29 19 09.48	291.9	89 22 31.25	843.2	53 37 39	233 37 31	⊡ $\frac{241}{3}$	841.2
⊡ $\frac{241}{3}$	29 18 53.29	1,640.7	89 22 56.33	1,520.0				
P. B. M. 7	29 17 30.37	935.1	89 21 51.80	1,398.0				
⊡ $\frac{242}{3}$	29 16 57.99	1,785.5	89 20 43.43	1,172.3	41 46 56	221 46 42	⊡ $\frac{242}{3}$	1,059.1
					20 34 57		Jump Tower	
⊡ $\frac{242}{3}$	29 16 32.34	995.7	89 21 09.57	258.3	312 11 34		do	
P. B. M. 6	29 15 32.94	1,014.2	89 19 51.24	1,383.4				
⊡ $\frac{242}{3}$	29 15 02.23	68.7	89 18 29.16	787.3	49 43 52	229 43 40	⊡ $\frac{242}{3}$	838.5
⊡ $\frac{242}{3}$	29 14 44.63	1,374.1	89 18 52.85	1,427.1				
⊡ $\frac{244}{3}$	29 13 03.13	96.4	89 16 46.75	1,262.7	64 32 09	244 31 50	⊡ $\frac{244}{3}$	1,173.5
					333 54 49	153 54 58	◬ Quarantine	1,119.9
⊡ $\frac{244}{3}$	29 12 46.74	1,439.1	89 17 25.97	701.4	302 02 22		◬ North	
					287 53 31	107 53 55	◬ Quarantine	1,630.9
⊡ $\frac{245}{3}$	29 10 52.84	1,626.9	89 15 23.49	634.7	353 13 52		Head Passes Light	
					245 16 48	65 16 48	Pilots Tower	22.0
					63 21 32	243 21 08	⊡ $\frac{242}{3}$	1,469.6

⊡ 2§4	20	10	31.44	968.0	89	16	12.09	826.7	243	23	11	63	23	35	Pilots Tower	1,491.6
									179	17	11	359	17	09	△ North	2,939.6
									192	51	40	......			Fogbell Tower	......
									297	25	04	117	25	51	△ Cubits chy	2,931.3
P. B. M. 2	29	08	34.26	1,054.8	89	15	08.77	101.9	131	17	19	311	17	18	P. B. M. 1	60.6
P. B. M. 1	29	08	35.69	1,098.9	89	15	05.62	151.9	333	22	56	153	22	56	Head Passes Light	53.8
									178	29	16	358	29	08	⊡ 2§4	......
									178	46	26	......			Pilots Tower	......

APPENDIX 3 D.

REPORT OF ASSISTANT ENGINEER JAMES A. PAIGE ON PRECISE LEVELING BETWEEN HEAD OF PASSES AND DONALDSONVILLE, LA.

OFFICE MISSISSIPPI RIVER COMMISSION,
St. Louis, May 10, 1893.

SIR: I have the honor to report as follows on the precise leveling operations between the Head of Passes and New Orleans.

Your instructions were to run a line of precise levels from the gauge and other bench marks at the Head of Passes to New Orleans, and there connect with certain bench marks established by the Commission when the line of precise levels was run from Biloxi to Carrollton in 1862; the work to be done by two field-leveling parties equipped in the usual manner, and the necessary force to be quartered on the U. S. S. *Patrol*, Assistant Engineer A. T. Morrow in charge, who at the same time would make a certain survey between Head of the Passes and New Orleans.

I left St. Louis for New Orleans January 11, 1893, and reached the *Patrol* at Kennerville, La., January 12, in company with Assistant E. J. Thomas, Recorder W. S. Williams, and Rodmen Joseph Sheehan and H. M. Conradt. The remainder of the men were assigned from Mr. Morrow's force on the *Patrol*, who had at this time about completed his work to New Orleans, working southward from Donaldsonville.

After the necessary preparation the *Patrol* proceeded from New Orleans on January 17 and arrived at Fort Jackson the same evening, where she was delayed by high winds till the morning of January 20. The Head of Passes was reached that day at noon and the regular fieldwork began there the same evening. The work was completed to New Orleans and all connections made on March 15, 1893, and on the 16th, in company with Mr. Thomas, I returned to St. Louis. Subsequent to this time Mr. Thomas and myself have been engaged in making the office reduction of the season's notes. While the *Patrol* was lying at Fort Jackson a certain bench mark of the vitrified clay and iron-pipe pattern was established there and connections made with it. This is referred to hereafter and is designated in the tabulated results as "Experimental BM."

The leveling force consisted of two field parties organized the same as heretofore on this kind of work, and comprised for one party: James A. Paige, leveler; A. O. Wheeler, recorder; two rodmen; two tent and umbrella men. For the other party: E. J. Thomas, leveler; W. S. Williams, recorder; two rodmen; two tent and umbrella men; making twelve men in all.

The methods in the field operations were about the same as have been in use heretofore on this class of work. All lines were duplicated in a direction contrary to that of the first line run.

Each observer duplicated his own work.

The telescope was made level as indicated by the level vial when the rod was read. The order of the back and fore sight was alternated at the successive instrument stations.

Both foot plates and pins were used for rod supports.

The route of the level line was from the gauge at the head of South Pass westward across the head of Southwest Pass to the west bank; thence northward along the west bank of the river to Fort Jackson; thence across the river to Fort St. Phillip on the east bank; thence northward along the east bank of the river to New Orleans, where connections were made with U. S. P. B. Ms. 2 and 3 and B. M. City Stone, "Half-way House."

These three bench marks were in the line of precise levels executed under the Commission between Biloxi and Carrollton in 1882.

U. S. P. B. Ms. 2 and 3 were also connected with the line of precise levels between Mobile and Carrollton, executed by the U. S. Coast and Geodetic Survey in 1886.

For reference to these bench marks see report of the Mississippi River Commission for 1883, p. 129, also Appendix 9 U. S. Coast and Geodetic Survey Report for 1887.

From the Head of Passes to the Jump, a distance of 11¼ miles by the levels, the surface of the ground leveled over was from 8 to 30 inches above mean tide. The bank here on the west side has a fringe of timber and heavy undergrowth and is composed of vegetable mold and a river deposit of very fine material which, of course, in this part of the Mississippi Valley contains little or no sand. It holds the moisture well and in general presents poor conditions for precise leveling purposes. However, about 80 per cent of the turning points on this stretch consisted of nails in trees and stumps and the results are satisfactory. From the Jump to New Orleans the levels follow the levee and wagon road all the way and it was good ground to work over. Other conditions incidental to the work were tolerably favorable. The principal trouble during the first part of the season was the prevalence of fogs. The difficulty did not arise from interruption of work exactly, but from the sudden appearance of hot winds. If the fog was light work would be in progress and a hot wind appearing would instantly absorb the fog and change the temperature several degrees. This, of course, would change the refraction very suddenly. Great care had to be taken that the sights at an intrument station were taken under similar conditions in this respect.

The permanent bench marks established were of the pattern heretofore used by the Commission, vitrified clay slabs buried in the ground with a copper bolt leaded in the center, and over which is set an iron pipe 4 feet long and projecting from 6 to 18 inches above the surface of the ground. They were set about 3 miles apart and varying from 20 to 200 meters from the river. This, in view of the fact that there is very little change in this region due to caving banks, and also that a dry and solid foundation for the bench marks, was only found near the river front.

The stone-line bench marks which were also established during the progress of this survey, and of the same pattern as the precise level bench marks, were set about once in every 3 miles of river distance. A P. B. M. was set approximately midway between consecutive stone lines.

The bench marks of a permanent nature will thus average about 1½ miles apart.

The following is a summary of the bench marks established and connected with (not including the temporary bench marks set for the purpose of checking the work):

Precise bench marks established (vitrified clay and iron pipe)	32
Other precise bench marks established (of miscellaneous nature)	5
Other precise bench marks established (copper bolts in various structures)	9
Precise bench marks connected with (of former precise levels)	3
Ordinary level bench marks connected with (of former surveys)	6
Stone-line bench marks connected with	28
Water gauges connected with	3
Total	86

There has been considerable discussion of the stability of bench marks established in surveys of this kind. The sinking of the structure is a defect, more or less, of all forms of permanent bench marks except those established in the natural rock.

The pattern now used by the Commission appears to be the best yet devised when all questions are considered. It is within the possibilities that at some future time the line from New Orleans to the Passes may be releveled, with a view of investigating the question of the gradual subsidence or elevation of that part of the Mississippi Valley. We can assume if a settling of bench marks does occur that it will increase in amount going southward from New Orleans. This would be the supposition, considering the nature of the deposit and the decreasing elevation above the river. A small movement of the bench marks would thus vitiate the comparison of results with those of a line of precise levels run at some future period. In fact, it might lead to wrong conclusions altogether. Many of the precise bench marks established on this survey were set in soft mud even when the best locations were selected. They were always well rammed down and the earth well filled in before being observed to.

On January 18 a bench mark was set at Fort Jackson, about 18 inches beneath the surface of the ground. It was well rammed down in the mud and water and then connected with a reliable bench mark on a tree near by. The earth was then filled in over it. On February 3 it was again observed to before the earth over it was disturbed. On February 5 the earth was taken off and the bench mark again connected with. The results indicate that between the first and second observations, during which time the earth was filled in and sixteen days elapsed, the bench mark sank about 4.8 millimeters; and between the second and third observations, during which time the earth was removed and three days elapsed, that the bench mark rose about 3.8 millimeters.

The results of February 3 and 5 were hardly those expected. However, this is all right as far as it goes, but the experiment covered a period of only eighteen days.

From the weight of the bench mark and its area it is generally supposed that about all of the movement takes place shortly after being set—say, the first thirty days.

It would be interesting to compare the results now obtained with those of a similar line of levels run over the same ground at some future time.

Results.—The final reduction has been compared with the field computations, and a few unimportant errors found.

In the fieldwork the collimation of the wires and the inclination of the level vial were examined each day, and it was attempted to keep the adjustment errors close to zero. The inequality of telescope collars was determined twice during the season for each instrument. The aggregate of these errors constitute a correction to be applied to the excess in length of back or fore sights between consecutive bench marks. If the sum of these corrections for collimation, inclination, and pivot error amounted to one-tenth of a millimeter or more on any stretch the correction was applied in the office reduction. In the entire line there were nine cases where these corrections changed the final elevation of a bench mark by 0.1 of a millimeter or more. The greatest accumulated amount due to these corrections was at the end of the season and amounted to +0.7 millimeters; that is, if no corrections had been applied for adjustment errors the elevation of the last bench mark would have been seven-tenths of a millimeter less than the one now given.

These results show that the methods in use on this work render the adjustment errors of very little importance. The limit of discrepancy between two lines run between bench marks was $3^{mm}\sqrt{2K}$, K being the distance between bench marks in kilometers.

From the gauge at the head of South Pass to the bench mark at Metairie Cemetery New Orleans was a distance of: Main line 164.270 kilos, equal 102.09 miles; side lines 17.705 kilos, equal 11.00 miles; total 181.975 kilos, equal 113.09 miles. The probable error of the determination of the final bench mark was 8.9 millimeters. This gave a computed probable error per kilometer for the entire line of 0.69 millimeters.

An inspection of the results show a gradual divergence of the two lines. The total amount at New Orleans being 65.5 millimeters. This has no effect on the results, however, except to make the computed probable error somewhat too large.

When two lines were run between bench marks, if they agreed within the prescribed limits they were taken for the result for that stretch.

No extra lines were run for the purpose of reducing the probable error. There were two stretches run three times due to error in recording the notes, the back and fore sight being transposed.

Two stretches were run four times due to error in the field computations. Neglecting these cases we have the following summary from the tabulated results:

	No. of stretches.	Kilo meters.	Per cent of total lines.
Lines run four times	7	6.708	4.06
Lines run two times	145	157.562	95.94
Total	152	164.270	100.00

	No. of stretches.	Kilo-meters.	Per cent of total line.
Discrepancies exceeding $3^{mm}\sqrt{2K}$	7	6.708	4.08
Discrepancies within $3^{mm}\sqrt{2K}$	26	29.484	17.95
Discrepancies within $2^{mm}\sqrt{2K}$	54	58.849	35.82
Discrepancies within $1^{mm}\sqrt{2K}$	65	69.229	42.15
Total	152	164.270	100.00

There were three river crossings made by the reciprocal method and the results are as reliable as those on other parts of the line; the first was at the head of Southwest Pass between TBMs. 2 and 3. The second was across the Jump between TBMs. 24 A and 24 B, and the third at Forts Jackson and St. Phillip across the river between TBMs. 62 and 63.

The following are the instrumental constants:

	Date.	Value in seconds.	Corrections in millemeters per meter.
Level No. 2, telescope collar, eye end larger	Jan. 19, 1893	3.39	−0.0168
Do	Apr. 8, 1893	0.00	0.0000
Adopted value, Jan. 19 to Feb. 10, 1893			−0.0017
Adopted value, Feb. 11 to Mar. 15, 1893			−0.008
Level No. 5, telescope collar, eye end larger	Jan. 19, 1893	2.01	−0.0098
Level No. 5, telescope collar, eye end smaller	Apr. 8, 1893		+0.0145
Adopted value, Jan. 19 to Feb. 10, 1893			−0.010
Adopted value, Feb. 11 to Mar. 15, 1893			+0.002
Level vial, "Fauth," one division	Jan. 19, 1893	3.03	0.0147
Adopted value for the season			0.0147
Level vial Kern No. 5, one division, Jan. 19, 1893		2.14	0.0104
Adopted value for the season			0.0104

Level No. 2, Stadia interval: From January 19 to February 19, 1893, 4.286 millimeters intercepted on rod equal 1 meter; from February 20 to March 15, 1893, 4.224 millimeters intercepted on rod equal 1 meter.

Level No. 5, Stadia interval: For the entire season, 5.026 millimeters intercepted on rod equal 1 meter.

Rod 10, corrections for A — 55.3 millimeters.
Rod 13, corrections for A — 55.3 millimeters.
Rod 18, corrections for A — 55.8 millimeters.
Rod 19, corrections for A — 55.8 millimeters.

No rod correction has been applied as the range in elevation of the bench marks is so small the correction can be neglected. The rods have been taken at standard lengths.

In the tabulation of results the reductions have been made from the bench mark, City Stone "Halfway House" at Metairie Cemetery, New Orleans, to the gauge at the head of South Pass. This bench mark is the starting point, and its elevation is that given in the report of the Mississippi River Commission for 1883, p. 129, being 7.9870 meters referred to the Cairo datum plane.

Column 1 gives the consecutive bench marks in the order in which the various elevations were deduced.

Column 2 gives the distance of any bench mark under consideration from the starting point.

Column 3 gives the direction which the lines were run, N. being north and S. being south.

Column 4 gives the difference in elevation between the bench marks named in column 1; also the mean difference.

Column 5 gives the residuals found by subtracting each result from the mean result.

Column 6 gives the probable error in the result for each stretch.

Column 7 gives the probable error in the result for each permanent bench mark, when referred to the first bench mark or starting point.

Column 8 gives the elevation of the second bench mark named in column 1.

Column 9 gives the same data as column 8, but reduced to feet.

Column 10 indicates the observer, P. being for Paige, T. for Thomas, and W. for Williams.

In computing the probable error per kilometer (giving 0.69^{mm}) the theoretical assumption is that the various stretches are 1 kilometer in length each. The average length of the stretches is 1,074 meters.

In reference to the three bench marks in New Orleans which were in the line of precise levels of 1882 and which were connected with this Survey (1893).

For B. M. City Stone "Halfway House" at Metairie Cemetery and U. S. P. B. M. 2 at St. Johns Bayou, the two results for 1882 and 1893 differ by 0.7 millimeters, but from U. S. P. B. M. 2 to U. S. P. B. M. 3 at the Fair grounds the results differ by 8.2 millimeters. This indicates that U. S. P. B. M. 3 has settled about 8 millimeters, if the other two bench marks have remained as they were in 1882.

U. S. P. B. M. 3 is in a brick column 4 feet square and about 9 feet high. It was erected about 25 years ago or 14 years previous to the time P. B. M. 3 was established. An inspection of the three bench marks would lead one to regard them all equally reliable. Nothing could be learned as to the depth of foundation for this brick column.

As before stated, the reductions start with the 1882 elevation of B. M. City Stone "Halfway House" at Metairie Cemetery, as this was thought preferable to an adjustment of all the elevations of the three bench marks.

Assistant Thomas's duties in the field were much interfered with by bad health. I consider him a careful and skillful observer on this kind of work.

Respectfully submitted.

JAMES A. PAIGE,
Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A., Secretary.

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893.

By Assistant Engineers Jas. A. Paige and E. J. Thomas.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
Zero of South Pass Gauge	0.000						5.8292	19.125	
3.5 foot mark on gauge	0.000		+1.0668				6.8960	22.625	
3.5 foot mark on gauge to T. B. M. 1	0.144	N	+0.1240	+ 0.4					T.
		S	+0.1247	− 0.3					T.
		Mean.	+0.1244		0.2		7.0204	23.033	
T. B. M. 1 to B. M. in Lighthouse	0.157	N	+1.1232	+ 0.2					T.
		S	+1.1227	− 0.3					T.
		Mean.	+1.1234		0.2	0.3	8.1438	26.719	
T. B. M. 1 to P. B. M.	0.190	N	−0.5078	− 0.3					P.
		S	−0.5078	+ 0.3					P.
		Mean.	−0.5076		0.2	0.3	6.5128	21.368	
T. B. M. 1 to P. B. M. 1 A	0.100	N	+0.6972	+ 0.2					P.
		S	+0.6975	− 0.1					P.
		Mean.	+0.6974		0.1	0.2	7.7178	25.321	
T. B. M. 1 to 4-foot mark on old gauge	0.190	N	+0.0638	+ 0.4					P.
		S	+0.0645	− 0.3					P.
		Mean.	+0.0642		0.2		7.0846	23.244	
Zero of old gauge			−1.2192				5.8654	19.244	
B. M. in Lighthouse to P. B. M. 2	0.185	N	−0.1140	+ 0.8					P.
		S	−0.1123	− 0.9					P.
		Mean.	−0.1132		0.6	0.7	8.0306	26.347	
T. B. M. 1 to T. B. M. 2	0.269	N	+0.0945	− 0.1					P.
		S	+0.0942	+ 0.2					P.
		Mean.	+0.0944		0.1		7.1148	23.343	
T. B. M. 2 to T. B. M. 3	1.010	S	+0.1137						P.
		N	+0.1440						T.
		Mean.	+0.1288	− 0.8					
		N	+0.2029						P.
		S	+0.0515						T.
		Mean.	+0.1272	+ 0.8					
			+0.1280		0.5		7.2428	23.763	
T. B. M. 3 to T. B. M. 4	2.242	N	−0.4873	− 1.1					T.
		S	−0.4895	+ 1.1					T.
		Mean.	−0.4884		0.7		6.7544	22.160	
T. B. M. 4 to T. B. M. 5	2.946	N	+0.2033	+1.2					T.
		S	+0.2048	−0.3					T.
		N	+0.2053	−0.8					T.
		S	+0.2047	−0.2					T.
		Mean.	+0.2045		0.3		6.9589	22.831	
T. B. M. 5 to P. B. M. 3	2.961	N	−0.2555	+0.1					
		S	−0.2553	−0.1					
		Mean.	−0.2554		0.1	0.9	6.7035	21.993	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 5 to P. B. M. 3 A	2.961	N	+0.9438	−0.2					
		S	+0.9435	+0.1					
		Mean	+0.9436		0.1	0.9	7.9025	25.927	
T. B. M. 5 to T. B. M. 6	3.737	N	+0.0787	−0.9					P.
		S	+0.0769	+0.9					P.
		Mean	+0.0778		0.6		7.0367	23.087	
T. B. M. 6 to T. B. M. 7	4.547	N	+0.2406	+1.8					P.
		S	+0.2442	−1.8					P.
		Mean	+0.2424		1.2		7.2791	23.882	
T. B. M. 7 to T. B. M. 8	4.777	N	−0.0710	+0.2					P.
		S	−0.0707	−0.1					P.
		Mean	−0.0708		0.1		7.2083	23.650	
T. B. M. 8 to B. M. $\frac{2}{41}$ A	4.821	N	+0.1870	−0.2					P.
		S	+0.1865	+0.3					P.
		Mean	+0.1868		0.2	1.7	7.3951	24.262	
T. B. M. 8 to T. B. M. 9	5.596	N	+0.4190	−0.1					P.
		S	+0.4188	+0.1					P.
		Mean	+0.4189		0.1		7.6272	25.024	
T. B. M. 9 to T. B. M. 10	6.389	N	−0.6048	−1.1					P.
		S	−0.6070	+1.1					P.
		Mean	−0.6059		0.7		7.0213	23.036	
T. B. M. 10 to T. B. M. 11	6.861	N	+0.1650	−0.4					T.
		S	+0.1643	+0.3					T.
		Mean	+0.1646		0.2		7.1859	23.576	
T. B. M. 11 to P. B. M. 4	6.878	N	−0.4070	−0.2					T.
		S	−0.4073	+0.1					T.
		Mean	−0.4072		0.1	1.8	6.7787	22.240	
T. B. M. 11 to P. B. M. 4 A	6.878	N	+0.7950	−0.2					T.
		S	+0.7947	+0.1					T.
		Mean	+0.7948		0.1	1.8	7.9807	26.184	
T. B. M. 11 to T. B. M. 12	8.008	N	+0.0953	+4.5					T.
		S	+0.1021	−2.3					T.
		S	+0.1017	−1.9					T.
		N	+0.1000	−0.2					T.
		Mean	+0.0998		1.0		7.2857	23.903	
T. B. M. 12 to T. B. M. 13	8.800	N	+0.0853	−0.3					T.
		S	+0.0847	+0.3					T.
		Mean	+0.0850		0.2		7.3707	24.182	
T. B. M. 13 to T. B. M. 14	9.586	N	−0.0448	−1.8					T.
		S	−0.0483	+1.7					T.
		Mean	−0.0466		1.2		7.3241	24.029	
T. B. M. 14 to T. B. M. 15	10.257	N	−0.1619	+1.0					P.
		S	−0.1598	−1.1					P.
		Mean	−0.1609		0.7		7.1632	23.502	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 15 to T. B. M. 16...	10.815	N.....	+0.1329	+0.3					P.
		S.....	+0.1336	−0.4					P.
		Mean.	+0.1332		0.2		7.2964	23.939	
T. B. M. 16 to T. B. M. 17...	11.757	N.....	+0.2665	−0.4					P.
		S.....	+0.2657	+0.4					P.
		Mean.	+0.2661		0.3		7.5625	24.812	
T. B. M. 17 to P. B. M. 5....	11.778	N.....	−0.8135	+0.1					P.
		S.....	−0.8133	−0.1					P.
		Mean.	−0.8134		0.1	2.5	6.7491	22.143	
T. B. M. 17 to P. B. M. 5A...	11.778	N.....	+0.3953	0.0					P.
		S.....	+0.3953	0.0					P.
		Mean.	+0.3953		0.0	2.5	7.9578	26.108	
T. B. M. 17 to T. B. M. 18...	12.656	N.....	+0.1497	+0.7					P.
		S.....	+0.1512	−0.8					P.
		Mean.	+0.1504		0.5		7.7129	25.305	
T. B. M. 18 to T. B. M. 19...	13.750	N.....	−0.3209	−0.1					P.
		S.....	−0.3211	+0.1					P.
		Mean.	−0.3210		0.1		7.3919	24.252	
T. B. M. 19 to T. B. M. 20...	14.847	N.....	−0.0742	+1.1					P.
		S.....	−0.0721	−1.0					P.
		Mean.	−0.0731		0.7		7.3188	24.012	
T. B. M. 20 to T. B. M. 21...	15.410	N.....	+0.5198	−0.3					P.
		S.....	+0.5192	+0.3					P.
		Mean.	+0.5195		0.2		7.8383	25.716	
T. B. M. 21 to T. B. M. 22...	16.131	N.....	−0.3294	+0.8					P.
		S.....	−0.3378	−0.8					P.
		Mean.	−0.3386		0.5		7.4997	24.606	
T. B. M. 22 to P. B. M. 6....	16.178	N.....	−0.9368	+0.4					P.
		S.....	−0.9360	−0.4					P.
		Mean.	−0.9364		0.3	2.7	6.5633	21.533	
T. B. M. 22 to P. B. M. 6A..	16.178	N.....	+0.2702	+0.2					P.
		S.....	+0.2707	−0.3					P.
		Mean.	+0.2704		0.2	2.7	7.7701	25.493	
T. B. M. 22 to T. B. M. 23...	17.982	N.....	−0.1707	+1.8					T.
		S.....	−0.1672	−1.7					T.
		Mean.	−0.1689		1.2		7.3308	24.051	
T. B. M. 23 to T. B. M. 24...	18.616	N.....	+0.4073	−0.2					T.
		S.....	+0.4077	+0.2					T.
		Mean.	+0.4075		0.1		7.7383	25.388	
T. B. M. 24 to T. B. M. 24 A...	18.638	N.....	−0.2290	0.0					T.
		S.....	−0.2290	0.0					T.
		Mean.	−0.2290		0.0		7.5093	24.637	
T. B. M. 24 A to T. B. M. 24 B.	18.788	N.....	−0.1857						T.
		S.....	−0.1829						P.
		Mean.	−0.1843	−1.0					

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
	....	N.....	−0.1873	....	......	......	....	....	P.
		S.....	−0.1854	....	......	......	....	....	T.
		Mean.	−0.1863	+1.0	......	......	....	....	
			−0.1853	....	0.7	......	7.3240	24.029	
T. B. M. 24 B to T. B. M. 25...	19.011	N.....	+0.0356	+0.4	......	......	....	....	T.
		S.....	+0.0363	−0.3	......	......	....	....	T.
		Mean.	+0.0360	....	0.2	......	7.3600	24.147	
T. B. M. 25 to B. M. $^{2}J^{3}$.......	19.104	N.....	−0.3210	−0.4	......	......	....	....	T.
		S.....	−0.3217	+0.3	......	......	....	....	T.
		Mean.	−0.3214	....	0.2	3.1	7.0386	23.093	
T. B. M. 25 to B. M. $^{2}J^{3}$A.....	19.104	N.....	+0.8840	−0.5	......	......	....	....	T.
		S.....	+0.8830	+0.5	......	......	....	....	T.
		Mean.	+0.8835	....	0.3	3.1	8.2435	27.046	
T. B. M. 25 to T. B. M. 26.....	20.247	N.....	+0.3902	−0.4	......	......	....	....	T.
		S.....	+0.3893	+0.5	......	......	....	....	T.
		Mean.	+0.3898	....	0.3	......	7.7498	25.426	
T. B. M. 26 to T. B. M. 27.....	21.238	N.....	−0.6813	+0.1	......	......	....	....	P.
		S.....	−0.6812	0.0	......	......	....	....	P.
		Mean.	−0.6812	....	0.0	......	7.0686	23.191	
T. B. M. 27 to P. B. M. 7......	21.345	N.....	−0.3670	+0.4	......	......	....	....	P.
		S.....	−0.3663	−0.3	......	......	....	....	P.
		Mean.	−0.3666	....	0.2	3.1	6.7020	21.988	
T. B. M. 27 to P. B. M 7A	21.345	N.....	+0.8362	−0.1	......	......	....	....	P.
		S.....	+0.8360	+0.1	......	......	....	....	P.
		Mean.	+0.8361	....	0.1	3.1	7.9047	25.934	
T. B. M. 27 to T. B. M. 28.....	22.890	N.....	+0.3527	+0.9	......	......	....	....	P.
		S.....	+0.3544	−0.8	......	......	....	....	P.
		Mean.	+0.3536	....	0.6	......	7.4222	24.351	
T. B. M. 28 to T. B. M. 29.....	24.012	N.....	+0.3003	+2.0	......	......	....	....	T.
		S.....	+0.3043	−2.0	......	......	....	....	T.
		Mean.	+0.3023	....	1.3	......	7.7245	25.343	
T. B. M. 29 to T. B. M. 30.....	25.250	N.....	−0.1917	+1.6	......	......	....	....	P.
		S.....	−0.1886	−1.5	......	......	....	....	P.
		Mean.	−0.1901	....	1.0	......	7.5344	24.719	
T. B. M. 30 to T. B. M. 30A...	25.941	N.....	+0.5620	−0.4	......	......	....	....	T.
		S.....	+0.5560	+5.6	......	......	....	....	T.
		N.....	+0.5633	−1.7	......	......	....	....	T.
		S.....	+0.5652	−3.6	......	......	....	....	T.
		Mean.	+0.5616	....	1.2	......	8.0960	26.562	
T. B. M. 30A to T. B. M. 31...	26.846	N.....	−0.7032	+0.2	......	......	....	....	T.
		S.....	−0.7027	−0.3	0.2	......	7.3930	24.255	T.
		Mean.	−0.7030						
T. B. M. 31 to P. B. M. 8......	26.866	N.....	−0.4360	+0.2	......	......	....	....	T.
		S.....	−0.4357	−0.1	......	......	....	....	T.
		Mean.	−0.4358	....	0.1	3.8	6.9572	22.826	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 31 to P. B. M. 8A	26.866	N	+0.7687	+0.3					T.
		S	+0.7693	−0.3					T.
		Mean	+0.7690		0.2	3.8	8.1620	26.778	
T. B. M. 31 to T. B. M. 32	27.893	N	−0.0560	+0.4					T.
		S	−0.0552	−0.4					T.
		Mean	−0.0556		0.3		7.3374	24.073	
T. B. M. 32 to T. B. M. 33	28.554	N	+0.7338	+1.0					P.
		S	+0.7359	−1.1					P.
		Mean	+0.7348		0.7		8.0722	26.484	
T. B. M. 33 to T. B. M. 56	29.652	N	−0.6186	−1.4					P.
		S	−0.6215	+1.5					P.
		Mean	−0.6200		1.0		7.4522	24.450	
T. B. M. 56 to B. M. $\frac{2}{12}$	29.942	N	−0.6665	−0.5					P.
		S	−0.6675	+0.5					P.
		Mean	−0.6670		0.3	4.0	6.7852	22.261	
T. B. M. 56 to B. M. $\frac{2}{12}$A	29.942	N	+0.5313	−0.1					P.
		S	+0.5312	0.0					P.
		Mean	+0.5312		0.0	4.0	7.9834	26.192	
T. B. M. 56 to T. B. M. 57	30.510	N	+0.0342	+0.8					P.
		S	+0.0358	−0.8					P.
		Mean	+0.0350		0.5		7.4872	24.565	
T. B. M. 57 to T. B. M. 58	31.435	N	+0.5837	−0.9					P.
		S	+0.5820	+0.8					P.
		Mean	+0.5828		0.6		8.0700	26.477	
T. B. M. 58 to P. B. M. 9	31.450	N	−1.1320	−0.1					P.
		S	−1.1318	+0.1					P.
		Mean	−1.1319		0.1	4.1	6.9381	22.763	
T. B. M. 58 to P. B. M. 9A	31.450	N	+0.0725	−0.4					P.
		S	+0.0770	+0.4					P.
		Mean	+0.0721		0.3	4.1	8.1421	26.713	
T. B. M. 58 to T. B. M. 59	32.569	N	−0.9017	+0.5					T.
		S	−0.9007	−0.5					T.
		Mean	−0.9012		0.3		7.1688	23.520	
T. B. M. 59 to T. B. M. 60	33.727	N	+0.6350	+0.5					T.
		S	+0.6360	−0.5					T.
		Mean	+0.6355		0.3		7.8043	25.605	
T. B. M. 60 to 7-foot mark, Fort Jackson gauge	33.898	N	+0.2000	−0.8					P.
		S	+0.1983	+0.9					P.
		Mean	+0.1992		0.6	4.1	8.0035	26.258	
Zero of Fort Jackson gauge	33.898		−2.1335				5.8700	19.258	
T. B. M. 60 to B. M. in hospital	33.860	N	−0.1680	−1.3					P.
		S	−0.1706	+1.3					P.
		Mean	−0.1693		0.9	4.2	7.6350	25.049	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		Meters.	Mm.	Mm.	Mm.	Meters.	Feet.	
T. B. M. 60 to B. M. in ordnance sergeant's quarters.	33.833	N.....	+0.0430	−0.2					P.
		S.....	+0.0433	+0.1					P.
		Mean.	+0.0432		0.1	4.1	7.8175	25.747	
T. B. M. 60 to T. B. M. 10 ...	33.759	N.....	−0.2657	−0.1					P.
		S.....	−0.2660	+0.2					P.
		Mean.	−0.2658		0.1	4.1	7.5385	24.733	
T. B. M. 60 to T. B. M. 61	34.264	N.....	−0.0943	+0.7					P.
		S.....	−0.0930	−0.6					P.
		Mean.	−0.0936		0.4		7.7107	25.298	
T. B. M. 61 to Experimental B. M	34.325	N.....	−1.0640	Jan...	18.				P.
		S.....	−1.0642	Jan...	18.				P.
		N.....	−1.0697	Feb...	3.				P.
		S.....	−1.0683	Feb...	3.				P.
		N.....	−1.0652	Feb...	5.				P.
		Mean.	−1.0663				6.6444	21.799	
T. B. M. 60 to B. M. $^{2}_{3}{}^{2}$	33.795	N.....	−0.8667	−0.1					T.
		S.....	−0.8670	+0.2					T.
		Mean.	−0.8668		0.1	4.1	6.9375	22.761	
T. B. M. 60 to B. M. $^{2}_{3}{}^{2}$	33.795	N.....	+0.3383	+0.7					T.
		S.....	+0.3397	−0.7					T.
		Mean.	+0.3390		0.5	4.1	8.1433	26.717	
T. B. M. 60 to T. B. M. 62....	33.908	N.....	+0.4930	0.0					T.
		S.....	+0,4930	0.0					T.
		Mean.	+0.4930		0.0		8.2973	27.222	
T. B. M. 62 to T. B. M. 63.....	34.638	N.....	−0.0849						T.
		S.....	−0.1065						T.
		Mean.	−0.0957	−0.7					
		N.....	−0.0727						P.
		S.....	−0.1214						P.
		Mean.	−0.0970	+0.6					
			−0.0964		0.4		8.2009	26.906	
T. B. M. 63 to B. M. $^{2}_{3}{}^{2}$	34.871	N.....	−1.0486	−0.3					P.
		S.....	−1.0492	+0.3					P.
		Mean.	−1.0489		0.2	4.1	7.1520	23.465	
B. M. $^{2}_{3}{}^{2}$ to P. B. M. 11.......	34.926	N.....	+0.7200	−0.2					P.
		S.....	+0.7196	+0.2					P.
		Mean.	+0.7198		0.1	4.1	7.8718	25.826	
P. B. M. 11 to B. M. $^{2}_{3}{}^{2}$ A....	34.961	N.....	+0.4877	+0.1					P.
		S.....	+0.4880	−0.2					P,
		Mean.	+0.4878		0.1	4.1	8.3596	27.427	
T. B. M. 63 to P. B. M. 12.....	34.802	N.....	+0.0392	−0.2					P.
		S.....	+0.0389	+0.1					P.
		Mean.	+0.0390		0.1	4.1	8.2399	27.034	
T. B. M. 63 to T. B. M. 64....	35.507	N.....	−0.3658	+0.7					P.
		S.....	−0.3644	−0.7					P.
		Mean.	−0.3651		0.5		7.8358	25.708	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	v.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 64 to T. B. M. 65	36.643	N	−0.3637	+1.7					P.
		S	−0.3603	−1.7					P.
		Mean	−0.3620		1.1		7.4738	24.521	
T. B. M. 65 to P. B. M. 13	36.656	N	−0.1240	0.0					P.
		S	−0.1241	+0.1					P.
		Mean	−0.1240		0.0	4.3	7.3498	24.114	
T. B. M. 65 to P. B. M. 13 A	36.656	N	+1.0867	+0.4					P.
		S	+1.0859	−0.4					P.
		Mean	+1.0863		0.3	4.3	8.5601	28.065	
T. B. M. 65 to T. B. M. 66	37.464	N	+0.0427	−0.3					T.
		S	+0.0422	+0.2					T.
		Mean	+0.0424		0.2		7.5162	24.660	
T. B. M. 66 to T. B. M. 67	38.514	N	+0.4707	+1.1					T.
		S	+0.4730	−1.2					T.
		Mean	+0.4718		0.8		7.9880	26.208	
T. B. M. 67 to T. B. M. 68	38.118	N	+0.3057	+1.5					T.
		S	+0.3087	−1.5					T.
		Mean	+0.3072		1.0		8.2952	27.215	
T. B. M. 68 to B. M. $\frac{212}{J}$	39.131	N	−1.3438	−0.4					T.
		S	−1.3445	+0.3					T.
		Mean	−1.3442		0.2	4.5	6.9510	22.805	
T. B. M. 68 to B. M. $\frac{212}{J}$ A	39.131	N	−0.1438	0.0					T.
		S	−0.1437	−0.1					T.
		Mean	−0.1438		0.0	4.5	8.1554	26.757	
T. B. M. 68 to T. B. M. 69	39.930	N	−0.4701	+3.7					T.
		S	−0.4653	−1.1					T.
		N	−0.4645	−1.9					T.
		S	−0.4657	−0.7					T.
		Mean	−0.4664		0.8		7.8288	25.685	
T. B. M. 69 to T. B. M. 70	40.845	N	−0.2643	+3.9					T.
		S	−0.2590	−1.4					W.
		N	−0.2602	−0.2					W.
		S	−0.2583	−2.1					W.
		Mean	−0.2604		0.9		7.5684	24.831	
T. B. M. 70 to P. B. M. 14	40.928	N	−0.8133	0.0					W.
		S	−0.8133	0.0					W.
		Mean	−0.8133		0.0	4.6	6.7551	22.163	
T. B. M. 70 to P. B. M. 14 A	40.928	N	+0.3913	0.0					W.
		S	+0.3913	0.0					W.
		Mean	+0.3913		0.0	4.6	7.9597	26.115	
T. B. M. 70 to T. B. M. 71	41.304	N	+0.0115	+0.5					W.
		S	+0.0125	−0.5					W.
		Mean	+0.0120		0.3		7.5804	24.870	
T. B. M. 71 to T. B. M. 72	42.444	N	+0.2063	−0.1					P.
		S	+0.2061	+0.1					P.
		Mean	+0.2062		0.1		7.7866	25.547	

Result of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 72 to P. B. M. 15	42.478	N	+0.2449	−0.3					P.
		S	+0.2455	+0.3					P.
		Mean	+0.2452		0.2	4.6	8.0318	26.351	
T. B. M. 72 to T. B. M. 73	44.110	N	−0.3668	−0.2					P.
		S	−0.3672	+0.2					P.
		Mean	−0.3670		0.1		7.4196	24.343	
T. B. M. 73 to B. M. ${}^{2}_{3}{}^{7}$	44.176	N	−0.5097	−0.1					P.
		S	−0.5100	+0.2					P.
		Mean	−0.5098		0.1	4.6	6.9098	22.670	
T. B. M. 73 to B. M. ${}^{2}_{3}{}^{7}$ A	44.176	N	+0.6925	+0.4					P.
		S	+0.6933	−0.4					P.
		Mean	+0.6929		0.3	4.6	8.1125	26.616	
T. B. M. 73 to T. B. M. 74	46.741	N	+0.4699	−1.9					P.
		S	+0.4661	+1.9					P.
		Mean	+0.4680		1.3		7.8876	25.878	
T. B. M. 74 to P. B. M. 16	46.752	N	−0.9542	+0.4					P.
		S	−0.9533	−0.5					P.
		Mean	−0.9538		0.3	4.8	6.9338	22.749	
T. B. M. 74 to P. B. M. 16 A	46.752	N	+0.2531	−0.5					P.
		S	+0.2520	+0.6					P.
		Mean	+0.2526		0.4	4.8	8.1402	26.707	
T. B. M. 74 to T. B. M. 75	47.898	N	−0.1597	+0.9					P.
		S	−0.1580	−0.8					P.
		Mean	−0.1588		0.6		7.7288	25.357	
T. B. M. 75 to T. B. M. 77	48.741	N	−0.0655	+0.5					P.
		S	−0.0646	−0.4					P.
		Mean	−0.0650		0.3		7.6638	25.144	
T. B. M. 77 to B. M. ${}^{2}_{3}{}^{8}$	48.756	N	−0.9427	−0.1					P.
		S	−0.9429	+0.1					P.
		Mean	−0.9428		0.1	4.9	6.7210	22.051	
T. B. M. 77 to B. M. ${}^{2}_{3}{}^{6}$ A	48.756	N	+0.2630	−0.2					P.
		S	+0.2626	+0.2					P.
		Mean	+0.2628		0.1	4.9	7.9266	26.006	
T. B. M. 77 to T. B. M. 77 A	49.844	N	−0.4680	+0.6					P.
		S	−0.4667	−0.7					P.
		Mean	−0.4674		0.4		7.1964	23.610	
T. B. M. 77 A to T. B. M. 78	51.094	N	+0.5823	+0.6					P.
		S	+0.5835	−0.6					P.
		Mean	+0.5829		0.4		7.7793	25.523	
T. B. M. 78 to P. B. M. 17	51.109	N	−1.1355	+0.1					W.
		S	−1.1353	−0.1					W.
		Mean	−1.1354		0.1	4.9	6.6439	21.798	
T. B. M. 78 to P. B. M. 17 A	51.109	N	+0.0720	0.0					W.
		S	+0.0720	0.0					W.
		Mean	+0.0720		0.0	4.9	7.8513	25.759	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 78 to T. B. M. 79	52.055	N	+0.0458	—0.9					W.
		S	+0.0440	+0.9					W.
		Mean	+0.0449		0.6		7.8242	25.670	
T. B. M. 79 to T. B. M. 80	52.948	N	—0.1826	+0.6					W.
		S	—0.1813	—0.7					W.
		Mean	—0.1820		0.4		7.6422	25.073	
T. B. M. 80 to B. M. $^{2}{}_{3}{}^{5}$	53.019	N	—0.8130	—0.2					W.
		S	—0.8133	+0.1					W.
		Mean	—0.8132		0.1	4.9	6.8290	22.405	
T. B. M. 80 to B. M. $^{2}{}_{1}{}^{5}$ A	53.019	N	+0.3972	—0.4					W.
		S	+0.3965	+0.3					W.
		Mean	+0.3968		0.2	4.9	8.0390	26.375	
T. B. M. 80 to T. B. M. 81	54.363	N	+0.0743	+2.1					W.
		S	+0.0785	—2.1					W.
		Mean	+0.0764		1.4		7.7186	25.324	
T. B. M. 81 to T. B. M. 82	56.293	N	—0.1675	+2.7					W.
		S	—0.1622	—2.6					W.
		Mean	—0.1648		1.8		7.5538	24.783	
T. B. M. 82 to P. B. M. 18	56.353	N	—0.8610	—0.2					W.
		S	—0.8615	+0.3					W.
		Mean	—0.8612		0.2	5.4	6.6926	21.958	
T. B. M. 82 to P. B. M. 18 A	56.353	N	+0.3475	+0.1					W.
		S	+0.3477	—0.1					W.
		Mean	+0.3476		0.1	5.4	7.9014	25.923	
T. B. M. 82 to T. B. M. 83	56.955	N	+0.5575	0.0					W.
		S	+0.5575	0.0					W.
		Mean	+0.5575		0.0		8.1113	26.612	
T. B. M. 83 to T. B. M. 84	58.584	N	+0.0060	—0.6					W.
		S	+0.0048	+0.6					W.
		Mean	+0.0054		0.4		8.1167	26.630	
T. B. M. 84 to B. M. $^{2}{}_{1}{}^{6}$	58.650	N	—1.1613	+0.1					W.
		S	—1.1610	—0.2					W.
		Mean	—1.1612		0.1	5.5	6.9555	22.820	
T. B. M. 84 to B. M. $^{2}{}_{1}{}^{6}$ A	58.650	N	+0.0503	—0.1					W.
		S	+0.0502	0.0					W.
		Mean	+0.0502		0.0	5.5	8.1669	26.795	
T. B. M. 84 to T. B. M. 85	60.060	N	—0.2313	+1.8					T.
		S	—0.2248	—4.7					T.
		N	—0.2343	+4.8					T.
		S	—0.2275	—2.0					T.
		Mean	—0.2295		1.4		7.8872	25.877	
T. B. M. 85 to Ⓐ White	60.258	N	+0.2433	+0.2					T.
		S	+0.2437	—0.2	0.1	5.6	8.1307	26.676	T.
		Mean	+0.2435						

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

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Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 85 to T. B. M. 86	61.486	N	−0.0563	+0.1					T.
		S	−0.0562	0.0	0.0		7.8310	25.692	T.
		Mean	−0.0562						
T. B. M. 86 to P. B. M. 19		N	−0.2090	0.0					T.
		S	−0.2090	0.0	0.0	5.6	7.6220	25.007	T.
		Mean	−0.2090						
T. B. M. 86 to P. B. M. 19 A	61.524	N	+1.0000	0.0					T.
		S	+1.0000	0.0	0.0	5.6	8.8310	28.973	T.
		Mean	+1.0000						
T. B. M. 86 to T. B. M. 87	62.514	N	+0.1528	−0.8					P.
		S	+0.1513	+0.7	0.5		7.9830	26.191	P.
		Mean	+0.1520						
T. B. M. 87 to T. B. M. 88	63.917	N	+0.3498	+2.5					P.
		S	+0.3548	−2.5	1.7		8.3353	27.347	P.
		Mean	+0.3523						
T. B. M. 88 to T. B. M. 89	65.571	N	−0.2433	−0.1					P.
		S	−0.2434	0.0	0.0		8.0919	26.548	P.
		Mean	−0.2434						
T. B. M. 89 to P. B. M. 20	65.629	N	−1.0382	−0.2					P.
		S	−1.0385	+0.1	0.1	5.9	7.0535	23.142	P.
		Mean	−1.0384						
T. B. M. 89 to P. B. M. 20 A	65.629	N	+0.1633	+1.3					P.
		S	+0.1660	−1.4	0.9	6.0	8.2565	27.088	P.
		Mean	+0.1646						
T. B. M. 89 to T. B. M. 90	65.891	N	−0.2130	0.0					P.
		S	−0.2130	0.0	0.0		7.8789	25.850	P.
		Mean	−0.2130						
T. B. M. 90 to T. B. M. 91	66.560	N	+0.2204	−0.9					P.
		S	+0.2186	+0.9	0.6		8.0984	26.570	P.
		Mean	+0.2195						
T. B. M. 91 to T. B. M. 92	67.836	N	+0.4150	−1.7					P.
		S	+0.4116	+1.7	1.1		8.5117	27.921	P.
		Mean	+0.4133						
T. B. M. 92 to B. M. ^{232}	68.036	N	−1.6830	0.0					P.
		S	−1.6831	+0.1	0.0	6.0	6.8287	22.404	P.
		Mean	−1.6830						
T. B. M. 92 to B. M. ^{232} A	68.036	N	−0.4780	0.0					P.
		S	−0.4780	0.0	0.0	6.0	8.0337	26.358	P.
		Mean	−0.4780						
T. B. M. 92 to T. B. M. 93	69.140	N	−0.3902	−0.8					T.
		S	−0.3918	+0.8	0.5		8.1297	26.643	T.
		Mean	−0.3910						
T. B. M. 93 to T. B. M. 94	70.664	N	+0.2622	−0.4					T.
		S	+0.2613	+0.5					T.
		Mean	+0.2618		0.3		8.3825	27.502	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

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Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 94 to P. B. M. 21	70.691	N	—1.3988	0.0					P.
		S	—1.3988	0.0					P.
		Mean	-1.3988		0.0	6.1	6.9837	22.913	
T. B. M. 94 to P. B. M. 21 A	70.691	N	—0.1930	0.0					P.
		S	—0.1929	—0.1					P.
		Mean	—0.1930		0.0	6.1	8.1895	26.869	
T. B. M. 94 to ⓐ Union	71.199	N	—9.5414	0.0					P.
		S	—0.5415	+0.1					P.
		Mean	—0.5414		0.0	6.1	7.8411	25.726	
T. B. M. 94 to T. B. M. 95	71.679	N	—0.1153	+0.6					P.
		S	—0.1141	—0.6					P.
		Mean	—0.1147		0.4		8.2678	27.126	
T. B. M. 95 to T. B. M. 96	72.945	N	—0.0986	—0.2					P.
		S	—0.0991	+0.3					P.
		Mean	—0.0988		0.2		8.1690	26.801	
T. B. M. 96 to B. M. $^{2}_{J}{}^{1}$	73.070	N	—1.2730	+0.2					P.
		S	—1.2725	—0.3					P.
		Mean	—1.2728		0.2	6.1	6.8962	22.626	
T. B. M. 96 to B. M. $^{2}_{J}{}^{1}$ A	73.070	N	—0.0670	—0.6					P.
		S	—0.0682	+0.6					P.
		Mean	—0.0676		0.4	6.1	8.1014	26.580	
T. B. M. 96 to T. B. M. 97	74.537	N	+0.0972	—0.3					P.
		S	+0.0966	+0.3					P.
		Mean	+0.0969		0.2		8.2659	27.119	
T. B. M. 97 to T. B. M. 100	75.871	N	+0.3839	—0.5					P.
		S	+0.3830	+0.4					P.
		Mean	+0.3834		0.3		8.6493	28.377	
T. B. M. 100 to P. B. M. 22	75.897	N	—1.1960	+0.2					T.
		S	—1.1957	—0.1					T.
		Mean	—1.1958		0.1	6.1	7.4535	24.454	
T. B. M. 100 to P. B. M. 22 A	75.897	N	+0.0140	—0.2					T.
		S	+0.0137	+0.1					T.
		Mean	+0.0138		0.1	6.1	8.6631	28.422	
T. B. M. 100 to T. B. M. 101	76.787	N	—0.6387	—1.1					T.
		S	—0.6410	+1.2					T.
		Mean	—0.6398		0.8		8.0095	26.278	
T. B. M. 101 to T. B. M. 102	77.989	N	—0.3292	—1.2					T.
		S	—0.3317	+1.3					T.
		Mean	—0.3304		0.8		7.6791	25.194	
T. B. M. 102 to B. M. $^{2}_{J}{}^{9}$	78.069	N	—0.8153	—0.2					T.
		S	—0.8157	+0.2					T.
		Mean	—0.8155		0.1	6.2	6.8636	22.519	
T. B. M. 102 to B. M. $^{2}_{J}{}^{9}$ A	78.069	N	+0.3930	+0.2					T.
		S	+0.3933	—0.1					T.
		Mean	+0.3932		0.1	6.2	8.0723	26.484	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 102 to T. B. M. 103	79.512	N	+0.2878	−2.0					T.
		S	+0.2837	+2.1					T.
		Mean	+0.2858		1.4		7.9649	26.132	
T. B. M. 103 to P. B. M. 23	79.532	N	−0.9190	+0.2					T.
		S	−0.9187	−0.1					T.
		Mean	−0.9188		0.1	6.4	7.0461	23.117	
T. B. M. 103 to P. B. M. 23 A	79.532	N	+0.2920	0.0					T.
		S	+0.2920	0.0					T.
		Mean	+0.2920		0.0	6.4	8.2569	27.090	
T. B. M. 103 to T. B. M. 104	80.614	N	+0.3348	+1.2					T.
		S	+0.3372	−1.2					T.
		Mean	+0.3360		0.8		8.3009	27.234	
T. B. M. 104 to P. B. M. 24	81.087	N	+1.1713	−1.1					T.
		S	+1.1692	+1.0					T.
		Mean	+1.1702		0.7	6.4	9.4711	31.073	
P. B. M. 24 to T. B. M. 105	83.475	N	−1.0815	+0.4					P.
		S	−1.0808	−0.3					P.
		Mean	−1.0811		0.2		8.3900	27.526	
T. B. M. 105 to T. B. M. 106	82.878	N	−0.7468	+0.6					T.
		S	−0.7457	−0.5					T.
		Mean	−0.7462		0.4		7.6438	25.078	
T. B. M. 106 to B. M. $^{2}J^{2}$	82.880	N	−0.5848	+0.2					T.
		S	−0.5843	−0.3					T.
		Mean	−0.5846		0.2	6.5	7.0592	23.160	
T. B. M. 106 to B. M. $^{2}J^{2}$ A	82.889	N	+0.6207	0.0					T.
		S	+0.6207	0.0					T.
		Mean	+0.6207		0.0	6.5	8.2645	27.115	
T. B. M. 106 to T. B. M. 107	84.064	N	−0.1430	+0.8					T.
		S	−0.1413	−0.9					T.
		Mean	−0.1422		0.6		7.5016	24.612	
T. B. M. 107 to T. B. M. 108	85.789	N	+0.2587	+1.5					T.
		S	+0.2617	−1.5					T.
		Mean	+0.2602		1.0		7.7618	25.465	
T. B. M. 108 to P. B. M. 25	85.879	N	−0.8233	−0.1					P.
		S	−0.8235	+0.1					P.
		Mean	−0.8234		0.1	6.6	6.9384	22.764	
T. B. M. 108 to P. B. M. 25 A	85.879	N	+0.3838	−0.4					P.
		S	+0.3845	+0.3					P.
		Mean	+0.3842		0.2	6.6	8.1460	26.726	
T. B. M. 108 to T. B. M. 109	87.331	N	+0.4406	+1.1					P.
		S	+0.4428	−1.1					P.
		Mean	+0.4417		0.7		8.2035	26.915	
T. B. M. 109 to T. B. M. 110	88.131	N	+0.2456	−0.2					P.
		S	+0.2460	+0.2					P.
		Mean	+0.2458		0.1		8.4493	27.721	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 110 to T. B. M. 111 ..	88.679	N.....	−0.3839	+0.6					P.
		S	−0.3827	−0.6					P.
		Mean .	−0.3833	....	0.4	......	8.0660	26.463	
T. B. M. 111 to B. M. $^{2}\frac{3}{3}{}^{8}$*.....	88.708	N.....	−0.7773	−0.2					T.
		S	−0.7777	+0.2					T.
		Mean .	−0.7775	....	0.1	6.6	7.2885	23.913	
T. B. M. 111 to B. M. $^{2}\frac{3}{3}{}^{8}$ A...	88.708	N.....	+0.4323	0.0					T.
		S	+0.4323	0.0					T.
		Mean .	+0.4323	....	0.0	6.6	8.4983	27.882	
T. B. M. 111 to T. B. M. 112 ..	90.095	N.....	−0.0066	+2.0					P.
		S	−0.0027	−1.9					P.
		Mean .	−0.0046	....	1.3	......	8.0614	26.448	
T. B. M. 112 to T. B. M. 113..	91.231	N.....	+0.8473	+1.5					P.
		S	+0.8504	−1.6					P.
		Mean .	+0.8488	....	1.0	......	8.9102	29.233	
T. B. M. 113 to P. B. M. 26...	91.259	N.....	−1.5283	−0.2					T.
		S	−1.5287	+0.2					T.
		Mean .	−1.5285	....	0.1	6.8	7.3817	24.218	
T. B. M. 113 to P. B. M. 26 A..	91.259	N.....	−0.3180	0.0					T.
		S	−0.3180	0.0					T.
		Mean .	−0.3180	....	0.0	6.8	8.5922	28.190	
T. B. M. 113 to T. B. M. 114...	93.277	N.....	−0.7800	+0.8					T.
		S	−0.7783	−0.9					T.
		Mean .	−0.7792	....	0.6	......	8.1310	26.677	
T. B. M. 114 to B. M. $^{2}\frac{3}{3}{}^{1}$	93.328	N.....	−1.0870	+0.2					T.
		S	−1.0867	−0.1					T.
		Mean .	−1.0868	....	0.1	6.8	7.0442	23.111	
T. B. M. 114 to B. M. $^{2}\frac{3}{3}{}^{1}$ A...	93.328	N.....	+0.1250	−0.5					T.
		S	+0.1240	+0.5					T.
		Mean .	+0.1245	....	0.3	6.8	8.2555	27.085	
T. B. M. 114 to T. B. M. 115...	94.250	N.....	−0.0370	+0.5					T.
		S	−0.0360	−0.5					T.
		Mean .	−0.0365	....	0.3	......	8.0945	26.557	
T. B. M. 115 to T. B. M. 116...	95.040	N.....	−0.1403	+0.3					T.
		S	−0.1397	−0.3					T.
		Mean .	−0.1400	....	0.2	......	7.9545	26.098	
T. B. M. 116 to T. B. M. 119...	95.823	N.....	+0.1526	−0.2					T.
		S	+0.1540	−1.2					T.
		S	+0.1517	+1.1					T.
		Mean .	+0.1528	....	0.3	......	8.1073	26.599	
T. B. M. 119 to P. B. M. 27....	95.886	N.....	−0.8280	+0.3					P.
		S	−0.8274	−0.3					P.
		Mean .	−0.8277	....	0.2	6.9	7.2796	23.883	
T. B. M. 119 to P. B. M. 27 A..	95.886	N.....	+0.3804	−0.1					P.
		S	+0.3802	+0.1					P.
		Mean .	+0.3803	....	0.1	6.9	8.4876	27.847	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 119 to T. B. M. 120...	97.246	N.....	−0.0916	+0.5	......	......	....	....	P.
		S	−0.0906	−0.5	......	......	....	....	P.
		Mean .	−0.0911	....	0.3	......	8.0162	26.300	
T. B. M. 120 to T. B. M. 121...	98.300	N.....	+0.2825	−1.0	......	......	....	....	P.
		S	+0.2805	+1.0	......	......	....	....	P.
		Mean	+0.2815	....	0.7	......	8.2977	27.224	
T. B. M. 121 to B. M. $\frac{2}{12}$	98.399	N.....	−0.6460	−0.5	......	......	....	....	P.
		S	−0.6470	+0.5	......	......	....	....	P.
		Mean .	−0.6465	....	0.3	6.9	7.6512	25.103	
T. B. M. 121 to B. M. $\frac{2}{12}$ A...	98.399	N.....	+0.5583	−0.3	......	......	....	....	P.
		S	+0.5577	+0.3	......	......	....	....	P.
		Mean .	+0.5580	....	0.2	6.9	8.8557	29.054	
T. B. M. 121 to T. B. M. 122...	100.111	N.....	−0.7270	−0.4	......	......	....	....	P.
		S	−0.7279	+0.5	......	......	....	....	P.
		Mean .	−0.7274	....	0.3	......	7.5703	24.837	
T. B. M. 122 to P. B. M. 28....	100.168	N.....	−1.0280	0.0	......	......	....	....	P.
		S	−1.0280	0.0	......	......	....	....	P.
		Mean .	−1.0280	....	0.0	6.9	6.5423	21.464	
T. B. M. 122 to P. B. M. 28 A .	100.168	N.....	+0.1797	0.0	......	......	....	....	P.
		S	+0.1797	0.0	......	......	....	....	P.
		Mean .	+0.1797	....	0.0	6.9	7.7500	25.427	
T. B. M. 122 to T. B. M. 123...	100.859	N.....	+0.1764	−1.6	......	......	....	....	P.
		S	+0.1731	+1.7	......	......	....	....	P.
		Mean .	+0.1748	....	1.1	......	7.7451	25.411	
T. B. M. 123 to T. B. M. 124...	103.003	N.....	+0.9976	+2.2	......	......	....	....	P.
		S	+1.0021	−2.3	......	......	....	....	P.
		Mean .	+0.9998	....	1.5	......	8.7449	28.691	
T. B. M. 124 to B. M. $\frac{2}{15}$......	103.073	N.....	−1.3042	−0.3	......	......	....	....	P.
		S	−1.3048	+0.3	......	......	....	....	P.
		Mean .	−1.3045	....	0.2	7.2	7.4404	24.411	
T. B. M. 124 to B. M. $\frac{2}{15}$ A...	103.073	N.....	−0.0912	+0.4	......	......	....	....	P.
		S	−0.0905	−0.3	......	......	....	....	P.
		Mean .	−0.0908	....	0.2	7.2	8.6541	28.393	
T. B. M. 124 to T. B. M. 125...	103.651	N.....	−0.4243	−0.9	......	......	....	....	T.
		S	−0.4260	+0.8	......	......	....	....	T.
		Mean .	−0.4252	....	0.6	......	8.3197	27.296	
T. B. M. 125 to T. B. M. 126...	104.501	N.....	−0.5370	+1.4	......	......	....	....	T.
		S	−0.5340	−1.6	......	......	....	....	T.
		S	−0.5357	+0.1	......	......	....	....	T.
		Mean .	−0.5356	....	0.6	......	7.7841	25.539	
T. B. M. 126 to T. B. M. 127...	105.308	N.....	+0.3177	−1.5	......	......	....	....	T.
		S	+0.3137	+2.5	......	......	....	....	T.
		N.....	+0.3180	−1.8	......	......	....	....	T.
		S	+0.3153	+0.9	......	......	....	....	T.
		Mean .	+0.3162	....	0.7	......	8.1003	26.576	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

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Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 127 to P. B. M. 29....	105.352	N.....	−1.1323	0.0	......	......	....	....	T.
		S.....	−1.1323	0.0	......	......	....	....	T.
		Mean.	−1.1323	....	0.0	7.2	6.9680	22.861	
T. B. M. 127 to P. B. M. 29 A.	105.352	N.....	+0.0743	0.0	......	......	....	....	T.
		S.....	+0.0743	0.0	......	......	....	....	T.
		Mean.	+0.0743	....	0.0	7.2	8.1746	26.819	
T. B. M. 127 to T. B. M. 128...	106.465	N.....	−0.4297	+0.4	......	......	....	....	T.
		S.....	−0.4290	−0.3	......	......	....	....	T.
		Mean.	−0.4293	....	0.2	......	7.6710	25.168	
T. B. M. 128 to T. B. M. 129...	107.582	N.....	+0.1170	−0.2	......	......	....	....	T.
		S.....	+0.1167	+0.1	......	......	....	....	T.
		Mean.	+0.1168	....	0.1	......	7.7878	25.551	
T. B. M. 129 to B. M. $\frac{24}{J}$......	107.705	N.....	−0.8803	0.0	......	......	....	....	T.
		S.....	−0.8803	0.0	......	......	....	....	T.
		Mean.	−0.8803	....	0.0	7.2	6.9075	22.663	
T. B. M. 129 to B. M. $\frac{24}{J}$ A...	107.705	N.....	+0.3257	+0.4	......	......	....	....	T.
		S.....	+0.3265	−0.4	......	......	....	....	T.
		Mean.	+0.3261	....	0.3	7.2	8.1139	26.621	
T. B. M. 129 to T. B. M. 130...	108.363	N.....	+0.4017	+0.1	......	......	....	....	T.
		S.....	+0.4019	−0.1	......	......	....	....	T.
		Mean.	+0.4018	....	0.1	......	8.1896	26.869	
T. B. M. 130 to T. B. M. 131...	109.915	N.....	+0.6217	+1.5	......	......	....	....	T.
		S.....	+0.6247	−1.5	......	......	....	....	T.
		Mean.	+0.6232	....	1.0	......	8.8128	28.914	
T. B. M. 131 to P. B. M. 30....	110.085	N.....	−1.5897	+0.5	......	......	....	....	P.
		S.....	−1.5882	−0.5	......	......	....	....	P.
		Mean.	−1.5892	....	0.3	7.3	7.2236	23.700	
T. B. M. 131 to P. B. M. 30 A.	110.085	N.....	−0.3820	−0.5	......	......	....	....	P.
		S.....	−0.3830	+0.5	......	......	....	....	P.
		Mean.	−0.3825	....	0.3	7.3	8.4303	27.659	
T. B. M. 131 to T. B. M. 132...	111.648	N.....	+0.0985	−1.7	......	......	....	....	P.
		S.....	+0.0950	+1.8	......	......	....	....	P.
		Mean.	+0.0967	....	1.2	......	8.9095	29.231	
T. B. M. 132 to Ⓐ Berthoud = B. M. $\frac{22}{J}$...............	112.518	N.....	+0.0590	+0.1	......	......	....	....	P.
		S.....	+0.0592	−0.1	......	......	....	....	P.
		Mean.	+0.0591	....	0.1	......	8.9686	29.425	
Ⓐ Berthoud to T. B. M. 133..	113.735	N.....	+0.5510	−1.8	......	......	....	....	P.
		S.....	+0.5473	+1.9	......	......	....	....	P.
		Mean.	+0.5492	....	1.2	......	9.5178	31.227	
T. B. M. 133 to T. B. M. 134...	114.733	N.....	−0.0463	−0.5	......	......	....	....	P.
		S.....	−0.0472	+0.4	......	......	....	....	P.
		Mean.	−0.0468	....	0.3	......	9.4710	31.073	
T. B. M. 134 to T. B. M. 135...	115.615	N.....	−1.1237	+1.5	......	......	....	....	T.
		S.....	−1.1207	−1.5	......	......	....	....	T.
		Mean.	−1.1222	....	1.0	......	8.3488	27.391	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

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Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 135 to P. B. M. 81	115.770	N	−1.4337	+0.2					T.
		S	−1.4333	−0.2					T.
		Mean	−1.4335		0.1	7.6	7.9153	22.688	
T. B. M. 135 to P. B. M. 81 A	115.770	N	−0.2280	0.0					T.
		S	−0.2280	0.0					T.
		Mean	−0.2280		0.0	7.6	8.1208	26.643	
T. B. M. 135 to T. B. M. 136	116.954	N	−0.0423	−1.0					T.
		S	−0.0443	+1.0					T.
		Mean	−0.0433		0.7		8.3055	27.249	
T. B. M. 136 to T. B. M $\frac{232}{3}$	117.102	N	−1.1837	+0.5					P.
		S	−1.1827	−0.5					P.
		Mean	−1.1832		0.3	7.6	7.1223	23.367	
T. B. M. 136 to B. M. $\frac{232}{3}$A	117.102	N	+0.0223	+0.5					P.
		S	+0.0233	−0.5					P.
		Mean	+0.0228		0.3	7.6	8.3283	27.324	
T. B. M. 136 to T. B. M. 137	118.416	N	+1.4551	−2.1					P.
		S	+1.4508	+2.2½					P.
		Mean	+1.4530		1.4		9.7585	32.016	
T. B. M. 137 to T. B. M. 138	120.439	N	−0.5439	−0.2					P.
		S	−0.5443	+0.2					P.
		Mean	−0.5441		0.1		9.2144	30.231	
T. B. M. 138 to P. B. M. 82	120.461	N	−0.7073	+0.3					T.
		S	−0.7067	−0.3					T.
		Mean	−0.7070		0.2	7.7	8.5074	27.912	
T. B. M. 138 to P. B. M. 82 A	120.461	N	+0.5043	−0.3					T.
		S	+0.5037	+0.3					T.
		Mean	+0.5040		0.2	7 7	9.7184	31.885	
T. B. M. 138 to T. B. M. 139	121.981	N	−1.3190	0.0					T.
		S	−1.3190	0.0					T.
		Mean	−1.3190		0.0		7.8954	25.904	
T. B. M. 139 to B. M. $\frac{231}{3}$	122.125	N	−0.2605	−0.5					P.
		S	−0.2614	+0.4					P.
		Mean	−0.2610		0.3	7.7	7.6344	25.047	
T. B. M. 139 to B. M. $\frac{231}{3}$ A	122.125	N	+0.9457				8.8411	29.006	P.
T. B. M. 139 to T. B. M. 140	123.298	N	+0.7078	−0.9					P.
		S	+0.7096	−0.9					P.
		Mean	+0.7087		0.6		8.6041	28.229	
T. B. M. 140 to T. B. M. 141	124.265	N	+1.0569	+0.9					P.
		S	+1.0586	−0.8					P.
		Mean	+1.0578		0.6		9.6619	31.699	
T. B. M. 141 to P. B. M. 83	124.447	N	−2.1782	+0.2					T.
		S	−2.1777	−0.3					T.
		Mean	−2.1780		0.2	7.8	7.4839	24.554	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 141 to P. B. M. 33 A..	124.447	N.....	−0.9713	+0.1					T.
		S	−0.9712	0.0					T.
		Mean .	−0.9712		0.0	7.8	8.6907	28.513	
T. B. M. 141 to T. B. M. 142...	125.503	N.....	+0.2025	−0.9					P.
		S	+0.2006	+1.0					P.
		Mean .	+0.2016		0.6		9.8635	32.361	
T. B. M. 142 to T. B. M. 143...	126.679	N.....	−0.4390	+0.6					P.
		S	−0.4379	−0.5					P.
		Mean .	−0.4384		0.4		9.4251	30.923	
T. B. M. 143 to B. M. $^{2}_{j}{}^{0}$	126.739	N.....	−1.1985	0.0					P.
		S	−1.1986	+0.1					P.
		Mean .	−1.1985		0.0	7.8	8.2266	26.990	
T. B. M. 143 to B. M. $^{2}_{j}{}^{0}$ A ...	126.739	N.....	+0.0089	−0.1					P.
		S	+0.0088	0.0					P.
		Mean .	+0.0088		0.0	7.8	9.4339	30.951	
T. B. M. 143 to T. B. M. 144...	129.052	N.....	−1.3087	+2.0					P.
		S	−1.3047	−2.0					P.
		Mean .	−1.3067		1.3		8.1184	26.635	
T. B. M. 144 to P. B. M. 34....	129.089	N.....	−0.8960	+0.8					P.
		S	−0.8943	−0.9					P.
		Mean .	−0.8952		0.6	7.9	7.2232	23.698	
T. B. M. 144 to P. B. M. 34 A..	129.089	N.....	+0.3080	+0.5					P.
		S	+0.3070	−0.5					P.
		Mean .	+0.3075		0.3	7.9	8.4259	27.644	
T. B. M. 144 to T. B. M. 145...	130.178	N.....	+0.5000	+1.0					P.
		S	+0.5021	−1.1					P.
		Mean .	+0.5010		0.7		8.6194	28.279	
T. B. M. 145 to T. B. M. 146...	131.046	N....	−0.5083	−1.7					P.
		S	−0.5117	+1.7					P.
		Mean .	−0.5100		1.1		8.1094	26.606	
T. B. M. 146 to B. M. $^{2}_{j}{}^{2}$	131.174	N.....	−0.7643	−0.2					T.
		S	−0.7647	+0.2					T.
		Mean .	−0.7645		0.1	8.0	7.3449	24.098	
T. B. M. 146 to B. M. $^{2}_{j}{}^{2}$ A ...	131.174	N.....	+0.4393	−0.3					T.
		S	+0.4387	+0.3					T.
		Mean .	+0.4390		0.2	8.0	8.5484	28.046	
T. B. M. 146 to T. B. M. 147...	132.724	N.....	−0.1717	+2.5					T.
		S	−0.1667	−2.5					T.
		Mean .	−0.1692		1.7		7.9402	26.051	
T. B. M. 147 to T. B. M. 148...	134.527	N.....	+1.0477	+0.5					T.
		S	+1.0487	−0.5					T.
		Mean .	+1.0482		0.3		8.9884	29.490	
T. B. M. 148 to P. B. M. 35....	134.961	N.....	−1.7560	+0.2					T.
		S	−1.7557	−0.1					T
		Mean .	−1.7558		0.1	8.2	7.2326	23.729	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
P. B. M. 35 to P. B. M. 35 A...	134.961	N	+1.2037	−0.5	......	......	....	....	T.
		S	+1.2027	+0.5	......	......	....	....	T.
		Mean.	+1.2032	....	0.3	8.2	8.4358	27.677	
T. B. M. 148 to T. B. M. 149...	135.757	N.....	+0.1094	−1.0	......	......	....	....	P.
		S	+0.1074	+1.0	......	......	....	....	P.
		Mean.	+0.1084	....	0.7	......	9.0968	29.845	
T. B. M. 149 to T. B. M. 150...	137.200	N.....	−0.3678	−0.1	......	......	....	....	P.
		S	−0.3680	+1.0	......	......	....	....	P.
		Mean.	−0.3679	....	0.1	......	8.7289	28.638	
T. B. M. 150 to B. M. $^{2}{}_{1}{}^{9}$......	137.394	N.....	−1.5625	+0.4	......	......	....	....	P.
		S	−1.5617	−0.4	......	......	....	....	P.
		Mean.	−1.5621	....	0.3	8.2	7.1668	23.513	
T. B. M. 150 to B. M. $^{2}{}_{1}{}^{2}$ A ...	137.394	N.....	−0.3543	−0.6	......	......	....	....	P.
		S	−0.3555	+0.6	......	......	....	....	P.
		Mean.	−0.3549	....	0.4	8.3	8.3740	27.474	
T. B. M. 150 to T. B. M. 151...	138.219	N.....	+0.8119	−0.1	......	......	....	....	P.
		S	+0.8118	0.0	......	......	....	....	P.
		Mean.	+0.8118	....	0.0	......	9.5407	31.302	
T. B. M. 151 to T. B. M. 152...	139.243	N.....	−0.4455	−1.3	......	......	....	....	P.
		S	−0.4482	+1.4	......	......	....	....	P.
		Mean.	−0.4468	....	0.9	......	9.0939	29.836	
T. B. M. 152 to P. B. M. 36....	139.529	N.....	−1.6537	−0.1	......	......	....	....	T.
		S	−1.6540	+0.2	......	......	....	....	T.
		Mean.	−1.6538	....	0.1	8.3	7.4401	24.410	
T. B. M. 152 to P. B. M. 36 A..	139.529	N.....	−0.4510	−0.2	......	......	....	....	T.
		S	−0.4513	+0.1	......	......	....	....	T.
		Mean.	−0.4512	....	0.1	8.3	8.6427	28.356	
T. B. M. 152 to T. B. M. 153...	140.555	N.....	−0.5563	−0.7	......	......	....	....	T.
		S	−0.5577	+0.7	......	......	....	....	T.
		Mean.	−0.5570	....	0.5	......	8.5369	28.008	
T. B. M. 153 to T. B. M. 154...	141.658	N.....	+0.0473	+1.0	......	......	....	....	T.
		S	+0.0493	−1.0	......	......	....	....	T.
		Mean.	+0.0483	....	0.7	......	8.5852	28.167	
T. B. M. 154 to T. B. M. 155...	142.261	N.....	+0.6353	−0.3	......	......	....	....	T.
		S	+0.6347	+0.3	......	......	....	....	T.
		Mean.	+0.6350	....	0.2	......	9.2202	30.250	
T. B. M. 155 to B. M. $^{2}{}_{1}{}^{7}$......	142.300	N.....	−1.4600	0.0	......	......	....	....	T.
		S	−1.4600	0.0	......	......	....	....	T.
		Mean.	−1.4600	....	0.0	8.3	7.7602	25.460	
T. B. M. 155 to B. M. $^{2}{}_{1}{}^{7}$ A...	142.300	N.....	−0.2570	0.0	......	......	....	....	T.
		S	−0.2570	0.0	......	......	....	....	T.
		Mean.	−0.2570	....	0.0	8.3	8.9632	29.407	
T. B. M. 155 to T. B. M. 156...	143.226	N.....	+0.1597	−0.2	......	......	....	....	T.
		S	+0.1593	+0.2	......	......	....	....	T.
		Mean.	+0.1595	....	0.1	......	9.3797	30.774	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 156 to T. B. M. 157	145.044	N	−0.0150	+2.2					T.
		S	−0.0107	+2.1					T.
		Mean	−0.0128		1.4		9.3669	30.732	
T. B. M. 157 to P. B. M. 37	145.139	N	−0.7823	+0.1					T.
		S	−0.7820	−0.2					T.
		Mean	−0.7822		0.1	8.5	8.5847	28.165	
T. B. M. 157 to P. B. M. 37 A	145.139	N	+0.4170	+0.2					T.
		S	+0.4173	−0.1					T.
		Mean	+0.4172		0.1	8.5	9.7841	32.100	
T. B. M. 157 to T. B. M. 157 A	145.809	N	+0.2160	+1.5					T.
		S	+0.2190	−1.5					T.
		Mean	+0.2175		1.0		9.5844	31.445	
T. B. M. 157 A. to T. B. M. 158	146.550	N	−0.0950	+1.2					T.
		S	−0.0920	−1.8					T.
		N	−0.0957	+1.9					T.
		S	−0.0927	−1.1					T.
		Mean	−0.0938		0.6		9.4906	31.137	
T. B. M. 158 to T. B. M. 159	147.416	N	+0.0493	+0.5					T.
		S	+0.0503	−0.5					T.
		Mean	+0.0498		0.3		9.5404	31.301	
T. B. M. 159 to B. M. $\frac{21}{8}$	147.759	N	−1.1268	+0.4					P.
		S	−1.1261	−0.3					P.
		Mean	−1.1264		0.2	8.5	8.4140	27.605	
T. B. M. 159 to T. B. M. 160	148.199	N	−0.4599	+0.7					P.
		S	−0.4586	−0.6					P.
		Mean	−0.4592		0.4		9.0812	29.794	
T. B. M. 160 to T. B. M. 161	149.335	N	+0.5696	+2.0					P.
		S	+0.5737	−2.1					P.
		Mean	+0.5716		1.4		9.6528	31.670	
T. B. M. 161 to T. B. M. 162	150.457	N	+1.5484	+1.0					P.
		S	+1.5505	−1.1					P.
		Mean	+1.5494		0.7		11.2022	36.753	
T. B. M. 162 to T. B. M. 163	150.802	N	−0.8793	0.0					P.
		S	−0.8793	0.0					P.
		Mean	−0.8793		0.0		10.3229	33.868	
T. B. M. 163 to P. B. M. 38	150.912	N	−0.8032	−0.3					P.
		S	−0.8038	+0.3					P.
		Mean	−0.8035		0.2	8.7	9.5194	31.232	
T. B. M. 163 to T. B. M. 164	152.393	N	−3.0972	+0.6					P.
		S	−3.0959	−0.7					P.
		Mean	−3.0966		0.4		7.2263	23.709	
T. B. M. 164 to T. B. M. 165	153.248	N	+0.2542	−2.9					P.
		S	+0.2495	+1.8					P.
		N	+0.2504	+0.9					P.
		S	+0.2513	0.0					P.
		Mean	+0.2513		0.7		7.4776	24.533	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench mark.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 165 to B. M. 214 A	153.689	N	+0.2220	+0.7					P.
		S	+0.2234	−0.7					P.
		Mean	+0.2227		0.5	8.7	7.7003	25.264	
T. B. M. 165 to T. B. M. 166	154.536	N	−0.1006	−0.1					P.
		S	−0.1008	+0.1					P.
		Mean	−0.1007		0.1		7.3769	24.203	
T. B. M. 166 to P. B. M. 39	155.208	N	+0.4083	+1.0					T.
		S	+0.4103	−1.0					T.
		Mean	+0.4093		0.7	8.8	7.7862	25.546	
T. B. M. 166 to T. B. M. 167	156.025	N	−0.1237	+1.2					T.
		S	−0.1213	−1.2					T.
		Mean	−0.1225		0.8		7.2544	23.801	
T. B. M. 167 to T. B. M. 168	156.769	N	+0.1190	+0.2					T.
		S	+0.1193	−0.1					T.
		Mean	+0.1192		0.1		7.3736	24.192	
T. B. M. 168 to P. B. M. 40	156.780	N	+1.2562	−0.3					T.
		S	+1.2556	+0.3					T.
		Mean	+1.2559		0.2	8.8	8.6295	28.312	
T. B. M. 168 to T. B. M. 169	157.983	N	−0.6730	+0.2					T.
		S	−0.6727	−0.1					T.
		Mean	−0.6728		0.1		6.7008	21.984	
T. B. M. 169 to P. B. M. 41	157.998	N	−0.1727	0.0					T.
		S	−0.1727	0.0					T.
		Mean	−0.1727		0.0	8.8	6.5281	21.418	
T. B. M. 169 to T. B. M. 171	158.795	N	+0.9027	−1.3					T.
		S	+0.9000	+1.4					T.
		Mean	+0.9014		0.9	8.8	7.6022	24.942	
T. B. M. 171 to T. B. M. 172	160.153	N	−0.3317	+0.7					T.
		S	−0.3303	−0.7					T.
		Mean	−0.3310		0.5		7.2712	23.856	
T. B. M. 172 to P. B. M. 42	160.201	N	+0.3553	−0.1					P.
		S	+0.3550	+0.2					P.
		Mean	+0.3552		0.1	8.8	7.6264	25.021	
T. B. M. 172 to P. B. M. 43	162.486	N	+2.9362	−0.8					P.
		S	+2.9347	+0.7					P.
		Mean	+2.9354		0.5	8.8	10.2066	33.486	
T. B. M. 169 to T. B. M. 170	159.095	N	−0.0837	−0.5					T.
		S	−0.0847	+0.5					T.
		Mean	−0.0842		0.3		6.6166	21.708	
T. B. M. 170 to T. B. M. 175	160.416	N	+0.3793	+0.5					T.
		S	+0.3803	−0.5					T.
		Mean	+0.3798		0.3		6.9964	22.954	
T. B. M. 175 to U. S. P. B. M. 3 of 1882	160.816	N	+0.6702	−0.8					P.
		S	+0.6687	+0.7					P.
		Mean	+0.6694		0.5	8.8	7.6658	25.150	

Results of precise leveling, New Orleans, La., to South Pass, La., January 13, 1893, to March 15, 1893—Continued.

[In these reductions the value of 1 meter is 3.2808693 feet.]

Bench marks.	Distance.	Direction.	Difference of elevation.	V.	r.	R.	Elevation above Cairo datum.		Observer.
	Km.		*Meters.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	
T. B. M. 175 to U. S. P. B. M. 2 of 1882	161.746	N	+2.1633	−1.1	......	......	....	....	P.
		S	+2.1610	+1.2	......	......	....	....	P.
		Mean .	+2.1622	....	0.8	8.9	9.1586	30.048	
U. S. P. B. M. 2 of 1882 to B. M. City Stone "Halfway House"	164.270	N	−1.1700	−1.6	......	......	....	....	P.
		S	−1.1732	+1.6	......	......	....	....	P.
		Mean .	−1.1716	....	1.1	8.9	7.9870	26.204	

DESCRIPTIONS AND ELEVATIONS OF PRECISE BENCH MARKS BETWEEN THE HEAD OF THE PASSES AND NEW ORLEANS, LA.

NOTE.—Elevations are given in meters and feet above Cairo datum plane. To reduce to mean gulf level at Biloxi, Miss., subtract 21.26 feet (preliminary value) from the elevations here given. These bench marks were established in 1893. One meter=3.2808693 feet. The term "P. B. M." denotes a precise bench mark which is set with special care so as to be practically permanent. In most cases a P. B. M. consists of a vitrified tile 18 inches by 18 inches by 4 inches, in the center of which is set vertically with lead a ½-inch copper bolt, the upper end being about flush with the upper surface of the tile. Surrounding the bolt on the surface of the tile is the inscription, "Mississippi River Commission, U. S. P. B. M., 1892." This is buried in the ground from 18 to 40 inches beneath the surface, the depth varying with the nature of the material. On top of the tile a 4-inch wrought-iron gas pipe 4 feet long is set concentric with the copper bolt; the lower end of the pipe, which is expanded somewhat like a boiler tube, fitting in a circular groove molded in the tile. A cast-iron cap fits over the top of the pipe and is fastened thereto with bronze bolts. The elevation of the top of the cup is also determined. The structure has thus two bench marks. P. B. M. 16, for example, being the top of the copper bolt, and P. B. M. 16 A being the top of the cap on the pipe. Other P. B. Ms. consist of copper bolts or well-defined marks in brick and stone buildings and masonry structures.

The term "T. B. M." denotes a temporary bench mark whose elevation is as well determined as that of a P. B. M., but is not regarded permanent. They consist of nails and spikes in roots of trees or stakes driven in the ground. They were established to obtain comparisons of results about once in every kilometer.

U. S. Engineers' gauge is a vertical board gauge fastened to foundation post of boat-house on west side at head of South Pass, La., and 140 meters northeastward from Head of Passes Light-House.

Elevation of zero, 5.8292 meters. 19.125 feet.

Old gauge is the remains of a vertical board gauge, standing about 100 meters from edge of water and 50 meters northwestward from the Head of Passes Light-House and about 15 meters west of fence on west side of light-house yard. No facts could be obtained relative to when this gauge was established and under whose direction it was maintained. Judging from its location and condition it has been abandoned many years.

Elevation of zero, 5.8654 meters. 19.244 feet.

Bench mark in Head of Passes Light-House is a + cut in top brick in the northeast corner of Head of Passes Light-House foundation. Is in the north end of brick farthest east and about 1 meter above ground.

Elevation, 8.1438 meters. 26.719 feet.

P. B. M. 1 is the top of copper bolt leaded vertically in a vitrified clay slab in ground and surmounted by an iron pipe. It is 1 meter from each fence in the northwest corner of the yard surrounding the Head of Passes Light-house. Is 52 meters from the northwest corner of the light-house.

Elevation, 6.5128 meters. 21.368 feet.

P. B. M. 1 A is top of cap on top of pipe over P. B. M. 1, described above.

Elevation, 7.7178 meters. 25.321 feet.

P. B. M 2. is the center of a horizontal copper bolt leaded in the west wall of the brick oil house about 20 meters east of the Head of Passes Light-House. It is in the sixteenth course of bricks above the ground and is marked thus: U. S. P. B. M.
⊙

Elevation, 8.0306 meters. 26.347 feet.

P. B. M. 3 is top of copper bolt in vitrified clay slab in ground on west bank, about 100 meters back from river, about 2,300 meters above the Head of Passes Light-House;

is S. 60° W. 84 meters from △ Donovan No. 2. It is 5$\frac{5}{10}$ meters from a 14-inch blazed willow tree.

Elevation, 6.7035 meters. 21.993 feet.

P. B. M. 3 A is top of cap on top of pipe over P. B. M. 3, described above.

Elevation, 7.9025 meters. 25.927 feet.

T. B. M. 5 is a spike in east root of a 14-inch willow tree, 5$\frac{5}{10}$ meters from P. B. M. 3.

Elevation, 6.9589 meters. 22.831 feet.

B. M. $^{2}/_{3}{}^{5}$ is top of copper bolt in vitrified clay slab in ground; is on west bank, just opposite Pilot tower and 30 meters from river. Azimuths and distances from the B. M. are: To Pilots' tower, 243° 23′ 11″—1,491.63 meters; to △ Cubitt's chimney, 297° 25′ 04″—2,931.28 meters; to △ north, 179° 17′ 11″—2,939.63 meters; to Fog-bell tower, 192° 51′ 40″.

Elevation, —— meters. —— feet.

B. M. $^{2}/_{3}{}^{5}$ A is top of cap on top of pipe over B. M. $^{2}/_{3}{}^{5}$, described above.

Elevation, 7.3951 meters. 24.262 feet.

T. B. M. 8 is nail in a four-pronged willow tree, 8 meters from B. M. $^{2}/_{3}{}^{5}$.

Elevation, 7.2083 meters. 23.650 feet.

P. B. M. 4 is top of copper bolt in vitrified clay slab in ground on west bank about opposite middle of Cubitts Crevasse and 50 meters back from river. There is a 12-inch willow 3¼ meters northwest of the B. M. and another 12-inch willow 12 meters northwest which contains T. B. M. 11.

Elevation, 6.7787 meters. 22.240 feet.

P. B. M. 4 A is top of cap on top of pipe over P. B. M. 4, described above.

Elevation, 7.9807 meters. 26.184 feet.

T. B. M. 11 is nail in root of a 12-inch willow tree 12 meters southeast of P. B. M. 4, described above.

Elevation, 7.1859 meters. 23.576 feet.

T. B. M. 14 is nail in east root of a 24-inch willow tree south 50° west; 30 meters from B. M. $^{2}/_{3}{}^{4}$.

Elevation, 7.3241 meters. 24.029 feet.

T. B. M. 5 is top of copper bolt in vitrified clay slab in ground on west bank. Is in F. L. Streckerts' orange grove and is 17 meters northward from Streckerts' house and midway between two orange trees. Is about 4 miles below the jump.

Elevation, 6.7491 meters. 22.143 feet.

P. B. M. 5 A is top of cap on top of pipe over P. B. M. 5, described above.

Elevation, 7.9578 meters. 26.108 feet.

T. B. M. 17 is nail in 12 inch willow tree about 6 meters from P. B. M. 5.

Elevation, 7.5625 meters. 24.812 feet.

P. B. M. 6 is top of copper bolt in vitrified clay slab in ground on west bank about 2,500 meters below the jump. Is 18 meters from the river in an open field. Azimuth to tower at the jump, 130° 38′ 21″.

Elevation, 6.5633 meters. 21.533 feet.

P. B. M. 6 A is top of cap on top of pipe over P. B. M. 6, described above.

Elevation, 7.7701 meters. 25,493 feet.

T. B. M. 22 is nail in root of 18-inch willow tree, 47 meters from P. B. M. 6.

Elevation, 7.4997 meters. 24,606 feet.

T. B. M. 24 is a spike in east side of the middle one of three willows 24 inches in diameter and 17 meters south of the old United States custom-house at the Jump.

Elevation, 7.7383 meters. 25,388 feet.

B. M. $^{2}/_{3}{}^{2}$ is top of copper bolt in vitrified-clay slab in ground on west bank, about 100 meters above the Jump, 53 meters from the Tropical Fruit Company's store and 45 meters from Levy's store. It is respectively 16 and 13 meters from two blazed willow trees. To B. M. $^{2}/_{3}{}^{2}$ 221° 46′ 56″; 1,059.06 meters. To tower at Jump, 312° 12′ 00″.

Elevation, 7.0386 meters. 23,093 feet.

B. M. $^{2}/_{3}{}^{2}$ A is top of cap on top of pipe over B. M. $^{2}/_{3}{}^{2}$, described above.

Elevation, 8.2435 meters. 27,046 feet.

P. B. M. 7 is top of copper bolt in vitrified-clay slab in ground on west bank about 2,200 meters above the Jump and on land of Pierre Leon Buras. It is 7 meters back of levee, 40 meters from river, and 17 meters towards river from Buras' house.

Elevation, 6.7020 meters. 21,988 feet.

P. B. M. 7 A is top of cap on top of pipe over P. B. M. 7, described above.

Elevation, 7.9047 meters. 25,934 feet.

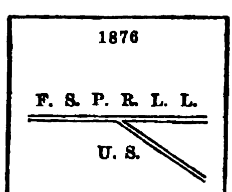
T. B. M. 28 is nail in east root of a 24-inch sycamore tree, 13 meters from river and about 28 meters east of a graveyard and 2¼ miles above the Jump.

Elevation, 7.4222 meters. 24,351 feet.

P. B. M. 8 is top of copper bolt in vitrified-clay slab in ground on west bank on Dr. Talbots land. Is on southern slope of levee, and is 20 meters south of an 18-inch tree, blazed. Is 947 meters above house now occupied by Pierre A. Jauntures. It is about 5 miles above the Jump.

Elevation, 6.9572 meters. 22.826 feet.

P. B. M. 8 A is top of cap on top of pipe, over P. B. M. 8, described above.
Elevation, 8.1620 meters. 26.778 feet.
T. B. M. 31 is spike in north root of an 18-inch willow tree 7 meters from levee, marked with a triangular blaze, and 17 meters above P. B. M. 8.
Elevation, 7.3930 meters. 24.255 feet.
B. M. $^{a}\frac{4}{3}^{\Omega}$ is top of copper bolt in vitrified-clay slab in ground on west bank, 33 meters back of levee, 13 meters below wire fence around orange grove. Is 10 meters from an 8-inch tree and 5 meters from a 10-inch hackberry tree, both blazed, and is about $2\frac{3}{4}$ miles below Fort Jackson.
Elevation, 6.7852 meters. 22.261 feet.
B. M. $^{a}\frac{4}{3}^{\Omega}$ A is top of cap on top of pipe. over B. M $^{a}\frac{4}{3}^{\Omega}$, described above.
Elevation, 7.9834 meters. 26.192 feet.
P. B. M. 9 is top of copper bolt in vitrified-clay slab in ground on S. Shoenberger's land on west bank, about $1\frac{1}{4}$ miles below Fort Jackson. It is $6\frac{7}{10}$ meters from the upper boundary of Shoenberger's land and 6 meters back of levee. Is 2 meters from an orange tree, and is 54 meters from Shoenberger's house.
Elevation, 6.9381 meters. 22.763 feet.
P. B. M. 9 A is top of cap on top of pipe over P. M. 9, described above.
Elevation, 8.1421 meters. 26.713 feet.
T. B. M. 58 is nail in crotch of 12-inch sycamore about 5 meters in front of levee, about 12 meters from P. B. M. 9.
Elevation, 8.0700 meters. 26.477 feet.
P. B. M. 10 is a vertical copper bolt in the granite block forming the bridge seat at the west abutment of the bridge crossing the moat at Fort Jackson. It is 3 inches from the lower flange of the iron stringer of the bridge, and is marked thus: U. S. ⊙ P. B. M
Elevation, 7.5385 meters. 24.733 feet.
Fort Jackson gauge is a vertical post gauge about 50 meters above the old hospital building at Fort Jackson.
Elevation of zero, 5.8700 meters. 19.258 feet.
B. M. "A" is upper surface of ship spike driven horizontally in brick chimney at upper or west end of building known as Ordnance Sergeant's dwelling. Is in west face of chimney, about 10 inches above the ground, and in second course below the weather boarding. A × is cut in brick just under the spike.
Elevation, 7.8475 meters. 25.747 feet.
T. B. M. 61 is spike in south root of 12-inch willow on old levee between new levee and river and about 400 meters above Fort Jackson.
Elevation, 7.7107 meters. 25.298 feet.
Experimental B. M. is top of copper bolt in vitrified clay slab in ground about 400 meters above Fort Jackson and 35 meters back of the levee. There is a 2-inch by 3-inch scantling set over the B. M. and projects about 18 inches above the ground.
Elevation, 6.6444 meters. 21.799 feet.
B. M. $^{a}\frac{4}{2}^{9}$ is top of copper bolt in vitrified-clay slab in ground on east bank. Is in the bend of levee surrounding Fort St. Philip military reservation and is about 100 meters below the fort. Is 109 meters from the river. To monument southeast corner of reservation 321° 06′ 45″—50.42 meters. To flag staff Fort St. Philip 69° 05′ 10″—350.4 meters.
Elevation, 7.1520 meters. 23.465 feet.
P. B. M. 11 is on top of monument marking the southeast corner of the United States reservation at Fort St. Phillip. The B. M. is the point in the obtuse angle at the intersection of the two grooves cut on the surface of the stone. The monument bears the inscription:



Elevation, 7.8718 meters. 25.826 feet.
P. B. M. 12 is a horizontal copper bolt in the granite facing of the portal on right-hand side of powder magazine No. 5, at Fort St. Philip. Is 43 inches above the concrete paving at the entrance of magazine.
Elevation, 8.2399 meters. 27.034 feet.

P. B. M. 13 is top of copper bolt in vitrified-clay slab in ground on east bank. Is on end of old levee running back to swamp on land of Patrick Callahan 1 mile above Fort St. Philip. It is 40 meters from Callahan's house and 49 meters from an old stable on the river side of main levee. Is about 6 meters inside of main levee and 70 meters from the river. To ⓐ Taylor 33° 06′ 18″. 1248.14 meters.

Elevation, 7.3498 meters. 24.114 feet.

P. B. M. 13 A is top of cap on top of pipe over P. B. M. 13, described above.

Elevation, 8.5601 meters. 28.085 feet.

T. B. M. 65 is nail in 18-inch willow tree on river side of levee in front of Patrick Callahan's house, and is about 10 meters from P. B. M. 13.

Elevation, 7.4738 meters. 24.521 feet.

B. M. $\frac{2}{2}^{8}$ is top of copper bolt in vitrified-clay slab in ground on east bank. Is 10 meters back of levee, 25 meters from river, and 20 meters above Mrs. S. H. Butler's store and Neptune post-office. It is about 2½ miles above Fort St. Philip.

Elevation, 6.9510 meters. 22.805 feet.

B. M. $\frac{2}{2}^{8}$ A is top of cap on top of pipe over B. M. $\frac{2}{2}^{8}$, described above.

Elevation, 8.1554 meters. 26.757 feet.

T. B. M. 68 is nail in north side of 18-inch willow in center of levee, 38 meters west of Mrs. Butler's store, and within 20 meters of B. M. $\frac{2}{2}^{8}$, described above.

Elevation, 8.2952 meters. 27.215 feet.

P. B. M. 14 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Marie Antoinette Grandpré Smith. It is 70 feet southwest of Mrs. Smith's house, and 3 feet inside of road fence, and 12 feet from a line stake between Mrs. Smith's and Herman Beck's lands and about 3½ miles above Fort St. Philip.

Elevation, 6.7551 meters. 22.163 feet.

P. B. M. 14 A is top of cap on top of pipe over P. B. M. 14, described above.

Elevation, 7.9597 meters. 26.115 feet.

T. B. M. 70 is nail in east root of 12-inch red elm on east side of levee on line between lands of Mrs. Smith and Mrs. Brophie, and within 80 meters of P. B. M. 14.

Elevation, 7.5684 meters. 24.831 feet.

P. B. M. 15 is top of vertical copper bolt in west end of second door sill from east end of the old United States customs and quarantine building, about 5 miles above Fort St. Phillip.

Elevation, 8.0318 meters. 26.351 feet.

B. M. $\frac{2}{2}^{1}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of August Barry about 1 mile above the old United States customs and quarantine buildings. It is 15 meters southeast of Barry's house and 10 meters back of levee, and 140 meters from the river. To Buras Church, 324° 46′ 35″, 1,368.7 meters; to B. M. $\frac{2}{3}^{7}$, 18° 02′ 12″, 897.9 meters.

Elevation, 6.9098 meters. 22.670 feet.

B. M. $\frac{2}{2}^{1}$ A is top of cap on top of pipe over B. M. $\frac{2}{2}^{1}$, described above.

Elevation, 8.1125 meters. 26.616 feet.

T. B. M. 73 is nail in root of 20-inch willow tree in line of fence along road about 1 mile above old United States customs and quarantine buildings, and about 60 meters below B. M. $\frac{2}{2}^{1}$.

Elevation, 7.4196 meters. 24.343 feet.

P. B. M. 16 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Antoine Jones, about 2½ miles above the old United States customs and quarantine buildings. It is 43 meters from Jones's house, and 52 meters from schoolhouse; is 5 meters back of levee, and 7 feet from a post marking the line between lands of Antoine Jones and Gilbert Buras. To ⓐ Grand Prairie, 149° 24′ 56″, 116.27 meters.

Elevation, 6.9338 meters. 22.749 feet.

P. B. M. 16 A is top of cap on top of pipe over P. B. M. 16, described above.

Elevation, 8.1402 meters. 26.707 feet.

B. M. $\frac{2}{2}^{6}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of V. Loceco. Is 6 meters back of the levee and 18 meters from Loceco's house, and 430 meters below negro school and church, and about 750 meters below O. K. red store.

Elevation, 6.7210 meters. 22.051 feet.

B. M. $\frac{2}{2}^{6}$ A is top of cap on top of pipe over B. M. $\frac{2}{2}^{6}$ described above.

Elevation, 7.9266 meters. 26.006 feet.

P. B. M. 17 is top of copper bolt in vitrified-clay slab in ground on east bank. Is in the southwest corner of Noel Buras' orange grove, 1 meter from each fence. Is 90 meters west of a schoolhouse, and about 5¼ miles above the old United States customs and quarantine buildings.

Elevation, 6.6439 meters. 21.798 feet.

P. B. M. 17 A is top of cap on top of pipe over P. B. M. 17, described above.

Elevation, 7.8513 meters. 25.759 feet.

T. B. M. 78 is nail in root of 10-inch willow, just outside of levee, about 100 meters below bend in levee, and about 13 meters from P. B. M. 17.

Elevation, 7.7793 meters. 25.523 feet.

B. M. ${}^{2}\frac{3}{2}{}^{5}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Meyer Wise, 15 meters back of road, and about 50 meters above fence corner, and about 195 meters above John Kelley's house and about 290 meters below Hicks Bayou.

Elevation, 6.8290 meters. 22.405 feet.

B. M. ${}^{2}\frac{3}{2}{}^{5}$ A is top of cap on top of pipe over B. M. ${}^{2}\frac{3}{2}{}^{5}$ described above.

Elevation, 8.0390 meters. 26.375 feet.

P. B. M. 18 is top of copper bolt in vitrified-clay slab in ground on east bank, 4 meters in front of J. Liugoni's house, about 80 meters back of levee and 20 meters from Harris' Canal.

Elevation, 6.6926 meters. 21.958 feet.

P. B. M. 18 A is top of cap on top of pipe over P. B. M. 18, described above.

Elevation, 7.9014 meters. 25.923 feet.

B. M. ${}^{2}\frac{3}{2}{}^{4}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Berkson Brothers. Is about 18 meters back of point where old and new levees unite. Is 17 meters below a house. Is 105 meters from the river, and 60 meters northwest of a 3-foot hackberry, blazed, which stands outside the levee. To church spire, 119° 03′ 18″, 141.21 meters.

Elevation, 6.9555 meters. 22.820 feet.

B. M. ${}^{2}\frac{3}{2}{}^{4}$ A is top of cap on top of pipe over B. M. ${}^{2}\frac{3}{2}{}^{4}$ described above.

Elevation, 8.1669 meters. 26.795 feet.

T. B. M. 84 is nail in root of 24-inch hackberry tree, outside of levee, and 60 meters from B. M. ${}^{2}\frac{3}{2}{}^{4}$.

Elevation, 8.1167 meters. 26.630 feet.

Ⓐ White is a U. S. Coast Survey station and is about 1,160 meters above Wesley church and 110 meters from the road on river side. It is an iron screw pile projecting above ground, the top terminating in a cast-iron cap bearing the inscription "U. S. Coast Survey, 1870, G + P." The bench mark is the highest point of the letter C.

Elevation. 8.1307 meters. 26.676 feet.

P. B. M. 19 is top of copper bolt in vitrified-clay slab in ground on east bank on land of William Laudebaugh. Is 1 meter north of a 36-inch hackberry tree, blazed. Is 30 meters north of Laudebaugh's house and 66 meters from levee and about 1¾ miles above Wesley church.

Elevation, 7.6220 meters. 25.007 feet.

P. B. M. 19 A is top of cap on top of pipe over P. B. M. 19, described above.

Elevation, 8.8310 meters. 28.973 feet.

T. B. M. 86 is nail in north root of 30-inch hackberry tree on south side of road and is 37 meters from P. B. M. 19.

Elevation, 7.8310 meters. 25.692 feet.

T. B. M. 88 is nail in root of 20-inch live oak 150 meters south of school house and 1,800 meters below Nestor landing.

Elevation, 8.3353 meters, 27.347 feet.

P. B. M. 20 is top of copper bolt in vitrified-clay slab in ground 15 meters back of levee and 4$\frac{3}{10}$ meters north of the northwest corner of S. M. Fusich & Co.'s store, at Nestor Landing. It is 32 meters south of the center of Nestor Canal.

Elevation, 7.0535 meters. 23.142 feet.

P. B. M. 20 A is top of cap on top of pipe over P. B. M. 20, described above.

Elevation, 8.2565 meters. 27.088 feet.

T. B. M. 91 is nail in root of 36-inch live-oak tree 5 meters east of levee and about one-half mile above Nestor Canal.

Elevation, 8.0984 meters. 26.570 feet.

B. M. ${}^{2}\frac{3}{2}{}^{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Mrs. Cannon. It is 118 meters above her house, 1 meter below fence running back from road behind levee; is 12 meters from the south corner of E. J. Cannon's house and 55 meters back from levee. It is 4 feet north of a fig tree. To B. M. ${}^{2}\frac{3}{2}{}^{2}$ 48° 27′. 816.59 meters. To Rigaud's chimney, 45° 23′ 35″.

Elevation, 6.8287 meters. 22.404 feet.

B. M. ${}^{2}\frac{3}{2}{}^{2}$ A is top of cap on top of pipe over B. M. ${}^{2}\frac{3}{2}{}^{2}$ A, described above.

Elevation, 8.0337 meters. 26.358 feet.

P. B. M. 21 is top of copper bolt in vitrified-clay slab in ground on east bank on Pierre Cossé's land, 6 meters back from road fence and 1 foot south of the division fence between lands of Cossé and Henry W. Fox, and about 1,000 meters below the white Episcopal Church. To Ⓐ Union, 147° 00′ 19″, 504.22 meters; to church roof apex, 150° 52′ 42″.

Elevation, 6.9837 meters. 22.913 feet.

P. B. M. 21 A is top of cap on top of pipe over P. B. M. 21, described above.
Elevation, 8.1895 meters. 26.869 feet.

⊕ Union is a U. S. Coast Survey station; is in an old orange grove 63 meters back from road and about 600 meters below the white Episcopal church. Is an iron screw pile projecting about 9 inches above the ground, terminating in a cast-iron cap bearing the inscription U. S. Coast Survey 1870 G+P. The bench mark is the + near center.
Elevation, 7.8411 meters. 25.726 feet.

T. B. M. 95 is nail in root of 30-inch willow on river side of levee, near foot of slope and about 30 meters from the white Episcopal church.
Elevation, 8.2678 meters. 27.126 feet.

B. M. $\frac{231}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank, on line between lands of William Cannon and George Wilson. It is 23 meters back of the new levee and 119 meters from the river bank and 165 meters westward from George Wilson's house. To St. Patrick's church, 323° 09′ 31″; to gable of red house, 295° 35′ 20″.
Elevation, 6.8962 meters. 22.626 feet.

B. M. $\frac{231}{2}$ A is top of cap on top of pipe over B. M. $\frac{231}{2}$, described above.
Elevation, 8.1014 meters. 26.580 feet.

P. B. M. 22 is top of copper bolt in vitrified-clay slab in ground on east bank on Dr. Herbert's land, 145 meters south of his north line, and on south side of ditch. Is 188 meters from the N. O. & S. Railway and 20 meters east of the levee, and about 1,300 meters above the railway water tank at Bohemia. To tower, 112° 02′ 45″.
Elevation, 7.4535 meters. 24.454 feet.

P. B. M. 22 A is top of cap on top of pipe over P. B. M. 22, described above.
Elevation, 8.6631 meters. 28.422 feet.

B. M. $\frac{230}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on north side of plantation road running along north side of Martin Brothers' plantation. Is 22 meters back of levee and about 2 miles below the Plaquemine Parish court-house.
Elevation, 6.8636 meters. 22.519 feet.

B. M. $\frac{230}{2}$ A is top of cap on top of pipe over B. M. $\frac{230}{2}$, described above.
Elevation, 8.0723 meters. 26.484 feet.

P. B. M. 23 is top of copper bolt in vitrified-clay slab in ground on east bank in Theophile Hingle's front yard, 6 meters southeast of house, 25 meters below storehouse, and 25 meters back of levee, and about 1 mile below Plaquemine Parish court-house. To Magnolia sugarhouse, 0° 27′ 41″; to tower, 359° 14′ 31″; to tank, 354° 49′ 45″.
Elevation, 7.0461 meters. 23.117 feet.

P. B. M. 23 A is top of cap on top of pipe over P. B. M. 23, described above.
Elevation, 8.2569 meters. 27.090 feet.

T. B. M. 105 is nail in 20-inch sycamore on river side of levee about 50 meters from Bauer's store and 1,400 meters above the Plaquemine Parish court-house.
Elevation, 8.3900 meters. 27.526 feet.

B. M. $\frac{229}{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank between lands of John Lafitte and B. Savois, 13 meters back of the levee, 1 meter north of row of large willows, and in fence corner. Is 375 meters above St. Thomas's church.
Elevation, 7.0592 meters. 23.160 feet.

B. M. $\frac{229}{2}$ A is top of cap on top of pipe over B. M. $\frac{229}{2}$, described above.
Elevation, 8.2645 meters. 27.115 feet.

P. B. M. 24 is top of vertical copper bolt in top of coping on lower side of steps leading to main entrance of the Plaquemine Parish court-house, at Pointe à la Hache. The top of the bolt is 8 millimeters below the concrete coating.
Elevation, 9.4711 meters. 31.073 feet.

P. B. M. 25 is top of copper bolt in vitrified-clay slab in ground on east bank on Mrs. Auguste Gravolet's land, about 3 miles above Plaquemine Parish court-house. Is 3 meters from a 24-inch hackberry, and 163 feet northward from the north corner of Mrs. Gravolet's house, and 111 meters from the N. O. and S. Railway.
Elevation, 6.9384 meters. 22.764 feet.

P. B. M. 25 A is top of cap on top of pipe over P. B. M. 25, described above.
Elevation, 8.1460 meters. 26.726 feet.

B. M. $\frac{228}{2}$ is top of copper bolt in vitrified-clay slab in ground between lands of Dr. Herbert and J. Dole. Is at end of lane leading back from main road and about 2 feet from fence corner on upper side of lane, and about 4½ miles above Plaquemine Parish court-house. To Celeste chimney, 321° 23′ 37″, 1,841.6 meters; to Junior chimney, 49° 53′ 42″, 1,286.1 meters.
Elevation, 7.2885 meters. 23.913 feet.

B. M. $\frac{228}{2}$ A is top of cap on top of pipe over B. M. $\frac{228}{2}$, described above.
Elevation, 8.4983 meters. 27.882 feet.

P. B. M. 26 is top of copper bolt in vitrified-clay slab in ground on east bank. Is on Bellevue Plantation, and 24 meters back of levee and 1 meter east of ditch, and

192$\frac{5}{10}$ meters from N. O. & S. Railway. To Bellevue S. H. Chimney, 111° 11′ 13″, 559.8 meters.

Elevation, 7.3817 meters. 24.218 feet.

P. B. M. 26 A is top of cap on top of pipe over P. B. M. 26, described above.

Elevation, 8.5922 meters. 28.190 feet.

T. B. M. 114 is a spike in west root of 36-inch live oak, on west edge of live-oak grove. Is 5 meters back of pasture fence and 15 meters back of levee, and 365 meters above the old sugarhouse at Harlem plantation. This bench mark was established by the levee engineers.

Elevation, 8.1310 meters. 26.677 feet.

B. M. $\frac{2}{2}7$ is top of copper bolt in vitrified-clay slab in ground on east bank on Harlem plantation, on south side of ditch running along north side of live-oak grove; is 365 meters above the old Harlem sugarhouse and 141 meters from the N. O. and S. Railway. Two live-oak trees blazed are respectively 19 and 22 meters from the bench mark. To Bellevue chimney, 299° 35′ 02″; 1,479.2 meters.

Elevation, 7.0442 meters. 23.111 feet.

B. M. $\frac{2}{2}7$ A is top of cap on top of pipe over B. M. $\frac{2}{2}7$, described above.

Elevation, 8.2555 meters. 27.085 feet.

P. B. M. 27 is top of copper bolt in vitrified-clay slab in ground on east bank on land of E. H. McCaleb, about 1¼ miles above Harlem sugarhouse. It is 75 meters back of levee; is 72 meters northward from Joshua Griffin's house and in corner of small field beside ditch. To Wilkinson's sugarhouse, 94° 09′ 31″.

Elevation, 7.2796 meters. 23.883 feet.

P. B. M. 27 A is top of cap on top of pipe over P. B. M. 27, described above.

Elevation, 8.4876 meters. 27.847 feet.

T. B. M. 120 is nail in root of 14-inch willow in front yard and about 30 meters from Leopold's store and about 2¼ miles above Harlem sugarhouse.

Elevation, 8.0162 meters. 26.300 feet.

B. M. $\frac{2}{2}6$ is top of copper bolt in vitrified-clay slab in ground on east bank just below Poverty Point, 14 meters back of base of levee on C. W. Johnson's land; is 304.5 meters in front of N. O. and S. Ry., in fence corner on lower side of ditch; is 99 meters below a 14-inch live-oak tree in line of road fence. Tree is near two small houses. To Wilkinson's sugarhouse, 22° 35′ 48″; to St. Joseph's Church, 284° 8′ 45″; to St. John's Church, 273° 6′ 20″.

Elevation, 7.6512 meters. 25.103 feet.

B. M. $\frac{2}{2}6$ A is top of cap on top of pipe over B. M. $\frac{2}{2}6$, described above.

Elevation, 8.8557 meters. 29.054 feet.

T. B. M. 122 is a boat spike in root of 36-inch live oak, about 70 meters from main dwelling at Mon Secour's plantation. This B. M. was established by the levee engineers.

Elevation, 7.5703 meters. 24.837 feet.

P. B. M. 28 is top of copper bolt in vitrified-clay slab in ground on east bank on Mon Secour's plantation; is 7 feet east of ditch along road and 53 meters from west corner of main dwelling and 67 meters from the northwest corner of a long dwelling near road leading back to sugarhouse. To union sugarhouse, 188° 15′ 35″.

Elevation, 6.5423 meters. 21.464 feet.

P. B. M. 28 A is top of cap on top of pipe over P. B. M., described above.

Elevation, 7.7500 meters. 25.427 feet.

T. B. M. 124 is nail in root of 5-foot live oak in cane field, about 25 meters from levee and 186 meters above St. Sophia post-office. This B. M. was probably established by levee engineers.

Elevation, 8.7449 meters. 28.691 feet.

B. M. $\frac{2}{2}5$ is top of copper bolt in vitrified-clay slab in ground on east bank on Monticello plantation; is 15 meters from base of levee on lower side of plantation road at its intersection with main road, and is 144 meters above St. Sophia post-office.

Elevation, 7.4404 meters. 24.411 feet.

B. M. $\frac{2}{2}5$ A is top of cap on top of pipe over B. M. $\frac{2}{2}5$, described above.

Elevation, 8.6541 meters. 28.393 feet.

P. B. M. 29 is top of copper bolt in vitrified-clay slab in ground on east bank on Fairview plantation, in northwest corner of garden, in front of manager's house; is 20 meters from house and 57 meters back from levee.

Elevation, 6.9680 meters. 22.861 feet.

P. B. M. 29 A is top of cap on top of pipe over P. B. M. 29, described above.

Elevation, 8.1746 meters. 26.819 feet.

B. M. $\frac{2}{2}4$ is top of copper bolt in vitrified-clay slab in ground on east bank on Belair plantation, in negro churchyard, 17 meters from the southwest corner of the church.

Elevation, 6.9075 meters. 22.663 feet.

B. M. ${}^{2}_{4}{}^{4}$ A is top of cap on top of pipe over B. M. ${}^{2}_{4}{}^{4}$, described above.
Elevation, 8.1139 meters. 26.621 feet.

T. B. M. 131 is nail in root of 5-foot live oak between levee and road and about 600 meters below the main buildings at Fanny plantation.
Elevation, 8.8128 meters. 28.914 feet.

P. B. M. 30 is top of copper bolt in vitrified-clay slab in ground on east bank on Fanny plantation, about 600 meters below the main buildings, in a graveyard; is 6 feet north of ditch, 38 feet towards river from a large live-oak tree, and 245 feet from the N. O. and S. Railway, and about 160 meters back from the levee measured along ditch. To Belair sugarhouse, 330° 59′ 08″; to Fanny sugarhouse, 161° 16′ 16″.
Elevation, 7.2236 meters. 23.700 feet.

P. B. M. 30 A is top of cap on top of pipe over P. B. M. 30, described above.
Elevation, 8.4303 meters. 27.659 feet.

Ⓐ Berthoud is a U. S. Coast and Geodetic Survey station, and is B. M. ${}^{2}_{4}{}^{2}$; is an iron-screw pile projecting about 1 foot above ground; is on the east bank on the old Woodland plantation, 10 meters in front of old levee and 101 meters back from new levee; is 8 meters above ditch and 232 meters from the New Orleans and Savannah Railway, on land of Charles Reggio. The cap on top the iron post bears the inscription "U. S. Coast and Geodetic Survey 1871, G+P." The bench mark is the + in center of cap. To Jesuit Church, 80° 03′ 48″; 894.0 meters.
Elevation, 8.9686 meters. 29.425 feet.

P. B. M. 31 is top of copper bolt in vitrified-clay slab in ground on east bank on Greenwood plantation; is in the northeast corner of a lot 110 meters above the manager's dwelling and 77 meters east of the N. O. and S. Railway.
Elevation, 6.9153 meters. 22.688 feet.

P. B. M. 31 A is top of cap on top of pipe over P. B. M. 31, described above.
Elevation, 8.1208 meters. 26.643 feet.

T. B. M. 136 is nail in root of 5-foot live oak about 25 meters back of levee and about 400 meters below the sugarhouse on Promised Land plantation. The bench mark is about 15 feet towards the river from the tree.
Elevation, 8.3055 meters. 27.249 feet.

B. M. ${}^{2}_{4}{}^{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Linwood plantation; is 12 meters east of the N. O. and S. Railway on lower side of ditch and 4 meters above road running back to woods and about 100 meters from the main dwelling on the plantation.
Elevation, 7.1223 meters. 23.367 feet.

B. M. ${}^{2}_{4}{}^{2}$ A is top of cap on top of pipe over B. M. ${}^{2}_{4}{}^{2}$, described above.
Elevation, 8.3283 meters. 27.324 feet.

T. B. M. 137 is nail in fork of 24-inch willow between levee and river, about 200 meters above Gould's store. Bench mark is about 2 feet above ground.
Elevation, 9.7585 meters. 32.016 feet.

P. B. M. 32 is top of copper bolt in vitrified-clay slab in ground on east bank on Stella plantation; is in southwest corner of William Homer's front yard and 37 meters north of plantation store and about 50 meters from river.
Elevation, 8.5074 meters. 27.912 feet.

P. B. M. 32 A is top of cap on top of pipe over P. B. M. 32, described above.
Elevation, 9.7184 meters. 31.885 feet.

B. M. ${}^{2}_{4}{}^{1}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Scarsdale plantation, on the upper edge of second ditch above Stella plantation and at intersection with ditch running parallel to river. It is 47 meters above plantation line and 153 meters from the N. O. and S. Ry.
Elevation, 7.6344 meters. 25.044 feet.

B. M. ${}^{2}_{4}{}^{1}$ A is top of cap on top of pipe over B. M. ${}^{2}_{4}{}^{1}$, described above.
Elevation, 8.8411 meters. 29.006 feet.

P. B. M. 33 is top of copper bolt in vitrified-clay slab in ground on east bank on Mon Plaisir plantation, about 14 meters above the north line of Scarsdale plantation; is 184 meters back from the levee and 132 meters from the N. O. and S. Ry. and 145 meters from a house back of the railway. It is on edge of ditch at junction of two plantation roads.
Elevation, 7.4839 meters. 24.554 feet.

P. B. M. 33 A is top of cap on top of pipe over P. B. M. 33 described above.
Elevation, 8.6907 meters. 28.513 feet.

P. B. M. ${}^{2}_{4}{}^{0}$ is top of copper bolt in vitrified-clay slab in ground on east bank on St. Clair plantation 1 meter east of fence along road, 430 meters from N. O. and S. Ry., and about 390 meters above St. Clair sugarhouse chimney. To Orange Grove lightning rod, 274° 23′ 50″; to St. Clair sugarhouse, 358° 34′ 20″; to Belle Chasse sugarhouse, 42° 34′ 32″.
Elevation, 8.2266 meters. 26.990 feet.

B. M. ${}^{2}_{4}{}^{0}$ A is top of cap on top of pipe over B. M. ${}^{2}_{4}{}^{0}$, described above.
Elevation, 9.4339 meters. 30.951 feet.

P. B. M. 34 is top of copper bolt in vitrified-clay slab in ground on east bank on Orange Grove plantation; is in the northwest corner of intersection of two plantation roads and between road and ditch, and is 137 meters back from base of levee measured along plantation road. To Orange Grove sugarhouse cupola, 295° 11′ 51″ — 751.5 meters.

Elevation, 7.2232 meters. 23.698 feet.

P. B. M. 34 A is top of cap on top of pipe over P. B. M. 34, described above.

Elevation, 8.4259 meters. 27.644 feet.

B. M. $^{2}\frac{1}{2}{}^{2}$ is top of copper bolt in vitrified-clay slab in ground on east bank on Orange Grove plantation; is in the northeast corner, where plantation road and ditch intersects; is 267 meters from N. O. and S. Railway and 132 meters back of levee. To Orange Grove sugarhouse cupola, 110° 38′ 22″ — 932.5 meters.

Elevation, 7.3449 meters. 24.098 feet.

B. M. $^{2}\frac{1}{2}{}^{2}$ A is top of cap on top of pipe over B. M. $^{2}\frac{1}{2}{}^{2}$, described above.

Elevation, 8.5484 meters. 28.046 feet.

P. B. M. 35 is top of copper bolt in vitrified-clay slab in ground on east bank on Poydras Hall plantation; is 144 meters back of the N. O. and S. Railway, at a point 90 meters above the three-throw switch at Poydras Hall junction; it is 8 meters west of the northwest corner of fence surrounding the plantation quarters.

Elevation, 7.2326 meters. 23.729 feet.

P. B. M. 35 A is top of cap on top of pipe over P. B. M. 35, described above.

Elevation, 8.4358 meters. 27.677 feet.

B. M. $^{2}\frac{1}{2}{}^{8}$ is top of copper bolt in vitrified-clay slab in ground on east bank on the old Repose plantation; is in the southwest corner of a pasture 10 meters back from the N. O. and S. Railway; is on upper side of ditch running along lower side of plantation; is 197 meters back of levee and just back of plantation quarters. Tile-works chimney, 165° 41′ 34″.

Elevation, 7.1668 meters. 23.513 feet.

B. M. $^{2}\frac{1}{2}{}^{8}$ A is top of cap on top of pipe over B. M. $^{2}\frac{1}{2}{}^{8}$, described above.

Elevation, 8.3740 meters. 27.474 feet.

T. B. M. 151 is nail in root of 4-foot pecan tree, about 25 meters from negro church and 400 meters above the mouth of Lake Borgne Canal.

Elevation, 9.5407 meters. 31.302 feet.

P. B. M. 36 is top of copper bolt in vitrified-clay slab in ground on east bank on the Stoney plantation 4 meters above ditch running back from levee and 1 meter from ditch running parallel with railway; is 243 meters back of N. O. and S. Railway and about 290 meters below two small negro churches. To Stoney sugarhouse chimney, 152° 37′ 50″.

Elevation, 7.4401 meters. 24.410 feet.

P. B. M. 36 A is top of cap on top of pipe over P. B. M. 36, described above.

Elevation, 8.6427 meters. 28.356 feet.

T. B. M. 154 is nail in west root of 36-inch live oak 125 meters above section house, 6 meters below railway and wagon road crossing, and 68 meters below Saxtonholm Depot.

Elevation, 8.5852 meters. 28.167 feet.

B. M. $^{2}\frac{1}{2}{}^{7}$ is top of copper bolt in vitrified-clay slab in ground on east bank on lower edge of first ditch below upper line of the Ducross plantation. Is 10 meters back of N. O. and S. Railway, and about 100 meters above dwelling and about 31 meters back of levee.

Elevation, 7.7602 meters. 25.460 feet.

B. M. $^{2}\frac{1}{2}{}^{7}$ A is top of cap on top of pipe over B. M. $^{2}\frac{1}{2}{}^{7}$, described above.

Elevation, 8.9632 meters. 29.407 feet.

P. B. M. 37 is top of copper bolt in vitrified-clay slab in ground on east bank on land of Willis Fassy. It is 510 feet below D. Danterives's house, and 6 meters back of N. O. and S. Railway and on west side of small ditch. To Ⓐ battle ground 149° 29′ 07″, 1,213.3 meters; to refinery chimney 91° 51′ 02″.

Elevation, 8.5847 meters. 28.165 feet.

P. B. M. 37 A is top of cap on top of pipe over P. B. M. 37, described above.

Elevation, 9.7841 meters. 32.100 feet.

B. M. $^{2}\frac{1}{2}{}^{8}$ is top of copper bolt in vitrified-clay slab in ground on east bank on land of Mrs. Alberdine, and at rear end of lane. Is 290 meters back of levee. Is in fence corner 57.5 meters from the northwest corner of house occupied by Louis Heier, 2 miles below Jackson Barracks, New Orleans, to Ⓐ battle ground 245° 57′ 09″, 1,742.4 meters.

Elevation, 8.4140 meters. 27.605 feet.

B. M. $^{2}\frac{1}{2}{}^{8}$ A is top of cap on top of pipe over B. M. $^{2}\frac{1}{2}{}^{8}$, described above.

Elevation, ——— meters. ——— feet.

T. B. M. 162, is nail in root of 15-inch tree at inner base of levee, and 6 meters east of the east line of Jackson Barracks, New Orleans.

Elevation, 11.2022 meters. 36.753 feet.

P. B. M. 38 is top of a vertical copper bolt in base of the second column on east side of the sally port on inside of inclosure at Jackson Barracks, New Orleans. The letters U. S. P. B. M. are cut near the bolt.

Elevation, 9.5194 meters. 31.232 feet.

T. B. M. 165 is nail in root of 15-inch hackberry on south side of St. Claude street and 40 feet eastward from intersection of St. Claude and Elizardi streets, New Orleans.

Elevation, 7.4776 meters. 24.533 feet.

B. M. $\frac{2}{1}{}^{5}$ A is top of cap on top of pipe over B. M. $\frac{2}{1}{}^{5}$. Is on east side of Forstal street about 18 inches from east fence and is 346.2 meters northward from the N. O. and S. Railway, New Orleans. To Ⓐ St. Maurice 325° 58′ 55″, 1,409.8 meters; to Ursulines Convent 47° 06′ 05″ 1,149.7 meters.

Elevation, 7.7003 meters. 25.264 feet.

T. B. M. 166 is nail in root of 15-inch live oak 6 feet from north side of St. Claude street and about 50 meters west of Lesseps street, New Orleans.

Elevation, 7.3769 meters. 24.203 feet.

P. B. M. 39 is top of vertical copper bolt in the granite doorstep at east entrance of the Academy of the Holy Angels, at the northwest corner of Congress and Rampart streets, New Orleans. The bench mark is at the Congress street entrance and is 1 inch from front of step and five inches from south jamb.

Elevation, 7.7862 meters. 25.546 feet.

P. B. M. 40 is center of horizontal copper bolt in the brick wall around the Church of the Annunciation, at the northeast corner of Mandeville and Marais streets, New Orleans. The bench mark is on Mandeville street and 3.2 meters north of the north line of Marais street. Is in the center of a buttress and in the sixteenth course of bricks above the pavement.

Elevation, 8.6295 meters. 28.312 feet.

T. B. M. 41 is top of a vertical copper bolt in brick pier under south post of the electric light tower at the southwest corner of Anthonia and Claiborne streets, New Orleans. It is 3 inches east of the southeast corner of the iron bed plate and about 2 feet inside of the curb line on the west side of Anthonia street and 2.7 meters south of the southwest corner of Anthonia and Claiborne streets.

Elevation, 6.5281 meters. 21.418 feet.

T. B. M. 170 is nail in east root of 15-inch oak tree on west side of St. Bernard street and 75 meters north of Aubrey street, New Orleans.

Elevation, 6.6166 meters. 21.708 feet.

T. B. M. 171 is nail in root of 12-inch elm tree on south side of Claiborne street, 80 meters west of Esplanade street and 52 meters east of brick culvert in New Orleans.

Elevation, 7.6022 meters. 24.942 feet.

T. B. M. 175 is a + cut on the iron bed plate supporting the southern post of the electric-light tower at the corner of Lapeyrouse street and Gentilly road, New Orleans.

Is marked thus: U + S, with chisel in the iron surface.

Elevation, 6.9964 meters. 22.954 feet.

P. B. M. 42 is a + cut on top of south end of granite step of the Crescent City Brewing Company's building at the southeast corner of Claiborne and Canal streets, New Orleans; is marked thus: U. + S.

Elevation, 7.6264 meters. 25.021 feet.

P. B. M. 43 is top of a vertical copper bolt set in the marble monument established by the U. S. Coast and Geodetic Survey for an astronomical station in Lafayette Park, New Orleans. The top of the bolt is flush with the top surface of the stone and is marked thus: U. S. P. B. M. ⊙

Elevation, 10.2066 meters. 33.486 feet.

U. S. P. B. M. 3, established by the Mississippi River Commission in 1882, is a horizontal mark on end of horizontal copper bolt in the east face of the middle brick gate-post of the Gentilly gate, on east side of the fair grounds at New Orleans. The bench mark is in the fifth course of bricks above the ground, and is marked thus: U. ⊙ S.

Elevation, 7.6658 meters. 25.150 feet.

U. S. P. B. M. 2, established by the Mississippi River Commission in 1882, is the center of end of horizontal copper bolt in the northwest face of the southern wing of the abutment at the northwest end of the drawbridge over Bayou St. John, on the Esplanade Road, New Orleans. It is marked thus: U. S. ⊙ P. B. M.

Elevation, 9.1586 meters. 30.048 feet.

B. M.—City stone, "Halfway House" is a + on top surface of a granite marking-stone set in ground, on west side of canal, near entrance to Metairie Cemetery, New

Orleans. The top of the stone is 120 millimeters by 200 millimeters and is in line with the fence along the south side of the cemetery, and is 4.7 meters from the southern end of the wall forming the cemetery entrance, and is 41 meters from the western end of the bridge crossing the canal.

Elevation, 7.9870 meters. 26.204 feet.

APPENDIX 3 E.

REPORT OF ASSISTANT ENGINEER J. A. OCKERSON ON LOCATION AND CONDITION OF GAUGES.

ST. LOUIS, MO., *December 26, 1892.*

SIR: I have the honor to submit the following report on inspection of Mississippi River Commission gauges made in the months of November and December, 1892.

The steamer *Patrol*, with the topographical party on board, reached St. Louis on November 15, and as the steamer was assigned to work on the lower river from Donaldsonville down, the opportunity was most favorable for a thorough inspection and repair of the gauges and bulletins on the way down to that point.

The party left St. Louis on November 17, and en route reëstablished all of the gauges and repaired or replaced all of the bulletin boards maintained by the Mississippi River Commission.

New bench marks were set at several stations where the old ones had been destroyed or where they were located too far away from the gauges for convenience. These benches were established by means of duplicate lines of levels from one or more reliable benches in the vicinity. This often necessitated levelling over long distances, but will make future inspections much easier. Many of the earlier benches were on trees, and most of them have been destroyed by decay caused by the blazing of the tree for the bench, or the tree has fallen from the force of winds or caving banks.

Most of the gauges are essentially temporary, as caving banks, drift, etc., make permanent structures impracticable, and can only be kept up by the vigilance of the observers, supplemented by a thorough inspection at high and low water. Some of them are also temporary from another cause. The changes in the bed and banks of the stream precipitate a heavy fill, thus necessitating a change of location. Morrissons and Mhoons are notable examples. In the latter case the gauge is now nearly 2 miles downstream from its original site. The gauge zero has been kept the same, hence it is evident that the relations between the present readings and the earlier ones can only be reached by taking into consideration the slope, which may amount to nearly a foot. In the discussion of gauge relations at different periods, it is important that this should be noted.

Where a fill is likely to occur a new gauge should be established under a new name to avoid confusion in the records, and the two gauges should be read for a period (preferably covering one high and one low water) long enough to establish the relations between the gauges.

The gauges which have been set with the zero above low water have been a fruitful source of error and annoyance. The records of the observers are full of mistakes when the zero is passed. The pilots also find it difficult to reconcile the bulletin readings, which at one point give 1 foot, and the next station 5 feet, when the actual stage is known to be the same.

It is very doubtful whether the possible confusion in the records, arising from a change of all the gauges so that the zeros would be at or below extreme low water, would outweigh the decided advantage of wiping out for all time to come the chief cause of error and confusion in the present records.

It has already been noted that changes of location from natural causes are sometimes imperative. If an occasional change of this kind, which might easily be overlooked, is not seriously objectionable, then a general change of the whole system would be still less so, as it would be so radical as to be generally known.

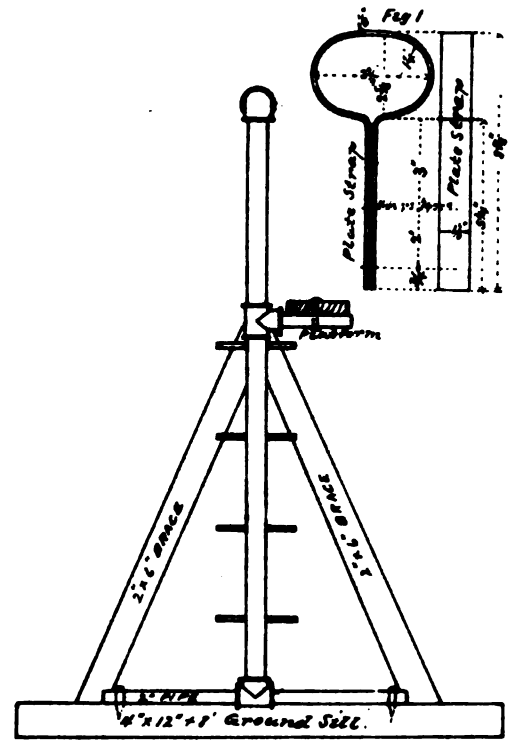
The first gauge bulletins erected were found to be too small, and the figures were too indistinct. The next size was somewhat larger, and later a still larger figure was brought into use.

The frames for the last named were made so that the figure plates were set in grooves. This arrangement looked quite simple, but has proven very unsatisfactory, owing to the difficulty of handling such large plates during even a moderate wind. Another objection is that the plates, being easily detachable, are often dropped and become battered, and then will not enter the grooves, or they may be carried away entirely.

RIVER STAGE BULLETIN

1892.

Scale 1" = 3' 1" +



END VIEW.

To remedy these defects a new bulletin frame was designed, made entirely of gas pipe. Three of these were put up. The appended drawing renders a detailed description unnecessary. New gauges were established at New Madrid and the Iron Mountain and Southern Railway Bridge across the St. Francis River. These are to take the places of the Morrissons and Wittsburg gauges, respectively, as soon as the gauge relations have been established by a sufficient period of readings.

The gauge at Yazoo City was not inspected, as it was to be soon abandoned.

Donaldsonville was reached on December 7, and assistants A. T. Morrow and George H. French joined at that point. The *Patrol* and party was turned over to Mr. Morrow, and after the inspection of the College Point gauge the other stations were reached by mail or local steamboat.

The work of inspection was finished on December 14, and my duties in the office resumed on the 15th.

Respectfully submitted.

J. A. OCKERSON,
United States Assistant Engineer.

Capt. CARL F. PALFREY,
Corps of Engineers, U. S. A.,
Secretary Mississippi River Commission.

Gauge at Grays Point, Mo. Distance from Cairo, 45 miles. R. Latitude, 37° 15′. Longitude, 89° 27′ + 1310^m. J. C. Gray, observer. Inspected November 18, 1892.—This gauge is in two sections and consists of straps of iron bolted firmly to the solid rock, and hence it may be considered permanent.

The bench marks to which the gauge is referred could not be found. They are probably covered with the soil which has been carried down from the higher elevations, and the descriptions are too meager to locate them. They are doubtless still intact, and any section of the gauge is quite as good as a special bench mark.

The bulletin was repaired and repainted.

Gauge at Belmont, Mo. Distance from Cairo, 21.3 miles. R. Latitude, 36° 46′ + 35^m. Longitude, 39° 07′ + 440^m. T. H. Parker, observer. November 20, 1892.—This gauge is located on the piling at the lower side of the elevator warehouse, as shown in accompanying sketch.

Both B. M. No. 2 and B. M. No. 3, given in stage pamphlet, have been destroyed and a duplicate line of levels was run from B. M. $\frac{1}{3}$, which, from its position in an angle of the fence and its general appearance, is probably the same elevation as when set.

All of the sections of the gauge are firmly spiked to the piling and practically unmovable. The sections from 5 to 46 feet were consistent with one another. With reference to B. M. $\frac{1}{3}$, they are, however, about 0.25 feet too low. The lower section (from 5 feet down) was found to be 0.03 feet too high from the same bench.

The reference benches were gone, and consequently there was no way of verifying the old determinations. The gauge sections have every appearance of being in same position as when set, and it was assumed that there was some good reason for setting the upper sections as they were found, and reasons which might perhaps be given in some of the inspection reports on file in the office. So on the whole it was thought best to make the entire gauge consistent by changing the short section, and this was consequently done.

If the elevation of B. M. $\frac{1}{3}$ is correct, then the zero of the entire gauge as it now stands is 0.25 feet too low. This value would have been verified by a river crossing from a P. B. M. in Columbus, had it not been that a high wind prevailed, making such work impracticable, and it was not deemed advisable to detain the *Patrol*.

As the inspection reports on file in this office do not give any clue to the differences found, it is important to check the value by river crossing from P. B. M. 8, as suggested.

The following bench marks were set from B. M. $\frac{1}{3}$:

B. M. 1, 1892, is the top of a railroad spike driven horizontally into southeast side of cypress pile standing at northeast corner of elevator superintendent's house. It is marked with tacks B. $\overset{1}{\odot}$ M. Elevation, 330.46.

B. M. 2, 1892, is highest point of railroad spike driven horizontally into south side of an oak pile standing 21.6 feet below elevator and 2.3 feet east of east line of elevator. It is marked with tacks B. $\overset{2}{\odot}$ M. Elevation, 331.69.

The bulletin is placed on top of the elevator warehouse. All of the plates and frame were repainted.

Gauge at Morrissons, Mo. Distance from Cairo, 69 miles R. Latitude, 36° 34′+700m. Longitude, 89° 29′+980m. Miss Bettie Morrisson, observer. November 21, 1892.—The gauge is located opposite upper side of yard surrounding the Morrisson residence, 1¼ miles above the main street of New Madrid, Mo. The gauge is now in seven sections, and only the upper one (from 34 to 43 feet) is permanent. This section is nailed to a sycamore tree standing at southeast corner of yard around the Morrisson residence.

The other sections are 2 by 6 inch scantling driven at intervals down the sloping bank and read as follows: Section 2, 30 to 34.3 feet; section 3, 26 to 30 feet; section 4, 20 to 27 feet; section 5, 13 to 20 feet; section 6, 10 to 16 feet; section 7, 0 to 10 feet.

All of these sections were set and driven as firmly as practicable. Section 4 was found to be 0.53 feet too low. All of the other sections were corrected within 0.1 foot. These sections all are temporary and may readily be destroyed by drift or other causes. The bank has a gentle slope and does not cave, particularly since the bar has formed in the bend. This bar connects with the shore about a mile above the gauge, and from about the 10-foot stage down the readings are taken in a pocket and hence do not bear the proper relations to the higher-stage readings, as the gauge registers the elevation of the water surface at or below the foot of the bar. The readings below the stage where the bar cuts off the water are therefore too small by about 0.2 feet. This would apply to the low-water readings of the past two or more years.

This gauge will be discontinued when the relations between it and the new gauge at New Madrid have been determined.

Gauge at New Madrid, Mo. Distance from Cairo, 70.3 miles R. Latitude 36° 35′. Longitude 89° 31′. W. O. Smith, observer. November 22, 1892.—A gauge was established at the mouth of St. Johns Bayou, on lower side of same, 860 meters above the main street of New Madrid, Mo.

The banks in front of New Madrid are very high and are chiefly a light, sandy soil. They cave badly and a gauge could not be maintained below the mouth of St. Johns Bayou. The caving is not so extensive in this vicinity, and the sloping bank of the bayou made it practicable to put in a sloping gauge from 9.4 to 23.8 feet. The bayou is used for running out logs at medium to high stages, and an upright gauge could not be maintained there on that account.

The local effect of the bayou may be felt in the stage readings. But as the gauge is only a few feet from the river it does not seem probable that the influence of the bayou can be very great.

Below 9.4 feet a temporary gauge must be used.

The sloping gauge consists of a 6 by 8 inch timber, placed near the ground and held in place by being driftbolted to 10 by 12 inch posts set 5 feet deep at intervals of 6 feet. The feet and tenths are marked by notches cut in the surface of this timber, the figures at footmarks being put in with tacks.

The sections above the 23-foot mark are firmly spiked to trees and are practically permanent.

An iron bulletin was erected on the high bank just above the sawmill.

A tile and pipe B. M. and a tree B. M. were established from B. M. $\frac{17}{3}$ with a duplicate line of levels, and a line was also run from B. M. 4 at Morrissons. There is a discrepancy in the determinations of the values of these two benches of 0.24 feet.

The elevation of the zero of the New Madrid gauge was made the subject of special investigation in May, 1890 (see note book 1872), and a line of duplicate levels were run from P. B. M. 22 and connecting on the way with B. M. $\frac{20}{2}$, $\frac{19}{1}$, $\frac{17}{3}$, $\frac{18}{1}$, B. M. 4, and $\frac{16}{3}$. This line showed a discrepancy between $\frac{17}{3}$ and B. M. 4 of 0.27 feet, which differs only 0.03 feet from that found in this inspection. The other values were found to accord with previous determinations, so that the fact is well established that B. M. 4 is practically correct, while $\frac{17}{3}$ is too low 0.255 feet.

The elevation of the zero of the gauge and gauge bench-marks at New Madrid are based on this conclusion and are as follows: Zero of gauge, 275.72, above Cairo datum.

B. M. 1, 1892, is tile and pipe set in woods about 200 feet north of gauge. It is near wagon road and on line between an osage orange tree 6 inches in diameter and a thorn tree 12 inches in diameter. It is 6.5 feet from the osage orange tree and 26.5 feet southeast of the thorn tree. Both trees are blazed on side toward B. M. and the thorn tree is marked B. M. 1, with tacks. Elevation above zero of gauge pipe 27.83 feet, tile 22.86 feet.

B. M. 2, 1892, is nail in root of gum tree standing north of sloping gauge. It is the first tree south of sycamore on which section of gauge is nailed.

Section 22.5 to 32 feet is firmly spiked to river side of a 24-inch sycamore tree standing 75 feet north of sloping gauge.

Section 31.7 to 45 feet is spiked to southwest side of an 18-inch gum tree, standing 30 feet northwest of above-described sycamore. It is 100 feet southeast of pipe B. M. and nearly on line between sycamore and pipe B. M.

Gauge at Cottonwood Point, Mo. Distance from Cairo, 123.0 miles. R. Latitude, 36° 03′ + 1460^m. Longitude, 89° 41′ + 290^m. H. C. Garrett, observer. November 24, 1892.—This gauge is located directly in front of Dr. Tipton's house, at Cottonwood Point, Mo.

All of the sections, except the high-water section (35 to 40 feet), are temporary. The high-water section is firmly spiked to the downstream side of a large cottonwood tree standing in front of and near the schoolhouse. The other sections are posts and stakes of various kinds set at intervals down a gently sloping bank. Several of the upper sections were set near Dr. Garrett's house, about 3,000 feet above the present location, which coincides with original location of gauge. The highest section (36 to 41 feet) at Dr. Garrett's was 0.12 foot too high and the sections from 16 to 25 feet were about 0.1 foot too low. The sections at Dr. Tipton's were practically correct.

As rebuilt opposite Dr. Tipton's, the sections are as follows: Section 1, 0 to 3 feet; 2, 3 to 6.5 feet; 3, 6 to 12 feet; 4, 12 to 14.2 feet; 5, 14 to 18.9 feet; 6, 18.9 to 23.5 feet; 7, 23.5 to 31 feet; 8, 31 to 36 feet; 9, 35.3 to 40 feet.

The old bulletin was out of order and was replaced by an iron one.

A duplicate line of levels was run from B. M., △ north base, near Dr. Garrett's house, to a pipe and tile B. M., which was set near the gauge at Dr. Tipton's and described as follows:

B. M. 1, 1892, is pipe and tile set just back of bulletin at northwest corner of yard surrounding Dr. Tipton's house. Elevation above zero of gauge, pipe, 36.81; tile, 32.83.

Gauge at Fulton, Tenn. Distance from Cairo, 175.4 miles L. Latitude, 35° 37′ + 175^m; longitude, 89° 53′ + 115^m. W. W. Butler, observer. November 25, 1892.—This gauge is located on the left bank (downstream side) of a prominent gully situated about 400 feet above the landing at Fulton, Tenn. All of the sections should be classed as temporary, as they are composed of scantling and posts set at intervals down a sloping bank.

All of the sections standing were found correct except 31.5 to 36 feet, which was 0.23 foot too low, probably caused by settling of warehouse, as it was attached to one of the blocks supporting same.

The gauge was rebuilt from 13 to 36 feet. The sections from 0.0 to 34.5 feet are at original location of gauge. A high-water section 31.5 to 36 feet was spiked to one of the posts supporting the lower side of the warehouse at landing.

The bulletin was repaired and repainted.

A duplicate line of levels was run from P. B. M. 42 in order to establish a tile and pipe B. M. near the gauge to take the place of the old gauge B. Ms., which have been destroyed.

B. M. 1, 1892, is a tile and pipe B. M. set back or inland from gauge about 75 feet. It is near foot of bluff on right bank (upstream side) of gully, and about 400 feet above Fulton Landing. It is about 110 feet back of (south) vertical face of bluff lying along river, just above mouth of said gully. On this bluff stands a building marked "U. S. Engineer Office."

The B. M. is on line between a 24-inch gum tree, standing on the flat ground, and a 15-inch beech tree standing at top of hill.

B. M. is about 10 feet east of gum tree and about 45 feet west of beech tree. Both trees are blazed on side toward stone, and gum tree is marked with tacks B. M. 1. The elevation is: Pipe, 37.87; tile, 33.89 above zero of gauge. A tree marked B. M. A. reads 36.63 feet on gauge. A tree B. M. B. reads 33.10 on gauge. These tree B. Ms. were probably set by the construction party at Plum Point.

Gauge at Mhoon Landing, Miss. Distance from Cairo, 277.3 miles L. Latitude, 34° 43′ + 1,750^m. Longitude, 90° 28′ + 80^m. G. E. Thomas, observer. November 28, 1892.—This gauge is located on the left bank of the river 1,685 meters below B. M. $\frac{L}{2}$, about a mile and a half below the original location of gauge and just above the present Mhoon's Landing.

All of the sections of this gauge, except the upper one, are temporary posts set at intervals down a sloping bank. The gauge was rebuilt from 0 to 40 feet. All of the gauge at this point, except the high-water section, which is nailed to a tree, was destroyed about August 15, 1892, by the bank settling down bodily, and the observer read on a temporary peg from that time to date of inspection.

As rebuilt the sections read as follows: Section 1, 0 to 6 feet; 2, 6 to 11 feet; 3, 11 to 16 feet; 4, 16 to 25 feet; 5, 25 to 31 feet; 6, 29 to 35 feet; 7, 35 to 40 feet. The latter is spiked firmly to a large cottonwood tree. A ship spike is driven in upper side of same tree with upper side of head reading 35 feet on gauge.

A duplicate line of levels was run from B. M. $\frac{L}{2}$ to establish these sections of the gauge.

The bank in the vicinity of the gauge is in bad condition and the gauge consequently in danger of being destroyed at any time. The bulletin is in good condition, but is the grooved style, which is very difficult to manipulate.

It will be noticed that the present position of the gauge is nearly 2 miles below its original position, and the zero is kept at the same elevation. It was moved down in consequence of a fill in the bend.

The slope for the above distance at high water would be about 0.9 foot; hence the gauge relations between this gauge and those at Helena and Memphis have changed by this amount. That is, to compare with the gauge relations in its old position, the present readings should be about 0.7 foot greater than they new are.

The difficulties of maintaining the gauge in its present position on account of caving banks, its remoteness from reliable observers, the fact that it is no longer in its true relations with the gauges above and below, and that the zero is nearly 2 feet above low water, suggests the desirability of moving it.

An excellent place could be found for it, free from most of these defects, on the right bank near foot of Bordeaux Island, about 5 miles below its present site.

It could be set just far enough above the mouth of the "Old River" to protect it from caving and the drift, and in this position would remain intact for a long time. It would be about 50 miles from the Memphis gauge.

Gauge at Sunflower Landing, Miss. Distance from Cario, 352.7 miles L. Latitude, 34° 10′ + 655 ^{m}. Longitude, 90° 48′ + 865^{m}. S. F. Bunch, observer. November 29, 1892.—This guage is situated on the left bank of Mississippi River at mouth of Hushpucana Creek and a few feet above Sunflower Landing.

At this gauge the two upper sections, 28.5 to 39 feet and 37 (?) to 43 feet, may be considered permanent, as they are spiked to trees. The other sections are 2 by 6 inch posts set at intervals down the bank and consequently temporary.

The limits of the temporary sections are as follows: 1, 0 to 7 feet; 2, 6 to 11 feet; 3, 11 to 15 feet; 4, 15 to 19 feet; 5, 17 to 21 feet; 6, 20.5 to 25 feet; 7, to 24.5 to 29 feet.

The section in the water at the time of inspection read 5.68, while the levels from the upper high-water section made it 7.53. That is the readings were too small by 1.85 feet. The next standing section above the one in the water read from 23 to 31, and its readings were only 0.06 foot too small.

The observer could not offer any explanation of the discrepancy, except that on one or more occasions he had set his gauge arbitrarily, in consequence of its having been disturbed by settling with the bank. The only alternative, therefore, seems to be to consider the error cumulative and correct the readings accordingly below the 23-foot mark.

All of the sections from 0 to 28.5 were reset.

The bulletin was found to be in good condition, but is very difficult to manipulate.

This gauge zero is 0.15 foot too low according to the determinations of the levee engineers, who claim to have found a discrepancy of that amount in elevation given for B. M. $\frac{4}{1}$ as determined by running duplicate lines from a P. B. M.

Gauge at Arkansas City, Ark. Distance from Cairo, 438.3 miles R. Latitude, 33° 36′ + 180^{m}. Longitude, 91° 12′ + 680^{m}. J. M. Whitehill, observer. November 30, 1892.—This gauge is located on the railway incline a short distance below the elevator or freight house at Arkansas City. All of the old sections were found to be correct within 0.1 foot; all are attached to piling and consequently are quite stable. The high-water section, 39 to 51 feet, is attached to piling near water tank, standing about 125 meters above freight warehouse or elevator.

Sections of the gauge read as follows: 1, 0 to 8 feet; 2, 5 to 14 feet; 3, 13 to 20 feet; 4, 19.5 to 29 feet; 5, 27 to 42 feet; 6, 39 to 51 feet.

The first four sections are attached to the piling of the railway incline. The fifth section is on pile in front (river side) of water tank above elevator and near the sixth section.

The bulletin was rebuilt at the upper corner at the warehouse.

Coast survey P. B. M. F. was connected with and its elevation reads 42.43 feet above zero of gauge.

The gauge zero was determined by levels in duplicate from B. M. A. (Ewens, 1886) and P. B. M. F. (Coast Survey).

Gauge at Greenville, Miss. Distance from Cairo, 478.3 miles, L. Latitude 33° 24′ + 1,380^{m}. Longitude, 91° 04′ + 90^{m}. W. M. Green, observer. December 2, 1892.—This gauge is on the downstream row of piling supporting the garbage dump at foot of Main street, Greenville, Miss., and is quite stable. All of the sections except the upper one (41.5 to 45.5) were found to be correct within 0.1 of a foot. The foot marks being worn, the old sections from 16 to 45 feet were replaced by new ones. The short section (41.5 to 45.5) was left standing attached to a pile near shore end of dump.

The building on which P. B. M. 1, C. and G. S., was placed is now called "City Jail" instead of "Bank Building." B. M. A. 1892 was set at First National Bank building on first corner of Main street east of city jail and on south side of said street. It occupies the same position on iron door sill of bank building as P. B. M. 1 does on sill of city jail. It is 43.55 feet above zero of gauge and 0.24 feet above P. B. M. 1, Coast and Geodetic Survey.

The bulletin is near the gauge and is in good condition.

This gauge is also watched at high water by the levee engineers, and hence the record at this period may be accepted as reliable.

Gauge at St. Joseph, La. Distance from Cairo, 648.3 miles, R. Latitude 31° 53′+1,492ᵐ. Longitude 91° 14′+630ᵐ. Robert Worrell, observer. December 4, 1892.—This gauge is situated about half a mile below the town of St. Joseph, La., and near the residence of Capt. Robert Worrell. The high-water section, 40 to 46 feet, is spiked to the levee side of a large cottonwood tree standing a short distance above warehouse and on river side of "front levee." A large ship spike is driven in same tree at 41-foot mark.

The other sections are 2 by 6 inches set at intervals down the bank and read as follows: Section 1, 0 to 4 feet; 2, 3.5 to 9 feet; 3, 8.5 to 13 feet; 4, 12 to 17 feet; 5, 16 to 21 feet; 6, 21 to 27 feet; 7, 26 to 32 feet; 8, 31.5 to 38.9 feet; 9, 30 to 41 feet. These sections are located about 500 feet below Capt. Worrell's house.

All of the sections of the old gauge, the bulletin, and also B. M. A., Ewens, were destroyed by a sudden caving of the bank, at which time a large area sank bodily into the river. The temporary gauge in the water was found by duplicate line of levels from B. M. No. 1, Hider (1881), to be 1.03 feet too high; that is, readings were too small by that amount. The observer could not account for the discrepancy, but thought most of the error came in after the caving noted above. The observer had pegged down the bank, as the water receded, from the 30-foot stage and part of the time the readings were taken during Mr. Worrell's absence by a young clerk, and the blame of the discrepancy seemed to rest on the latter.

There is, however, no well-defined break in the results, and the discrepancy can only be adjusted by regarding it as cumulative.

A new iron bulletin was erected a short distance above Mr. Worrell's house.

Gauge at Bayou Sara, La. Distance from Cairo, 799.8 miles, L. Latitude 30° 45′+1,615ᵐ. Longitude 91° 23′+810ᵐ. L. H. Chisholm, observer, December 6, 1892.—This gauge is directly in front of the residence of Mr. B. T. White, situated on Front street, about 500 meters below the mouth of Bayou Sara. It consists of sections set at intervals down the sloping bank, with the exception of the upper sections, which are nailed to the sheet piling protecting the levee in front of Mr. White's house.

The errors found in the sections were less than 0.1 feet.

The gauge was rebuilt from 17.0 to 42.7 feet, and sections are arranged as follows: section 1, 0 to 7 feet; 2, 7 to 12 feet; 3, 11.5 to 17 feet; 4, 17 to 23 feet; 5, 21 to 28 feet; 6, 27 to 42 feet; 7, 38 to 42.7 feet. The two latter are nailed to the piling. The sections are nearly in line.

The levels were derived from B. M. A., Ewens (1889), which is in west front of Mr. White's house.

The bulletin is about 200 meters below mouth of Bayou Sara. It is very difficult to manipulate.

Gauge at Plaquemine, La. Distance from Cairo, 854.1 miles, R. Latitude 30°17′+1,170ᵐ. Longitude 91°13′+1,365ᵐ. Frank Turner, observer. December 7, 1892.—This gauge is situated at steamboat landing near foot of Main street, at Plaquemine, La. It consists of 2 by 6 inch sections set at intervals down the bank, at such points in the vicinity as promise the greatest degree of permanence. The gauge can only be maintained by vigilance and care of the observer, as it is so exposed to steamboats, rafts, and drift that the life of a section is generally very brief.

The levels were derived from B. M. A., Ewens (1883), and the zero of the gauge was found to be 0.21 feet too low.

A new low-water section (0 to 5 feet) and a new high-water section (28 to 35 feet) were placed. No sections were placed between them, owing to the impracticability of making them even in a slight degree permanent.

The point opposite would be an easier place to maintain this gauge.

The bulletin was demolished by a steamer during the high water in June, and the old bulletin was put up.

The large bulletin was put up at time of inspection about 140 meters below Main street, and on river side of levee.

Gauge at College Point, La. Distance from Cairo, 904.5 miles, L. Latitude 29° 59′+830ᵐ. Longitude, 89° 49′+500ᵐ. Ernest Subra, observer. December 8, 1892.—This gauge is situated at College Point, almost directly in front of Jefferson College. It consists of 2 by 6 inch posts set at intervals down a sloping bank and a high-water section spiked to a tree a short distance below the other sections of the gauge. Another high-water section (21.5 to 26.5) is nailed to the bulletin frame at ferry landing which is a short distance above the gauge.

All of the sections were found to be practically correct and read as follows: Section 1, 0 to 9 feet; 2, 6 to 17 feet; 3, 15 to 22 feet; 4, 21 to 28 feet. Levels were derived from the high-water section.

The bulletin is the grooved form for the figure plates. It is in good condition, but very difficult to manipulate.

This gauge is on the extreme end of College Point, and no difficulty is found in maintaining it. This suggests that on the stable banks of the river below mouth of Red River the gauges should all be on the points rather than in the bends.

Gauge at Fort Jackson, La. Distance from Cairo, 1,039 miles, R. Latitude, 29° 21 + 1,000^m. Longitude, 89° 27′ + 830^m. Peter E. B. Ostrom, observer. December 10, 1892.—This gauge is situated directly in front of ordnance sergeant's quarters and about 50 meters above the frame hospital building standing on river side of levee. It consists of a single post set vertically at the water's edge and braced from the top to the bank.

B. M. "A" is upper surface of a ship's spike driven horizontally into brick chimney at upper or west end of building known as "ordnance sergeant's quarters." The spike is in middle of the west face of the chimney, about 10 inches above the ground and in second course below weatherboarding of house. A × is cut in brick just under the spike. Top of spike reads 6.50 on gauge.

B. M. "B" is the upper surface of a nail driven in the brick pier supporting southwest corner of hospital building. Nail is in west face of said pier 2 inches from the southwest corner and between third and fourth courses below top of pier. H. is cut in pier just under nail. Top of nail reads 5.80 on gauge.

It should be noted here that the readings are affected by the tide and hence it is difficult if not impracticable to give accurately height of water due stage of river proper.

Gauge at Clarendon, Ark., on White River. W. N. Johnson, observer. December 13, 1892.—This gauge is in one section, attached to lower or downstream side of upper pier cylinder at east end of drawspan of Cotton Belt Railway Bridge crossing the White River at Clarendon.

The extreme high water reached 2 feet above the fixed gauge, and is read on a temporary gauge set by the observer near by.

Accumulation of drift at upper side of bridge sometimes affects the reading on gauge a few tenths of a foot.

The gauge proper is firmly attached to bridge, so that it is practically permanent.

The bulletin was replaced by a better one from one of the Mississippi River stations, instructions being left with observer to put it up in a conspicuous place at end of a new building in process of construction.

Gauge at Wittsburg, Ark., on St. Francis River. Miss Jimmie Smith, observer. December 14, 1892.—This gauge is located in the bend of the St. Francis River, just above the sawmill at Wittsburg, Ark.

From 3.8 feet to 43 feet the gauge is practically permanent, being firmly spiked to trees. Below the 3.8-foot mark temporary stakes are set to suit the changes in stage.

The gauge reads 3.5 feet below zero, and as the zero stage is passed there is much confusion in the records as to whether the stage is plus or minus. There is also considerable doubt as to the accuracy of the temporary gauge set at this point.

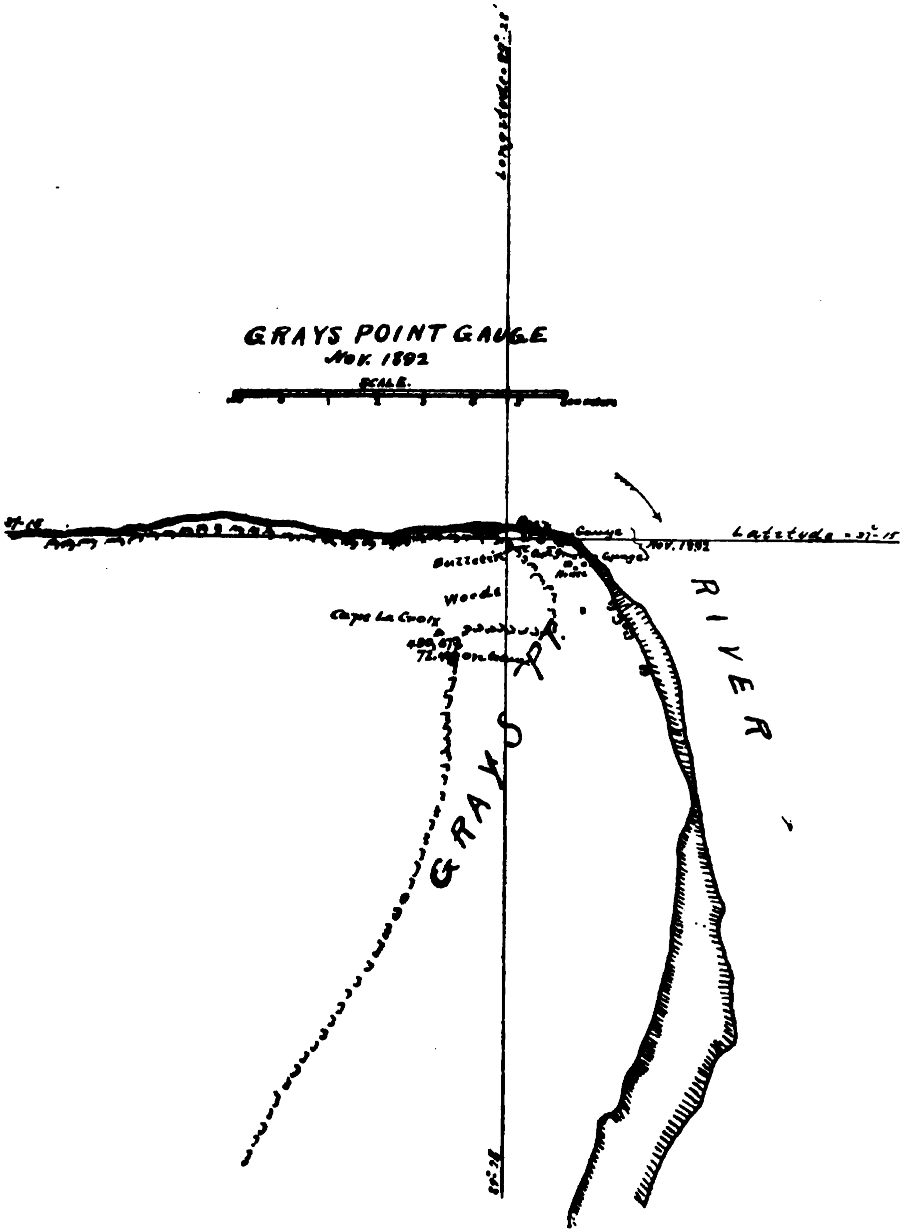
At time of inspection a sudden rise had just covered the temporary sections and they could not be tested. The bulletin is practically useless, as there are rarely any steamboats except at high water and even then the boats do not often come up as high as Wittsburg. The bulletin is small and of no value in any other situation.

It is intended to abandon this gauge and substitute for it a new gauge at the Iron Mountain Railway crossing, about 14 miles farther up the river. The Wittsburg gauge will be abandoned as soon as the relation between the two gauges are determined by a sufficient period of readings.

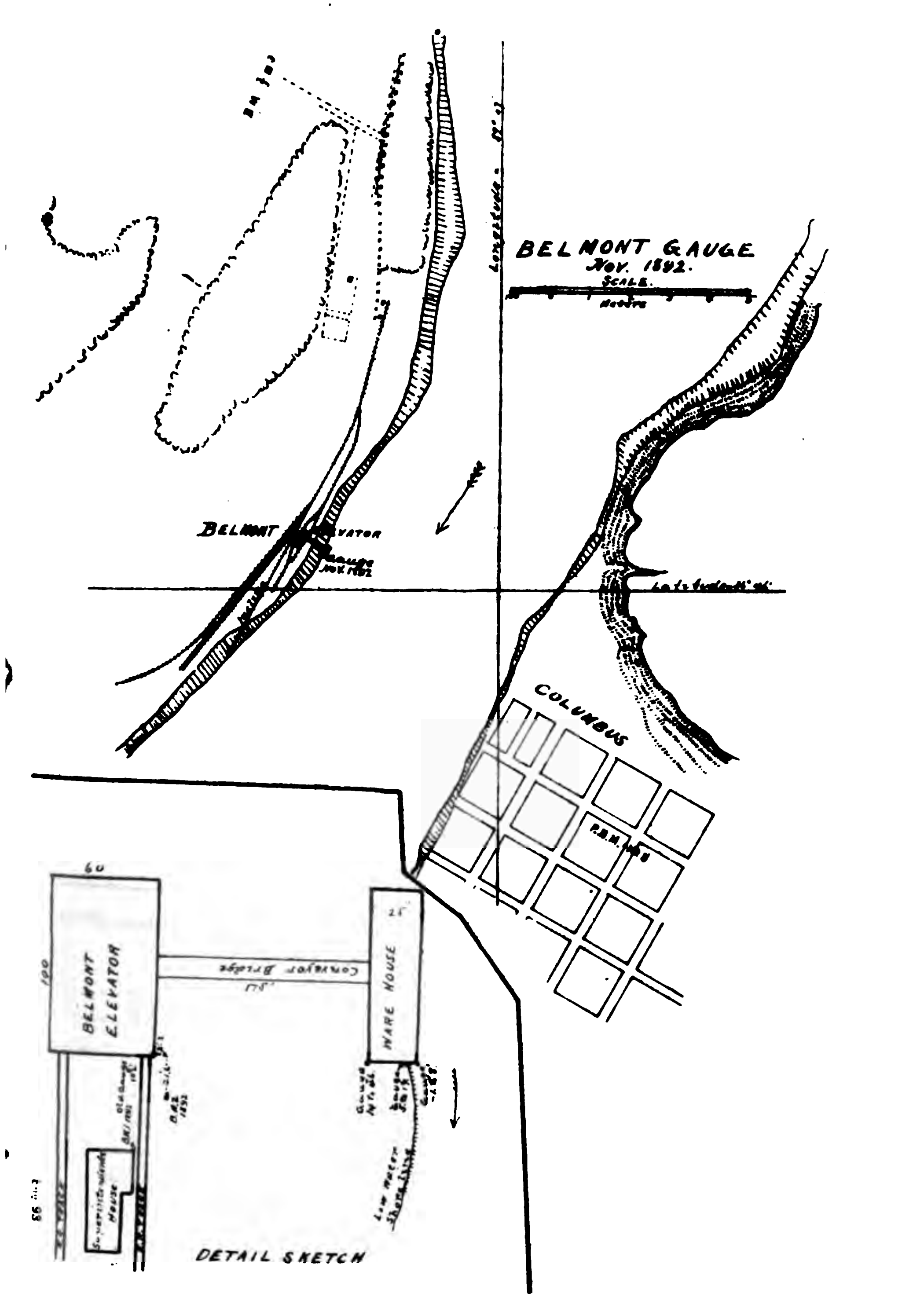
Gauge at Iron Mountain Railway Bridge across St. Francis River. G. W. Brown, observer. December 14, 1892.—This gauge from 6 feet up to high water is firmly attached in a continuous section to the trusses between the two cylinder piers at east end of draw of railway bridge across the St. Francis River, about 14 miles by river above Wittsburg, Ark. It is just below the upper cylinder at east end of drawspan of bridge. This gauge was placed December 14. The lower section will be placed when stage of water is low enough to permit. The bridge watchman, G. W. Brown, was appointed gauge-keeper. The result can be forwarded by mail from this point daily if desired.

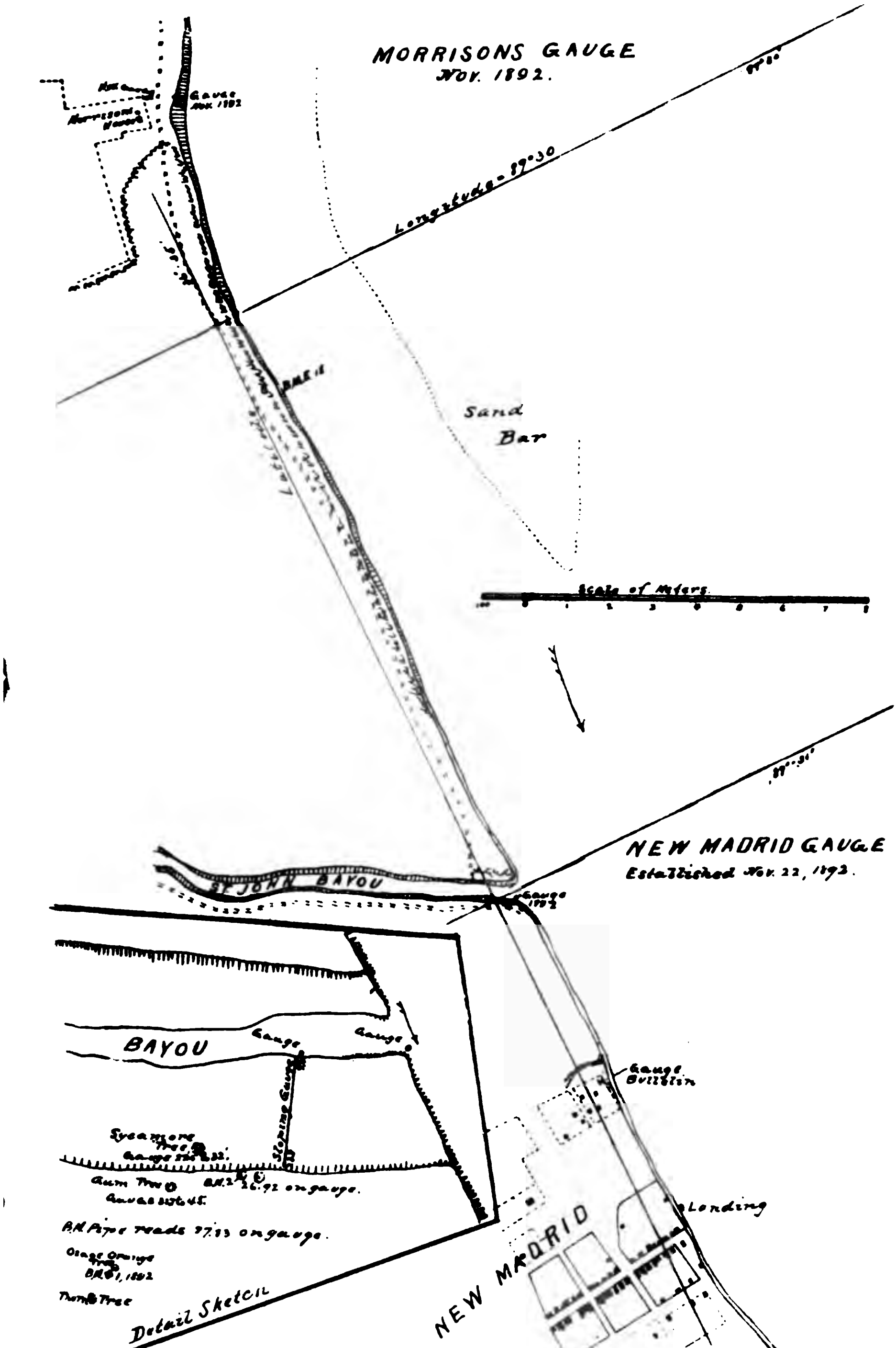
The upper side of bottom truss reads 9 feet on gauge. The upper side of upper truss reads 46 feet on gauge. The base of rail reads 53 feet on gauge. Railroad levels give base of rail = 229.5 feet above sea level, hence zero of gauge = 176.5 above sea level.

No bench marks were set, as the concrete piers were considered as permanent as any marks that could be made.



GRAYS POINT GAUGE
Nov. 1892
SCALE.
Gauge
Nov. 1892
Woods
RIVER
GRAYS PT.


BELMONT GAUGE
Nov. 1892.
SCALE.
BELMONT ELEVATOR
COLUMBUS
60
100
BELMONT ELEVATOR
Conveyor Bridge
175
25
WARE HOUSE
DETAIL SKETCH



MORRISONS GAUGE
Nov. 1892.
Longitude = 89°30
Sand
Bar
Scale of Meters
NEW MADRID GAUGE
Established Nov. 22, 1892.
ST JOHN BAYOU
BAYOU
Gauge
Gauge
Sloping Gauge
Sycamore Tree
Gum Tree
B.M. Pipe reads 27.13 on gauge.
Gauge Bulletin
Landing
NEW MADRID
Detail Sketch

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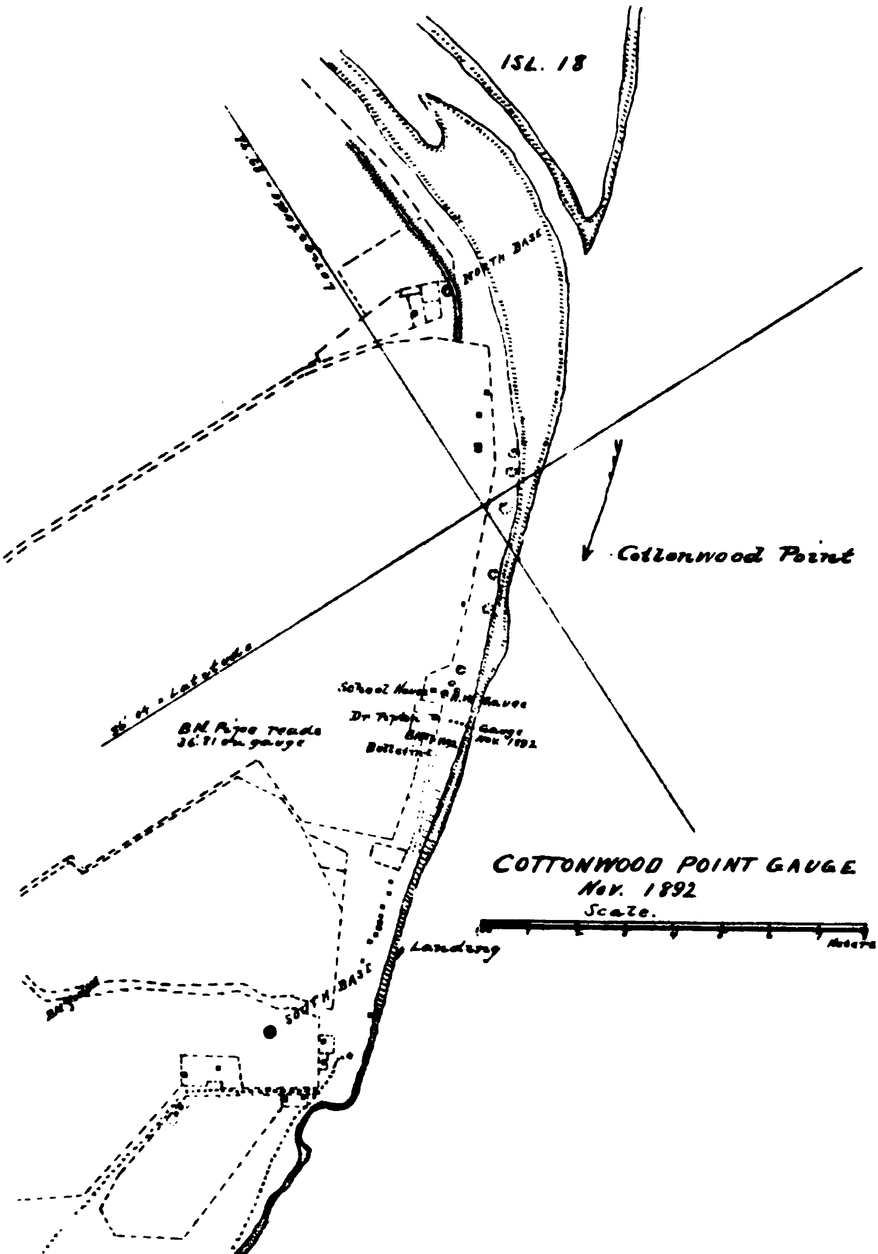
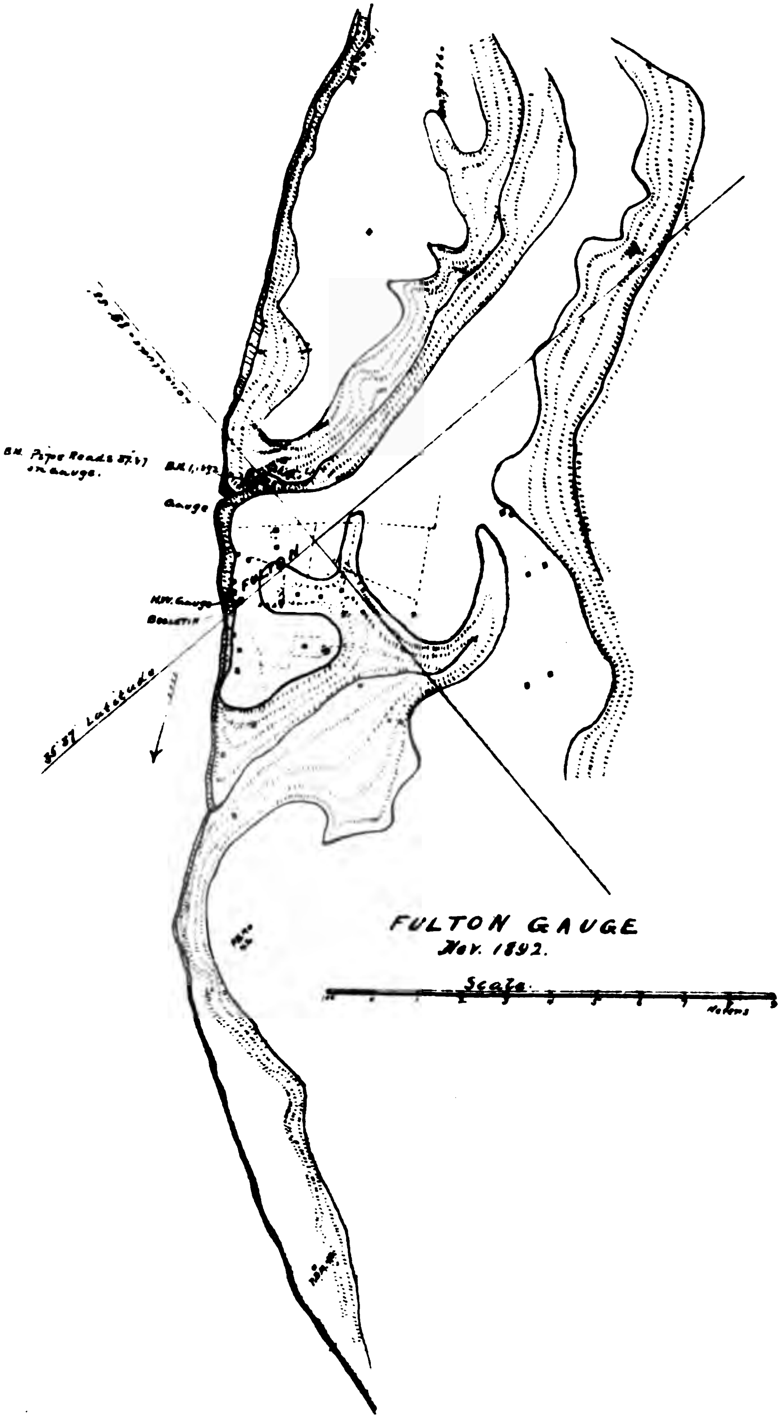
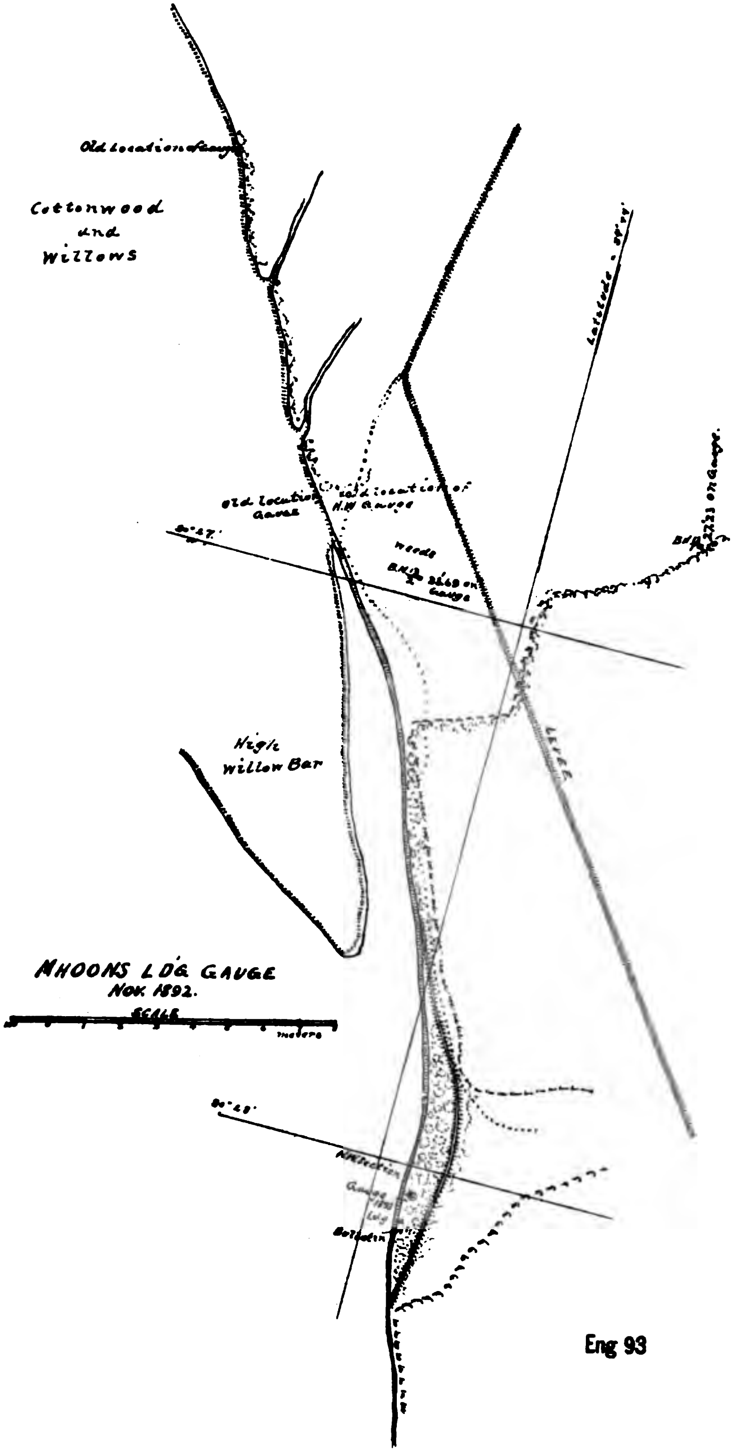
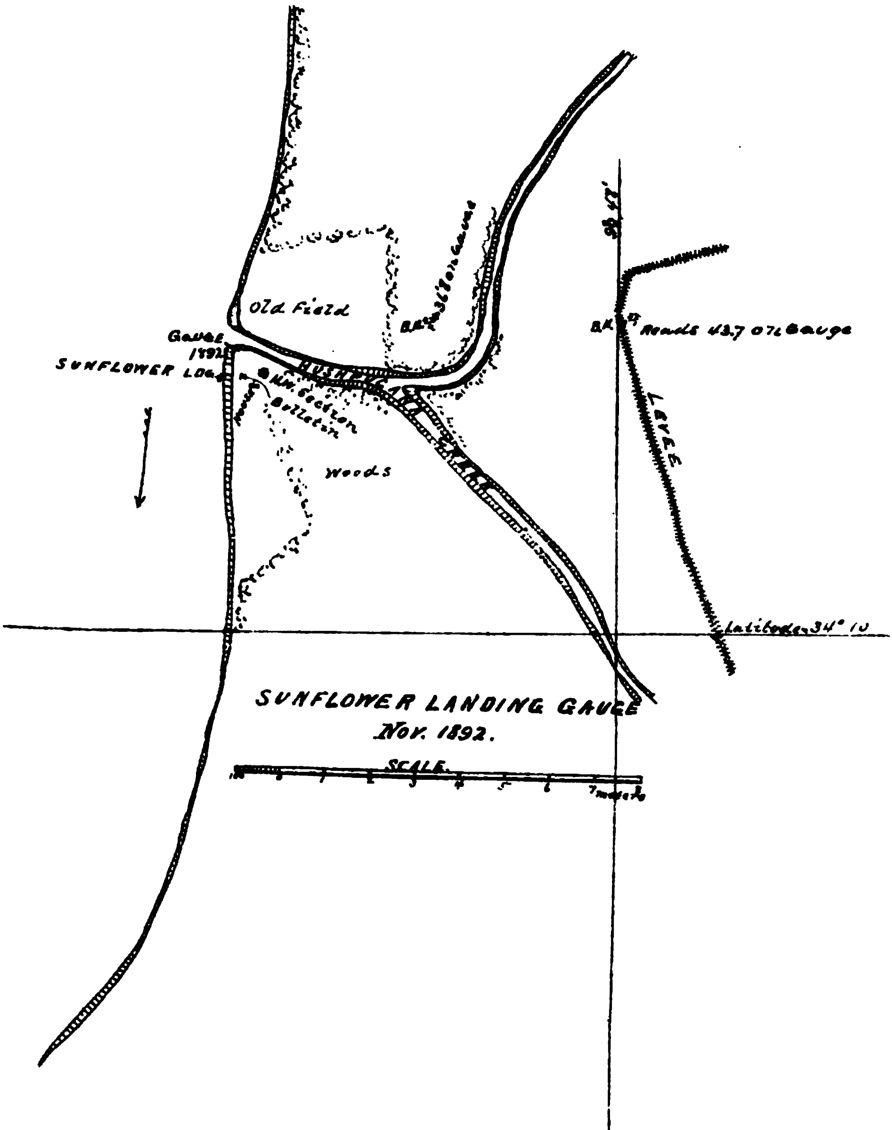

ISL. 18
NORTH BASE
Cottonwood Point
COTTONWOOD POINT GAUGE
Nov. 1892
Scale.
Meters
Landing
SOUTH BASE



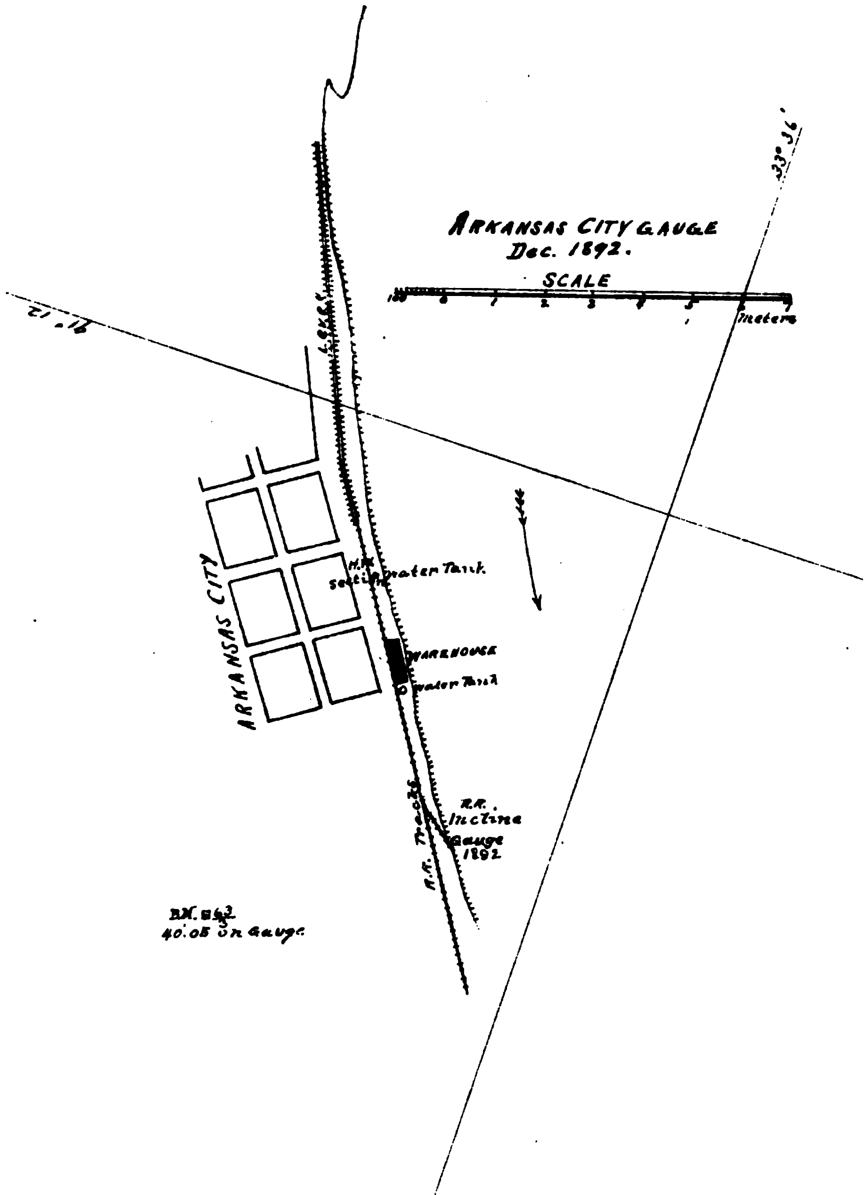
FULTON GAUGE
Nov. 1892.


Cottonwood
and
Willows
Levee
High
Willow Bar
MHOONS LDG GAUGE
NOV. 1892.
SCALE
meters

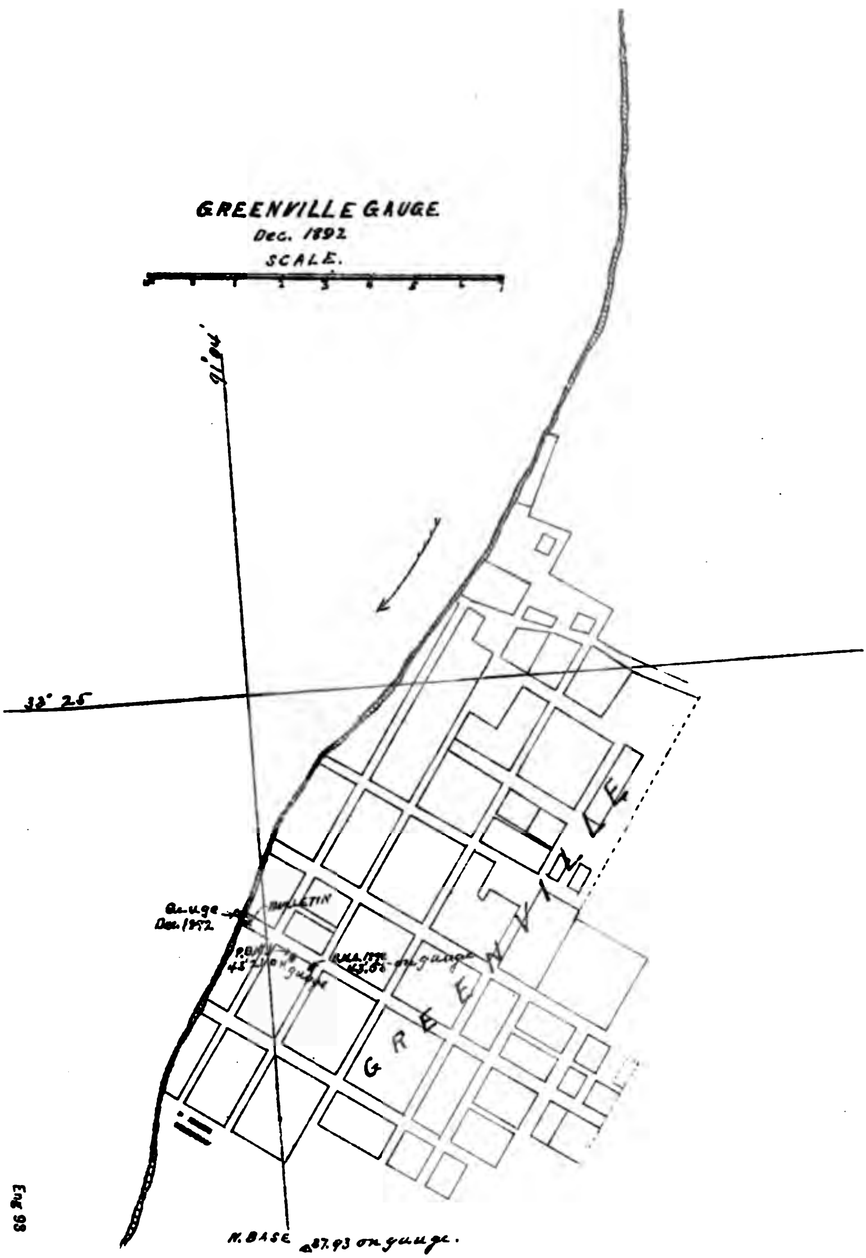
Eng 93

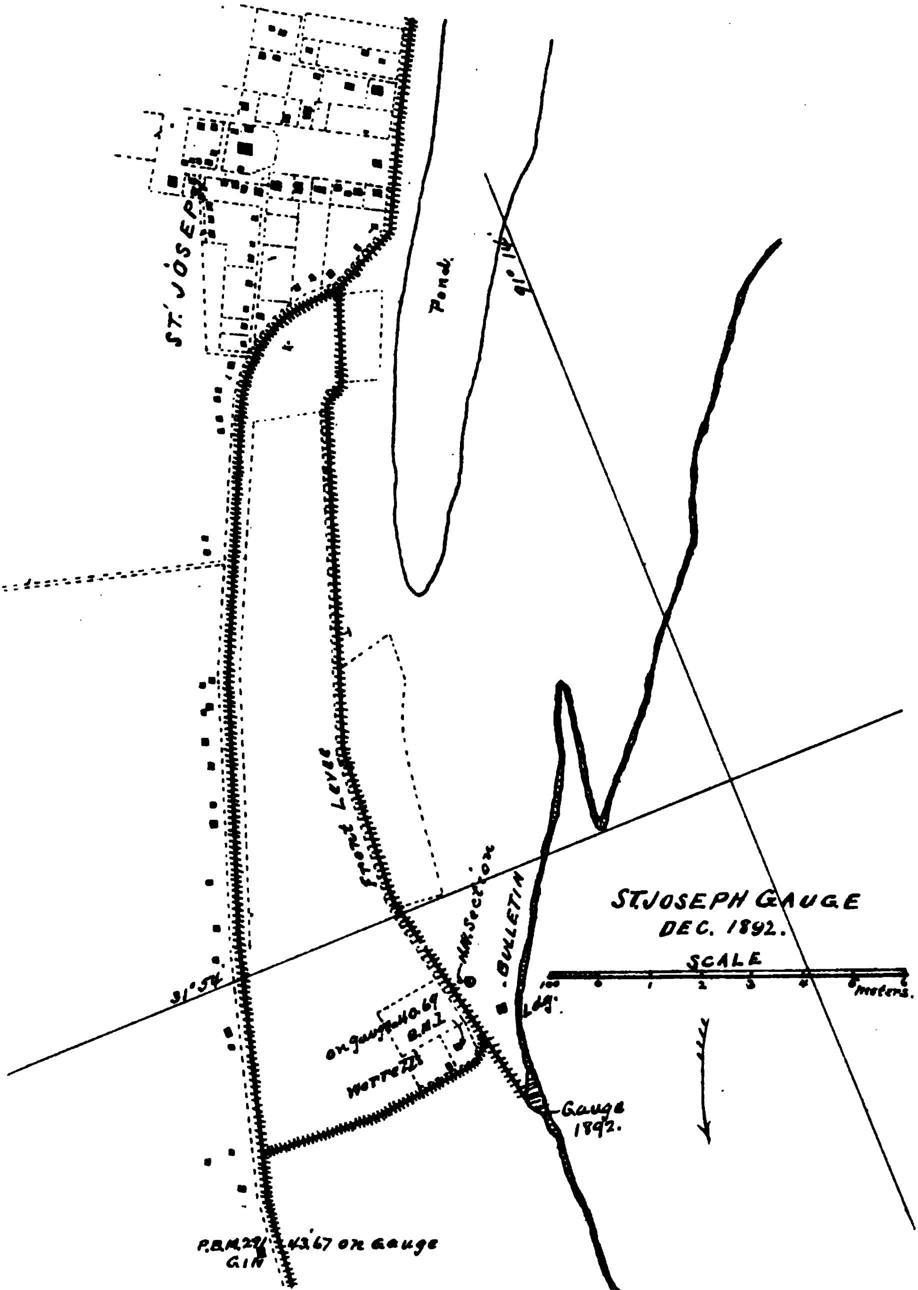


SUNFLOWER LANDING GAUGE
Nov. 1892.

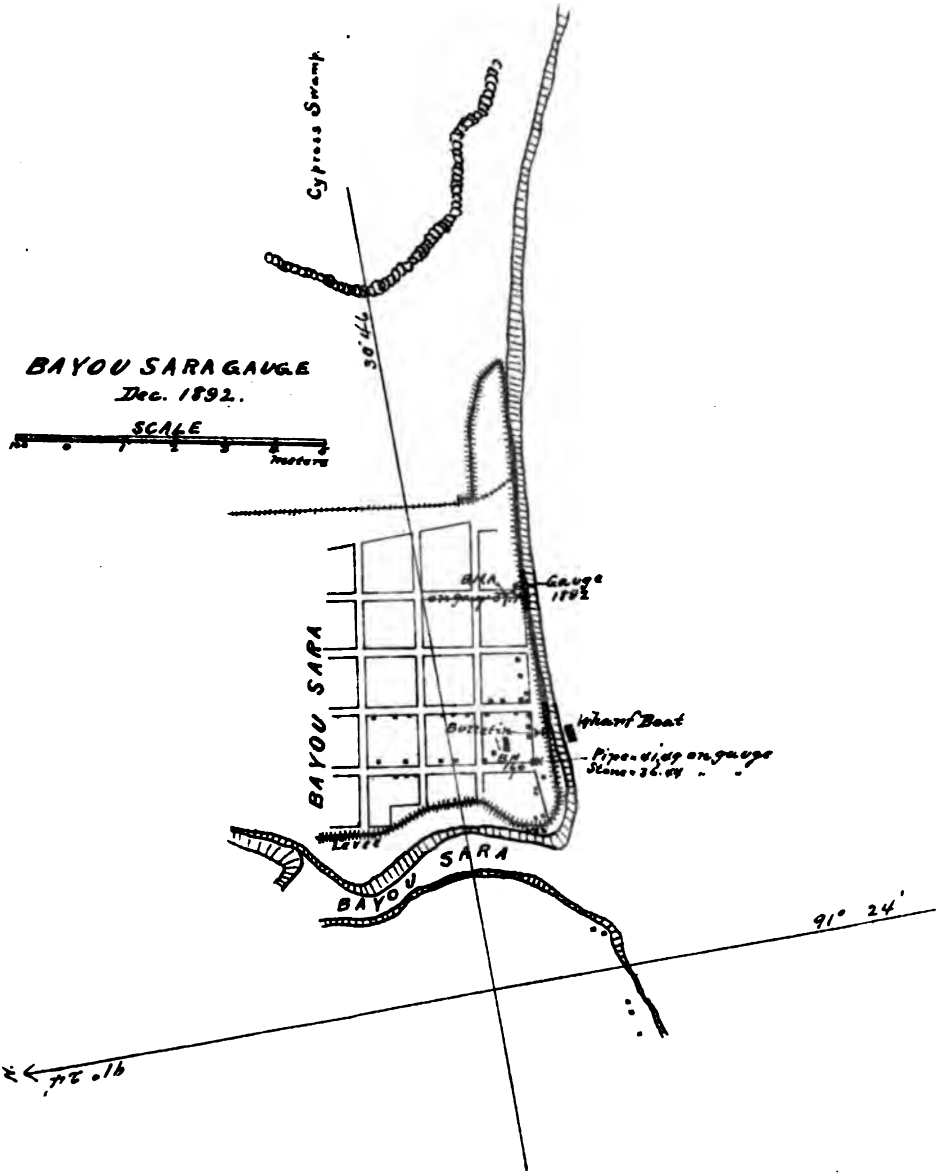

ARKANSAS CITY GAUGE
Dec. 1892.
SCALE
Meters
ARKANSAS CITY
water Tank.
WAREHOUSE
water Tank
R.R.
Incline
Gauge
1892
R.R. Tracks
40.05 on Gauge

Eng 93

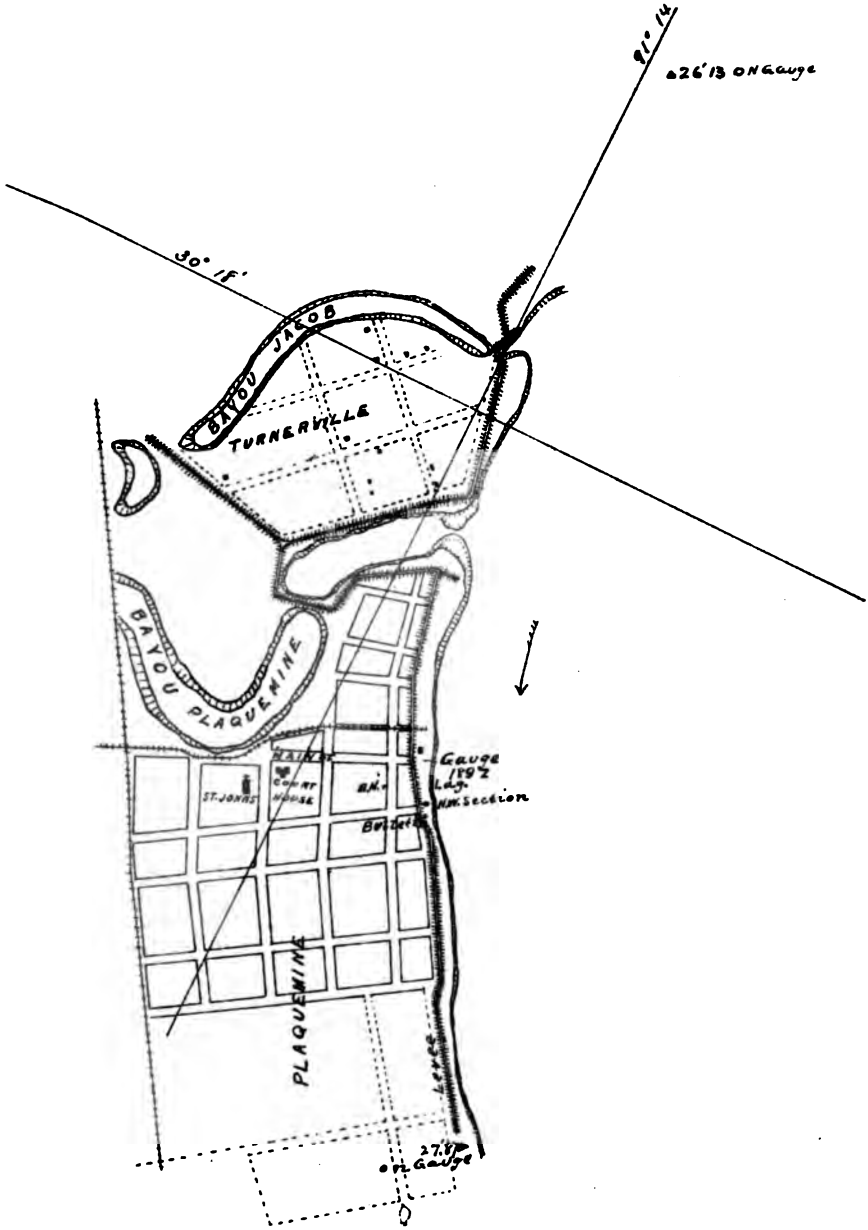

GREENVILLE GAUGE
Dec. 1892
SCALE.
91°04'
33° 25'
BULLETIN
GREENVILLE
N. BASE
37.93 on gauge.


ST. JOSEPH
Pond
91° 14'
Front Levee
BULLETIN
Bldg.
ST. JOSEPH GAUGE
DEC. 1892.
SCALE
meters.
31° 54'
Gauge
1892.
43.67 on Gauge

Eng 93



BAYOU SARA GAUGE
Dec. 1892.
SCALE
meters
Cypress Swamp
30°46'
BAYOU SARA
Gauge
1892
Wharf Boat
Bulletin
Levee
BAYOU SARA
91° 24'

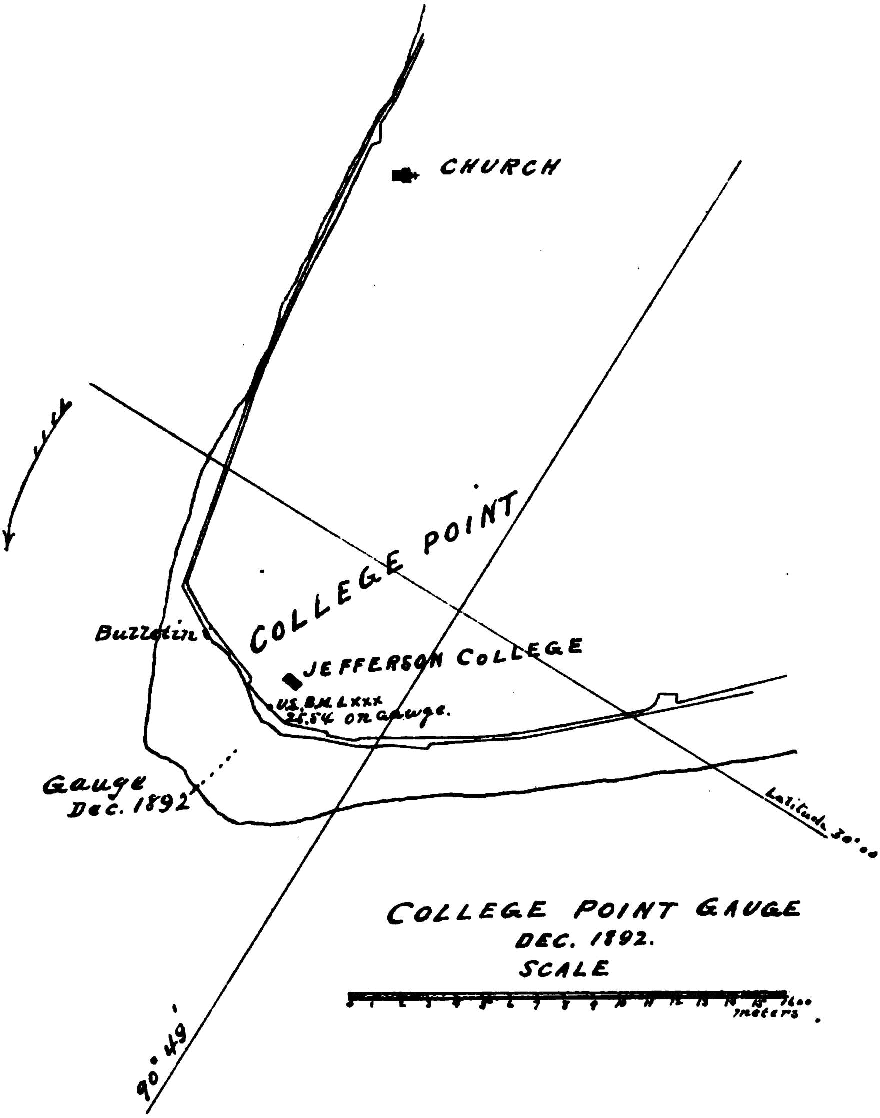


PLAQUEMINE GAUGE
DEC. 1892.

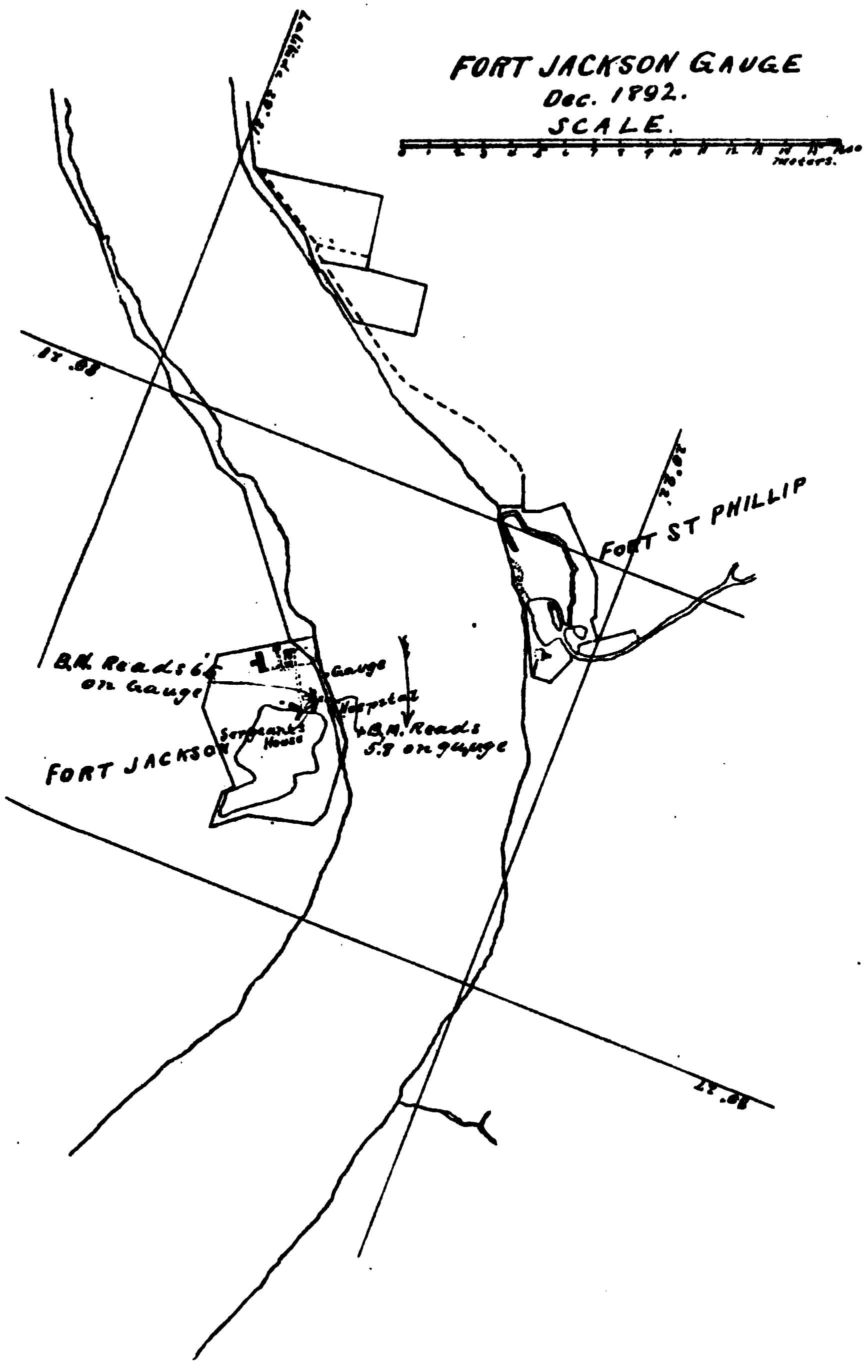
SCALE

metres

Eng 93

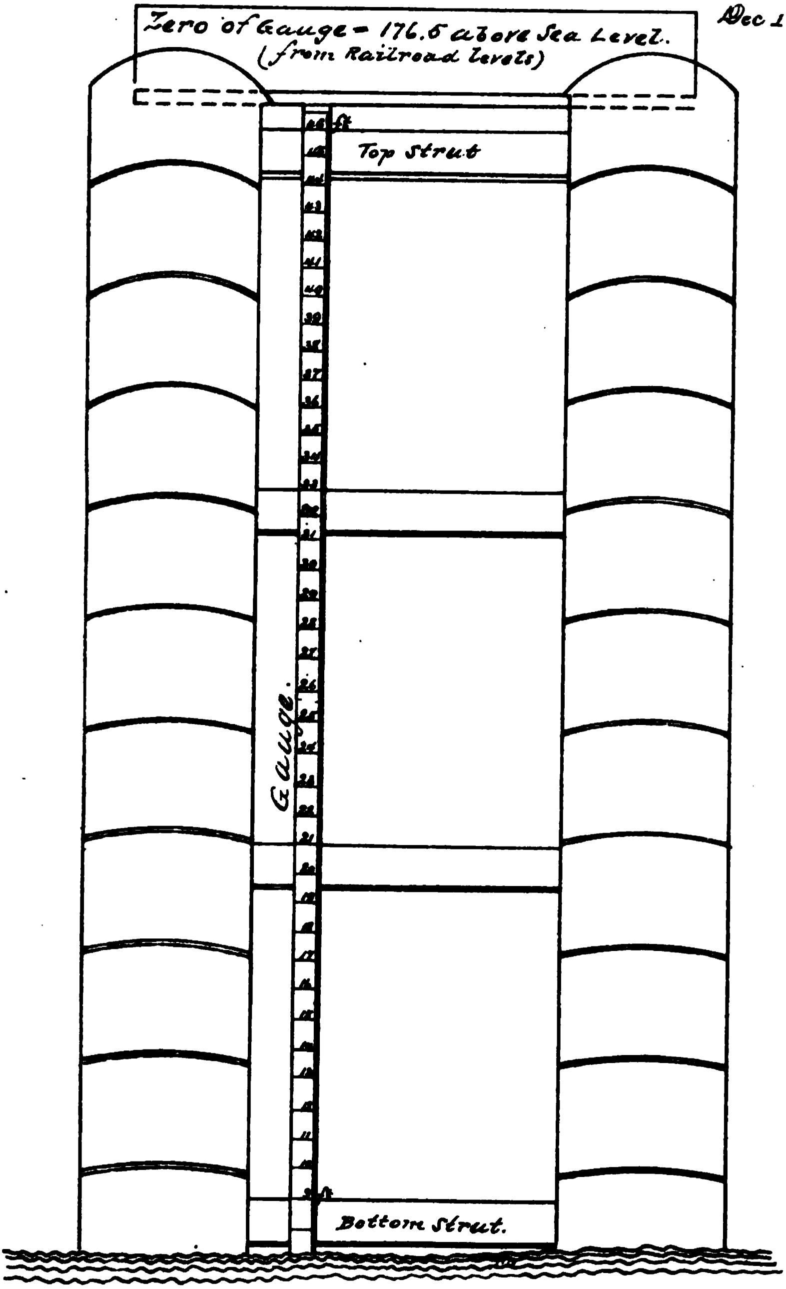


COLLEGE POINT GAUGE
DEC. 1892.
SCALE

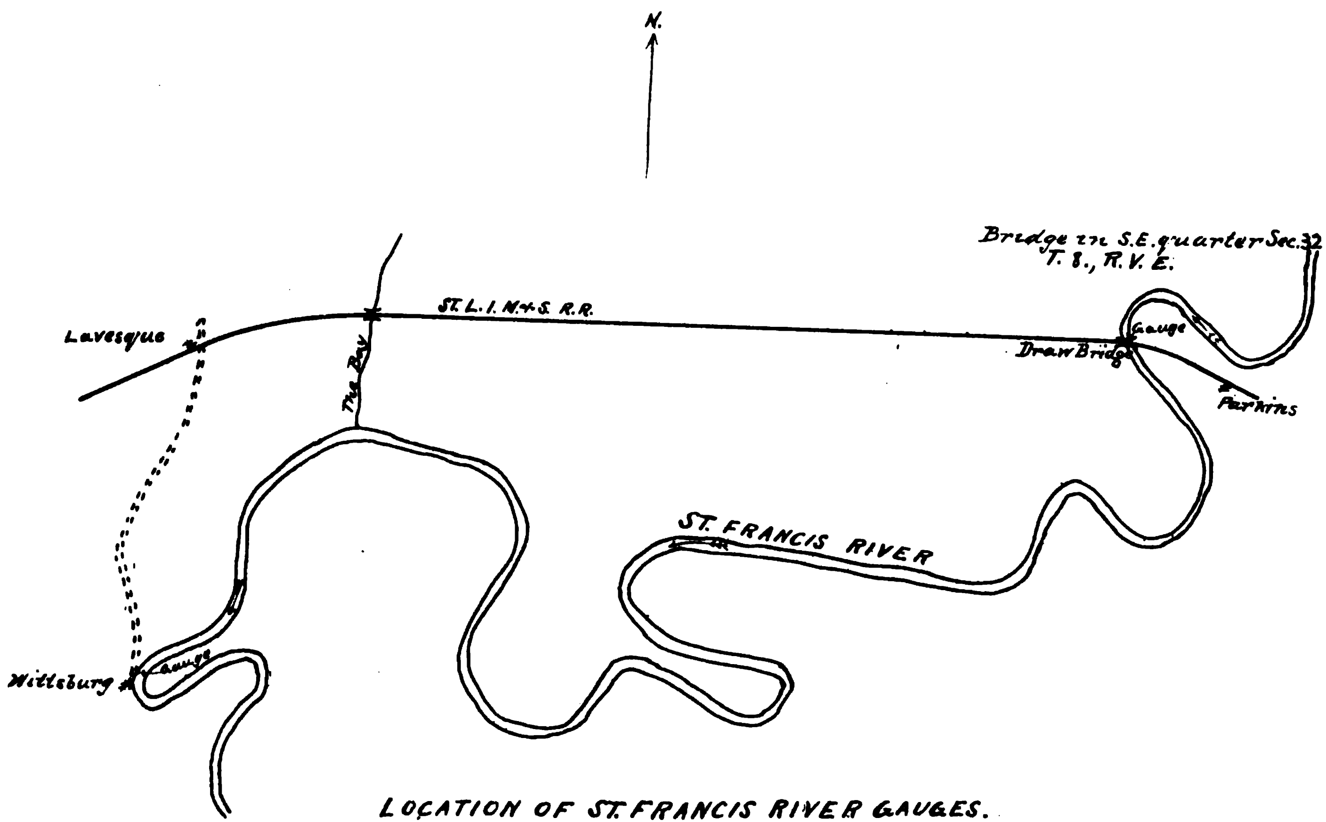

FORT JACKSON GAUGE
Dec. 1892.
SCALE.
Meters.
FORT ST PHILLIP
B.M. Reads 6.6 on Gauge
Gauge
Hospital
Sergeant's House
B.M. Reads 5.8 on gauge
FORT JACKSON

Eng 93

East pier St Francis River Bridge Memphis Branch of St L. I.M. & S.R.R. Showing location of gauge established Dec 14.1892.



Eng 93



LOCATION OF ST. FRANCIS RIVER GAUGES.
Draw Bridge Gauge Established Dec. 14, 1892.
Wittsburg Gauge Established June 29, 1884.
SCALE OF SKETCH, 1 in. = 1 mile.

Eng 93

APPENDIX 3 F.

Highest and lowest gauge-readings, 1892.

MISSISSIPPI RIVER.

[Gauge zeros are referred to Cairo datum plane, which is 21.26 feet below the (provisional) mean Gulf level.]

Zero elevation.	Station.	Stages. Highest. Date.	Stages. Highest. Gauge reading.	Stages. Lowest. Date.	Stages. Lowest. Gauge reading.
690.79	Hastings, Minn	May 26	13.1	Nov. 23	—0.70
660.34	Winona, Minn	May 26–7	13.1	Nov. 24	1.1
624.88	North McGregor, Iowa	May 31	15.8	Nov. 23	1.7
469.72	Hannibal, Mo	July 3	20.8	Dec. 21	—1.4
233.97	Grafton, Ills	May 18	215.85	....	....
400.23	St. Louis, Mo	May 19	35.95	Dec. 24	1.1
*361.30	Chester, Ills	May 21	31.20	Jan. 15	—1.8
321.28	Grays Point, Mo	May 22	35.00	Dec. 29–30	1.85
287.14	Belmont, Mo	Apr. 28	43.14	Oct. 28–9	2.68
275.80	New Madrid, Mo (Morrissons Landing)	Apr. 29	†37.68	...do	†3.4
250.62	Cottonwood Point, Mo	Apr. 30	36.45	Oct. 29–31	0.40
228.55	Fulton, Tenn	...do	31.27	Oct. 30, Nov. 1.	4.72
208.97	Memphis, Tenn	May 2–3	34.60	Oct. 30–31	1.60
181.48	Mhoon Landing, Miss	May 8–11	36.30	Nov. 1–2	—2.2
161.98	Helena, Ark	May 11	45.73	Oct. 31	1.18
147.06	Sunflower Landing, Miss	May 11–13, June 1.	41.70	Nov. 1	3.2
128.78	Mouth White River, Ark	June 1	49.27	Oct. 27	6.50
116.44	Arkansas City, Ark	...do	50.0	Oct. 28	2.1
108.00	Greenville, Miss	...do	44.28	Oct. 27–28	2.80
89.62	Lake Providence, La	June 2	41.90	Oct. 28–29	0.70
66.04	Vicksburg, Miss	June 2–3	48.45	Oct. 30	—1.00
52.74	St. Joseph, La	June 3–4	44.55	Nov. 6–7	—2.00
36.89	Natchez, Miss	June 26	48.10	Oct. 29–31	5.00
23.85	Red River Landing, La	June 27	48.87	Oct. 31	2.12
28.95	Bayou Sara, La	June 28	42.25	...do	—0.75
20.66	Baton Rouge, La	...do	38.45	...do	2.50
21.06	Plaquemine, La	June 13	33.50	Oct. 30	0.50
19.14	Donaldsonville, La	...do	30.15	Nov. 9–10	2.80
21.24	College Point, La	...do	25.62	*Oct. 27 & Nov. 20.	0.25
20.91	Carrollton, La	June 10	17.35	Nov. 21	0.15
	Fort Jackson, La	June 13	†6.85	Nov. 20	0.50

* Approximate. † No record June 3–11.

TRIBUTARIES OF MISSISSIPPI RIVER AND ATCHAFALAYA.

Zero elevation.	Station.	Highest. Date.	Highest. Gauge reading.	Lowest. Date.	Lowest. Gauge reading.
	Arkansas River.				
241.55	Little Rock, Ark	May 21	31.20	Jan. 17	6.00
199.80	Pine Bluff, Ark	May 22	35.60	Oct. 17–18	7.85
	Atchafalaya River.				
24.17	Barbre Landing, La	June 27–28	49.70	Oct. 25	0.20
24.17	Simmsport, La	June 24	46.64	....	....
20.17	West Melville, La	June 25	35.0	Oct. 26, 27	2.80
	Cumberland River.				
	Nashville, Tenn	Apr. 26	38.80	Nov. 1	—0.20
	Illinois River.				
*444.26	Beardstown, Ill	May 15, 16	18.4	Oct. 29–31	6.0
	Ohio River.				
447.58	Cincinnati, Ohio	Apr. 25	43.80	Nov. 5, 6	3.50
419.76	Louisville (upper), Ky	Apr. 23	21.80	Nov. 8	2.00
392.85	Louisville (lower), Ky	Apr. 23	47.40	Nov. 7	2.70
308.40	Paducah, Ky	Apr. 29	42.9	Oct. 30–Nov. 2.	0.7
290.84	Cairo, Ill	Apr. 28	48.29	Oct. 29	3.85

Highest and lowest gauge readings, 1892—Continued.

TRIBUTARIES OF MISSISSIPPI RIVER AND ATCHAFALAYA—Continued.

Zero elevation.	Station.	Stages. Highest. Date.	Highest. Gauge reading.	Lowest. Date.	Lowest. Gauge reading.
	Old River.				
24.17	Head of Turnbull Island, La	June 28	50.15		
	Ouachita River.				
96.69	Camden, Ark	June 6	37.10	Oct. 12–14	2.50
51.55	Monroe, La	June 27–29	41.1	Oct. 19	1.7
	Red River.				
244.78	Fulton, Ark	May 23, 24	34.85	Oct. 14	5.20
223.44	Garland, Ark	May 24, 25	28.40	...do	2.66
161.27	Shreveport, La	May 28	35.70	Oct. 13, 15	—2.00
64.46	Alexandria, La	June 12, 13	38.25	Oct. 20, 23	—0.65
	St. Francis River.				
	Wittsburg, Ark	May 9	39.4	Oct. 27–31 Nov. 10–14	—3.60
	Tennessee River.				
*651.90	Chattanooga, Tenn	Jan. 17	37.9	Oct. 26–Nov. 1.	1.1
	Florence, Ala	Apr. 8	24.00	Oct. 28–Nov. 2.	0.80
	Wabash River.				
*397.81	Mount Carmel, Ill	Apr. 18	21.5	Oct. 13–22	0.6
	White River.				
	Jacksonport, Ark	May 20	30.40	Oct. 13–14	0.80
	Clarendon, Ark	May 27–28	32.65	Oct. 19–20	6.45
	Yazoo River.				
93.92	Yazoo City, Miss	Apr. 29–30	37.40	Oct. 31	—1.00

* Approximate.

APPENDIX 3 G.

MISSISSIPPI RIVER, FROM CAIRO TO HEAD OF PASSES.

TABLE I.—*Showing for the years 1872–1892 (except as noted), highest and lowest and mean highest and mean lowest stages.*

[Gauge zeros are referred to Cairo datum plane which is 21.26 feet below the (provisional) mean Gulf level.]

Gauge zero.	Station.	Highest. Stage.	Highest. Date.	Lowest. Date.	Lowest. Stage.	Means. Highest.	Means. Lowest.
Feet.		*Feet.*			*Feet.*	*Feet.*	*Feet.*
290.84	Cairo	52.17	Feb. 27, 1883	Dec. 31, 1876	0.10	44.84	4.04
203.97	Memphis	35.60	Mar. 23–4, Apr. 4, 5, 1890.	Dec. 25, 1872	—0.95	32.88	2.09
161.98	Helena	48.10	Apr. 30, 1886	Jan. 5, 1888	—0.18	43.27	4.36
128.73	† Mouth White River	50.40	Mar. 31, 1890	Oct. 14–15, 1879	2.40	46.67	6.71
89.62	Lake Providence	41.90	June 2, 1892	Dec. 29, 1872	—3.85	37.23	2.72
66.04	‡ Vicksburg	49.05	Apr. 24, 25, 1890	Nov. 24, 1887	—3.91	43.70	2.80
36.89	Natchez	48.60	Apr. 23, 1890	Dec. 14, 15, 1872	0.00	42.99	4.54
23.85	* Red River Landing	48.87	June 27, 1892	Nov. 25, 1887	0.46	43.34	4.10
20.06	Baton Rouge	38.45	June 28, 1892	Jan. 9, 1877	0.90	32.47	2.89
20.91	Carrollton	17.85	June 10, 1892	Dec. 27, 1872	—1.60	13.72	—0.04

† High waters 1880–1892; low waters, 1879–1892.
‡ Low waters 1878–1879 interpolated from Lake Providence and Natchez.
* 1879–1892 only.

APPENDIX 3 H.

MISSISSIPPI RIVER, FROM CAIRO TO HEAD OF PASSES.

TABLE II.—*Showing for the years 1872–1892 (except as noted) the mean number of days during which the stage in feet above extreme low water was embraced between the figures at heads of columns.*

[Gauge zeros are referred to Cairo datum plane, which is 21.26 feet below the (provisional) mean Gulf level.]

Gauge zero.	Extreme low water.	Station.	0 to 4.9	5 to 9.9	10 to 19.9	20 to 29.9	30 to 39.9	40 to 49.9	50 to 54.9
Feet.	*Feet.*		*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
290.84	[1] —1.00	Cairo	14.4	46.5	102.0	99.6	60.9	39.1	2.7
203.97	—0.95	Memphis	37.4	67.0	121.6	84.3	54.9	0	0
161.98	—0.18	Helena[2]	21.0	40.6	96.4	88.9	65.8	52.6	0
128.73	[3] 0.0	Mouth White River[4]	5.2	32.4	83.5	84.4	69.9	89.2	0.7
89.62	—3.85	Lake Providence	6.0	42.5	97.9	86.4	94.2	38.2	0.0
66.04	—3.91	Vicksburg	12.3	25.5	82.4	71.6	70.9	90.0	12.8
36.89	0.0	Natchez	19.8	42.8	85.1	70.0	84.1	63.6	0
23.85	[5] 0.0	Red River Landing[6]	32.2	41.1	81.9	65.2	90.6	54.4	0
20.06	0.90	Baton Rouge	67.2	59.1	76.7	117.3	45.0	0	0
20.91	—1.60	Carrollton	131.5	78.8	155.0	0	0	0	0

[1] December 24, 1871. [2] Except in 1879. [3] December 28, 1871.
[4] Except in 1872–'74 and 1878–'79. [5] December 15, 1872. [6] Except 1874 and 1878.

Small breaks in records interpolated from stations above and below.

APPENDIX 3 I.

TABULATED RESULTS, WITH FIELD AND OFFICE REPORTS, OF DISCHARGE MEASUREMENTS ON THE MISSISSIPPI RIVER AND TRIBUTARIES AND THE ATCHAFALAYA, AND OF CREVASSE AND OVERFLOW MEASUREMENTS, 1892.

Contents.

Table of meter ratings on page 3700.

APPENDIX.

FIELD REPORTS.

EXTRACTS FROM REPORT OF MR. WILLIAM GERIG, CHIEF OF PARTY, UPON OBSERVATIONS AT COLUMBUS AND HELENA.

AMELIA, ARK., *August 9, 1892.*

I have the honor to make the following report on the high-water discharge observations made at Columbus, Ky., and Helena, Ark.:

The observations were made with the steamer *H. L. Abbot*, and the party of 9 men was subsisted on board. The meter method was used.

The instruments in use were Price meter No. 34, one register, one break-circuit sidereal chronometer No. 1344, made by T. S. & J. D. Negus, electric batteries, transit, level, sounding leads, lines, etc.

The meter was suspended from a boom 10 feet long at the stern of the *Abbot*, the boom projecting over the starboard side from the roof and making a right angle with the axis of the boat. A steel sash cord three-sixteenths of an inch in diameter passed around a reel on roof and near stern of boat through a small pulley in the end of the boom, thence to the meter. There was another steel sash cord which ran from the meter through a pulley on the end of a 20-foot boom, which extends over the bow of the boat, to a reel on the roof on bow of boat. By paying out proper lengths of standing and guy lines the meter could be immersed to any desired depth and held in place.

The observations of Columbus, Ky., were made on the same section that was used in 1891. The sounding and velocity stations were located with a sextant. The meter was lowered to the six-tenths depth.

The soundings on April 15 and 16 were made with a 60-pound lead attached to a steel piano wire, which passed around a reel on bow of the boat. The depth was obtained by counting the number of revolutions of the reel.

The observations were made in the usual manner. In deep water drifting soundings were made.

* * * * * * *

The gauge readings correspond to mean time of observation.

* * * * * * *

At Helena, Ark.—The section was the same as that used in 1888–'89. The methods of taking the observations were the same as at Columbus, Ky. The soundings on April 18 and May 3 were made with the 60-pound lead.

* * * * * * *

By referring to the accompanying table it will be noticed that after June 1 the velocities at Helena, Ark., have decreased very perceptibly. This was noticed at the time, and the meter was examined to see if there was anything wrong, and it was found to be in first-class condition. * * *

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

EXTRACTS FROM REPORT OF MR. A. F. KILPATRICK, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT FULTON, TENN.

MEMPHIS, TENN., *June 9, 1892.*

I have the honor to submit the following report on the field work of high-water-discharge observations at Fulton, Tenn., in April and May, 1892.

The party, consisting of assistant engineer, recorder, leadsman, pilot, mechanical engineer, fireman, and two deck hands, was organized April 13. The steamer *Itasca* and one skiff were used during the observations. Instruments in use consisted of two transits, one level, one stop watch, one 16-pound lead with ⅜ inch woven cotton line, and one set of double floats. A piano wire with 41-pound weight was also used to check soundings, but from awkward arrangement of reel and want of practice in its manipulations proved unsatisfactory.

The discharge section is located about 5,000 feet above Fulton, as indicated on the accompanying map*, which also shows position of gauges and surface velocity sections at Craighead Point and Falls Landing.

From a point above the steamer was allowed to drift to range B C, at which instant the sounding was made and signal given to transitman at D (see sketch*

*Not printed.

herewith), who noted the angle and color of signal flag, which latter and depth was recorded by assistant on board. In No. 1 and all odd soundings a red flag was used; a white flag was used in all even soundings. This system of flag signaling is highly recommended for this class of work.

Soundings were taken about 90 feet apart. The lead line used was very elastic, and although tape corrections were applied each day as soon as soundings were over apparent discrepancies are in great part due to it during the first week of observations.

In float observations the boat would occupy a position on an auxiliary range line above discharge station, and then be directed to the proper point on same by the transitman at D. The float was then dropped and closely followed by timekeeper in skiff, and when under good headway a signal was given to transitman at B and D, who observed and noted the "start" angles. At the expiration of one minute the signal was repeated and stop angles noted. Thus was determined the location, path, and time of each float. In the tabulated sheet herewith submitted the velocity normal to line B C at point of crossing or on prolongation of path of float is given. The object in view was to run the floats at certain places and have the anchor or submerged portion to travel mid depth the stream at each place.

The float consisted of a double-coned, air-tight tin buoy, with flag, connected by a fine cord with a tin anchor, which consisted of two sheets of tin 20 by 14 inches, crossed at right angles, making four leaves or flanges 7 by 20 inches. The buoy was 5¼ inches diameter; total length, 12 inches. The connecting cord varied in length to suit depth of stream at each point used.

Of a number of surface floats passing through 200 feet ranges at Craighead Point and Falls Landing the velocity of the swiftest is reported.

Gauges were read daily and hour noted at Craighead Point, station "B," Falls Landing gauge, and at Fulton, and finally reduced to reading at time of discharge observations.

Levels carefully checked between gauges gave relative heights and data for calculating sin. of slope inclination.

*   *   *   *   *   *   *

The plan of discharge section, triangulation points, and paths of floats, etc., was platted on a scale of $\frac{1}{1000}$, as per tracings* herewith, and distances scaled and applied in arriving at results.

*   *   *   *   *   *   *

The river width was constant, the banks on each side being vertical during observations.

*   *   *   *   *   *   *

As the angle of slope inclination was exceedingly small the sin. was obtained by dividing the fall by the distance between two gauges and given to seven decimal places.

There are submitted herewith tracings showing discharge section, triangulation stations, and paths of floats each day, and cross-section sheets showing contour of bottom and velocity curves. The notes have been copied into one field book in ink, and all the plats and calculations carefully checked.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

EXTRACTS FROM REPORT OF MR. CHARLES H. MILLER, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT ARKANSAS CITY, ARK.

GREENVILLE, MISS., *July 19, 1892.*

The following is a report of the observation party stationed at Arkansas City Ark.:

The party, numbering thirteen, arrived at the station April 18, on board the U. S. snag boat *Florence*, which boat was used for the observations. Some of the old targets were found, and the range used last year was reëstablished, with the observing stations in practically the same places.

Velocity observations.—Price current meter No. 39 was used from April 22 until May 30, on which day old meter No. 5 was used; from May 31 until the end of the work, July 1, Price meter No. 38 was used.

The meter was attached to a rod holding a 230-pound lead weight, and lowered to six tenths of the depth on a three-eighth-inch wire cable. This apparatus about

*Not printed.

midway of the boat, to be near the center of gravity. A guy line of No. 12 wire, leading from the lead to the forward end of the boat, helped to steady and hold in place the weight. This line, after some experimenting, was finally attached to the upper end of 3-foot rod on which the lead hangs and meter is placed, instead of attaching it directly to the lead, which, it is thought, will cause much canting of the lead. To still further prevent the canting of the weight, and also to steady it, a sheet-iron vane, having both vertical and horizontal wings, was placed behind the weight.

For a recorder a telegraph sounder was used and the "ticks" counted. The usual time of occupying a station was five minutes, care being taken to begin and end on the discharge range, this being more carefully obtained by having a man in the pilot house assisting the pilot, one watching each range. This rule was observed universally, except where some extra work was being done.

Soundings.—Were taken with a 20-pound lead on a three-eighth-inch cotton line, located instrumentally by a transit at a point 2,000 feet above the range, reading the angle from the perpendicular. The flagman on the steamer being careful to always keep on the range by moving back and forth on the roof of the boat.

Meter ratings.—Ratings were taken as often as the time could be found. * * *

Double float observations.—Five of these observations were taken from time to time with the results as shown in the table.

The subsurface float was a tin cylinder about 15 inches high and 10 inches in diameter; the surface float was of tin in the usual shape of a buoy, about 10 inches long and 8 inches thick, these attached with fish cord.

Meter observations would be taken in the morning and the floats in the afternoon, using the same section which was sounded between the time of the observations. The subsurface floats put at six-tenths of the depth. Ranges set one 200 feet above and another 200 feet below the discharge range. The floats were dropped far enough above the upper range so as to acquire the velocity of the current and at a place so that they would strike near the respective stations. It was difficult to have them strike the proper place, and many were tried several times. Most times only one transit could be used. A skiff followed the float and signalled to the transit man when crossing the ranges; the skiff man keeping the time. The observation of July 1 was taken with two transits and therefore may be more nearly accurate than the others. It shows a marked increase in the floats over the meter, almost 4 per cent.

Drifting soundings.—Two sets of drifting soundings with piano wire were taken as a check on the lead line soundings. June 14 giving seven-tenths per cent less and June 21 giving 2¼ per cent less than the lead line.

Movement of boat.—Four observations were taken to determine the path of steamer during the time of occupying a station; observations taken every thirty seconds. When possible these were taken with two transits on the bank reading simultaneously at a signal from the boat, angles to a fixed flag on the roof of the steamer. But when only one transit was used it read the angle to the flag to determine the lateral motion, while the movement above or below the range was observed from the boat at the same time by having the railing graduated in feet both ways from the flag (or zero) and a man to move back and forth, constantly remaining on the range and recording his position at the proper moment.

The observation of May 5 being incomplete no calculations were made for that day, but the corrections for the other days are: May 14, subtract 11,781 cubic feet; May 30, subtract 2,410 cubic feet; June 3, subtract 880 cubic feet.

It will be observed that the large amount on May 14 is due mainly to the fact that on two of the stations the observations ended at a considerable distance above the place of starting. This, because of a necessarily different distribution of the force, there being no one to assist the pilot; hence the results are much in excess of what they would be under the usual distribution of the force, and show that the movement of the boat introduces little or no error.

Direction of current.—This can be observed from the path of the floats shown on the tracing, and it will be seen that there is almost always some angle with the perpendicular to the range. It is believed, however, that any error from this source is very small and should not be considered.

Panther Forest Crevasse.—Occurred May 13, 11:30 p. m., at a point about 3 miles below Gaines Landing, and 450 miles by channel distance from Cairo. (For results see crevasse table).

Fulton Lake Crevasse.—Occurred June 2 about 1 mile below Arkansas City and 459 miles by channel distance below Cairo. At first a series of small breaks a foot or so in depth running through the railroad.

The observations from June 3 to 15, inclusive, were taken by Mr. Baily who had charge of the party during that time; those of the 27, 28, and 29 of June were also taken by Mr. Baily (with his party and outfit).

REPORT OF MR. E. C. TOLLINGER, CHIEF OF PARTY, UPON OVERFLOW BETWEEN ARKANSAS CITY AND TRIPPE.

ARKANSAS CITY, ARK., *June 25, 1892.*

I have the honor to submit the following report upon the discharge observations between Arkansas City and Trippe, May 28 to 31, 1892.

The nature of the openings.—The discharge was through two kinds of openings. The one was under pile bridges with the surface of the water about 3 inches above the top of the stringers, and the other was over the railroad embankment and track.

Methods employed.—The first series of discharge observations was taken with surface floats, the points of observation being generally from 25 feet to 50 feet below the railroad.

It was feared that the indicated surface velocity below the bridges was too small on account of the obstruction of the current at the surface, by the stringers, and too great below the embankment, on account of the tendency of the surface water to flow over the lower strata behind the embankment. In the second series weighted rods from 5 to 10 feet long were therefore used for floats below the bridges, but on account of the bushes under the water [in other locality], tin surface floats were used, the same as in the first series of observations.

On account of the rods not nearly reaching the bottom of the water, eight-tenths of the observed velocities was taken as the mean of the vertical, the same as for surface floats. (See tabulated results).

In comparing the two sets of observations it will be observed that the velocities average about the same, but that in gauging the flow over the embankment a considerable portion was gauged in the first set of observations, that was omitted as unimportant in the second set, otherwise the results would have been more nearly equal.

Testing the relation of mean vertical velocities to surface velocities.—Noting the difference between the results of the discharge observations in 1890 and 1892, some observations were made, June 14 to 16, with Price current meter No. 5 to ascertain to what extent the relation of the mean vertical velocity to the surface velocity, was modified by the above-mentioned conditions.

In these observations the mean vertical velocities were generally obtained by differentiation, that is, by noting the velocities indicated by the meter while passing slowly from the surface to the bottom and return.

The results of these test observations are appended, and show that in the observations below the embankment, the mean vertical velocity was 56 instead of 80 per cent of the surface velocity, and below the bridges, 108 instead of 80 per cent.

Substituting these ratios for 80 per cent in the computations would change the results as follows:

Observations of May 28 and 29: $\frac{56}{80}$ of $188 = 132$ (approximately); $\frac{108}{80}$ of $121 = 163$ (approximately); 295 (approximately) thousand cubic feet per second.

Observations of May 30 and 31: $\frac{56}{80}$ of $121 = 85$ (approxi ately); $\frac{108}{80}$ of $140 = 189$ (approximately); 274 (approximately) thousand cubic feet per second.

When these test observations were made the surface of the water was very little above the bottom of the stringers, whereas at the time the discharge observations were made it was about 3 inches above the top of the stringers.

Again, the observations of series 2 of the test observations were not made as far from the embankment as in the regular discharge observations and hence the influence of the disturbing element is magnified in the test.

These considerations would indicate that in each case the discharge was somewhat greater than the above substitution of ratios would show.

Comparison of discharges in 1890 and 1892.—The maximum discharge in 1890 was only about 149,000 cubic feet per second, or about one-half as great as in 1892.

In 1890 this overflow was principally from crevasses in the levees along the Mississippi River south of Amos Bayou. In 1892 there were no crevasses in these levees, but several in the levees along the Arkansas River. Of these the Auburn Crevasse was 1¼ miles long and the Sarassa 1 mile long. The river was 3.6 feet higher (at Little Rock) in 1892 than in 1890.

These crevasses not only had a large sectional area, but were so located that parts of them were in line with the direction of the current immediately above, giving the discharge a high velocity, and being about 35 miles above the back water from the Mississippi River and 100 miles by river from the locality of our discharge observations, while only 35 miles distant by the route through the crevasse, the resulting slope was much greater than that of the overflow of 1890.

Effect of the high stage of the Mississippi River.—The crevasse being about 60 miles from the mouth of the river and about 35 miles above the back water from the Mississippi River I infer that the discharge would have been about as great had the Mississippi River been several feet lower than the stage reached by this flood.

* * * * * * *

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER, UPON DISCHARGE OF BAYOU BARTHOLOMEW, WITH LETTER OF MR. HOWARD DOBB, OBSERVER.

ARKANSAS CITY, ARK., *July 2, 1892.*

I would respectfully state that the discharge observations of Bayou Bartholomew were taken at Browns Bridge, Lincoln County, Ark. This location was more favorable than at any point below for obtaining satisfactory results. The water in the bayou had fallen 4 feet when the observations were taken, and it is reasonable to presume that a greater surface velocity would have been obtained at the maximum rise, but as the water had been over one part and against the stringers of the remaining part, and as the bridge did not show any signs of being moved from its foundation it is my opinion that the maximum velocities were but little if any greater than at the time the observations were taken.

The bayou is through a low flat country, and above the Lincoln County line. The bed of the bayou is occupied with a growth of large cypress trees giving it the appearance of a large cypress brake.

"ARKANSAS CITY, ARK., *June 29, 1892.*

"In connection with report, herewith returned, of observations taken on discharge of Arkansas River flood into Bayou Bartholomew, I wish to state that owing to the fact that the water had fallen 4 feet from its maximum height before observations were made, accuracy in obtaining correct soundings and measurements was difficult. Only three openings were found at that time emptying into Bayou Bartholomew—*i. e.*, Fletcher Brake, Deep Bayou, and Ambon Bayou. The actual width of these was taken by measurement, 4 feet added to soundings for depth, while the additional width allowed for added height could not be accurately ascertained, but was estimated as nearly as possible, from marks left by the water. In all these streams the velocity was taken by surface floats, and after repeated trials was found to be 1 foot per second, and having one week before taken observations on Ambon Bayou and Fish Deadening, when the flood was at its greatest height, and found the velocity to be the same as at this date, that figure was taken for the correct velocity. The remaining points of discharge, six openings into Fletcher Brake, Browns Bayou, The Wash, north of Deep Bayou, and Fish Deadening were dry, and no observations could be taken further than estimates from measurements of the depth and width as shown by the marks left on the trees and banks, by the overflow; and the velocity, all else being equal, was considered at the same rate with the streams taken, and with Fish Deadening as formerly taken at the greatest height of flood.

"In order to have proof of the correctness of observations made, I took soundings, etc., of Bayou Bartholomew at a bridge crossing just below the confluence of Deep Bayou, where it carried off the water from Deep Bayou, the Wash designated, Fish Deadening, and Ambon Bayou, and return figures in my report. The velocity here was tested thoroughly and showed only 1 foot per second with surface floats. The sluggish current in this stream I attribute to several causes, being that it is a long and extremely crooked stream, draining an even and almost level swamp, having virtually two channels, or rather having the low-water channel in the center of a depression extending 50 yards on each side of the banks, before reaching the general level of the swamp. The channel proper will average from 100 to 120 feet wide and 3 feet deep, which carries all drainage, except in rainy seasons. The depression referred to extends the whole length of the stream and is filled with a thick growth of vines and timber, and retards the current to such an extent that there is little difference in its velocity at different stages, and for the velocity of the streams and inlets found emptying into it I am satisfied that no greater rate existed, from the fact that owing to excessive rains prevailing during the flood, the water in Bayou Bartholomew was at or near a level with the water in the swamps; and more current existed during the first rise and subsequent fall of the overflow than at the time when both were at their greatest height. This fact was illustrated in the case of Fletcher Brake. The brake or lake was a circular body of water 100 yards wide and 4 or 5 miles long, emptying into it its full width. This lake was fed by a bayou about 200 feet wide and six small washes leading from the overflow, and yet no current was perceptible at its mouth, where both currents met, and dead water was the consequence. This could not have been in case of protracted flood, but it having existed only four or five days, the water from all sources only served to fill the lake, and it could only find egress as the bayou fell."

EXTRACTS FROM REPORT OF MR. T. C. J. BAILY, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT WILSON POINT AND CHICOT CITY.

GREENVILLE, MISS., *July 22, 1892.*

The following report on discharge observations taken by me during the high water of 1892 is respectfully submitted:

On April 11 the survey steamer *Meter*, with quarterboat and a party of thirteen, left for observations in Lake Providence Reach.

From the 16th of the month until June 20 continuous gaugings were taken, except on a few days when storms prevented.

Party.—The party consisted of a chief, two assistants, pilot, engineer, leadsman, and crew, in all thirteen souls.

Section.—A discharge section was set up just above Wilson Point Landing, it being the same that was used for high and low water observations taken last year. The river here is 3,842 feet broad between banks, but during the entire series of gaugings the water was over the Louisiana bank against an old levee, which is 80 feet back. The velocity in this 80 feet was so uniform that no separate measurements for it were made, it being included in the last partial discharge.

Profiles of shore and section of levee were run, stakes being driven every 10 feet out to the bank line, so that the water width at any date could be accurately determined. From April 16 to April 29 this width increased from 3,925 to 3,946 feet; after the 29th, and until the end of the series, the water was against the nearly vertical side of the old levee and its width remained constant at 3,946 feet. The meter stations were placed 300 feet apart, No. 1 being 42 feet from the Mississippi bank and No. 13 190 feet out from the Louisiana side.

Halfway across the section a pivot 1,000 feet above and radial targets on the nearest bank were used; for the remaining half all the targets were on the opposite bank. This gave for the smallest intersection 27° 31′. Two thousand feet above the range on the Mississippi side the Duncansby Chute pours an immense volume of water into the river at a high velocity, the axis of the chute forming an angle of 39 degrees with that of the river at the point of entrance. It is believed that this water, by eating out the bar which has formerly existed at the east end of the section, is one of the causes of the great variations which may be observed from day to day in the discharges. Stations 2, 3, and 4 were the ones affected, the current varying on them so greatly from minute to minute that it was extremely difficult to judge when a true average velocity had been obtained. For this reason these stations were occupied from ten to twenty minutes, and, in fact, all the stations were occupied for an average time of eight minutes, no fixed period being used, the counting beginning and ending on range and continuing until, in the judgment of the chief, a fair mean velocity had been obtained. From June 6 until the end the current on Station 1 was running upstream as determined by double floats, and the entire partial discharge of this section thereafter was subtracted from the sum of the remain'ng partial discharges. The position of the seam beween the up and downstream currents was not at all constant, it shifting from a point 50 feet outside Station 1 to Station 2 within a minute. These circumstances rendered it difficult to obtain a true discharge during the highest stages of the river.

Methods of procedure.—Until May 30 Price meter No. 38 was used at this station; from that date until the end of the series No. 39 took its place, No. 38 being sent to Arkansas City. The meter was attached to a rod 18 inches above a 225-pound lead, and submerged to six-tenths the depth by a reel worked with a system of spur wheels so arranged that one revolution of the crank would lower the meter 1 foot. A stout wire was attached at first to the weight, afterward to the swivel in the rod above the meter, and ran forward over a cleat in the bow of the steamboat to another reel.

The proper length of this guy line to pay out in order that the weight should be under its reel was obtained by means of a table prepared for the purpose. No vane was used on the weight, but my experience while in charge of the party at Arkansas City (where an 18-inch iron one was used) has demonstrated the fact that the meter is much steadier in the water and the lowering wire much nearer vertical with the vane than without it. The revolutions of the meter wheel were counted on an ordinary telegraph sounder in a circuit with from three to four Leclanche cells.

The chief of the party personally supervised the working of the steamer, all arrangements of the meter, and at times checked the countings of the assistant. He also gave the signal when to start and when to end counting, recording the revolutions per minute and motion of boat with reference to the current, and judging when a mean velocity had been registered. The average time used in measuring velocity was three hours.

After using the meter, soundings were taken at irregular intervals across the section using a 20-pound lead on a three-eighths-inch cotton line, each sounding being located by a transit angle from a point 1,700 feet above the section. The chief remained on the steamer and checked every reading of the leadsman, taking care that the soundings were caught on a vertical line. After the soundings were taken the lead line was tested, and in case of a line which changed much tests were made both before and after running over the section, each set of corrections being applied for half way across. In order to test the accuracy of this method drifting soundings were taken. A 20-pound lead was attached to fine steel wire graduated every foot with solder and tagged every 5 and 10 feet; this was paid off from a reel. The weight being lowered to within a few feet of the bottom, the steamer would drift down; when near the section the flagman would raise his flag as a warning to the transit man and also give warning signal to the man manipulating the brake. At the instant of crossing range flagman would call time and drop his flag, while the lead would be allowed to run down until it touched the bottom when the depth was read. The results will be found in the table of discharges:

June 10, mean depth—	Feet.
By ordinary method	61.9
By drifting	60.5

As this is the first trial of the method it is believed that errors were made in reading some of the depths, the graduation being very fine and difficult to read.

[NOTE.—At Arkansas City I used a register devised by Mr. John S. Dodge, a member of the party. It consisted of a pointer revolving around a dial graduated for every foot and connected by a train of wheels with the axle of the lowering wheel. It was arranged to read zero when the bottom of the lead touched the surface of the water and graduated by paying out every 5 feet of wire off the reel, marking the dial opposite the arm and dividing the spaces between into five equal parts. The appliance worked very satisfactorily for checking the readings of the leadsman, and would indicate correct depths to the nearest half foot.]

June 17, mean depth—	Feet.
By ordinary method	60.0
By drifting	59.6

A very close agreement.

All gauges were read to the nearest hundredth before and after each velocity observation.

Float observations.—In order to test the discharge measurements with the meter, four observations with double floats were taken. The meter was run in the morning, soundings taken, and floats in the afternoon, using the same water area for both. Ranges parallel to and 250 feet above and below the discharge section were set up and two transits used for locating the floats, one being on the levee in the discharge range the other at △ Ruple 1,770 feet above. The surface floats consisted of two tin cones, 7 inches in diameter at base and 6 inches high, placed base to base. The subsurface float consisted of a tin cylinder 12 inches high and 10 inches in diameter, having a strip of lead around the bottom and sixteen air chambers, half cylinders 4 inches high, 1¼ inches diameter around the top. The float was submerged to six-tenths depth, as determined by the soundings taken in the morning.

The object being to so place the float that it would cross the discharge range on or near the meter stations, the steamer, towing a skiff, would move up to the section, flank over until on the required station, then run upstream parallel to the current. When a sufficient distance above the upper range the skiff would cast loose, float placed in the water, and skiff remain near and opposite to it. When close to the upper range a flagman in the boat would raise his flag, which would be dropped in crossing the range, time noted, and the two transit angles read.

This programme would be repeated for the other two ranges, after which the steamer, which had drifted down, would pick up the skiff and proceed to the next station.

* * * * * * *

The results of these observations may be found in the tabulated statement of discharge and will be seen to agree closely in every case with the meter work.

*Motion of steamer while on stations.**—There appears to have been some doubts as to the accuracy of the present method of meter observations, due to the lateral and normal motion of the boat. To discover what effect this motion would have, three sets of observations were made to determine the path of the boat, the method of procedure being as follows: Two transits were placed, at △ Ruple, the other at △ Harris, both above the section on opposite sides of the river transits being set in azimuth by sights on the opposite stations. A piece of white cloth was placed on the starboard steam pipe nearly above the meter and simultaneous azimuths read

* Discussion of error due to lateral motion of boat and formula for correction given in report on reduction in secretary's office of Arkansas City discharges of 1884–'85. See Report Chief of Engineers, 1887, p. 2836.

every minute on this mark, the chief on the steamer counting and signaling at the proper times. At first these azimuths were taken every thirty seconds, but it was found that nearly all the motion could be obtained by minute intervals. One set was taken in a light wind and the other two in a strong one, from the most unfavorable quarters parallel to the section; the azimuths were then plotted to a scale of 125 feet to 1 inch, and the course of the boat traced.

When the steamer is sliding along parallel to the section, that is, perpendicular to the current, the meter is measuring the resultant of its motion and that of the current; in other words the hypothenuse of a right triangle whose base is the side velocity of the boat in feet per second, and whose perpendicular is the velocity of the current in feet per second. If the movement is upstream parallel to the current, the sum of the current's and boat's motion is registered; if downstream, the difference.

Let l denote the sum of all the components of the boat's motion on a station parallel to the section.

n = distance between the initial and final position, at the end of an observation on one station, measured normal to the section.

t = time in seconds that the station is occupied.

V = velocity registered by the meter.

v = true velocity.

c = correction to be applied to V in order to obtain v.

Then: $c = \frac{l^2}{2t^2} V \pm \frac{n}{t}$, the second term being minus when the steamer ends above and plus when it ends below the initial point.

Using the formula given above, corrections were made to the discharge obtained on these days, as indicated in the table. The observations showed that the first term, even on the windiest day, is very small, both quantitively and relatively to the second term, and that, with proper care an error less than one-half per cent is introduced into the discharge.

Meter ratings.—During the time that meter No. 38 was in use at Wilson's Point, that is, from April 16 until May 30, four ratings were obtained, one in Old River, Louisiana, taken from the steamboat along a 1,600-foot base, meter submerged 15 feet, and three at Wilsons Point, taken from a skiff along a 400-foot base, meter submerged 4 feet in 10 feet of water.

* * * * * * *

The rate of meter No. 38 while in use at Wilsons Point remained constant. Meter No. 39 was rated once at Wilsons Point and once near Greenville. The results were identical with those found at Arkansas City.

* * * * * * *

On July 5, meters Nos. 38 and 39 were rated in a borrow pit along the railroad at Sunnyside Landing, Arkansas. The water was but 6 feet deep and the pit narrow. It was found that the rates of both had changed on the same side, but as observations of July 11 in the deep water of a chute opposite Greenville did not indicate this change it was decided that owing to the shallowness and narrowness of the pit at Sunnyside the displaced water did not have free play. The results were therefore not used in the reductions.

Bank discharge.—Was measured on the Mississippi side alone, that on the west side, as before stated, being included in the river discharge. The range was above the discharge section, and about half a mile back from the river, at the intersection of the main levee with the one running out to the Lower Skipwith's Landing. The meter was held just beneath the surface, a reduction factor of nine-tenths being used to reduce surface to mean velocity. Owing to the heavy growth of timber and underbrush through which water was running it was impossible to measure all the water flowing over the banks, but it is believed that three-fourths of the total amount was obtained.

Crevasse measurements.—Brooks' Mills Crevasse, 505¼ R., occurred at 5:30 a. m. May 9. Three measurements for discharge were taken, one by Mr. George C. Thomas, one by Mr. Charles Miller, and one by myself.

Leland Crevasse, 484¾ R., occurred May 25. It was measured by me three times.

Crevasse below Columbia, Ark., 470 R., occurred June 22. It was measured by me once. The results of these measurements are found in the accompanying crevasse table.

Chicot City discharge section.—On June 27, Mr. Charles H. Miller, in charge of the Arkansas City party, set up a discharge range 2,300 feet below Chicot City Landing, and 6¼ miles by channel above the Arkansas City discharge section. The river here is 3,962 feet broad between banks. Fourteen meter stations were located 300 feet apart, Station 14 being 90 feet from the Mississippi bank line, and Station 1, 70 feet from the Arkansas shore. The section was shallow and the velocity observed on stations extremely variable. On June 28 and 29 Mr. Miller measured discharge here with meter No. 38; on June 30, a. m. and p. m., and July 1, a. m., I measured the discharge with meter No. 39. In the afternoon I ran double floats over the section. On July 2 both parties proceeded to Chicot on the steamer *Florence*, where simultaneous observations were taken with both meters, No. 38 being on the starboard and No. 39 on the port side. Results of these observations are in accompanying table.

The observations of July 1 were taken simultaneously with those at Arkansas City; meter observations at 7 o'clock, floats at 2 o'clock. It will be noticed that the difference in the discharge at the two points by the two methods is practically the same, it being for the meters 118,400 cubic feet more at Arkansas City than at Chicot, and for floats 120,900 more.

Velocity observations below Lake Providence.—On June 21 a velocity range was staked off 1½ miles below Lake Providence, on which June 22 and 23 velocity was measured, the meter being submerged 5 feet.

REPORT OF MR. T. C. J. BAILY, CHIEF OF PARTY, ON DISCHARGE OBSERVATIONS AT WILSON POINT, LOUISIANA.

GREENVILLE, MISS., *February 10, 1893.*

The following report on low-water discharge observations at Wilson Point, Louisiana, for the season of 1892 is respectfully submitted:

The section had its old position but was divided into 100 instead of 300-foot stations in order to determine, if possible, how close an approximation to a true velocity curve the 300-foot stations give.

The weight on the meter was 250 pounds, with a wrought-iron vane, which by presenting the sharp point of the weight to the currrent would reduce the eddies around the meter. The steamer *Meter* was employed for the work, and the regular method for obtaining the velocity, with the following exceptions:

(1) Current meter was submerged but 10 feet. * * *

(2) Meter stations were occupied but two minutes, the rapid shifting of the current during high water demonstrating the necessity of more meter stations and a shorter time on them.

October 26 the 100-foot stations were each occupied for two minutes. Dividing the sections into partial areas of 100 feet length, and using all the velocity stations, gives for that day a discharge of *147,992 cubic feet per second, and a mean velocity of 1.878 feet per second.

Dividing the section into 300 feet partial areas, and using the velocities found only on the regular 300-foot stations, gives a discharge of 146,774 cubic feet per second, and a mean velocity of 1.862 feet per second, a difference of less than 1 per cent. At the same time the accompanying platt† shows the variableness of the current, which is even greater in high than in low water. October 29, but 300-foot stations were occupied on account of a lack of time.

Under instructions from you, a new method for obtaining discharge was tried November 22 First, the regular meter stations were occupied. Then, that same morning, starting at station 11¾ + 50, meter submerged 5 feet, the steamer flanked slowly across the river on the section, from the Louisiana to the Mississippi side. Chief, with watch in hand, would call and record time as a meter station was crossed, assistant counting and recording revolutions of the meter wheel, continuously, setting down total revolutions at each call of "time."

This method was tried twice that morning, the steamer on both occasions flanking across from the west to the east bank. For computation the river was divided into 100-foot sections (from meter station to meter station), except the 50-foot one from 11¾ + 50 to 11¾.

By this method the meter, passing through every filament of water flowing along a plane 5 feet below the surface, would integrate the velocities of these differential elements. The revolutions of the wheel between two stations divided by the time would give the true mean revolutions per second in that section. This reduced to velocity would be the resultant of the boat's and the current's velocity per second, or, considering the current as normal to the section, the hypothenuse of a right-angled triangle, whose base is the side velocity of the boat in feet per second on passing through the 100-foot section (considering this motion as uniform, meanwhile), and whose perpendicular is the required mean velocity of the section, in a plane 5 feet below the surface. * * *

It may be seen that while the flanking method on this day gives a discharge 25 per cent greater than the ordinary method, yet the results of the two flanking trials differ from each other by less than four-tenths per cent. It is believed that the boat by compressing the water against the wheel (it being but 5 feet below the surface,

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*For final result see tabulation. †Not printed.

and the boat drawing 2½), caused the meter to register too high velocities. At the same time, the close agreement of the results obtained by the two trials would tend to show that the error is a constant one. * * *

The shifting of the current within the half hour elapsing between the two trials is also apparent, especially in section 7¾–7¼, where the trough in the second trial occupies the place of the crest in the first.

There was 300 feet of dead water at the west end of, and 180 feet at the east end of section. Price meter No. 38 was employed, being rated once at Ashton, La., from a skiff pulled along a 200-foot base, in dead water. The meter was submerged 4 feet in from 7 to 12 feet of water. * * *

REPORT OF MR. A. F. KILPATRICK, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT LITTLE ROCK, ARK.

MEMPHIS, TENN., *June 27, 1892.*

I have the honor to submit the following, with the accompanying tabulated sheet,* maps,* and notes, as a report on high-water discharge observations of the Arkansas River, taken at Little Rock, Ark., in May, 1892.

With Mr. M. Gardner as assistant, I left Memphis on May 19, arrived in Little Rock on May 20, and located the stations and ranges. On account of rain no observations were taken until May 23, when the river had declined 0.8 feet.

Method.—A departure from the usual method of the field work, and consequently of the graphical computations, was necessary on account of having no steamboat. The current was so rapid that floats could not be handled nor reliable soundings made from a skiff.

In January of this year, when the water was low, elaborate soundings were made under direction of Capt. H. S. Taber, as shown on blue-print map* herewith. Four of the sections, as indicated on the map, were selected, reduced and platted on cross-section paper, and from them a section, whose dimensions were an average of the four, was platted. * * *

Velocity of current was obtained by noting time of floats in passing from range A C to B D, 3,200 feet below it. The path of each float was located by transitmen at A and B. The floats were dropped from the railroad bridge† and, as they crossed the line A C were observed by a transitman at B and, at crossing of line B D, by transitman at A. Time was noted by assistant who dropped the floats in response to the signals given by assistants at the transits. The floats were subsurface ones, and consisted of double-coned, air-tight tin buoys, connected by fine cords with submerged sheets of tin crossed at right angles, so that the four leaves or flanges were 7 by 20 inches. The length of cord varied to suit depth of stream, the object being to have the submerged sheets travel mid-depth the stream at each place.

Levels run on May 25 between the bridge and gauge B gave data for calculating slope of river at mean time of observations. An attempt was made to utilize the United States gauge at Baring Cross Bridge, which is about 5,000 feet above the bridge shown on map, but owing to its unfavorable position—on side of pier—it could not be read to within 0.5 feet with any degree of certainty.

During the observations I had the coöperation of Capt. H. S. Taber, through his assistant engineer, Mr. Van Frank, and from him obtained data for approximating results in all cases where it was impossible, under the circumstances, to make measurements. * * *

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

REPORT OF MR. A. F. KILPATRICK, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS AT MONROE, LA.

MEMPHIS, TENN., *June 14, 1892.*

I have the honor to submit the following * * * as a report on the field work of high-water discharge observations at Monroe, La. [Ouachita River], in May and June, 1892.

With Mr. Gardner as assistant, I arrived in Monroe on the 29th of May and selected location for discharge section and gauges, as indicated in the sketch* herewith.

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*Not printed. † About 1,600 feet above A C.

The party, consisting of assistant engineer, recorder, leadsman, and skiffman, was organized May 30, and established stations, erected gauges, and made a complete set of soundings. A high wind prevented observations of floats.

On the two days following, velocity observations were made, gauges read, etc., and on June 1 levels run and checked between gauges. As the river bed in this vicinity is practically uniform, the stream sluggish, and the water clear, the soundings of May 30 were used as a basis in calculating subsequent discharges.

The soundings were made on line A C (see sketch),* from a skiff, with a one-half inch hemp line and 12-pound lead. Angles were recorded by transitman at B in response to signal from skiff at proper moment, and depths were noted by assistant in skiff. Soundings were taken about 25 feet apart.

Mid-depth velocities, normal to section, were obtained by noting the time consumed by each float in passing from section A C to E D (300 feet below it) and path located by transitman at B? who observed angles as the floats crossed each line. * * * [Floats as described for Fulton, Tenn., see page 3665.]

The length of connecting cord was varied to suit the depth of stream at each place, the object being to run the floats at regular distances and have the submerged tin travel middepth the stream at each place.

On account of prevailing winds greatest surface velocity was obtained but once, and at the discharge section. * * *

The sine of slope inclination is not given because the water was almost level and the wind too high to allow close reading of gauges at the time. * * *

The transit notes taken were connected with map of the city of Monroe at point F on the sketch* submitted, which is reduced from part of original map in use there.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

REPORT OF MR. GEORGE C. THOMAS, CHIEF OF PARTY, UPON DISCHARGE OBSERVATIONS, RED RIVER, AT ALEXANDRIA, LA.

GREENVILLE, MISS., *June 28, 1892.*

The party arrived at Alexandria on the 22d of May, but owing to delay in arrival of outfit no work was done until the 24th.

The point selected for measuring this discharge was immediately in front of Alexandria, La., where the stream is comparatively straight for a distance of one-half mile above and below, and confined between the levee on the west side and the high bank on the east; width at extreme high water, 820 feet; maximum depth, 50 feet; bed of stream, soft clay.

A base line 1,800 feet long was laid out along top of levee parallel with the stream, from which four parallel ranges are located across stream, each 200 feet apart and at right angles to base line.

Slope gauges were established on the left bank 2,000 feet above and below the discharge range; these were connected with the gauge and read immediately after each observation.

Range No. 3, or "Discharge Range," was divided into ten sections, nine of 83 feet each and one of 87.4 feet.

Range No. 1 (for starting floats) was divided into ten stations, each station being located opposite the center of its corresponding section on the discharge range.

Floats were started from each station and accurately timed when crossing Range No. 2 to No. 3 and from No. 3 to No. 4. The float on the instant of crossing each range being located by an angle from the zero of base line, 800 feet below discharge range.

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Double floats of tin were used; upper float a double cone 6 inches in diameter; the top float was immersed to one-half its height; lower float a 12-inch cylinder, 18 inches long, with 4½ inch air-tight compartments; float connected by small silk fish line; lower float run at six-tenths the depth.

Three ranges were sounded on the 26th, with a view of obtaining a mean section, but finding no material difference between the three, only the discharge range was sounded afterwards.

Soundings taken with a 15-pound lead on one-quarter inch line, graduated to feet; lead thrown from bow of skiff; angles read on leadsman; soundings were first taken approximately every 20 feet, but finding the bed of the stream comparatively uniform, the distance between was increased to 40 feet.

Water commenced escaping through chute on east bank, above the range on the

*Not printed.

6th. Two measurements were made of this, one on the 9th and the other on the 14th. Velocity obtained by surface floats; soundings located by stadia.

Considerable trouble was experienced on account of wind up to June 3, but for the remainder of the time the party was out all conditions were favorable. * * *

MEMORANDA:

TO ACCOMPANY TABULATED RESULTS OF FINAL REDUCTION,* IN SECRETARY'S OFFICE, OF DISCHARGE OBSERVATIONS ON THE MISSISSIPPI RIVER AND TRIBUTARIES AND THE ATCHAFALAYA; 1892.

St. Louis, Mo.—Observations were made under the direction of the secretary, by party in charge of Mr. J. A. Ockerson, assistant engineer, and at about the time of highest water.

One discharge section was at the Merchants Bridge and the other section about 4½ miles below that, at the Pittsburg Dike.

The Merchants Bridge consists of 3 spans of about 500 feet each, and approaches. The velocity was measured at the centers of the first and second spans, with Price current meter No. 10, when the meter was lost; the meter was held at six-tenths depth and for ten and eight minutes. The velocity measured at second span was assumed for the third span. The velocity of flow over the bank east of section was estimated by the observer.

In reducing the registrations of meter to velocity in feet per second, the results of the latest rating, made April 11, 1890, were used; the equation is: $y=3.9897x+0.2986$, in which y = velocity and x = registrations.

The soundings were taken from the bridge, with a three-sixteenths-inch wire rope and a 16-pound lead. The distance apart of soundings was about 29 feet for the first span and 58 feet for other spans.

The velocities at the Pittsburg Dike section were obtained with double floats, except at one station on the shallow side, where the Price meter No. 10 was used May 19.

The floats were run at irregular distances apart across the river; the subsurface float was approximately at middepth. The highest velocity and deepest part of the river were near the left bank. The last station at which the velocity was measured, at the left bank side, was 300 feet from shore, and 275 feet from the nearest station on the river side of it; the velocity found 300 feet from shore was 16.2 feet per second; this velocity was applied over the area included between the shore and 437 feet out, on the statement of the observer that the maximum velocity was probably between the last station and shore. The city harbor boat, a large side-wheel tug, was used at this section. In consequence of the strength of current, the steamer was headed up stream, dropped down across the section, feeling the bottom with the sounding line. The soundings were made May 23, except one, which was taken May 19; they were all corrected to agree with stage of May 21, the date of float observations. The soundings were taken with same lead and line used at the Merchants Bridge, and at irregular distances across the river; the first sounding at the deep side was about 200 feet from shore and at the shallow side about 250 feet.

The observations were irregular, owing to the difficulties of the situation. In calculations allowance was made for these irregularities, based on personal recollection of the observers, who were of the force of this office.

The gauge readings are from the standard United States Engineer gauge at foot of Market street, whose zero is 400.23 feet above the Cairo datum plane.

Columbus, Ky.—The discharge section is at the same location as in 1891, and is about 2,000 feet below the section of 1881–'82.

The section is shown on a tracing, scale 1:20000, accompanying the field notes. The left bank end is about 200 feet above where the Mobile and Ohio Railroad would cut the shore if the straight line east of switches was produced. The right bank end is about 550 feet below where the St. Louis, Iron Mountain and Southern Railroad would cut the shore if the straight line before entering Belmont was produced.

Azimuth of section, R. B. to L. B., 305° 30′.
R. B. from stone line B. M. ½: azimuth 351°; distance, 5,020 feet.
L. B. from △ Fort Halleck; azimuth 29° 10′; distance, 4,850 feet.
L. B. from P. B. M. 7; azimuth 27° 30′; distance, 2,050 feet.

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* The methods of reduction are the same as heretofore used in this office for similar observations and have been fully described in previous published reports. All the results tabulated are from recomputation in this office, except some given in the slope and crevasse tables, where it is specially noted in each case. Generally two-thirds or four-fifths of the velocity observed at the last velocity station was taken to find the discharge between that station and the shore; this was determined by the form of the transverse curve of velocity in each case, as heretofore; exceptional cases are noted in the memoranda.

Soundings and velocities were taken at irregular intervals across the river, the velocities being generally less than 200 feet apart.

Cross sections were plotted to a scale of 1 inch = 200 feet horizontal and 1 inch = 20 feet vertical, and on these the velocity curve was plotted in registrations of the meter per second.

Soundings were scaled from these, 100 feet apart, and velocities generally 200 feet apart, for computing discharges.

The end areas were computed precisely from the notes. The end velocity station on shallow side was generally about 200 feet from shore, and on the deep side was from 26 feet to 164 feet from shore.

The meter was not rated during the season, hence the rating of September 23, 1891, was used; the equation is $y = 3.7895\,x + .212$.

The time during which meter was run at each station varied from 70 to 294 seconds, but was generally about 160 seconds.

Datum line was taken same as last season, at 40.55 feet on the standard M. R. C. gauge at Belmont, Mo.,* whose zero is 287.14 feet above the Cairo datum. Datum width taken at 3,121 feet.

Slope gauges were 8,400 feet apart on the left bank, the lower one being about 1,700 feet below the discharge section; for results see slope table.

Fulton, Tenn.—Section line is about normal to the direction of the current, and about 5,000 feet above the landing at Fulton, Tenn.

This discharge section is about 1,600 feet above that used in 1879–'80 and 1884.

Azimuth of section, R. B. to L. B., 330°.

R. B. Shore line from B. M. $\frac{48}{3}$, 1,150 feet; azimuth 260° 00′.

L. B. Shore line from B. M. $\frac{48}{7}$, 950 feet; azimuth 225° 10′.

The above are derived from a location of the section on a M. R. C. map, scale 1 inch = 1 mile, received from district officer, and transferred to chart, scale 1:20000. Divergence is very small, hence the point of intersection is not given.

The float paths were plotted to a scale of 1 inch = 100 feet, and from this velocities were derived.

The soundings and velocities were plotted on cross-section paper to a horizontal scale of 1 inch = 100 feet, and vertical scales of 1 inch = 20 feet for soundings, and 1 inch = 2 feet per second for velocities.

The distances of end velocity stations varied from about 30 to 75 feet on the deep side, and from 70 to 200 feet on the shallow side of the river. The end soundings were generally taken less than 50 feet from shore.

For computing area and discharge, soundings were scaled off from the plots every 50 feet, and the velocities every 100 feet, except that where the curves were very regular the distance between velocities was increased.

The observer attributes apparent discrepancies in results of first few days to the lead line (see field report), but considerable changes in velocity are also noticeable. The readings are given of standard M. R. C. gauge at Fulton, Tenn., whose zero is 228.55 feet above the Cairo datum plane.

Datum line is taken at 250.10 feet on the local gauge at section, which was the reading of April 30 and May 2, 1892; the datum width is taken at 2,570 feet. The tabulated slope is from reduction at district office.

Helena, Ark.—The discharge section is shown on a map, scale 1:20000, accompanying the field notes, to have the left bank end on line with the Memphis and Helena Railroad and the right bank end about 300 feet below the elevator; the section is nearly in prolongation of the Memphis and Helena Railroad, as it enters Glendale, Miss.

Right bank shore line, from B. M. $\frac{22}{3}$, 800 feet; azimuth 245°.

Left bank shore line, from $\frac{22}{3}$, 2,740 feet; azimuth 42°.

Section line intersects stone line 22 at 1,280 feet from B. M. $\frac{22}{3}$, divergence 25° 20′ downstream.

Azimuth of section line from R. B. to L. B., 288° 05′.

The soundings and velocities were at irregular distances apart; soundings were mainly about 50 feet apart, except near the shores where the distances were generally much less. Distances apart of velocities varied, being mainly about 200 feet in deep parts and about 300 feet in shallow parts, or where velocities changed but little.

The cross sections were plotted to a scale of 1 inch = 300 feet horizontal, and 1 inch = 20 feet vertical, and velocities plotted in meter registrations per second.

NOTE.—Geodetic positions are from scaling on the 1:20000 M. R. C. charts, and shore lines are as shown on same charts, unless otherwise stated.

*This gauge was connected with stone line B. M. $\frac{1}{3}$ by duplicate line of levels of inspection party in November, 1892. If the elevation of B. M. $\frac{1}{3}$ is correct, then the gauge is 0.25 feet too low. No correction has been applied to the reading tabulated here. Connection with P. B. M. 8 at Columbus, by river crossing, will be made as early as practicable; meanwhile the elevation is doubtful.

From these plots soundings were scaled off every 150 feet and velocities every 300 feet, except where velocities changed rapidly between stations, in which case they were scaled every 150 feet and soundings 75 feet. The end areas for about 500 feet from shore were computed precisely from the sounding notes.

Velocities were generally observed within 300 feet of shore, but the distance varied from about 170 to 370 feet.

The same meter and rating was used as at Columbus, and length of time at stations was also about the same. (See page 3676.)

Datum line was taken at 45.73 feet on the standard United States Engineer gauge, whose zero is 161.98 feet above the Cairo datum plane. Datum width taken at 5,119 feet, as observed May 11, 1892.

Slope gauges were 12,570 feet apart on the right bank, the upper one being about 2,500 feet above the discharge section.

Chicot City, Ark.—For description of location of discharge section and distances between velocity stations, etc., see field report on page 3671.

The soundings were located in the usual manner from a 3,000-foot base, the distance apart rarely exceeding 75 feet. Distances out of these were checked from the angles, also corrections to lead line were checked. The cross sections were plotted to a horizontal scale of 1 inch = 200 feet and vertical 1 inch = 20 feet, and soundings scaled from the plots every 75 feet between the velocity stations, and from these the partial areas were computed; the end areas were computed directly from the notes.

From the location of Station I it did not give a good mean velocity for the end area, for this area, therefore, the velocity at Station I was corrected by adding one-sixth of the difference between Stations I and II. At all the other stations the observed velocity was applied directly to its corresponding partial area.

The meter ratings used were as described for Arkansas City and given in table meter ratings. The results of low velocity ratings were used at Station XIV.

The meter was run at each station generally for five minutes.

Float observations were reduced in the usual manner.

The datum line was taken at water surface level at the discharge section on June 28, which is approximately 165.2 feet above the Cairo datum plane. The gauge readings tabulated are as observed by the discharge party on the Arkansas City gauge, whose zero elevation is 116.44 feet above the Cairo datum plane.

Datum width 4,054 feet.

The discharge over bank was observed June 29, and assumed to be constant from June 28 to July 2.

Arkansas City, Ark.—(See also field report, p. 3665.) The discharge section is in same position as in 1891; a field sketch, dated June 4, 1891, scale 1 inch = 300 feet, shows the section intersecting the Arkansas shore 2,646 feet downstream from center of elevator building at Arkansas City. The magnetic bearing of section line is stated to be N. 41° 10′ W.

On the same sketch a B. M. (probably stone line B. M. $\frac{63}{2}$ is shown 1,300 feet from intersection of left bank and section line; bearing E. (magnetic) and a P. B. M. (probably P. B. M. 84) is shown distant from same intersection 1,080 feet, bearing E. 14° S. (magnetic).

The discharge section of 1889 and 1890 intersects the Arkansas shore at same point and the Mississippi shore 100 feet above the present section.

The soundings were generally well distributed across the river, distance apart seldom reaching 100 feet, and near the shores being less than 50 feet.

The distances out of soundings and corrections to lead line in note books were checked.

The partial areas were computed directly from the soundings up to May 19, and after that the soundings were scaled from the plotted cross sections at intervals of 75 feet, and 50 feet near shore, and from these the areas were computed.

The scale of cross section plots was horizontal 1 inch = 200 feet to 1 inch = 20 feet vertical.

The velocity stations were 300 feet apart across the river (except Stations I and II, which were 240 feet apart); the end velocity stations were about 110 and 120 feet from shore. The observed velocities were applied to the corresponding partial areas in computing the discharge. The meter was generally run for five minutes at each station.

No correction for motion of boat, noted in the field report, has been applied. On days when piano wire soundings were taken on same day as the ordinary line soundings, areas by both methods, computed separately, are given; also separate discharges.

The old meter, No. 5, and two new ones, Nos. 38 and 39, were used in measuring velocities. These meters were rated several times during the season, and the results of final reduction in this office are given in table on page 3700. The different series were divided at about 3 feet per second velocity, and the upper and lower groups of each series reduced separately.

The results of the higher groups were used for reducing the river velocities, and that of the lower group for over-bank flow. The results of each group for the different meters have been combined in the usual manner by weighting the constants inversely as the squares of the respective mean errors of the constants. The resulting values are given in the table. Meter No. 39 was taken apart April 28, hence the rating of April 23 was not combined with later ratings, but used separately for discharges of April 22 to 27. The float observations were reduced in the usual manner.

The gauge readings tabulated are from the gauge at elevator and as reported by the observation party; the elevation of zero of this gauge is 116.44 feet above the Cairo datum plane.

Datum line is taken at 41.73 feet on the gauge and datum width at 3,416 feet, both the same as in 1891.

Over-bank discharge was measured April 25, May 3, 5, 11, 19, and 31, June 10 and 22, and July 1, and from these the bank discharges for intervening dates were interpolated.

Wilson Point, La.—For position of velocity stations, methods of observation, etc., see field reports, pp. 3669 and 3672.

The discharge section is shown on a sketch accompanying the field notes, scale 1:10000, with the right bank end about 250 feet above Wilson Point Landing; the azimuth of section R. B. to L. B., is 248° 32′, measured on same sketch. This section was used in both high and low-water discharges this year, and was also used in 1891.

The distances out of soundings were checked from the angles, and also lead line corrections to soundings checked. The cross sections were plotted to a scale of 1 inch = 200 feet horizontal and 1 inch = 10 feet vertical, and for these plats the soundings were scaled off every 75 feet; for the low water set soundings were scaled every 50 feet except near shore, since the velocity stations in the low-water observations, were 100 feet apart. End soundings were taken directly from the notes. From these scaled soundings the partial areas were computed, and the velocities observed at the different stations applied to the corresponding partial areas, except at Station I, during high water, where the observed velocity was increased by adding one-fourth of the difference between that and the velocity observed at Station II, to compensate for the nearness of Station I to shore; see field report.

The new Price meters Nos. 38 and 39 were used in measuring velocities, and also double floats.

The results of ratings of the meters, given in table on page 3700, and as described for Arkansas City, were used in computing high-water discharges; for the low-water discharges meter No. 38, with rating of November 26, was used.

Where meter and floats are used on the same day the same set of soundings is used in obtaining both discharges; hence the area quantities are not repeated in the table

In the low-water discharges the meter was held at 10 feet below the surface, except near shore, and these observed velocities were reduced to correspond to six-tenths depth by the table given in Mississippi River Commission Report for 1884, p. 189, last line.

Two discharges are given for October 26, one using all the stations 100 feet apart, and the other using only the regular stations, 300 feet apart, the same soundings being used.

The Lake Providence gauge readings tabulated are from the regular gauge reports. The zero of this gauge is 89.62 feet above the Cairo datum plane. The "local gauge" readings are the elevations of the water surface at the discharge section above a horizontal plane at same elevation as that of the zero of the Lake Providence gauge. The datum line is taken at 41.83 feet on this local gauge as tabulated.

The width at datum line was taken as observed at 3,938 feet.

In computing the low-water datum areas the same datum line and width were taken; and at 39.43 feet and 37.43 feet the widths were taken, as observed during high water, at 3,923 and 3,841 feet, respectively. Between these heights the slope of bank was assumed to be uniform, and also between the last height and the water surface.

The overbank discharge given in the table was on the Mississippi side of the river, as described in field report. The dates it was observed are noted in the table; for the intervening dates it is interpolated in proportion to time.

Crevasse measurements, third district.—(For field reports see pp. 3668 and 3671.) In this re-computation only obvious errors in the first computation were corrected, the judgment of the observer being accepted where it was evidently his intention to allow for small irregularities or insufficient observations.

The results of meter ratings on p. 3700 were used in computing discharges, the low velocity groups being generally taken.

Where the submergence of meter is not noted on the table it was assumed to be six-tenths of the depth.

The widths of the breaks tabulated are mainly copied from field reports. Since the discharge range was not always in line between ends of break its width would sometimes be greater than that tabulated. The discharge of Brooks Mill crevasse was observed May 25 also, but the results are not tabulated since the district officer regards them as worthless.

The observer notes, June 1, for Leland crevasse that conditions were unfavorable, but thinks results as given can be relied on to within 10 per cent.

Natches, Miss.—A rough sketch, accompanying notes of 1891, shows section to be immediately in front of the town of Vidalia and normal to the direction of the river. The left-bank end is about 3,300 feet below where Orleans street, Natchez, if produced, would intersect the shore line.

R. B. shore line from B. M. $\frac{132}{2}$, 1,900 feet; azimuth, 345° 20′.

R. B. shore line from △East Base = P. B. M. LXIII, 1,100 feet; azimuth, 20° 10′.

L. B. shore line from B. M. $\frac{132}{1}$, 850 feet; azimuth, 81°.

Section line nearly parallel with stone line 132; azimuth, 323° 30′.

It is stated in notebook that the discharge section is in same position as in 1891.

The distances between stations varied from 98 to 200 feet, except that until May 28 the distance from station 11 to station 12 was 224 feet, when station 12 was moved to make this 200 feet.

The distance of end stations from shore was about 100 feet until May 30, when the "distance out" of left-bank station was increased to 129 feet by the change above noted.

Until May 20 the boat was not exactly at the established stations on account, the observer states, of new crew. The departure from stations however is exactly noted.

Velocities were measured with the Price current meter No. 25. The time of an observation varied from about one minute to three minutes, but was generally less than one and one-half minutes. At stations 5 to 9, after the first few days, the meter was held at two-tenths depth and at other stations was held at from three-tenths to eight-tenths depth.

Since the meter was held at two-tenths depth for the greatest number of stations, all the others were first reduced to this depth, and the whole result finally reduced to six-tenths depth, using the values for the different depths given in Mr. Price's tables. This method of observing obviously increases the work of reduction and also introduces an additional series of assumptions between the observations and the final result, besides those involved in the adopted method of computation.

The notebook contains two sets of observations for rating the meter, July 2 and July 12, 1892, respectively; but as the first set was marked "no good," only the second set was reduced and used in computing discharges. For results of reduction see table of meter ratings.

Datum line was taken at 48.08 feet on the United States Engineer gauge, and datum width at 2,179 feet, both as observed June 25, 1892. Datum line was taken at this height because the river width at datum height of last year was not observed this season.

Mr. G. Ed. Mott, assistant engineer, who was the observer during the season, states in a letter that up to May 19 the observations are not reliable on account of new crew. In the notebook the observations of June 23 and 24 are also questioned for the same reason.

The formula correction to discharge was from about 2,100 to 3,700 cubic feet per second.

Red River Landing, La.—The discharge section is shown on sketch scale 1 inch = 1 mile to be due east and west, latitude 30° 57′ + 2,340 feet, and is at Red River Landing.

R. B. end is said to be nearly at same place as section of former years, but left-bank end is moved downstream to make section normal to direction of the current.

R. B. shore line from B. M. $\frac{149}{3}$, 5,000 feet; azimuth, 351°.

L. B. shore line from B. M. $\frac{152}{2}$, 4,100 feet; azimuth, 22° 30′.

Section line (produced inshore) intersects stone line No. 150 at 4,700 feet from B. M. $\frac{150}{1}$ divergence 45° upstream.

Range signals on left bank were used to locate stations. The stations were mainly 200 feet apart, except near shore, where they were 100 and 120 feet apart. End stations were 98 to 120 feet from right bank and 56 to 138 feet from left bank.

NOTE.—In the fourth district, comprising Natchez, Red River Landing, Simmsport, and Carrollton, the sounding and velocity stations were coincident and were maintained at the same places on the discharge section throughout the season, with some exceptions at Natchez, which are specially noted. The means of velocities at adjacent stations have been applied over the included areas to find the partial discharges. The usual formula correction for error due to this method has been approximately applied, the maximum correction at the Mississippi stations being about one-fourth of 1 per cent of the total discharge and about one-half of 1 per cent at Simmsport. Generally this correction is unimportant. Its range is given in the memoranda for each station.

Velocities were measured with the meter at mid depth until June 14, after which they were taken at four-tenths depth. These have all been redu ed to six-tenths depth for computing discharge. The meter was run from two to three minutes at each station until May 11, and after that uniformly for two minutes at each station.

The notes contain tables of lead-line corrections up to May 13 for this station and Simmsport, and corrected soundings have been checked by these tables; but after that date Mr. Oliveira, the observer, states that "The corrections for each day's soundings were made by stretching the lead line alongside the tape line and reading off on the tape the correct soundings corresponding to each recorded reading on the lead line. The readings on the tape line were entered as the corrected soundings." The corrections, as given in the tables, seldom exceeded 1 foot and were generally one or two tenths of a foot.

Datum line was taken at 48.85 feet on the United States Engineer gauge and datum width at 4,046 feet, both as observed June 27, 1892. The formula correction for a total discharge was from about —300 to + 700 cubic feet per second.

Mr. W. G. Price, assistant engineer, was observer until May 13, after that Mr. B. J. Oliveira. Slope gauges were read at the discharge section and at Rows Landing. The results are given in the accompanying slope tables.

The location map accompanying the discharge notes shows a flow over the left bank following the foot of the bluffs from Clarkes Lake, just below Fort Adams, and coming into the river again at Rows Landing, making a nearly straight cut across of about 8 miles long, which opposite the discharge section was about 4 miles from the river. No measurement or estimate is given of this overflow in the notes of discharge work.

*Simmsport, La.**—Two different discharge sections were used at this place, the first one stated to have been established by Mr. G. Ed. Mott, assistant engineer, between sill dams Nos. 1 and 3. This section was used until May 7. The stations were 100 feet apart, except near shore they were 50 and 60 feet apart. The end stations were about 30 and 70 feet out until April 7, and then about 70 feet from shore on both sides while this section was used. (See Red River Landing memorandum for notes on lead line.)

The second discharge section at this place, established by Mr. W. G. Price May 13, 1892, is shown on sketch to be located below the mouth of Bayou des Glaise and just above the mouth of Alligator Bayou. The stations were 100 feet apart, except near shore they were 60 and 70 feet apart. The end station at the right bank was about 60 feet from shore. The end station at the left bank was about 60 feet out from main shore.

As the river rose this bank was overflowed and an angle in levee just above formed a pocket, so that this overflowed part was dead water.

The datum line for first section used was taken at 42.33 feet on the gauge, and datum width at 1,056 feet, both as observed May 7.

The datum line for the second section was taken at 46.64 feet on the gauge, and datum width at 1,222 feet. In computing datum areas the width at 44.40 feet on the gauge was taken at 1,057 feet.

The Simmsport gauge readings are tabulated as reported by the discharge party. The zero is 24.17 feet above the Cairo datum plane.

The change of gauge in twenty-four hours is from the regular gauge reports, but since these reports were discontinued, May 15, and those of the discharge party are not continuous, this column is blank after May 13.

*Carrollton, La.**—The section is reported by observer to be at the same place as in 1891, who also states that the water width is greater than last year, owing to an old spur levee and batture being cut away in building a new levee.

A sketch, scale approx. 1:20000, shows the section to intersect the left-shore line about 600 feet above the foot of Carrollton avenue, Carrollton, La.

The section is normal to the direction of river at that place, and is about 1¼ miles above upper limit, at the river, of Audubon Park.

The stations were at irregular distances across the river, varying from 50 to 200 feet. The end station, at the deep side, 120 feet from shore, that at the shallow side was 250 feet from shore.

Velocities were measured with Price meter No. 22. The meter was held at four-tenths depths at stations covering the deepest part of the river, and at others at five-tenths and six-tenths. They were all reduced to six-tenths depth before computing discharge. The meter was run for two minutes at each station, except that on June 30 about half the stations were observed for one minute, and one station for three minutes.

The meter was rated June 8, and the results used in computing discharges. See table of meter ratings for values.

The observer reports lead line correct. Datum line is taken at 17 feet on the United States Engineer gauge and datum width at 2,490 feet, as observed June 10, 1892.

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*See note on page 3679.

The formula correction was about 200 to 800 cubic feet per second for a total discharge.

Mr. William Garvin, assistant engineer, was the observer during the season.

*Arkansas River,** *Little Rock, Ark.*—(See also field report on p. 3673.) The mean cross section, derived as described in field report, was plotted to a horizontal scale of 1 inch = 100 feet; vertical, 1 inch = 10 feet, and from these plots soundings were scaled every 100 or 150 feet for computing areas.

The floats were run over a distance between ranges of 3,200 feet. The upper range was 1,600 feet below the railroad bridge over the Arkansas River. This bridge is stated to be about 5,000 feet below the "Baring Cross" Bridge, upon which the United States Engineer gauge is located.

The end velocity stations were less than 150 feet from shore and the maximum distance between observed velocities on May 23 was about 300 feet and on May 24 about 500 feet. Those observed velocities were plotted on the cross sections to a vertical scale of 1 inch = 2 feet per second, and from these plats velocities were scaled off mainly 200 feet apart, and the discharges computed in the usual manner.

The Little Rock gauge in the tabulation is the standard United States Engineer gauge, whose zero is 241.55 feet above the Cairo datum plane.

Ouachita River, Monroe, La.—(See field report on p. 3673.) The discharge section is shown on a map, scale 1 inch = 400 feet, accompanying the notes, to be normal to the direction of the river. The left-bank end is 2,320 feet below the south line of Calypso street, Monroe. The section is three-fourths of a mile below the Vicksburg, Shreveport, and Pacific Railroad Bridge over the Ouachita River.

Velocities were observed on May 31 and June 1. Soundings were taken only on May 30, and these soundings were corrected for change of stage and used for obtaining areas for May 31 and June 1. The observations were carefully distributed across the river; the velocities were taken on May 30 about 50 and 100 feet from the shores, but on June 1 the velocity at 100 feet out was borrowed from the day before, as it was not observed June 1 at this point.

The cross sections were plotted from soundings corrected, as above noted, to a scale of 1 inch = 100 feet horizontal and 1 inch = 10 feet vertical; velocities were plotted on these to a scale of 1 inch = 1 foot per second.

Soundings were scaled from these plots every 25 feet, and velocities every 50 feet, and from these the areas and discharges were computed in the usual manner.

The Monroe gauge, whose readings are tabulated, is that reported by the United States Weather Bureau. The preliminary value of its zero is 51.55 above the Cairo datum plane.

Red River, Alexandria, La.—(See field report on p. 3674.) The discharge section is described as being immediately in front of the town of Alexandria, and is shown by a sketch in the notebook to be exactly in prolongation of the southeast line of Lee street, and normal to the direction of the river. The soundings were at irregular distances across the river, located by transit angles from an 800-foot base; the distance apart of the soundings varied, generally being from about 20 to 60 feet; in a few cases being from 5 or 6 to over 100 feet apart.

No lead-line corrections are given. The areas between soundings were computed precisely from the notes, and these were grouped into partial areas to correspond to each velocity station.

The floats crossed the discharge section at irregular distances apart across the river. The observed velocity, derived from the float, was applied to the corresponding partial area. The end-velocity stations were generally less than 50 feet from shore, and soundings were frequently less than 10 feet from shore. The velocities observed at the end stations were applied from the shore to halfway out to the second velocity station.

From the measured discharges over bank of June 10 and 14 this discharge for included dates was interpolated, and also for June 15, assuming that the change was proportional to the time and having regard to change of stage.

The datum line was taken at 38.24 feet on the United States Engineers gauge whose zero is 64.46 feet above the Cairo datum, and datum width is taken at 820 feet, both as observed June 13, 1892.

For results of slope observations see tables.

* For measurement of flood escape of Arkansas River through levees below Pine Bluff, see report of Mr. Tollinger, on p. 3667.

Results of discharge observations, Mississippi River.

ST. LOUIS, MO.

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	St. Louis.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cubic feet.	Cu. feet.	Cubic feet.			
May 20*	35.70	....	—0.2	103,956	....	54.7	....	78.6	1,901	....	9.623	1,000,331	43,000	1,043,331	2	41	
21†	35.20	....	—0.5	94,361	....	53.6	....	85.6	1,762	....	12.149	1,146,415	0	....	8	11	

*Discharge section at Merchants Bridge.

† Discharge section at Pittsburg dike, about 4½ miles below Merchants Bridge.

COLUMBUS, KY.

[Section same as 1891. Datum line 40'.55 on Belmont gauge. Velocities obtained with meter.]

Date.	St. Louis.	Local.	Rise or fall	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.	Scour or fill.	Mean velocity.	Discharge.	Discharge over bank.	Total discharge.	No. of velocity stations.	No. of soundings.	Wind.
Apr. 13*	†41.28	....	—0.0	202,574	200,295	64.9	64.2	86.0	3,122	+12,602	6.415	1,299,518	....	....	18	40	VIII—Strong.
15	41.20	....	—0.1	190,295	188,266	60.9	60.3	79.8	3,123	—12,029	6.319	1,202,518	....	....	18	33	Calm.
16	41.00	....	—0.1	189,291	187,887	60.7	60.2	79.8	3,121	— 379	6.142	1,162,625	....	....	17	36	IV—Slight.
26	42.96	....	+0.2	203,614	196,035	64.3	62.8	86.0	3,169	+ 8,148	6.701	1,364,430	....	....	19	59	Calm.
27	43.00	....	+0.1	205,752	198,047	64.9	63.5	84.5	3,169	+ 2,012	6.724	1,383,577	....	....	18	52	V—Medium.
28	43.10	....	+0.1	206,257	198,237	65.1	63.5	84.0	3,169	+ 190	6.776	1,397,568	....	....	18	44	V—Medium.
29	43.10	....	—0.1	205,071	197,051	64.7	63.1	85.0	3,169	— 1,186	6.594	1,352,221	....	....	17	47	X—Slight.
30	42.88	....	—0.2	205,729	198,401	64.9	63.6	85.0	3,169	+ 1,350	6.810	1,401,052	....	....	19	52	I—Slight.

† Belmont gauge.

*Raining.

FULTON, TENN.

[Datum line taken as observed on local gauge April 30 and May 2 at 250.10 feet. Velocities obtained with double floats.]

Apr. 15	*33.0	248.75	+0.2	158,058	161,528	61.5	62.9	92.0	2,570	....	7.541	1,191,846	....	....	20	25	XI—Light.
16	33.1	248.95	+0.2	157,844	160,800	61.4	62.6	92.7	2,570	— 728	7.293	1,151,110	....	....	21	27	IV—Light.
18	33.2	249.10	0.0	174,848	177,418	68.0	69.0	99.1	2,570	+16,618	7.370	1,288,699	....	....	21	30	IV—Medium.
19	33.3	249.12	0.0	173,963	176,482	67.7	68.7	93.7	2,570	— 936	7.947	1,382,482	....	....	21	29	III.—Light.
21	33.4	249.25	0.0	162,235	164,419	63.1	64.0	92.5	2,570	—12,068	7.694	1,248,184	....	....	21	33	IV—Medium.
22	33.4	249.22	0.0	146,661	148,923	57.1	57.9	82.1	2,570	—15,496	7.469	1,095,378	....	....	21	28	VI—Light.
23	33.3	249.23	0.0	156,104	158,340	60.7	61.6	86.0	2,570	+ 9,417	7.801	1,217,725	....	....	21	30	Calm.
25	33.5	249.37	+0.1	136,424	138,300	53.1	53.8	73.7	2,570	—20,040	8.058	1,099,266	....	....	21	29	Calm.
26	33.7	249.52	+0.2	154,637	156,128	60.2	60.8	84.5	2,570	+17,828	7.981	1,234,176	....	....	21	28	III—Light.
27	33.8	249.67	+0.2	157,248	158,353	61.2	61.6	83.5	2,570	+ 2,225	8.059	1,267,255	....	....	21	27	IV—Strong.
28	34.0	249.83	+0.2	154,295	154,989	60.0	60.3	83.0	2,570	— 3,364	7.893	1,217,864	....	....	20	27	V—Light.
29	34.2	250.03	+0.2	153,006	153,186	59.5	59.6	85.4	2,570	— 1,803	8.014	1,226,140	....	....	21	29	XII—Light.
30	34.2	250.10	+0.1	156,988	156,988	61.1	61.1	84.6	2,570	+ 3,802	7.930	1,244,842	....	....	21	29	VI—Medium.
May 2	34.2	250.10	0.0	160,337	160,337	62.4	62.4	85.3	2,570	+ 3,349	8.035	1,288,320	....	....	21	27	V—Strong.
3	34.2	250.04	0.0	158,789	158,943	61.8	61.8	86.8	2,570	— 1,394	8.081	1,283,105	....	....	21	31	V—Strong.

*Fulton gauge.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.

[Section is approximately same as 1888–'89; datum line taken at 45'.73 on standard gauge, as observed May 11, 1892. Velocity taken with meter.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Helena.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cubic feet.*	*Cu. feet.*	*Cubic feet.*			
Apr. 18	42.60	....	+0.2	206,318	222,309	40.5	43.4	97.0	5,099	....	5.207	1,074,297	....	....	24	53	VI—Strong.
19	42.73	....	+0.1	215,463	230,790	42.3	45.1	97.0	5,099	+8,481	4.829	1,040,448	....	....	22	48	IV—Light.
20	42.87	....	+0.2	217,881	232,494	42.7	45.4	96.0	5,100	+1,704	5.037	1,097,506	....	....	21	51	II—Mild (rain).
21	43.25	....	+0.4	215,933	228,583	42.3	44.7	96.0	5,101	—3,911	5.159	1,113,991	....	....	23	55	XI—Light.
May 3	44.50	....	+0.1	219,345	225,641	42.9	44.1	98.4	5,118	—2,942	5.512	1,209,040	....	....	20	58	V—Strong.
4	44.64	....	+0.1	221,685	227,264	43.3	44.4	97.0	5,118	+1,623	5.440	1,205,860	....	....	22	66	VI—Medium.
5	44.77	....	+0.1	223,389	228,303	43.6	44.6	96.0	5,118	+1,039	5.643	1,260,657	....	....	22	68	VI—Mild.
6	44.88	....	+0.1	225,445	229,796	44.0	44.9	96.0	5,118	+1,493	5.570	1,255,669	....	....	22	60	Calm.
7	44.98	....	+0.1	226,478	230,317	44.3	45.0	96.5	5,118	+ 521	5.446	1,233,422	....	....	21	56	I—Light.
9	45.48	....	+0.3	227,844	229,124	44.5	44.8	96.0	5,119	—1,193	5.467	1,245,649	....	....	23	63	Calm.
10	45.66	....	+0.2	229,200	229,558	44.8	44.8	97.0	5,119	+ 434	5.630	1,290,339	....	....	22	70	X—Light.
11	45.73	....	+0.1	230,793	230,793	45.1	45.1	97.0	5,119	+1,235	5.747	1,326,393	....	....	21	74	XI—Light.
12	45.69	....	—0.1	229,515	229,720	44.8	44.9	97.0	5,119	—1,073	5.720	1,312,758	....	....	22	66	I—Light.
13	45.51	....	—0.2	229,750	230,876	44.9	45.1	97.0	5,119	+1,156	5.749	1,320,835	....	....	20	62	V—Light.
14	45.26	....	—0.3	228,263	230,669	44.6	45.1	96.0	5,118	— 207	5.762	1,315,245	....	....	22	74	VI—Strong.
16	44.77	....	—0.2	225,814	230,727	44.1	45.1	96.0	5,117	— 58	5.631	1,271,449	....	....	21	73	Calm.
17	44.55	....	—0.2	222,701	228,740	43.5	44.7	96.0	5,117	—1,987	5.613	1,250,076	....	....	22	64	V—Mild.
June 1	44.67	....	+0.2	220,857	226,282	43.2	44.2	95.0	5,117	—2,458	5.647	1,247,267	....	....	23	69	VI—Strong.
2	44.70	....	0.0	221,186	226,458	43.2	44.2	96.0	5,117	+ 176	5.400	1,194,872	....	....	23	64	IX—Mild.
3	44.66	....	—0.1	218,314	223,790	42.7	43.7	95.0	5,117	—2,668	5.393	1,177,835	....	....	22	77	XII—Mild.
4	44.61	....	0.0	219,631	225,368	42.9	44.0	94.0	5,117	+1,573	5.372	1,179,837	....	....	22	69	Calm.
6	44.56	....	0.0	218,173	224,161	42.6	43.8	95.0	5,117	—1,202	5.432	1,185,121	....	....	22	69	Calm.
7	44.60	....	+0.1	219,109	224,892	42.8	43.9	96.0	5,117	+ 731	5.371	1,176,781	....	....	23	66	XI—Light.
8	44.62	....	0.0	221,033	226,713	43.2	44.3	96.0	5,116	+1,821	5.418	1,197,662	....	....	22	65	V—Light.
9	44.72	....	+0.1	223,042	228,212	43.6	44.6	96.5	5,118	+1,499	5.395	1,203,365	....	....	23	65	IV—Light.
10	44.77	....	+0.1	224,478	229,392	43.9	44.8	96.0	5,118	+1,180	5.346	1,199,953	....	....	21	76	Calm.
11	44.86	....	+0.1	225,550	230,004	44.1	44.9	96.0	5,119	+ 612	5.416	1,221,632	....	....	21	74	Calm.
13	45.00	....	+0.1	225,329	229,066	44.0	44.7	96.0	5,119	— 938	5.355	1,206,720	....	....	21	64	Calm.
14	45.06	....	0.0	226,445	229,875	44.2	44.9	96.0	5,119	+ 809	5.419	1,227,060	....	....	20	72	Calm.
15	45.11	....	0.0	227,185	230,309	44.4	45.0	96.0	5,119	+ 434	5.420	1,230,973	....	....	21	78	Calm.
16	45.12	....	0.0	228,214	231,337	44.6	45.2	95.0	5,119	+1,028	5.466	1,247,312	....	....	22	74	Calm.
17	45.06	....	—0.1	227,090	230,520	44.4	45.0	96.0	5,119	— 817	5.328	1,209,975	....	....	21	74	VI—Medium.
18	45.00	....	0.0	226,972	229,709	44.1	44.9	96.0	5,119	— 811	5.555	1,255,271	....	....	21	83	VI—Strong.
20	44.82	....	—0.1	226,710	231,366	44.3	45.2	95.0	5,119	+1,659	5.456	1,236,852	....	....	21	75	VI—Light.
21	44.63	....	—0.2	224,788	230,419	43.9	45.0	96.0	5,119	— 949	5.298	1,190,993	....	....	21	79	VI—Light.
22	44.45	....	—0.2	225,240	231,792	44.0	45.3	96.0	5,119	+1,373	5.154	1,160,941	....	....	21	79	VI—Medium.

CHICOT CITY, ARK.

[Datum line taken at water surface at section June 28, which is approximately 165.2 feet above the Cairo datum plane.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Arkansas City.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cubic feet.	Cu. feet.	Cubic feet.			
June 28	46.9	....	—0.4	222,613	222,612	54.9	54.9	68.5	4,054	....	5.805	*1,292,347	5,828	1,298,175	14	58	
29	46.6	....	—0.6	224,686	225,902	55.4	55.7	70.0	4,054	+3,290	5.592	*1,256,538	5,828	1,262,366	14	57	
29	46.51	....	—0.6	....	....	....	....	....	....	....	....	....	‡5,828	....	7	21	
30†	46.07	....	—0.5	217,669	221,034	53.7	54.5	68.0	4,054	—4,868	4.778	‡1,039,943	5,828	1,045,771	14	61	IX.
30§	45.97	....	—0.5	....	....	....	....	....	....	....	4.856	‡1,059,170	5,828	1,064,998	13	....	
July 1	45.38	....	—0.7	219,464	225,626	54.1	55.7	68.0	4,054	+4,592	4.646	‡1,019,530	5,828	1,025,358	14	57	XII—Light.
1	45.33	....	—0.7	....	....	....	....	....	....	....	4.879	‖1,070,856	5,828	1,076,684	14	....	
2	44.56	....	—0.6	209,995	219,481	51.8	54.1	66.5	4,054	—6,145	5.259	*1,104,287	5,828	1,110,115	14	61	Some wind.
2	44.56	....	—0.6	....	....	....	....	....	....	....	4.891	‡1,027,161	5,828	1,032,989	14	....	

* Meter No. 38. † A. m. ‡ Meter No. 39. § P. m. ‖ Double floats.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.

[Datum line taken at 41.73′ on Arkansas City gauge. Velocities taken with meter except for discharges marked thus *, when double floats were used.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Arkansas City.	Local	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cubic feet.	Cu. feet.	Cubic feet.			
Apr. 22*	46.00	....	+0.4	225,270	209,918	65.2	61.5	88.0	3,453	....	5.807	1,308,146	2,376	1,310,522	12	48	
23	46.35	....	+0.2	241,132	224,579	69.8	65.7	91.0	3,453	+14,061	6.002	1,447,253	2,675	1,449,928	12	48	
25	46.90	....	+0.1	239,831	221,389	69.5	64.8	93.0	3,453	— 3,190	5.761	1,381,748	3,274	1,385,022	12	48	
26	47.07	....	+0.2	247,044	228,010	71.5	66.7	93.0	3,455	+ 6,621	6.161	1,521,971	3,663	1,525,634	12	50	
27	47.25	....	+0.1	246,354	226,702	71.3	66.4	95.0	3,455	— 1,308	6.468	1,593,377	4,052	1,597,429	12	47	Windy.
28	47.45	....	+0.3	248,870	228,514	71.9	66.9	95.0	3,461	+ 1,812	6.109	1,520,396	4,441	1,524,837	12	56	
29	47.61	....	+0.2	251,600	230,694	72.7	67.5	95.0	3,461	+ 2,180	6.128	1,541,833	4,830	1,546,663	12	54	Downstream. Strong.
30	47.78	....	0.0	252,906	231,415	73.1	67.7	95.0	3,461	+ 721	6.256	1,582,280	5,219	1,587,499	12	55	
May 2	47.96	....	+0.1	246,564	224,454	71.2	65.7	95.0	3,461	— 6,961	6.564	1,618,559	5,997	1,624,556	12	51	Upstream.
3	48.02	....	+0.1	247,551	225,235	71.5	65.9	94.0	3,461	+ 781	6.166	1,526,488	6,387	1,532,875	12	49	
4†	48.10	....	0.0	246,407	223,816	71.2	65.5	95.0	3,461	— 1,419	7.009	1,727,117	6,559	1,733,676	12	52	
4‡	48.10	....	0.0	....	....	....	....	....	....	....	7.041	1,734,967	6,559	1,741,526	12	.....	
5	48.25	....	+0.1	248,712	225,605	71.9	66.0	93.0	3,461	+ 1,789	6.363	1,582,441	6,731	1,589,172	12	52	Light.
6	48.33	....	+0.2	247,726	224,344	71.6	65.7	95.0	3,461	— 1,261	6.625	1,641,266	6,871	1,648,137	12	52	Calm.
7	48.55	....	+0.1	247,198	223,059	71.4	65.3	95.0	3,461	— 1,285	6.500	1,606,703	7,011	1,613,714	12	52	
9	48.75	....	0.0	249,627	224,801	72.1	65.8	95.0	3,461	+ 1,742	6.621	1,652,706	7,291	1,659,997	12	50	High.
10	48.80	....	0.0	247,249	222,251	71.4	65.1	94.9	3,461	— 2,550	6.447	1,594,066	7,431	1,601,497	12	51	High to light.
11	48.88	....	+0.2	248,656	223,383	71.8	65.4	95.5	3,461	+ 1,132	5.975	1,485,630	7,571	1,493,201	12	51	Light.
12	48.95	....	0.0	249,755	224,241	72.2	65.6	94.5	3,461	+ 858	6.200	1,548,413	7,652	1,556,065	12	50	
13	49.14	....	+0.2	248,170	222,003	71.7	65.6	95.5	3,461	— 2,238	5.879	1,458,873	7,733	1,466,606	12	51	
14	49.14	....	0.0	243,345	217,178	70.3	63.6	95.0	3,461	— 4,825	5.761	1,401,997	7,814	1,409,811	12	51	Slight.
16	49.10	....	0.0	250,912	224,882	72.5	65.8	96.0	3,461	+ 7,704	5.756	*1,444,252	7,976	1,452,228	12	50	
19	49.15	....	0.0	251,441	225,239	72.6	65.9	95.5	3,461	+ 357	5.793	1,456,502	8,221	1,464,723	12	51	
21	49.27	....	+0.1	247,559	220,945	71.5	64.7	90.	3,461	—4,294	5.647	1,397,985	8,317	1,406,302		50	Slight.
23	49.40	....	+0.1	250,968	223,907	72.5	65.5	96.	3,461	+2,962	5.685	1,426,841	8,413	1,435,254		51	
23	49.40	....	+0.1	....	....	....	....	....	....	....	5.843	*1,466,317	8,413	1,474,730		...	
24	49.46	....	0.0	247,954	220,687	71.6	64.6	95.5	3,461	—3,220	5.708	1,415,237	8,461	1,423,698		51	
26	49.59	....	+0.1	251,889	224,175	72.8	65.6	97	3,461	+3,488	5.701	1,436,119	8,557	1,444,676		51	Light.
27	49.64	....	+0.1	250,857	222,971	72.5	65.3	96	3,461	—1,204	5.661	1,420,014	8,605	1,428,619		51	Calm.
28	49.73	....	0.0	250,868	222,672	72.5	65.2	96	3,461	— 299	5.730	1,437,497	8,653	1,446,150		50	High.
30	49.82	....	0.0	249,698	221,198	72.1	64.7	96	3,461	—1,479	5.735	1,432,000	8,749	1,440,749		49	Calm to brisk.
31	49.82	....	0.0	248,349	219,844	71.8	64.4	94.5	3,461	—1,349	5.945	1,476,534	8,796	1,485,330		52	Very strong.
June 1	49.88	....	+0.1	251,289	222,577	72.6	65.2	95.5	3,461	+2,733	5.876	1,476,603	8,743	1,485,346		51	Calm.
3	49.73	....	—0.1	246,607	218,411	71.8	63.9	94	3,461	—4,166	5.952	1,467,892	8,639	1,476,531		52	West.—Light.
4	49.60	....	—0.1	245,821	218,072	71.0	63.8	92	3,461	— 339	5.873	1,443,738	8,587	1,452,325		57	

	6	49.47		0.0	243,470	216,168	40.3	63.3	91	3,461	—1,904	5.781	1,407,409	8,483	1,415,892		56	South.—Light.
	7	49.43		—0.1	251,458	224,294	72.7	65.7	96	3,461	+8,126	5.786	1,[?]54,910	8,431	1,463,341		62	
	8	49.39		0.0	251,761	224,734	72.7	65.8	95	3,461	+ 440	5.784	1,456,230	8,379	1,464,609		68	Light.
	9	49.39		0.0	254,831	227,804	73.6	66.7	96	3,461	+3,070	5.790	1,475,400	8,327	1,483,727		61	
	10	49.42		0.0	253,040	225,910	73.1	66.1	94	3,461	—1,894	5.822	1,473,122	8,275	1,481,397		63	South.—Light.
	11	49.44		0.0	253,347	226,148	73.2	66.2	95.5	3,461	+ 238	5.738	1,453,676	8,178	1,461,854		60	Light.
	13	49.45		0.0	248,400	221,167	71.8	64.7	94	3,461	—4,981	5.811	1,443,467	7,990	1,451,457		66	SE.—Light.
	14	49.45		0.0	245,300	218,067	70.9	63.8	93	3,461	—3,100	5.862	1,437,988	7,897	1,445,885	12	74	E.—Light.
	14	49.45		0.0	§242,025	214,792	69.9	62.9	93	3,461	—3,275	5.848	1,415,298	7,897	1,423,195		46	Do.
	15	49.44		0.0	247,206	220,007	71.4	64.4	93.6	3,461	+5,215	5.663	1,399,985	7,804	1,407,789		70	
	16	49.37		0.0	250,563	223,605	72.4	65.5	93.5	3,461	+3,698	5.782	1,448,859	7,711	1,456,570		52	
	17	49.30		—0.1	249,433	222,716	72.1	65.2	95	3,461	— 889	5.727	1,428,398	7,618	1,436,016		53	
	18	49.20		—0.1	248,128	221,755	71.7	64.9	94	3,461	— 961	5.703	1,414,865	7,525	1,422,390		50	SW.—Fair.
	20	48.97		—0.2	249,278	223,695	72.0	65.5	93	3,461	+1,940	5.604	1,397,002	7,339	1,404,341		52	
	20	48.97		—0.2								5.591	*1,393,709	7,339	1,401,048		...	
	21	48.85		0.0	247,190	222,020	71.4	65.0	92.5	3,461	—1,675	5.616	1,388,210	7,246	1,395,456		51	
	21	48.85		0.0	§240,414	215,244	69.5	63.0	90	3,461	—6,776	5.608	1,348,311	7,246	1,355,557		45	
	22	48.62		—0.2										7,153			...	
	23	48.47		—0.2	245,642	221,779	71.0	64.9	94	3,461	+6,535	5.446	1,337,836	6,604	1,344,440		52	
	24	48.28		—0.2	246,258	223,048	71.2	65.3	92.5	3,461	+1,269	5.498	1,353,958	6,055	1,360,013		54	Up stream.—Strong.
	27	47.52		—0.2	240,268	219,671	69.4	64.3	90	3,461	—3,377	4.979	1,196,262	4,408	1,200,670		56	X.—Brisk.
	28	47.17		—0.4	244,949	225,556	70.8	66.0	92	3,461	+5,885	4.798	1,175,157	3,859	1,179,016		59	IL.—Light.
	29	46.65		—0.6	244,007	226,401	70.5	66.3	92	3,461	+ 845	4.824	1,177,005	3,310	1,180,315		52	SW.—Slight.
	30	46.13		—0.5	236,632	220,833	68.5	64.6	89	3,453	—5,568	5.024	1,188,932	2,761	1,191,693		52	SW.—Upstream, strong.
	30	46.13		—0.5								4.994	*1,181,689	2,761	1,184,450		...	
July	1	45.49		—0.7	239,929	226,328	69.5	66.3	89	3,453	+5,495	4.819	1,156,144	2,212	1,158,356		53	
	1	45.49										4.752	*1,140,130	2,212	1,142,342		...	

* Observations doubtful. † A. m. ‡ P. m. § Piano wire soundings.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.

[Datum taken at 41'.83 on local gauge as here tabulated. Velocities taken with current meter except where floats are noted.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Lake Providence.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum									
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cu. feet.	Cu. feet.	Cu. feet.			
Apr. 16	36.2	39.43	+0.6	193,596	203,029	49.3	51.6	67.0	3,923	....	5.637	1,091,388	....	....		67	VII.—Brisk.
18	37.2	40.38	+0.4	199,852	205,557	50.8	52.2	68.0	3,931	+ 2,528	5.583	1,115,787	....	....		68	VII.—Light.
19	37.5	40.61	+0.4	199,101	203,902	50.6	51.8	67.5	3,932	− 1,655	5.827	1,160,233	....	....		63	VII.—Brisk.
20	37.8	41.03	+0.3	203,787	206,936	51.8	52.5	68.5	3,934	+ 3,034	5.923	1,206,990	....	....		57	VII.—Fair.
21	38.2	41.28	+0.4	205,150	207,315	52.1	52.6	68.0	3,936	+ 379	5.846	1,199,389	....	....		63	I.—Light.
22	38.6	41.58	+0.4	205,281	206,265	52.1	52.4	68.5	3,937	− 1,050	5.830	1,196,788	*2,500	1,199,288		70	XII.—Light.
23	38.8	41.91	+0.3	211,642	211,327	53.7	53.7	70.0	3,939	+ 5,062	6.116	1,294,334	2,800	1,297,134		68	X.—Light.
25	39.5	42.52	+0.3	216,485	213,766	54.9	54.3	70.5	3,942	+ 2,439	6.088	1,317,979	*3,400	1,321,379		69	IV.—Light.
26	39.7	42.81	+0.2	217,613	213,751	55.2	54.3	70.0	3,944	− 15	6.156	1,339,655	4,400	1,344,055		62	V.—Light.
27	39.9	42.98	+0.2	212,689	208,157	53.9	52.9	70.5	3,944	− 5,594	6.325	1,345,290	5,300	1,350,590		76	VII.
28	40.2	43.19	+0.3	215,859	210,499	54.7	53.5	71.0	3,944	+ 2,342	6.420	1,385,873	6,300	1,392,173		65	VI.—Light.
29	40.4	43.50	+0.2	222,836	216,255	56.5	54.9	71.5	3,944	+ 5,756	6.278	1,399,014	7,200	1,406,214		79	XI.
30	40.6	43.67	+0.2	221,532	214,279	56.1	54.4	71.0	3,946	− 1,976	6.031	1,335,996	8,200	1,344,196		79	IX.
May 2	40.8	43.95	0.0	222,554	214,195	56.4	54.4	71.0	3,948	− 84	6.145	1,367,623	*11,100	1,378,723		84	VIII.—Fair.
3	40.9	44.05	+0.1	222,247	213,494	56.3	54.2	71.0	3,948	− 701	6.278	1,395,346	11,200	1,406,546		77	VII.—Brisk.
4	41.0	44.15	+0.1	224,834	215,086	56.9	54.9	71.5	3,948	+ 2,192	5.639	1,267,771	11,300	1,279,071		84	Do.
5	41.2	44.29	+0.1	222,008	212,308	56.2	53.9	69.5	3,948	− 3,378	6.130	1,360,946	11,500	1,372,446		75	VII.—Fresh.
6	41.3	44.45	+0.2	220,952	210,621	56.0	53.5	71.5	3,948	− 1,678	6.000	1,325,607	11,600	1,337,207		78	VI.—Light.
7	41.4	44.56	+0.1	224,300	213,536	56.8	54.2	71.0	3,948	+ 2,915	6.111	1,370,802	11,700	1,382,502	18	83	VII.—Light.
9	41.6	44.83	+0.1	225,353	213,524	57.1	54.2	71.0	3,948	− 12	6.060	1,365,600	12,000	1,377,600		76	VIII.—Brisk.
10	41.6	44.67	−0.1	224,675	213,477	56.9	54.2	71.0	3,948	− 47	6.290	1,413,318	*12,100	1,425,418		71	XII.—Light.
11	41.4	44.58	−0.2	224,707	213,864	56.9	54.3	71.0	3,948	+ 387	5.852	1,315,071	12,800	1,327,871		97	I.—Light.
12	41.5	44.65	+0.1	225,417	214,298	57.1	54.4	71.0	3,948	+ 434	5.998	1,352,132	13,500	1,365,632		102	V.—Light.
14	41.6	44.83	+0.1	226,570	214,741	57.4	54.6	71.5	3,948	+ 443	5.680	1,286,834	15,000	1,301,834		105	VII.—Brisk.
16	41.5	44.63	−0.1	227,321	216,281	57.6	54.9	71.5	3,948	+ 1,540	5.509	1,252,254	16,400	1,268,654		88	
18	41.4	44.68	0.0	229,555	218,317	58.1	55.4	72.5	3,948	+ 2,036	5.652	1,297,510	17,900	1,315,410		89	X.—Brisk to strong.
a.m. 19 / p.m. 19†	41.4	44.58	0.0	227,032	216,189	57.5	54.9	71.5	3,948	− 2,128	5.636 / 5.515	1,279,456 / 1,252,114	18,600 /	1,298,056 /		78	VIII to X.—Light to brisk.
20	41.4	44.58	0.0	228,794	217,951	58.0	55.3	72.0	3,948	+ 1,762	5.649	1,292,369	19,300	1,311,669		91	XI.—Light.
21	41.5	44.66	+0.1	229,962	218,803	58.2	55.6	72.0	3,948	+ 852	5.745	1,321,116	20,100	1,341,216		76	IX.—Fresh.
24	41.6	44.71	0.0	232,956	221,600	59.0	56.3	74.0	3,948	+ 2,797	5.662	1,319,048	22,200	1,341,248		85	VIII.—Brisk.
25	44.6	44.78	0.0	231,659	220,027	58.7	55.9	74.0	3,948	− 1,578	5.445	1,261,442	22,900	1,284,342		93	VII.—Light.

	26	41.6	44.76	0.0	231,184	219,631	58.6	55.8	73.5	3,948	− 896	5.639	1,303,616	23,700	1,327,816		03	VII.—Pleasant.
	27	41.6	44.78	0.0	229,530	217,898	58.1	55.4	73.5	3,918	− 1,733	5.800	1,331,201	24,400	1,355,601		95	VII to XII.—Pleasant.
	27†											5.600	1,285,301	....	....			
	28	41.7	44.83	+0.1	232,465	220,636	58.9	56.0	74.5	3,948	+ 2,738	5.857	1,361,546	25,100	1,386,646		81	VII.—Strong.
a. m.	30†	41.8	44.85	0.0	232,201	220.298	58.8	55.9	74.0	3,948	− 343	5.385	1,250,349	....	....		97	VIII.—Pleasant.
p. m.	30											5.426	1,259,822	26,600	1,286.422			
	31	41.8	44.88	0.0	234.441	222,415	59.4	56.5	74.0	3,948	+ 2,122	5.827	1,366.120	27,300	1,393,420		93	
June	1	41.8	44.96	0.0	236,494	224,152	59.9	56.9	74.0	3,948	+ 1,737	5.480	1,296,017	*28,000	1,324,017		92	IX.—Pleasant.
	2	41.9	45.03	0.0	239,542	226,924	60.7	57.7	79.0	3,948	+ 2,772	5.379	1,288,545	27,000	1,315,545		104	XI.—Fair.
	3	41.8	44.98	−0.1	242,772	230,352	61.5	58.5	83.0	3,948	+ 3,428	5.203	1,263,072	26,000	1,289,072		86	Do.
	4	41.7	44.88	−0.1	241,757	229,731	61.2	58.3	79.5	3,948	− 621	5.363	1,296,461	25,000	1,321,461		90	XII.—Fair.
a. m.	6	41.6	44.73	0.0	239,270	227,835	60.6	57.9	84.0	3,948	− 1,896	5.079	1,215,196	23,000	1,238,196		67	
p. m.	6†											5.113	1,223,373	....	....		67	IV.—Pleasant.
	7	41.6	44.68	0.0	243,080	231,842	61.6	58.9	86.0	3,948	+ 4,007	4.976	1,209.515	22,000	1,231,515		63	
	8	41.5	44.67	−0.1	243,014	231,816	61.6	58.9	84.0	3,948	− 26	5.048	1,226,759	21,000	1,247,759		65	VI.
	9	41.5	44.64	0.0	243.934	232,854	61.8	59.1	90.0	3,948	+ 1,038	4.870	1,187,920	20,000	1,207,920		63	VII.—Fair.
	10	41.5	44.63	0.0	244,699	233,659	62.0	59.3	88.5	3,948	+ 805	4.858	1,188,819	19,000	1,207.819	13	67	I.
	10‡	41.5	44.63	0.0	238,927	227,887	60.5	57.9	88.5	3,948	− 5,772	4.869	1,163,330	19,000	1,182,330		54	
	11	41.5	44.67	0.0	243.018	231,820	61.6	58.9	87.0	3,948	+ 3,933	4.724	1,148,035	*18,000	1,166,035		62	
	13	41.5	44.68	0.0	239,387	228,149	60.6	57.9	84.5	3,948	− 3,671	4.914	1,176,438	18,000	1,194,438		62	
	14	41.5	44.68	0.0	241,349	230,111	61.1	58.4	84.0	3,948	+ 1,962	4.905	1,159,779	18,000	1,177,779		61	XII.—Pleasant.
	15	41.5	44.68	0.0	239,816	228.578	60.7	58.0	83.0	3,948	− 1,533	4.878	1,169.914	18,000	1,187,914		63	Calm.
	16	41.5	44.63	0.0	239,626	228,586	60.7	58.0	82.0	3,948	+ 8	4.899	1,173,812	18,000	1,191,812		61	VI.—Pleasant.
	17	41.4	44.58	−0.1	237,172	226,329	60.1	57.5	82.0	3,948	− 2,257	5.050	1,197,630	18,000	1,215,630		60	VI.—Light.
	17‡	41.4	44.53	−0.1	234,287	223,641	59.3	56.8	81.5	3,948	− 2,688	5.047	1,182,526	18,000	1,200,526		57	
	20	41.3	44.45	−0.1	235,757	225,426	59.7	57.3	79.0	3,948	+ 1,785	4.807	1,133,235	18,000	1,151,235		62	VII.
Oct.	26	0.8	4.67	0.0	79,780	214,696	24.0	54.5	35.5	3,323	−10,780	1.821	145,333	....	....	29	45	XII.—Light.
	26											1.809	144,352	....	....	10	45	Do.
	29	0.7	4.58	0.0	78,871	214,086	23.8	54.4	34.0	3,317	− 610	1.771	139,679	....	....	10	38	XI.—Light.
Nov.	22§	1.6	5.76	+0.2	81,814	213,085	24.3	54.1	36.5	3,364	− 1,001	2.086	170,666	....	....	10	62	Calm.

* Observed.
† Double floats.
‡ Piano wire soundings; those of June 10 doubtful.
§ Results of ordinary method, velocity stations 300 feet apart.

Result of discharge observations, Mississippi River—Continued.

NATCHEZ, MISS.

[Same section as 1891. Datum taken at 48'.08 on the gauge as observed June 25, 1892. Velocities obtained with meter.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Natchez.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
May 16*	47.05	....	0.0	151,098	153,339	69.5	70.4	119.3	2,173	....	9.152	1,382,881	....	....	12	12	Upstream; light.
17*	47.06	....	+0.1	150,280	152,500	69.2	70.0	120.2	2,173	— 839	9.105	1,368,356	....	....	12	12	Upstream; strong.
18†*	47.16	....	0.0	158,648	160,650	73.0	73.7	119.6	2,173	+8,150	7.759	1,230,879	....	....	12	12	Do.
19*	47.16	....	0.0	153,125	155,127	70.5	71.2	120.3	2,173	—5,523	8.930	1,367,465	....	....	11	12	Calm.
20	47.18	....	0.0	154,088	156,046	70.9	71.6	123.8	2,173	+ 919	9.209	1,419,072	....	....	11	12	Do.
21	47.14	....	—0.1	151,498	153,543	69.7	70.5	125.0	2,173	—2,503	9.256	1,402,211	....	....	11	12	Do.
23	47.10	....	0.0	154,216	156,348	71.0	71.8	119.8	2,173	+2,805	9.182	1,416,003	....	....	11	12	Downstream; light.
25	47.07	....	0.0	153,113	155,311	70.5	71.3	128.1	2,173	—1,037	9.114	1,395,462	....	....	11	12	Upstream; brisk.
26	47.05	....	0.0	151,307	153,548	69.6	70.5	121.4	2,173	—1,763	9.061	1,370,984	....	....	11	12	Upstream; light.
27	47.04	....	0.0	155,215	157,478	71.4	72.3	119.0	2,173	—3,930	8.897	1,380,893	....	....	11	12	Cross stream; light.
28	47.10	....	0.0	150,616	152,749	69.3	70.1	118.6	2,174	—4,729	8.700	1,310,310	....	....	11	12	Upstream; stiff.
30	47.13	....	0.0	152,788	154,856	70.3	71.1	122.8	2,174	+2,107	8.764	1,338,900	....	....	11	12	Upstream; strong.
31	47.19	....	0.0	151,043	152,981	69.4	70.2	124.3	2,175	—1,875	9.025	1,363,203	....	....	11	12	Upstream; high.
June 2	47.37	....	+0.1	154,020	155,566	70.8	71.4	121.0	2,176	+2,585	8.990	1,384,677	....	....	11	12	Downstream; brisk.
3	47.41	....	+0.1	158,797	160,256	72.9	73.5	128.4	2,177	+4,690	8.833	1,402,708	....	....	11	12	Downstream; light.
6	47.40	....	0.0	153,385	154,866	70.5	71.1	119.6	2,177	—5,390	9.177	1,407,547	....	....	11	12	Do.
7	47.39	....	0.0	152,931	154,434	70.2	70.9	117.6	2,177	— 432	8.937	1,366,729	....	....	11	12	Do.
14	47.65	....	+0.1	153,173	154,110	70.3	70.7	121.3	2,178	— 324	8.584	1,314,834	....	....	11	12	Do.
15	47.71	....	0.0	158,593	159,396	72.8	73.2	123.5	2,178	+5,286	8.458	1,341,337	....	....	11	12	Do.
16	47.73	....	+0.1	160,579	161,341	73.7	74.0	124.0	2,178	+1,945	8.480	1,361,745	....	....	11	12	Calm.
17	47.83	....	0.0	156,795	157,340	72.0	72.2	121.6	2,178	—4,001	8.491	1,331,335	....	....	11	12	Left bank to right bank.
18	47.87	....	0.0	155,654	156,111	71.5	71.7	120.9	2,178	—1,229	8.410	1,309,111	....	....	11	12	Upstream; brisk.
19	47.97	....	+0.1	156,957	157,197	72.1	72.1	122.3	2,178	+1,086	8.109	1,272,698	....	....	11	12	Do.
20	48.00	....	0.0	157,797	157,971	72.5	72.5	123.1	2,178	+ 774	8.392	1,324,261	....	....	11	12	Upstream.
21	48.06	....	0.0	152,277	152,321	69.9	69.9	120.2	2,179	—5,650	8.682	1,322,047	....	....	11	12	Do.
22	48.06	....	0.0	156,279	156,323	71.7	71.7	122.2	2,179	—4,002	8.684	1,357,180	....	....	11	12	Upstream; brisk.
23‡	48.06	....	0.0	158,365	158,409	72.7	72.7	122.5	2,179	+2,086	8.138	1,288,845	....	....	11	12	Upstream; stiff.
24‡	48.07	....	0.0	159,925	159,947	73.4	73.4	122.3	2,179	+1,538	8.223	1,315,019	....	....	11	12	Upstream; very light.
25	48.08	....	0.0	161,917	161,917	74.3	74.3	123.1	2,179	+1,970	8.116	1,314,042	....	....	11	12	Upstream; stiff.
27	48.06	....	0.0	165,207	165,251	75.8	75.8	122.8	2,179	+3,334	8.068	1,332,851	....	....	11	12	Downstream; light.
28	47.98	....	—0.1	167,777	167,995	77.0	77.1	124.6	2,179	+2,744	7.939	1,331,930	....	....	11	12	Do.
29	47.88	....	—0.1	170,610	171,046	78.3	78.5	123.6	2,178	+3,051	7.799	1,330,459	....	....	11	12	Upstream; very light.
30	47.72	....	—0.2	169,263	170,047	77.7	78.0	122.1	2,178	— 999	7.527	1,274,107	....	....	11	12	Upstream; brisk.

* Observations unreliable on account of new party. † Should be rejected. ‡ Observations unreliable on account of new boat and crew.

RED RIVER LANDING, LA.

Discharge section approximately same as former years. Datum line taken at 48′.85 on Red River Landing gauge, as observed June 27; velocity taken with meter.

Date.	Gauges. Red River Landing.	Gauges. Local.	Gauges. Rise or fall in the preceding 24 hours.	Cross section of discharge. Area. Water.	Area. Below datum.	Depth. Mean.	Depth. Mean datum.	Depth. Maximum.	Width.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. feet.	Feet.	Cu. feet.	Cu. feet.	Cu. feet.			
April 3	33.50	....	+0.3	166,237	227,484	42.3	56.2	78.5	3,934	....	4.424	735,437	....	....	20	20	Upstream; strong.
5	34.21	....	+0.3	168,675	227,089	42.9	56.1	78.9	3,934	− 395	4.616	778,583	....	....	20	20	Upstream; light.
7	34.96	....	+0.4	171,231	226,673	43.5	56.0	80.9	3,937	− 416	4.701	804,886	....	....	20	20	From right bank; light.
21	40.80	....	+0.5	192,565	224,809	48.6	55.6	85.0	3,965	−1,864	5.204	1,002,108	....	....	21	21	Calm.
May 4	43.78	....	+0.2	199,645	219,993	50.1	54.4	87.5	3,981	−4,816	5.422	1,082,434	....	....	21	21	Upstream; light.
6	44.09	....	+0.2	201,689	220,793	50.7	54.6	86.8	3,981	+ 800	5.413	1,091,754	....	....	21	21	Do.
11	44.79	....	+0.1	205,926	222,223	51.7	54.9	87.7	3,982	+1,430	5.423	1,116,746	....	....	21	21	From left bank; light.
19	45.36	....	+0.1	207,585	221,695	51.4	54.8	86.2	4,040	− 528	5.444	1,130,079	1,826	1,131,905	22	22	
21	45.40	....	0.0	208,424	222,372	51.6	55.0	87.0	4,040	+ 677	5.432	1,132,059	2,567	1,134,626	22	22	N.—Strong.
23	45.45	....	0.0	208,835	222,581	51.7	55.0	89.6	4,040	+ 209	5.339	1,115,016	4,438	1,119,454	22	22	Calm.
25	45.50	....	0.0	210,393	223,939	52.1	55.3	88.7	4,041	+1,358	5.402	1,136,506	5,500	1,142,006	22	22	Upstream.
27	45.60	....	+0.1	211,731	224,872	52.4	55.6	88.1	4,041	+ 933	5.384	1,139,957	5,593	1,145,550	22	22	SW.—Light.
June 1	45.96	....	+0.1	212,867	224,554	52.7	55.5	88.6	4,042	− 318	5.390	1,149,293	5,784	1,155,077	22	22	SE.
3	46.12	....	+0.1	211,275	222,316	52.3	54.9	87.4	4,043	−2,238	5.370	1,134,529	6,800	1,141,329	22	22	NW.
7	46.50	....	+0.1	214,122	223,628	52.9	55.3	86.6	4,044	+1,312	5.381	1,152,115	7,265	1,159,380	22	22	Calm.
9	46.70	....	+0.1	219,662	228,359	54.3	56.4	88.2	4,044	+4,731	5.325	1,169,709	7,097	1,176,806	22	22	Do.
11	46.95	....	+0.1	222,392	230,078	55.0	56.9	87.7	4,044	+1,719	5.311	1,181,173	6,851	1,188,024	22	22	SE.
14	47.45	....	+0.2	226,525	232,188	56.0	57.4	88.9	4,044	+2,110	5.357	1,213,409	7,500	1,220,909	22	22	South.
16	47.70	....	+0.1	229,669	234,321	56.8	57.9	89.2	4,044	+2,133	5.450	1,251,768	8,201	1,259,969	22	22	NE.—Light.
20	48.22	....	+0.1	229,575	232,124	56.8	57.4	89.6	4,045	−2,197	5.571	1,279,044	8,875	1,287,919	22	22	NW.
23	48.60	....	+0.1	231,371	232,382	57.2	57.4	90.0	4,045	+ 258	5.636	1,303,913	8,332	1,312,245	22	22	SW.
25	48.70	....	+0.1	229,694	230,301	56.8	56.9	91.0	4,045	−2,081	5.768	1,324,916	9,481	1,334,397	22	22	West.
27	48.85	....	0.0	228,594	228,594	56.5	56.5	91.0	4,046	−1,707	5.779	1,321,011	9,577	1,330,588	22	22	South.

Result of discharge observations—Continued.

SIMMSPORT, LA. (ATCHAFALAYA RIVER).

[April 1 to May 7, datum line taken at 42'.33; after that at 46'.64, as observed May 7 and June 24 on Simmsport gauge; velocities taken with meter.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Red River Landing.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*			
April *1	†31.15	....	+0.2	48,439	59,658	50.9	56.5	71.9	951	....	2.758	133,597	....	....	10	10	Upstream; light.
6	32.50	....	+0.2	47,810	57,684	50.2	54.6	72.8	953	−1,974	2.947	140,882	....	....	10	10	From left bank; light
8	33.08	....	+0.3	48,527	57,819	50.9	54.7	72.6	953	+ 135	3.036	147,309	....	....	10	10	Calm.
22	38.32	....	+0.3	55,377	59,592	52.9	56.4	79.2	1,046	+1,773	3.648	202,017	....	....	11	11	Downstream; light.
May 2	41.45	....	+0.2	57,485	58,414	54.5	55.3	80.8	1,055	−1,178	4.276	245,787	....	....	11	11	
7	42.33	....	+0.2	58,522	58,522	55.4	55.4	83.8	1,056	+ 108	4.479	262,143	....	....	11	11	Calm.
‡13	43.18	....	+0.1	56,433	60,270	53.7	49.8	85.0	1,050	....	4.889	275,908	§895	....	11	11	From left bank; light
20	43.60	....	....	59,366	62,761	56.5	51.4	86.8	1,051	+2,491	5.105	303,049	1,681	....	11	11	Calm.
22	43.68	....	....	60,275	63,587	57.2	52.0	87.0	1,053	+826	4.927	296,983	1,642	....	11	11	NW.—Strong.
24	43.76	....	....	59,647	62,875	56.5	51.5	86.5	1,055	−712	5.067	302,257	2,127	....	11	11	S.—Light.
26	43.81	....	....	60,407	63,582	57.3	52.0	87.6	1,055	+707	4.958	299,479	2,137	....	11	11	Calm.
28	43.90	....	....	59,996	63,076	56.9	51.6	87.5	1,055	−506	5.110	306,556	2,321	....	11	11	SE.—Strong.
June 2	44.40	....	....	61,517	64,069	58.2	52.4	91.1	1,057	+993	5.254	323,230	2,739	....	11	11	NW.
4	44.58	....	....	60,586	62,763	57.3	59.4	90.5	1,057	....	5.295	320,812	3,175	....	11	11	Calm.
6	44.82	....	....	60,659	62,583	57.4	59.2	91.1	1,057	−180	5.410	328,148	3,254	....	11	11	Do.
8	45.02	....	....	61,227	62,939	57.9	59.5	91.7	1,057	+356	5.516	337,749	3,355	....	11	11	Do.
10	45.28	....	....	61,356	62,794	58.0	59.4	90.1	1,057	−145	5.558	341,020	3,586	....	11	11	Do.
13	45.77	....	....	62,452	63,372	59.1	60.0	91.6	1,057	+578	5.874	366,857	4,280	....	11	11	SE.
15	46.10	....	....	62,964	63,536	59.6	60.1	91.4	1,057	+164	5.844	367,965	4,513	....	11	11	Calm.
17	46.48	....	....	63,770	63,939	60.3	60.5	92.4	1,057	+403	6.279	400,442	5,006	....	11	11	South.
19	46.60	....	....	64,207	64,249	60.7	60.8	94.2	1,057	+310	6.283	403,428	5,181	....	11	11	NW.
21	46.60	....	....	64,026	64,068	60.6	60.6	92.4	1,057	−181	6.511	416,847	5,444	....	11	11	Calm.
24	46.64	....	....	64,320	64,320	60.9	60.9	92.2	1,057	+252	7.005	450,561	6,449	....	11	11	SW.
26	46.63	....	....	64,532	64,542	61.1	61.1	91.5	1,057	+222	6.981	450,557	6,543	....	11	11	SW.—Light.
28	....	....	....	63,424	....	60.0	....	90.8	1,057	....	6.803	431,408	6,551	....	11	11	North.

*April 1 to May 7, discharge section located between sill dams 1 and 2. † Simmsport gauge. ‡ New section. § Discharge of Alligator Bayou, which is shown on field sketch entering the Atchafalaya just below the new discharge section.

CARROLLTON, LA. (MISSISSIPPI RIVER.)

[Datum line taken at 17′ on Carrollton gauge, as observed June 10, 1892; velocities taken with meter.]

May	14	* 16.61	....	—0.1	170,346	172,811	68.4	69.4	101.0	2,490	....	6.147	1,047,052	....	....	15	15	Calm.
	16	16.15	....	—0.1	172,740	174,856	69.4	70.2	102.8	2,490	+2,045	5.977	1,032,488	....	....	15	15	Do.
	18	16.25	....	+0.2	176,130	177,988	70.7	71.5	103.0	2,490	+3,132	6.150	1,083,185	....	....	15	15	Do.
	19	16.10	....	—0.2	176,616	178,857	70.9	71.8	102.8	2,490	+ 869	6.288	1,110,552	....	....	15	15	Do.
	21	16.30	....	+0.3	174,085	175,828	69.9	70.6	103.0	2,490	—3,029	6.086	1,059,461	....	....	15	15	Do.
	24	16.30	....	0.0	176,911	178,654	71.0	71.7	102.0	2,490	+2,826	5.961	1,054,638	....	....	15	15	Do.
	27	16.25	....	—0.1	174,695	176,563	70.2	70.9	100.0	2,490	—2,091	5.988	1,046,113	....	....	15	15	Do.
June	1	16.50	....	0.0	176,975	178,220	71.1	71.6	100.0	2,490	+1,657	5.968	1,056,172	....	....	15	15	Upstream; strong.
	4	16.60	....	—0.2	179,418	180,414	72.1	72.5	104.0	2,490	+2,194	6.080	1,090,945	....	....	15	15	Calm.
	6	16.70	....	—0.1	184,605	185,152	74.1	74.4	105.0	2,490	+4,738	5.891	1,087,508	....	....	15	15	Do.
	8	16.70	....	0.0	184,215	184,962	74.0	74.3	104.0	2,490	— 190	6.083	1,120,583	....	....	15	15	Do.
	10	17.00	....	+0.1	183,804	183,804	73.8	73.8	104.5	2,490	—1,158	5.872	1,079,260	....	....	15	15	Do.
	14	16.70	....	—0.5	184,777	185,524	74.2	74.5	104.0	2,490	+1,720	5.908	1,091,708	....	....	15	15	NE.—Strong.
	17	16.10	....	—0.1	182,332	184,573	73.2	74.1	103.0	2,490	— 951	5.764	1,050,884	....	....	15	15	Calm.
	20	16.10	....	+0.1	180,126	182,367	72.3	73.2	103.0	2,490	—2,206	5.709	1,028,404	....	....	15	15	NE.—Light.
	24	15.90	....	—0.1	175,534	178,273	70.5	71.6	102.0	2,490	—4,094	5.814	1,020,587	....	....	15	15	Calm.
	30	15.50	....	—0.1	172,815	176,550	69.4	70.9	101.0	2,490	—1,723	5.652	976,785	....	....	15	15	Do.

* Carrollton gauge.

Results of discharge observations, Mississippi River and tributaries.

LITTLE ROCK, ARK. (ARKANSAS RIVER).

[Areas based on soundings made by Capt. Taber in January, 1892; the mean of four cross sections within limits of distance traveled by floats is taken for discharge section.]

Date.	Gauges.			Cross section of discharge.						Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
	Little Rock.	Local.	Rise or fall in the preceding 24 hours.	Area.		Depth.			Width.								
				Water.	Below datum.	Mean.	Mean datum.	Maximum.									
1892.	Feet.	Feet.	Feet.	Sq. feet.	Sq. feet.	Feet.	Feet.	Feet.	Feet.	Sq. Feet.	Feet.	Cu. feet.	Cu. Ft.	Cu. feet.			
May 23	30.	26.7	....	37,710	....	25.4	....	....	1,487	....	12.107	456,565	....	....	6	41	Calm.
24	29.4	26.2	—0.8	36,962	....	24.9	....	....	1,484	....	11.115	410,829	....	....	5	41	IX—Medium.

MONROE, LA. (OUACHITA RIVER).

[Velocities taken with double floats.]

Date.	Little Rock.	Local.	Rise or fall in the preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	No. of velocity stations.	No. of soundings.	Direction and force of wind.
May 30	*37.5	37.48	....	24,835	....	31.0	....	42.0	800	....	....	....	....	....	(‡)	36	VI—Strong.
31	37.6	37.55	+0.1	†24,891	....	31.1	....	....	800	....	2.217	50,180	....	....	14	36	Do.
June 1	37.8	37.78	+0.2	†25,075	....	31.3	....	....	800	....	2.241	56,182	....	....	7	36	Calm.

* Monroe gauge. † Based on soundings of May 30, corrected for change of stage. ‡ Wind too strong for floats.

ALEXANDRIA, LA. (RED RIVER).

[Datum taken at 38'.24 on the gauge, as observed June 13; velocity obtained by double floats.]

May 26	*28.22	....	+0.9	23,718	31,714	30.5	38.7	38	777	....	3.820	90,572	....	....	9	36	
27	29.50	....	+1.0	24,524	31,503	31.6	38.4	38	777	— 211	4.143	101,604	....	....	9	42	Calm.
28	30.62	....	+1.2	25,381	31,481	32.5	38.4	40	781	— 22	4.055	102,908	....	....	9	40	
31	33.70	....	+1.0	26,890	30,540	34.1	37.2	43	788	— 941	4.122	110,848	....	....	10	39	
June 1	34.48	....	+0.8	29,239	32,275	36.8	39.4	46	795	+1,735	4.722	138,042	....	....	10	27	Calm.
2	35.00	....	+0.6	29,434	32,058	36.8	39.1	46	800	— 217	4.923	144,890	....	....	10	26	Light.
3	35.63	....	+0.5	29,353	31,474	36.5	38.4	46	805	— 584	4.865	142,814	....	....	10	23	Calm.
4	36.10	....	+0.5	29,528	31,272	36.5	38.1	47	810	— 202	4.944	145,989	....	....	10	25	
6	37.02	....	+0.4	30,298	31,297	37.1	38.2	47	817	+ 25	4.918	149,017	....	....	10	21	Do.
7	37.50	....	+0.5	31,482	32,088	38.5	39.1	48	817	+ 791	5.101	160,579	....	....	10	23	Do.
8	37.80	....	+0.2	31,912	32,273	39.0	39.4	51	819	+ 185	5.459	174,210	....	....	10	25	Do.
9	37.80	....	+0.1	30,627	30,988	37.4	37.8	48	819	—1,285	5.483	167,932	679	168,611	10	24	
10	37.92	....	+0.1	32,721	32,983	40.0	40.2	50	819	+1,995	5.534	181,092	†819	181,911	10	20	Do.
11	38.14	....	+0.2	30,894	30,976	37.7	37.8	49	819	—2,007	5.562	171,820	†1,004	172,824	10	19	Do.
13	38.24	....	0.0	33,123	33,123	40.4	40.4	49	820	+2,147	5.488	181,781	†1,218	182,999	10	28	Do.
14	38.18	....	0.0	31,925	31,974	38.9	39.0	50	820	—1,149	5.319	169,804	1,274	171,078	10	23	E.—Light.
15	38.05	....	—0.2	32,574	32,730	39.7	39.9	49	820	+ 756	5.605	182,563	†1,207	183,770	10	26	SE.—Light.

* Alexandria gauge, read by observation party.

† Interpolated.

Slope observations, Mississippi River.

COLUMBUS, KY.

Distances between gauges 8 400 feet. [Results of reduction at office of first and second districts engineer.]

	Belmont gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.
1892.	*Feet.*	*Feet.*	*Feet.*	
April 13	41.28	....	....	....
15	41.20	....	....	.0001024
16	41.00	....	....	....
26	42.96	9.488	8.833	0988
27	43.00	9.141	8.833	0976
28	43.10	9.527	9.064	0976
29	43.10	9.874	9.103	0976
30	42.88	9.565	9.103	1012

FULTON, TENN.

[Results of reduction at office of first and second districts engineer.]

	Fulton gauge.	Maximum surface velocity at Craighead, per second.	Maximum surface velocity at Falls Landing, per second.	Slope sine of inclination.	
				Between Craighead and Section.	Between Section and Falls gauge.
1892.	*Feet.*	*Feet.*	*Feet.*		
April 15	32.94	....	7.69	.0002441	.0000374
16	33.10	7.69	8.00	2393	0424
18	33.21	7.14	8.83	2374	0464
19	33.25	8.00	8.00	2422	0454
21	33.38	8.00	8.00	2403	0444
22	33.35	7.69	8.33	2346	0444
23	33.37	7.41	8.70	2355	0464
25	33.50	7.14	9.09	2441	0444
26	33.63	7.14	8.00	2441	0474
27	33.81	7.14	8.33	2470	0444
28	33.96	8.33	8.00	2489	0444
29	34.03	8.00	8.70	2393	0504
30	34.22	7.41	8.00	2403	0484
May 2	34.21	7.14	7.69	2422	0504
3	34.18	7.41	7.69	2384	0494

NOTE.—Gauge B is at discharge section, Craighead gauge is 10,500 feet above, and Falls gauge 9,000 feet below gauge B. The river is nearly straight from 1,000 feet below Craighead gauge to Falls gauge. The slope of river around Craighead point in vicinity of gauge was 1 foot on 600 feet. Sine=about 0.00167.

Slope observations, Mississippi River.—Continued.

HELENA, ARK.

Distance between gauges 12,570 feet. [Results of reduction at office of first and second districts engineer.]

	Helena gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.		Helena gauge.	Maximum surface velocity at upper gauge, per second.	Maximum surface velocity at lower gauge, per second.	Slope sine of inclination.
1892.	*Feet.*	*Feet.*	*Feet.*		1892.	*Feet.*	*Feet.*	*Feet.*	
April 18	42.60	....	....	....	June 2	44.70	7.139	8.448	.000684
19	42.73	6.714	8.216	.0000708	3	44.66	7.060	8.294	0684
20	42.87	....	....	....	4	44.61	7.060	8.178	0692
21	43.25	7.368	8.718	0708	6	44.56	6.984	7.630	0692
May 3	44.50	7.368	8.987	0637	7	44.60	7.023	7.677	0700
4	44.64	7.137	8.486	0660	8	44.62	7.176	8.409	0700
5	44.77	7.677	9.103	0676	9	44.72	7.060	8.756	0708
6	44.88	7.368	9.218	0637	10	44.77	7.003	8.062	0708
7	44.98	7.291	9.218	0644	11	44.86	6.800	8.486	0708
9	45.48	7.754	8.910	0637	13	45.00	6.834	8.332	0716
10	45.66	7.484	9.103	0605	14	45.06	7.947	9.180	0708
11	45.73	7.985	9.450	0605	15	45.11	7.835	8.332	0708
12	45.69	7.638	9.064	0621	16	45.12	7.947	8.525	0708
13	45.51	7.754	9.257	0605	17	45.06	7.600	8.139	0716
14	45.26	7.561	9.296	0668	18	45.00	7.409	7.831	0708
16	44.77	7.638	9.604	0684	20	44.82	7.638	8.679	0660
17	44.55	7.600	9.450	0692	21	44.63	7,137	8.255	0660
June 1	44.67	7.291	8.872	0692	22	44.45	6.946	8.409	0676

ARKANSAS CITY, ARK.

[From reduction at office of third district engineer.]

	Arkansas City gauge.	Slope sine of inclination.			Arkansas City gauge.	Slope sine of inclination.	
		Above.	Below.			Above	Below.
1892.	*Feet.*			1892.	*Feet.*		
Apr. 23	46.35	....	.0000645	May 31	49.82	.0000600	.0600642
25	46.90	....	638	June 1	49.88	595	642
26	47.07	....	635	3	49.73	591	643
27	47.25	....	631	3	49.73	591	643
28	47.45	.0000562	629	4	49.60	594	642
29	47.61	566	629	4	....	594	....
30	47.78	559	627	6	49.47	587	644
May 2	47.96	552	624	7	49.43	591	647
3	48.02	556	620	8	49.39	594	645
4	48.10	557	620	9	49.39	594	645
4	48.10	557	620	10	49.42	593	646
5	48.25	553	620	11	49.44	590	647
6	48.33	564	615	13	49.45	589	647
7	48.55	553	618	14	49.45	589	647
9	48.75	544	620	14	49.45	589	....
10	48.80	549	620	15	49.44	590	646
11	48.88	550	624	16	49.37	587	649
12	48.95	562	623	17	49.30	585	646
13	49.14	563	624	18	49.20	585	646
14	49.14	573	624	20	48.97	579	647
14	49.14	573	624	20	48.97	579	647
16	49.10	585	632	21	48.85	571	646
19	49.15	580	634	21	48.85	571	....
21	49.27	579	635	23	48.47	569	649
23	49.40	585	638	24	48.28	....	647
23	49.40	585	638	27	47.52	....	651
24	49.46	581	638	28	47.17	....	651
26	49.59	577	639	29	46.65	....	651
27	49.64	581	644	30	46.13	....	652
28	49.73	582	643	30	46.13	....	....
30	49.82	593	642	July 1	45.49	....	638
30	49.82	593	642	1	45.49	....	638

NOTE.—The slope obtained by taking for the "above," the gauge at Bolivar Landing and Arkansas City, and for the "below," the gauges at Arkansas City and Greenville, and the distance as 216000 feet. And the slopes are given in decimals of a foot; being the fall per foot.

Slope observations, Mississippi River—Continued.

WILSON POINT, LA.

[From reduction at office of third district engineer.]

	Gauge.	Slope sine of inclination.			Gauge.	Slope sine of inclination.	
		Above.	Below.			Above.	Below.
1892.	*Feet.*				*Feet.*		
Apr. 16	*36.2	....	.0000570	May 19	41.4	.0000663	.0000549
18	37.2	....	567	20	41.4	668	549
19	37.5	....	546	21	41.5	663	549
20	37.8	....	561	24	41.6	665	546
21	38.2	....	544	25	41.6	671	553
22	38.6	....	532	26	41.6	666	554
23	38.8	....	546	27	41.6	666	558
25	39.5	....	530	28	41.7	666	553
26	39.7	....	549	30	41.8	673	535
27	39.9	....	544	31	41.8	671	540
28	40.2	....	533	June 1	41.8	671	546
29	40.4	.0000679	547	2	41.9	658	549
30	40.6	674	547	3	41.8	656	558
May 2	40.8	666	539	4	41.7	661	553
3	40.9	676	565	6	41.6	658	540
4	41.0	664	547	7	41.6	656	540
5	41.2	671	551	8	41.5	654	542
6	41.3	674	553	9	41.5	655	551
7	41.4	673	549	10	41.5	656	553
9	41.6	676	558	11	41.5	656	556
10	41.6	673	542	13	41.5	651	558
11	41.4	665	553	14	41,5	651	556
12	41.5	669	553	15	41.5	646	558
14	41.6	668	558	16	41.5	640	553
16	41.5	661	553	17	41.4	636	558
18	41.4	663	567	20	41.3	636	576

* Lake Providence gauge.

NOTE.—Upper slope gauge at Leota, Miss. Lower slope gauge at Lake Providence, La.

RED RIVER LANDING, LA.

Apr. 5	†34.2	....	.0000284	May 25	45.5	....	.0000275
7	35.0	....	284	27	45.6	....	278
21	40.9	....	249	June 1	45.9	....	264
May 4	43.8	....	251	3	46.2	....	261
6	44.1	....	269	9	46.7	....	284
11	44.8	....	261	14	47.5	....	287
19	45.4	....	254	16	47.7	....	289
23	45.4	....	274	20	48.2	....	267

† Red River Landing gauge. Distance between gauges 36,716 feet.

LITTLE ROCK, ARK. (ARKANSAS RIVER).

[Slope taken between bridge and gauge B, 60 feet below range B. D.; distance, 4,830 feet.]

	Little Rock engineer gauge.	Maximum middepth velocity at section.	*Maximum surface velocity at section.	*Slope sine of inclination.
1892.	*Feet.*	*Feet.*	*Feet.*	
May 23	30.2	15.30	13.44	.00019672
24	29.4	12.92	13.22	.00022336

*Results of reduction at office of second district engineer.

Slope observations, Mississippi River—Continued.

ALEXANDRIA, LA. (RED RIVER).

[Distance between upper and lower gauges, 4,000 feet.]

	Alexandria gauge.	Slope sine of inclination between upper and lower gauges.		Alexandria gauge.	Slope sine of inclination between upper and lower gauges.
1892.	*Feet.*		1892.	*Feet.*	
May 27	29.5	.000450	June 7	37.5	.000475
28	30.6	050	8	37.8	500
30	33.2	450	9	37.8	500
31	33.7	450	10	37.9	450
June 1	34.5	400	11	38.1	450
2	35.9	425	13	38.2	700
3	35.6	450	14	38.2	450
4	36.1	500	15	38.0	450
6	37.0	....			

Results of final reduction of rating observations with Price current meters.

No. of meter.	Date.	A.	B.	Mean error of observation.	Mean error of A.	Mean error of B.	No. of observations.	(*)	Length of base.	Limits of observed velocity.	Locality.
	1892.								*Feet.*	*Feet per second.*	
5	May 30	3.73306	+0.2900	±0.0841	±0.0439	±0.0648	16	S	200	3.2 to 9.1	Huntington Loop.
	June 3	3.68321	+0.3920	0.0389	0.0209	0.0343	12	R	200	3.3 10.0	Do.
	Weighted means	3.69243	+0.36970								
5	May 30, June 3	4.1852	−0.046	0.0812	0.1130	0.0518	24	S	200	0.8 2.8	Do.
22	June 8	3.86543	+0.2847	0.0807	0.0182	0.0247	38	R	200	1.1 9.5	Company Canal.
23	July 12	4.0118	+0.2318	0.0968	0.0322	0.0450	18	R	200	1.0 9.2	Do.
25	do	4.0072	+0.2250	0.1377	0.0396	0.0472	30	R	200	1.0 9.6	Do.
38	May 4	3.96203	+0.3282	0.0867	0.0887	0.1186	16	R	400	3.1 7.5	Wilson Point.
	May 11	3.81063	+0.5532	0.0429	0.0389	0.0525	12	R	400	3.1 8.0	Do.
	May 26	3.91319	+0.396	0.0368	0.0267	0.0322	16	R	400	2.2 7.0	Do.
	June 6	3.8545	+0.30646	0.0968	0.1071	0.2075	6	R	200	5.6 9.5	Huntington Loop.
	June 8	3.83225	+0.3108	0.112	0.0643	0.1108	8	R	200	2.8 9.5	Do.
	Weighted means	3.87894	+0.42477								
38	Nov. 26	4.41178	+0.0483	0.0585	0.0410	0.0289	22	R	200	0.6 5.4	Ashton.
38	May 4	4.20594	+0.1499	0.124	0.6508	0.2069	6	R	400	0.5 2.4	Wilson Point.
	May 11	4.0882	+0.1466	0.0781	0.1220	0.0508	7	R	400	0.5 3.7	Do.
	May 26	4.43242	−0.00565	0.0321	0.0603	0.0273	6	R	400	0.6 3.4	Do.
	June 6	4.28415	−0.03195	0.0397	0.0555	0.0249	12	R	200	0.6 3.2	Huntington Loop.
	June 8	4.28495	−0.0324	0.0447	0.0847	0.0317	10	R	200	0.6 2.9	Do.
	Weighted means	4.31828	−0.00714								
39	April 23	3.57443	+0.7733	0.1137	0.0785	0.0354	13	S	200	3.4 7.7	Do.
39	April 29	3.60705	+0.7163	0.0898	0.0558	0.0720	20	S	200	3.4 7.7	Do.
	May 9	3.76672	+0.5380	0.0967	0.0633	0.0936	13	S	200	3.8 8.7	Do.
	May 12	3.79859	+0.4564	0.0656	0.0371	0.0534	18	S	200	3.7 8.7	Do.
	May 23	3.72022	+0.4339	0.0770	0.0449	0.0601	13	S	200	3.1 8.7	Do.
	July 12	3.66562	+0.5612	0.108	0.0719	0.0944	16	R	200	3.0 7.1	Below Chicot Point.
	Weighted means	3.73111	+0.5185								
39	April 23	4.6000	−0.0217	0.1012	0.708	0.4186	6	S	200	2.1 2.9	Huntington Loop.
39	May 9 and 12	4.4118	−0.0013	0.0314	0.0726	0.0381	9	S	200	1.0 3.0	Do.
	May 23	4.45161	+0.0045	0.0658	0.216	0.101	5	S	200	1.3 2.9	Do.
	June 11	4.30412	−0.0008	0.0922	0.2228	0.1098	6	R	400	0.9 2.7	Wilson Point.
	July 12	4.32156	+0.0571	0.0295	0.0395	0.0160	10	R	200	0.6 2.5	Below Chicot Point.
	Weighted means	4.34402	+0.04658								

* "R" indicates observations in running water, and "S" in still water.

Overflow discharge between Arkansas City and Trippe, Ark.

[Velocities taken with surface floats. Results of reduction at office of Third District Engineer. For report, see p. 3667.]

1892.	Nature of opening.	Width.	Mean depth.	Area.	Mean velocity per second.	Discharge per second.
		Feet.	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*
May 28 and 29	Over track	9,525		95,425	1.97	188,000
	Through bridge	7,017		105,115	1.15	121,000
Total		16,542		200,540	1.54	309,000
May 30 and 31	Over track	5,655		60,644	1.99	121,000
	Through bridge	7,083		107.357	1.31	140,000
Total		12,738		168,001	1.55	261,000

Discharge of inlets into Bayou Bartholomew from overflow.

[Velocities taken with surface floats. Results of reduction at office of Third District Engineer. For report, see p. 3668.]

1892.	Nature of opening.	Width.	Mean depth.	Area	Mean velocity per second.	Discharge per second.
Above Browns Bridge.		*Feet.*	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*
June 11	Deep Bayou	300	8.85	2,655	0.8	2,124
11	Wash	100	6	600	0.8	480
13	...do	200	2.6	520	0.8	416
13	Ambon Bayou	200	10.9	2,180	0.8	1,744
Total		800	7.44+	5,955	0.8	4,764
Below Browns Bridge.						
	Fletcher Brake	358	1.66	594	0.8	475
June 9	...do	210	10.32	2,167	0.8	1,733
10	Browns Bayou	250	2	500	0.8	400
Total		818	3.98+	3,261	0.8	2,608
Grand total		1,618	5.70—	9,216	0.8	7,372

Discharge of Bayou Bartholomew at Browns Bridge.

[Velocities taken with surface floats. Results of reduction at office of Third District Engineer. For report, see p. 3668.]

1892.	Nature of opening.	Width.	Mean depth.	Area.	Mean velocity per second.	Discharge per second.
		Feet.	*Feet.*	*Sq. feet.*	*Feet.*	*Cu. feet.*
June 10	Bayou Bartholomew.	416	19.5	8,104	0.8	6,483

SUMMARY.

	Cubic feet per second.
Bayou Bartholomew, at Browns Bridge	6,483
Inlets into Bayou Bartholomew, below Browns Bridge	2,608
Total discharge of Bayou Bartholomew	9,091
Total discharge of inlets from overflow	7,372
Total discharge for natural drainage	1,719

Crevasse measurements.

[For notes on reduction, see p. 3678.]

MISSISSIPPI RIVER, THIRD DISTRICT.

Name.	Distance from Cairo.	Bank.	Width.	Discharge per second.	Date of break.	Date of observation.	Method.
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Fulton Lake	439	Right.	1,666	*14,988	June 2	June 8	Meter No. 5.
Do	439	Right.	1,809	15,960	....	June 18	Do.
Do	439	Right.	1,922	19,554	....	June 22	Do.
Panther Forest	452	Right.	1,091	74,214	May 13	May 17	Meter No. 39.
Do	452	Right.	1,410	69,550	....	May 25	Do.
Do	452	Right.	1,673	80,884	....	June 2	Meter No. 38.
Do	452	Right.	2,085	91,623	....	June 17	Do.
Columbia	470	Right.	389	†18,483	June 22	June 25	Meter No. 39.
Leland	484	Right.	312	‡9,800	May 25	June 1	Surface floats.
Do	484	Right.	423	17,253	....	June 16	Do.
Do	484	Right.	423	§6,935	....	June 26	Meter No. 39.
Brooks Mill	506	Right.	668	‡35,000	May 9	May 13	Surface floats.
Do	506	Right.	715	87,331	....	June 9	Meter No. 39.
Do	506	Right.	715	80,093	....	June 24	Do.

* Integration method.
† Meter at six-tenths depth.
‡ Results of reduction at office of Third District Engineer.
§ Meter 4 feet below surface.

Crevasse measurements.

[Results of reduction at office of Fourth District Engineer.]

MISSISSIPPI RIVER, FOURTH DISTRICT.

Name.	Distance below Cairo.	Bank.	Maximum width of crevasse.	Approximate maximum discharge per second.	Date of occurrence.	Date of closure.	Cause of crevasse.
	Miles.		*Feet.*	*Cubic feet.*	1892.	1892.	
Ascension	882.5	Right.	148	17,200	June 6	June 9	Crayfish hole.
Hermitage	886.5	Left..	63	9,500	June 21	June 23	Do.
New Hope	897	Right.	160	19,100	June 1	June 6	Do.
Delogny	906.5	Right.	126	16,400	June 23	June 28	Do.
Belmont	908	Left..	1,427	139,846	June 12	....	Do.
Tessier	909.75	Left..	204	25,520	May 22	May 29	Do.
Anchor	929.6	Left..	396	21,000	May 6	....	Unknown.
Sarpy	937	Left..	1,380	115,920	June 13	....	Crayfish hole.
Avondale	952	Right.	139	16,120	June 13	June 19	Do.
Villere, No. 1	972	Left..	15	742	May 3	May 4	Do.
Villere, No. 2	971.9	Left..	124	1,816	June 11	....	Do.
Story, No. 1	975	Left..	23	952	May 28	May 30	Do.
Story, No. 2	974.75	Left..	114	16,560	June 11	....	Do.
Merritt	976.5	Left..	96	13,500	June 13	June 19	Do.
Belle Chasse	982.5	Right.	107	14,186	June 3	June 15	Do.
Cedar Grove	989.5	Right.	26	686	May 24	May 28	Old rice flume.
Belair	995	Left..	62	8,700	May 24	May 28	Crayfish hole.
Monsecour, No. 1	998.9	Left..	24	2,100	May 11	May 11	Do.
Monsecour, No. 2	999	Left..	26	2,280	May 29	June 4	Do.
Happy Point	993	Left..	51	6,750	May 18	May 28	Rice flume.
Monsecour, No. 3	999.1	Left..	37	2,785	June 7	June 18	Crayfish hole.
Harlem*	1,002.0 1,003.2	Left.. Left..	441	22,050	May 12 to June 10	May 15 to July 1	Muskrat, crayfish, and rice flume.
Miller	1,011.7	Left..	39	5,985	....	June 14	Muskrat.
Octave	1,012.0	Left..	35	5,600	....	May 14	Do.
Martin	1,013.5	Left..	194	3,492	....	July 2	Caving bank.

* In a distance of 6,000 feet there were 11 breaks at Harlem, and figures presented are aggregates.

BAYOU LAFOURCHE.

Hill	....	....	145	....	May 9	....	
Upper Ten	....	....	40	....	July 2	July 8	
Boudreaux	....	....	225	....	Apr. 25	....	

ATCHAFALAYA RIVER.

Philip White	....	....	6,000†	....	June 16	....	

† About.

APPENDIX 3 K.

STUDY OF EARLY MAPS OF MISSISSIPPI RIVER. BY CAPT. CARL F. PALFREY, CORPS OF ENGINEERS.

ST. LOUIS, MO., *June 9, 1893.*

GENERAL: I have the honor to present the result of a study of some early maps of the Mississippi River, as compared with those of the Commission.

The three maps herewith shown are:

(1) "Course of the River Mississippi, from the Balise to Fort Chartres. Taken on an expedition to the Illinois in the latter end of the year 1765. By Lieut. Ross, of the Thirty-fourth Regiment. Improved from the surveys of the river made by the French."

(2) "A draft of the Mississippi River from the Balise up to Fort Chartres," from a report to the secretary of state for the colonies, by Capt. Philip Pitman, published in London in 1770.

(3) "Map of the course of the Mississippi from the Missouri and the country of the Illinois to the mouth of the river," from the travels of Gen. Victor Collot, published in Paris in 1826.

Of Ross, directly, I have been able to learn nothing. Fort Chartres was turned over by its French commandant to the English commission on November 11, 1765.

For the privilege of tracing the map I am indebted to the Missouri Historical Society.

Pitman, for the reading of whose report and the privilege of tracing the map I am indebted to Col. George E. Leighton, of St. Louis, describes himself as having been employed in "those countries" for five years as an engineer. The only date mentioned in his report is 1768.

Collot, a young officer of the etat-major under Rochambeau in America, brigadier-general and governor of Guadaloupe under the Republic, prisoner of war and left in Philadelphia by the English in the winter of 1795–'96, was detained in this country by a lawsuit, and was, at his own suggestion, commissioned by Citizen Adet to explore the former French province of Louisiana. His book, in the hands of the printer at the time of his death, but not published till long after, shows great intelligence, acute observation, and a scrupulous accuracy in stating what he saw himself and what he reports from hearsay. He left St. Louis on September 16, 1796, in an open boat (pirogue) with one white assistant and four Indians, and reached three leagues above New Orleans, when he was arrested as a spy by Baron Carondelet, on October 26.

Of the three, Pitman has the largest scale and the fullest detail, and is most convenient for comparison. Ross is very noteworthy for the accuracy of his topographical eye and his rendering of characteristic outlines. Collot has the best general alignment. I regard them all as topographical reconnoissances, probably platted by compass bearings and estimated distances, and from the general goodness of their latitudes, probably checked by altitudes of Polaris. The later forms of astrolabe or the single reflecting sextant would have made this practicable. It is almost needless to state that the longitudes are all bad.

For comparison of the three, I have selected a series of clearly recognizable points giving a meander line of the general course of the river, platted them directly from Collot's map, which is on smaller scale, and constructed the others by offsets from the straight line, Cairo–New Orleans. The results are shown on the accompanying plat.

For the course of the river, I have collated the old maps with the "Alluvial Valley," looking for details to the inch-mile series, and occasionally even to the contour lines of the detail charts. By the topography surveyed about 1880, I find, from Cairo to Donaldsonville, the river bed of 1765 recognizable in the present bed, the cut-off lakes, the lines of bayous, sloughs, and creeks, the belts of swamp, the depressions as shown by the contour lines, and the lines of levee following old banks because of their altitude. In making this comparison I have derived some little aid from the reconnoissance of 1821 by Young, Poussin, and Tuttle, and much more from the "Navigator," edition of 1817, a pilot's guide describing the channels by reference to points and islands.

As regards the shortening of the bed by cut-offs, it is noticeable that, from 1765 to 1796, there is no change of this character. Since 1800 there has been no such period of thirty-one years. Four cut-offs, whose dates are undetermined, occurred between 1796 and 1817—the Montezuma Bend, Grand Lake, Yazoo, and Homochitta. The "Navigator" mentions the old beds at Grand Lake and the Yazoo Bend as filled, and overgrown, but recognizable by the smaller willows therein. The others are not referred to. Humphreys and Abbot, in their summary of tradition of early floods, signalize that of 1799. From the filling and growth I surmise that these cut-offs are of date at least as early.

As regards the lengthening of the bed by erosion of concave banks and building out of points in the bends, this more gradual and widely distributed change is noticeable, even on these small-scale maps, in most of the greater bends. There are points where bends have been shortened; most of these are in the neighborhood of cut-offs, but there remain Plum Point, the "Devils Elbow," Grand Gulf, and Port Hudson. The most interesting instance of the lengthening of a bend is at Cowpen Point. The bend around Vidal Island is apparently a very old bed. Concordia Lake, east of the island, suggests a cut-off at the neck of the old bend and a subsequent lengthening of the point. In 1765 the river bent around a broad, obtuse point having not half the length of Cowpen; now the river has moved three-quarters of the distance from the last-named channel towards Concordia Lake.

The characteristic movement downstream of both points and islands, by erosion of the upstream bank and building out of the downstream one, while preserving the same general outline, is observable in many of the larger points. The change of direction of the axis of the point, shown in a few instances by the caving-bank survey of 1891–'92, I find only in Coles Point and doubtfully in one or two others.

As regards the breadth of the river, I do not think that any trustworthy conclusions are to be drawn from these maps. Ross and Collot probably drew from one sight of the river only. Their delineations of width show characteristic proportions, but I do not look to them for measurements. Pitman undoubtedly knew the river much better than either of them. The great width of the river on his map is very noticeable. In studying his work, I find his bank line often agreeing well with the higher land, and a dotted line suggesting a submerged bar, agreeing fairly with the lowlands, while islands are shown which, with a relief at all like the present, would not be visible at a stage such as to fill his banks. I conclude that he drew the lines of the most permanent and characteristic banks (perhaps, not unreasonably, despairing of determining any other) and drew the islands as he saw them. I do not think that his delineation corresponds to any actual or possible stage, nor that any measurement of width can be taken upon it.

The following is a description of the river bed of 1765–'96 by modern topography and current names. The numbers of paragraphs correspond to the maps of the inch-mile series:

1. From Cairo, bending boldly eastward, probably as far as Lost Pond, then following the line of the creek flowing southward from near Flat Pond, the lower part of Mayfield Creek and the back slough. The turn corresponding to Lucas Bend is not deeper than through the chute of Island No. 2, and Pitman shows the space between that chute and the bluffs as a group of small islands. The point on which Belmont is situate and the bend against the bluffs near Columbus are as now. All show an island corresponding to No. 5, with the chute straighter and broader.

2. Below Columbus the river is closer to the bluffs and near the line of Long Pond and the lower reaches of the Little Obion. French Point and Island No. 8 (to which Ross gives the name of "Wolf") are very recognizable in shape and position.

3. Below French Point the river divides around Island No. 9 in about equal channels. Donaldsons Point is shorter than now, ending about with the present cultivated land. All the maps show a long island against the opposite bank in the bend (No. 10?). Watsons Point nearly as now; little shorter, with its extremity broken into islands. Ross notes St. John Bayou as "Chepoussea or Sound River." Pitman shows mouths of two bayous in position of St. John and the Dry Bayou. Below New Madrid the curve to the westward is full, as through the old chute of Island No. 11. Darnells Point is part of a fully rounded curve which continues around the old chute of Island No. 12, which island appears in all. Ruddles Point and Little Cypress Bend are much as now, except that the chute of Island No. 13 is open.

4. In the bend below, Pitman indicates the lower opening of the "old river" shown on our maps, and Ross sketches doubtfully its whole line. The point to which Island No. 14 is now joined is shown with an island longer than No. 14 along its front, but presenting nearly the same general outline. The Little Prairie Bend (which name appears in French and English) is not so sharp as now; the opposite point has nearly the same outline below, but its upstream bank is straighter. Islands 16 and 17 show as a single island as now. No. 18 is very recognizable, its chute much wider. Islands 20 and 21 appear as one island in Pitman, though separate in Ross. The main channel leaves them on the right, curves around the present highest land, into the "old river" around Needhams Island. (The reconnoissance map of Young, Poussin, and Tuttle, gives the date of this cut-off, February, 1821.) Pitman indicates a tributary in the position of the Obion River, but does not note the Forked Deer; Ross has a tributary in the bend above, apparently intended for the Obion.

5. The higher land of Ruckers Point, just back of a narrow belt of swamp, the

land back of the towhead of Island 25, Daniels Point, and Keyes Point, appear to be of the old bank, and a bend in the left bank like that around islands 26 and 27 is recognized. The reach is full of islands called the "Canadian," having only a general resemblance to the present chain.

6. Plum Point appears to extend out to Osceola Bar. Bending around it the river cuts more than now into its right bank, dividing equally around Island 33, and meeting the bluffs higher up than now. Island No. 34 shows broader at its lower end, coming into line with Morgans Point; the river divides about equally around No. 34, and strikes the second bluffs higher up than now, leaving small islands in the bend. The next bend with Island 35 is as now except that the channels are nearly equal.

7. Below Cedar Point the river bends well back to the cliffs (indicated on all the maps) around Island 36, then around a point apparently extending beyond Deans Island and separated from No. 36 by a narrow chute (now the main river), around the chute of 37 (shown as a double island) and of 38 (now continuous with the right bank), across the lower end of Centennial Island and upper end of Brandywine Island, where depressions now show, and along the lines of Berkeley Bayou and Bear Creek, dividing equally around No. 40, receiving the Loosahatchie as an independent tributary, having a very broad reach with islands where is now the bend above Memphis, and meeting the Wolf River at its emergence from the bluffs.

8. Below Memphis the characteristic shapes of Presidents Island and its companion (46 and 45) are very recognizable, especially in Ross. From Presidents Island to Commerce, the maps show a difference which may be of stage. All have the right bank nearly as now, but following the chute of Cat Island; all show islands 47 and 48, Cat Island, and No. 53 (much larger than now); Pitman marks the two ends of the Horseshoe Lake. On the left bank, Ross's line merely cuts off the point which would be rounded in passing down out of Tennessee chute, while Pitman's would indicate overflow back to the bluffs and down to Horn Lake. Collot, with less detail, agrees more nearly with Pitman.

9. Continuing against the high land above Commerce, the river passes around the Council Bend (cut-off in 1874), in which all the maps show an island cut off from Linwood Point, then around through the sloughs and Old River Lake, against the old line of levee. Ashley Point would appear to have extended to Clarks tow-head, and to have a considerable island cut off from it. The river then passes around Walnut Bend, with an island in about the position of Whiskey Island, but not especially resembling it in shape, and around Hardins Point, cutting more into its left bank than now; the maps show islands not resembling the present ones.

10. Harberts Point shows an island cut-off by a narrow chute near the present line of levee, and this bend cuts more deeply into its right bank than now. From the mouth of the St. Francis the river cut more into its left bank than now, nearly against the line of levee, leaving an island near the present No. 60, a point at Trotters Landing, and then probably through the Swampy Eagle Lake. (I place the river so far east just here, partly because of the lines of the maps, and partly because neither Ross nor Collot, who usually represents the bluffs, have any notes of those near Helena.) Then through Hubbard Lake, around through Moon Lake (in which Texas and Alcorn Islands are especially well drawn by Ross), crossing its present bed as far as Willow Lake, and around through Horseshoe Lake. (The Horseshoe cut-off is of 1848; the Montezuma Bend, date not known; Navigator, 1817, does not mention the lake.)

11. From Horseshoe Lake, following the belt of swamp in the right bank of Old Town Bend, and against the high land behind Island 62, around the next three bends, showing Island 63 larger than now, the chute of 64 in a considerable width (Navigator, 1817, gives 64 in middle of river), and an island opposite 64 in about the position of Robsons tow-head, Jacksons Point apparently extending to Island 65, and Island 66, or a narrower island, cut off through the depression across its middle.

12. Following around Island 67, with its chute open, the river had to Concordia Bend a straighter course than now. Ross's lines are not very characteristic; Pitman's show, on the right bank, the line of high ground occupied by the levee to a little below Laconia; thence following the chute of Island No. 70 into Scrub Grass Bend, with a small island cut out, whose chute is indicated on the detail charts, by a belt of swamp, and on the left bank, very nearly the lines of levee, with a narrow island representing the lowlands of Hurricane Point; thence through Scrub Grass and Victoria bends, leaving Smiths Point broader than now, and the small island at its end smaller. (Pitman shows three breaks in the right bank, which agree in position with the double mouth of White River and One Mile Bayou, but does not give the name of White River. Ross gives the name of White River to what, I think, is the Deep Bayou. He draws the junction of the White and Arkansas, but much north of its true position. It appears to me that he must have drawn the rivers from description, not from observation, and mistaken the White, as above. Collot gives the two names, and the rivers, and their junction fairly well.)

13. From the mouth of the White River, through the chute of Island 73, around through Beulah Lake (cut-off in 1863), then in a full curve through a belt of swamp and the chute of Ozark Island (No. 75), meeting the Arkansas, coming from the north, one bend above its present mouth. Pitman notes, in the chute of 73, the opening of Knowltons Bayou, and draws it as forming a double mouth of the Arkansas. The bend around Caulks Point and Island 76, Cypress Bend, with the mouth of Cypress Creek and Island 77, and Choctaw Bend, with the chute of 78 very wide and the point behind it cut into islands (called the Mulberry Islands), are very recognizable in Pitman and in Collot, but not well represented by Ross.

14. From the point opposite Arkansas City to Rowdy Bend the course is much straighter than now. The river divides nearly equally around a long island representing 80 and 81; Georgetown Bend is slight, Ashbrook Point broad and shorter than now. Rowdy Bend, Millers Bend, with Point Comfort and Island 82 cut by chutes running south, Point Chicot, with a broad chute, probably the main stream, cutting squarely across it, all show a channel shorter than the present. In Walkers Bend, the chute of Island 84 is evident, and the left bank line is that of the levee.

15. The river then follows around Lake Lee (American cut-off in 1858), along the high land of the left bank as far as Williams Plantation; thence along the highland back of Islands 86 and 87, which divide the river nearly equally (so in Navigator, 1817) into Mathews Bend; thence, along the left bank, around a point and island no longer existing, and around Grand Lake (date of cut-off not known; Navigator, 1817, describes the lake as grown up with willows) back into the present bed around Island No. 89; then around through the Old River Lake (Bunchs cut-off, 1830) and back into the present bed with a sharp bend in which Island No. 92 is very recognizable.

16. Below Skipwith the river cuts more into its left bank than now, dividing equally around Island 93 (so in Navigator, 1817) and through the next bend is in its present bed. Point Lookout and Island 95 are much changed in shape; the curved belt of swamp below Fitlers Point defines Pitmans left bank line.

17. Around Tompkins Bend the old river kept close to the high land of the left bank, with a small island representing the lowland. In the next bend, the main river was close to the high land of Willow Point, with an island much larger than No. 98 in the bight; thence around Eagle Lake (Terrapin neck cut-off, 1866), through Millikens Bend much as now, dividing around the higher part of Paw Paw Island (No. 103), with the main channel against the left bank, and then around the old bend receiving the Yazoo River at its bight. (Date of cut-off not determined; Navigator, 1817, states that the old bed can be readily recognized by the smaller willows growing in it.)

18. Thence around the Centennial Lake at Vicksburg (cut off in 1876), in which Pitman indicates Willow, Chickasaw, and Glass Bayous. From Vicksburg to New Town Bend the course was straighter than now, with each of the two points of the left bank represented by an island at Sargent's Point, holding close to the levee, around through Palmyra Lake (Davis cut-off, 1867) and back around Big Black Island No. 110. The shape of the bend, now Palmyra Lake, varies in the three maps, but Pitmans lines and islands are fairly comparable with what little topography of Davis Island is shown on our maps.

19. From Island No. 110 the old bed cuts into the lower side of the right bank point, follows the line of bayou at upper end of Hard Times Bend, cuts again into the lower side of Thrasher's Point, passes around Grand Gulf Island, which appears to be the extremity of a long point, meeting the Big Black River at the bluffs. From the cliffs at Grand Gulf to Rodney the river was straighter and nearer the bluffs than now, meeting the Bayou Pierre as it rounds the bluff, but having as strong a bend at Rodney.

20. From Rodney to Fairchilds Bend the old maps agree closely with the present; Coles Island, No. 113, and the point behind it, Coles Point, showing in the old maps a northward curvature which has disappeared, and Fairchilds Island, No. 114, with its chute, are clearly recognizable. From the foot of Fairchilds Island the river held close to the high land of Rifle Point, swept around a broad point of the left bank, whose outline is traceable in the curving lines across the low lands of Rifle Point and the neck of Cowpen Point, followed the higher land of Vidalia Point, now marked by the levee, and met the bluffs of the left bank at Fort Rosalie (Natchez).

21. From Natchez the river curved more boldly westward than now, along Whitehall Lake and the main land back of Natchez Island (115); in St. Catharines Bend, held close to the high land of the left bank, meeting St. Catharines Creek where it expands into a small lake, around by the Ellis Cliffs, cutting across the lowlands of the present Esperance Point (left by the above course a mile wider on its upstream side) around by the Mill Bayou, and down through Dead Mans Bend. The island whose chute is Mill Bayou, and the main land of the opposite point, as defined by

the levee, are very recognizable; the intervening sandy point and islands are entirely changed.

22. Turning close to the high land of Jacksons Point, the river followed a straight course nearly south, then around the Old River, in which Pitman and Collot note two tributaries which would correspond to the Homochitta and perhaps an outlet of the Buffalo (the Alluvial Valley map has the Homochitta cut-off as of 1776; I think this is an error), then around Palmetto Point, and bending westward against the high land back of two lakes, and meeting the cliffs of the left bank at Fort Adams (Rocks of Davion). Ross shows the Buffalo River as now under the name of "Innocents or Junica;" Pitman and Collot show a stream from the eastward, as though the small creek above Fort Adams. From Fort Adams to the Angola Plantation, then around Turnbull Island (Shreves cut-off, made by U. S. Engineer Department 1831), meeting the Red River and the Atchafalaya. This last, Ross and Collot show as about equal to the Red; Pitman draws the mouth of the Red as of a great tributary, and marks the opening of the Atchafalaya only as he does those of small creeks. All the maps show the Lake of the Cross and the portage.

23. From the foot of Turnbull Island around the Raccourci Bend of Old River (Raccourci cut off made by State of Louisiana, 1848), through the Tunica Bend, showing Tunica Island as in mid stream, and the mouth of Tunica Bayou.

From here to the English Turn all the maps agree closely with the present, except that at Port Hudson the river bends sharply at the cliffs, and that the peculiarly square turn to the left just below Donaldsonville is not shown. From English Turn to Head of Passes, Pitman and Collot agree closely with the present lines.

Measuring upon the inch-mile maps the line above described, and comparing the results with the "mid-bank distances," entered on those maps (taking no account of the Waterproof cut-off, which occurred since the surveys for these maps), I obtain the following results:

Cairo to Memphis.—Old river, 249 miles; present river, 230 miles; shortening, 19 miles, or 0.076 of old river. In this reach the river is shortened by Needham's cut-off (10 miles), and Centennial cut-off (18 miles) and by its changes of line below New Madrid and around and below Plum Point. It is lengthened by erosion in Lucas Bend, the bends around the points above and opposite New Madrid, and just above Little Prairie Bend.

Memphis to Arkansas City.—Old river, 272.5 miles; present river, 208.3; shortening, 64.2 miles, or 0.272 of old river. In this reach the river is shortened by Commerce cut-off (12.75 miles), Bordeaux Chute (5.75 miles), Montezuma and Delta Bend cut-off (10.25 miles), Horseshoe cut-off (7.25 miles), the cut-off of Beulah Lake and of the bend behind Ozark Island (10.25 miles), and by its change of line around and below Hardins Point. It is lengthened by its change of line opposite Helena, near Islands 66 and 67 and thence to Concordia Bend.

Arkansas City to Vicksburg.—Old river, 208.5 miles; present river, 161 miles; shortening, 47.5 miles, or 0.228 of old river. In this reach the river is shortened by American cut-off (8.75 miles), Grand Lake cut-off (10 miles), Bunchs cut-off (7.75 miles), Terrapin Neck cut-off (13.75 miles), Yazoo cut-off (14 miles), and Centennial cut-off (6.25 miles). It is lengthened in all the bends from Arkansas City to Greenville, and near Willow Point.

Vicksburg to Bayou Sara.—Old river, 261.75 miles; present river, 200.7 miles; shortening, 61.05 miles, or 0.229 of old river. In this reach the river is shortened by Davis cut-off (17.50 miles), Grand Gulf Island cut-off (3.5 miles), Homochitta cut-off (16.25 miles), and the two great artificial cut-offs, Shreves (16.25 miles), and Raccourci (17.5 miles). It is lengthened by its changes of line from Vicksburg to New Town Bend, from Grand Gulf to Rodney, and in the bends around Cowpen Point and Viadalia.

For the whole distance, Cairo to Bayou Sara, we have: old river, 991.75 miles; present river, 800 miles; shortening, 191.75 miles, or 0.1933 of old river. The cut-offs aggregate 205.75 miles (172 natural, and 33.75 artificial), leaving 14 miles as the lengthening by erosion.

These changes are of a century in which the conditions of the river were very greatly changed by the settlement of the drainage basin of the Ohio (in its wild state, largely wooded, with close turf in open ground, and having a considerable percentage of steep slope); in a much less degree, by that of the upper Mississippi (naturally less wooded, and of less slope), and probably very little by that of the Missouri, still in great proportion a wild country.

The magnitude of these changes led me to make similar measurements on the maps of the Caving Banks Survey of the Winter of 1891-'92, which show the changes of about 10 years. Here two instrumental surveys are collated by superposition. The latest "mid-bank" line, Cairo-Bayou Sara, is 800.53 miles, as against 800 ten years before; the line is shortened 12.85 miles by the Waterproof cut-off (1884), and and 5.3 miles by change of channel to the chutes of islands; it is lengthened 1.1 miles by change of channel and 17.58 miles by the erosions, of which some few have tended towards shortening.

The reach, Cairo to Memphis, is shortened 0.25 of a mile; the change of channel to the chute of Beef Island makes a shortening of 3.5 miles, leaving the lengthening due to erosion 3.25 miles.

The reach, Memphis to Arkansas City, is lengthened 0.7 of a mile; the change of channel to Tennessee chute shortens by 1 mile; that at Commerce Cut-off, following the right bank from Peters Landing, lengthens by 0.5 of a mile; the lengthening by erosion is 1.2 miles.

The reach, Arkansas City to Vicksburg, is lengthened 6.03 miles; the change of channel to chute of Island 97 shortens by 0.8 of a mile; that to chute of Island 93 lengthens by 0.6 of a mile; the lengthening by erosion is 6.23 miles.

The reach, Vicksburg to Bayou Sara, is shortened 5.95 miles; the Waterproof Cut-off shortens by 12.85 miles; leaving the lengthening by erosion 6.9 miles.

These changes are of a short period during which the natural action of the river has been modified by artificial works of bank protection and of channel contraction and by a general restoration of the levees. It is noteworthy that the only cut-off is of a very narrow point (Coles Point), which had stood with little change for a century and a quarter; it is among the most readily recognized landmarks on each of the early maps.

I present these results as a contribution to the history of the Mississippi River, with hope that future studies of other early maps, and future surveys of the bank lines may give such continuity to that history as to make it more available for engineering study.

From the long period without cut-offs covered by the maps, studied the river bed, Cairo to Bayou Sara, must have had nearly its least length in 1765, and nearly its greatest in 1796. Maps of just before and after this period are likely to show interesting changes. I have the honour to be,

Very respectfully, your obedient servant,

CARL F. PALFREY,
Captain of Engineers,
Secretary Mississippi River Commission.

Gen. C. B. COMSTOCK,
President Mississippi River Commission.

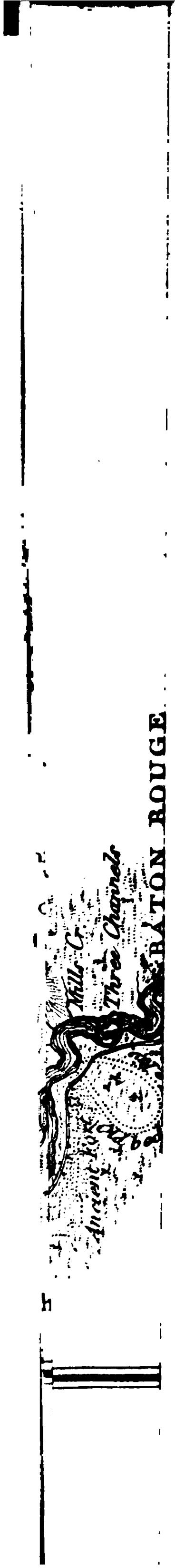
APPENDIX 3 L.

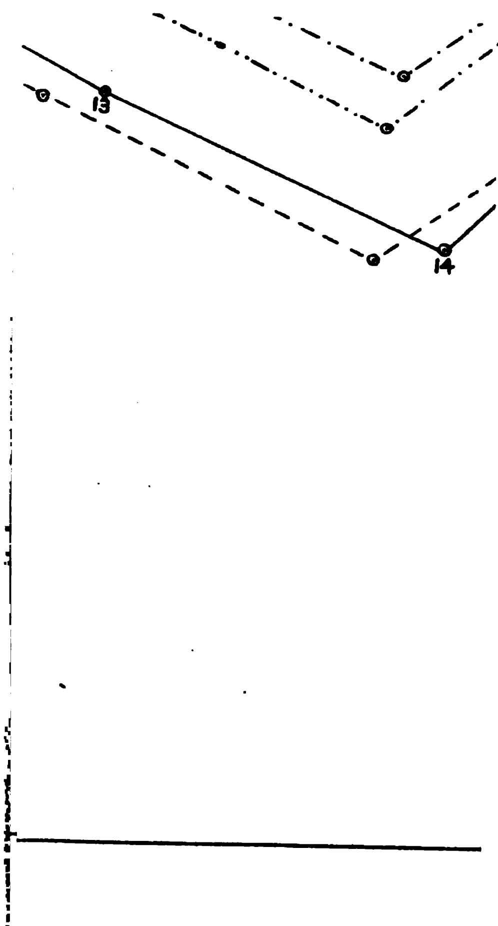
COMMERCIAL STATISTICS, 1892.

Statement by districts of through and local freights during calendar year 1892.

	Through.					Local.	Total.
	Down.		Up.		Total through.		
	In transit.	Delivered.	In transit.	Shipped.			
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
First district						54, 558	
St. Louis	460, 178	38, 940	68, 516	21, 864	589, 498		
Pittsburg	1, 592, 000	258, 000			1, 850, 000		
Cincinnati	11, 393	16, 678	11, 393	16, 418	55, 882		
Total	2, 063, 571	313, 618	79, 909	38, 282	495, 380	54, 558	2, 549, 938
Second district						47, 266	
St. Louis	460, 178		68, 516		528, 694		
Pittsburg	1, 532, 000	60, 000			1, 592, 000		
Cincinnati	11, 393		11, 393		22, 786		
Total	2, 003, 571	60, 000	79, 909		2, 143, 480	47, 266	2, 190, 746
Third district						*75, 000	
St. Louis	425, 499	34, 679	49, 788	18, 728	528, 694		
Pittsburg	1, 390, 000	142, 000			1, 532, 000		
Cincinnati	5, 793	5, 600	11, 243	150	22, 786		
Total	1, 821, 292	182, 279	61, 031	18, 878	2, 083, 480	*75, 000	2, 158, 480
Fourth district						(†)	
St. Louis		425, 499		49, 788	475, 287		
Pittsburg		1, 390, 000			1, 390, 000		
Cincinnati		5, 793		11, 243	17, 036		
Total		1, 821, 292		61, 031	1, 882, 323		1, 882, 323

* Estimated. † None reported.


BATON ROUGE
Three Channels
Mills C.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Shipment of bulk grain by river to New Orleans during 1892.

Date.		Name of boat.	Corn.	Wheat.	Oats.	Bulk grain.	Other freight.	Total.
			Bushels.	*Bushels.*	*Bushels.*	*Tons.*	*Tons.*	*Tons.*
Jan.	4	Sidney Dillon and barges		74,000		2,229		2,229
Feb.	1	My Choice and barges		65,000		1,950		1,950
	1	Sidney Dillon and barges		62,500		1,875		1,875
	3	Jay Gould and barges		104,200		3,125		3,125
	8	My Choice and barges		83,100		2,195	960	3,155
	9	Sidney Dillon and barges		136,800		4,105		4,105
	12	do		134,500		4,035		4,035
	16	do	14,000	82,416		2,865	695	3,560
	18	Jay Gould and barges		124,660		3,740		3,740
	23	do		133,233		3,995		3,995
	25	do		144,244		4,265		4,265
	27	Sidney Dillon and barges		100,000		3,000	870	3,870
Mar.	1	Jay Gould and barges		146,830		4,285		4,285
	3	Sidney Dillon and barges		145,500		4,365		4,365
	7	Jay Gould and barges	50,000	77,335		3,720	1,120	4,840
	8	Sidney Dillon and barges	64,920	63,250		3,715		3,715
	9	E. M. Norton and barges	50,000	99,925		4,395		4,395
	12	Jay Gould and barges	145,500			4,365		4,365
	12	Sidney Dillon and barges	47,735	47,390		2,757	1,148	3,905
	16	Jay Gould and barges	91,445	50,999		4,090		4,090
	16	E. M. Norton and barges	43,000	80,270		3,630		3,630
	19	Geo. Lysle and barges		87,321		2,619	1,136	3,755
	19	Sidney Dillon and barges	48,017	88,673		4,005		4,005
	19	Jay Gould and barges	89,765	46,030		3,895		3,895
	23	Geo. Lysle and barges	85,696	39,456		3,480		3,480
	25	Jay Gould and barges	100,500	45,347		4,175		4,175
	28	My Choice and barges	50,550	47,000		2,825		2,825
	28	Jay Gould and barges	89,854	36,869		3,620		3,620
	28	Sidney Dillon and barges	46,000	96,418		4,180		4,180
	30	E. M. Norton and barges	105,640			2,960	1,050	4,010
Apr.	1	Sidney Dillon and barges	104,000	41,066		4,145		4,145
	4	Jay Gould and barges	93,300	51,000		4,140		4,140
	9	L. Houck and barges		136,733		4,100	925	5,025
	11	Jay Gould and barges	140,240			3,925		3,925
	13	H. Lourey and barges	145,979	44,599		5,425		5,425
	13	Sidney Dillon and barges	55,406			1,550		1,550
	15	Jay Gould and barges	49,373	101,938		4,440		4,440
	15	E. M. Norton and barges	95,000			2,620		2,620
	16	Sidney Dillon and barges	153,143			4,285		4,285
	18	E. M. Norton and barges		77,522		2,325		2,325
	19	Jay Gould and barges	97,020			2,715		2,715
	22	My Choice and barges	109,033			3,053	1,027	4,080
	22	Sidney Dillon and barges	43,449	33,951		2,235		2,235
	27	Future City and barges	107,000	50,783		4,520		4,520
	27	Sidney Dillon and barges	74,858	24,855		2,840	1,000	3,840
May	4	Jno. Gilmore and barges	152,049			4,257	1,188	5,445
	10	Henry Lourey and barges	95,760			2,680	1,270	3,950
	10	Sidney Dillon and barges	149,561			4,190		4,190
	19	H. M. Hoxie and barges					1,875	1,875
June	2	S. H. H. Clark and barges					1,415	1,415
	13	Future City and barges	21,116			590	830	1,420
	23	My Choice and barges					1,010	1,010
July	2	Jno. Gilmore and barges		46,003		1,360	1,360	2,720
	11	Henry Lourey and barges	94,400	44,794		5,510	1,960	7,470
	16	H. M. Hoxie and barges		80,014		2,400	1,150	3,550
	23	S. H. H. Clark and barges		30,000		900	1,425	2,325
	30	Oakland and barges		135,391		4,062	1,443	5,505
Aug.	4	My Choice and barges		118,535		3,555		3,555
	8	Jno. Gilmore and barges		68,965		2,070	1,135	3,205
	9	Sidney Dillon and barges		105,000		3,150		3,150
	10	H. Lourey and barges		102,550		3,080		3,080
	12	E. M. Norton and barges	41,523	61,760		3,025		3,025
	13	H. M. Hoxie and barges	37,931	69,000		3,130		3,130
	13	Sidney Dillon and barges		106,495		3,195		3,195
	13	S. H. H. Clark and barges		35,000		1,050	1,455	2,505
	20	My Choice and barges		100,094		3,000		3,000
	20	Jay Gould and barges		33,365		1,000	590	1,590
	26	Sidney Dillon and barges		70,618		2,120		2,120
	28	My Choice and barges		53,466		1,602	438	2,040
	29	Jay Gould and barges		67,176		2,015		2,015
Sept.	3	Sidney Dillon and barges }		66,439	36,857	2,582	793	3,375
	3	My Choice and barges }						
	10	Sidney Dillon and barges		39,465		1,180	585	1,765
	10	My Choice and barges		60,535		1,815		1,815
	14	do		62,375		1,870		1,870
	17	Sidney Dillon and barges		44,831		1,342	873	2,215
	22	My Choice and barges		60,791		1,825		1,825
	25	Sidney Dillon and barges					1,660	1,660
	30	My Choice and barges		65,390		1,960		1,960
Oct.	1	Sidney Dillon and barges		19,160		575	1,110	1,685
	5	My Choice and barges	59,487			1,665		1,665
	8	Sidney Dillon and barges	20,103			564	1,216	1,780

Shipment of bulk grain by river to New Orleans during 1892—Continued.

Date.	Name of boat.	Corn.	Wheat.	Oats.	Bulk grain.	Other freight.	Total.
		Bushels.	*Bushels.*	*Bushels.*	*Tons.*	*Tons.*	*Tons.*
Oct. 12	My Choice and barges		35,166		1,055		1,055
15	......do		34,070		1,020		1,020
17	Sidney Dillon and barges					1,270	1,270
25	My Choice and barges	18,700			523	1,462	1,985
26	Sidney Dillon and barges	30,215	33,918		1,860		1,860
31	My Choice and barges	16,800			470	875	1,345
Nov. 3	Sidney Dillon and barges	20,802	26,776		1,385		1,385
5	My Choice and barges	16,083	14,500		885		885
8	Sidney Dillon and barges					870	870
13	My Choice and barges		15,112		425		425
16	Sidney Dillon and barges		42,700		1,280		1,280
19	My Choice and barges		43,650		1,310		1,310
24	Sidney Dillon and barges		17,200		518	1,542	2,060
24	My Choice and barges		43,200		1,300		1,300
28	Sidney Dillon and barges		30,500		915		915
29	My Choice and barges		42,615		1,280		1,280
Dec. 5	Sidney Dillon and barges		15,500		465	1,300	1,765
10	My Choice and barges	28,486			800	270	1,070
12	Sidney Dillon and barges	35,206	13,876		1,400		1,400
	Total	3,228,645	5,149,708	36,857	246,979	42,301	289,280
Via Belmont and Cairo:							
January		886,430	669,221		44,900		44,900
February		1,110,620	169,022		36,170		36,170
March		422,900	51,084		16,440		16,440
April			64,000		1,420		1,420
July			45,000		1,350		1,350
August			81,000		2,430		2,430
September			19,000		520		520
December		114,592	414,764		15,650		15,650
Grand total		5,763,187	6,662,799	36,857	365,859	42,301	408,160

Shipments by New Orleans boats and barges for three years.

Articles.	1892.	1891.	1890.
Apples ... barrels	164	144	348
Ale and beer ... packages	2,570	1,892	2,503
Bagging ... pieces	16,226	22,973	88,276
Barley ... sacks	41	4	39
Barley ... bushels			
Barbed wire ... pounds	20,260	253,864	1,831,163
Butter ... do	2,028	1,106	9,377
Bran ... sacks	34,674	46,507	70,746
Cattle ... head	8	1	5
Corn ... sacks	58,930	96,984	152,908
Corn in bulk ... bushels	3,228,645	1,482,731	8,717,850
Corn meal ... barrels	77,622	80,905	133,697
Cotton ... bales			2,054
Cotton-seed meal ... tons			
Eggs ... packages			2
Flour ... barrels	262,944	222,329	390,300
Hay ... tons	409	754	956
Horses and mules ... head	244	243	704
Hogs ... do	5	23	24
Hominy and grits ... barrels	20,410	23,978	40,247
Pork ... do	3,497	5,896	6,279
Hams ... pounds	81,676	85,194	131,926
Meats ... do	1,325,714	1,143,318	1,789,865
Lard ... do	7,450,298	6,869,290	8,116,580
Malt ... sacks			15,845
Oats ... do	95,649	257,728	403,173
Oats in bulk ... bushels	36,857		89,960
Onions ... packages	86	270	153
Potatoes ... do	463	245	656
Rye ... sacks	120	42	1,036
Rye in bulk ... bushels		45,600	
Sheep ... head			
Tallow ... pounds	359,194		220
Tobacco ... hogsheads			
Tobacco, manufactured ... pounds	15,794	7,473	36,757
Wheat ... sacks	51	207	418
Wheat in bulk ... bushels	5,149,708	6,940,215	1,409,440
Whisky ... barrels	443	402	1,646
White lead ... pounds	1,124,415	1,050,481	1,184,295
Merchandise and sundries ... packages	153,979	87,877	189,651
Total ... tons	315,605	331,850	418,400

Shipments by Memphis, Vicksburg, and Natchez boats for three years.

Articles.	1892.	1891.	1890.
Apples .... barrels..	1,174	1,112	2,926
Ale and beer .... packages..	35,423	34,003	33,127
Bagging .... pieces..	13,972	56,233	40,349
Barley .... sacks..	59	234	577
Barley .... bushels..	....	....	....
Barbed wire .... pounds..	1,090,958	2,034,106	879,045
Butter .... do....	34,268	31,540	94,761
Bran .... sacks..	8,429	26,393	39,533
Cattle .... head..	52	34	77
Corn .... sacks..	80,324	144,563	119,403
Corn, in bulk .... bushels..	....	....	....
Corn meal .... barrels..	117,909	157,012	201,964
Cotton .... bales..	5	....	....
Cotton-seed meal .... tons..	....	....	....
Eggs .... packages..	60	56	270
Flour .... barrels..	61,205	131,358	178,970
Hay .... tons..	1,715	2,675	3,488
Horses and mules .... head	1,577	1,515	1,834
Hogs .... do....	42	82	181
Hominy and grits .... barrels..	3,324	3,466	4,778
Pork .... do....	6,301	5,738	7,507
Hams .... pounds..	222,152	491,238	791,112
Meats .... do....	6,566,373	11,089,187	13,066,078
Lard .... do....	985,443	1,284,463	1,338,629
Malt .... sacks..	....	50	362
Oats .... do....	63,012	116,009	123,234
Oats, in bulk .... bushels..	....	....	....
Onions .... packages..	3,170	3,357	2,246
Potatoes .... do....	14,188	12,359	13,365
Rye .... sacks..	260	381	1,378
Rye, in bulk .... bushels..	....	....	....
Sheep .... head..	2	160	6
Tallow .... pounds..	....	....	....
Tobacco .... hogsheads..	38	2	....
Tobacco, manufactured .... pounds..	247,500	242,185	489,363
Wheat .... sacks..	935	370	173
Wheat, in bulk .... bushels..	....	....	....
Whisky .... barrels..	2,319	3,023	2,909
White lead .... pounds..	458,611	495,717	536,637
Merchandise and sundries .... packages..	747,855	872,774	1,091,050
Total .... tons..	77,065	112,420	125,405

Classified statement for three years of commodities transported to St. Louis from the Lower Mississippi by the St. Louis and Mississippi Valley Transportation Company.

Commodities.	1890.	1891.	1892.
Anvils, machinery, etc .... packages..	2,116	2,251	1,603
Cement .... barrels..	169,415	182,084	129,950
Chemicals, caustic, etc .... packages..	2,057	1,565	3,273
Earthern and glassware .... do....	5,703	10,577	1,230
Fertilizer .... do....	....	7,533	2,408
Iron bars, rails, etc .... do....	14,706	2,105	....
Iron, pig and scrap .... tons..	204	....	....
Do .... packages..	12,255	....	....
Lumber .... feet..	1,252,980	988,051	825,977
Oils and paints .... barrels..	210	52	598
Rice .... packages..	13,204	9,500	17,262
Salt .... do....	6,672	6,989	11,499
Shingles .... bundles..	78,710	163,447	166,601
Steel, bars, blooms, etc .... tons..	1,121	6,137	1,024
Tin plate .... boxes..	....	576	925
Sundries .... packages..	4,137	2,370	2,621
Total .... tons..	47,282	52,291	40,425

HENRY P. WYMAN,
Secretary.

ST. LOUIS, *June 5, 1893.*

STATEMENT OF THE PITTSBURG COAL EXCHANGE.

PITTSBURG, *June 7, 1893.*

SIR: The following list shows the coal shipments for the year 1892 to the various points on the Mississippi River. These statistics were not available when your letter was received, but had to be collected from the different operators:

	Bushels.
1. Points on the Mississippi down to and including Memphis	6,450,000
2. Points below Memphis down to and including White River	1,500,000
3. Points below White River down to and including Vicksburg	3,550,000
4. Points below Vicksburg down to and including New Orleans	34,750,000
Total	46,250,000

Number of steamers employed, 17; their total tonnage, 9,000.
Return freight, empty craft, if any.
Very respectfully,

THE PITTSBURG COAL EXCHANGE,
J. FRANK TILLEY, *Secretary.*

Capt. CARL F. PALFREY,
Corps of Engineers.

STATEMENT SHOWING RECEIPTS AT CINCINNATI FROM POINTS ON MISSISSIPPI RIVER, YEAR ENDED DECEMBER 31, 1892.

From all points, New Orleans to Memphis.

Cement	barrels..	800	
Scrap iron	tons..	95	
Lumber	feet..	427,000	
Merchandise	tons..	1,140	
Molasses	barrels..	18,480	
C. S. oil	do....	671	
Rice	do....	7,734	
Sugar	do....	5,774	
Sugar	hogsheads..	129	
Shingles	bundles..	28,368	
Cotton	bales..	6,911	
Moss	bales..	990	
Paper stock	bales..	924	
Aggregate tonnage			11,393

From all points, Memphis to Cairo.

C. S. meal	bags..	45,960	
Cotton	bales..	32,632	
Scrap iron	tons..	100	
Merchandise	tons..	401	
C. S. oil	barrels..	1,008	
Soap stock	do....	2,088	
Spar	do....	6,351	
Lumber	feet..	1,787,000	
Aggregate tonnage			16,418
Total tonnage			27,811

STATEMENT SHOWING SHIPMENTS FROM CINCINNATI TO POINTS ON MISSISSIPPI RIVER, YEAR ENDED DECEMBER 31, 1892.

To all points south of Memphis to New Orleans.

Nails	kegs..	44,571	
Iron	tons..	1,126	
Merchandise	tons..	8,954	
Aggregate tonnage			11,393

All points south of Cairo to Memphis.

Nails......kegs..	111,328	
Salt......barrels..	16,025	
Iron......tons..	1,547	
Merchandise......do....	6,364	
Aggregate tonnage......		16,678
Total tonnage......		28,071

APPENDIX 4.

REPORT OF CAPT. S. W. ROESSLER, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1893.

GENERAL: I have the honor to submit the following report of operations in the First and Second Districts for the period May 31, 1892, to May 31, 1893:

FIRST DISTRICT (CAIRO TO FOOT OF ISLAND 40, 220 MILES).

Columbus, Ky. (21 miles below Cairo).—The work of improvement at this point consists of five spur dikes built in 1889–'90 to protect about 2,200 feet of bank in front of the town which was threatening to cave. No injury to the spurs has been noted since their completion in October of 1890, and no further work is at present required.

Hickman, Ky. (36 miles below Cairo).—The acts of 1886 and 1888 contained specific appropriations for this locality amounting together to $88,750. The evil to be remedied was the caving of the bank in front of the town. Owing to the existence of a projecting point of tough clay above the town, it was possible to do this with a small development of work. A continuous revetment about 1,000 feet long, extending downstream from the clay point, was placed in October, 1890, its downstream end resting on a second clay point opposite the middle of the town. After the flood of 1891, a slight undermining of the downstream end of the mat above water was noted, which was further enlarged by the flood of 1892. The injury was limited to the portion of the mat above low water, and was repaired in October and November, 1892, by extending the shore mattress downstream to cover the pocket which had been scoured out below the end mat. The balance of the mat above low water remained uninjured, but had become much weakened by decay of the brush of which the mattress was constructed. To strengthen it, a layer of riprap stone 10 inches thick was placed along the whole revetment, extending from low water up to the level of the 7-foot stage. The ballast will be extended further up the bank, if necessary, the coming season.

A survey of the whole harbor front at this point was made in October of 1892, and included sections 100 feet apart over the existing revetment. Very great depths were found. At the downstream end of the mattress the depth was 97 feet below low water at a point 200 feet from the bank. One hundred feet further upstream the depth was 116 feet at a point 225 feet from the bank, and the same depth was found in the section next above it, and at about the same distance from the shore. The existence of these greath depths so near the shore are a great menace to the permanence of the revetment, but there is nothing to show that any portion of the river mat has yet been lost. No further work is recommended at this locality at the present time beyond placing such additional stone ballast on the shore mats as may be found necessary after the water recedes.

New Madrid, Mo. (71 miles below Cairo).—To comply with the requirements of the act of September 19, 1890, as interpreted by the Secretary of War, the Commission allotted $1,000 from the appropriation contained in that act to be expended in making a survey. The survey was made in September and October, 1891. The evil which the inhabitants desire to have corrected is the caving of the bank in front of the town. Between 1880 and 1884, the bank caved away at an average rate of 113 feet a year, and between 1884 and 1891 at the rate of 57 feet a year. It was estimated that $70,000 would be required to protect the bank immediately in front of the town. The river and harbor act of July 13, 1892, contained a specific appropriation of

$25,000 for the improvement of this locality. By resolution of the Commission, as approved by the Secretary of War, this sum is to be expended in revetting the bank opposite the upstream portion of the town, beginning at the upper limit of the town at Dry Slough and extending downstream as far as the funds will allow. The stone required has been stored on the bank during the present high water, and it is contemplated to build the revetment the first thing this season, beginning probably the latter part of June.

Plum Point Reach (147–186 miles below Cairo).—Under this title works of improvement have been executed at various points between Daniels Point and Craighead Point, a distance by river of about 20 miles. They are fully described in previous report. During the current fiscal year the improvement of the reach has been continued by the construction of new revetment in Ashport Bend, and by repairs to the revetment at Daniels Point and Fletchers Bend.

Ashport Bend.—The shape and position of the bank line in this bend exert a controlling influence on the effectiveness of the works of improvement lower down in the reach, and its protection against caving formed a part of the original project for the improvement of this reach. Revetment was commenced in 1882, at the upper end of the bend, but was suspended after 2,694 linear feet had been built, in order that the plant and funds designed for this point might become available for other works which had developed into greater urgency in the course of the same season. No steps were taken to resume the work till 1890. In that year an allotment was made to begin the revetment, and in the following year a second allotment of sufficient amount was made to complete the protection of the entire bend. Work was commenced late in the fall of 1891, and 3,250 linear feet of revetment was placed before the end of the season, beginning at the upper end of the bend. During the following high water as much as possible of the riprap stone required to complete the work was purchased and stored on the bank. The revetment work was resumed early in August of 1892, and actively prosecuted until the close of the season in February, 1893. Two mattress ways had been provided, and with these it was hoped to complete the revetment of the entire bend before the end of the season, but the withdrawal of one of the ways for the repairs at Daniels Point in October made this impossible. Good progress was, however, made with the one plant, and 8,504 feet of revetment completed before the end of the season, leaving about 4,000 feet of bank at the lower end of the bend yet to be protected.

Grading.—The most difficult feature of the work was the preparation of the bank for paving above low water. For a distance of over 1,000 feet in the vicinity of Mud Point the composition of the bank was of a treacherous nature, causing the bank to cave or slough off in large blocks, giving the bank line a very irregular shape of salients and reënterings. But little grading was possible here, and but little was done. There was, however, along the greater portion of this bank a natural slope of about 1 on 2½ to 1 on 3 from the low-water line up to the level of the 15-foot contour, on which the shore protection could be placed without grading. Below this point the bank line was uniform in shape and direction and favorable for grading. The grading was, however, slow and tedious on account of the large number of old cypress stumps encountered at all points of the graded slope, being the relic of an old cypress swamp, which the surface deposit of the present bank entirely covers and conceals. At one point there were 74 stumps in the graded slope along 300 feet length of bank, and this was by no means the most thickly wooded portion. Grading opposite two of the mats was done before the mats were sunk, but with very unsatisfactory results, as the bank sloughed badly at the water line. Resort to hand dressing, at considerable expense, was had to establish a suitable slope for the riprap paving. After this the grading was done after the river mats were sunk, and with much more satisfactory results, there being but little caving or sloughing after the pockets under the shore edge of the mats had been filled up by the material which was washed down from the bank by the hydraulic jet. The grading was done with large graders Nos. 2 and 4. One month was lost with grader No. 4 on account of a bursted steam cylinder. The two large pumps were taken off and four pile-driver jet pumps were put on instead, and gave good satisfaction during the remainder of the season. To expedite this work, both graders were worked at night between September 28 and October 26, by the aid of a Wells lamp. In November grader No. 4 was transferred to Daniels Point.

River mats.—Construction was commenced with river mats of the width heretofore used, viz, 200 feet, as one of the mattress ways would not permit the construction of a wider one. After 3,952 feet of mat had been built of this width, a new and larger mat-ways was procured, and the remainder of the mats were constructed with a width of 240 feet.

Late in the season, while work was in progress, I received the resolutions of the Commission directing certain changes in the construction of the mats. The resolutions were: (1) "That under-water mattresses shall be thickened by a layer 3 or 4 inches thick of fine brush to make them less permeable; and (2) that the district officers be authorized to experiment on constructing the outer 50 feet of mattress so as to be more flexible, in order to follow the caving of the bank."

The first resolution doubles the amount of brush required in building a given length of mat, and as the brush supply was already inadequate for the ordinary form of construction, causing delay and loss, it was deemed impracticable to carry out the resolutions to the full extent and at the same time build the amount of mattress that was necessary in order to close the gaps between the mats already placed.

When the second mat party was withdrawn from this work for Daniels Point, there existed a long gap between the revetment placed by it and that of the first party, which had to be closed before the end of the season or have an unprotected interval which would be liable to cave back during the succeeding high water and destroy the free ends of the mattress. It being deemed unsafe to leave such an unprotected interval at this point, and it being impossible to close it if the resolution was fully carried out, it was complied with only to the extent of placing an extra layer of brush on the inshore edge of the mat for a width of 40 to 50 feet. Special care, however, was taken here and at other points, to weave the brush more closely than had been the custom heretofore, to connect the top and bottom grillage more securely, and to strengthen the mat lengthwise and crosswise by a more liberal use of steel-wire strand. The mats are believed to be better in every particular than any heretofore built of the same type of construction in the First and Second Districts.

The following are the river mats built during the season:

Mat No. 1.—1,090 feet long, 200 feet wide.

Mat No. 2.—1,038 feet long, the upper 695 feet being 200 feet wide, the remainder 240 feet wide.

Mat No. 3.—Length 1,045 feet, width 200 feet.

Mat No. 4.—Length 989 feet, width 240 feet.

Mat No. 5.—Length 1,122 feet, width 200 feet.

Mat No. 6.—Length 1,103 feet, width 240 feet.

Mat No. 7.—Length 421 feet, width 240 feet. This mat covers the softest part of Mud Point, and has an extra layer of brush over the whole width of mat for a distance of 300 feet.

Mat No. 8*a*.—Length 830 feet, width 240 feet.

Mat No. 8*b*.—Length 866 feet, width 240 feet.

The above is the order in which the mats were built. Geographically they are differently located. The mat farthest downstream is No. 5, and the one next above it No. 8*b*. The latter was built under difficulties, on account of cold weather and ice, and it was found necessary to sink it, on account of ice, before it had been given the length necessary to overlap the head of mat No. 7, thus leaving a short unprotected interval between them.

Connecting mats.—Of these 31 were made, in lengths of from 75 to 400 feet, and widths of 40 to 120 feet. They overlap the river mats about 25 feet, and extended up the bank to the level at which the water line stood at the time they were built. They were built of two thin layers of brush at right angles, with top and bottom grillage poles securely wired together.

Paving.—The paving begins at the low-water line and extends up the graded slope, terminating at a level of about the 18-foot stage. It consists of a thin layer of quarry spalls, on which is placed a layer of riprap stone. At first the paving was given a uniform thickness of 10 inches, but was afterwards made with a thickness of 12 inches for a distance of 5 feet, measured vertically up the slope, then gradually reduced to a thickness of 6 inches at the top of slope.

Spur dike.—In order to break the force of the strong eddy which exists under Mud Point, three spur dikes have been commenced, each consisting of two rows of piles perpendicular to the bank. Owing to the rapidly rising river, they were not completed before suspension of work by high water.

Surveys and borings.—Before any revetment was built, the bend was carefully sounded along sections 100 feet apart, the soundings being referred to a permanently established base line on shore. The soundings were repeated after the revetment was built, and a third set over a portion of the mattress was taken, after the water had risen. The latter indicate a decided scour of the river bed along the outer edge of the mattress at the lower end of the work, and an undermining of a portion of it. Being taken at high water in a swift current, the last set of soundings are, however, not very reliable. A resurvey of the bend will be made at next low water, and it is anticipated that it will throw some light on the manner in which the current at high water acts upon a revetted bank. Test borings to ascertain the composition of the bank in the vicinity of Mud Point are in progress.

For further details see report of Assistant Engineer Aug. J. Nolty.

The cost of the work during the season, including all expenses incidental thereto, except office expenses, is as follows:

River mats	per square..	$4.276
Connecting mats	do....	8.17
Pocket mats	do....	5.90
Paving	per square yard..	.911
Grading	do....	.038
Cost per linear foot of protection		19.22
Amount expended on this work in 1891-'92		60,171.31
Amount expended on this work in 1892-'93		174,546.30
Total		234,717.61

Daniels Point.—As before reported, a continuous revetment, 5,300 feet long, was placed in this vicinity in 1889 to protect the bank at lower end of Canadian Reach, in which rapid caving had developed. The river mats were 200 feet wide, and were made continuous with the shore work, which also consisted of brush mats lightly ballasted with stone. After the flood of 1890 the upper end of the revetment was found to have been undermined by the caving of the unprotected bank above it, and some settling to have taken place in the shore mat at a point 300 feet below the head of the work. The settling had not been sufficient to rupture the brush work, and no repairs were made this season. During the flood of 1891 this settling had developed into a rupture of the mat, causing a deep pocket and leaving but a small length of revetment in place above it. An examination at low water failing to show that any of the original mat was in place, the break was repaired the same season by a mat 200 feet wide and 300 feet long, and shore work. It was intended, during the same season, to extend the revetment upstream 500 feet, but for reasons given in last annual report, this was not done.

After the flood of 1892, five breaks appeared, which, including the mat lost by undermining at the upper end of the work, involved the loss of over one-half of the original revetment. These breaks were as follows, beginning with the one farthest upstream:

	Feet.
Break No. 1, length	750
Break No. 2, length	330
Break No. 3, length	880
Break No. 4, length	560
Break No. 5, length	530

A careful survey at low water, with soundings along sections 100 feet apart, showed that considerable scour had taken place in the bed of the river along the outer or channel edge of the mat. At the upper end of the revetment depths of 100 feet below low water were found less than 200 feet from the shore, and the loss of mat in this vicinity was doubtless due to the scour which has here taken place since the mats were sunk. The scour was much less at the lower end of the revetment and the causes of breaks 4 and 5 are not so evident. These breaks were made the subject of a special report, dated September 21, 1892, and to repair them the commission provided the sum of $60,000 by transfer from the allotment for Gold Dust Dam, the construction of which was deferred until another season.

The preliminary work of repairing the break was commenced October 8 and mat construction October 13. Breaks Nos. 1, 2 and 3, having practically developed into one continuous break, were treated as such and covered by continuous mattress 1,940 feet long and 240 feet wide. Connecting mats were constructed to cover the pockets between the shore edge of the river mats and the water line. Pocket No. 5 was repaired by mattress 613 feet long and 240 feet wide, with connecting mat and shore paving. Authority having been obtained to experiment in the construction of a fascine mat, it was proposed to cover pocket No. 4 with a mat of this construction. After a study of the subject, it was proposed to build it as follows:

The fascines to be made 12 inches in diameter and in lengths of 50 and 100 feet, and tightly compressed and bound every 3 feet. These fascines were to be placed at right angles to the bank and were to form the woof of the mattress, pairs of longitudinal wire strand cables forming the warp. The top and bottom cables of each pair were clamped together every 3 feet by long cable clamps. On top of the mattress so built a grillage of poles was placed and tied down to the fascines by galvanized wire. The construction of the mat was commenced February 2, 1893, and was very slow work, the best progress made on any one day being about one-half that of the ordinary woven mat. After 173 linear feet had been built, the river became filled with heavy ice, crowding the mooring barges and the mats into an oblique position with respect to the bank. To prevent total loss, the unfinished mat was hurriedly ballasted and sunk the same day.

The experiment with this form of mat has therefore not been, on the whole, a success, but enough of it was built to demonstrate that it possessed two great advantages over the old form of mat, viz.: more flexibility and less permeability. The cost per linear foot of mat is of course some greater than that of the old mat, but the experiment was not carried far enough to enable me to give even an approximate estimate of its cost if used on a large scale. Further experiments in the construction of this form of mat will be made at New Madrid during the coming working season.

To aid in breaking up the eddy in the pockets formed by the breaks in the old mat, the spur dikes of piles were commenced as the water began to rise, but the river rose too rapidly to permit their completion before suspension of work by high water All work was discontinued March 1. The revetment will be extended up-stream about 1,000 feet during the coming season.

The cost of repairs of the past season was as follows:

River mat	per square..	$5.09
Connecting mat	do....	7.8112
Grading	per cubic yard..	.063
Paving	do....	1.995
Total expended		$54,016.52

Fletchers Bend.—A few unimportant faults in the old work were restored during the season and 4,807 square yards of work reballasted and 684 square yards of additional paving laid, at a total cost of $2,632.66. One of the projects for last season was the repair of a fault in the revetment of Section B, near its upstream end, but owing to the necessity of using the plant at other points, this could not be done. A special allotment of $15,000 has been made for repairing this break, to be done the coming season.

Gold Dust Dike.—The funds withdrawn from this work last season and applied in repairing Daniels Point revetment having been restored by a new allotment of $60,000 it is proposed to build the dam, or as much of it as possible, the coming season. The stone required has been stored on the bank in the near vicinity of the dam.

Bullerton Tow-Head.—The revetment along the channel face of Bullerton Tow-Head has been broken up in places during the past year. For some years after its construction it was not exposed to the action of the current, being protected by an outlying sand bar. This bar was scoured away during the flood of 1892, leaving the channel face of the tow-head exposed to a strong current. Being one of the first experiments in mat building in which mats only 100 feet wide were used, which widths have since been found insufficient, it is probable that the entire revetment will require renewal in the near future, and, in anticipation that a part of it will have to be renewed the coming season, an allotment of $100,000 has been made for this purpose.

Condition of the works in the reach.—The most serious injuries sustained by the works in the reach occurred, as above described, at Daniels Point, Bullerton Tow-Head, and Fletcher Bend. There has also been some further enlargement of the unrevetted gaps in the interrupted revetment in Fletcher Bend, but not of sufficient extent to require immediate repairs. The undermining of the lower end of the Plum Point revetment has also continued to a small extent. With these exceptions the works in the reach are believed to be in substantially the condition reported in the last Annual Report.

Results at Plum Point Reach.—The river was at a low stage from September 1 to December 15, with a minimum of 3.9 feet on the Cairo gauge. The least depths recorded in the reach were 7¼ feet in Gold Dust and the same depth at Island 30 crossings. All other crossings gave 10 feet or more.

SURVEYS, GAUGES, AND OBSERVATIONS.

Surveys.—A low-water survey of Plum Point Reach was made in September and of Helena Harbor in October. A survey of Nonconnah Rock was made in September.

During the construction period very careful soundings were made over the revetment works at Daniels Point, Ashport Bend, and Hopefield Bend, and the same sections were resounded during April, 1893, when the river was at a much higher stage. The results obtained from these surveys are noted in the description of improvement works at the above localities.

A low-water survey was made of Harris Crossing, just below New Madrid, Mo. This is a shoal locality, and at the time of the survey, October, 1892, there was a least channel depth of 7 feet, with the New Madrid gauge reading 5.7 feet.

In compliance with a resolution of Congress I had a survey made of the lower portion of Wolf and Loosa Hatchie rivers, Tennessee, using the regular survey party for this purpose.

Levee surveys.—During December, 1892, and January, 1893, surveys were made for a levee location along the upper portion of the St. Francis front. The length of levee surveyed was 30 miles, in two sections. The upper section was 22½ miles long, from Point Pleasant, Mo. (80 R), to Gayoso, Mo. (105 R), and the lower sections 7½ miles long from Barfield, Ark. (142 R), to the upper end of the Plum Point system of levees at Bear Bayou (151 R).

Discharge observations.—A single low-water discharge was taken at Memphis, Tenn., October 25, 1892, gauge 1.9 feet. The discharge in cubic feet per second was 116,756.

High-water discharges were taken in February and March, 1893, at Columbus, Ky., New Madrid, Mo., Fulton, Tenn., and Helena, Ark. The results have been reduced and forwarded to the secretary of the Commission. This flood was of only moderate proportions, the highest stage reached being below extreme high water—5.4 feet at Columbus and 6.3 feet at Helena.

A second flood in May, 1893, was 2 feet below high water at Columbus, and has reached the high-water mark at Helena. Parties were sent to all the above discharge stations to gauge this flood, and at some points the observations are still in progress. As soon as completed the results will be reduced and forwarded to the secretary.

Low water of 1892.—The river was at a low stage from September 1 to December 15, reaching its lowest the last of October. The least gauge readings were: Cairo, 3.9; Belmont, 2.7; Morrisons, 3.4; Cottonwood Point, 0.4; Fulton, 4.7; Memphis, 1.6; Mhoons, — 2.2; Helena, 1.2; Sunflower, 3.2.

These readings are some greater than for low water of 1891, being 1.5 greater at Cairo, 1.1 at Morrisons, 2.0 at Fulton, 0.6 at Memphis, and 0.9 at Helena.

Only 26 shoal crossings of under 10 feet depth were reported by pilots, against 42 reported in 1891. Of these 20 had less than 9 feet, 13 less than 8 feet, and 4 less than 7 feet, the shoalest at Harris being left.

Table of depths at shoal-water crossings, 1892, Cairo to White River.

Name of crossing.	Distance below Cairo.	Depth.	Date.
	Miles.	*Feet.*	
Wolf Island	26	7	Oct. 3
Beckhams	77	8	Sept. 5
Harris	79	6	Oct. 3
Point Pleasant	80	7	Sept. 20
Below Point Pleasant	81	8	Sept. 20
Darnells	82	8	Sept. 20
Cherokee	88	6½	Sept. 10
Stewarts	89	9	Sept. 10
Gold Dust	157	7½	Oct. 18
Island No. 30	162	7½	Oct. 18
Island No. 34	180	8½	Sept. 20
Centennial	203	9	Sept. 10
Island No. 40	212	7	Oct. 3
Fort Pickering	232	7	Oct. 3
Armstrongs	241	9	Sept. 6
Reeves	243	6½	Oct. 20
Scanlans	248	8	Oct. 20
Cat Island	253	8	Sept. 6
Norfolk	254	6½	Oct. 17
Peters	271	7½	Nov. 1
McCulloughs Tow-Head	272	9	Sept. 17
Hardins Point	288	9	Oct. 17
Montezuma	312	8	Nov. 14
Friars Point	319	9	Nov. 17
Henrico	382	7	Sept. 17
Scrub Grass	384	7½	Sept. 17

Lower St. Francis levee district.—This district includes the area which is subject to overflow by water escaping over the right bank of the river between Point Pleasant, Mo., and the mouth of the St. Francis River. Its length on a north and south line is about 125 miles and by river 218 miles. Its average width on an east and west line is about 25 miles. The area liable to overflow is estimated at 1,932,000 acres, of which only 217,000 acres, or 11 per cent of the total, is under cultivation. Local protection to about 41,000 acres of land in the vicinity of Osceola, Ark., is afforded by the levee, about 22 miles long, extending from Bear Bayou to Craighead Point, and which was built by the United States in 1886-'87, in connection with other works for improving the channel of the river in Plum Point Reach.

Above and below this levee the water is practically free to escape over the banks into the lowlands of the basin. The remnants of the old State levee, long since abandoned, which exist here and there along the whole length of the district, form no barrier to and retard but little the general escape of water over the banks.

The overflows of the past few years have been very destructive to the district, especially that of 1892, which, occurring very late in the season, made it impossible to make any crops whatever in many of the deeply-submerged localities. The present overflow promises to be quite as disastrous as that of 1892.

Realizing that a succession of such overflows would not only prevent any further development of the territory, but would lead to the abandonment of much of it that is now occupied, the inhabitants took prompt steps, after the flood of 1892, to organize themselves into a district for the purpose of building a levee. With great promptness both the Missouri and Arkansas sections of the overflowed area succeeded in obtaining from their respective legislatures at their last sessions laws by which they could form into levee districts, and when so formed to join together as one district, under one administration, for the purpose of building and maintaining the levees of the district without regard to State lines.

At present writing the levee boards and executive officers authorized by law have been organized, and steps have been taken for levying a tax. The rate of taxation is subject to a vote of the inhabitants of the district, and will be submitted to a vote on the 10th instant. Considerable opposition has been developed, and there is a possibility that no tax whatever will be levied. Should, however, the tax recommended by the levee board be adopted, the district expects to collect about $100,000 the first year.

To aid the district in constructing their levees the Commission have allotted the sum of $264,000, under the provisions of the act of July 13, 1892, to be expended in the fiscal years of 1893-'94, 1894-'95, and 1895-'96. As by far the greatest escape of water into the district takes place in the gap, 66 miles long, which exists between the high ground at Point Pleasant, Mo., and the upper end of the Plum Point Reach levee at Bear Bayou, it was proposed to expend the first year's allotment of $88,000 in beginning the levee at the upper end of the gap at Point Pleasant and extending it downstream as far as the funds would allow. The levee was advertised December 30, 1892, and bids opened January 24, 1893. Before advertising, the district officer was assured that the right of way would be freely given or promptly obtained, but after advertising and before the opening of the bids, notice was received that some of the landholders had assumed a somewhat uncompromising attitude regarding right of way and drainage questions, and having no assurance that the then local county levee board could adjust the questions satisfactorily and promptly, I recommended, for this and other reasons, that all the bids be rejected, and that the money be applied at the lower end of this gap, by extending the Plum Point Levee from Bear Bayou upstream as far as the funds would go. This project has been duly approved by the Commission and the Secretary of War. and all bids on the Point Pleasant location have been rejected and steps taken toward locating the levee above Bear Bayou. Owing to the overflow, which has prevented an examination of the locality and selection of the proper location of the levee, the work has not yet been advertised.

SECOND DISTRICT.

Hopefield Bend, Arkansas (227–230 miles below Cairo).—The revetment in this bend is over 3 miles long, extending from Mound City to Hopefield Point. The upper mile was built in the working seasons of 1882, 1883, 1884, and 1885, and has been protected from serious injury up to the present time by a sand bar which formed in front of it shortly after its construction. The lower 2 miles of the revetment, which was built in 1884, 1887, and 1888, has been subjected to the action of a very strong current since its construction, and numerous breaks have occurred since 1890, requiring extensive repairs to prevent the loss of the remaining portion of the work. The first break in this work occurred during the flood of 1890, and was repaired by a complete revetment, 762 feet long, built in the fall of 1890. Two more breaks occurred during the flood of 1891, one 2,750 feet long, at the head of the 1884 work, and the other, 600 feet long, in the 1887 work. Both were repaired in the season of 1891-'92. Five more breaks occurred during the flood of 1892, as follows, beginning with the one farthest upstream:

	Feet.
Break No. 1, length	300
Break No. 2, length	1,200
Break No. 3, length	700
Break No. 4, length	600
Break No. 5, length	1,400

To repair these breaks and to strengthen about 1,300 linear feet of mat not actually displaced, but which had become seriously weakened by decay of the brush in the vicinity of the low-water line, an allotment of $91,000 was made from the appropriation contained in the act of July 13, 1892. This sum, together with an unexpended balance and a small contribution from the allotment for repairs to existing works, sufficed to complete the repairs as contemplated. An examination of these breaks at these and other points at low water suggested that the revetments have been destroyed by one of the following causes:

(1) Insufficient width, which allowed undermining by scour at the channel edge of the subaqueous mats.

(2) Want of flexibility in the subaqueous mats, which prevented them from following the scour without rupturing.

(3) Want of compactness or too great permeability of the mats, by reason of which the material under the mat is scoured out, either by direct attack by the current through them or by the return flow from the saturated strata on a receding river.

To obviate these objections as far as practicable, the plan adopted for the last season's work was to make the mats as wide as the mat barges would allow (240 feet), to use smaller brush and weave it more closely than heretofore, to make the connecting mats much thicker and with greater lap over the river mats, and to protect the bank above low water by a layer 10 inches thick of riprap stone.

Work was begun August 26, 1892, and continued under favorable conditions till its completion January 11, 1893.

Break No. 1 (300 feet long).—This failure occurred near the low-water line and carried away all the upper bank revetment. The subaqueous mat was found unbroken, with the inshore edge of the connecting mats, which was originally a few feet above low-water line, in about 15 feet of water. Repairs were made with heavy connecting mats from 115 to 180 feet wide, and a complete bank paving.

Break No. 2 (1,200 feet long).—This was in the work of 1887. The current in front of it is exceedingly strong and close to the bank. Upon examination at low water the river mat was found, in a number of places, at 50 to 100 feet out, but at other places it could not be found. The extent of caving was slight, and for nearly the entire length the top portion of the revetted slope was standing. This break was repaired with a complete revetment 1,200 feet long.

Break No. 3 (700 feet long).—This break was at the lower end of the 1887 work, and occurred just under a steamboat which had for some time been anchored along the bank. The break for a length of 300 feet and about 60 feet back occurred in twenty-four hours. Its subsequent enlargement was gradual. No river mat could be found in the middle of the break, and where found, near the ends, it was badly broken. The cave extended under the river mat of 1890, the head of which was found along the bank. Repairs here consisted of a river mat 750 feet long, with connecting mats and paving.

Break No. 4 (600 feet long).—This was in the 1888 work, and consisted of a series of small breaks along the low-water line. In places the revetment was unbroken, and at no point was the inshore edge of the river mat over 30 feet from the low-water line. Along this break is a stratum of blue clay a few feet above the zero line, with strata of fine sand above and below. Numerous springs come out of the stratum of sand above the layer of clay, undermining the sand beneath and making large holes under the brush work, allowing the mat to settle down, and at times causing ruptures in the mat where the settling is considerable. The repairs were made by heavy connecting mats of from 65 to 110 feet in width and paving.

Break No. 5 (1,400 feet long).—The first cave occurred inside of a large wharfboat lying along the bank near the upper end; a pocket 300 feet long and 75 feet back went out in a day. Afterward another pocket caved near the lower end, and both were subsequently enlarged until they nearly connected. The stratification of the bank described under Break No. 4 occurs here. The repairs made were 1,470 feet of complete revetment.

In addition to the above, 1,000 feet of the revetment above Break No. 4 and 300 feet of revetment below it were strengthened in the vicinity of the low-water line by mats 50 to 95 feet wide and some additional ballast on the upper bank work. There were no actual breaks in the revetment, but the brush work was decayed, more or less broken and displaced, and but lightly ballasted.

The work of the season included *grading*, length of bank 3,650 feet, contents 71,000 cubic yards; *wide river mats*, length 3,470, number of squares 8,253, length of bank covered 3,420 feet; *connecting mats*, length 6,200 feet, number of squares 5,416; *paving*, length of bank covered 4,970 feet, number of squares 3,120.

The average cost was—

Grading	per cubic yard..	$0.044
Wide-river mats	per square..	3.653
Connecting mats	do......	5.893
Paving	do......	11.70
Reballasting old work, 590 squares	do......	5.50
Total cost of work		101,639.36

Brush and poles were obtained by contract at 95 cents per cord for the brush and $1.50 per cord for the poles. The deliveries were at times insufficient, causing delays and loss.

Stone was obtained by contract from Williford, Ark., over the Kansas City and Memphis Railroad, one-half on the top of the bank and one-half on barges. The deliveries were prompt. The price paid was $1.85 per gross ton on bank and $1.70 on barges. The stone was limestone, of variable quality. From careful determinations, made by measuring the displacement of several barges loaded and empty, the weight of the stone was found to be 2,496 pounds per cubic yard.

For further details, see accompanying report of William M. Rees, the assistant engineer in local charge of the work.

As a preliminary step toward investigating the effect of the river current on a revetted bank, and ascertaining, if possible, the causes of failure in the revetments, the lower two-thirds of the revetment in this bend was sounded along sections 100 feet apart during the low water of 1892. The soundings were made with great care. Two barges, each 130 feet long, were lashed end to end and moored at a right angle to the bank along the section to be sounded. The soundings were made 10 feet apart along the upstream side of the barges, the positions of the soundings being indicated by marks on the sides of the barges. The distance of each sounding from the shore end of the barges was carefully measured, as was also the horizontal distance from the shore end of the barges to a permanent base line on shore. Given these measurements and the stage of water at the time the soundings were made, it was possible to construct very accurate profiles of the revetment, which can be used in connection with similar profiles to be made in the future for the purpose of ascertaining any changes that may take place in the shape or position of the mats at any point.

Comparative soundings were made over a number of sections along the old 1888 work in March, 1893, at a stage of river between 26 and 28 feet, and in a very swift current. Compared with the soundings taken last year at low water they appear to indicate that the mat has settled in places in the vicinity of the low-water line, and that the whole of the river mats at a few points have settled; but the later soundings are not submitted as conclusive as to the changes noted, since the current was too swift to permit soundings to be taken with any degree of accuracy. The extent of the settling can only be determined by an examination at next low water. There are known to be at present four new breaks in the stone work, but their extent cannot be ascertained until the water recedes.

To repair these and to renew the old revetments where wide mats have not been placed since 1890 an allotment of $100,000 has been made from the appropriation contained in the sundry civil bill of March 3, 1893. The work will be done during the coming low-water season.

To ascertain if the frequent failures of the revetment in this bend might not be due to a specially treacherous formation of the bank, 7 borings have been made 1,000 feet apart along the lower 7,000 feet of the revetment. The average depth of 6 borings was about 130 feet below the top of the bank, and 1 boring was carried to to a depth of 160 feet. Samples of the borings have been arranged and a full report will be prepared at an early date.

Memphis Harbor (230 miles below Cairo).—The outlying sand bar and the causes which have led to its formation, are fully described on page 3587 in the Annual Report of the Chief of Engineers for 1891. During the low water of 1890 the sum of $4,802.33 was expended in maintaining a channel through the bar to the Memphis Elevator. The channel so dredged was filled by deposit the following high water to a higher level than before, and in 1891 an allotment of $15,000 was made and expended in again keeping open this channel. Though the traffic to the elevator was at no time suspended in 1891, the maintenance of a channel to the elevator proved of but little value, as all but one of the boats landing at the elevator had gone to the bank on account of the extreme low water of that season.

The heavy deposit on the bar, which occurred during the flood of 1892, made it impracticable to attempt to reopen this channel again, and no work was done that season. No further dredging is recommended at the present time. The bar appears to have not yet reached its greatest development. In 1890 the tail of the bar had dropped down to a point 150 feet above the paved levee. During the flood of 1891 it advanced downstream about 450 feet, overlapping the paved levee about 300 feet, and a further advance of 160 feet took place during the flood of 1892.

The protection of the city front consists of 9,500 linear feet of revetment, of which the upper 7,500 feet is continuous mattress and the lower 2,000 feet is of the spur-dike system. No injuries have been noted to the spurs or the continuous revetment above it, both of which remain in serviceable condition.

Nonconnah Rock (236 miles below Cairo).—This so-called rock is located opposite the mouth of Nonconnah Creek and 3 miles below the Memphis Bridge. The distance from the Tennessee shore is about 700 feet and from Presidents Island shore 2,000 feet. For many years before 1890 the channel of the river occupied the space between the rock and Presidents Island, where the waterway was of sufficient width for all craft to pass without coming dangerously near to the rock. Since 1890 the channel has moved to the narrow way between the rock and the Tennessee shore. thus forcing all craft, especially heavy tows, to pass uncomfortably close to the rock at medium and low stages. The rock was surveyed at low water in October, 1891. and its contents found to be about 3,000 cubic yards above a plane 8 feet below low water. The top of the rock was 2.3 feet above low water. The material is a soft, ferruginous sandstone, easily pulverized under the hammer. To remove the rock to a depth of 8 feet an allotment of $6,000 was made August 4 from the appropriations contained in the act of July 13, 1892. The work was advertised November 1, 1892. and bids opened December 1, 1892, four bids being received, the lowest being $2.65 per cubic yard and the highest $4.95 per cubic yard. The lowest bid was accepted and the contract made, the work to be completed before November 1, 1893. No work has yet been done.

Helena Harbor (306 miles below Cairo).—The work of improvement consists of a continuous revetment 600 feet long and 5 spur dikes, protecting 3,000 feet of bank in front of the town. It was constructed in 1889-'90 under a specific appropriation of $75,000, contained in the act of August 11, 1888. The three lower dikes were not completed on account of lack of funds. No work has been done since. The cave or landslide which occurred after the flood of 1891 at the lower two dikes, which were not completed, and referred to in last Annual Report, has enlarged still further, but no repairs could be economically made short of rebuilding the dikes complete or substituting continuous revetment. No further work is recommended at the present time.

Levees.—The levees in the second district include the levees of the Upper Yazoo levee district on the left bank, Upper and Lower White River levee districts on the right bank, and a part of the Lower St. Francis levee district. The latter has been described in the report relating to the first district. Work has been done in all three of the first-mentioned districts under allotments of August 4, 1892, from the appropriation contained in the act of July 13, 1892.

Upper Yazoo levee district (244 to 365 miles below Cairo).—From an estimate made in the summer of 1892 the total area included in this district is 2,169,524 acres, of which 356,227 acres are under cultivation. The assessed valuation of cleared and uncleared lands is $10,708,000, and of all property, including lands, personal and other property, $15,184,000. The real value of all property is estimated to be over $29,000,000, or about $246,000 per mile of levee in the district. The levee is, in round numbers, 120 miles long, and, as compared with other levees on the river, is in a high state of efficiency, though not yet up to the standard of strength that will ultimately be required.

Up to the date of the last annual report about 28 per cent (33 miles) of the levee had been raised to the present standard grade of 4 feet above highest water, crown widths of 10 feet and minimum side slopes of 1 on 3, and with banquettes or bermes as buttresses to the bases of very high levees. The remainder of the levees which had not been brought up to this standard had grades of about 3 feet above high water, crown widths of 6 to 10 feet, and slopes of not less than 1 on 3.

To aid the local district in still further strengthening their levees the Commission alloted the sum of $400,000 to be expended, $100,000 annually, in the four fiscal years ending June 30, 1896. The portion of the levee which is subjected to the greatest strain is that included between a point opposite Helena, Ark., and the lower limit of the district at the Bolivar County line. The first year's allotment has, therefore, been expended in this locality. Work has been done at three points, viz: In enlarging existing levees in the vicinity of Burkes Landing (332 to 337 miles below Cairo), and at a point about 1 mile below Sunflower Landing (354 miles below Cairo), and in constructing a new loop at Pushmataha (359 to 360 miles below Cairo), where the old levee was threatened by a caving bank. The levees were advertised and bids opened October 8, 1892. Work was promptly commenced the same month and the levees completed before March, 1893.

The enlargement at Burkes was 4.3 miles (22,712 feet) long, contained 254,105 cubic yards of earth work, and was let in three contracts, at prices varying from 17½ to 18⅜ cents per cubic yard.

The enlargement below Hushpuckanna was 4,235 feet long, contained 40,618 cubic yards, and was let at 20 cents per cubic yard.

The new loop at Pushmataha was 7,205 feet long, contained 208,945 cubic yards, and was let in two contracts, at 18 and 16¾ cents per cubic yard, respectively. The total quantity of material placed under all the contracts was 503,668 cubic yards, at a cost of $92,833, or an average price of 18.4 cents per cubic yard.

As recommended in my project of October 31, 1892, and as approved by the Secretary of War, the second year's allotment is to be expended in the following manner: In enlarging 16,000 feet of the existing levee in mile sections 57, 58, and 59

(304 to 307 miles below Cairo), 12,900 feet in sections 60-62 and 63 (309 to 312 miles below Cairo), 16,700 feet of levee in the vicinity of Malones Landing (356 to 358 miles below Cairo), and 11,900 feet below Pushmataha Landing (360 to 365 miles below Cairo). Also in constructing a new loop 3,483 feet in length below Lake Charles (358 miles below Cairo), where the old levee is threatened by a caving bank. The levees were advertised December 30, 1892, and bids opened January 24, 1893. Formal acceptance of bids was deferred till after sundry civil bill of March 3, 1893, containing the appropriation, had become a law. One of the successful bidding firms having failed to make their contract, the levee awarded them has been re-advertised informally and contracted for with the successful bidder of the second letting. These levees are to be completed January 1, 1894.

The total amount of work contracted for under the appropriations for the fiscal year of 1893-'94 comprises the enlargement and construction of 11¼ miles of levee, containing 577,000 cubic yards of earth, and costing $89,902.50. The following table shows the amount of work done by the local levee board and the United States in this district to date:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	7,413,195
Added by United States up to May 1, 1893	503,448
Added by others up to May 1, 1893	439,106
Total to May 1, 1893	8,355,749
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	75,000
Aggregate remaining May 1, 1893	8,280,749

Upper White River levee district (306 to 340 miles below Cairo).—This district comprises the upper half of the narrow belt of overflowed land, about 10 miles wide, which lies between the Mississippi and White rivers and below the foot of Crowleys Ridge. The lower third of the district is but sparsely settled on account of the frequent overflows. The upper two-thirds, namely, that above Yellow Banks Bayou, constitutes the local district known as Cotton Belt Levee District No. 1. Its area comprises 157,000 acres of land, of which 50,000 are under cultivation. The assessed valuation of all property, real and personal, is $1,058,000, and its real value, not including the town of Helena, is estimated at $1,898,000, or $86,000 for each mile of existing levee in the district.

The existing levee begins at the foot of Crowleys Ridge above Helena, and extends downstream 22 miles to Yellow Banks Bayou. The grade varies from 1.5 to 3 feet above highest water, except along the lower two miles above Yellow Banks, which is much below a safe grade. By the allotments of August 4, 1892, this district received $50,000 for the fiscal year ending June 30, 1893, and $53,000 for each of the three years ending June 30, 1894, 1895, and 1896.

Believing that the local levee board was abundantly able to enlarge and care for the short levee in the district, the first year's allotment has been expended in enlarging the existing levee above Yellow Banks, which was much below grade, with the view of extending this levee southward from year to year, as appropriations become available, and to eventually close the White River front by forming a junction with the levees of the Lower White River levee district, which would at the same time be extended northward with the same object in view.

Bids were opened October 10, 1892, and 146,000 cubic yards of earthwork was awarded at 27 cents per cubic yard. After some delays, which were unavoidable, the contractors commenced work early in November. The work proved exceedingly difficult, and, hindered by boggy ground, heavy rains, and, finally, by the overflow, the contractors have succeeded in doing only about one-half of the work. The contract has been extended till August 1, 1893. The following table shows the amount of work done by the local levee board and the United States to date:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	1,374,191
Added by United States up to May 1, 1893	59,727
Added by others up to May 1, 1893	94,000
Total to May 1, 1893	1,527,918
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	....
Aggregate remaining May 1, 1893	1,527,918

The second year's allotment, as approved by the Commission and the Secretary of War, is to be expended in extending the levees southward as far as the funds will go, and the levee to be built has been contracted for, to be completed January 1, 1894.

Lower White River levee district (340 to 385 miles below Cairo).—This district comprises the lower half of the narrow belt of overflowed land between the Mississippi and White rivers. Above the Desha County line the country is but sparsely settled, on account of the frequent overflows. Below the Desha County line the district includes an area of 26,608 acres, of which 14,238 are under cultivation. The assessed valuation of all property, personal and real, is $193,500, and its real valuation is estimated to be about $568,000.

Not including the private Circle levee, which is maintained by private subscription, this district contained at the date of last Annual Report 19 miles of levee, beginning at a point below Henrico, Ark., and extending eastward and northward to the middle of the bend of Island 68. The upper part of the line above the Desha-Phillips County line, which was new levee, had been raised to a grade of 4 feet above highest water, while below the county line the grade was, on an average, only 1¼ feet above high water. Under the allotments of August 4, 1892, this district received the sum of $300,000, to be expended $75,000 each year for the four fiscal years ending June 30, 1896. The first year's allotment has been expended in part in raising and enlarging 30,630 feet, or about 5¾ miles, of the existing levee between Laconia and the county line to a grade of 3 feet at Laconia and 4 feet at the county line, and in extending the Carson Loop northward 11,800 feet by a new levee. The work was divided into five contracts and bids opened October 10 and October 24, 1892.

All the levees have been completed. The prices varied from 15 to 15¾ cents per cubic yard for the enlargement work, and from 16¼ to 19¾ for the new levees.

The total work of the season comprised 138,612 cubic yards of enlargement and 196,931 cubic yards of new levee, costing, including extras, $59,315.56.

The second year's allotment will be expended in extending the Carson Loop northward as far as the funds will go, and the work to be done has been contracted for to be completed January 1, 1894.

The following table shows the work which has been done by the local district and the United States in this district:

	Cubic yards.
Aggregate yardage of levees to June 30, 1892	855, 025
Added by United States up to May 1, 1893	335, 613
Added by others up to May 1, 1893	10, 000
Total to May 1, 1893	1, 200, 638
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	
Aggregate remaining May 1, 1893	1, 200, 638

PLANT.

Steamers.—New stacks have been placed on steamer *Titan* and cylinder timbers stiffened by athwartship braces.

Steamer *Graham* was docked, hull repaired and calked, cabin repaired and painted, furnace reconstructed, and a new wheel and cylinder timbers placed on her.

Steamer *Kirns* had cylinder timbers, hog-chain braces, transom, stem, and rudders renewed. This boat was sunk in an ice gorge at Belmont, Mo., on January 19, and proved a total loss, the boiler and part of machinery only being saved.

The *Itasca* and *Abbot* received minor repairs. The former has an iron hull, the bottom plates of which are very thin, and will require renewal in the near future.

The two large hydraulic graders were docked and repaired; the compound low-pressure pumps on one (No. 4) being badly damaged, were removed and replaced by four small pumps taken from the pile-drivers.

The two machine boats were docked and hulls thoroughly repaired.

Two quarter boats and three barges were also docked, repaired, and calked.

Minor repairs were made to 7 pile-drivers, four quarter boats, 5 mat boats, 4 mooring barges, 4 decked barges, and 4 flats. One district barge was cut down and converted into a flat, and the engine on sand-pump boat removed and sent to the fourth district for use there.

Repairs were also made to skiffs, tools, appliances, etc.

Eight model barges were loaned, by the courtesy of Maj. A. M. Miller, Corps of Engineers, and were used during the working season in towing stone from quarries.

The steamer *Minnetonka* and 43 barges were received by transfer from the general service. Of these barges, 15 only are in serviceable condition for hauling loads. The balance are quite old, having been built from nine to ten years ago.

Two mattress ways and two mooring barges were purchased of the Kansas City and Memphis Bridge Company. These were constructed from coal barges.

The detailed cost of the foregoing repairs is shown in the report of Assistant C. W. Sturtevant.

Four barges were lost by sinking and twelve have been condemned and dropped from the returns.

Contracts have been entered into for the construction of 29 decked barges 120 by 30 by 6 feet; 2 mattress barges 160 by 32 by 5 feet, and one for experimental dredge. Work on these has already begun, and it is expected that they will all be completed in time for use at the opening of the ensuing working season.

HIGH WATER OF 1893.

The relative heights of the high water of 1893, as compared with the highest known water at the various points in the First and Second districts, are shown in the following table:

Station.	Distance from Cairo.	Highest known.		Highest water, 1893.		Above or below highest known, 1893.
		Date.	Gauge.	Date.	Gauge.	
			Feet.		Feet.	
Cairo	0	Feb. 27, 1883	52.17	May 8-12	49.3	—2.87
Belmont	21	Feb. 23, 1884	45.80	May 10	43.8	—2.00
New Madrid, Mo	69	Feb. 24, 1884	41.52	May 11	38.6	—2.92
Cottonwood Point	123	Feb. 28, 1883	37.85	May 13	36.5	—1.35
Fulton	175	Mar. 1, 1882	36.69	May 15	34.6	—2.09
Memphis	232	Mar. 15, 1890	35.60	May 17	35.2	—0.4
Mhoons	275	Mar. 8, 1883	40.20	May 25	37.9	—2.3
Helena	307	Apr. 30, 1886	48.10	May 25	48.0	—0.1
Sunflower	353	Apr. 1, 1890	42.90	May 27	42.9	—0.0

As seen from the table the river has not reached an excessive height between Cairo and Memphis, but from Memphis down to the lower limit of the Second District at White River it closely approximated the highest floods known, being four-tenths of a foot below the highest recorded flood at Memphis, one-tenth below at Helena, and the same elevation as the 1890 flood at Sunflower Landing. At a point near Westover, 13 miles below Helena, a voluntary gauge observer reports a height of 3 inches above the highest flood known.

As yet there have been no crevasses in the First and Second districts, and as the river has fallen about 3 feet at Helena, it is confidently expected there will be none.

The levees in Arkansas, viz, those in the Upper and Lower White River Levee districts, have been held only by the exercise of the greatest vigilance and prompt and timely repairs of defects before they had assumed alarming proportions. To secure the necessary vigilance on the part of the people, Government aid was granted only in the event that the local authorities complied with two essential requirements in levee protection. First, that the levee be thoroughly patrolled, to guard against injuries to levees by trespassers, to keep off stock, to prevent landing of boats, etc.; and second, that the levee be divided into small lengths and each one put under the charge of a competent man, to inspect it, to discover and locate weak places, to make immediate repairs, if necessary, or, if time permits, to report to the engineer in charge for repair by a regular repair force.

Realizing the advantages and security which this method of coöperation afforded, the local authorities have carried out their part of the programme with energy, and with the aid extended by the Government, have been able to hold their levees against one of the most threatening floods ever experienced, and have averted crevasses which would certainly have occurred with any less degree of vigilance.

In the Upper Yazoo District the levees are under the control of a very efficient local levee board, and the only aid extended so far by the Government has been in the way of purchase of material, the local board providing the labor.

Respectfully, submitted.

S. W. Roessler,
Captain of Engineers.

Gen. C. B. Comstock,
President Mississippi River Commission.

APPENDIX 4 A.

REPORT OF ASSISTANT ENGINEER W. M. REES ON IMPROVING MISSISSIPPI RIVER AT HOPEFIELD BEND, ARKANSAS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., April 22, 1893.

CAPTAIN: I have the honor to submit my report on improving Mississippi River at Hopefield Bend, Arkansas, during the season of 1892 and 1893.

Description.—The lower portion of the revetment, 2 miles long, was built during the seasons of 1884, 1887, and 1888. The first break in this work occurred during the high water in the spring of 1890, near its middle, and was repaired by a complete revetment 762 feet long, built in the fall of 1890. The flood of 1891 caused breaks above this repair work to the extent of 3,350 linear feet, which were repaired during the season of 1891-'92. The remainder of the original work was in a weak condition, especially near the low-water line, and some repairs were made to the weakest places during the same season. It was then thought that all of this work needed a general strengthening. The flood of 1892 proved this to be necessary, for, upon its subsidence, breaks appeared at a number of places, an examination made on July 22, 1892, showing five distinct breaks. These are described as follows:

Break No. 1.—From station 18 to 21, 300 feet long. This was where the complete revetment of 1891 ends on the old work of 1887. The failure occurred near the low-water line, and carried away all the upper bank revetment. The lower work was found unbroken, with the inshore edge of the connecting mats, which was originally a few feet above the low-water line, in about 15 feet of water. Repairs were made with heavy connecting mats, from 115 to 180 feet wide, and a complete bank paving.

Break No. 2.—From station 28 to 40, 1,200 feet long. This was in the work of 1887, and was a stretch of bank projecting riverward beyond the average bank line, the projection being caused by the caving below in 1890, and above in 1891; consequently the high-water current along this location was exceedingly strong and near the bank. Upon examination the river mat was found in a number of places at from 50 to 100 feet out, but at other places it could not be found, so it is uncertain whether the failure was by undermining or by breaking near the low-water line. The extent of caving was slight, and for nearly the entire length the top portion of the revetted slope was standing. This break was repaired with a complete revetment 1,200 feet long.

Break No. 3.—From station 43 to 50, 700 feet long. This was at the lower end of the 1887 work, and immediately above the repair work of 1890. It was the first break of the flood of 1892, and occurred just under a steamboat which had for some time been anchored along the bank. The break, for a length of 300 feet, and about 60 feet back, occurred in twenty-four hours, and the subsequent enlargement was gradual. No river mat could be found in the middle of this break, and where found, near the ends, it was badly broken. This cave extended under the river mat of 1890, the head of which was found along the bank. Repairs here consisted of a river mat 750 feet long, connecting mats and paving.

Break No. 4.—Between Stations 68 and 74. This was in the 1888 work, and was a series of small breaks along the low-water line. In places the revetment was unbroken, and at no point was the river mat over 30 feet out from the low-water line. Along this break is a stratum of blue clay a few feet above the zero line, with stratas of fine sand above and below. Springs come out over the clay, undermining the sand beneath and making large holes under the brush work, letting it down and at times causing breakage. The repairs here made were connecting mats of from 65 to 110 feet width and paving.

Break No. 5.—From Stations 77 to 91, 1,400 feet long. The first breaking occurred inside of a large wharf boat lying along the bank near the upper end. A pocket 300 feet long by 75 feet back went out in a day; afterward another pocket caved near the lower end, and both enlarged until they nearly connected. The stratification described under Break No. 4 occurs here. The repairs made were 1,470 feet of complete revetment.

Between Stations 58 to 68 and 70 to 77 the revetment near the low-water line was in bad condition at numerous places, the brush work being decayed, more or less broken and displaced, the ballasting light, and below the low water the slope was often as steep as 1 on 1½. This entire stretch was covered with connecting mats from 50 to 95 feet wide, and the upper slope reballasted.

The construction of the original revetment was as follows: River mats of the usual woven type were 200 feet wide; generally sunk with their inner edge along zero contour, but in some places along the 1888 work. The inner edge is about at the 10-foot contour, making the width below the zero line about 175 feet. Connecting mats were of similar build, and were made continous with the bank brush work; the latter had a double layer of brush, and was ballasted with stone of sizes from 20 to 200 pounds, the quantity used being less than 1 ton per square, as against over 3 tons now used in paving, so that spaces amounted to fully 75 per cent.

The weak points in this revetment, as observed, are: First, insufficient thickness of connecting mats. These cover a belt extending from 15 to 20 feet below low water to 5 to 10 feet above. The slope below low-water is frequently steep and the bank material mostly fine sand. Scour has frequently been observed under them, caused by the action of springs and wave wash of wind and passing boats. Second, insufficient ballast on bank work, exposing the underlying brush to air and moisture, and causing rapid decay. After three years, much of the brush work is thoroughly rotten. Third, insufficient width of river mats. In places where these do not reach practically to deep water, the work may fail by undermining. Fourth, it is probable that scour occurs through the mats at such places where the interstices are too large, and the underlying material easily washed.

Plans.—To make the repairs above described, the plan was: First, to make the river mats of sufficient width to practically reach deep water, being careful to leave no large openings in the work. Second, to make connecting mats much thicker and with greater lap on river mats. Third, upon a graded bank, with slope not steeper than 1 on 3, to place 3 inches of crushed stone and 6 to 8 inches of small riprap, closely packed.

Construction.—Work began immediately after the arrival of the first tow of plant, August 26, 1892, and was practically finished January 11, 1893. The season was favorable, and the river kept at a low stage, remaining below the 6-foot stage until December 15, when it began rising, reaching the 15-foot stage on December 24, and continuing above the 10-foot stage for about three weeks, when it began to fall, and reached the 1.8-foot stage on January 24. The first time lost by rain was on October 31, and total time lost by rain nine days. Ice began running on January 13, and continued eleven days, and again ran for two days on February 9 and 10.

Labor.—The supply was at all times plentiful. Whites, subsisted by the Government, were employed in nearly all the responsible positions. Most of the common laborers were negroes, and subsisted themselves. They were good laborers, steady, and submissive, and preferable to the shifting white laborers formerly employed. The price paid was $1 per day and subsistence, or $1.25 per day to non-subsisting labor. The day worked was eight hours, and the price the same as paid in the vicinity for ten hours' work. The maximum force employed was 245 common laborers.

Materials.—Brush and poles were obtained by contract at 95 cents per cord for the former and $1.50 per cord for the latter, and the source of supply was from 6 to 25 miles above the work. The deliveries were at times insufficient, causing delay and loss.

Stone was obtained by contract from Williford, Ark., and delivered—one-half on top of bank and one-half on barges. The deliveries were prompt. The price paid was $1.85 per gross ton on bank and $1.70 on barges. The stone was limestone of variable quality, some containing much fine silica and frequently flint nodules. The riprap was in pieces from 20 to 100 pounds in weight, and crushed stone of dimensions to go through a 2¼ inch ring. Fifty-eight car loads, with weights determined, were loaded on four barges and carefully measured. The average weight per cubic yard thus obtained was 2,496 pounds. The measurements were checked by measuring the displacements of the barges, loaded and empty. This gave the weight of 1 cubic foot of river water 63.48 pounds, and 1 cubic yard, as measured, displaced 39.3 cubic feet of water.

Grading.—The bank was graded to a slope of 1 on 3, or flatter, and in the pockets this slope was not carried to the top of a bank, a shoulder 6 to 8 feet high being left.

Hydraulic grading began August 29, and the last grader finished work November 26. Three graders were used, being the same plant as employed last year, viz, grader No. 40, having a Gordon & Maxwell condensing duplex pump with 20-inch steam cylinders, 10-inch plungers, and 12-inch stroke, pile-drivers No. 20 and No. 59, each having Worthington compound duplex pumps with 16½-inch and 10-inch steam cylinders, 6¼-inch plungers and 10-inch stroke. Grader No. 40 threw two streams and the others one each. The hose was 3-inch diameter, 8-ply rubber, each line 150 feet long, with nozzles seven-eighths inches diameter. When properly working a water pressure of 160 pounds per square inch at the pumps was maintained on all the graders, with steam pressures of 80 to 85 pounds.

Prior to grading the bank was cleared of timbers, drift, and old mat work, and after grading with the pumps the grade was dressed by hand and stumps removed by blasting. This work cost nearly as much as the grading proper.

The cost in detail was as follows:

Grader No. 40:

Labor and subsistence	$1,178.28
Coal	349.00
Oils and engineers' supplies	43.63
Miscellaneous and repairs	140.96
Total	1,711.87

Time worked, 356 hours; time lost, 64 hours. Work done, 1,672 linear feet (36,062 cubic yards). Graded per hour, 101.3 cubic yards. Cost per cubic yard, $0.0475.

Grader No. 59:

Labor and subsistence	$1,034.11
Coal	313.80
Oils and engineers' supplies	23.32
Miscellaneous and repairs	24.72
Total	1,395.95

Time worked, 493 hours; time lost, 19 hours. Work done, 1,976 linear feet (35,312 cubic yards. Graded per hour, 71.6 cubic yards. Cost per cubic yard, $0.0395.

Grader No. 20:

Labor and subsistence	$273.98
Coal	80.00
Oils and engineers' supplies	2.57
Miscellaneous and repairs	33.69
Total	390.24

Time worked, 124 hours; time lost, 12 hours. Work done, 414 linear feet (10,106 cubic yards). Graded per hour, 81.5 cubic yards. Cost per cubic yard, $0.0386.

The excessive cost of No. 40 was due to the bad condition of the pumps; had they been in proper order they would undoubtedly have done cheaper work than either of the others.

The total hydraulic grading was 4,062 linear feet (81,480 cubic yards), and cost $3,498.08. Cost per linear foot, $0.86; per cubic yard, $0.0429. One thousand five hundred and eighty-two cubic yards was graded by hand, and the cost of clearing and hand grading was $3,022.20. The total work done preparatory to paving was 4,970 linear feet (83,062 cubic yards), at total cost of $6,520.28; cost per linear foot, $1.312; per cubic yard, $0.0785.

Subaqueous mattresses.—Mattress construction was begun on September 15 and continued without interruption until November 4, when the last mat was sunk. No change was made in the method of construction. The brush used averaged some smaller than heretofore, and was woven as close as practicable, so as to leave no large openings. The mat was also better wired and cabled, fully one-third more wire and strands being used per unit than last season. At every 16 feet along the bank and about midway up the slope, a cast-iron plate anchor (Nier's patent) was sunk by jetting to a depth of about 6 feet, and the three eighth inch transverse strands of the mat were fastened to them.

Four mattresses were sunk of the following dimensions:

No. 1:
- 1,000 by 240 feet.

No. 2:
- 440 by 240 feet.
- 80 by 200 feet.

No. 3:
- 620 by 240 feet.

No. 3—Continued.
- 36 by 220 feet.
- 94 by 200 feet.

No. 4:
- 1140 by 240 feet.
- 60 by 190 feet.

The variation in widths was caused by building around projecting points. They were all sunk under favorable conditions, and at stages between 2 and 5 feet above low water.

Total linear feet of mats made	3,470
Total linear feet of bank covered	3,420
Total squares made	8,253
Total squares bank covered	8,133

The cost in detail was:

Labor and subsistence	$7,854.92	7,369 feet lumber	$115.32
4,724.3 cords brush	4,488.09	Manilla rope	855.29
856 cords poles	1,281.00	Miscellaneous materials	65.85
800 feet piling	46.94	Sinking 261 Nier anchors	124.40
3,850 tons (gross) stone	6,545.00	Superintendence	959.35
53,102 pounds galvanized wire	1,423.24	Care of plant	1,308.81
44,385 pounds galvanized wire strand	1,762.00	Repairs to plant	837.75
2,009 pounds iron	45.05	Towing	1,859.46
2,400 pounds spikes	65.40	Miscellaneous expense	211.48
1,170 cable clamps	137.50	Total	29,989.81

Cost per square built, $3.633, and per square of bank covered, $3.687. The average quantities of material used in the construction of one square (100 square feet) was:

Brush ... cords	.572	Wire ... pounds	6.44
Poles ... do	.104	Wire strand ... do	5.40
Stone ... tons	.466		

Connecting mats.—Work on these was begun October 3, 1892, and the last piece sunk on January 11, 1893. Thirty-two pieces in all were built, on ways 200 feet long, and after being launched in the proper places were well cabled together and covered with a 4-inch layer of brush normal to the bank. In certain localities, where the slope was steep, additional layers were put on. Longitudinal top grillage poles only were used, and the whole well cabled together. These mats were sunk at stages between 2 and 10 feet, with their inner edges from 5 to 12 feet above low water, depending upon the nature of the bank and the time of sinking. They lap the river mats from 20 to 60 feet, with an average of about 40 feet. In addition to those placed along older work to strengthen it, these varied in width from 40 to 180 feet, the average width of all connecting mats being 87 feet.

Total linear feet made and sunk, 6,200; total squares made and sunk, 5,416.

The cost in detail was:

Labor and subsistence	$7,508.01	Manila rope	$228.77
7,128.1 cords brush	6,771.69	Miscellaneous material	4.75
535.3 cords poles	802.95	Superintendence	948.19
5,795 tons stone	9,874.29	Care of plant	1,308.81
35,880 pounds wire	923.37	Repairs to plant	837.75
4,857 pounds wire strand	227.96	Towing	2,143.21
650 pounds iron	12.43	Miscellaneous expense	211.48
3,000 pounds spikes	80.70		
2,600 feet lumber	32.50	Total	31,916.86

Cost per square, $5.893.

The average quantities of material used in the construction of one square was:

Brush ... cords	1.316	Wire ... pounds	6.60
Poles ... do	.099	Wire strands ... do	.90
Stone ... tons	1.07		

Paving.—This work began October 15, 1892, and was finished January 11, 1893. Progress was much retarded by the delay in connecting mat construction, and later in the season by bad weather. Paving began at or near the low-water line and extended to near the two-thirds stage, the upper edge being between the 20 and 24 foot contours, the height depending upon the nature of the bank material. Where this material was fine sand, as was usual near the lower slope, a layer of brush was placed under it, and, where no brush was used, from 3 to 4 inches of crushed stone, of dimensions to pass through a 2¼-inch ring, was placed as a foundation. Where the springs came out on the impervious blue clay stratum already described, the overlying fine sand was washed into a series of pockets. To remedy this, longitudinal trenches 2 to 3 feet deep were made, heeling on the blue clay, and filled with crushed stone. This appeared to prevent the sand movement, as the water came through clear.

The stones used in paving was smaller and of more uniform size than used last season, the pieces varying between 15 and 40 pounds. Besides the crushed stone, 395 cubic yards of river gravel were used. This was obtained by hired labor, and although costing less, it is not as good as the crushed stone. The average thickness of the paving was 10 inches, of which 3 inches was crushed stone and 7 inches riprap.

The linear feet of bank paved was 4,970; square feet of bank paved was 312,000 (34,667 square yards).

The cost in detail was:

Labor and subsistence	$7,498.59	Superintendence	$1,257.24
10,957 tons stone	20,130.59	Towing	565.75
395 cubic yards gravel	295.95	Miscellaneous expense	211.50
Miscellaneous materials	8.75		
Clearing and grading	6,520.28	Total	36,488.65

Cost per square foot, $0.117; per square yard, $1.05.

Repaving old work.—The low water exposed many bare places in the work of 1891, which had been constructed at a higher stage. About 1,000 linear feet of this was repaved, and 1,730 linear feet along the old revetment. The total work of this kind covered was 59,000 square feet to an average thickness of 6 inches.

The cost was:

Labor	$611.50
1,425 tons stone	2,422.50
Superintendence	150.00
Towing	60.00
Total	3,244.00

Cost per square foot, $0.055.

SUMMARY.

Work done.	Cost.	Cost per unit.
River mattresses, 3,470 linear feet (8,253 squares)	$29,989.85	$3.633 per square.
Connecting mats, 6,200 linear feet (5,416 squares)	31,916.86	$5.893 per square.
Paving, 312,000 square feet	36,488.65	$0.117 per square foot.
Repairing old work, 59,000 square feet	3,244.00	$0.055 per square foot.
Total cost	101,639.36	

SURVEYS AND EXAMINATIONS.

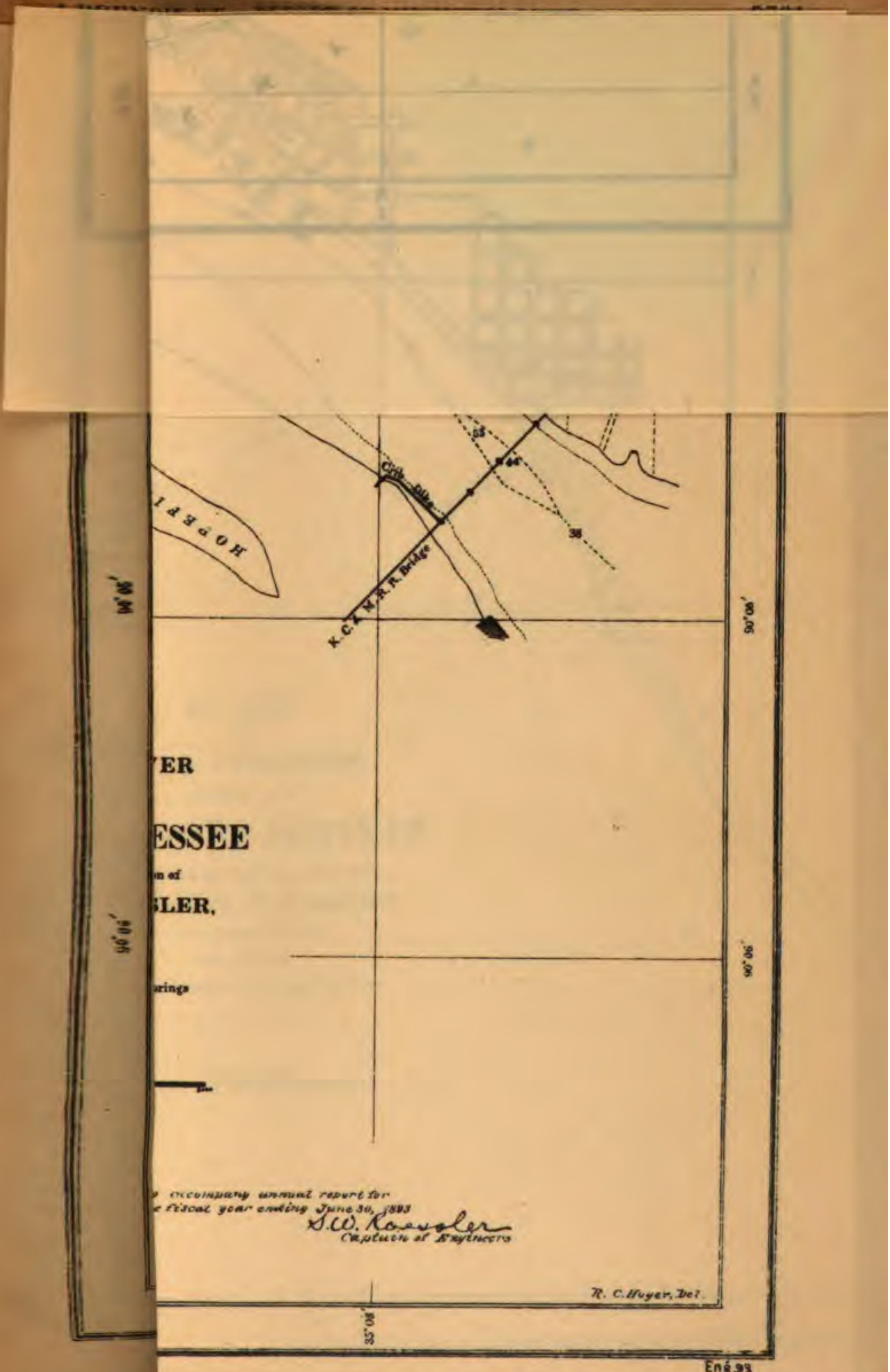
Soundings.—A line was run on top of bank, connecting with all stations of last year's surveys not lost by caving. Soundings were taken on sections 100 feet apart and perpendicular to bank line, and have been referred to low water and plotted on the map. The manner of taking soundings was as accurate as practicable; a pair of barges 270 feet long were lashed end to end and placed along the section line, and soundings taken with a carefully graduated and checked lead line at each 10 feet, and at stages between 3 and 5 feet, and when the current was very slack. The cost of making this survey was $410.82.

Comparative soundings were made over a number of sections along the old 1888 work in March, 1893, at a stage of river between 26 and 28 feet, and in a very swift current. They show greater depths of from a few to 20 feet, the greatest increase being near the low-water line. That the work is broken in some localities is shown by caving along the bank. At other places it appears to be unbroken at the low-water line, but to have settled. At two places the failure appears to have occurred in the paving just above the connecting mats, and where the bank is of sand. That the river mats have settled is evident, but whether this is due to undermining and slipping riverward or to scour through the mats can only be determined by careful examination at a lower stage of water. All the sections showing decided change are along subaqueous revetment of 1888. Not enough sections were re-sounded over new river mats to make a comparison.

There are four breaks along the revetment at this writing, but their nature and extent can not be determined with much accuracy until the water recedes. They are all along the old (1888) revetment, and each break appears to be about 300 feet long, but the present high water will, beyond doubt, increase their extent.

Borings.—Tools and appliances for making test borings were made and work started on January 2, but after a few days was discontinued, to make other tools, and, on account of bad weather, not resumed until January 23. This work is still in progress, and will be reported upon when finished. Sufficient borings have been made to show that the bank formation is principally sand, varying in fineness in different holes, and always finer near the low-water line than at greater depth, where more coarse gravels and clays are found.

The recent failures indicate that a decided change should be made in the manner of construction. While there is no definite proof to show that failure is due to undermining from the outside, many cases have been observed where the first break



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ing was at or near the low-water line, leaving both upper and lower portions of the revetment in place. The bank here, being steeper and more irregular in slope, the revetment fails either at weak points, where it may have been broken by bending over obstructions, or by scour through it. I would, therefore, respectfully suggest:

That the grade be reduced, say to 1 on 4, especially at the lower part of the slope; that the brush work be made much thicker for a distance of 150 to 200 feet out; that more brush work be used under the paving, where the material is fine and there is a tendency to uneven settling of the pavement or to scour through it; that the river mats be made wider, to prevent any possible undermining from the outside, and that crib dikes of sufficient length and height be placed along such portions of the bank where the slope under the zero contour is steeper than 1 on 3.

The above scheme would require a river mat 300 feet wide, another on top of this 150 to 200 feet wide, a connecting mat about 75 feet wide and 1 foot thick, and, along steep banks, a crib about 200 feet long by 12 feet high as a maximum for each 250 feet of bank. The two river mats could be more rapidly placed (I think as cheaply), and they would certainly be better than to increase the thickness of one river mat with additional layers of brush.

The cost for a complete revetment of this description would be, per linear foot:

River mats, 5 squares, at $3.50	$17.50
Connecting mats, ¾ squares, at $6	4.50
Paving, 75 square feet, at 10 cents	7.50
Cribs, 200 cubic feet, at 3 cents	6.00
Total	35.00

Accompanying this report is a map of the work and a tabulated statement of expenditures.

Respectfully submitted.

W. M. REES.
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

APPENDIX 4 B.

REPORT OF ASSISTANT ENGINEER AUG. J. NOLTY ON OPERATIONS AT PLUM POINT REACH.

UNITED STATES ENGINEER OFFICE,
Amelia, Ark., April 25, 1893.

CAPTAIN: I have the honor to submit my report of operations at Plum Point Reach for the ten months beginning with June 1, 1892, and ending March 31, 1893:

The only work in progress at the beginning of the period was unloading stone at Ashport Bend and Elmot Chute as fast as received from the quarries. This work was continued until September, by which time there had been unloaded 34,528 cubic yards of stone and 1,186 cubic yards of spalls.

There were received during the same period 40,538 cubic yards, the excess of receipts over the quantity unloaded representing stone used on the works directly from barges. At such times, when no stone was on hand, the unloading party were employed in clearing a strip of bank in Ashport Bend, along the site of contemplated operations.

Revetment, Ashport Bend.—Three thousand two hundred and fifty feet of the upper part of this actively-caving bend had been revetted the previous season. The work of extending this revetment downstream was begun on the 1st of August, upon which date a small party was put in the field to cut brush and poles sufficient to begin construction of a floor mat for Pocket No. 1, formed just below the termination of the previous year's work. The caving, which usually takes place at the foot of a revetment, had formed here a pocket 120 feet deep, measured from the general bank line back and 400 feet long longitudinally, forming a crescent-shaped pocket. Four mattresses were constructed and sunk so as to entirely cover the bottom, and extending outstream far enough to be well overlapped by the regular river mat to be subsequently built. The part of the bank above water was revetted up to the mid-stage line.

Most of the brush and poles used for this work were obtained by hired labor, as, owing to the still high stage of the river and consequent uncertainty as to when full operations would begin, it was not deemed advisable to order the brush contractors out.

Pocket No. 2, situated 1,350 feet below No. 1, and whose dimensions are 135 feet deep and 420 feet long, was treated in the same manner as No. 1. Five floor mats were put in here. No further caving or sliding has taken place here, but in Pocket No. 2 the soft material is at one place beginning to flow over the shore mat.

In the meantime a part of the force were engaged in doing the preliminary work for River Mat No. 1, such as driving abutment and anchor piles, getting out lines and cables, putting in dead men for head lines, etc.

River Mat No. 1.—The plant for this mat was swung out on August 16 and the mat sunk on September 2. It is 1,090 feet long by 200 feet wide, and beginning at Station No. 32, or 50 feet above the termination of the previous season's work, runs to Station 42.90. The reason that the point of beginning was placed 50 feet above the old work was that, on account of the formation of Pocket No. 1, the lower end had been somewhat damaged. No difficulties were encountered, either in construction or sinking.

River Mat No. 2.—The outfit for this mat was swung into position on August 30 and the mat sunk on September 15. This mat has a total length of 1,038 feet, and when 695 feet of its length had been constructed of the usual width, *i. e.*, 200 feet, orders were received to henceforth make all mats, as far as practicable, as wide as the mattress barges would permit. The outfit in use here permitted a width of 240 feet; hence the width was increased 40 feet and completed at that. This mat is therefore 200 feet wide for the first 695 feet of its length and 240 feet for the last 343 feet. No difficulties were met with, either in construction or sinking. The starting point is Station 55.50 and termination is Station 65.88.

River Mat No. 3.—The party constructing this mat swung into position on September 6 and sank it on the 22d of the same month. Beginning at Station 76.36, it extends down to Station 86.80, making its length 1045 feet. Its width is 200 feet, only one mattress plant having capacity for a greater width having been available. Construction and sinking were accomplished without difficulty.

On this and subsequent river mats, except No. 7, No. 8*a*, and No. 8*b*, the inner 25 or 30 feet of its width received an additional layer of brush. This layer was laid normal to the long axis of the mat and tied down by the top grillage poles. The object of this change was to obtain additional thickness of mattress along the low-water zone, where, as has been repeatedly demonstrated, rupture of the mat first takes place. This change in construction required an additional expenditure of one cord of brush to every 10 feet of mat, but nothing else, as the poling gang had sufficient leisure to place the brush.

River Mat No. 4.—This mat begins at Station No. 45.84 and extends downstream 989 feet, or to Station 55.75. It covers the greater part of the sliding bank, though not the worst part, below Mud Point (Stations 44 to 55.) Its width is 240 feet. Begun on the 19th of September, it was sunk successfully on the 7th of the following month. No trouble was encountered in its construction, but the first abutment was lost by the sudden subsidence of a large block of bank, necessitating the driving of a second one. More information in detail further on. Upon the completion of this mat the plant heretofore used by this party was transferred to Daniels Point.

River Mat No. 5.—This mat was begun on the 26th of September and sunk on October 14. It covers the space between Station 104.48 and Station 115.70, being 1,122 feet long and 200 feet wide. It was at first contemplated to make this mat much longer than the previously-constructed ones, and with this object in view anchor piles were driven for more than 2,000 feet downstream, but, agreeably to your orders to exchange the 200-feet mat barge in use here for a longer one then available at Hopefield Bend, the mat was launched off after attaining the length given above. In the meantime it was decided that, as now there was only one mattress outfit available for Ashport Bend, and considerable mattress work remaining to be done above No. 5, the work should not be extended downstream until all mat work above had been completed.

River Mat No. 6.—This mat, which is 1,103 by 242 feet, extends from Station 65.48 to Station 76.51, and covers the space between mats No. 2 and No. 3. It was begun on October 13 and was not sunk until the 12th of the following month. Bad weather and frequent scarcity of brush were the retarding causes. The mat was completed and sunk without any mishap.

River Mat No. 7.—This mat covers the worst part of the Mud Point Bank, and extends from the foot of No. 1 to the head of No. 4. The construction was rather difficult, as the mat had to be built in a curved form in order to follow as closely as possible the shape of the bank. Its mean length is 421 feet and width 242 feet. The preliminary work was completed by the 14th, but owing to scarcity of brush the plant was not swung into position for weaving until the 18th. In order to obtain a close and thick mat for this part of the bank, an extra layer of brush was placed for the entire width on top of the woven layer, the usual grillage being placed on top of this extra layer. This double layer, though contemplated for the entire length, could not be carried further than for a little over 300 feet, as the brush supply was entirely inadequate, and to continue the double layer to the end of this mat would have caused too long a delay in starting the next mat, for of course the mooring barges would not be available until No. 7 was sunk. The top layer in this case was laid longitudinally, or up and down stream, in order to bring it nearly at right angles to the bottom or woven layer. Another innovation was that the longitudinal strand cables were doubled and each one alternately passed under and over the mat for each shift or launch. Thus each pair of cables crossed themselves about every 25 feet, the pair forming long loops of a chain within which the brush lay. The additional layer over the whole width of mat increased its cost considerably, not only in material, but also in labor. To put the extra brush on the mat from the weaving barge would have retarded the progress of weaving; therefore an extra barge of brush was placed on the outside of the mat and the brush distributed from thence. This involved a long carriage of the material and frequent shifting of the run plank over which the men walked. Wiring together of the top and bottom grillage and the fastening of the longitudinal and transverse strand cables was also rendered more difficult by the increased thickness of the mat. This form of mat required for each square 6 cords of brush and 4 cubic yards of stone above that required for the ordinary construction. This mat was sunk without any difficulty.

River Mat No. 8a.—After river mat No. 7 had been sunk there remained a gap of about 1,800 feet in the subaqueous revetment, namely, from Station No. 86.60 to 104.48, the latter being at the head of river mat No. 5. It was intended to make one continuous mat to cover this space, but by the time 830 feet had been completed, the river, which had been rising slowly for several days past, began rising more rapidly, bringing down considerable drift. In anticipation of the latter, a drift boom 600 feet long had been placed about the mooring barges and this held or deflected most of the drift from the mat. Still, as reports from above indicated the coming of considerable more water, it was decided to sink what mattress was then afloat, and this was successfully done. River mat No. 8*a* was begun on the 2d of December and sunk on the 24th. It is 830 feet long by 240 feet wide. Construction was somewhat retarded by the rapid rise and heavy run of drift. The drift boom was held by a 1-inch steel cable, but the accumulation of drift become so great that at 4 a. m. of the 22d, this cable parted, letting the boom barges swing in against the mooring barges. No damage was done, but it required the united efforts of the *Minnetonka* and a force of men on two capstans to haul the boom back into position.

River Mat No. 8b.—The plant for this mat was swung into position on January 2, by which time drift had about ceased running. Construction was carried on rapidly until the 13th, when floating ice was first noticed in the river. The run of ice increased rapidly during the day, and it was decided to sink this mat at once This was accomplished without difficulty, although the river was bank-full of heavy ice, the drift boom, which had been put out where the mat was begun, sheering off the ice nicely. This mat, when sunk, lacked 100 feet of lapping over river mat No. 5, and this small gap in the subaqueous revetment still remains, as there has been no opportunity since to close it. No damage, however, is apprehended from the small gap. No. 8*b* is 866 by 245 feet, and begins at Station 94.74, ending at Station 103.40.

River Mat No. 9.—The only work done for this mat was the driving of the abutment and the anchor piles for 1,000 feet. This was done in the earlier part of the working season, and before one revetment plant was ordered to Daniels Point. This work will all be lost. Its cost was small.

The total length of all river mats made here during the season is 8,504 linear feet, of which 3,952 feet is 200 feet wide, the balance being 240 feet or more. The total length of bank having subaqueous revetment, inclusive of the 1891 work (3,200 feet), is 11,704 feet, the excess in length of mattress made over bank covered being due to overlap. As noted under the different mats, very little difficulty was met with in construction, and none in sinking. Had there not been a partial failure in the brush supply, and serious interruptions from running ice, about 1,000 feet more of mattress might have been constructed with the available plant. It is believed that the mattresses just described are the very best ever constructed at Plum Point Reach, as particular pains were taken to compress the brush as it was being woven. The extra layer along the inner edge also improved the mats, as it gives them increased strength and thickness where most needed.

A better plan to obtain this result would be to construct a supplemental mat of 50 feet or more in width for the entire length of the main mat and sink this so as to lap over the latter 25 or 30 feet. This supplemental mat could be so laid that no connecting mats would be necessary, but the paving could start from the inshore edge of the small mat. In some cases, as for instance passing over a scallop in the bank, a small connecting mat would be necessary, but in most cases the supplemental mat could be built so that its inner edge would be above water, and the paving connected directly with it, without the additional connecting mats. These mats could be made quicker and cheaper and stronger than the ordinary connecting mats.

Connecting mats.—Of these, which were constructed and sunk as fast as the river mats were down and the bank graded, there were made 31, varying in length from 75 to 400 feet and in width from 40 to 120 feet. The variations in width are due to the different stages of water prevailing during construction, for the inner edge of river mat in nearly all cases lies along the zero line, and the connecting mats overlap the former 25 feet or more with the inner edge resting upon the dry slope. Hence, at a high stage, the connecting mats are necessarily wider than at a lower stage. The standard dimensions during the prevalence of a low stage of water are 240 feet in length and from 40 to 50 feet in width. Owing to the nonavailability of the regular weaving barges, a large number of these mats were made from two 100-foot barges, lashed end to end.

These barges held up the outer end of the grillage poles, and as fast as these were extended and the brush laid upon them the barges were pushed outstream until the required width was obtained. The other ends of the poles rested on the dry bank. Two layers of brush placed perpendicular to each other were used, the whole tied down by the top and bottom grillage. Where a weaving barge was available, these mats were made similarly to the regular river mats, except, of course, that the weaving poles were normal to the bank instead of parallel to it. One connecting mat, begun in January at Mud Point, had to be abandoned before completion, as soon as the ice began running, as the plant was lying in a very exposed position. This work was destroyed by the ice.

It being considered necessary to finish the protection of this part of the bank, another mat was started on February 17. As the river was then already quite high (19.75, Ashport gauge) and rising rapidly, it was decided to construct this connecting mat as a river mat. An abutment, mooring and mat barges, and steel cables were used precisely as in a large mat, and a drift boom placed across the head. Before the mat was completed, the river had attained a stage of 27.25, Ashport gauge, and the entire bank was submerged, with the river full of drift. The mat was successfully sunk on the 24th of February. Its length is 237 feet, and width 120 feet.

Owing to the large amount of preliminary work, such as driving abutment, driving anchor piles, putting in dead men for head and shackle lines, putting out drift boom, etc., the cost of this mat will be found to be high, but this was the only way it could have been constructed and sunk. Some idea of the velocity of the current may be obtained when it is mentioned that the *Graham*, going full head, was unable to push unaided a barge loaded with 100 yards of stone up to the head of the mat.

Floor or pocket mats.—These mats, of which there were sunk five in pocket No. 1 and four in No. 2, were put down for the purpose of covering the bottom of the pockets. They extended outstream far enough to be overlapped 25 feet by the regular river mat to be subsequently sunk. Their construction was similar to that of the river mats, but owing to the shape of the pockets they had to be made of small size and odd shaped, so as to completely cover the bottom. The method employed was first to build one large mat, beginning at the upper point of the pocket and working downstream until there was just room enough to get the mattress barge out. This was then turned around and a piece built by working upstream until a good lap over the first one was obtained. Smaller mats were then fitted in between the bank and the two first ones, the small ones extending well up the dry bank from whence the paving was started. The only grading done at these places was to trim off the inequalities of the natural foot slope, which extended up to about mid-stage. The riprap, or shore work, was carried up to that height only. In one case the bank was found to be composed of semifluid material, and here a shore mat was built as a foundation for the stone. Since these pockets have been thus treated, they have passed through one high water and have not suffered the slightest enlargement.

Hydraulic grading.—This work was begun with hydraulic grader No. 4, on the 11th of August, followed by hydraulic grader No. 2 on the 16th. These machines began on sections No. 2 and No. 3 respectively. The work proceeded favorably until the 26th, when an old crack just back of the front flange of the high-pressure cylinder began to leak steam badly. On examination, it was found that this crack extended almost entirely around the circumference, and that it would not be safe to use this side of the machine any longer. The opposite engine had been disabled the previous season, hence it was decided to place four of the condemned P. D. pumps aboard. Two duplex Worthington and two duplex Knowles pumps were coupled up so as to discharge into one main discharge pipe, each pump being so connected that it could be cut out without interfering with the operation of the others. Repairs to No. 4 were not completed until the 27th of the following month. The two graders worked well throughout the balance of the season, nothing more occurring except some slight damages to the machinery, and the cracking of the old Dean pump water cylinder. This, however, did not interrupt the work, as the pressure was not reduced thereby.

It will be remembered that during the previous season's work, one of the water cylinders of the Dean pump developed a crack, and that the manufacturers sent a new one, which had been strengthened by increasing the thickness of the metal and by doing away with all sharp angles where the diaphragm joins the sides. At this juncture all cracks here hitherto originated in the original cylinders of both the Dean and Davidson pumps, while the new ones are still perfect. Both sets of pumps were originally designed for a pressure of 200 pounds per square inch, but this had been reduced to 175 pounds, which may be assumed as the safe limit.

Grading along sections No. 2 and No. 3 proceeded in advance of mattress construction, and with fair results both as to economy and perfectness of slope, but as the lower end of the latter section was reached, the outcrop of the strata changed and much sand was encountered, and in consequence but a poor slope, requiring much hand dressing, was obtained. Finally, as grading proceeded downstream, the results were so unsatisfactory that it was decided to abandon grading in advance of the mattress construction and grade only where the mats had been previously sunk.

This should be adopted as a rule, for it has been demonstrated here that no matter what the composition of the bank, a good slope can be obtained after the river mat is sunk. At section No. 1, where the composition of the bank is closely allied to that at Mud Point, grading was done after the river mat was down. At first the results were discouraging, as the lower strata of sand caved and washed badly, but upon a continuance of the work it was found that as soon as the voids under the mat were filled up by the washed-down material caving ceased and a good slope was obtained.

The progress of grading, while slow when compared with that made at other localities on the Reach, was satisfactory when the physical features of the bank operated upon are considered. The main cause of the slow progress was the number of stumps encountered on all the sections except No. 5. On section No. 3 the stumps on a piece of graded bank measuring 77 by 300 feet numbered 74, varying in diameter from 5 to 13 inches, and this was by no means the most thickly wooded portion. These stumps penetrated as much as 15 feet below the surface, and in addition there were a large number of stumps uncovered that were evidently the remains of a former cypress swamp. Section No. 5 was comparatively free of timber.

In order to expedite this class of work, two Wells lights were put in use, one for each grader, and by their aid and with double crews on each machine, night-work was done. This began on September 28, and continued until October 26, by which time grading had advanced sufficiently to warrant a discontinuance of night-work. The lights worked well, required little attention and gave ample light, with a consumption of 1¼ gallons of oil per hour. On November 29, grader No. 4 was transferred to Daniels Point, where it continued until the close of the season.

Paving.—In the early part of the season riprap was laid, as has been customary hitherto; that is, to a uniform thickness of 10 inches. This was subsequently changed by your orders to 12 inches or more for about 5 feet above the zero line, thence tapering to 6 inches at the 15-foot contour, to which latter height only all paving was to be carried.

Some soft places along the foot of slope were first covered with brush foundation mats, and all depressions of any magnitude were filled up with brush, this being always raised above the general level so as to allow for settlement and compression. There are a few places, principally at sections No. 8*a*, No. 8*b* and No. 5, where, owing to the advent of high water, the paving was not carried up quite to the 15-foot contour.

Spur dikes.—Of these there were three constructed, two in front of the Mud Point bank and one in pocket No. 2. The object of placing these spurs there was to break up the strong eddy existing there, which result has in a manner been accomplished, though the dikes are not yet completed. No. 2 requires extension outstream 50 feet and wattling for the entire length. No. 3 requires wattling and slight extension inshore, and No. 4 requires wattling. The dikes are constructed of two rows of piling 12 feet apart, strengthened at the outstream ends by an "L," the piles being placed 8 feet apart, and the whole structure well braced and turned. All piles used are cypress. Where the dikes have the low-water contour on their inshore extensions, shore mats 50 feet wide and running up to top of bank were laid. Through them the piles are driven. No. 1 has not been begun.

Test borings—This work, begun on March 22, is now in progress along the Mud Point bank. A separate report of this work will be made upon its completion.

REVETMENT AT DANIELS POINT.

River mat No. 1.—Repairs to this work, which had suffered serious damage during the previous flood, were begun on October 8, by commencing the construction of a river mat 240 feet wide, its inner edge lying along the low-water line. Considerable preliminary work, such as clearing away drift and old revetment, driving abutment, driving anchor piles, getting out mooring cables, etc., had to be done. The plant for the mat was swung into position for weaving on the 13th. When about 700 feet of its length had been completed it was found that the mat was begining to sag badly where it had been ballasted, this sagging being due to deposits of silt accumulating upon the mat. This sagging continuing to such a degree that it was feared the mat might be strained too much, it was sunk on the 31st, after a length of 800 feet had been obtained. This mat was intended to cover the upper 1,000 feet of the damaged work. Its sinking before that length had been obtained was merely a precautionary measure.

River mat No. 2.—Immediately after sinking No. 1, this mat was begun high enough above the foot of the former to make the usual 25-foot overlap. It had to be curved around a projecting point of the old work, which compelled us to move the inner edge considerably beyond the low-water line, and afterwards to construct a wide connecting mat. This point lay 250 feet below the head of No. 2. Construction proceeded slowly, owing to shortage of the brush supply and bad weather. The mat was sunk on November 29. Its dimensions are, length 1,140 feet by 242 feet.

River mat No. 4.—This mat, which was to cover the farthest downstream fault, was begun December 19, the construction of river mat No. 3, which was to cover the break between the foot of No. 2 and head of No. 4 having been postponed for reasons given farther on. Progress of construction was slow on account of scarcity of labor and of brush, mainly due to the last cause. Its length is 613 feet and width 240 feet. It was sunk on January 6.

River mat No. 3.—Immediately after the sinking of river mat No. 2, the construction of fascines for this mat was begun. These were made of small brush, were from 50 feet to 100 feet long and 12 inches diameter. They were tightly compressed and wired together every 3 feet. These fascines were to form the warp of the mattress, pairs of longitudinal strand cables spaced 8 feet apart forming the woof. Long cable clamps to clamp together the top and bottom cables were used every 3 feet, the fascines being first compressed together; a top grillage of poles was then placed over the whole.

The actual construction of the mat did not begin until January 12, upon which day 20 feet of it was constructed on the mat barges, but as running ice was looked for the plant was not swung into position until the 2d of February, as after the ice ceased running it was not deemed safe to swing out until the Belmont ice gorge had broken. This took place on the 28th, and as no ice from this gorge made its appearance it was assumed that it had either sunk or melted, and that therefore it would be safe to swing out and begin construction of this mat. On February 8th, after 173 feet of the mat had been completed, ice suddenly made its appearance, and by evening the river was full of very heavy gorge ice. This was from the gorges in the upper Mississippi, and proved to be the heaviest run of the season. The mat was hurriedly ballasted and sunk under great difficulties, as it was almost impossible for the steamboats to get through the ice. In sinking, the pressure of the ice against the mooring barges became so great that some of the outstream-mooring cables parted, allowing the mat to swing in shore. Whether it was crowded upon the bank or "buckled" up has not as yet been ascertained, owing to the high stage of river. I believe that the latter is the case, and that the mat is practically destroyed. No hopes were entertained of saving it when the run of ice began, the one object in sinking it being to prevent its breaking away. It was 173 feet long by 245 feet wide. Its cost, as will be seen by a reference to the table giving cost of work, is very high, though a large number of fascines still on hand are included in the cost of this mat. The fascines will probably be available the coming season for connecting mats or shore work. The cost of loading these fascines on barges was also charged to the mat.

This style of mat has many desirable features, its flexibility and the possibility of utilizing brush too small for the standard constructions being not the least important. On the other hand its extreme cost and slow progress are serious objections. Rate of progress might be accelerated if the fascines were made directly at the brush camp and delivered to the construction parties ready for use. The cost, too, may partially be reduced after the men have had more experience with this style.

Connecting mats.—There were constructed and sunk 7 connecting mats, varying in width from 44 to 100 feet, and all of a uniform length of 240 feet. All except No. 7, or the last one constructed, are of the usual construction. No. 7 was built at a high stage of river, and consequently its width was increased. It was constructed of fascines and in a manner similar to river mat No. 3. The completion of this mat terminated the season's work at this place.

Grading.—This work was begun on the 29th of November, upon which day hydraulic grader No. 4 was received from the Ashport work. Grading was begun at the head of river mat No. 1 and continued to its lower end. About one-half of the bank in front of river mat No. 4 was also graded, and 275 feet in front of river mat No. 2. Grading was suspended on January 8.

Paving.—Fourteen hundred and twelve square yards of this work was done.

Spur dikes.—Five of these are to be constructed here, but only 2 have been under construction, the high water interfering with, and finally, on March 1, compelling the stoppage of all work. These dikes, which will be constructed like those already built at Ashport Bend, are to project out from the deep scallops in the bank, and their duty will be to destroy the strong eddies prevailing along the bank.

All work was suspended at this place on March 1st. Since the suspension of the work the sharp salient located at the head of the 1889 work, and which caused destructive eddies below, has been cut away by the erosive action of the river, and the bank above the work is now in much better shape for upstream extension of the work than formerly.

REPAIRS TO EXISTING WORKS.

Fletchers Bend.—One of the projects for the season's work was the repair of a fault at the head of section "B" (1888 work) in this bend, but owing to nonavailability of mattress plant this could not be done. The fault has since increased in extent until now about one-half of section "B" is involved. This fault originated just below the salient formed by the juncture of the 1891 with the 1888 work. A few unimportant faults in the old work were restored, and 4,807 square yards of work reballasted, and 684 square yards of additional paving laid.

Ashport Bend.—Nineteen hundred and twenty-five square yards of the previous season's work received additional ballast.

The present condition of the work on the reach may be briefly summed up as follows, viz:

Bullerton Tow Head revetment will need extensive repairs shortly.

Osceola Bar revetment, both old and new, in good condition, except some slight faults in the old work.

Plum Point revetment damaged somewhat at lower end.

Fletchers Bend revetment, half of section "B" gone; foot of section "D" somewhat damaged; balance of new work in good condition; old work is fair.

Ashport Bend revetment in good condition.

Daniels Point revetment repairs unfinished.

No changes to be noted in the dike work.

Before concluding, I beg leave to submit the following suggestions and remarks:

The anchor piles which it has been customary to drive at 25 or 50 feet intervals along the inshore edge of the river matresses might be, without detriment to the work, omitted, and in lieu thereof piles 150 feet apart be driven for the mat to rest against during construction, so as to hold them at the proper distance out. The anchor piles were driven for the purpose of fastening the mat to them by means of strand cables yoked around the piles and fastened to the mat. We, however, found that frequently, in sinking, the cables cut into the soft wood of the piles and refuse to slip down as the mat sinks, thus holding it up. These have to be pushed down, or, if this is not possible, the strand has to be cut or the pile pulled out. Before sinking the mat, the piles are cut off close to the water surface, and if, before the connecting mats are constructed, the river should rise over their tops, much searching has to be done to locate the proper places on the mat for the holes to be cut, so that when these mats are sunk they will slip down over the piles. Should these holes, from any cause, not match with the piling, the mat will hang up.

Should it be decided to construct supplemental mats in place of the standard connecting mats, these piles would have to either be omitted or else pulled out after the main mat is sunk. Experience has shown that in sinking a matress always crowds inshore, and where the piles are driven as close as 50 feet the friction of the edge of the mat against the piling is sufficient to either hold the former up or break off the piles. In my experience there is no authenticated case of a river mattress sliding down the slope, nor do I think that if such sliding should take place the present number of cables would be sufficient to prevent it. A change in the present style of work, where the revetment will be strengthened at the line where the graded slope and the under-water slope meet, is urged as imperatively necessary, for most of the damage starts here.

The enforcement of the eight-hour law has had its effect both upon the cost and the progress of the work. The advocates of the eight-hour law say that a man will do as much work in eight as he formerly did in ten hours. If this is the case, the average public-works laborer will be found an exception, for he now looks as eagerly for the end of the eight as he formerly did for the end of the ten-hour day. A strict observance of the law is not always compatible with an energetic and economical prosecution of the work, and the penalties threatened will tend to make the assistant in charge overcautious as to the "extraordinary-emergency" clause. It sometimes happens that some work, the postponement of which neither involves loss of life, public property, or destruction of work, might be economically completed by working a short overtime, but this is imperatively prohibited. A concise interpretation of the law by competent authority would be of value.

The question from whence to draw the brush supply is one that demands early consideration. All bars within a radius of 50 miles of the works have been pretty well denuded. There are a few places where considerable brush still stands, but it is practically inaccessible on account of the miry nature of the soil. At some places, by increasing the length of haul, a quantity might be obtained, but the bulk of the supply will have to be obtained from a long distance down the river.

With the use of the "Wells" lights the capacity of the present plant is doub[illegible] but as soon as the nights begin to get cold it is hard to keep an outside night cr[illegible] nor is the work satisfactory then.

The gap between Sections "D" and "E," Fletchers Bend Revetment, should [illegible] covered as soon as possible, as the caving is attacking the foot of Section "D."

Ashport Revetment should be extended up about 1,000 feet to insure the safety [illegible] the work.

The false point or salient formerly existing at the head of the Daniels Point w[illegible] having caved off, and the bank line, which only last year was very concave, hav[illegible] become almost a straight line, the contemplated extension upstream could now [illegible] undertaken with advantage.

Appended hereto is a summary of work done, together with a statement of t[illegible] cost of the different works constructed the past season.

Respectfully submitted.

AUG. J. NOLTY,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Work done during the season 1892-'93.

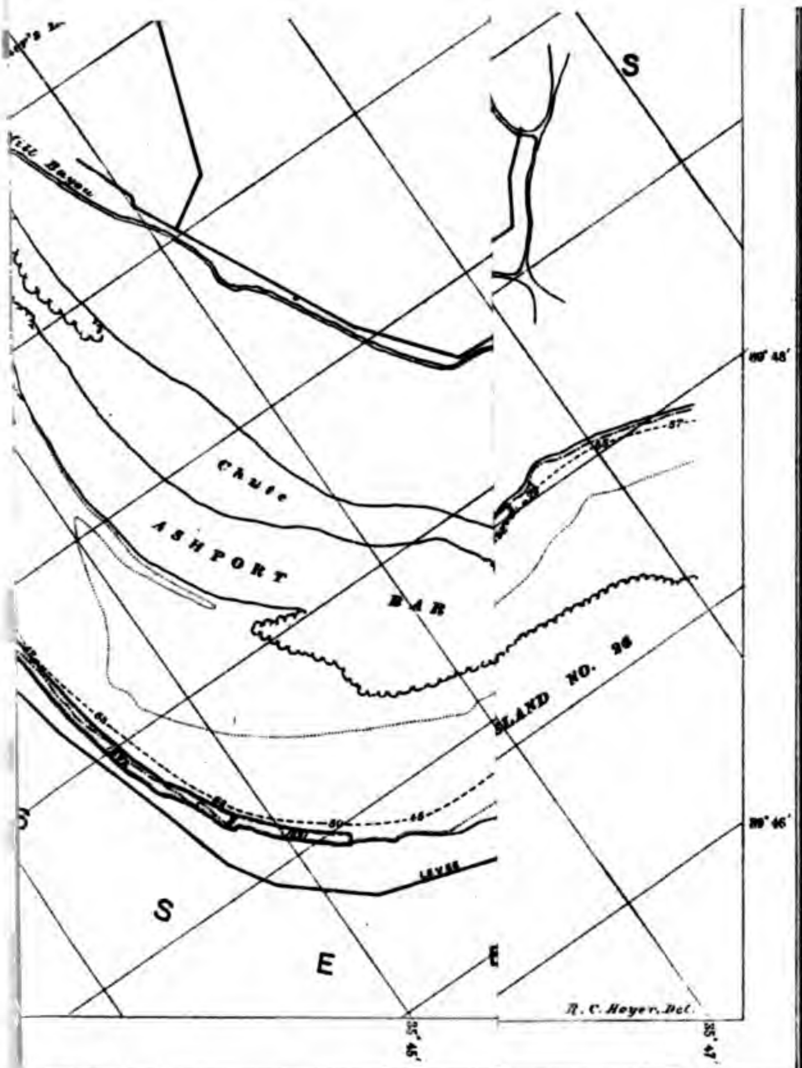
Ashport Bend:		
Stone unloaded on bank	cubic yards	21,211
Stone loaded on bank	do	39,900
River mat made	squares	18,906
Connecting mat made	do	4,242
Pocket mat made	do	1,199
Grading	cubic yards	304,715
Paving	square yards	25,508
Clearing	acres	6.
Dikes constructed	linear feet	350
Anchor piles driven		214
Abutments constructed		10
Brush cut and loaded	cords	1,690
Poles cut and loaded	do	351

Repairs to existing works.

Ashport Bend:		
Additional ballast	square yards	1,925
Fletchers Bend:		
Additional ballast	do	4,807
Paving	do	684
Keys Point and Elmot Bar:		
Stone unloaded on bank	cubic yards	14,503
Daniels Point:		
River mat	squares	6,551
Connecting mat	do	1,437.5
Grading	cubic yards	33,060
Paving	square yards	1,412
Dikes constructed	linear feet	225
Clearing	acres	3
Anchor piles driven		48
Abutments constructed		4

In addition to the above classified work, a large amount of work that, on the statement of cost of work, appears as "miscellaneous work," was done. This consisted in hand-dressing the slope after hydraulic grading, grubbing, blasting stumps, removing snags and drift piles, putting in dead men, sinking anchors for the transverse cables, making model of channel works for the Columbian Exposition, etc. Care of and repairs to plant, though appearing as separate items, can not be properly classified.

Material used per square of river mat:		
Brush	cords	.948
Poles	do	.111
Stone	cubic yards	.647
Wire	pounds	8.07
Wire strand	do	2.9
Spikes	do	.4
Cable clamps	number	.114
Staples	pounds	.048
Piling	number	.0093



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Paving, per square yard:		
Stone	cubic yards	.385
Spalls	do	.113
Paving, per linear foot:		
Stone	do	1.709
Spalls	do	.501
Connecting mat, per square:		
Brush	cords	1.117
Poles	do	.136
Stone	cubic yards	2.228
Wire	pounds	6.716
Wire strand	do	2.024
Spikes	do	.24
Cable clamps	number	.0078
Staples	pounds	.0012
Pocket or floor mats, per square:		
Brush	cords	.83
Poles	do	.145
Stone	cubic yards	1.55
Wire	pounds	7.44
Wire strand	do	2.00
Spikes	do	.206
Clamps	number	.065
Staples	pounds	.025

Detailed cost of works, Plum Point Reach, 1892-'93.

The following shows the cost of work in detail and also the cost per unit:

Ashport Bend:		
River mats, 18,996 squares, at $4.276 per square		$81,228.20
Connecting mats, 4,242 squares, at $8.17 per square		34,656.07
Pocket mats, 1,199 squares, at $5.90 per square		7,079.69
Paving, 25,508 square yards, at $0.9112 per square yard		24,921.61
Grading, 304,715 cubic yards, at $0.038 per cubic yard		11,586.87
Clearing, 16.5 acres, at $42.56 per acre		753.04
Spur dikes		1,230.48
Repairs to and preservation of existing works		1,906.17
Towing*	$7,793.21	
Miscellaneous*	3,388.71	
Handling stone†	12,797.47	
Care of quarters		720.89
Care of plant		7,543.47
Repairs to plant		2,919.81
Total cost		174,546.30

Length of revetment (1892-'93), 8,350 feet. Care of quarters, care of plant, repair to plant, cost per lineal foot, exclusive of dikes, and repair to old work, $19,222.

Fletchers Bend:		
Repair to and preservation of existing work		$2,632.66
Daniels Point:		
River mat, 6,551 squares, at $5.090 per square		33,345.46
Connecting mat, 1,437 squares, at $7.8112 per square		11,234.86
Grading, 33,060 cubic yards, at $0.06295 per cubic yard		2,081.53
Paving, 1,412 square yards, at $1.995 per square yard		2,816.81
Clearing		468.98
Spur dikes‡		1,037.25
Towing*	$3,681.04	
Miscellaneous*	1,037.94	
Care of quarters		236.08
Repairs to plant		345.06
Care of plant		2,450.49
Total cost		54,016.52

Length of revetment, 2,761 feet. Cost per linear foot, exclusive of dikes, $18.322. Revetment not complete.

*Incorporated in "cost of work."

†Cost per yard, $0.1692; includes unloading on bank and reloading on barges. This being added to quarry price and cost of towing, gave the cost per cubic yard ($1.46), and is included in "cost of work."

‡Not completed.

Materials expended, Plum Point Reach, season 1892–'93.

ASHPORT BEND.

Names of articles.	Quantity.	Cost.
Anchors, revetment ....number..	377	$35[illegible]
Acid, muriatic ....pounds..	3	[illegible]
Bushing ....do....	1	[illegible]
Beeswax ....do....	81½	[illegible]
Bolts, copper ....do....	24	15[illegible]
Bars, capstan ....do....	45	2[illegible]
Bolts, wheelbarrow ....dozen..	6	1.[illegible]
Brush ....cords..	23,712	24,024.9[illegible]
Burners, lantern ....dozen..	7½	[illegible]
Bolts ....number..	472	[illegible]
Brackets, lamp ....do....	37	[illegible]
Burners, lamp ....dozen..	9½	6[illegible]
Bottoms, lantern ....number..	20	5[illegible]
Candles ....pounds..	30	[illegible]
Coal ....bushels..	81,972	7,734[illegible]
Crash ....yards..	111	9[illegible]
Clamps, cable ....number..	2,808	73.[illegible]
Castings, stove ....pounds..	1,797	69.4[illegible]
Couplings ....number..	23	5.4[illegible]
Cloth, oiled ....rolls..	6½	14.0[illegible]
Cloth, emery ....sheets..	48	1.[illegible]
Chain ....pounds..	822	31.[illegible]
Chimneys, lamp ....dozen..	80½	19[illegible]
Chrome, green ....pounds..	1	[illegible]
Clamps, hose ....number..	71	4.[illegible]
Charcoal ....barrels..	4½	3.[illegible]
Clay, fire ....do....	1½	[illegible]
Castings, brass ....pounds..	138	47.[illegible]
Castings, iron ....do....	1,078	[illegible]
Cylinder, water ....number..	1	4[illegible]
Drop, Black ....pounds..	12	[illegible]
Dryer, Japan ....gallons..	1½	[illegible]
Dope ....pounds..	10	[illegible]
Ducking ....yards..	174	14.[illegible]
Dynamite ....pounds..	1,000	[illegible]
Exploders ....number..	445	21.5[illegible]
Globes, lantern ....dozen..	15½	[illegible]
Gauges, glass ....number..	5	[illegible]
Glass ....panes..	158	14.67
Grates, stove ....number..	8	9.5[illegible]
Gauge cocks ....do....	8	1.[illegible]
Guards, valve ....do....	6	2.[illegible]
Hemp, Italian ....pounds..	7½	1.[illegible]
Handles, ax ....number..	112	12.[illegible]
Handles, maul ....do....	107	8.[illegible]
Hose ....feet..	300	341.[illegible]
Handles, file ....number..	1	[illegible]
Hasps ....do....	16	[illegible]
Hinges ....pairs..	25	3.[illegible]
Iron ....pounds..	1,182	29.[illegible]
Labor	....	53,314.[illegible]
Lye ....cases..	17½	31.7[illegible]
Locks, pad ....number..	23	6.41
Leather, sole ....pounds..	38½	12.[illegible]
Lead, white ....do....	1,106	73.[illegible]
Lead, sheet ....do....	2½	[illegible]
Nuts, blank ....number..	6	[illegible]
Nails ....pounds..	1,407	29.[illegible]
Lumber ....feet..	16,373	216.[illegible]
Matches ....gross..	18	[illegible]
Marlin ....pounds..	9.18	85.[illegible]
Metal, antifriction ....do....	10	2.[illegible]
Oil, signal ....gallons..	649	181.79
Oil, cylinder ....do....	206	76.99
Oil, headlight ....do....	2,123	203.[illegible]
Oakum ....pounds..	625	43.74
Oil, linseed ....gallons..	86	34.[illegible]
Oil, black ....do....	162	8.54
Oil, lard ....do....	105½	62.32
Pipe ....lengths..	8	25.8[illegible]
Piling ....number..	223	267.60
Piling ....feet..	5,155	219.0[illegible]
Putty ....pounds..	34	.77
Paint, Benzole ....gallons..	5	3.00
Poles ....cords..	2,861½	4,267.1[illegible]
Packing, asbestos ....pounds..	44½	18.[illegible]
Packing, hemp ....do....	76½	16.06
Prussian blue ....do....	2	.4[illegible]
Packing, square ....do....	5½	3.07

Materials expended, Plum Point Reach, season 1892-'93—Continued.

ASHPORT BEND—Continued.

Names of articles.	Quantity.	Cost.
Plumbago ... pounds..	$8\frac{3}{4}$	$1.41
Poison, rat ... box..	1	.07
Packing, flax ... pounds..	60	16.80
Pipe, gas ... feet..	28	3.36
Packing, sheet ... pounds..	$115\frac{1}{2}$	37.14
Paper, toilet ... dozen..	1	.46
Packing, cucks ... pounds..	$117\frac{3}{4}$	27.83
Powder, emery ... do...	$4\frac{1}{4}$	.61
Pipe, stove ... joints..	94	28.45
Packing, Usudurian ... pounds..	15	7.32
Packing, round ... do...	111	26.64
Polish, stove ... do...	$2\frac{1}{2}$	.50
Packing, cotton stem ... do...	$12\frac{1}{3}$	4.21
Packing, gum pure ... do...	$44\frac{3}{4}$	22.19
Packing, Selden's ... do...	25	10.02
Plugs ... number..	1	.02
Paint, mineral ... pounds..	227	2.27
Rope, manilla ... do...	23,690	1,443.34
Rope, braided cotton ... do...	$15\frac{1}{2}$	3.63
Rope, wire ... do...	1,836	126.36
Rivets, copper ... do...	3	.83
Rope, grass ... coils..	2	1.20
Rope, cotton ... pounds..	$3\frac{1}{4}$	.76
Rosin ... do...	$9\frac{1}{4}$	.27
Rope, tiller ... feet..	150	14.75
Prussiate potash ... pounds..	2	.70
Sponges ... ounces..	23	3.73
Soap, laundry ... box..	$62\frac{17}{65}$	117.52
Soap, toilet ... bars..	236	10.45
Staples ... pounds..	340	12.42
Springs, poppet valve ... number..	8	6.85
Straw ... bales..	52	87.73
Stationery ...	...	27.44
Spikes ... pounds..	99.28	213.81
Steel ... do...	8	63
Strand, wire ... do...	67,788	2,874.14
Sheet, copper ... do...	3	.96
Solder ... do...	5	1.09
Screws ... dozen..	$85\frac{1}{3}$	2.14
Brick, fire ... number..	500	14.70
Subsistence ...	...	15,929.16
Stone ... yards..	37,568.67	54,850.26
Tallow ... pounds..	45	2.50
Tiles, center ... number..	15	5.85
Tin, sheet ... sheets..	6	1.80
Tacks ... pounds..	8	1.44
Twine ... balls..	1	.35
Turpentine ... gallons..	$31\frac{5}{8}$	12.90
Turnbuckles ... number..	2	2.00
Valves, rubber ... do...	29	17.11
Varnish ... gallons..	1	1.53
Valves, globe ... number..	11	8.14
Waste ... pounds..	116	8.83
Wicks, lamp ... dozen..	40	4.00
Wheels, barrow ... do...	3	31.85
Wire, copper ... pounds..	$1\frac{1}{2}$	.39
Wood ... cords..	23	71.89
Wire, galvanized ... pounds..	203,501	5,630.30
Wire, insulated ... feet..	500	15.00
Washers ... pounds..	$21\frac{1}{2}$	.88
Zinc ... do...	16	2.34
Unions ... number..	1	.90
Total cost ...	...	174,546.30

DANIELS POINT.

Beeswax ... pounds..	22	$6.38
Bars, capstan ... number..	5	3.75
Brush ... cords..	8,826	8,916.37
Bolts ... number..	190	3.80
Brackets, lamp ... do...	6	.54
Burners, lamp ... dozen..	$2\frac{1}{2}$	1.88
Bottoms, lantern ... number..	12	3.43
Coal ... bushels..	21,831	2,408.50
Crash ... yards..	35	2.87

Materials expended, Plum Point Reach, season 1892-'93—Continued.

DANIELS POINT—Continued.

Names of articles.	Quantity.	Cost.
Clamps, cable ... number..	547	$29.94
Clamps, cable, fascine ... do....	3,065	349.4[illegible]
Cloth, emery ... sheets..	49	1.[illegible]
Chrome, yellow ... pounds ..	1	.[illegible]
Castings, brass ... do....	15	18.[illegible]
Castings, iron ... do....	180	3.[illegible]
Dope ... do....	10	[illegible]
Globes, lantern ... dozen..	3	2.[illegible]
Glass ... panes..	34	5.0[illegible]
Grates, stove ... number..	3	3.6[illegible]
Handles, ax ... do....	6	.6[illegible]
Handles, maul ... do....	8	.[illegible]
Hasps ... do....	5	.15
Iron ... pounds..	156	4.3[illegible]
Labor ...	....	19,04[illegible].6[illegible]
Lye ... cases..	5	6.3[illegible]
Leather, sole ... pounds..	9	2.9[illegible]
Lead, white ... do....	25	1.7[illegible]
Nails ... do....	28	.[illegible]
Lumber ... feet..	654	13.[illegible]
Matches ... gross..	7½	8.1[illegible]
Oil, signal ... gallons..	76	20.46
Oil, cylinder ... do....	57	19.[illegible]
Oil, headlight ... do....	591	55.[illegible]
Piling ... number..	66	73.[illegible]
Piling ... feet..	5,067	215.[illegible]
Putty ... pounds..	1	.[illegible]
Poles ... cords..	880	1,305.[illegible]
Packing, asbestos ... pounds..	2	.4[illegible]
Prussian blue ... do....	1	.[illegible]
Packing, hemp ... do....	3½	.[illegible]
Packing, square ... do....	2¼	1.[illegible]
Plumbago ... do....	½	.[illegible]
Pipe, gas ... feet..	8½	1.[illegible]
Packing, sheet ... pounds..	18	3.5[illegible]
Pipe, stove ... joints..	12	3.9[illegible]
Packing, round ... pounds..	5½	1.[illegible]
Packing, Selden's ... do....	3½	1.[illegible]
Plugs ... number..	1	.5[illegible]
Rope, manilla ... do....	8,310	612.[illegible]
Rope, wire ... pounds..	1,013	69.[illegible]
Rope, cotton ... do....	2	.4[illegible]
Shackles ... number..	4	7.[illegible]
Soap, laundry ... box..	23$\frac{11}{12}$	45.[illegible]
Soap, toilet ... bars..	49	2.[illegible]
Staples ... pounds..	142	4.9[illegible]
Straw ... bales..	23	14.[illegible]
Stationery ...	....	5.[illegible]
Spikes ... pounds..	402	12[illegible]
Steel ... do....	10	.[illegible]
Strand wire ... do....	34,576	1,006.[illegible]
Screws ... dozen..	1	.[illegible]
Subsistence ...	....	5,344.[illegible]
Stone ... yards..	8,377.82	12,231.[illegible]
Tin, sheets ... sheets..	46½	12.[illegible]
Tacks ... pounds..	2	.[illegible]
Valves, globe ... number..	1	.7[illegible]
Waste ... pounds..	44	3.[illegible]
Wicks, lamp ... dozen..	21½	2.4[illegible]
Wheels, barrow ... do....	1	10.[illegible]
Wire, galvanized ... pounds..	71,665	1,965.[illegible]
Wood ... cords..	27	81.15
Total cost ...	....	54,016.[illegible]

TOWING NEW MADRID REACH.

Bluing ... bottles..	1	$0.25
Strawboard ... sheets..	3	.[illegible]
Beeswax ... pounds..	4	1.[illegible]
Bolts ... number..	18	.36
Burners, lamp ... dozen..	1½	.[illegible]
Coal ... bushels..	6,605	779.[illegible]
Cloth, emery ... sheets..	6	.[illegible]
Candles ... pounds..	5	.40
Chimneys, lamp ... dozen..	3	1.75
Chrome green ... pounds..	4	.49

Materials expended, Plum Point Reach, season 1892-'93—Continued.

TOWING NEW MADRID REACH—Continued.

Names of articles.	Quantity.	Cost.
Drop black .... pounds..	11	$1.21
Dryer, Japan .... gallons..	1	.64
Globes, lantern .... number..	17	1.53
Glass .... panes..	3	.12
Iron .... pounds..	48	.96
Labor	....	743.84
Matches .... gross..	1	.65
Oil, signal .... gallons..	15	4.50
Oil, headlight .... do....	123	11.32
Oakum .... pounds..	100	6.74
Packing, asbestos .... do....	3	1.29
Soap, toilet .... bars..	12	.55
Starch .... pounds..	5	.25
Subsistence	....	121.20
Waste .... pounds..	34	2.62
Wicks, lamp .... dozen..	4	.13
Wood .... cords..	6	7.50
Total cost	....	1,690.66

FLETCHERS BEND.

Labor	....	$668.47
Stone .... cubic yards..	1,201	1,753.46
Subsistence	....	33.41
Total cost	....	2,455.34

LEVEES, WHITE RIVER FRONT.

Labor	....	$294.29
Subsistence	....	61.66
Coal .... bushels..	1,691	150.16
Total cost	....	506.11

APPENDIX 4 C.

REPORT OF ASSISTANT ENGINEER C. W. STURTEVANT ON REPAIRS TO PLANT.

UNITED STATES ENGINEER OFFICE,
Amelia, Ark., April 18, 1893.

CAPTAIN: I have the honor to submit the following report upon repairs to plant at Amelia, Ark., from May 1, 1892, to April 1, 1893.

Steamboats.—Steamer *Titan*, during the months of October and November, 1892, had two pairs of vertical posts set along the sides of both sets of cylinder timbers with the top of each pair framed to its opposite pair on the other side of the boat to prevent the side or weaving motion of the cylinder timbers. New stanchions have been placed under the cylinder timbers and diagonal braces so placed as to prevent the fore and aft movement of the timbers. New stacks 2 feet in diameter were put on the boat in place of the old ones, which were rusted out and were 3 feet in diameter. The decrease in the size of stacks improved the draft of the furnace. Other minor repairs have been made that are usually necessary to a towboat in commission.

Steamer *Graham* was docked in June, 1892, and received a new set of starboard cylinder timbers, a new wheel, hull repaired and caulked, cabin repaired and painted, forward mud drum on boilers moved back, grate surface lengthened 12 inches, and cylinders counterbored.

Steamer *Kirns* was docked in July, 1892, and had the following parts renewed, as well as other minor repairs: New cylinder timbers complete, hog-chain braces, transom, stem, and rudders.

Steamer *Itasca* has received only such minor repairs as have been necessary to keep this boat in working condition.

Steamer *Abbot* has had two knees built on bow for towing and such repairs as were necessary to keep the boat in commission.

Hydraulic graders.—Grader No. 2 was docked in April and May, 1892. Machinery repaired and tested June 10, 1892, as follows:

Boiler pressure	pounds..	100
Vacuum	inches..	25
Revolutions	per minute..	27
Hydraulic pressure	pounds..	175
Nozzle pressure	do....	140

discharging through six 1¼-inch nozzles, each at the end of a 50-foot section of hose. A new smokestack was made for this grader and the boilers covered with asbestos covering.

Grader No. 4 was docked in May and June, 1892, and had new gunwales made out of 6-inch yellow pine; also had a new rake and rake timbers put in. Cabin repaired and painted. This grader had two independent Davidson compound pumps. One pump was so badly damaged it was not thought best to repair it. The other pump was overhauled and tested as follows: Boiler pressure, 100 pounds; hydraulic pressure varied from 120 to 190 during the stroke; vacuum, 24 inches; revolutions, 30 per minute and discharging through three 1¼-inch nozzles, each at the end of a 50-foot section of hose. During the season's work at Ashport Bend the high-pressure cylinder cracked, and as the grader was needed at once, the pump was taken off and four small pile-driver pumps put in place, two being compound duplex "Worthington" and two high-pressure "Knowles." They were all worked condensing, the condensers used belonging to the Davidson pumps.

Grader No. 40 had boiler covered and machinery and cabin painted.

Sand-pump boat No. 12.—No repairs have been made to this boat. The ball engine and link belt have been sent to the Fourth district.

Pile-drivers.—Nos. 59, 21, 20, 61, 57, 25, and 27 have had such minor repairs as were necessary for one season's work.

Machine boat.—Machine Boat No. 1 was docked in September, 1892, and had new gunwales, rakes, floor timbers, and a few new bottom planks put in.

Machine boat No. 2 was docked in September, 1892, and had new gunwales, rakes, floor timbers, and a few new bottom planks put in.

Quarter boat.—Quarter boat No. 30 had rake and one seam above water line on each side caulked so that the boat could be used during the season.

Headquarter boat No. 29 has been painted and kitchen and pantry ceiled.

Material store boat No. 26 was docked in October, 1892, and was patched and caulked for two seasons' use, as the hull was not worth rebuilding.

Quarter boat No. 12 was docked in August to be caulked for one season's use.

Quarter boat No. 10, used as a bake shop, was repaired and calked for one season's work.

Quarter boat No. 28 was repaired and calked for one season's use.

Barges.—Four new district barges, Nos. 55, 66, 74, and 76, and mattress barges Nos. 1, 2, 3, and 4 had decks caulked and pitched.

Gunwale barge No. 161, received from the general service, was docked and cut down to be used for a landing barge in unloading stone.

Frame barge No. 223 was docked in March, 1893. It was caulked and had a new yellow pine head block put in.

Frame barge No. 224 was docked in March, 1893, and caulked.

Frame barge No. 227 was placed on dock, March 31, 1893, to be caulked.

The two second district (coal barge) mooring barges, two mooring barges, Nos. 180 and 189, and old mattress barge No. 6 were repaired sufficiently for one season's work.

Flats.—Four small flats were repaired for use of mattress parties in the field.

Skiffs, wheelbarrows, and tools of all kinds have been repaired.

Warehouse A was finished in May, 1892, with tin roof and track for hauling up machinery complete.

Floating dock has received such minor repairs only as were necessary to keep it in working condition.

Eight of the model barges borrowed from Major Miller have received necessary repairs and were painted before being returned.

General repairs necessary to keep the fleet afloat and repairs to tools in shops have been made and charged under the head of general repairs.

There is inclosed herewith a table showing amounts expended on each piece of plant from May 1, 1892, to April 1, 1893.

This cost includes all material, labor, subsistence, and administration as expended at this place.

Respectfully submitted.

C. W. STURTEVANT,
Assistant Engineer.

Capt. S. W. ROESSLER,
Corps of Engineers, U. S. A.

Table of cost of repairs to plant at Amelia, Ark., from May 1, 1892, to April 1, 1893.

Steamers:	
Titan	$1,443.49
Graham	2,806.88
Kirns	4,022.43
Itasca	266.18
Abbot	62.59
Hydraulic grader No.—	
2	2,719.48
4	4,121.27
40	167.91
Pile-drivers No.—	
20	198.66
21	425.07
25	1.26
27	100.11
57	140.57
59	252.65
61	36.39
Machine boat No.—	
1	3,071.39
2	3,645.17
Quarter boat No.—	
30	109.28
29 (headquarters)	310.70
26 (material store boat)	418.84
12	326.04
10 (bake shop)	282.83
28	31.17
6	3.49
25	35.86
11	16.70
13	18.70
27	14.01
District barge No.—	
55	$101.05
66	88.98
74	82.57
76	126.52
94	43.96
152	1.78
Mattress barge No.—	
1	52.41
2	48.52
3	219.78
4	258.22
6 (old)	265.23
Gunwale barge No.—	
161 (cut down)	988.62
193	43.86
180 (mooring)	283.18
189 (mooring)	64.38
Two (coal barge) mooring barges	375.43
Frame barge No.—	
223	213.44
224	180.10
8 model barges (Maj. Miller)	211.68
Skiffs and flats	245.39
Floating dock	37.33
Warehouse A	542.74
General repairs	1,682.83
Total cost	31,207.12

Abstract of proposals for furnishing brush and poles for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	12,000 cords willow brush.	2,000 cords willow poles.
		Per cord.	*Per cord*
1	Hunter & Frey, Memphis, Tenn.*	$0.95	$1.50

* Accepted.

Abstract of proposals for furnishing stone for use at Hopefield Bend, Arkansas, received in response to advertisement dated August 22, 1892, and opened September 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	10,000 cubic yards on bank at Hopefield.	10,000 cubic yards on barges at West Memphis.
		Per cubic yd.	*Per cubic yd.*
1	Edward Hely, West Plains, Mo.*	$1.85	$1.70
2	Henry & Co., Birmingham, Ala.	1.94	1.97
3	J. W. Alley, Memphis, Tenn.	....	1.75

* Accepted.

Abstract of proposals for levee work in Upper and Lower White River levee districts received in response to advertisement dated September 28, 1892, and opened October 10, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Upper—Station 1040 to 1120	Lower.			
			Station 989 to 1032.	Station 1032 to 1107.	Station 903 to 780.	Station 780 to 677.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*
1	J. H. Cary, Memphis, Tenn		$0.20	*$0.16½		
2	Sneed & Blue, Memphis, Tenn				$0.17¾	
3	R. H. Beith, Beiths Landing, Ark					$0.17½
4	Scott & Russell, Memphis, Tenn		.21	.21	*.15¾	*.15¾
5	C. F. DeGaris & Co., Memphis, Tenn	$0.2758	*.19⅝	.16⅝	.16⅞	.16⅞
6	J. S. McTighe & Co., Memphis, Tenn	*.27	.23	.22	.24	.24
7	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.37½	.21½	.21	.18½	.19½
8	Jeffries & Dameron, Memphis, Tenn	.27				
9	Hartnett & O'Brien, Memphis, Tenn			.17 93/100	.17¾	.17¼

*Lowest bid—accepted.

Abstract of proposals for levee work in Upper Yazoo levee district received in response to advertisement dated September 28, 1892, and opened October 8, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Station 4346 to station 4417.	Station 4417 to station 4488.	Station 4488 to Ward Lake Levee.	Station 1159 to station 1202.	New Pushmataha Loop.	
						Upper half.	Lower half.
		Per cu.yd.	*Per cu.yd.*	*Per cu.yd.*	*Per cu.yd.*	*Per cu.yd.*	*Per cu.yd.*
1	Harvey & McGuire, Greenville, Miss	$0.19½	$0.18½	$0.18½	$0.22	*$0.18	$0.19
2	Scott & Russell, Memphis, Tenn	.19½	.20½	.24		.21	.21
3	J. S. McTighe & Co., Memphis, Tenn	.21	.26	.25	.30	.29	.32
4	A. McDonald, Memphis, Tenn	*.18⅜					
5	DeGaris & Arnold, Memphis, Tenn	.18¾	*.18¼	.19¾	.27	.24	.26¼
6	P. F. Lamb, Memphis, Tenn				*.20		*.16¾
7	J. H. Cary, Memphis, Tenn	.22	.33	.27			
8	Hartnett & O'Brien, Memphis, Tenn					.20	.21
9	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.27	.27	.30	.40	.22½	.24½
10	Jeffries & Dameron, Memphis, Tenn	.18¾	.23	.21	.27	.19	.20
11	Hugh Morgan, Memphis, Tenn			*.17½			
12	E. B. Mantell, Memphis, Tenn	.20 9/10					
13	T. S. Aderholdt, Friars Point, Miss	.21½	.22	.23	.43		

*Lowest bid—accepted.

Abstract of proposals for levee work in Lower White River levee district received in response to advertisement dated October 17, 1892, and opened October 24, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From Station 677 southward to vicinity of Beasley's.	
		To be finished March 1, 1893.	To be finished January 1, 1894.
		Per cu. yard.	*Per cu. yard.*
1	Scott & Russell, Memphis, Tenn		$0.21
2	Hartnett & O'Brien, Memphis, Tenn		*.15
3	Vance & Franklin, Garvey, Ark	$0.20	.17
4	John R. Greer, Memphis, Tenn		.21⅜
5	Sullivan, Johnson & McLaughlin, Memphis, Tenn	.19½	.17⅜
6	C. F. DeGaris & Co., Memphis, Tenn	.21⅜	.17⅝
7	Timothy Sullivan, Memphis, Tenn		.17⅜

*Accepted.

Abstract of proposals for removal of Nonconnah Rock, Mississippi River, received in response to advertisement dated November 1, 1892, and opened December 1, 1892, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Price per cubic yard.
1	Johnson & Townsend, Somers Point, N. J.	$4.95
2	Ethan A. Burress, New Orleans, La	2.90
3	H. S. Brown, Quincy, Ill	2.75
4	J. H. Cary, Memphis, Tenn.*	2.65

* Accepted.

Abstract of proposals for furnishing stone for use on Plum Point Reach, received in response to advertisement dated March 6, 1893, and opened March 16, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Names and address of bidder.	Kind of stone.	10,000 cubic yards coarse riprap.	10,000 cubic yards small riprap.	5,000 cubic yards spalls.
			Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*
1	J. W. Worthington & Co., Birmingham, Ala	Limestone	$3.50	$3.50	$3.50
		Sandstone	3.50	3.50	3.50
2	Johnson Barrett, Frankfort, Ky	Limestone			
		Sandstone	1.64	1.64	1.49
3	Frederick Hartwig, Cincinnati, Ohio*	Limestone	1.59	1.69	1.30
		Sandstone	1.54	1.64	1.20
4	John J. Shipman, Shawneetown, Ill	Limestone	1.85	1.80	1.75
		Sandstone	1.90	1.85	1.75

* Accepted.

Abstract of proposals for levee work, Upper and Lower White River levee districts, received in response to advertisement dated December 24, 1892, and opened January 19, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Upper White River levee district.		Lower White River levee district.	
		From Station 1120 to 1160.	From Station 1160 to 1200.	From Station 1110 to 1205.	From Station 1205 to 1295.
		Per cu. yd.	*Per cu. yd.*	*Per cu. yd.*	*Per cu. yd.*
1	McLaughlin Bros., Memphis, Tenn	$0.30¼	0.24\frac{98}{100}$	$0.20¼	$0.26¼
2	James M. Sullivan, Memphis, Tenn	.26¼	.26⅛	.20	.20⅛
3	Thomas C. Ferguson, Glendale, Miss			.21¼	
4	Arnold DeGaris & Co., Memphis, Tenn	.23⅝	*.21⅜	.14⅞	*.18⅜
5	Jeffries & Dameron, Memphis, Tenn	.23	.24	.18⅛	.22
6	Hugh Morgan, Memphis, Tenn			.17½	.21⅞
7	Fruin-Bambrick Constuction Co., St. Louis, Mo.	.24$\frac{84}{100}$	.24$\frac{84}{100}$	.23	.30
8	J. B. Lewis, Luna, Ark	.24¾	.23¼	*.14¼	.19½
9	William R. Harvey, Greenville, Miss			.16	.20
10	T. J. Bogne, Beulah, Miss		.24$\frac{74}{100}$	.24$\frac{34}{100}$	
11	W. L. Killebrew, Greenville, Miss			.16$\frac{9}{10}$	.21$\frac{9}{10}$
12	J. S. McTighe & Co., Memphis, Tenn	.28⅓	.28⅛	.16$\frac{85}{100}$	.21$\frac{88}{100}$
13	Patrick F. Lamb, Memphis, Tenn			.16⅞	.21
14	James H. Cary, Memphis, Tenn	*.22	.22	.17	.20⅛

*Accepted (lowest bid).

Abstract of proposals for constructing 30 decked barges, received in response to advertisement dated January 18, 1893, and opened February 1, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	Price per barge for 10 barges.	Remarks.
1	Weigel Bros., & Co., Elizabeth, Penn	$3,100	Accepted for 10 barges.
2	David S. Barmore, Madison, Ind	3,170	Accepted for 9 barges.
3	Ed. J. Howard, Jeffersonville, Ind	3,192	
4	S. M. Flesher, Lavanna, Ohio	2,800	Accepted for 10 barges.
5	Thos. P. Morse, South St. Louis, Mo	3,500	

Abstract of proposals for levee work, received in response to advertisement dated December 30, 1892, and opened January 24, 1893, by Capt. S. W. Roessler, Corps of Engineers.

[Price per cubic yard.]

No.	Name and address of bidder.	Upper Yazoo levee district.					Lower St. Francis levee district.			
		Sections 60, 62, and 63.	Station 1340 to 1420.	Station 1420 to 1493, and station 1531 to 1544.	Station 1630 to 1749.	Station 1493 to 1531.	Station "0" to 158.	Station 158 to 317.	Station 317 to 422.	Station 422 to 475.
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	Garbish & O'Neil, Memphis, Tenn	15 7/10								
2	C. A. Winter, Greenville, Miss		20 48/100	22 50/100	19	26 38/100				
3	Timothy Sullivan, Memphis, Tenn	15 74/100	*15 98/100	21	21 1/2	36 1/2	11 99/100	11 48/100	12 48/100	15 48/100
4	W. A. Shippey, Memphis, Tenn	15 1/2						11 93/100		
5	Edward B. Mantell, Memphis, Tenn	18 1/2								
6	McLaughlin Bros., Memphis, Tenn	16 1/2	17	*16 74/100	18	22	12 43/100	11 99/100	11 99/100	18 23/100
7	Haman, McFadden & Cassidy, Baton Rouge, La					34	12 9/10	13 3/10	14 4/10	23
8	A. J. Robinson, Memphis, Tenn	18 7/8								
9	John C. Hodge, Memphis, Tenn						13 1/2	11 5/8	11 7/8	16 7/8
10	Hogan & Robertson, Cairo, Ill						14 3/8	14	14	15
11	Conner & Lester, Benoit, Miss	16 3/4	16 1/2	17	17	*†19	15	14 1/2	14 3/4	15
12	Epply & Martin, Bolivar, Miss						12 74/100	11 85/100	12 58/100	20
13	R. T. Martin, Bolivar, Miss	15 44/100	18 74/100		15	26				
14	Hunter & Frey, Memphis, Tenn						10 1/2	9 3/4	12 3/4	18
15	Harvey & McGuire, Greenville, Miss		16	19	15	20	14	13 1/2	14 1/2	16 1/2
16	Hartnett, O'Brien, Donovan & Daily, Memphis, Tenn		18 3/8		16 9/10		11 99/100	10 99/100	11 44/100	18 48/100
17	Thomas J. Bogue, Beulah, Miss						11 74/100	10 94/100	11 24/100	22 3/8
18	Earnest Hyner, Greenville, Miss						19 93/100	13 88/100	14 33/100	20 88/100
19	T. S. Aderhold, Friars Point, Miss	*14 43/100	19	19 1/2	*13 49/100	33				
20	M. N. Hewey, Birmingham, Ala					25	13 97/100	11 33/100	12 93/100	19 78/100
21	Green Clay & Son, Mexico, Mo						17	12 3/8	12 7/8	24
22	T. C. Ferguson, Glendale, Miss	15 78/100, 16 48/100	17 90/100	18 23/100	17 95/100		17 40/100	15 48/100		
23	Arnold, De Garis & Co., Memphis, Tenn	17 3/4	18	20	20 3/4	26	14	13 5/8	14 1/2	15
24	W. L. Withers & Co., Gladstone, Miss						15 1/2	12	12 1/2	27
25	Hebron & Hebron, Vicksburg, Miss			23 98/100	19 99/100	24 99/100	14 3/8	11 3/8	11 5/8	19 7/8
26	J. S. McTighe & Co., Memphis, Tenn	21	23	24 1/2	24 1/2	29	10 3/4	10 3/4	10 3/4	11 1/2
27	Scott & Russell, Memphis, Tenn						13	12	12	17 92/100
28	Jeffries & Dameron, Memphis, Tenn	16	17	18 1/2	15	21	12 1/2	11 3/4	13	17
29	Hayes & Hayes, Welchton, La						14 3/4	12 70/100	15	18
30	A. B. Carter, Memphis, Tenn						18 3/4	13 1/2	16 3/4	
31	Sullivan & Johnson, Memphis, Tenn	24	21	22	22 1/2	19 3/4	14	12 48/100	12 97/100	15 1/2
32	Jno. Scott & Son, St. Louis, Mo						12 49/100	11 48/100	12 99/100	21 48/100
33	J. W. Eldridge, Hillhouse, Miss		17 75/100	17 78/100						
34	Meredith & Speers, Memphis, Tenn						16	13 1/2	15 1/2	19 1/2

* Accepted (lowest bid.) † Bidder failed to enter into contract. This piece of work was readvertised.

Abstract of proposals for levee work received in response to advertisement dated December 20, 1892, etc.—Continued.

No.	Name and address of bidder.	Upper Yazoo levee district.					Lower St. Francis levee district.			
		Sections 60, 62, and 63.	Station 1340 to 1420.	Station 1420 to 1493, and station 1531 to 1544.	Station 1630 to 1749.	Station 1493 to 1531.	Station "0" to 158.	Station 158 to 317.	Station 317 to 422.	Station 422 to 475.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
35	Edwin R. Shelton, Memphis, Tenn	......	......	......	......	......	......	13	......	......
36	P. F. Lamb, Memphis, Tenn	......	19 3/4	18 1/4	17 95/100	30	12 95/100	12 3/4	13	16 3/4
37	Chas. E. Sessions, Friars Point, Miss	16 48/100	18 48/100	20 90/100	17	24 74/100	12 90/100	12 90/100	......	......
38	Hugh Morgan, Memphis, Tenn	16 7/8	......	......	......	......	......	......	......	......
39	M. McTighe, Memphis, Tenn	18	......	......	......	......	15	......	......	......
40	J. E. O'Hearn, Wilmington, N. C	......	21 3/4	21 5/8	17 13/20	20 9/10	12 1/10	11 7/10	11 9/10	21
41	James H. Cary, Memphis, Tenn	20	21	21	19	22 1/2	16	13 9/10	15	18

NOTE.—Work in Lower St. Francis levee district withdrawn.

Abstract of proposals for levee work in Upper Yazoo levee district, received in response to advertisement dated February 8, 1893, and opened February 18, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From Section 59 northward.
		Per cu. yd.
1	Jeffries & Dameron, Memphis, Tenn	$0.14
2	Scott & Russell, Memphis, Tenn	.17
3	Timothy Sullivan, Memphis, Tenn	.14 38/100
4	W. A. Shippey, Memphis, Tenn	.14 88/100
5	Robert Vance, Memphis, Tenn	.13
6	Thomas J. Bogue, Beulah, Miss	*.12 24/100
7	J. B. Lewis, Luna, Ark	.13 22/100
8	Harvey & McGuire, Greenville, Miss	.16
9	Jennings & Co., Memphis, Tenn	.14 1/4
10	P. F. Lamb, Memphis, Tenn	.14 1/2
11	T. C. Ferguson, Glendale, Miss	.14

*Accepted.

Abstract of proposals for levee work in Upper Yazoo Levee District, received in response to public notice dated April 6, 1893, and opened April 12, 1893, by Capt. S. W. Roessler, Corps of Engineers.

No.	Name and address of bidder.	From station 1493 to 1531.
		Per cu. yd.
1	C. A. Winter, Greenville, Miss	$0.25 94/100
2	Timothy Sullivan, Memphis, Tenn	25 1/2
3	J. C. Hodge, Memphis, Tenn	.27 1/8
4	W. A. Shippey, Memphis, Tenn	.25 90/100
5	William R. Harvey, Greenville, Miss	*.20
6	E. R. Shelton, Memphis, Tenn	.29
7	Robert Johnson, Memphis, Tenn	.20 1/4
8	Robert Vance, Memphis, Tenn	.28

*Accepted.

NOTE.—Bids for this work were opened January 24, 1893, but Conner & Lester, who were the lowest bidders, having failed to enter into contract, the work was readvertised.

List of civilian engineers employed on works of improving Mississippi River, First and Second districts, in charge of Capt. S. W. Roessler, Corps of Engineers, from June 1, 1892, to May 31, 1893.

Name and residence.	Time employed.	Pay per month.	Where employed.	Work on which employed.
	Months.			
M. M. Rees, Memphis, Tenn.	12	$200	Memphis	Hopefield Bend and miscellaneous work.
C. W. Sturtevant, Appleton City, Mo.	12	150	Amelia, Ark	Repairs to plant and surveys.
Aug. J. Nolty, Chattanooga, Tenn.	12	150	....do	Construction, Plum Point Reach.
Fred Wigstrand, Memphis, Tenn.	$8\frac{27}{30}$ $1\frac{8}{30}$	125 150	Hillhouse, Miss.	Upper Yazoo Levee district.
A. F. Kilpatrick, Memphis, Tenn.	$9\frac{8}{30}$	125	Sessions, Miss	Do.
William Gerig, Columbia, Mo.	12	125	Amelia, Ark	Surveys, gauges, and observations.
S. E. Moore, Memphis, Tenn.	$\frac{3}{30}$	125	Hillhouse, Miss	Upper Yazoo Levee district.
C. H. Purvis, Helena, Ark	$1\frac{11}{30}$	150	Helena, Ark	Upper White River Levee district.
L. Engstfeld, Memphis, Tenn.	$\frac{22}{30}$	135	Memphis	Do.
C. W. Stewart, Champaign, Ill.	3 $4\frac{10}{30}$	175 150	Memphis	Plum Point Reach, and surveys.
M. Gardner, Memphis, Tenn.	$8\frac{8}{30}$	125	Allisons Landing, Ark.	Upper White Riveer Levee district.
A. L. Dabney, Clarksdale, Miss.	$8\frac{28}{30}$	125	Beiths, Ark	Lower White River Levee district.
E. A. Fisher, Memphis, Tenn.	$\frac{17}{30}$	125	Amelia, Ark.	Surveys, gauges, and observations.
Charles LeVasseur, Memphis, Tenn.	$\frac{23}{30}$	75	New Madrid, Mo.	Improving harbor at New Madrid, Mo.

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, First and Second districts.

Class of property.	No.	Approximate value May 31, 1893.	Class of property.	No.	Approximate value May 31, 1893.
Steamer Minnetonka	1	$22,000	Machine-shop boats	2	$8,000
Steamer Titan	1	19,000	Floating dock	1	4,000
Steamer Itasca	1	5,000	Flat boats	3	450
Steamer Graham	1	7,000	Skiffs	30	300
Steamer Abbot	1	2,500	Storehouse	1	2,000
Pile-drivers	12	10,000	Tools, appliances, and outfit		14,500
Quarter boats	13	14,000	Office furniture		500
Barges	84	90,000	Surveying instruments		1,000
Sand pump	1	2,200			
Hydraulic graders	3	22,500	Total		$226,250
Derrick boat	1	1,300			

FIRST AND SECOND DISTRICTS.

Disbursements made under appropriation for improving Mississippi River, from June 1, 1892, to May 31, 1893.

Contracts made with—	For what made.	Disbursements under contract.	Liabilities under contract.	Total.
Hunter & Frey	Brush and poles	$54,427.65	$700.00	$55,127.65
Edward Hely	Stone	38,360.38		38,360.38
Hugh Morgan	Levee work	15,969.57		15,969.57
DeGaris & Arnold	do	14,580.70		14,580.70
Augustine McDonell	do	15,327.71		15,327.71
Patrick F. Lamb	do	24,468.88		24,468.88
Harvey & McGuire	do	20,216.10		20,216.10
J. S. McTighe & Co.	do	17,694.87	11,966.00	29,660.87
Hartnett & O'Brien	do	6,968.29		6,968.29
James H. Cary	do	20,291.99		20,291.99
C. F. DeGaris & Co.	do	17,536.19		17,536.19
Scott & Russell	do	14,519.14		14,519.14
Total		260,361.47	12,666.00	273,027.47

Disbursements made otherwise than under contract.

For what expended.	By public notice and sealed proposals.	In open market.	Liabilities.	Total.
Material and supplies	$15,298.80	$69,276.38	$13,158.27	$97,733.45
Subsistence	24,044.70	11,533.97	2,491.18	38,069.85
Services		215,158.30	5,000.00	220,158.30
Tools, appliances, and outfit	1,290.30	13,845.92	327.41	15,463.63
Miscellaneous		9,604.44	1,362.06	10,966.50
Total	40,633.80	319,419.01	22,338.92	382,391.73

Disbursements under appropriation for improving harbor at New Madrid, Mo., from June 1, 1892, to May 31, 1893.

For what expended.	In open market.
Material and supplies	$3,796.70
Subsistence	77.53
Services	2,199.33
Tools, appliances, and outfit	
Miscellaneous	65.41
Total	6,138.97

First and Second Districts.

	Cubic yards.
Aggregate yardage of levees on Mississippi River, June 30, 1892	10,354,614
Added by United States up to May 1, 1893	898,790
Added by others up to May 1, 1893	543,106
Total	11,796,510
Lost by caving or abandonment, June 30, 1892, to May 1, 1893	75,000
Aggregate yardage remaining May 1, 1893	11,721,510

Appropriations for improving Mississippi River, first and second districts.

May 31, 1892, balance available		$213,131.11
July 13, 1892, amount appropriated for improving harbor at New Madrid, Mo	$25,000.00	
July 13, 1892, amount appropriated for improving harbor at Memphis, Tenn	25,000.00	
August 5, 1892, amount allotted by the Mississippi River Commission	477,000.00	
December 30, 1892, amount received from proceeds of Government property	27.40	
February 13, 1893, amount received from proceeds of Government property	135.00	
		527,162.40
Total		740,293.51
December 30, 1892, deposited to credit of the Treasurer of the United States, being proceeds of Government property	27.40	
February 13, 1893, deposited to credit of the Treasurer of the United States, being proceeds of Government property	135.00	
March 8, 1893, amount transferred to allotment for rebuilding steamer Mississippi	25,000.00	
May 31, 1893, amount expended from June 1, 1892, to May 31, 1893, exclusive of liabilities outstanding May 31, 1892	559,127.03	
May 31, 1893, outstanding liabilities	22,338.92	
May 31, 1893, amount covered by existing contracts	23,000.00	
		629,628.35
Balance available		110,665.16

Amount that can be profitably expended in fiscal year ending June 30, 1895	1,000,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

APPENDIX 5.

REPORT OF CAPT. C. M'D. TOWNSEND, CORPS OF ENGINEERS, UPON OPERATIONS IN THE THIRD DISTRICT.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., June 1, 1893.

GENERAL: I have the honor to submit the following report of operations in the third district, improving the Mississippi River, for the year ending May 31, 1893:

This district extends from the mouth of White River to Warrenton, Miss., a distance of 220 miles. In its improvement work has been undertaken at Lake Bolivar Front, Ashbrook Neck, Greenville, Lake Providence Reach, Delta Point, and Vicksburg Harbor, and levees have been constructed and enlarged in the Lower Yazoo, Upper Tensas, and Middle Tensas Levee districts.

Lake Bolivar Front.—The object of this improvement has been to stop a caving of the bank, which was threatening the destruction of a large levee across the end of Lake Bolivar; 4,400 linear feet of mattress was constructed in 1888–'89, covering 4,250 feet of bank.

Additional description of this work will be found in the Report of the Chief of Engineers for 1889, p. 2704. The revetment consisted of a subaqueous mat 250 feet wide for a distance of 3,300 feet from the upper end, the lower 1,100 feet being covered by a mat of a width of 180 feet, reported as being built on a rapidly rising river.

The upper bank was graded to a slope of 1 on 3 and covered with a brush revetment loaded with stone. The following amounts of material were used in its construction:

Material.	Total.	Per square of 100 feet.	Per running foot.
Brush ....cords..	9,639	.41	2.26
Poles ....do....	1,669	.07	.39
Stone ....cubic yards..	10,154	....	2.39
Wire ....pounds..	129,310	5.5	30.4
Cable ....do....	25,025	2.4	5.88
Iron rods ....do....	51,924	5.04	12.2

In November, 1889, this work was repaired at the landing by sinking a foot mat 255 by 65 feet, and revetting a space 250 feet wide above. During the past season 2,234 cubic yards of stone have been placed on the upper bank revetment from a stage of about 5 feet above extreme low water to a two-thirds stage at points where the brush showed a tendency to decay.

Soundings were taken over this revetment in December, 1892, on ranges about 100 feet apart, and have been compared with a set taken in June, 1889. These soundings show a general fill over the mats 250 feet wide, while the 180-foot mat has sunk from 5 to 15 feet at its outer edge. On a number of ranges the mat appears to have rotated about an axis situated approximately at the low-water surface, and has assumed a steeper slope, although on three of the sections this action is not manifest. To 2 + 38 the mat could be detected by the leadsman. Below this range it appears to have been destroyed a distance of about 400 feet. An examination of the sections of 1889 shows that while the outer edge of this mat was in water from 50 to 60 feet deep, thalweg depths of from 90 to 100 feet obtained. In 1892, on ranges from 27 + 10 to 0 + 75 the thalweg has moved in closer to the mat.

This revetment has accomplished the purpose for which it has been constructed. The caving has ceased at the end of the lake. To prevent the tendency to undermine observed along the mat 180 feet wide it is proposed during the coming season to construct a mat over it of sufficient width to extend to the line of deepest water.

Ashbrook Neck.—The object of the work at this locality has been to prevent the caving of the bank which was threatening to form a cut-off across the Neck, with its resultant disturbance of the regimen of the river.

The project adopted for this improvement in 1890 consisted of a continuous revetment of the upper side of the Neck at its narrowest part for a distance of 8,000 feet, the mats to extend to the deepest water. During the season 1890–91, 2,820 linear feet of this revetment was constructed. Due to the high stage of the river at which the work was done, the subaqueous mat was given a width of 300 feet, with the exception of the lower 500 feet, which was constructed upon a rapidly rising river, and given a width of but 180 feet. The bank was graded to a slope of 1 to 3, and covered with a brush and stone revetment to a two-thirds stage.

The amount of material expended was as follows:

Material.	Total.	Per square.	Per running foot.
Brush ....cords..	7,901	.708	2.80
Poles ....do....	1,723	.136	.61
Stone ....cubic yards..	12,185	....	4.32
Wire ....pounds..	92,016	8.3	32.6
Cable ....do....	58,984	6.79	20.9

When work was resumed during the season 1891-'92, it was found that the mat 180 feet wide had been seriously undermined. A mat 300 feet wide was sunk over it, and the revetment continued 2,500 feet below the work of 1890, and 1,500 feet above it, 4,460 linear feet of revetment being constructed. The widths of the subaqueous mats varied from 300 to 250 feet. The bank was graded to a slope of 1 on 4, a brush and stone revetment constructed to 5 feet above the water level at the time the work was done, and the remainder of the slope riprapped with a layer of stone 10 inches thick to a two-thirds stage.

The following amounts of material were used:

Material.	Total.	Per square.	Per running foot.
Brush ....cords..	12,361.5	.661	2.72
Poles ....do....	2,156	.132	.48
Stone ....cubic yards..	24,768	*.688 †2.89	5.136
Wire ....pounds..	97,589	....	19.52
Cable ....do....	74,087	5.1	14.8

*Mat. †Upper bank.

Work was resumed September 15, 1892 and 2,610 linear feet of revetment constructed during the season, completing the project of 1890.

The subaqueous mats were given a width of 250 feet; the upper bank was graded to a slope of 1 on 4 and covered with a riprap of 10 inches of stone to a two-thirds stage. The method of construction was similar to that employed in former years, which has been fully described in preceding annual reports. Detailed statements of the cost of the work, quantities of material used, and of labor applied, will be found in the appended reports of Mr. Arthur Hider, assistant engineer, in local charge, and of Mr. Charles Miller, superintendent of construction.

The amounts of material used were as follows:

Material.	Total.	Per square.	Per running foot.
Brush ....cords..	5,285	.62	2.025
Poles ....do....	1,071	.14	.41
Stone ....cubic yards..	16,017.6	....	6.137
Wire ....pounds..	59,900	7.7	22.95
Cable ....do....	27,030	4	13.6

The cost per linear foot was $29.07. Soundings were made over the mats in November, 1892. When compared with a set taken during the construction of the work in 1891, they showed no evidence of the settlement of the revetment observed at other localities.

The levee constructed parallel to the axis of the Neck in 1891, to prevent the flow of water across it, was badly damaged by the flood of 1892. During the flood, however, there accumulated a large mass of drift on the upper side of the Neck, which appears to have caused a checking of the current and a deposition of considerable sand. The levee has not been repaired, but breaks in the drift pile have been closed with brush and fallen trees for the purpose of accelerating the deposit from the river.

Greenville Harbor.—The object of the improvement at Greenville has been to prevent the caving of the bank at this locality, which was rapidly destroying the city. In 1887, 1888, and 1889, the front of the town was protected by a system of spur dikes, which prevented further caving in their vicinity. Their construction has been fully described in preceding reports, but caving has continued in the bend above, which in 1890, during the flood, flanked the upper dikes and threatened the destruction of the remainder.

In 1891 it was determined to commence the revetment of the bend above the city; 6,600 feet of continuous revetment was constructed above the dykes of a character similar to that adopted at Ashbrook Neck, with the exception that the subaqueous mats were given a uniform width of 300 feet.

The amounts of material used were as follows:

Material.	Total.	Per square.	Per running foot.
Brush .... cords..	17,331	.7	3.11
Poles .... do....	3,151	.13	
Stone .... cubic yards..	40,271	*.64 †3.54	6.12
Wire .... pounds..	137,978	....	20.9
Cable .... do....	102,018	5	15.46

* Mat. † Upper bank.

During the past season the revetment has been extended 4,450 linear feet up the bend. Additional report of operations will be found in the appended report of the superintendent of construction, Mr. Luther Y. Kerr.

The amounts of material expended were as follows:

Material.	Total.	Per square.	Per running foot.
Brush .... cords..	11,367	.71	2.55
Poles .... do....	2,008	.13	.35
Stone .... cubic yards..	26,484	*.63 †3.03	5.74
Wire .... pounds..	93,352	5.36	20.98
Cable .... do....	63,432	4.28	14.92

*Mat. † Upper bank.

The cost of the work was $27.08 per linear foot.

Soundings were taken over the revetment on ranges 100 feet apart in April, 1893, and have been compared with similar sets taken in January, 1893, and during the working season of 1891. These soundings show a marked increase of depth along the outer edge of the mat—on some ranges, of over 40 feet. The mats appear to have adapted themselves to this scour, on some ranges by settling at their outer edge; but on others there appears to be a settlement the entire width of the mat.

Lake Providence Reach.—This reach extends from Carolina Landing, Mississippi (517 miles below Cairo), to Island 95, a distance of 35 miles. A brief description of the operations in this reach from 1882 will be found in my last annual report. The destruction of portions of the earlier works necessitated the construction of a new series beginning at Louisiana Bend, the head of the reach. This project was begun in 1889, during which season 6,024 feet of bank revetment was constructed at the head of the bend. During the season 1891–'92 this revetment was extended a distance of 5,000 feet.

During the present fiscal year the revetment has been further extended 5,835 linear feet. The revetment is of a character similar to that constructed at Ashbrook Neck and Greenville. The amounts of material expended were as follows:

Material.	Total.	Per square.	Per running foot.
Brush .... cords..	15,339	.88	2.63
Poles .... do...	2,622	.17	.44
Stone .... cubic yards..	37,952	*.63 †3.58	6.25
Wire .... pounds..	117,766	5.61	20.14
Cable .... do....	63,116	3.53	10.69

* On mat. † On bank.

The cost of the work was $27.86 per linear foot.

A detailed description will be found in the accompanying report of the superintendent of construction, Mr. George C. Thomas.

Soundings have been taken over this revetment similar to those taken at Greenville and Ashbrook Neck, but comparison can not be satisfactorily made with those taken in 1891, as the earlier soundings were made before the mat was sunk and extensive caving was noted between the time of taking the soundings and sinking the mats; but at the mouth of Old River a tendency to scour at the outer edge of the mat is also noted.

In compliance with a resolution of the Mississippi River Commission I append a report upon a comparison of the low-water soundings taken through Lake Providence Reach since 1882.

Vicksburg Harbor and Delta Point.—The works for the improvement of Vicksburg

Harbor consist, first, of the revetment of Delta Point to prevent its further recession; second, of the basin dredged in front of the city, and a dredged canal connecting it with the river at Kleinston.

Between the years 1878 and 1884, 10,700 feet of bank were revetted at Delta Point. From the records of the office I find that in 1882 and 1883 the width given to the sub aqueous mat was 144 feet; the bank was graded, to a slope of 1 on 2½, and covered with a brush revetment.

The following amounts of material were used:

	Per square.	Per running foot.
Brush............cords..	.41	.6
Poles............	1.16	1.66
Stone............cubic yards..	.41	.6
Wire............pounds..	1.18	1.70

No repairs have been made to the work for a number of years. A survey was made in November, 1892, and has been compared with soundings taken in 1884 and 1888.

At the upper end of the revetment the same scour is observed at the outer edge of the mat that was noted at Lake Bolivar, Greenville, and Louisiana Bend. Thalweg depths have increased over 50 feet on some sections, and the mat has assumed a much steeper slope. At the lower end of the work there has been a heavy deposit. The upper bank revetment, where not covered with sand, appears to have rotted out.

Upon completion of the work at Ashbrook Neck, the force was transferred to Delta Point for the purpose of constructing a mat to cover the portion of revetment where settlement had been observed. A mat 300 by 685 feet was built, but in sinking was torn from its fastenings and floated to the bar at the lower end of the point. It was then cut in two and towed to the incline of the Vicksburg, Shreveport and Pacific Railway, where it was sunk, it being impossible to tow it further up the river with the towing plant available.

It is proposed to make the repairs to this work during the next fiscal year.

The work of dredging the canal and basin in front of Vicksburg was begun in 1887. In the project then adopted it was proposed to inclose the canal and basin by a dam constructed across Centennial Lake from the city to De Soto Island, and along the island parallel to the canal, for the purpose of limiting the flow of water into the basin during floods and thus reducing the annual deposit of sediment.

The dam has been constructed of material dredged from the canal and basin, and has an elevation of from 25 feet to 35 feet above the zero of the Vicksburg gauge.

At the time of submitting the last annual report dredging was in progress under a contract with the Alabama Dredging and Jetty Company, which was completed July 31, 1892. The following amounts of material have been dredged to that date, measured in scows:

	Cubic yards.
1888............	324,941
1890............	465,573
1891............	331,204
1892............	294,447
Total............	1,416,165

The river and harbor act approved July 13, 1892, appropriates $80,000 for continuing the improvement of Vicksburg Harbor, and also contains the following proviso: "Improving mouth of the Yazoo River (Miss.) in accordance with the plan of Capt. J. H. Willard, Corps of Engineers, U. S. Army, dated February 4, 1892, contained in House Ex. Doc. No. 125, Fifty-second Congress, first session * * * $75,000." This plan contemplates closing the existing mouth of the Yazoo River and diverting the river through Centennial Lake by the city, and will necessitate the removal of the dam under construction. It was therefore recommended and approved that further work on this dam be suspended, and that the material dredged be deposited at such localities as would best conform to the project for the diversion of the Yazoo River adopted by Congress.

A contract was entered into with the Rittenhouse-Moore Dredging Company to dredge the canal and basin at 16 cents per cubic yard measured in scow, and dredging was resumed January 30, 1893. On May 31, 1893, there had been excavated 244,642 cubic yards, the cut being made to zero on the Vicksburg gauge.

Careful surveys have been made of the canal, in May, 1893, and characteristic sections are submitted herewith. A large fill is noted since August, 1892, estimated at 128,000 cubic yards measured in situ, or about 148,000 cubic yards measured in scows. During the preceding flood the deposit was estimated at 150,000 cubic yards. The total fill since dredging was begun has been about 400,000 cubic yards, the greater part of which has taken place in the canal.

Of the material dredged this season in the canal, over one-half has been a deposit since last year's flood. The removal of such a deposit requires the maintenance of a dredge in the channel at the time it is needed for navigation. Until the inflow from the Mississippi is restricted either by the construction of a dam or the diversion of the Yazoo River, the results attained by dredging in Vicksburg Harbor are not considered commensurate with the cost.

Upon the completion of existing contract, it is recommended that further dredging at this locality be deferred until the completion of the project for the diversion of the Yazoo River.

Further details of the work will be found in the appended report of Assistant Engineer H. St. L. Coppee, in local charge.

Levees, Lower Yazoo district.—This district is situated on the east bank of the river, and extends from the line between Bolivar and Coahoma counties (Mississippi) to Eagle Lake, a distance by river of 215 miles. The length of the levee line is about 190 miles. It is locally known as the Lower Mississippi levee district.

The levee section of 1882 had a crown of from 4 to 6 feet wide, slopes of from one on two and one-half to one on three, and a narrow berm on the river side. The standard section at present adopted by the local authorities has a width of crown of 8 feet and slopes of at least 1 on 3; the width of berm has been increased to 30 feet, and the levees are generally backed by a banquette 8 feet from the crown of the levee, from 20 to 40 feet wide, with a slope of from 1 on 3 to 1 on 5. Below the mouth of White River they have been generally raised to an elevation 1 foot above the estimated height which the flood of 1890 would have attained if there had been no crevasses in the third district. I am indebted to Maj. William Starling, chief engineer of the Lower Mississippi levee district, for the following statement of the yardage in levees in 1882, of levees caved away or abandoned since that time, and of subsequent work by local authorities up to January 1, 1893:

	Cubic yards.
Yardage in place in 1882, after the flood and before repair or rebuilding..	6,278,728
Abandoned in 1882	310,002
Leaving available in 1882	5,968,726
Work done by levee board July 1882–January 1893	10,892,685
Total	16,861,411
Abandoned since 1882	2,879,259
Levee-board work in place January 1893	13,982,152
U. S. Government work to June 30, 1892, less Ashbrook Neck	2,595,774
U. S. Government work during fiscal year 1892–'93	793,365
Total	17,371,291

During the year 1892 the local authorities erected 1,500,429 cubic yards. The result of this work has been to increase the height of levees in general 5 feet above that which obtained in 1882, while the area of cross-section to the height of that year's flood has been frequently increased threefold.

The allotment of $200,000 for this subdistrict during the fiscal year ending June 30, 1893, has been expended in enlarging the levee from Hughes to Eutaw (L 403 to 433), Station 2,380 to Station 3,400 of the local levee line. The standard section of the Lower Mississippi levee board was adopted for this work, so as to bring the levee line to standard height below the mouth of White River.

Exterior slopes of 1 on 3 were in general adopted, but where the material of which the levee was composed was sandy and exposed to wave-wash the slope was increased to 1 on 4. An abstract of the various contracts is appended.

Under the allotment of $150,000 for the fiscal year ending June 30, 1894, contracts have been awarded for enlarging the levee as follows:

Stations.		Estimated yardage	Price per cubic yard.	Name of contractor.
From—	To—			
		Cubic yards	*Cents.*	
0	290	118,000	19	Starling & Smith Co.
407	808	63,500	18¼	W. L. Withers & Co.
808	900	74,300	17¾	W. L. Withers & Co.
900	1000	70,000	19	Timothy Sullivan.
1000	1200	128,000	18	Starling & Smith Co.
1200	1264	61,000	16⅜	Arnold, De Garis & Co.
1330	1423	43,000	17¼	W. L. Withers & Co.
Leota	(L 510)	65,000	14 42/100	Merritt Williams.

These stations are located between the Bolivar-Coahoma county line (L 365) and Rosedale (L 397). The standard height adopted for these levees is the same as that for Government levees in the Upper Tensas district, three feet above the highest known water.

While the levee line through this subdistrict is considered the strongest of any in the third district, it has the defect of being located at numerous localities close to caving banks.

The standard height adopted by local authorities is also less than that to which the new levees on the opposite bank of the river are being constructed.

A profile of the levee line giving the flood heights of 1882, 1890, and 1892 accompanies this report, based upon a survey of 1888 by the Lower Mississippi levee board, with enlargements since that date plotted to net grade.

Levees, Upper Tensas district.—This district is situated on the right bank of the river and extends from the Arkansas River to the Louisiana-Arkansas state line. It is divided into three local levee districts, viz: The Red Fork levee district, which extends from the Desha-Lincoln county line on the Arkansas River to the mouth of Cypress Creek; the Desha Levee district from the mouth of Cypress Creek to the Desha-Chicot county line, and the Chicot Levee district, which contains Chicot County.

From the president of the Red Fork levee district I have the following statement of the condition of its levee line: Length of the line in 1882, 30 miles, containing about 1,500,000 cubic yards. Since that time there has been destroyed by caving banks and crevasses about 500,000 cubic yards, of which 126,000 cubic yards have been replaced. January 1, 1893, the length of levee line intact was 18 miles. No work has been done in this subdistrict by the General Government. Its levees are separated from the levees along the Mississippi River by Cypress Creek, but it covers the head of the levee system, and a crevasse in its levees floods the Tensas Basin by flanking the front line.

The levee line proper begins at Amos Bayou, about 17 miles north of Arkansas City, extends along Cypress Creek to Lucca Landing, on the Mississippi, and thence to the Louisiana state line, a distance of 84.8 miles. In 1882 there were numerous breaks. Such levees as remained after the flood had, in general, a width of crown of 4 feet, and slopes of from 1 on 2 to 1 on 3. They were of defective construction, containing stumps, logs, and growing trees, and appear to have been constructed in accordance with the whims of the planters along whose fronts they were located.

I am unable to give an accurate statement of the yardage in the levees, as the local boards have kept no record of the work they have done, with the exception of the amounts they have expended. A large part of this expenditure has been for the high-water protection of the levees, and has added little to the yardage in the line. A careful survey of the levee line was, however, completed in 1888, by the General Government. Based on that survey, and assuming that the yardage erected by the local boards and the State of Louisiana between 1882 and 1888 was equal to the amount in the levees which were abandoned between those dates, I deduce the following approximate Statement of Yardage:

	Cubic yards.
In levees in 1882	1,788,304
Built by the U. S. Government to June 30, 1892	3,098,606
Built by the Tensas Basin levee board 1891-'92	176,073
Built by Desha levee board 1891-'92	27,941
Built by Chicot levee board (estimated)	100,000
	5,190,924
Less levee abandoned 1888-'92	642,000
Total yardage in levees in 1892 *	4,548,924
Levees built by U. S. Government during fiscal year ending June 30, 1893	1,202,884
Levees built by Tensas Levee Board, 1893	41,187
Total	5,792,995
Less levees abandoned in 1893	150,000
Total yardage in levees 1893	5,642,995

* Of this amount 423,555 cubic yards have been erected by the Tensas Levee Board of Louisiana since 1882.

The levees constructed by the United States prior to 1890 had, generally, a width of crown of 6 feet, and slopes of 1 on 3. Since that date they have been given a width of crown of 8 feet, slopes of 1 on 3; through sloughs or bayous backed by a banquette from 8 to 10 feet from the top of the levee, and of widths of from 20 to 40 feet; the established grade is 3 feet above the highest known water.

I submit with this report a typical section of a levee of 1882 enlarged to the sections of 1888 and 1892. There is also shown on the same sketch the levee of 1882 topped during floods, a form of levee not infrequently found in this subdistrict.

The allotment of $310,000 for the fiscal year 1892-'93 for the Upper Tensas district has been expended in closing the crevasses that occurred during the flood of 1892, and in enlarging the weak portions of the levee line at the following localities:

Locality.	Character of work.	Distance from Cairo.	Yardage.
		Miles.	*Cubic yards.*
Middle Place	Loop enlargement	R...430	75,334.1
Panther Forest	Crevasse	R...451	172,435.1
Do	Enlargement	R...451	326,003.1
Pastoria	do	R...466	28,186.3
Luna	New loop	R...468	337,229.2
Upper Leland	Enlargement	R...469	95,382.2
Lower Leland	Crevasse	R...485	10,982.5
Lakeport	do	R...496	6,941.5
Do	Enlargement	R...496	85,493.7
Brooks Mill	Crevasse	R...506	64,895.7
Total			1,202,884

Under the allotment of $300,000 for the fiscal year ending June 30, 1894, the following contracts have been awarded:

Levee.	Station.		Distance from Cairo.	Estimated yardage.	Price per cubic yard.	Contractor.
	From—	To—				
			Miles.	*Cubic yards.*	*Cents.*	
Opossum Fork to Lucca	374	414	R....427	60,000	21	Starling & Smith Co.
Belleview	95	127	R....465	53,000	18.5	Arnold, Degaris & Co.
Upper Pastoria	127	164	R....466	55,000	20	The Whitehill Co.
Dulaneys Loop	624	690	R....485	79,000	15.94	Ernest Hyner.
Leland	690	790	R....486	120,000	18.94	Do.
Vaucluse	832	862	R....487	60,000	27	McLaughlin Brothers.
Lakeport:						
First section	1,216	1,292	R....494	56,000	12	J. S. Peak.
Second section	1,292	1,368	R....495	79,000	15	J. B. Lewis.
Below Lakeport	40	105	R....497	140,000	17.98	Ernest Hyner.
Adams Front	105	210	R....498	102,000	14.49	Kilpatrick & Storer.
Florence Front	210	306	R....500	87,500	14.49	Do.
Keigers Front:						
First section	50 stations		R....505	67,000	12	J. S. Peak.
Second section	30 stations		R....505	64,000	13.88	Timothy Sullivan.
Third section	23 stations		R....505	79,000	13.99	Do.

In anticipation of a flood in 1893 about $100,000 was left available. With this fund it is expected that the crevasses that have occurred this season can be closed, and the enlargement of the levee line be made continuous from Opossum Fork to Brooks Mill. with the exception of the railroad embankment at Arkansas City, a section of levee from the end of the enlargement of Panther Forest to Linwood, which it is expected will have to be abandoned within the next three years due to caving banks, and between Sunnyside and Lakeport, where the desired right of way can not be obtained. At Lucca Landing (R 427) and Eunice (R 442), however, the levee will only be enlarged to the section of 1888. The enlargement of the Fulton Lake Levee is under construction by the Tensas levee board of Louisiona.

Levees, Middle Tensas District.—The Middle Tensas Levee District extends from the Louisiana-Arkansas State line to Bedford, opposite Warrenton, and forms a portion of the Fifth Louisiana Levee District. The length of the line is 87.33 miles. Through the courtesy of Mr. H. B. Richardson, chief State engineer of Louisiana, I am enabled to submit the following resumé of the levees in the Middle Tensas District from February 1, 1882, to February 20, 1893:

	Miles.	Cubic yards.
Condition of levee line February 1, 1882	88.67	3,631,400
Crevasse openings in 1882	9.81	450,400
Remained standing after flood of 1882	78.86	3,181,000
Levees constructed by State and local authorities since flood of 1882		3,723,500
Raised and enlarged by State and local authorities		2,335,053
Built by United States to June 30, 1892		1,994,558
Built by United States during fiscal year ending June 30, 1893		460,216
Total	157.03	11,694,327
Levee line abandoned since 1882	69.70	4,407,400
Existing levee line	87.33	7,286,927

During the last fiscal year the Fifth Louisiana Levee District has erected 257,627 cubic yards, which has been principally expended in enlarging the Louisiana Bend Levee (R. 522) and the levee in front of Lake Providence (R. 542).

The allotment of $110,000 for this subdistrict has been expended in the construction of a levee from Millikens Bend to Cabin Teele (R. 581 to R. 584), to replace a levee which is rapidly caving into the river. Under the allotment of $100,000 for the fiscal year ending June 30, 1894, the following contracts have been made for the construction of a levee at Villa Vista (R. 574) to replace a levee which it is expected will be breached by caving banks before the next flood.

	Estimated yardage.	Price per cubic yard.	Contractor.
	Cubic yards.	*Cents.*	
First section	125,000	14.93	Manoah V. Henry.
Second section	123,000	18.45	John Scott & Son.
Third section	126,000	17	W. L. Withers & Co.

The levees recently constructed by the General Government have a width of crown of 8 feet, slopes of 1 on 3. Their grade is 3 feet above the flood of 1890. Their height is not as great as is desirable, and the higher levees should be backed by a banquette, but the levee line has been located too close to the river banks, and the funds allotted by the General Government are entirely inadequate to replace the levees which I anticipate will cave into the river in the next three years.

The floods of 1892 and 1893.—At the date of my last annual report the flood of 1892 was at its maximum. This flood attained a height in the third district only exceeded by that of 1893. In the following table are given the maximum heights at the gauge stations of the third district during the floods of 1882, 1890, 1891, and 1892, together with those at Helena and Cairo, and at Little Rock and Clarendon, Ark., while the crest of the flood was passing the mouth of White River:

Station.	1882.	1890.	1891.	1892.
	Feet.	*Feet.*	*Feet.*	*Feet.*
White River	48.40	50.4	47.7	49.3
Arkansas City	47	49.5	48.2	49.9
Greenville	41.68	43.45	43.25	44.45
Lake Providence	38.32	41	41.1	41.9
Vicksburg	48.75	49	48.1	48.4
Cairo	51 87	48.8	46.2	48.3
Helena	47.2	47.7	44.7	45.7
Little Rock	25.7	23.9	17.7	28.2
Clarendon		36.6	29	32.6

The effect of leveeing the Tensas Basin in raising the flood heights is clearly exhibited in this table, for while the flood of 1892 was 1.5 feet below that of 1882 at Helena, it exceeds it at the mouth of White River by nine-tenths of a foot, at

Arkansas City by 2.9 feet, at Greenville by 2.8 feet, and at Lake Providence by 3.6 feet.

The following are the maximum discharges of the river and the estimated flow past the latitude of Lake Providence for the corresponding years:

[In cubic feet per second.]

	1882.	1890.	1891.	1892.
Measured discharge	1,057,000	1,288,000	1,346,000	1,433,000
Estimated flow	2,000,000	1,720,000	1,400,000	1,760,000

An increase in the maximum river discharge since 1882 of at least 376,000 cubic feet is noted, about 35 per cent.

During the flood six crevasses occurred, which were confined to the Upper Tensas Levee District. The levees of Mississippi and Louisiana in the third district successfully withstood the strain brought upon them. The following table gives the width, location, and maximum measured discharges of the various crevasses:

	Location.	Date.	Width.	Maximum discharge per second.
		1892.	*Feet.*	*Cubic feet.*
Railroad embankment at Arkansas City	R....439	June 2..	2,279	14,523
Panther Forest	R....451	May 13..	2,327	94,507
Upper Leland	R....470	June 22.	420	18,300
Lower Leland	R....484	May 25..	435	15,700
Lakeport	R....496	....	200	....
Brooks Mill	R....506	May 9...	715	83,400

The crevasse at Lakeport occurred as the river was falling, and was not reported in time to obtain its discharge.

While a disastrous flood would have been caused by the water that poured through these crevasses, a considerable portion of the Tensas Basin would have escaped overflow if it had not been for a flood which swept across Amos Bayou around the head of the levee system from breaks in the levees along the Arkansas River.

Cypress Creek is the natural outlet of a number of bayous at the head of the Tensas Basin. To allow a drainage to this area, the levee line leaves the Mississippi River at Cypress Creek and extends along that stream to the banks of Amos Bayou, which in 1882 were above overflow. But due to the increase in flood heights that has been caused by the construction of the levees, and to breaks which have occurred in the levees on the Arkansas River, the floods of 1890, 1892, and 1893 have overflowed the Amos Ridge, flanking the levee line. The maximum discharge from this source has been measured since 1890 along the railroad from Arkansas City to Trippe, and is as follows:

	Cubic feet per second.
1890	50,000
1891	5,000
1892	300,000
1893	97,000

The large flow of 1892 was due to an abnormal flood in the Arkansas River. The measured discharge of 1893 has also arisen from the same source, but since the flood of the Arkansas has subsided a second rise in the back water has been observed, which can only be attributed to the Mississippi River.

By extending the levee along Amos Bayou to the land above overflow on Bayou Bartholomew this year's flow from the Mississippi would be cut off, but this line would afford inadequate protection to a flood in the Arkansas River like that of 1892. The only protection from the Arkansas River is a strong line of levees from Pine Bluff to the mouth of Cypress Creek, and if the leveeing of the Saint Francis front raises the flood height as much as has been caused by the closing of the Tensas Basin, a levee across Cypress Creek will also be required, in which case it will be necessary to drain that stream into some of the bayous south of the existing levee system.

The flood of 1893 has already attained a greater height from the mouth of White River to Greenville than that of 1892; from Greenville to Lake Providence it varies from one-tenth below that of 1892 to two-tenths above; below Lake Providence this flood has been exceeded by that of 1892.

Crevasses have occurred as follows: Adams' Front (R. 497), May 11; Keiger's Front (R. 505), May 14; Matthews Bend (R. 508), May 15; Wylys (R. 545), May 23; Station 202 on Cypress Creek levee, May 29.

All of these breaks, with the exception of that at Wylys, have occurred in the Upper Tensas levee district. The Mississippi side of the river has to date escaped overflow.

The inundation of the Tensas Basin will be as great as in the preceding year, the crevasse at Wylys being particularly destructive, a measured discharge May 26 of 200,000 cubic feet per second being observed.

Strenuous efforts have been made to hold the levee line, by both local and Government authorities, but no effort has been made to close the crevasses after they have occurred, nor hold the exposed ends of levees, except at Wylys, where two old levees, flanking the break, have been topped to check the caving after it exceeds 4,000 feet.

The maximum river discharge obtained to date at Wilsons Point has been 1,490,000 cubic feet per second, on May 24, the day after the crevasse at Wylys.

Surveys and observations.—Surveys have been made of the revetments at Lake Bolivar, Ashbrook Neck, Greenville, Louisiana Bend, and Delta Point. Hydrographic surveys of Lake Providence Reach and the bend above Greenville were made during low water; low-water discharge observations were taken at Wilsons Point, and the results forwarded to the secretary of the Commission. Parties are at present engaged in taking the high-water discharge at Wilsons Point and Arkansas City. At the request of the secretary of the Commission parties were sent to Little Rock and Clarendon to obtain the flood discharges of the Arkansas and White rivers. Reconnaissances have also been made of Ashbrook Neck and Carters Point during the flood to determine the force and direction of the flow across them.

The flow through the crevasses has also been measured.

The following approximate maximum discharges have been obtained.

	Date.	Stage.	Discharge per second.
	1893.	*Feet.*	*Cubic feet.*
Arkansas City	May 27	49.97	1,760,000
Wilsons Point	May 24	40.45	1,490,000
Little Rock	May 6	22.1	196,000
Clarendon	May 10	33.85	180,000
Crevasse, Station 202 on Cypress Creek	May 30	....	35,000
Crevasse (R. 497)	May 19	....	85,000
Crevasse (R. 505)	May 20	....	15,000
Crevasse (R. 508)	...do...	....	59,000
Crevasse (R. 545)	May 26	....	200,000

During low water soundings were taken on the various crossings in the Third district by the tow boats employed on the works of construction.

The following were the least depths obtained:

Crossing.	Distance from Cairo.	Least depth.	Date, 1892.
	Miles.	*Feet.*	
Prentiss	403.6	8½	Oct. 1.
Ozark Island	407	8½	Do.
Monteray	410	10½	Nov. 7-11.
Caulks Point	413.8	9	Sept. 20-29.
Content	420	10½	Sept. 24.
Catfish Point	423.2	8	Nov. 1, 2.
Choctaw	434	12	Oct. 25.
Linwood	464	13	Sept. 28.
Salona	474	7½	Oct. 23.
Warfield	484	15½	Oct. 24, 25, and Nov. 8-21.
Vaucluse	486.9	16½	Oct. 24, 25.
Refuge	491.1	9	Oct. 24-29.
Harwood	496	10½	Oct. 24-29, and Nov. 14, 15.
Longwood	501.8	9	Oct. 14-19.
Leota	511.7	9	Sept. 24-Oct. 14.
Sterling	515	5½	Oct. 24, 25.
Cordell	526	12½	Oct. 14.
Wilsons Point	531	16½	Oct. 24-Nov. 23.
Homochitta	535.9	15	Oct. 13.
Lake Providence	542.8	12	Nov. 7-22.
Ajax Bar	548	5½	Oct. 23.
Island 95	552	9	Nov. 3.
Hayes	554	19	Oct. 29.
Island 97	560	6	Oct. 16-31.
Duvals	568	15	Oct. 29.
Henderson	573.5	12	Do.

Care of fleet and repairs to plant.—The floating plant and other property when not in use has been collected and cared for about 1 mile below Greenville, Miss. There has been no loss of floating plant during the year. Extensive repairs have been made to the steamboats, the hulls of the *Osceola*, *Vidalia*, and *Vedette* having been rebuilt and new boilers placed in the *Etheridge*. The quater boats have been generally overhauled; extensive repairs were made to Grader No. 3, which was badly damaged during a storm. Five barges have been rebuilt, the machine and carpenter shops moved onto new hulls, and minor repairs made to the rest of the fleet.

A statement in detail of the expenditures on each piece is appended and also a list of floating property.

General remarks.—In the regulation of a river, two problems confront the engineer; first, the protection of the adjoining country from its destructive action; second, the utilization of the force contained in its waters so as to obtain the best navigable channel at all seasons—two apparently antagonistic propositions, the one requiring a large area of waterway to carry off the flood discharge at as low an elevation as possible, the other a restriction of the width of the river so as to obtain the greatest effects on the low-water channel. On the Mississippi River the prevention of overflows has been attempted by the construction of levees along its banks. Prior to the war of rebellion a continuous levee system existed through the Third district on both sides of the river, but of insufficient dimensions as shown by the crevasses reported in 1858 and 1859. During the war the levee line was neglected and the levees frequently cut by the contending armies.

Feeble attempts were made to close the gaps after the cessation of hostilities, but the flood of 1882 again destroyed miles of levees, leaving the levee system in a condition summed up in the reports of the various subdistricts.

The typical sketch submitted of a levee in 1882 in the Upper Tensas district concontains the average area of its levees. The levees in the Middle Tensas and Lower Yazoo districts had a greater average width of crown and a greater height. The average area of all the levees in the Third district in 1882 would exceed the section submitted by between one-third and one-half its area.

The problem which confronted the Mississippi River Commission at its organization was to confine a river which had a maximum discharge of 2,000,000 cubic feet per second in the third district within a channel which in 1882 discharged but one-half that amount. In the Lower Yazoo and Middle Tensas districts it has been efficiently assisted in its efforts by local authorities, the work done by the General Government being subordinate to that of the local boards, but in the Upper Tensas district the work done by local authorities has been insignificant. From this it has resulted that while the levees in Mississippi are rapidly attaining the section of 1892, during last year's flood there were over 40 miles of levees in Arkansas that had received little enlargement since 1882 except topping, the material for which had been frequently obtained from the base of the levee itself. As the levees of Arkansas could not resist the flood of 1882, an increase of flood height of over 3 feet has simply ensured their destruction. While the exertions of the people of the Middle Tensas district have equaled those of the Lower Yazoo, their levee line is not as strong, due to the 69 miles of levees which have been abandoned from caving banks. With the allotments made for the Upper Tensas district from the last appropriation for the Mississippi River it is expected that the section of 1892 will be completed the entire length of its line, with the exception of the banquette, which will also be erected where the levee crosses sloughs or bayous.

The results that have been achieved to date may be summed up as follows: That there can now be carried through the third district 30 per cent more water than in 1882 without flooding the country, and that for the same elevation there is an increased discharge, but from surveys of Lake Providence Reach and of the bend above Greenville it would appear that the increased area of cross section of channel has principally occurred above the level of low water.

The plans of the Commission for improving the low-water channel contemplate, first, increasing the force that will act on the bed of the river by confining the flood discharge between levees; second, in wide reaches to contract the low-water currents to narrower limits by means of dikes; third, by revetting caving banks to give permanency of direction to these forces.

Dikes have been constructed in Lake Providence Reach, as explained in preceding annual reports. Their immediate effect was beneficial, a marked increase in the depths of the low-water channel opposite them having been observed, but these depths have been gradually diminishing as the channel moved further from their sphere of action with the caving of the opposite banks.

But the changes which have taken place in the location of the low-water channel through this reach, which are shown in a map appended, offer conclusive evidence that little permanent improvement in the low-water navigation may be expected from the influence of levees, dikes, or from dredging, until permanency in direction is given to the forces acting by the revetment of the bends. An increased depth may be obtained for one season, but the continual caving of a bend above may be expected to so change the direction of the river currents that they will be acting on bars or banks outside of the improved channel and filling the channel up with the material they have scoured out.

The bank revetment which was constructed in 1883 and 1884 in Lake Providence Reach was destroyed. The cause is believed to be the narrow width given to the mats, as well as an insufficient thickness. No revetment constructed since that date in the third district has been lost, with the exception of exposed ends which have been flanked by caving above or below them. There has been noted, however, a general deepening of the river at the outer edge of the mat, which has occasioned a greater or less settlement. With the narrow mats at Lake Bolivar and Delta Point, it is deemed prudent to extend the revetment to the thalweg of the river, to prevent the continuance of this undermining action.

At Greenville I do not consider the situation at all critical. The mats were given as great a width as could be conveniently constructed on our mat barges, in anticipation of this very action. The maximum existing depths at the date of construction would have been covered by a 250-foot mat.

During the flood of 1890 there had been an abnormal caving of the bank, in some places exceeding 900 feet, accompanied by an abnormal fill in the river channel, thalweg depths of about 40 feet at low water being found, while low-water depths in bends in the third district of 80 feet are not infrequent. When the forces in the river are prevented from caving away the banks a condition exists similar to that in a bend where erosion is slow, and the river may be expected to try to assume a similar form of cross section, and thalweg depths exceeding 80 feet should result. The mats have in general adjusted themselves to their new beds in a satisfactory manner, and the fact that on some sections a settlement is observed the entire width of the mat does not, in my judgment, afford sufficient reason for the abandonment of the existing form of revetment.

The fact that the revetment of Delta Point has stood for ten years, though containing but one-half the material per square foot that has been put in the revetment of 1892, and with mats only one-half as wide, would indicate that in certain localities the existing form of revetment is sufficiently strong to hold the bank.

If the fine sand found in some portions of the Greenville Front, or the mud found at Louisiana Bend passes through the revetment, such sections should receive local treatment. To construct a revetment sufficiently thick to prevent such action would at localities where the soil is firmer be an unnecessary expense. These sections are of a limited extent even on a given front, and can be covered by an additional mat should the settlement ever become so great as to necessitate such action. While a still greater deepening of the river is to be expected at Granville, it is not yet evident that the revetment can not again adjust itself to the required change.

A financial statement accompanies this report.

Very respectfully, your obedient servant,

C. McD. Townsend,
Captain of Engineers.

Gen. C. B. Comstock,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

Financial statement.

LAKE PROVIDENCE REACH.

Balance May 31, 1892	$34,558.52	
Allotted during current fiscal year	176,000.00	
		$210,558.52
Expended to May 31, 1893		185,833.49
Balance May 31, 1893		24,725.03
In treasury		15,000.00
In hand		9,725.03
Less amount covered by existing contracts and liabilities		24,725.03

Expenditures apportioned:	
Labor on construction	$38,222.27
Material for construction	88,594.14
Subsistence	12,584.94
Cost of plant, repairs, and outfit	18,265.87
Care of public property	1,841.49
Towage and steamer expenses	23,278.01
Administration and office expenses	2,067.74
Medicine and medical attendance	907.38
Miscellaneous	71.65
Total	185,833.49
Amount that can be profitably expended during fiscal year ending June 30, 1895	500,000.00

Financial statement.

VICKSBURG, MISS., AND DELTA POINT, LA.

Balance May 31, 1892	$44,916.31
Expenditures May 31, 1893	38,876.69
Balance May 31, 1893	6,039.62
In Treasury	5,000.00
In hand	1,039.62
Available balance May 31, 1893	6,039.62
Expenditures apportioned:	
Vicksburg, Miss.:	
Cost of plant, outfit, and repairs	2,161.99
Subsistence	1,050.90
Care of public property	824.17
Administration and office expenses, and inspection	1,045.77
Dredging	24,705.44
Mileage, traveling expenses, and miscellaneous	84.84
Delta Point, La.:	
Labor on construction	2,274.68
Material for construction	4,395.93
Subsistance	421.36
Cost of plant, repairs, and outfit	279.57
Care of public property	231.33
Towage and steamer expenses	1,268.71
Administration and office expenses	72.00
Miscellaneous	60.00
Total	38,876.69

Financial statement.

GREENVILLE, MISS.

Balance May 31, 1892	$49,711.27
Expended to May 31, 1893	49,711.27
Expenditures apportioned:	
Labor on construction	6,383.39
Material for construction	32,983.90
Subsistence	3,124.69
Cost of plant, repairs, and outfit	3,042.87
Care of property	349.00
Towage and steamer expenses	1,400.39
Administration and office expenses	1,132.87
Medicine and medical attendance	286.72
Miscellaneous	1,007.44
Total	49,711.27

Financial statement.

LAKE BOLIVAR FRONT.

Balance May 31, 1892		$6,000.00
Expended to May 31, 1893		3,377.20
Balance May 31, 1893		2,622.80
In hand	$2,622.80	
Available balance May 31, 1893		2,622.80
Expenses apportioned:		
Labor on construction		922.09
Material for construction		876.57
Subsistence		307.48
Cost of plant, repairs, and outfit		243.69
Care of public property		34.50
Towage and steamer expenses		787.92
Administration and office expenses		9.60
Miscellaneous		195.35
Total		3,377.20

Financial statement.

ASHBROOK NECK.

Balance May 31, 1892		$111,196.84
Expended to May 31, 1893	$85,182.26	
Transferred to plant third district	25,000.00	
		110,182.26
Balance May 31, 1893		1,014.58
In hand		1,014.58
Less amount covered by liabilities		1,014.58
Expenditures apportioned:		
Labor on construction		20,263.35
Material for construction		34,595.06
Subsistence		7,944.36
Cost of plant, repairs, and outfit		10,161.49
Care of public property		1,527.51
Towage and steamer expenses		6,979.08
Administration and office expenses		1,704.58
Medicine and medical attendance		688.79
Miscellaneous		1,318.04
Total		85,182.26

Financial statement.

PLANT THIRD DISTRICT.

Balance May 31, 1892	$15,464.80
Allotted during current fiscal year	50,000.00
March 18, by transfer from Ashbrook Neck	25,000.00
Total	90,464.80
Expended to May 31, 1893	84,783.09
Balance May 31, 1893	5,681.71
In hand	5,681.71
Less liabilities	5,681.71

Expenditures apportioned:	
Labor on repairs	$37,724.01
Material for repairs	19,384.91
Care of plant, labor	4,613.77
Subsistence	14,894.72
Cost of plant, outfit, and supplies	6,683.63
Administration and office expenses	281.36
Miscellaneous	1,200.69
Total	84,783.09
Amount that can be profitably expended during the fiscal year ending June 30, 1895	113,000.00

Financial statement.

SURVEYS, GAUGES, AND OBSERVATIONS.

Balance May 31, 1892	$525.38
Allotted during current fiscal year	10,000.00
	10,525.38
Expended to May 31, 1893	10,226.96
Balance May 31, 1893	298.42
In Treasury	1,000.00
Due other allotments	701.58
Balance	298.42
Less liabilities	298.42
Expenditures apportioned:	
Pay, gauge observers	120.00
Surveys	6,372.55
Steamer expenses	2,949.99
Outfit, material, and stationery	433.00
Miscellaneous	351.42
Total	10,226.96
Amount that can be profitably expended during fiscal year ending June 30, 1895	12,000.00

Financial statement.

LOWER YAZOO LEVEE DISTRICT.

Balance May 31, 1892	$3,089.66
June 7, 1892, by transfer from general service	4,000.00
Allotted during fiscal year	200,000.00
	207,089.66
Expended to May 31, 1893	182,170.68
Balance May 31, 1893	24,918.98
In Treasury	24,000.00
In hand	918.98
	24,918.98
Less liabilities	9,918.98
Available balance May 31, 1893	15,000.00

Expenditures apportioned:	
Levee construction and repairs	$167,537.59
Engineering and office expenses	9,319.68
High-water protection	5,313.41
Total	182,170.68
Amount that can be profitably expended during fiscal year ending June 30, 1895	200,000.00

Financial statement.

UPPER TENSAS LEVEE DISTRICT.

Balance May 31, 1892	$22,719.40
June 7, 1892, by transfer from general service	5,000.00
Allotted during current fiscal year	310,000.00
Overpayment on vouchers	5.17
	337,724.57
Expended to May 31, 1893	310,245.25
Balance May 31, 1893	27,479.32
In Treasury	43,000.00
Due other allotments	15,520.68
	27,479.32
Less amount covered by existing contracts and liabilities	12,479.32
Available balance May 31, 1893	15,000.00
Expenditures apportioned:	
Levee construction and repairs	264,495.90
Engineering and office expenses	11,361.98
High-water protection	34,387.37
Total	310,245.25
Amount that can be profitably expended during fiscal year ending June 30, 1895	500,000.00

Financial statement.

MIDDLE TENSAS LEVEE DISTRICT.

Balance May 31, 1892	$5,977.15
Allotted during current fiscal year	110,000.00
	115,977.15
Expended to May 31, 1893	98,635.96
Balance May 31, 1893	17,341.19
In Treasury	7,000.00
In hand	10,341.19
	17,341.19
Less liabilities	7,341.19
Available balance May 31, 1893	10,000.00
Expenditures apportioned:	
Levee construction and repairs	85,757.11
Engineering and office expenses	4,563.26
High-water protection	8,315.59
Total	98,635.96
Amount that can be profitably expended during fiscal year ending June 30, 1895	250,000.00

Financial statement.

IMPROVING HARBOR AT VICKSBURG, MISS.

Act July 13, 1892 (special appropriation)	$80,000.00
Expended to May 31, 1893	24,187.74
Balance May 31, 1893	55,812.26
In Treasury	60,000.00
Due other allotments	4,187.74
	55,812.26
Less amount covered by existing contracts and liabilities	37,512.26
Available balance May 31, 1893	18,300.00
Expenditures apportioned:	
Cost of plant repairs and outfit	8.30
Care of public property	481.50
Administration and office expenses	20.00
Dredging	23,643.70
Mileage, traveling expenses, and miscellaneous	34.24
Total	24,187.74

Financial statement.

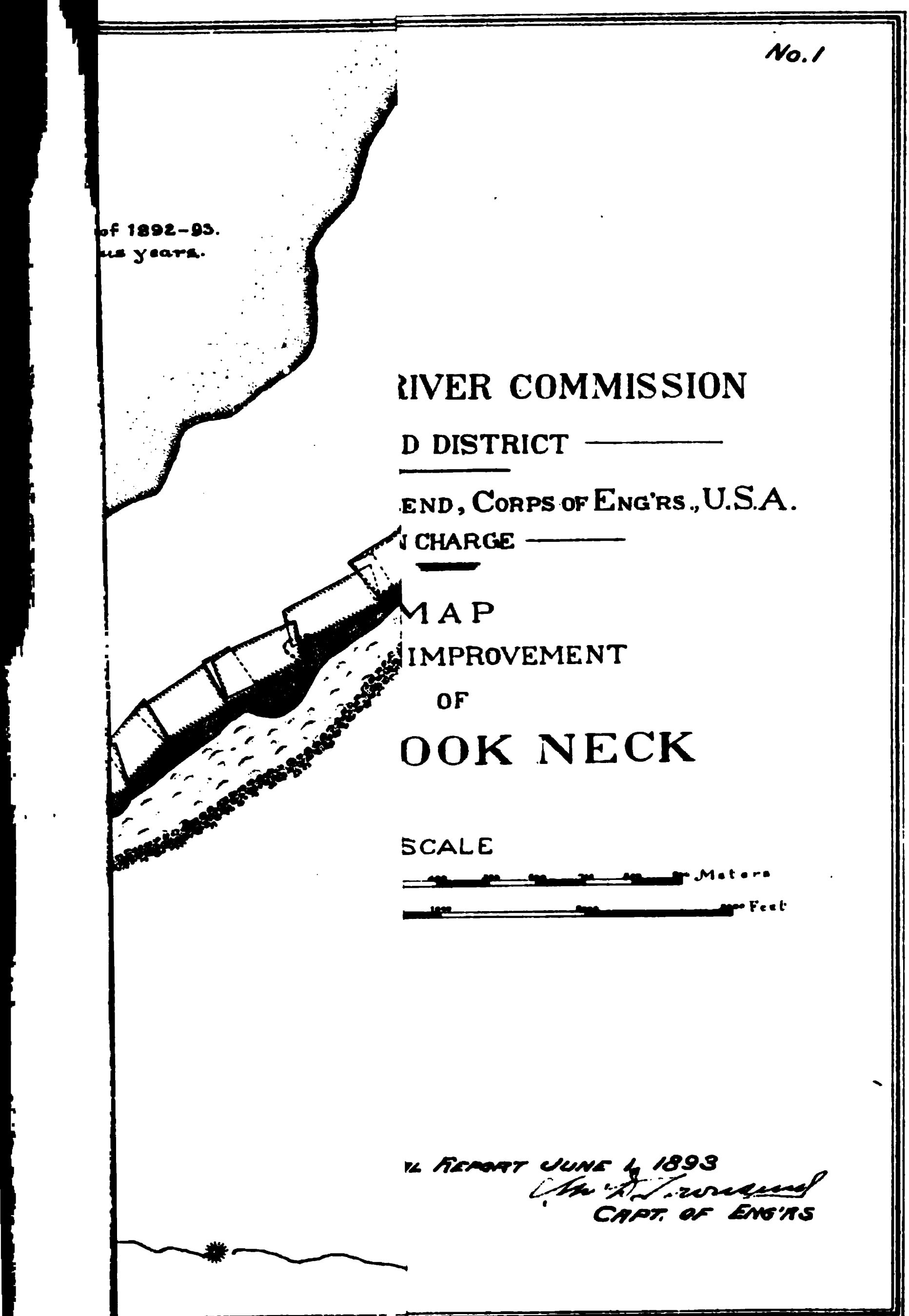
IMPROVING HARBOR AT GREENVILLE, MISS.

Act July 13, 1892 (special appropriation)	$100,000.00
Expended to May 31, 1893	94,758.46
	5,241.54
In Treasury	5,000.00
In hand	241.54
Available balance May 31, 1893	5,241.54
Expenditures apportioned:	
Labor on construction	26,764.39
Material for construction	46,876.11
Subsistence	4,206.99
Cost of plant, repairs, and outfit	7,720.78
Care of public property	1,338.16
Towage and steamer expenses	6,212.48
Administration and office expenses	1,182.60
Medicine and medical attendance	425.50
Miscellaneous	31.45
Total	94,758.46
Amount that can be profitably expended during fiscal year ending June 30, 1895	200,000.00

Financial statement.

DRY DOCK, THIRD DISTRICT.

Balance May 31, 1892	$11.43
Expended to May 31, 1893	11.43


No. 1
of 1892-93.
years.
RIVER COMMISSION
D DISTRICT
END, CORPS OF ENG'RS., U.S.A.
CHARGE
MAP
IMPROVEMENT
OF
OOK NECK
SCALE
Meters
Feet
REPORT JUNE 1893
CAPT. OF ENG'RS

APPENDIX 5 A.

:PORT OF ASSISTANT ENGINEER ARTHUR HIDER ON WORK AT GREENVILLE, ASHBROOK NECK, AND LOUISIANA BEND.

GREENVILLE, MISS., *March 10, 1893.*

SIR: I submit below final reports of Greenville Harbor, Ashbrook Neck, and Louıana Bend improvements, prepared by the superintendents of the respective works. As these reports give a complete statement of the cost in detail, and a full descripɔn of the work, they are forwarded as the final reports of these improvements.

A comparison is given below of the labor cost per unit, the quantities of material ·ed, and the average cost per linear foot of the revetment works at Ashbrook Neck, reenville Harbor, and Louisiana Bend last season.

Comparative statement.

COST PER UNIT FOR LABOR.

Kind of work.	Ashbrook Neck.	Greenville Harbor.	Louisiana Bend.
at work, per square	$1.356	$1.519	$1.452
:ading and dressing bank, per linear foot	2.387	1.845	1.003
ıving slope and revetment, per square	1.603	1.855	1.676
me (pile-driver)	1.423	1.570	1.344
me (wheelbarrows)	1.208	.760	.788
ıading stone, per cubic yard	.341	.537	.374

QUANTITY OF MATERIAL USED.

·ush, per square of mat ... cords	.62	.71	.85
›les, per square of mat ... do	.14	.13	.17
one, per linear foot ... cubic yards	6.14	5.74	6.25
ire, per linear foot ... pounds	20.96	20.98	20.14
'ire strand, per linear foot ... do	13.60	14.92	10.69
›ikes, per linear foot ... do	2.30	1.28	.84
aples, per linear foot ... do	.18	.04	.05
›st, per linear foot	$29.07	$27.08	$27.86

This gives the average cost of the three works per linear foot as $28. To this ıould be added cost of repairing during the season, interest, deterioration of plant, ıperintendence, surveys, and other expenses, as per following estimate:

epairs of plant for 12 months		$50,000.00
aluc of plant June 1, 1892	$169,391.00	
orty G. S. barges, at $1,000	40,000.00	
›eamer *Vedette*	6,000.00	
	215,391.00	
Ten per cent of this total		21,539.10
ɔr office expenses, surveys, etc		12,000.00
Total		83,539.10

he linear feet of work finished was:

Ashbrook Neck	2,610
Greenville Harbor	4,450
Louisiana Bend	5,835
Total	12,895

$3,539 ÷ 12,895 = $6.48 to be added, making total cost, say, $34.50 per linear foot.

Very respectfully,

ARTHUR HIDER,
Assistant Engineer in Charge.

Capt. C. McD. TOWNSEND,
Corps of Engineers, U. S. A.

REPORT OF MR. CHARLES H. MILLER, SUPERINTENDENT OF CONSTRUCTION, ASHB NECK.

DELTA, LA., *January 30*, 1

SIR: The following gives in detail the cost and amount of labor and materi in the work at Ashbrook Neck. Work was commenced on September 15, 18 2,610 linear feet of work was completed by January 7, 1893, and party dis with exception of towboat crew and clerical force, the crew of the boat bein to tow in "plant" and waiting for pay until the 11th of January, the clerical and assistant in charge being transferred to Delta Point work on January 14.

The following facts are to be considered in comparing the work just finishe that of the previous season at the same place:

First. The excessive cost per foot of the hand grading was due to an extr narily bad bank—one filled with large cypress stumps. An ordinarily bad would not cost over half as much. The excess was 75 cents per linear foot.

Second. The number of squares of bank slope paved this season for 2,610 feet of work was 75 squares in excess of the number laid last season for 4,460 this work. This was due to the fact that the work this season was all done a water, giving a very wide slope to be paved (104 feet), about the same amo stone being used both seasons (3.2 cubic yards per square). We have 1.48 excess per linear foot this season, giving, at $2.07 per yard, $3.06 per foot.

Third. Delay at the end of the season because of no stone.

From November 15 to December 12, 1892 (on which latter date the stone about exhausted), we received an average of one barge per day, counting Su and two rainy days. After December 12 there was needed to complete the wor barges of stone, and if received at rate of one per day (throwing out the 16t 19th, rainy days) we could have finished by December 24. Work was finished teen days later.

Expenses.

Steamer *Vedette*	
Superintendence, cooks, etc	
Board, 40 men	
Total	

Fourteen days, at $100 = $1,400 for 2,610 feet of work, gives an average exc cost of 53 cents per foot.

Fourth. The charges for towage were above the actual necessities of the These deductions would bring the cost of the work per foot to $25, a figure w which, under ordinary circumstances, the work could be done. A tracing of brook Neck map, showing entire work done each season, bar line for 1891 and and position of breakwaters has been prepared, blue prints from which accom this report.

Very respectfully,

CHAS. H. MILLER,
Superintendent Constructi

MR. ARTHUR HIDER,
U. S. Assistant Engineer.

Statement of cost of work done, 1892–'93.

Kind of work.	Cost per unit.	Labor cost per unit.	Material cost per unit.	Material expended.	Time list expended (total).	Subsistence expended (total).	Total cost of work.
t work (6,688 squares)	$3.99	$1.356	$2.63	$17,620.52	$6,956.59	$2,110.06	$26,687.17
draulic grading (2,500 linear set)	1.17	.842	.325	811.45	1,857.17	248.74	2,917.36
nd grading (2,500 linear feet)	1.503	1.445	.058	145.75	2,121.35	......	......
Team hire	......	......	......	......	848.00	643.43	3,758.53
vetment (1,089 squares)	7.476	2.346	5.131	5,586.87	1,960.45	594.62	8,141.94
ore connections (115 squares)	14.62	7.354	7.265	835.46	649.10	196.59	1,681.15
aring (10.2 acres)	53.999	54.00	......	......	422.61	128.18	550.79
ving slope	7.841	1.233	6.605	......	......	......	......
Driver, 500 squares	......	1.423	......	29.25	547.56	134.81	......
Hand, 2,310 squares	......	1.208	......	18,530.58	2,141.39	649.51	22,033.10
wing	......	......	......	2,586.19	3,884.96	894.74	7,865.89
ndries, office and traveling expenses	......	......	......	......	......	......	1,026.55
e-half value of property purchased	......	......	......	......	......	......	1,723.10
tal cost of work done, 2,610 linear feet, at $29.075 per foot	......	......	......	......	......	......	75,885.58
ilding breakwaters	......	......	......	......	173.24	52.24	224.48
pairs to old work	......	......	......	1,088.69	449.73	136.41	1,674.83
Total expended	......	......	......	47,234.76	22,011.15	5,789.33	77,784.89
one loaded (14,955.7 cubic yards)	.3414	......	......	......	5,531.75	70.35	5,602.10

Percentage of cost.

	Per cent.	Amount.
aterial, supplies, property, etc.	59.67	$45,282.98
ubsistence	6.20	4,705.94
owing	9.71	7,365.89
ffice and traveling expenses	1.35	1,026.55
uperintendence	3.08	2,338.87
abor	19.99	15,165.35
Total	100.00	75,885.58

WORK DONE.

,610 linear feet of mat built and bank slope paved, at $29.075 per linear foot, total cost of same		$75,885.58
Subdivided as follows:		
fat work:		
6,688 squares mat built, at $3.99		26,687.17
34,371 hours' labor, at 20.24 cents	$6,956.59	
34,371 hours' subsistence, at 6.139 cents	2,110.06	
	9,066.65	
4,164 cords brush	3,670.17	
911.3 cords poles	1,312.27	
4,636 cubic yards stone	9,605.51	
26,750 pounds wire cable	1,306.27	
56,135 pounds wire	1,573.47	
5,200 pounds spikes	122.18	
325 pounds staples	30.65	
	17,620.52	

NOTE.—The cost of labor and subsistence per hour was found by dividing net time ist ($15,647.20)—towage and loading stone having been deducted—and subsistence $4,714.53) by total hours of labor applied to work (76,799), giving $20.24 for labor and 6.139 as subsistence average.

Mat work—Continued.		
Labor, cost per square	$1.356	
Material, cost per square	2.63	
Hour's labor, per square	5.14	
Laying and ballasting revetment:		
1,089 squares revetment built and laid, at $7.476		$8,1
9,686 hours' labor, at 20.24 cents	$1,960.45	
9,686 hours' subsistence, at 6.139 cents	594.62	
	2,555.07	
899 cords brush	800.11	
130 cords poles	187.20	
2,645 pounds wire	75.02	
350 pounds spikes	8.02	
2,178 cubic yards stone, at $2.0737	4,516.42	
	5,586.87	
Labor, cost per square	2.346	
Material, cost per square	5.131	
Hour's labor per square	8.95	
Building and ballasting shore connections:		
115 squares, at $14.62		1,6
3,207 hours' labor, at 20.24 cents	$649.10	
3,207 hours' subsistence, at 6.139 cents	196.59	
	845.69	
222 cords brush	197.58	
30 cords poles	43.20	
267 cubic yards stone, at $2.0737	553.68	
280 pounds cable (wire)	13.47	
250 pounds spikes	5.72	
1,120 pounds wire, No. 12	21.81	
	835.46	
Labor, cost per square	7.354	
Material, cost per square	7.265	
Hour's labor, per square	28	
Clearing bank:		
10.2 acres, at $54		5
2,088 hours, at 20.24 cents	$422.61	
2,088 hours' subsistence, at 6.139 cents	128.18	
Paving slope:		
2,610 squares bank slope paved, at $7.841		22,0
2,196 hours' labor (driver)	$547.56	
2,196 hours' subsistence (driver)	134.87	
10,580 hours' labor (hand)	2,141.39	
10,580 hours' subsistence (hand)	649.51	
	3,473.27	
360 bushels coal, at $0.0975	29.25	
8,936 cubic yards stone, at $2.0737	18,530.58	
	18,559.83	
Labor cost, 500 squares, each (driver)	$1.423	
Labor cost, 2,310 squares, each (hand)	1.208	
Material, cost, 2,810 squares	6.605	
Hours' labor, per square (driver)	4.392	
Hours' labor, per square (hand)	3.03	
Hydraulic grading:		
2,500 linear feet bank graded, at $1.117		2,9
Labor, as per time list	$1,857.17	
Subsistence	248.74	
4,525 bushels coal	601.81	

draulic grading—Continued.			
247.5 gallons oils, etc		$161.16	
30 pounds waste		3.00	
10 pounds graphite		2.00	
51 pounds cotton rope		6.12	
25 yards duck		2.75	
225 feet wire and insulators		12.21	
56 pounds packing		22.40	
		811.46	
Labor, cost per linear foot		.842	
Material, cost per linear foot		.325	

Graders employed 43 working days.
Single-crew graders employed 15 working days.
Double-crew graders employed 28 working days.
Average cost per day, single crew, 8 hours, $44.
Average cost per day, double crew, 16 hours, $82.76.

ressing grade (by hand):			
2,500 linear feet of grade dressed, at $1.503			$3,758.63
10,481 hours' labor, at 20.24 cents		$2,121.35	
10,481 hours' subsistence, at 6.131 cents		643.43	
212 days' team hire, at $4		848.00	
		3,612.78	
175 detonation, caps		1.75	
600 pounds dynamite		102.00	
100 pounds powder		10.00	
400 feet fuse		32.00	
		145.75	
Labor, cost per linear foot		1.445	
Material, cost per linear foot		.058	
Hour's labor, per linear foot		4.19	
Towing:			
Total expenses of steamers *Osceola* and *Vedette*			7,365.89
Steamer *Osceola*:			
Time list		$1,543.49	
Subsistence		353.28	
9,427 bushels coal	$1,395.34		
50 carbons	1.25		
1 cad matches	.45		
2 pounds drop black	.40		
4 globe valves	1.00		
5 pounds plumbago	1.00		
14 pounds asbestos	7.70		
10 pounds candles	1.10		
		1,408.24	
Total cost of *Osceola*		3,305.01	
Steamer *Vedette*:			
Time list		2,341.47	
Subsistence		541.46	
		2,882.93	
11,472 bushels coal	$1,069.78		
(Included in same item)	.09		
159 gallons oils, etc	72.11		
3 dozen wicks	1.65		
10 pounds waste	1.00		
34 lamps and lantern globes	8.45		
241 yards crash	19.74		
41 pounds cotton rope	5.13		
		1,177.95	
Total cost of *Vedette*		4,060.88	

Steamer *Osceola* (double crew) in commission 42 days, average (running steadily, heavy towing from Cairo)		[illegible]
Steamer *Vedette* (single) 69 days, average (harbor work)		[illegible]
Steamer *Vedette* (double crew) 33 days, average (harbor and shore work).		[illegible]
Sundries expended and traveling expenses		1,[illegible]
One-half value of property purchased		1,[illegible]
Total expended on main work		75,[illegible]
Building breakwaters:		
851 hours' labor, at 20.24 cents	$172.24	
851 hours' subsistence, at 6.139 cents	52.24	
		2[illegible]
Repairs to old work:		
2,222 hours' labor, at 20.24 cents	449.73	
2,222 hours' subsistence	136.41	
525 cubic yards stone	1,888.69	
		1,[illegible]
Total amount expended		77,[illegible]

REPORT OF MR. LUTHER Y. KERR, SUPERINTENDENT OF CONSTRUCTION, GREENV[illegible] HARBOR.

GREENVILLE, MISS., *March 2*, 1[illegible]

SIR: The following report of Greenville Harbor improvement, giving the am[illegible] and description of work done, the quantity and cost of material, labor, etc. [illegible] respectfully submitted:

Description.—The plan of the work, as proposed at the beginning of the sea[illegible] was to put in 4,500 linear feet of revetment immediately above last season's w[illegible] the bank to be graded down to a slope of 1 on 4.

A continuous line of willow mattresses made and sunk with shore connecti[illegible] brush revetment securely fastened to the inside edge of the mat and extending up [illegible] slope to an elevation of 3 feet above the water on a falling river and 5 feet on a r[illegible] river. The shore mat and graded bank to be covered from the water's edge to [illegible] two-thirds stage, or about 30 feet on the Greenville gauge, with a stone pavin[illegible] inches thick. The plan was slightly modified during the progress of the work[illegible] will hereinafter appear.

Work began October 4, 1892, and closed February 11, 1893, with 4,450 linear [illegible] of work completed during the season.

Hydraulic grading was begun October 5, 1892, and discontinued December [illegible] with 4,450 linear feet graded. Grader No. 1 arrived from Louisiana Bend and be[illegible] work on October 6, using one 4-inch hose with a 1¼-inch nozzle; pump pressure, [illegible] pounds; steam, 80 pounds. A double crew was employed, working sixteen h[illegible] per day, during the entire service of fifty-eight days (Sundays excepted), in wh[illegible] time 3,240 linear feet were graded, an average of 55¼ feet per day. Grader No [illegible] arrived from Ashbrook Neck on November 6, and began work on the 7th, using o[illegible] 4-inch hose with a 1¼-inch nozzle; pump pressure, 140 pounds, and steam, 80 pou[illegible] per square inch. A double crew was also employed on No. 3, working sixteen hou[illegible] per day for twenty-nine days (Sundays excepted), grading 1,210 linear feet, an ave[illegible] age of 42 feet per day.

The bank before grading was about 39 feet high, composed of clean sand a[illegible] gumbo lying in strata varying in thickness and relative positions. This cau[illegible] considerable gullying and caving, especially when the gumbo was found at the t[illegible] with a stratum of sand beneath. The consequence of this was that when [illegible] grader had passed over the work it was left in a very rough and unfinished co[illegible] tion, badly cut up with gullies and by caving, which had to be dressed by means [illegible] shovels and drag scrapers. The cost of grading by the hydraulic graders was $1[illegible] per linear foot; the dressing, 65 cents per linear foot; total cost of finished slop[illegible] $2.20 per linear foot.

Mat building.—The construction of mats, on the same plan as followed at th[illegible] place during the season 1891–'92, was begun October 26 and completed Februar[illegible] 1893. Eight mats, all 300 feet wide and varying in length from 165 to 1,120 fe[illegible] were made and sunk. One pocket mat, 160 by 110 feet, was made and sunk at [illegible] head of the old work, where a part of mat No. 1 (1891–'92) had been broken in or[illegible] o make a good connection. The dimensions of the mats and the order of building re as follows:

	Linear feet.
Mat No. 1	970 by 300
Mat No. 2	1,120 by 300
Mat No. 3	310 by 300
Mat No. 4	640 by 300
Mat No. 5	340 by 300
Pocket mat	160 by 110
Mat No. 6	415 by 300
Mat No. 7	343 by 300
Mat No. 8	165 by 300
Total	4,463

Mat No. 1 was begun about 3,300 feet above the head of the old work, and it was ntended to cover this distance with three mats. Mats Nos. 1 and 2 were built and unk between October 19 and December 3, 1892. Of this time seventeen working lays were lost to mat-building for want of brush and poles. This expensive delay vas caused partly by the inadequate towing facilities, but principally by the failure of the contractor to furnish the material as rapidly as needed.

Mat No. 3 which, to close the gap between new and old work would have been something over 1,200 feet long, was begun December 5, 1892, and by the 18th of that nonth had been built 1,127 feet. The river was rising rapidly and it became apparent that further delay in order to complete the mat would be dangerous, and preparations to sink it were begun at once, but delayed by the heavy rains until December 21, when the sinking was attempted. About 300 feet was submerged, the head lowered to the bottom and released from the mooring barges, when they, owing to the rapid current (over 4 miles an hour), and the immense amount of heavy drift brought down by the sudden rise in the Arkansas River, which had accumulated under and above the barges, parted the headlines one after the other and swung around, releasing the entire mass of drift. This drift, floating down, became entangled with the inclined portion of the mat, which was at an angle of about 45 degrees, parting it 310 feet below the head. Eight hundred and ten feet of mat was carried down the river and grounded on the bar just above Warfield's Towhead, from whence it was subsequently towed to Louisiana Bend and succesfully sunk just above the mouth of Old River.

Mat No. 6 had to be sunk, on account of running ice, before it was completed the full length, leaving a small space between it and No. 1, which necessitated the building of mat No. 8.

The amount of brush used per square of mat built was 0.71 cords; of poles, 0.13 cords; total brush and poles 0.84 cords. Stone used in ballasting and sinking, 0.63 cubic yards. Total cost per square of completed mat was $3.876.

Shore work.—A shore connection was begun according to instructions and carried along with the mattress construction. Seven hundred and fifty linear feet of this work was built in front of mat No. 1, when, on the inspection of the Commission it was discontinued, and afterwards restricted to the water's edge.

Brush used per square of this work, 0.63 cords; poles, 0.11; total brush and poles, 0.74 cords.

The slope from low water to the 30-foot stage was covered with a stone paving 10 inches thick, carefully and closely laid by hand. The greater part of the stone was deposited on the slope by wheelbarrows, wheeling it up only far enough each time to make the work rapid and economical, keeping the slope well paved to a safe distance above the water. A steam pile-driver with traveler was used for a time to distribute stone on the upper slope. The comparative cost of the driver and barrows, while the driver was in service, was, driver, $1.57 per square; barrows, $0.57 per square. At the time when the comparison was made the circumstances were more favorable for the barrows than at any other time during the season's work, and the cost was below the average for that work, which was $0.76 per square. With the driver considerable time was lost in damp or rainy weather for want of friction between the drum and hoisting falls. If pile-drivers are to be used for this purpose in the future I would respectfully suggest that they be provided with larger drums, constructed of wood, and both drums and falls protected from the weather.

The stone used per square was 3.03 cubic yards; total cost of labor and material, complete, $7.69 per square.

Some damage was done the slope by the heavy rains during the latter part of the season, which was repaired by removing the stone from the washes, regrading the slope, and repaving with spawls to a depth of from 10 to 14 inches. The amount of brush, poles, and stone used per linear foot of completed work was—brush, 2.55 cords; poles, 0.35 cords; stone, 5.74 cubic yards. Total cost per linear foot of completed work, $27.08, including the cost of the lost mat. Deducting the cost of that par mat lost (810 feet), the cost per linear foot would be $25.19.

Material.—Brush and poles were furnished by contract on barges, delivered contractor's camp and towed by the United States service, the average dis towing being about 160 miles. Stone was obtained by contract, delivered at ville, Miss., on barges, to the amount of 27,627 cubic yards; 18,092 cubic yard loaded on barges by contract from the surplus stone at Greenville; 1,959 cub were reloaded from the surplus unloaded on the slope at the close of last s work. This reloading was done at odd times to keep the force employed. A deal of it had to be dug out, having been covered by a deposit during the las water. The expense of loading was 53 cents per cubic yard.

Soundings.—A series of soundings was made along the entire work on ran feet apart before and after grading the bank and after sinking the mat. So were taken along the old work also, and compared with the sections of last s The result of the observations are shown by the plotted comparative sections

Repairs to old work.—Considerable repairs were made to the old work dur season. Deep gullies had been cut in the slope during heavy rains by the water flowing down the slope, undermining the riprap. To repair these the stone was removed from the washes and stripped back from the sides, t sloped off, and the whole repaved with small stone to a depth of from 1 inches.

The cost of repairs made was $3,470.39. The larger part of this amoun expended in September in putting the old work in good shape at that tim other repairs had to be made to some extent later in the season. To av trouble with the surface water on the new work, the principal natural drai opened out down the slope, and carefully paved to a depth of from 10 to 14 with small stone. The items and percentages of cost of the work done this are as follows:

	Cost.	Pe
Materials and supplies	$71,898.17	
Labor	32,212.57	
Towage	9,815.19	
Subsistence	5,884.31	
Superintendence	3,525.00	
Office and traveling expenses	663.44	
Total	123,998.68	

Very respectfully,

LUTHER Y. KERR,
Superintendent Constru

Mr. ARTHUR HIDER,
U. S. Assistant Engineer.

Statement of cost of work done.

26,484 cubic yards stone		$50,[illegible]
11,366.9 cords brush		9,[illegible]
2,008.3 cords poles		2,[illegible]
93,362 pounds wire		2,[illegible]
66,432 pounds wire strand		2,[illegible]
800 pounds staples and clevises		[illegible]
Lumber		1[illegible]
47,704 bushels coal		4,[illegible]
5,600 pounds spikes		1[illegible]
Oils		[illegible]
		72,[illegible]
Labor pay roll	$40,147.23	
Subsistence	6,780.33	
		46,[illegible]
Miscellaneous material		[illegible]
One-half value property purchased		2,1[illegible]
Drugs		1[illegible]
Traveling expenses		[illegible]
Telephone rent		[illegible]
Miscellaneous		1,71[illegible]
Total expended		123,9[illegible]

'ork was begun October 5, 1892, and closed February 11, 1893, making—

ıber of days	129
t, Sundays and other days	27
Number of working days	102
lraulic Grader No. 1 worked .... days..	57
lraulic Grader No. 3 worked .... do...	28
Total	85

Laborers employed.

Month.	General work, number of men.	Hydraulic grading, number of men.
ber, 1892	1,690	434
mber, 1892	5,155	913
mber, 1892	5,771	333
ıary, 1893	5,334	....
uary, 1893	1,017	....
Total	18,967	1,680

18,967 ÷ 102 = 186 men per day on general work.
1,680 ÷ 85 = 20 men per day on hydraulic graders.

An average of 206 men per day.

Labor statement.

Month.	General work.	Hydraulic grading.	Towing.	Total.
	Hours.	*Hours.*	*Hours.*	*Hours.*
ember, 1892	4,180	....	....	4,180
ber, 1892	19,103	5,310	....	24,413
ember, 1892	46,315	10,928	5,096	62,339
mber, 1892	52,709	3,953	5,368	62,030
ıary, 1893	50,269	....	4,904	55,173
uary, 1893	11,405	....	2,592	13,997
Total	183,981	20,191	17,960	222,132

Distribution of time.

Kind of work.	Hours applied.
tress work	111,352
ing bank and revetment	43,882
raulic grading	26,520
sing slope	14,034
of fleet	13,706
ding stone	5,195
airing old work	7,443
Total	222,132

'ay rolls as per abstracts sent in, not including subsistence, $38,206.48 ÷ 222,132 = } cents per hour. Pay rolls $38,206.48 and subsistence $6,780.33 = $44,986.81. ,986.81 ÷ 222,132 = 20.2 cents per hour.

Labor per unit statement.

	Hours applied.	Squares built.	Linear feet worked.	Cubic yards loaded.
Mattress work	120,489	16,057		
Paving bank and revetment	48,451	5,292		
Hydraulic grading	26,520		4,450	
Dressing slope	14,034		4,450	
Loading stone	5,195			1,959

Kind of material.	Mattress work, 15,506 squares built.		Shore connection, 551 squares built.		Bank pa[illegible] square[illegible]
	Quantity.	Per square.	Quantity.	Per square.	Quantity.
Brush ... cords	11,019.8	$0.71	347.1	$0.63	
Poles ... do	1,947.7	.13	60.6	.11	
Stone (on 13,076 squares sunk)	8,291.7	.63			16,034.[illegible]
Stone (on 2,430 squares lost)	358.9	.23			
Wire ... pounds	90,827	5.86	2,535	4.60	
Wire strand ... do	66,432	4.28			
Spikes ... do	5,600	.36			
Staples ... do	200	.013			
Clevises ... do	600	.088			

NOTE.—All time, as per time sheets, included in above statements of distribution and c[illegible]

Material per linear foot of completed work.

Material.	Total quantity.
Brush ... cords	11,366.9
Poles ... do	2,0[illegible]
Stone ... cubic yards	25,585
Wire ... pounds	93,362
Wire strand ... do	66,432
Spikes ... do	5,600
Staples ... do	200

Labor per linear foot completed work.

For entire work, including hydraulic grading, towing, etc., 222,132 ÷ 4,45[illegible] hours.

NOTE.—See "Labor per unit statement" for classified work.

Subsistence statement.

Total cost of stores consumed ... $[illegible]
Total cost of serving ... [illegible]

Total cost of subsistence served ... [illegible]
Number of rations issued ...
Number of days' labor secured ...
Daily cost per ration, raw ...
Daily cost per ration, served ...
Daily cost per ration for each day's labor secured ...

NOTE.—Two thousand nine hundred and twenty-five days' labor secur[illegible] party not subsisted is not included in the above statement.

Tabulated unit statement of cost.

Kind of work.	Unit cost.		Total.	Entire cost work done.
	Labor and subsistence.	Material.		
ttress work	$1.519	$2.355	$3.876	$62,236.93
ring bank and revetment	1.855	5.837	7.692	40,706.06
iding and dressing slope	1.845	.353	2.198	9,781.10
iding stone	.537		.537	1,051.98
r rolls, etc., from Memphis office				3,658.47
ngs, transportation, office expenses, etc				988.88
e-half value of property				2,104.87
Cost of completed work				120,528.29
st of repairs to old work:				
Materials				1,966.48
Labor and subsistence				1,503.91
Total cost of repairs				3,470.39
tire cost of work done				123,998.68

50 linear feet work completed .... $120,528.29 + 4,450 = $27.08 per linear foot.
duct cost of lost mat 8,428.40

112,099.89 + 4,450 = 25.19 per linear foot.

NOTE.—Cost of towing, $9,815.19, distributed in above statement.

List of materials on hand at close of work.

ire, 3,360 pounds, at $2.49	$83.67
ire strand, 15,520 pounds, at $3.49	541.65
ikes, 12,000 pounds, at $2.29	274.80
al, 3,000 pounds, at 9¾ cents	292.50
Total	1,192.62

:PORT OF MR. GEORGE C. THOMAS, SUPERINTENDENT OF CONSTRUCTION, LOUISIANA BEND.

GREENVILLE, MISS, *February 16, 1893.*

SIR: The plan of the work as originally proposed was for a continuous line of sub- ueous mats 300 feet wide, commencing at the foot of last season's work and extend- g downstream a distance of 7,500 feet, with a shore connection of brush revetment tending up the bank to an elevation of 3 feet above the water on a falling stream id to 5 feet above when the river was rising; this revetment and the slope above to two-third stage, or to an elevation of 24 feet on the Lake Providence gauge, to be vered with a stone paving 10 inches thick; bank to be graded to a slope of 1 on 4. is plan was strictly adhered to in the construction of Mats Nos. 1, 2, and 3, but ider instructions slightly modified as to the remainder of the work, brush revet- ent being restricted to the water line.

Work began September 3, 1892, and closed down on account of high water January , 1893, with 5,835 linear feet of work completed during the season.

Clearing.—The bank along the proposed work was covered by a heavy growth of mber; this was cleared back a distance of 200 feet from shore; work was done r contract and same completed September 20, 1892. A total of 38 acres was cleared, a cost of $46.95 per acre.

A second contract was let on November 17 for the slashing of timber below this ason's work, to prevent its caving in and forming an obstruction to future work in ay of snags. This timber was slashed and cut into 20-foot lengths for a distance 3,400 feet; width of clearing, 200 feet; amount cleared, 15.6 acres, at $50 per acre.

Grading.—Hydraulic grading commenced on September 3, 1892, and was completed December 15, 1892, total amount graded being 7,000 feet. Grader No. 1 began ork on September 3 with double crew and two lines of hose, one 2½ inches and one inches; nozzles, 1 inch and 1¼ inch, respectively; pump pressure, 160 pounds; steam,) pounds. Grader was continuously employed sixteen hours per day until October when, owing to the danger attending its further progress by reason of snags, it as transferred to Greenville Harbor, having been in service twenty-seven days, cutting during that time 4,205 linear feet of slope, with an average of 156 f day.

Grader No. 77, with a single crew and one line of 2½-inch hose with 1-inch began work on September 17, and was in service until the completion of th December 15. A second line of 2½-inch hose with five-eighth-inch nozzle w on November 20, and was continued for the remainder of the work. Grader was in service sixty-nine working days, one-fifth of which time was lost on a of necessary repairs to machinery. It graded during the season 2,795 feet o with an average of 40 feet per day of eight hours. Pressure used was stea pounds; water, 150 pounds.

The bank (with the exception of 600 feet at the head of the work, which w sand) was composed of "gumbo," which cut rapidly and washed withou of gullying, and but for its constant sloughing, which was mainly due to the of water through the bank from a pond or basin behind the work, but litt work would have been required to complete the slope. A large ditch for the age of this pond was opened on December 9, followed by a total disappear sipe water along the slope, and no further sloughing occurred. I am convin had this ditch been opened at the beginning of the work the cost of slo ing would have been materially lessened, and for the future protection of th I would respectfully recommend a permanent system of drainage to preve accumulation of water behind it, by digging ditches 4 feet wide on botto slope of 4 feet to 1, the average length of which would be 350 feet, depth 5 wooden culvert of logs to be constructed in bed of ditch, with opening of 1 feet, to prevent its being closed by deposit from overflow.

Mat construction.—Mattress construction began September 13, 1892, and wa pleted December 28, 1892; a total of six mats were built and sunk, varying in from 830 feet to 1,187 feet; average lap, 20 feet; plan of construction the same previous season. Everything was favorable for the rapid construction of thi up to October 14, brush and poles being obtainedwithin 2 miles of the work, the supply at all times equal to the demand, but for the remainder of the material was obtained from Island No. 97, 40 miles below the work, and for i sufficient towing facilities delays were numerous and costly.

No trouble was experienced in sinking any of these mats, though, owing accumulation of drift against the mooring barges over Mat No. 6, it was advisable to put on an extra set of mooring lines and to strengthen the mat ting in a series of five-eighth-inch wire cables, securely fastened to the mat and extending down the mat a distance of 100 feet, with a round turn over ea of poles forming the frame of the mat. This was done to prevent the tearing of the mat in the event of the drift coming under the mooring barges.

Below are given the numbers and dimensions of the mats constructed:

	Fe
Mat No. 1	1,00
Mat No. 2	1,04
Mat No. 3	98
Mat No. 4	85
Mat No. 5	1,187
Mat No. 6	83
Total ....linear feet..	5,892

The amount of brush used per square was 0.73 of a cord; poles, 0.12; total and poles, 0.85 of a cord. Stone used per square in ballasting and sinking wa of a cubic yard. Cost complete, $3.739 per square.

Brush revetment was constructed as per instructions over Mats Nos. 1, 2, and elevation of 5 feet above the stage of water at which the mats were built. revetment consisted of a double line of brush laid crosswise between a top a tom frame of poles securely wired together every 8 feet. This plan was changed as per instructions for Mat No. 3, the double course extending only water edge, with a single course for the remaining distance.

For Mats Nos. 4, 5, and 6 the revetment extended only to the water line, as di A stone paving 10 inches thick was laid over the entire slope from low-water an elevation of 24 feet (Lake Providence gauge). This paving was closely h hand, strict attention being given to the filling in of all spaces to prevent d from wave wash.

The stone was unloaded on slope by means of wheelbarrows and a steam pile dr with "traveler," the comparative cost of which was:

	Per sq
Pile-driver	$
Wheelbarrows	

)uring the heavy rains toward the close of the work considerable gullying was ised by the surface water along the slope at the head of the work, which was irly all sand. These were thoroughly cleared of all loose material, regraded, and aved to a depth of 18 inches with small stone.

ι total of 7,079 squares of shore work was built during the season, including bank ·ing and the construction and paving of brush revetment. Brush used per square revetment was 0.85 cords; poles, 0.17 cords; total brush and poles, 1.02 cords. ·ne used per square of paving was 3.58 cubic yards. Total cost per square com- te, $9.887. The amount of brush, stone, and poles per linear foot of completed rk was: Brush, 2.62 cords; poles, 0.45 cords; stone, 6.25 cubic yards. Total cost · linear foot of completed work was $27.86.

Iaterial.—Brush and poles were delivered by contract, two-fifths of the amount fur- hed being obtained 2 miles above the work, the remainder 40 miles below. The ncipal amount of stone used was obtained by contract, shipped from North Ala- na by rail, and delivered on barges at Greenville, Miss. Nine thousand eight hun- ·d and forty-three cubic yards of stone were delivered on barges up White River, ·ved to the work, and unloaded on the bank during high water. The cost of re- ding this stone for use was $0.384 per cubic yard. I would respectfully suggest ιt in future where stone is to be unloaded on the bank at a high stage of water ιt it be deposited as nearly as possible in one body and as nearly the top of the nk as safety from caving will admit, so as to avoid the extra expense of a long eel and the constant shifting of runs. The percentage of the different items was follows:

	Total cost.	Per cent.
terial and supplies	$106,768.79	64.22
wage	12,171.59	7.32
bor	35,991.49	21.64
osistence	8,167.71	4.92
ce and traveling expenses	619.55	.37
perintendence	2,530.00	1.55
Total	166,269.13	100.00

Repairs, old work.—Repairs to the amount of $3,713.36 were done on the last sea- ι's work, consisting principally of reballasting revetment at lower end of work· system of brush dikes, extending from the top of the revetment to the main bank ιs ordered constructed to prevent scouring behind the work, but owing to the con- ιued high stage of water only two of these dikes were built. An itemized state- ·nt accompanies this report, giving the labor, subsistence, and material cost of each ιss of work in detail.

In conclusion, I beg leave to thank Messrs. W. M. Kellar, receiver of material, Mar- ι Christensen, foreman, and J. W. Webb, commissary, for their valuable assistance the management of the work.

The amount and value of material expended was as follows:

,952.3 cubic yards stone	$76,991.99	
,338.9 cords brush	14,587.81	
522.5 cords poles	3,933.75	
7,760 pounds galvanized wire	3,558.23	
0 pounds wire strand (three-eighths inch)	24.43	
,416 pounds wire strand (five-eighths inch)	2,728.86	
900 pounds wire spikes	124.81	
0 pounds staples	8.97	
,294 feet lumber	276.25	
,009 bushels coal	5,240.64	
ynamite, powder, etc	276.25	
160 gallons oils	302.17	
		$108,054.16
ιbor pay roll	45,536.00	
ιbsistence	9,086.96	
		54,622.96
iscellaneous material		345.38
·ansportation		103.90
earing bank		1,783.77
rugs		175.55
ationery		115.65
ae half value of property		1,067.76
Total expended		166,269.13

Began work September 3, 1892; closed January 14, 1893.

Number of days......
Lost Sundays and other days......

Number of working days......

Hydraulic grader No. 1 worked ......days
Hydraulic grader No. 77 worked ......do..

Labor empolyed.

Month.	General work (men).	H...
September	3,555	
October	7,012	
November	7,137	
December	7,352	
January	1,484	......
Total	26,540	

26,540 ÷ 105 = 253 men per day.
967 ÷ 96 = 10 men per day.

An average of 263 men per day.

Labor statement.

Month.	Hours of labor.		
	General work.	Hydraulic grading.	T...
September	33,962	5,922	
October	43,384	2,622	
November	70,617	2,440	
December	75,459	1,196	
January	20,540	......	
Total	243,962	12,180	

Total amount of pay rolls for labor, not including subsistence, $45,536.00 ÷ 256,142 = 17.8 cen[ts per] hour.

Distribution of time.

Kind of work.	F...
Mattress	
Paving bank and revetment	
Loading stone	
Dressing slope	
Hydraulic grading	
Care of fleet	
Total	

Material used per unit of mat.

[17,676 squares of mat built.]

Material.	Total.	...
Brush ......cords..	2,903.5	
Poles ......do....	2,120.0	
Stone (ballasting) ......cubic yards..	4,565.8	
Stone (sinking) ......do....	6,701.9	
Wire, galvanized ......pounds..	99,229.0	
Wire strand, five-eighths inch ......do....	62,416.0	
Spikes, wire ......do....	4,900.0	
Staples ......do....	800.0	

Material used per unit of revetment.

Material.	Total.	Per square.
h ...cords..	2,385.4	.85
...do....	497.5	.17
...cubic yards..	10,043.7	3.59
, galvanized...pounds..	18,273.0	6.50

Material used per unit of bank paved.

[4,274 squares paved.]

Material.	Total.	Per square.
e ...cubic yards..	15,336	3.58

k graded...linear feet..	7,125		
or required...hours..	12,800	=1.7	per linear foot.
e dressed...linear feet..	5,835		
or required...hours..	27,680	=4.75	per linear foot.
e loaded...cubic yards..	9,843.1		
or required...hours..	18 604	=1.9	per cubic yard.

Labor and material, per linear foot, completed work.

	Total.	Per linear foot.
Material.		
ush ...cords..	15,288.9	2.62
es ...do....	2,617.5	.45
ne...cubic yards..	36,447.4	6.25
re, galvanized ...pounds..	117,502	20.14
re, strand (five-eighths inch) ...	62,416	10.69
kes, wire...	4,900	.84
ples ...	300	.05
Labor.		
ading bank...hours..	12,180	2.09
in work ...do....	243,962	41.81

Subsistence.

tal amount expended ...	$9,086.96
tal cost of serving ...	2,245.15
Total cost, served...	11,332.11
umber of rations issued...	38,902
umber of days' labor secured ...	32,018
ily cost per ration, served ...cents..	29.2
ily cost per ration, raw ...do...	23.4
ily cost for each day's labor, secured ...do...	35.5

List of materials on hand.

,884 pounds wire strand (five-eighths inch), at $4.81...	$571.62	
,017 pounds wire strand, at $3.49...	314.70	
,905 pounds galvanized wire (five-eighths inch), at $3.49...	380.58	
,950 pounds galvanized wire, at $2.79 ...	417.10	
,440 pounds galvanized wire, $2.49...	1,305.03	
,300 pounds spikes, at $2.29...	258.77	
700 pounds staples, at $2.99 ...	20.93	
		$3,268.73

CREDITS.

137 cords poles to Greenville Harbor	$205.50
3,358 cords brush to same	328.01
300 cubic yards stone to same	720.56
2,816 bushels coal to Delta Point	274.56
2,100 bushels coal to survey party	204.75
Subsistence stores, survey party	86.27
Subsistence stores, Delta Point	105.90
Subsistence stores, care of fleet	666.33
One-half value of property purchased	1,067.75
Clearing bank below this work	780.50
	[illegible]
Total credits	[illegible]

Tabulated unit statement of cost.

Kind of work.	Unit cost. Labor and subsistence.	Unit cost. Material.	Unit cost. Total.	En[illegible] o[illegible]
Mattress work ... squares	$1.452	$2.287	$3.739	[illegible]
Paving bank and revetment ... do	1.676	8.214	9.887	[illegible]
Loading stone	.374	.01	.384	[illegible]
Grading and dressing bank, linear feet	1.003	.108	1.111	[illegible]
Clearing bank				
Towing				1[illegible]
Office expenditures				
Transportation				
Property, one-half value				1[illegible]
Total cost work done				16[illegible]
Cost of repairs to old work:				
Cost of material				[illegible]
Labor and subsistence				
Total cost of repair work				[illegible]
Entire cost of season's work				16[illegible]

5,835 linear feet work completed: $162,555.97 ÷ 5,835 linear feet = $27.86 per linear foot.

Very respectfully,

GEO. C. THOMAS,
Superintendent of Construct[illegible]

MR. ARTHUR HIDER,
U. S. Assistant Engineer.

APPENDIX 5 B.

REPORT OF ASSISTANT ENGINEER H. ST. L. COPPÉE ON WORK AT VICKSBU[illegible]

VICKSBURG, MISS., *April 30, 1*[illegible]

SIR:

* * * * * * *

Vicksburg Harbor.—At the time of submitting the last annual report the d[illegible] *Herndon*, of the Alabama Dredging and Jetty Company, was working in the ca[illegible] the extension of the original contract of 1891 (11.9 cents). The contract was comp[illegible] and the final estimate submitted July 31, 1892. As soon as the dredge was re[illegible] from the canal careful cross sections throughout the entire harbor were sound[illegible] the fill and general change in form of slopes, etc., obtained, a report of whic[illegible] forwarded to office at Memphis, together with detailed drawings, map sections. The fill in canal and basin from September, 1891, to August, 1892, as estimated [illegible] the soundings, was 129,604 cubic yards situ measurement, equal to 150,340 cubic [illegible] scow measurement. The dredging was carried on in such a manner as to obta[illegible] channel depth to the zero plane of the gauge, but this was not realized perman[illegible] as the sides of the cut slid in, reducing the level of the bottom to + 2 feet at [illegible] and later to an average in canal of + 6 feet on gauge, the basin being consider[illegible] deeper.

The theory of the subsidence of the sides of the excavation and cause of exce[illegible] fill was submitted with my report, mentioned above, it being recommended [illegible] slopes be cut and the dam at head of basin be completed in order to remedy t[illegible] defects.

On July 22, 1892, I submitted to you, in accordance with instructions, a project for he further expenditure of $80,000 in the harbor. This project contemplated the use f the "Menge" dredge and a contractor's plant, the continued dredging of the canal nd basin, and deposit of dumpage on dam at head of basin, and the constructing f a levee on said dam to level of De Soto Island.

The new contract was let October 1, 1892, to the Alabama Dredging and Jetty 'ompany at 16 cents per cubic yard in scows, the increase in price being caused to great extent by clause in specifications requiring dredges to keep channel open for avigation.

Work was commenced on this new contract January 30, 1893, your orders being to ut to the —5-foot plane, to dump no material on dam, and to cut perpendicularly, naking no slopes. The work of dredging is progressing satisfactorily up to the resent time, the material being placed in Lake Centennial, west of De Soto Island, t such points as will be beneficial if the Yazoo project for improvement of harbor s undertaken. An approximate survey of the canal and basin was made March 15, 893, and from the soundings it was estimated that a fill had taken place amounting o 120,062 cubic yards (in situ) since August, 1892. This fill includes all the area within the limits of the top of changing bank on each side of excavation, and shows hat there is a continuation of the increased accretion that has occurred in the last wo years. The only way to check this abnormal fill (as stated in my former reports) s by building the dam at head of basin to cut off all inflowing currents that are aden with silt from the main river.

The dredging up to date in the harbor is as follows:

Excavation (scow measurement):	Cubic yards.
1888	324,941
1890	465,573
1891	331,204
1892	294,447
1893 (to April 30, inclusive)	156,918

In 1888 the price in situ was 18 cents (Alabama Dredging and Jetty Company).

In 1890 the price in scows was 10 and 12 cents (Alabama Dredging and Jetty Company).

In 1891-'92 the price in scows was 11.9 cents (Alabama Dredging and Jetty Company).

In 1893 the price in scows was 16 cents (Alabama Dredging and Jetty Company).

The 12 cents in 1890 was account long haul, which was never made. The plant now employed by the contractor is the same as last year.

The original intention of working the "Menge" dredge after repairs were made was abandoned, and she has been looked after and is held in reserve to use in case the contractor fails to carry out the present contract in accordance with the specifications. With the exception of a new roof covering put on October, 1892, no repairs have been made since last year's extensive overhauling of her.

Delta Point, Louisiana.—Last year the continued caving of the bank above the Delta wharf boat and the deterioration of the revetment below necessitated a more careful study of the changes in the river along the Delta Point reach. A survey was made, and maps and cross sections of bank submitted. A comparison of the lines and sections of former years with the results of the survey showed that the change in the Delta bank had been gradual and not very extensive since 1884. A deep hole had been scoured out by the confined low-water current in the vicinity of the upper end of revetted reach, threatening its stability. On January 18, 1893, taking advantage of low water and availability of organized party that had just completed work above Greenville, outfit was sent down to construct and sink a mattress in the deep hole, it being deemed expedient to postpone the upper bank work till another low-water season. A mattress 300 by 685 feet was made in the usual manner, but in sinking was torn from its fastenings and floated to the bar just below the Vicksburg, Shreveport and Pacific Railway transfer incline, where the sunken end lodged. The mattress was cut in two, and the end remaining intact towed up in the eddy about half a mile and sunk, it being impossible to get it to the desired point. A full report of this was submitted in February. The cost of the work was as follows, including towing from Greenville and return:

Subsistence	$1,636.69
Wire spikes, cable, coal, etc., from Greenville	2,871.92
Repairs, brush, stone, hardware, coal, etc., purchased	4,577.11
Time list, labor account	3,896.70
	12,782.42
Credit, material returned, deducted	2,289.91
Total cost of work	10,492.51

This gives cost per square of 100 square feet of $5.10, and per running foot of $[illegible] Material per square and per running foot was as follows:

[Mattress 300 by 685 feet.]

Material.	Total amount.	Per foot.	Per squa[re]
Wire cable........pounds..	15,525	22.66	[illegible]
Wire No. 12........do....	9,635	14.06	[illegible]
Spikes........do....	1,700	2.48	
Brush........C..	1,219	1.78	
Poles........C..	292.8	0.427	
Stone........cubic yards..	1,059.57	1.54	

Only part of the mattress was sunk, 374.1 cubic yards of rock received. [illegible] included in this, being unloaded in a pile on bank for further use. The outfit [illegible] returned to Greenville, Miss., and party disbanded about February 15, 1893.

From my report, submitted at close of this work, I quote as follows:

"The following modifications in the practice in mattress work are suggeste[d] [to] me by the present disaster: In the first place, the necessity for reënforcing the d[illegible] men timber with iron where cable comes in contact with it, even when overla[illegible] to preclude any possibility of shearing; also the advisability of building heads ev[ery] 200 feet across mat, so that in case of drift the mat can be cut and the lower p[art] dropped downstream and sunk, or where it gets away it can be cut in 200-foot se[c]tions with heads of sufficient stiffness to sink."

As soon as the river drops to a medium low stage a careful examination and soun[d]ings should be made at Delta Point, in view of the probable necessity of furt[her] repairs and additions.

Yours, very respectfully,

H. St. L. Coppée,
U. S. Assistant Engineer.

Capt. C. McD. Townsend,
Corps of Engineers, U. S. A.

Appendix 5 C.

COMPARISON OF LOW-WATER SOUNDINGS TAKEN THROUGH LAKE PROVIDENCE REACH 1882–1891, INCLUSIVE.

Memphis, Tenn., *November 2, 189[illegible].*

Sir: I have the honor to invite your attention to the accompanying tables deriv[ed] from the low-water surveys of Lake Providence Reach since 1882, and to certa[in] deductions I make therefrom as to the effect of the works which have there be[en] constructed upon the low-water channel.

These tables contain the following data computed from the maps for every sect[ion] surveyed: First, the width at bank-full stage; second, the low-water width, tak[en] at an arbitrary stage (minus 1.5 feet); third, the maximum depth on the secti[on] at the same stage; fourth, the mean depth; fifth, area of the section—these elemen[ts] being computed both with and without chutes. These soundings were taken in th[e] years 1882, 1883, 1884, 1886, 1888, 1890, and 1891.

I have also made the following subdivisions of the reach, and computed the me[an] of the above data for the various sections: First, from Station 61 to 87, inclusiv[e], which is opposite and below the dikes which are in existence; second, from Statio[n] 39 to 60, which includes the section of river in which dikes have been constructe[d] and destroyed.

The portion of the reach above has been divided into three sections on account [of] the imperfections of the records, the early surveys only extending to Station 1[illegible]. Between Stations 14 and 29 there is a further complication, due to the fact that [in] certain years soundings were only taken at the even stations. In making compari[]sons, therefore, I have only selected, through this section, the even stations to deter[]mine the mean shown on blue prints by a full line. The mean of all soundings [is] shown by a broken line.

Tables showing these means are also appended, and they are also graphicall[y] represented on the accompanying drawings.

will be noted from these tables that there has been, first, a general increase in k-full width; second, a marked increase in the widths at a 1.5 stage to 1888, with exceptions of from Stations 61 to 87, while in 1891 all low-water widths show a inution from those of 1890; third, the maximum depths have diminished (though materially from Stations 40 to 87 until 1891); fourth, the mean depths have inished, except between Stations 61 and 87; fifth, that areas appear to have eased until 1888, and since then diminished.

n other words, the large expenditure on Lake Providence Reach, and for levees he third district, has been accompanied by a gradual increase in high and low er widths, and a diminution of maximum and mean depths, except between Stans 61 and 87, a distance of 26,000 feet, and the survey of 1891 gives grounds for prehension that further deterioration may there occur. The reduction in areas well as low-water widths in 1891 is also deserving of serious consideration, espelly where accompanied by a reduction of mean and maximum depths.

uch injurious changes in the regimen of the river through this reach should be ompanied by a deterioration in the navigable channel. A direct comparison of various crossings is impracticable on account of the extensive changes in their sition during the last ten years.

n the following table the least depths on crossings reported since 1884 is given, rived from the annual reports to 1890:

Year.	Least depth on crossings.	Lake Providence gauge.	Year.	Least depth on crossings.	Lake Providence gauge.
	Feet.	*Feet.*		*Feet.*	*Feet.*
34	11	5.8	1889	8.5	2.25
35	13	9	1890	11	8.5
86	8.5	5.3	1891	7	10
87	7	4.5	1892	6	1.25
88	9	.9			

In investigating the causes of these changes of regimen, it has been noted that the esults appear to be independent of the stage of water at which the surveys were nade. (Hydrographs of Lake Providence are submitted for the various years with he dates of survey recorded upon them.) And that records of the rate of cavng in the vicinity of Elton, as reported by the Louisiana board of engineers, indiate that in that section of the river caving has rapidly increased in recent years; rom 1860 to 1882 being at the rate of 100 feet a year, and from 1882 to 1890 at the ate of 262 feet per year, and from 1890 to 1891 over 600 feet per year.

Observations have been made of the intensity and direction of the river currents luring high and low water. Three stations were selected; one near the head of each at Pilchers Point, a second at Wilsons Point, about the middle of the reach, and the third at Shipland. The accompanying blue prints show the results of the observations at Wilsons Point and Shipland.

The thread of maximum velocity during floods did not coincide with that during low water. At Louisiana Bend and Shipland the thread of maximum velocity during floods was on bars outside of the low-water channel. A continual variation in the locus of the maximum velocity at Wilsons Point during floods was also observed.

It is to be noted that on the crossings above Shipland in 1891 there was but 7 feet, with the Lake Providence gauge reading 10 feet, and in 1892 7 feet, with the Lake Providence gauge reading 7.5 feet.

The observed mean velocities during floods at Wilsons Point have also been plotted under hydrographs. There has been an increase in flood heights from 1882 to 1892 of 3.6 feet; the floods of 1890, 1891, and 1892 exceeding in height that of 1882.

The maximum and minimum gauge readings at Lake Providence Reach during the period from 1882 to 1892 are as follows:

Date.	High water.	Low water.	Date.	High water.	Low water.
1882	38.32	8.00	1888	38.10	5.50
1883	36.47	4.20	1889	29.40	2.80
1884	38.40	5.55	1890	41.00	8.50
1886	37.91	2.55	1891	41.1	0.6
1887	38.00	1.52	1892	41.9	....

These observations appear to indicate, first, that while the closing of chute the diminishing the widths of the river by means of permeable dikes will ten rily improve its low-water channel, if the bank opposite be not protected caving, the channel will gradually remove from their sphere of action; se that the construction of levees in the third district has largely increased th acting during high stages, but that it is very doubtful whether this increase is being applied through Lake Providence Reach in such a manner as to p work useful in improving its low-water channel; that the force acting has increased during floods is shown, not only by the gauge heights recorded, b the measured maximum discharges past the latitude of Lake Providence, whi as follows:

	Cub per
1882	1,6
1890	1,2
1891	1,3
1892	1,4

The principal points of application of this increased force appear to be, first levees themselves, which it breaks when practicable; second, caving banks; t bars beyond the reach of low water; while in some places it is applied in des ing the low-water channel of the preceding year and increasing the amount of that is necessary to be moved during the succeeding low water.

That levees can be constructed that will better direct the flood flow through L Providence Reach is possible; the advisability of such construction is quest A levee is primarily and principally intended to protect land from overflow; to ize it for improving navigation would necessitate its location in the vicinity o currents to be controlled, and render it liable to be breached by caving bank normal function of protecting property is too important to expose it to such r for the uncertain benefits to be derived from its influence on the navigable cha

Levees will continue to be constructed, whether injurious or beneficial to na tion, and it becomes, therefore, a question of vital importance to prevent the f acting during a flood stage from causing a further deterioration of the navig channel at this locality.

Lake Providence Reach has been selected by the Commission for the applicati its methods of river improvement. The country will reasonably expect, with liberal appropriations of the last Congress, some practically beneficial results in interests of navigation. Without a large portion of the appropriation w remains unallotted be applied to Lake Providence Reach, or there is some cha in the physical conditions which have obtained during the last ten years, th expectations can not be realized.

The deductions made above are only intended to apply to the portion of the r surveyed. Data is insufficient to deduce a general law applicable to the w river. It is deemed probable that where the threads of maximum velocity coin during high and low water stages, the construction of levees has improved the water channel. I have, however, investigated the question whether the injur effects noted in Lake Providence Reach might not be due to a deepening of river above, which was gradually extending downward and causing a depositio the reach.

It can be stated that from the limited records of the third district no evid has been deduced that levees have improved the navigation at any locality betw White River and Warrenton.

Very respectfully, your obedient servant,

C. McD. Townsend,
Captain of Engineers.

Gen. C. B. Comstock,
Colonel of Engineers, U. S. A.,
President Mississippi River Commission.

rvey of November, 1888.—Sections of river from Range 5 to 13, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
	3,630	44	56,400	....	....	....	4,850	3,630	56,400
	2,440	43	58,100	....	....	....	4,460	2,440	58,100
	2,320	43	57,400	....	....	....	3,930	2,320	57,400
	2,310	36	54,000	....	....	....	3,260	2,310	54,000
	3,660	44	76,400	....	....	....	4,280	3,660	76,400
	2,400	65	54,700	....	....	....	4,060	2,400	54,700
	1,850	61	56,800	....	....	....	4,200	1,850	56,800
	2,110	61	66,500	....	....	....	10,000	2,110	66,500
	7,790	45	128,600	....	....	....	8,300	7,790	128,600
Total	28,510	442	608,900	....	....	....	47,340	28,510	608,900
lean area		67,655			....			67,655	
lean width		3,168			....			3,168	
lean depth		21.4			....			21.4	
lean maximum depth		49.1			....			49.1	
lean high-water width		....			....			5,260	

Survey of November and December, 1890.—Sections of river from Range 5 to 13, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
5	3,320	44	53,400	....	....	....	4,890	3,320	53,400
6	4,140	25	49,800	....	....	....	4,700	4,140	49,800
7	3,820	23	48,700	....	....	....	4,220	3,820	48,700
8	3,600	33	49,300	....	....	....	3,700	3,600	49,300
9	3,900	22	51,600	....	....	....	4,020	3,900	51,600
10	3,500	26	56,300	....	....	....	3,800	3,500	56,300
11	3,340	25	59,800	....	....	....	3,900	3,340	59,800
12	3,050	35	52,600	....	....	....	10,000	3,050	52,600
13	2,830	39	50,600	....	....	....	9,320	2,830	50,600
Total	31,500	272	472,100	....	....	....	48,550	31,500	472,100
Mean area		52,455			....			52,455	
Mean width		3,500			....			3,500	
Mean depth		15.0			....			....	
Mean maximum depth		30.2			....			....	
Mean high-water width		....			....			5,394	

Survey of October and November, 1891.—Sections of river from Range 5 to 13, inc[...] reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.
5	1,900	51	59,200				5,040	1,900
6	2,350	35	49,700				4,850	2,350
7	2,700	30	44,500				4,400	2,700
8	2,850	23	41,000				3,800	2,850
9	3,550	22	40,000				4,200	3,550
10	2,850	39	48,500				3,800	2,850
11	2,800	47	51,900				3,900	2,800
12	2,890	37	56,200				10,000	2,890
13	2,600	35	44,600				9,300	2,600
Total	24,490	321	435,600				49,290	24,490
Mean area	48,400							48,400
Mean width	2,721							2,721
Mean depth	17.7							
Mean maximum depth	35.7							
Mean high-water width								5,477

Survey of September, 1883.—Even sections of river from Range 14 to 28, inclusi[...] duced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.
14	4,100	55	120,200				4,200	4,100
16	2,100	74	88,500				4,270	2,100
18	1,600	102	75,000				4,100	1,600
20	1,680	85	71,200				4,670	1,680
22	1,600	64	66,800				5,900	1,600
24	2,000	62	65,100				3,930	2,000
26	3,150	27	51,500				3,960	3,150
28	1,700	32	28,400	630	18	7,600	4,620	2,330
Total	17,930	501	566,700	630	18	7,600	35,650	18,560
Mean area	70,838			7,600			71,788	
Mean width	2,241			630			2,320	
Mean depth	31.6			12.1			30.9	
Mean maximum depth	62.5			18			62.5	
Mean high-water width	52.8						4,456	

Survey of October, 1884.—Even sections of river from Range 14 to 28, inclusive, re[...] to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.
14	4,160	42	126,000				4,250	4,160
16	2,200	78	96,400				4,600	2,200
18	1,600	93	81,000				4,600	1,600
20	1,460	81	57,800				5,120	1,460
22	1,900	68	69,000				6,200	1,900
24	2,490	54	74,300				5,400	2,490
26	3,100	33	76,700				4,100	3,100
28	2,400	39	43,600	200	20	1,200	4,700	2,600
Total	19,310	488	624,800	200	20	1,200	38,970	19,510
Mean area	78,100			1,200			78,250	
Mean width	2,414			200			2,439	
Mean depth	32.4			6			32.1	
Mean maximum depth	61			20			61.0	
Mean high-water width							4,871	

urvey of November, 1888.—Even sections of river from Range 14 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
4	6,100	53	131,800	....	....	....	7,740	6,100	131,800
6	5,200	43	153,300	....	....	....	5,300	5,200	153,300
8	3,300	61	99,700	....	....	....	3,610	3,300	99,700
0	1,320	49	50,000	....	....	....	4,300	1,320	50,000
2	1,760	61	66,000	....	....	....	4,850	1,760	66,000
4	2,700	53	81,600	....	....	....	3,230	2,700	81,600
6	2,850	36	54,800	....	....	....	3,940	2,850	54,900
8	3,300	24	54,200	....	....	....	4,520	3,300	54,200
Total	26,530	380	691,400	....	....	....	37,490	26,530	691,400
Mean area	86,425			....			86,425		
Mean width	3,316			....			3,316		
Mean depth	26.1			....			26.1		
Mean maximum depth	47.5			....			47.5		
Mean high-water width	....			....			4,686		

Survey of November, 1888.—Sections of river from Range 14 to 28, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
14	6,100	53	131,800	....	....	....	7,740	6,100	131,800
15	5,700	52	135,800	....	....	....	6,450	5,700	135,800
16	5,200	43	153,300	....	....	....	5,300	5,200	153,300
18	3,300	61	99,700	....	....	....	3,610	3,300	99,700
20	1,320	49	50,000	....	....	....	4,300	1,320	50,000
21	1,450	56	51,700	....	....	....	4,300	1,450	51,700
22	1,760	61	66,000	....	....	....	4,850	1,760	66,000
23	1,920	60	65,900	....	....	....	3,300	1,920	65,900
24	2,700	53	81,600	....	....	....	3,230	2,700	81,600
25	3,000	47	65,500	....	....	....	3,620	3,000	65,500
26	2,850	36	54,800	....	....	....	3,940	2,850	54,900
28	3,300	24	54,200	....	....	....	4,520	3,300	54,200
Total	38,600	575	1,010,300	....	....	....	55,160	38,600	1,010,300
Mean area	84,192			....			84,192		
Mean width	3,217			....			3,217		
Mean depth	26.2			....			26.2		
Mean maximum depth	47.9			....			47.9		
Mean high-water width	....			....			4,597		

Survey of November and December, 1890.—Sections of river from Range 16 to 28, in reduced to —1.5 on Lake Providence gauge.

Range.	Main channel. Width.	Main channel. Maximum depth.	Main channel. Area.	Chutes. Width.	Chutes. Maximum depth.	Chutes. Area.	Channel and chutes. High-water width.	Channel and chutes. Width.
16	1,760	51	54,300	1,480	4	4,400	3,050	3,240
18	4,350	54	152,600				4,690	4,350
19	3,550	44	100,300				3,810	3,550
20	2,560	57	40,300				3,650	2,560
21	1,740	65	72,300				3,290	1,740
22	2,360	59	54,700				3,160	2,360
23	1,730	54	61,400				3,460	1,730
24	2,150	61	68,700				3,600	2,150
25	2,500	51	66,800				3,950	2,500
26	3,300	22	52,100				4,750	3,300
28	4,050	14	38,800				4,720	4,050
Total	30,050	532	762,800	1,480	4	4,400	47,160	31,530
Mean area	69,300			4,400			69,700	
Mean width	2,732			1,480			2,866	
Mean depth	25.4			3			24.3	
Mean maximum depth	48.4			4			48.4	
Mean high-water width							4,287	

Survey of November and December, 1890.—Even sections of river from Range 16 to inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel. Width.	Main channel. Maximum depth.	Main channel. Area.	Chutes. Width.	Chutes. Maximum depth.	Chutes. Area.	Channel and chutes. High-water width.	Channel and chutes. Width.
16	1,760	51	54,300	1,480	4	4,400	3,050	3,240
18	4,350	54	152,600				4,690	4,350
20	2,560	57	40,300				3,650	2,560
22	2,360	59	54,700				3,160	2,360
24	2,150	61	68,700				3,600	2,150
26	3,300	22	52,100				4,750	3,300
28	4,050	14	38,800				4,720	4,050
Total	20,530	318	461,500	1,480	4	4,400	32,620	22,010
Mean area	65,929			4,400			66,557	
Mean width	2,933			1,480			3,144	
Mean depth	22.5			3.0			21.2	
Mean maximum depth	45.4			4.0			45.4	
Mean high-water width							4,660	

rvey of October and November, 1891.—Sections of river from Range 15 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
	2,460	30	49,000				8,050	2,460	49,000
	2,100	28	37,600	1,960	26	29,100	5,000	4,060	66,700
	3,520	44	73,300				4,210	3,520	73,300
	3,400	56	92,100				3,900	3,400	92,100
	2,000	78	86,300				3,500	2,000	36,300
	1,500	77	68,500				2,400	1,500	68,500
	1,460	78	59,800				2,400	1,460	59,800
	1,860	62	72,900				3,850	1,860	72,900
	1,750	66	65,200				3,690	1,750	65,200
	1,920	54	62,000				3,620	1,920	62,000
	2,550	29	42,500				4,000	2,550	42,500
	3,050	16	38,800				4,890	3,050	38,800
Total	27,570	618	748,000	1,960	26	29,100	49,510	29,530	777,100
ean area	62,333			29,100			64,758		
ean width	2,298			1,960			2,461		
ean depth	27.1			14.8			26.3		
ean maximum depth	51.5			26			51.5		
ean high-water width							4,126		

urvey of October and November, 1891.—Even sections of river from Range 18 to 28, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
8	2,100	28	37,600	1,960	26	29,100	5,000	4,060	66,700
0	3,400	56	92,100				3,900	3,400	92,100
2	1,500	77	68,500				2,400	1,500	68,500
4	1,860	62	72,900				3,850	1,860	72,900
6	1,920	54	62,000				3,620	1,920	62,000
8	3,050	16	38,800				4,890	3,050	38,800
Total	13,830	293	371,900	1,960	26	29,100	23,660	15,790	401,000
Mean area	61,983			29,100			66,833		
Mean width	2,305			1,960			2,632		
Mean depth	26.9			14.8			25.4		
Mean maximum depth	48.8			26			48.8		
Mean high-water width							3,943		

Survey of September, 1883.—Sections of river from Range 30 to 39, inclusive, reduced —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	1,700	35	33,900	700	15	7,200	4,280	2,400	[illegible]
31	1,300	37	26,500	640	30	12,200	4,000	1,940	[illegible]
32	1,300	41	25,100	900	30	14,000	4,120	2,200	[illegible]
33	1,450	33	30,000	1,130	27	20,000	4,480	2,580	[illegible]
34	1,780	26	29,000	1,400	33	18,000	5,100	3,180	[illegible]
35	1,500	27	18,600	940	29	19,000	5,550	2,440	[illegible]
36	1,800	17	19,600	1,680	23	22,400	5,620	3,480	[illegible]
37	2,730	35	43,600	....	....	....	5,580	2,730	[illegible]
38	1,420	36	32,200	....	....	....	5,680	1,420	[illegible]
39	2,000	35	46,400	....	....	....	5,900	2,000	[illegible]
Total	16,980	322	304,900	7,390	187	112,800	50,310	24,370	[illegible]
Mean area	30,490			16,114			41,770		
Mean width	1,698			1,055			2,437		
Mean depth	17.9			15.3			17.1		
Mean maximum depth	32.2			26.7			33.7		
Mean high-water width	....			....			5,031		

Survey of October, 1882.—Sections of river survey from Range 30 to 39, inclusive, reduced —1.5 Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High water width.	Width.	Area.
30	800	42	20,800	1,400	32	22,500	4,200	2,200	[illegible]
31	725	39	22,800	1,400	29	22,100	3,790	2,125	[illegible]
32	1,200	44	38,600	1,200	22	15,000	4,100	2,400	[illegible]
33	1,525	39	30,000	1,100	15	10,000	4,490	2,625	[illegible]
34	2,100	52	35,600	....	....	....	5,100	2,100	[illegible]
35	2,160	37	31,500	....	....	....	5,600	2,160	[illegible]
36	2,600	42	47,400	....	....	....	5,630	2,600	[illegible]
37	2,200	28	37,500	....	....	....	5,650	2,200	[illegible]
38	2,400	20	36,100	....	....	....	5,700	2,400	[illegible]
39	2,900	17	36,000	....	....	....	5,980	2,900	[illegible]
Total	18,610	360	336,300	5,100	98	69,600	50,240	23,710	[illegible]
Mean area	33,630			17,400			40,590		
Mean width	1,861			1,275			2,371		
Mean depth	18.1			13.7			17.1		
Mean maximum depth	36.0			24.5			36		
Mean high-water width	....			....			5,024		

urvey of October, 1884.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
0	2,550	42	38,000	350	10	2,000	4,440	2,900	40,000
1	1,450	42	39,000	840	9	3,700	4,240	2,290	42,700
2	1,550	52	49,000	1,150	24	11,000	4,320	2,700	60,000
3	1,750	41	38,200	900	20	8,000	4,790	2,650	46,200
4	1,550	38	35,100	1,090	19	5,000	5,050	2,640	40,100
5	1,540	39	31,100	690	16	8,200	5,590	2,230	39,300
6	1,710	31	22,800	1,320	8	8,400	5,650	3,030	31,200
7	2,050	36	44,500	1,550	22	16,000	5,600	3,600	60,500
8	3,040	59	66,700	....	....	....	5,700	3,040	66,700
9	2,400	38	42,400	....	....	....	6,020	2,400	42,400
Total	19,590	418	406,800	7,890	128	62,300	51,400	27,480	469,100
Mean area	40,680			7.787			46,910		
Mean width	1,959			986			2,748		
Mean depth	20.8			7.9			17.1		
Mean maximum depth	41.8			16			41.8		
Mean high-water width	....			....			5,140		

Survey of November, 1888.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	4,880	18	47,400	....	....	....	4,880	4,880	47,400
31	2,350	29	36,200	700	20	8,800	4,760	3,050	45,000
32	2,520	37	45,100	1,800	19	11,000	5,400	4,320	56,100
33	2,050	46	45,400	1,100	18	12,700	6,430	3,150	58,100
34	1,220	36	37,400	1,150	14	9,400	6,940	2,370	46,800
35	1,640	41	37,800	900	23	10,400	7,050	2,540	48,200
36	3,800	40	59,400	....	....	....	6,450	3,800	59,400
37	2,340	38	37,600	....	....	....	5,820	2,340	37,600
38	2,960	40	52,500	....	....	....	5,550	2,960	52,500
39	4,250	25	74,900	....	....	....	5,850	4,250	74,900
Total	28,010	350	473,700	5,650	94	52,300	59,130	33,660	526,000
Mean area	47,370			10,460			52,600		
Mean width	2,801			1,130			3,366		
Mean depth	16.9			9.3			15.6		
Mean maximum depth	35			18.8			35.0		
Mean high-water width	....			....			5,913		

Survey of November and December, 1890.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum width.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	3,390	17	32,000	550	8	4,100	4,840	3,940	[illegible]
31	3,850	22	33,000	220	16	1,400	4,790	4,070	[illegible]
32	2,000	29	28,500	1,450	13	7,000	5,320	3,450	[illegible]
33	1,460	37	27,400	1,200	11	8,900	6,320	2,660	[illegible]
34	1,350	29	27,800	1,400	17	13,700	7,200	2,750	[illegible]
35	1,620	31	29,900	1,300	12	9,100	7,700	2,920	[illegible]
36	1,150	40	31,300	1,480	7	8,000	6,900	2,630	[illegible]
37	1,360	43	34,700	2,600	8	12,900	6,000	3,960	[illegible]
38	2,900	37	43,800	780	8	4,000	5,800	3,680	[illegible]
39	2,100	42	44,500	560	3	1,200	6,080	2,660	[illegible]
Total	21,180	327	332,900	11,540	103	70,300	60,950	32,720	[illegible]
Mean	33,290			7,030			40,320		
Mean width	2,118			1,154			3,272		
Mean depth	15.7			6.1			12.3		
Mean maximum depth	32.7			10.3			32.7		
Mean high water width	.....			.....			6,095		

Survey of October and November, 1891.—Sections of river from Range 30 to 39, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Width.	Area.
30	2,540	18	30,000	300	7	1,200	4,800	2,840	[illegible]
31	1,600	29	24,000	220	7	2,000	4,720	1,820	[illegible]
32	1,550	29	25,800	800	15	8,000	5,360	2,350	[illegible]
33	1,550	34	27,000	1,600	4	4,000	6,360	3,150	[illegible]
34	1,500	35	24,200	800	6	2,800	7,200	2,300	[illegible]
35	1,210	30	17,000	1,300	11	7,400	7,950	2,510	[illegible]
36	1,160	36	23,200	860	12	6,800	7,140	2,020	[illegible]
37	1,280	29	27,000	1,600	11	8,000	6,520	2,880	[illegible]
38	1,500	29	27,300	400	9	2,400	6,050	1,900	[illegible]
39	1,420	26	23,400	640	3.5	1,000	6,100	2,060	[illegible]
Total	15,310	295	248,900	8,520	85.5	43,600	62,200	23,830	[illegible]
Mean area	24,890			4,360			29,250		
Mean width	1,531			852			2,383		
Mean depth	16.3			5.1			12.3		
Mean maximum depth	29.5			8.55			29.5		
Mean high-water width	.....			.....			6,220		

urvey of October, 1892.—Sections of river from Range 40 to 60, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel. Width.	Main channel. Maximum depth.	Main channel. Area.	Chutes. Width.	Chutes. Maximum depth.	Chutes. Area.	Channel and chutes. High-water width.	Channel and chutes. Area.	Channel and chutes. Width.
0	2,740	20	31,050	....	....	....	6,050	31,050	2,740
1	2,200	27	26,850	....	....	....	6,400	26,850	2,200
2	2,170	18	31,200	....	....	....	7,050	31,200	2,170
3	2,270	25	34,050	....	....	....	7,300	34,050	2,270
4	1,980	24	31,200	1,320	37	31,200	4,380	62,400	3,300
5	2,580	54	53,550	....	....	....	3,250	53,550	2,580
6	2,790	43	52,200	....	....	....	3,570	52,200	2,790
7	2,970	30	52,500	....	....	....	4,100	52,500	2,970
8	3,130	22	46,200	....	....	....	4,500	46,200	3,130
9	2,800	25	38,250	....	....	....	5,290	38,250	2,800
0	2,680	20	37,500	....	....	....	6,130	37,500	2,680
1	2,100	27	30,150	....	....	....	7,550	30,150	2,100
2	2,130	27	36,900	....	....	....	7,880	36,900	2,130
3	1,920	29	37,350	....	....	....	9,180	37,300	1,920
4	2,030	31	33,450	....	....	....	8,350	33,450	2,030
5	2,190	27	32,250	....	....	....	7,000	32,250	2,100
6	1,550	32	25,650	....	....	....	6,000	35,650	1,550
7	2,380	35	39,450	....	....	....	5,000	39,450	2,380
8	2,750	39	43,200	....	....	....	4,630	43,200	2,750
9	3,040	27	43,950	....	....	....	4,550	43,950	3,040
0	3,680	23	47,850	....	....	....	4,780	47,850	3,680
Total	51,990	605	804,750	1,320	37	31,200	122,940	845,900	53,810
Mean area	38,321			31,200			40,281		
Mean width	2,476			1,320			2,539		
Mean depth	15.5			23.6			15.9		
Maximum depth	28.8			37			29.4		
Maximum high-water width	....			....			5,854		

Survey of September, 1883.—Sections of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel. Width.	Main channel. Maximum depth.	Main channel. Area.	Chutes. Width.	Chutes. Maximum depth.	Chutes. Area.	Channel and chutes. High-water width.	Channel and chutes. Area.	Channel and chutes. Width.
40	2,200	30	45,200	450	7	2,000	6,140	47,200	2,650
41	2,320	31	47,200	....	....	....	6,400	47,200	2,320
42	2,640	32	49,900	....	....	....	7,050	49,900	2,640
43	2,940	36	52,000	....	....	....	7,180	52,000	2,940
44	4,200	35	70,000	....	....	....	4,440	70,000	4,200
45	2,050	63	55,500	....	....	....	3,310	55,500	2,050
46	2,160	45	60,500	....	....	....	3,510	60,500	2,160
47	2,560	37	60,400	....	....	....	3,940	60,400	2,560
48	3,050	25	51,700	....	....	....	4,430	51,700	3,050
49	3,450	20	26,400	....	....	....	5,200	26,400	3,450
50	3,030	16	26,000	....	....	....	6,290	26,000	3,030
51	2,580	20	25,000	....	....	....	7,500	25,000	2,580
52	2,210	18	24,500	....	....	....	8,000	24,500	2,210
53	1,250	39	29,400	....	....	....	9,160	29,400	1,250
54	1,600	41	48,500	....	....	....	8,150	48,500	1,600
55	1,710	47	45,600	....	....	....	7,150	45,600	1,710
56	1,570	38	40,000	....	....	....	5,700	40,000	1,570
57	1,980	51	58,200	....	....	....	5,100	58,200	1,980
58	2,480	48	61,200	....	....	....	4,620	61,200	2,480
59	2,750	40	67,200	....	....	....	4,450	67,200	2,750
60	3,350	28	50,800	....	....	....	4,805	50,800	3,350
Total	52,080	740	995,200	450	7	2,000	122,525	997,200	52,530
Mean area	47,390			2,000			47,486		
Mean width	2,480			450			2,501		
Mean depth	19.1			4.4			19		
Mean maximum depth	35.2			7			35.2		
Mean high-water width	....			....			5,834		

Survey of October, 1884.—Sections of river from Range 40 to 60, inclusive, red[uced to] — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chu[tes]	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area
40	1,220	40	38,000	....	....	....	6,180	38,000
41	1,260	49	47,000	....	....	....	6,380	47,000
42	1,950	49	56,400	....	....	....	7,120	56,400
43	2,350	36	56,900	....	....	....	7,110	56,900
44	3,990	26	70,200	....	....	....	4,260	70,200
45	3,320	55	58,200	....	....	....	3,440	58,200
46	3,400	47	55,400	....	....	....	3,560	55,400
47	3,700	45	49,500	....	....	....	4,000	49,500
48	2,880	43	40,500	....	....	....	4,580	40,500
49	1,430	50	47,000	....	....	....	5,300	47,000
50	2,110	39	46,000	....	....	....	6,250	46,000
51	2,730	45	37,200	....	....	....	7,500	37,200
52	2,900	47	42,000	....	....	....	8,730	42,000
53	2,800	29	35,300	....	....	....	9,200	35,300
54	2,440	37	31,200	....	....	....	8,340	31,200
55	2,180	22	28,300	350	5	2,000	7,050	30,300
56	2,000	32	33,900	640	5	2,400	5,980	36,300
57	1,780	24	29,800	600	6	2,000	5,030	31,800
58	1,280	45	29,400	....	....	....	4,720	29,400
59	1,380	56	44,700	....	....	....	4,650	44,700
60	1,780	46	60,000	....	....	....	4,790	60,000
Total	48,880	862	936,900	1,590	16	6,400	124,170	943,300
Mean area		44,614			2,133			44,919
Mean width		2,328			530			2,403
Mean depth		19.2			4			18.7
Mean maximum depth		41			5.3			41
Mean high-water width		....			....			5,913

Survey of December, 1886, and January, 1887.—Sections of river from Range 40 t[o 60], inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
40	3,770	17	62,250	....	....	....	6,180	62,250
41	2,610	31	38,400	....	....	....	6,560	38,400
42	2,395	56	40,650	....	....	....	7,300	40,650
43	1,800	47	35,550	....	....	....	7,000	35,550
44	1,780	45	45,750	380	5	2,100	4,370	47,850
45	1,810	37	45,450	400	13	3,000	3,500	48,450
46	3,640	29	48,000	160	6	1,200	3,550	49,200
47	3,585	20	45,450	....	....	....	3,820	45,450
48	3,920	39	37,200	....	....	....	4,500	37,200
49	3,410	42	42,000	....	....	....	5,440	42,000
50	2,560	54	40,200	....	....	....	6,520	40,200
51	620	48	28,500	670	10	5,250	7,530	33,750
52	1,680	30	27,300	....	....	....	8,380	27,300
53	2,675	24	42,000	....	....	....	9,250	42,000
54	1,790	49	51,750	....	....	....	8,520	51,750
55	1,720	37	40,650	....	....	....	7,130	40,650
56	2,510	23	37,800	....	....	....	5,800	37,800
57	2,610	20	35,700	....	....	....	5,130	35,700
58	2,900	22	39,450	....	....	....	4,750	39,450
59	3,110	25	35,400	....	....	....	4,680	35,400
60	2,930	33	37,500	....	....	....	4,900	37,500
Total	53,825	718	856,950	1,610	34	11,550	124,810	868,500
Mean area		40,807			2,887			41,357
Mean width		2,563			402			2,639
Mean depth		15.9			7.2			15.7
Mean maximum depth		34.2			8.5			34.2
Mean high-water width		....			....			5,943

Survey of November, 1888.—Sections of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	4,330	29	60,100				6,280	60,100	4,330
41	3,100	33	51,600				6,820	51,600	3,100
42	2,450	46	54,100				7,340	54,100	2,450
43	2,150	47	56,300				7,080	56,300	2,150
44	2,200	43	54,300				4,300	54,300	2,200
45	2,150	42	57,500				3,550	57,500	2,150
46	2,300	37	53,400				3,550	53,400	2,300
47	3,180	32	63,500				4,100	63,500	3,180
48	4,320	26	60,000				4,750	60,000	4,320
49	4,650	21	58,300				5,320	58,300	4,650
50	5,730	17	61,700				6,450	61,700	5,730
51	3,700	33	50,800				7,940	50,800	3,700
52	2,540	47	45,200	1,100	16	4,600	8,700	49,800	3,640
53	1,350	37	27,700	1,050	13	7,800	9,050	35,500	2,400
54	2,100	27	43,400	1,300	10	8,600	8,520	52,000	3,400
55	2,200	38	48,200	1,350	8	4,400	7,200	52,600	3,550
56	2,900	38	49,400				5,780	49,400	2,900
57	2,150	54	59,200				5,120	58,200	2,150
58	2,160	47	62,400				4,700	62,400	2,160
59	2,100	40	53,000				4,600	53,000	2,100
60	3,380	31	54,400				4,960	54,400	3,380
Total	61,140	765	1,123,500	4,800	47	25,400	126,110	1,148,900	65,940
Mean area	53,500			6,350			54,709		
Mean width	2,911			1,200			3,140		
Mean depth	18.4			5.3			17.4		
Mean maximum depth	36.4			11.[illegible]			36.4		
Mean high-water width							6,005		

Survey of November, 1890.—Section of river from Range 40 to 60, inclusive, reduced to — 1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
40	2,620	33	52,400	450	3	600	6,220	53,000	3,070
41	2,150	61	52,900	600	7	1,500	6,700	54,400	2,750
42	2,700	36	52,400	450	5	1,400	7,500	53,800	3,150
43	3,160	32	52,500				6,950	52,500	3,160
44	3,300	45	73,200				4,600	73,200	3,300
45	3,700	47	67,300				3,700	67,300	3,700
46	3,800	44	68,700				3,800	68,700	3,800
47	2,890	37	62,600	750	5	1,400	4,300	64,000	3,640
48	2,490	34	57,100	700	14	5,800	4,700	62,900	3,190
49	2,000	30	36,500	700	11	2,400	5,500	38 900	2,700
50	2,080	28	38,600	810	8	4,800	6,550	43,400	2,890
51	2,080	22	29,300	820	12	6,600	7,890	35,900	2,900
52	2,150	14	24,700	750	16	8,000	8,890	32,700	2,900
53	2,750	26	30,800	660	22	6,000	9,500	36,800	3,410
54	2,700	23	23,400	1,200	14	6,800	9,220	30,200	3,900
55	2,150	22	24,700	400	9	2,000	7,500	26,700	2,550
56	1,650	16	15,200	990	43	25,000	6,010	40,200	2,640
57	3,700	49	58,600	400	6	1,000	5,150	59,600	4,100
58	2,100	50	44,800	1,180	17	7,400	4,960	52,200	3,280
59	1,590	50	32,100	1,160	10	8,400	4,750	40,500	2,750
60	1,960	61	42,800				4,940	42,800	1,960
Total	53,720	760	940,600	12,020	202	89,100	129,830	1,029,700	65,740
Mean area	44,790			5,569			49,033		
Mean width	2,558			751			3,130		
Mean depth	17.5			7.4			15.7		
Mean maximum depth	36.2			12.6			37.6		
Mean high-water width							6,159		

Survey of 1891.—Sections of river from Range 40 to 60 inclusive, reduced to—Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
40	1,600	26	30,400	660	3	800	6,300	31,200
41	2,160	29	30,000	600	3	1,000	6,830	31,000
42	3,520	19	32,400	600	3	800	7,430	33,200
43	2,900	29	38,200				7,020	38,200
44	3,000	25	43,200				4,720	43,200
45	3,330	30	59,400				3,710	59,400
46	3,120	42	62,400				3,880	62,400
47	2,250	40	53,600				4,350	53,600
48	1,810	39	45,800				4,750	45,800
49	1,650	41	45,600				5,580	45,600
50	1,840	42	40,000				6,500	40,000
51	2,280	26	46,400				7,940	46,400
52	2,550	23	40,000				9,000	40,000
53	2,700	16	30,800				9,600	30,800
54	2,880	15	22,600				9,280	22,600
55	4,000	17	29,800	820	25	10,600	7,800	40,400
56	1,460	22	17,600	500	27	7,400	6,140	25,000
57	1,300	22	14,800	1,600	18	13,200	5,320	28,000
58	1,400	24	13,200	1,600	20	12,600	5,150	25,800
59	1,200	22	13,000	1,600	17	20,000	4,750	33,000
60	1,610	24	23,200	2,380	12	15,800	4,950	39,000
Total	48,000	578	732,400	10,380	128	82,200	131,000	814,600
Mean area	34,876			9,133				38,790
Mean width	2,286			1,151				2,779
Mean depth	15.3			7.9				14.0
Mean maximum depth	27.3			14.2				27.9
Mean high-water width								6,238

Survey of October, 1882.—Sections of River from Range 61 to 87, inclusive, reduced to—on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
61	3,100	46	52,350				5,020	52,350
62	2,770	58	45,000				5,210	45,000
63	1,170	54	41,700	340	25	5,700	5,280	47,400
64	1,100	65	38,400	500	16	6,450	4,920	44,850
65	1,280	61	45,600	300	25	4,050	4,950	49,650
66	1,480	57	52,950	660	26	11,700	5,100	64,650
67	2,220	56	59,100	900	20	10,350	5,450	69,450
68	2,450	28	42,000				6,080	42,000
69	2,950	16	31,200				7,500	31,200
70	4,300	15	33,750	800	16	2,100	8,290	35,850
71	3,020	16	30,300	420	27	6,150	8,000	36,450
72	1,080	20	14,850	1,930	16	28,950	7,090	43,800
73	1,300	61	9,750	1,530	16	42,000	7,220	21,750
74	870	48	9,600	1,800	18	24,800	7,310	34,400
75	780	44	8,250	1,830	19	34,650	6,750	42,900
76	1,660	87	12,450	1,120	15	16,000	6,420	28,450
77	1,880	29	12,450	1,380	16	17,450	6,050	29,900
78	1,740	32	22,500	1,200	47	22,650	4,920	45,150
79	1,050	26	22,200	1,440	59	33,000	4,550	55,200
80	1,360	18	21,750	1,700	59	57,150	4,750	78,900
81	1,830	16	16,800	1,720	51	37,200	5,250	54,000
82	2,800	51	50,400				5,400	50,400
83	2,310	48	39,900				5,710	39,900
84	1,500	74	29,850				4,780	29,850
85	2,200	47	51,150				5,000	51,150
86	2,420	38	43,950				5,100	43,950
87	5,100	16	45,300				5,350	45,300
Total	55,750	1,077	883,500	19,070	471	330,350	157,450	1,213,850
Mean area	32,722			19,432				44,950
Mean width	2,065			1,122				2,771
Mean depth	15.8			17.3				16.2
Maximum depth	39.9			27.7				44.0
Maximum high-water width								5,831

Survey of September, 1883.—Sections of river from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
61	3,330	27	40,000	....	....	....	5,030	40,000	3,330
62	2,680	39	36,200	....	....	....	5,480	36,200	2,680
63	2,300	47	51,200	....	....	....	5,300	51,200	2,300
64	2,250	59	47,200	460	19	5,400	5,000	52,600	2,710
65	2,110	53	59,100	590	23	10,800	5,050	69,900	2,700
66	1,810	52	47,500	700	8	2,300	5,150	49,800	2,510
67	1,800	45	49,500	680	17	5,500	5,460	55,000	2,480
68	1,660	45	49,600	650	15	7,000	6,110	56,600	2,310
69	2,200	30	41,800	300	2	400	7,620	42,200	2,500
70	2,200	22	31,500	....	....	....	8,400	31,500	2,200
71	2,740	16	24,000	320	19	3,800	7,800	27,800	3,060
72	4,000	13	30,000	750	14	5,400	7,150	35,400	4,750
73	3,400	50	51,400	....	....	....	7,250	51,400	3,400
74	2,660	20	41,000	....	....	....	7,500	41,000	2,660
75	2,360	38	46,800	....	....	....	6,920	46,800	2,360
76	2,200	33	40,000	....	....	....	6,100	40,000	2,200
77	2,200	35	35,850	....	....	....	5,910	35,850	2,200
78	950	33	40,200	....	....	....	5,000	40,200	950
79	1,500	23	45,600	....	....	....	4,400	45,600	1,500
80	1,560	20	20,000	850	57	32,000	4,800	52,000	2,410
81	1,500	15	16,800	1,010	39	25,000	5,570	41,800	2,510
82	2,110	12	14,000	960	39	22,700	5,320	36,700	3,070
83	3,160	51	45,600	....	....	....	5,150	45,600	3,160
84	1,550	64	40,000	....	....	....	4,760	40,000	1,550
85	1,650	69	50,000	....	....	....	4,760	50,000	1,650
86	1,580	57	47,000	....	....	....	5,100	47,000	1,580
87	1,880	49	50,000	....	....	....	5,350	50,000	1,880
Total	59,340	1,017	1,091,850	7,270	252	120,800	157,440	1,212,150	66,610

	Main channel.	Chutes.	Channel and chutes.
Mean area	40,435	10,936	44,894
Mean width	2,197	661	2,467
Mean depth	18.4	16.5	18.3
Mean maximum depth	37.7	22.9	41.1
Mean high-water width	....	....	5,831

Survey of October, 1884.—Sections of river from Range 61 to 87, inclusive, reduced t- on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and ch-	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
61	2,600	36	53,800	....	....	....	5,100	53,300
62	3,090	19	40,500	....	....	....	5,210	40,500
63	3,100	32	43,400	....	....	....	5,400	43,400
64	2,280	56	26,000	150	8	1,200	5,000	27,200
65	2,050	51	33,000	500	24	8,400	5,090	41,400
66	1,780	50	42,000	650	13	6,000	5,240	48,000
67	1,840	49	40,600	700	12	5,600	5,550	46,200
68	1,390	53	43,800	350	8	1,400	6,080	45,200
69	1,750	41	43,000	350	6	1,300	7,050	44,300
70	2,050	36	44,800	....	....	....	8,040	44,800
71	2,400	25	38,400	....	....	....	8,020	38,400
72	2,400	29	40,800	....	....	....	7,150	40,800
73	2,840	26	35,000	840	30	18,500	7,480	53,500
74	3,200	18	23,600	700	29	10,600	7,550	34,200
75	3,650	23	26,000	950	29	16,000	6,990	42,000
76	3,460	20	56,800	400	17	3,100	6,400	59,900
77	2,490	49	48,600	420	17	4,000	6,100	52,600
78	1,800	49	37,700	800	5	3,000	4,900	40,700
79	1,220	54	36,000	850	5	3,600	4,550	39,600
80	2,000	34	38,000	400	4	1,400	4,800	39,400
81	2,500	21	36,900	500	8	2,800	5,490	39,700
82	2,780	23	34,400	840	27	8,000	5,550	42,400
83	2,760	17	28,400	700	40	1,400	5,190	29,800
84	4,000	52	35,700	....	....	....	4,800	35,700
85	3,700	49	33,400	....	....	....	5,220	33,400
86	1,880	55	40,000	....	....	....	5,780	40,000
87	1,540	58	52,000	....	....	....	6,100	52,000
Total	66,500	1,025	1,052,100	10,100	282	96,300	159,830	1,148,400
Mean area		38,966			5,665			42,533
Mean width		2,463			594			2,837
Mean depth		15.8			9.58			14.9
Mean maximum depth		37.9			16.6			39.7
Mean high-water width	....			....				5,919

rvey of December, 1886, and January, 1887.—Sections of river from Range 61 to 87, inclusive, reduced to —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
	3,000	19	34,350				5,100	34,350	3,000
	3,500	22	39,300				5,350	39,300	3,500
	3,490	31	39,150	100	5	450	5,460	39,600	3,590
	3,260	47	38,100	280	5	1,200	5,100	39,300	3,540
	2,940	53	33,600				5,190	33,600	2,940
	1,910	45	40,500	150	18	800	5,400	40,800	2,060
7	1,760	44	45,900	500	19	1,650	5,680	47,550	2,260
	1,850	45	43,500				6,260	43,500	1,850
9	2,120	53	54,900				7,600	54,900	2,120
0	2,140	32	43,950				8,400	43,950	2,140
1	2,200	32	48,450				8,020	48,450	2,200
2	2,100	46	49,800				7,800	49,800	2,100
3	2,000	48	52,350	230	12	2,250	7,800	54,600	2,230
4	2,800	40	52,050	380	21	4,950	7,530	57,000	2,680
5	2,940	26	44,850	280	16	2,400	7,000	47,250	3,220
6	3,960	16	42,000	450	3	900	6,550	42,900	4,410
7	5,300	11	33,600				6,100	33,600	5,300
8	4,560	22	29,700				5,400	29,700	4,560
9	2,610	34	31,350				5,250	31,350	2,610
30	1,600	42	26,850	420	9	1,850	5,380	28,700	2,020
31	1,400	38	31,200	650	10	2,580	5,920	34,050	2,050
32	1,690	27	30,600	520	9	3,450	5,720	34,050	2,210
33	1,890	28	29,850	620	10	3,300	5,410	33,150	2,510
34	2,300	29	30,150	730	8	3,750	5,010	33,900	3,030
35	1,460	22	29,850	700	7	2,400	5,370	32,250	2,160
36	4,430	13	35,700				5,960	35,700	4,430
37	3,800	20	30,600				7,000	30,600	3,800
Total	72,510	885	1,042,200	6,010	152	31,700	166,760	1,073,900	78,520

	Main channel.	Chutes.	Channel and chutes.
Mean area	38,600	2,264	39,774
Mean width	2,686	429	2,908
Mean depth	14.4	5.3	13.7
Mean maximum depth	32.8	10.9	32.8
Mean high-water width			6,176

Survey of November, 1888.—Sections of river from Range 61 to 87, inclusive, —1.5 on Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
61	3,740	26	58,400				5,160	58,400
62	3,750	39	50,200				5,500	50,200
63	3,500	52	45,100				5,560	45,100
64	800	57	31,000	1,500	10	6,200	5,240	37,200
65	1,150	57	51,400				5,300	51,400
66	1,480	52	57,300				5,460	57,300
67	1,620	55	54,400				5,800	54,400
68	1,910	46	50,400				6,520	50,400
69	1,700	38	48,100				7,840	48,100
70	2,300	38	64,800				8,600	64,800
71	2,000	37	46,300				8,380	46,300
72	2,150	41	58,400				8,350	58,400
73	2,400	38	55,700				8,620	55,700
74	3,100	42	60,700				8,140	60,700
75	2,120	45	40,100	300	10	1,200	7,360	41,300
76	3,400	23	57,700	250	3	1,000	6,690	58,700
77	4,000	17	53,000	500	13	3,600	6,400	56,600
78	3,750	23	44,100	300	7	1,200	5,680	45,300
79	4,400	21	38,600	400	25	6,600	5,450	45,200
70	2,250	19	22,000	2,000	7	8,400	5,800	30,400
81	2,200	26	23,000				6,650	23,000
82	4,450	30	44,000				6,980	44,000
83	3,200	32	40,000	900	16	5,000	6,750	45,000
84	2,250	35	42,900	500	22	6,800	6,040	49,700
85	1,550	38	38,300	600	7	800	5,490	39,100
86	1,960	38	42,000				6,000	42,000
87	3,140	31	47,600				7,000	47,600
Total	70,270	996	1,265,500	7,250	120	40,800	176,760	1,306,300
Mean area		46,870			4,080			48,381
Mean width		2,603			725			2,871
Mean depth		18			5.6			16.8
Mean maximum depth		36.9			12			37
Mean high-water width								6,547

rvey of November, 1890.—Sections of river from Range 61 to 87, inclusive, reduced to — 1.5 on Lake Providence Gauge.

Range.	Main channel.			Chutes.			Channel and chutes.		
	Width.	Maximum depth	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.	Width.
	1,700	36	42,400				5,110	42,400	1,700
	2,380	25	46,900				5,400	46,900	2,380
	3,000	21	46,400				5,580	46,400	3,000
	3,300	19	46,500				5,200	46,500	3,300
	3,050	45	45,800				5,310	45,800	3,050
	2,360	46	48,200				5,480	48,200	2,360
	2,200	39	48,000				6,080	48,000	2,200
	600	60	38,200				6,610	38,200	600
	1,810	58	52,800				8,000	52,800	1,810
	2,020	43	53,300				9,110	53,300	2,020
	2,080	45	54,800				9,250	54,800	2,080
	2,110	42	56,900				9,150	56,900	2,110
3	2,010	45	58,600				9,410	58,600	2,010
4	2,420	57	71,600				8,950	71,600	2,420
5	2,900	50	65,500	220	10	1,400	8,050	66,900	3,120
6	3,580	41	52,500				6,900	52,500	3,580
7	5,300	28	54,300	580	11	4,400	6,400	58,700	5,880
8	3,700	29	32,100	400	16	2,400	5,650	34,500	4,100
9	4,380	21	45,500	400	24	4,400	5,440	49,900	4,780
0	3,500	25	29,200	1,300	4	3,600	5,720	32,800	4,800
1	3,050	34	43,000				6,700	43,000	3,050
2	2,600	38	40,800				7,100	40,800	2,600
3	2,200	33	44,290	400	7	1,000	7,180	45,200	2,600
4	2,450	28	45,400	300	3	400	6,900	45,800	2,750
5	2,450	27	44,200	900	13	8,400	6,500	52,600	3,350
6	2,400	25	44,100	900	7	4,400	6,350	48,500	3,300
7	2,240	32	41,300				7,000	41,300	2,240
Total	71,790	982	1,292,500	5,400	95	30,400	184,530	1,322,900	77,190
Mean area	47,870			3,377			48,996		
Mean width	2,659			600			2,859		
Mean depth	18			5.6			17.1		
Mean maximum depth	36.3			10.5			36.5		
Mean high-water width							6,834		

Survey of 1891.—Sections of river from Range 61 to 87, inclusive, reduced to [illegible] Lake Providence gauge.

Range.	Main channel.			Chutes.			Channel and [illegible]	
	Width.	Maximum depth.	Area.	Width.	Maximum depth.	Area.	High-water width.	Area.
61	1,000	33	25,800	1,800	2	2,800	5,140	2[illegible]
62	1,090	39	29,000	400	4	1,600	5,440	30,[illegible]
63	1,760	33	37,200	750	3	1,400	5,530	[illegible]
64	1,750	30	37,660	220	8	1,600	5,210	39,[illegible]
65	3,160	25	43,000				5,400	43,[illegible]
66	2,910	20	42,400				5,440	42,4[illegible]
67	2,660	19	38,000				6,050	38,[illegible]
68	2,320	31	46,200				6,680	46,[illegible]
69	1,090	37	42,400				8,030	42,[illegible]
70	1,600	39	41,400				9,100	41,[illegible]
71	1,380	43	44,000				9,400	44,[illegible]
72	2,020	37	40,200				9,720	40,[illegible]
73	2,510	38	57,400				9,790	57,4[illegible]
74	2,400	40	50,000				9,280	50,[illegible]
75	2,500	36	58,600				8,500	58,[illegible]
76	2,500	35	52,800				7,430	52,[illegible]
77	2,390	32	55,400				6,500	55,4[illegible]
78	1,730	35	37,600				5,600	37,[illegible]
79	2,040	19	33,000				5,470	33,[illegible]
80	4,800	17	42,400				5,730	42,4[illegible]
81	4,520	22	45,200				6,760	45,2[illegible]
82	1,090	35	30,600	1,500	8	5,200	7,300	35,[illegible]
83	1,390	27	19,400	1,600	7	4,600	7,860	24,[illegible]
84	1,090	27	21,000				7,790	21,[illegible]
85	1,130	20	19,000				7,140	19,[illegible]
86	1,800	21	26,800				7,390	26,8[illegible]
87	1,900	20	23,400				7,800	23,4[illegible]
Total	58,030	810	1,039,800	6,270	32	17,200	191,480	1,057,[illegible]
Mean area	38,511			2,866			39,143	
Mean width	2,149			1,045			2,381	
Mean depth	17.9			2.7			16.4	
Mean maximum depth	30			5.3			30	
Mean high-water width							7,092	

APPENDIX 5 D.

COST OF UNITED STATES LEVEES IN MISSISSIPPI, ARKANSAS, AND LOUISIANA.

Cost of levees in the Third District, built and enlarged by the United States, from [illegible] May 31, 1893.

MISSISSIPPI.

Year built.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location [illegible]
1882–'92	Levee construction		2,651,774	$617,645.26	
1882–'92	High-water protection and engineering expenses.			120,669.72	
1892	From Station 2380 to 2638 and 2654 to 2700.	J. S. McTighe & Co.	304,157	66,914.55	
1892	From Station 2800 to 2900	W. L. Withers	95,943	19,188.60	[illegible]
1892	Station 2900 to 2962	John G. Sessions	66,867	13,039.06	
1892	Catfish Point	J. S. McTighe & Co.	55,896	11,738.16	
1892	Station 2700 to 2800	Green Clay	95,226	19,997.46	
1892	Station 2148 to 2380	C. F. De Garis & Co.	111,744	23,466.24	
1892	Station 3400 to 3500	Timothy Sullivan	63,532	13,182.89	
	Expended, high water protection and engineering expenses, May 31, 1892, to May 31, 1893.			14,643.72	
	Total to May 31, 1893		3,445,139	920,485.66	

of levees in the Third District, built and enlarged by the United States, from 1882 to May 31, 1893—Continued.

ARKANSAS.

·ar ilt.	Name of levee.	Built by—	Cubic yards.	Cost, including extra work.	Location on inch to mile map.
·'92..	Levee construction		3,098,606	$660,143.37	
·'92..	High-water protection and engineering expenses.			139,319.06	
	Panther Forest	Arnold & Co	172,435	56,256.92	R. 451.
	Lower Leland	Sterling Fort	10,982.5	2,196.50	R. 485.
	Middle Place Loop	J. S. McTighe & Co	75,384.1	18,080.18	R. 430.
	Lakeport Crevasse	James S. Peak	6,941.5	1,093.28	R. 496.
	Brooks Mill Crevasse	...do	64,895.7	9,444.84	R. 506.
	Upper Leland	Stripling & Wright	95,382.2	19,076.44	R. 409.
	Luna	Sullivan & Lewis	337,229.2	47,802.24	R. 468.*
	Panther Forest (Station 1535 to station 1742).	Isaac M. Worthington	326,003.8	67,957.78	R. 452-453.
	Pastoria	C. F. De Garis	28,186.3	6,482.85	R. 466.
	Lakeport	John C. Hodgo	85,493.7	20,411.62	R. 467.
	Expended, high-water protection and engineering expenses, May 31, 1892, to May 31, 1893.			61,442.60	
	Total to May 31, 1893		4,301,490	1,109,707.70	

*$5,311.35 additional retained and unpaid May 31, 1893.

LOUISIANA.

-'92..	Levee construction		1,994,557.8	$443,016.27	
-'92..	High-water protection and engineering expenses.			120,278.57	
	(Millikens Bend to Cabin Teele) Station 0 to 31.	M. V. Henry	73,118	13,892.42	R. 581 to R. 584.
	Station 31 to 164	...do	309,998.5	60,449.70	
	Station 164 to junction with levee, below Cabin Teele.	F. L. Maxwell	77,099.7	11,364.49	
	Expended, high-water protection and engineering expenses, May 31, 1892, to May 31, 1893.			12,929.35	
	Total to May 31, 1893		2,454,774	661,930.80	

APPENDIX 5 E.

.TEMENT, SUBMITTED BY MR. ARTHUR HIDER, UNITED STATES ASSISTANT ENGINEER, ·F COST OF REPAIRS TO PLANT, THIRD DISTRICT, IMPROVING MISSISSIPPI RIVER, MAY , 1892, TO APRIL 30, 1893.

[Boats marked (*) have been docked, twenty-three in number.]

amer *Osceola**. General repairs; new cylinder timbers, new sides and ew frames where necessary; new beams and new deck forward of ngine; repairs to cabin, same painted; two sheets put in boilers, new reeching, machinery overhauled, new furnaces, and ordinary repairs uring the season $5,135.31

amer *Meter*. New heaters, shafts welded, wheel rebuilt, new packing n engines, furnaces rebuilt, new fire pump, and painting and ordinary epairs during the season 859.61

amer *Vidalia*.* General repairs; new sides and new frames where necesary; stern repaired, new rudders, new deck and beams forward of ngines, new boiler deck outside of cabin, new crank pins, new bed plates nd fastenings for cylinders, new breeching, three new sheets put in oilers, new fire pump, machinery overhauled, painting and ordinary epairs during the season 5,272.31

amer *Parker* (tug). Ordinary repairs; two new head sheets put in boilrs, new breeching and ordinary repairs to hull and machinery during he season 939.23

Steamer *Etheridge*. General repairs; new deck forward of engines, repairs to guards, boiler deck, painting, new battery of boilers, new engine and dynamo, new breeching and fire pump, machinery overhauled, and ordinary repairs during the season..

Steamer *Vedette*.* General repairs; new sides, stern and stem, new beams and deck forward of engines, new guards, new crank pins, new packing for cylinders, machinery repaired, pipe work in hold renewed, and ordinary repairs during the season..

Grader No. 1. Ordinary repairs; machinery overhauled, new roof over after cabin, painting, and minor repairs during the season..............

Grader No. 3.* General repairs, sides and rakes rebuilt, new deck beams and deck, new roof over after cabin, machinery overhauled and repaired, new stack, painting, and ordinary repairs during the season ....

Grader No. 77. Ordinary repairs; new steam and water pipes, new coil in heater, new suction and siphon pipe, two auxiliary Hooker pumps set up, and minor repairs made during the season ....

Quarter boat No. 16. Ordinary repairs during season ....

Quarter boat No. 17. Same ....

Quarter boat No. 19. Same ....

Quarter boat No. 38.* General repairs; new gunwales and rakes, new floor timbers where necessary, and ordinary repairs during the season.......

Headquarters boat No. 31. General repairs to guards, deck, and cabin, calking above light water, and repairs to water pipes and boiler, and minor repairs during season..

Quarter boat No. 34. General repairs to cabin to make ready for service. (Cabin now transferred to barge No. 87)....................................

Quarter boat No. 33. Ordinary repairs to kitchen outfit. (Cabin now transferred to Barge No. 86)..

Quarter boat No. 156.* General repairs; new gunwales, rakes, deck beams, and deck. Cabin of old quarter boat No. 22 transferred and fitted up inside. Kitchen outfit repaired......................................

Quarter boat No. 157. General repairs to hull. Cabin of old quarter boat No. 21 transferred and fitted up inside, and kitchen outfit repaired.........

Quarter boat No. 155.* General repairs to hull. Cabin of old quarter boat No. 35 transferred and fitted up inside. Kitchen outfit repaired........

Quarter boat No. 159.* General repairs; new gunwales, rakes, deck beams, floor timber, and bulkheads. Cabin of quarter boat No. 24 transferred and fitted up inside. Kitchen outfit repaired..............................

Quarter boat No. 88.* General repairs, new gunwales, rakes, deck beams and deck. Cabin of old quarter boat No. 23 transferred and fitted up inside. Kitchen outfit repaired..

Quarter boat No. 154.* General repairs. New bottom gunwales and rakes. Cabin of old quarter boat No. 37 transferred and fitted up inside. Kitchen outfit repaired..

Quarter boat No. 36. Ordinary repairs made to cooking ranges and minor repairs to cabin. Cabin now transferred onto barge No. 158 ....

Quarter boat No. 142 (the *Chester*) minor repairs...............................

Quarter boat No. 86. General repairs to hull, etc. Cabin of old quarter boat No. 33 transferred and fitted up inside. Kitchen outfit repaired ....

Quarter boat No. 87.* General repairs to hull. Cabin of old quarter boat No. 34 transferred and fitted up inside. Kitchen outfit repaired........

Quarter boat No. 158.* Cabin of quarter boat No. 36 moved on barge No. 158, now in dock having new bottom gunwales and rakes put in.......

Carpenter shop No. 78.* General repairs to hull; new guards, deck calked; old shop transferred and new shop fitted up with separate engine, boiler, and wood-working machinery..

Machine shop No. 222.* General repairs to hull, new guards, calking, old shop and machinery transferred. Shop fitted up with separate engine and boiler. Machinery set in place..

Property boat No. 85.* General repairs. Boat sunk in storm; boat raised; new bottom, gunwales, and rakes; decks calked and cabin repaired.....

Pile-driver, No. 31. Ordinary repairs; new stack, new flues put in boiler, furnace rebuilt ....

Pile-driver No. 32. Ordinary repairs; new pump set up, new flues put in boiler, furnace rebuilt...

Pile-driver No. 33. Ordinary repairs during the season..........................

Pile-driver No. 49. Ordinary repairs during the season..........................

Pile-driver No. 34. Ordinary repairs; new flues put in boilers; furnace rebuilt ....

Pile-driver No. 54. Ordinary repairs; boilers and hoisting engine set up, new flues put in boiler, and furnace rebuilt...................................

Model barge *Apache*. Ordinary repairs during the season, including calking above light water	$111.99
Model barge *Cheyenne*. Same	91.85
Model barge *Chinook*. Same	142.48
Model barge *Commanche*. Same	151.12
Model barge *Maricopa*.* Same. Also break in hull repaired	218.66
Model barge *Mohave*. General repairs; new deck, new frames, and calking above light water	485.59
Model barge *Piute*. Ordinary repairs during the season, including calking above light water	47.00
Model barge *Shoshone*. Same	68.82
Model barge *Uintah*.* General repairs; new frames, stems, side plank, deck calked, new kevils, and bitts	2,458.66
Mat boat No. 24. Ordinary repairs to put in service, including calking above light water	188.73
Mat boat No. 31. Same	131.23
Mat boat No. 30. Same	127.53
Mat boat No. 32. Same	117.69
Mat boat No. 33. Same	128.01
Mat boat No. 184. Same	20.09
Dump scow No. 1. Same	76.69
Dump scow No. 2. Same	105.52
Coal boat No, 139. Repairs to bottom	115.93
Fuel barge "E." Minor repairs	7.43
Fuel barge "A." Same	8.86
Fuel barge "F." Same	8.07
Barge No. 79.* General repairs, new gunwales, rakes, deck beams, and deck	1,774.93
Barge No. 80. Ordinary repairs	11.13
Barge No. 82. Same	29.83
Barge No. 83. Same	18.11
Barge No. 84. General repairs, new gunwales, rakes, deck beams, and deck.	1,735.02
Barge No. 86. Ordinary repairs	19.77
Barge No 87.* General repairs, new gunwales, rakes, deck beams, and deck	1,817.20
Barge No. 106. Ordinary repairs	22.14
Barge No. 108. Same	9.68
Barge No. 111. Same	21.23
Barge No. 110. Same	10.80
Barge No. 135. Same	25.65
Barge No. 136. Same	74.15
Barge No. 137. Same	82.07
Barge No. 138. Same	63.26
Barge No. 530.* General repairs, new gunwales, bulkheads, rakes, and deck	1,267.34
Barge No. 534. Ordinary repairs	39.24
Barge No. 535. Same	57.79
Barge No. 539. Same	30.94
Barge No. 540. Same	37.01
Barge No. 541. Same	54.41
Barge No. 542. Same	28.90
Barge No. 543.* Same	95.66
Barge No. 545. Same	177.28
Barge No. 546. Same	71.41
Barge No. 547. Same	147.78
Barge No. 548. Same	51.38
Barge No. 549. Same	161.30
Barge No. 550. Same	31.26
Barge No. 45. Same	14.58
Barge No. 169. Same	3.30
Barge No. 204. Same	63.78
Barge No. 225. Same	66.15
Barge No. 544. Same	17.63
Tug dock. New stern dock built	256.18
Barge No. 230. Ordinary repairs	34.34
Barge No. 205. Same	125.56
Barge No. 212. Same	24.08
Barge No. 201. Same	32.10
Barge No. 207. Same	31.23
Barge No. 216. Same	14.46
Barge No. 217. Same	83.03
Barge No. 219. Same	60.94
Barge No. 214. Same	22.97

Barge No. 220. Same ....
Barge No. 210. Same ....
Barge No. 226. Same ....
Warehouse No. 2. Moving part of old machine shop on bank and blocking it up above high water for use as a shed ....

Total .... 6[illegible]

Approximate value of plant belonging to the United States and used upon the Th[illegible] trict, Mississippi River, May 31, 1893.

Class of property.	Pieces.	Approximate value.	Class of property.	Pieces.	A[illegible]
Steamboats, etc.			*Steamboats, etc.*—Continued.		
Etheridge	1	$9,000	Machine shop with outfit	1	[illegible]
Osceola	1	7,000	Floating dock	1	
Vidalia	1	6,000	Camel dock	1	
Vedette	1	4,000	Piled rivers and machinery	6	
Meter	1	3,000	Small scow	1	
Steam tug Parker	1	4,000	Yawls	7	
Mattress boats	5	6,000	Skiffs	54	
Headquarter boat	1	1,500	Tools and appliances		
Quarter boats with outfit	12	7,200	Office furniture, safe, etc.		
Store boat	1	500	Dump scows	2	
Hydraulic graders	2	16,000	Surveying instruments		
Hydraulic graders (small)	1	1,000	Dredge boat Menge	1	
Barges, model	10	15,000			
Square barges	90	85,000	Total value		[illegible]

List of civilian engineers employed on work of river and harbor improvement in cha[illegible] Capt. C. McD. Townsend, Corps of Engineers, from June 1, 1892, to May 31, [illegible] inclusive, under the river and harbor acts approved August 11, 1888, September 1[illegible] March 3, 1891, and July 13, 1892.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which employ[illegible]
	Months.			
Arthur Hider, Greenville, Miss.	12	$250	Greenville, Miss	Care and repairs to plant [illegible] vetment at Louisiana [illegible] La., Ashbrook Neck [illegible] and Greenville, Miss.
E. C. Tollinger, Greenville, Miss.	12	175	Arkansas City, Ark	Construction and protect[illegible] levees in Arkansas.
			Benoit, Miss	Construction and protecti[illegible] levees in Mississippi.
H. St. L. Coppée, Vicksburg, Miss.	12	175	Vicksburg, Miss	Dredging in Vicksburg [illegible] bor.
John J. Hoopes, Arkansas City, Ark.	12	150	Arkansas City, Ark	Construction and protec[illegible] levees in Arkansas.
J. D. Van Meter, Rosedale, Miss.	12	150	Benoit, Miss	Construction and protecti[illegible] levees in Mississippi.
			Arkansas City, Ark	Construction and protec[illegible] levees in Arkansas.
W. S. Brown, Lake Providence, La.	12	150	Millikens Bend, La.; Lake Providence, La.	Construction and protecti[illegible] levees in Louisiana.

Abstract of proposals for levee work in Lower Yazoo levee district, received and opene[illegible] Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Station 2148 to 2380.	Station 2380 to 2480.	Station 2480 to 2550.	Station 2550 to 2638.	St[illegible] 2654 t[illegible]
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Sterling Fort	24	30	32	37	
5	Wm. R. Harvey	25				
6	John G. Sessions	25				
8	Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	[illegible]
9	P. F. Lamb		25½			
11	C. F. DeGaris & Co	21	24	23	24½	[illegible]
16	J. S. McTighe & Co	22	22	22	22	[illegible]
17	Sullivan & Lewis	22				

bstract of proposals for levee work in Lower Yazoo levee district, etc.—Continued.

	Name of bidder.	Station 2700 to 2800.	Riverside, Station 2800 to 2900.	Land Side, Station 2800 to 2900.	Station 2900 to 2962.	Catfish Point Levee.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
	Sterling Fort	22	25	....	30	49
	Wm. L. Withers	....	20	....	22	....
	Green Clay	21	....	....	22	....
	Wm. R. Harvey	....	....	24	....	24
	John G. Sessions	22½	22	....	19½	....
	Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	27½
1	C. F. DeGaris & Co	22	21	....	21	23
6	J. S. McTighe & Co	23	22	....	22	21
7	Sullivan & Lewis	....	....	....	....	24
5	M. V. Henry	....	....	....	....	33
6	C. A. Winter	....	25	24	24½	....

bstract of proposals for levee work in Upper Tensas levee district, received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Closing crevasses.				Closing crevasses and enlarging Upper Leland (R. 469).	Raising and enlarging Middle Place Loop (R. 430).
		Panther Forest (R. 431).	Lower Leland (R. 484).	Lakeport (R. 496).	Brooks Mill (R. 506).		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Sterling Fort	59	*20	20	....	21	38
4	Ernest Hyner	34	....	....	....	....	....
7	Jeffries & Dameron	39	....	22	19½	28	....
8	Johnson, McLaughlin & Sullivan	37	....	....	25	....	....
9	P. F. Lamb	....	....	....	22½	....	....
10	Scott & Russell	....	....	....	17¾	....	....
11	DeGaris & Arnold	....	24	23	....	24¾	27
13	John McGuire	....	....	....	19	....	....
16	J. S. McTighe & Co	34	22	21	25	21½	24
17	Sullivan & Lewis	....	....	....	18	....	....
18	Whitehill Co	....	....	....	....	....	25
20	Stripling & Wright	....	20	....	....	20	....
23	A. A. Arnold & Co	32½	....	....	24½	....	....
25	M. V. Henry	46	....	30	24	31	35
27	I. M. Worthington	....	....	16	15½	23	....
28	Jas. S. Peak	....	....	15¾	13 1/16	....	....
29	Isaac Henry & Co	....	....	25	20	....	....

* Contract awarded.

Abstract of proposals for levee work in Upper Tensas District received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Raising and enlarging Panther Forest Levee.			Constructing Luna Levee.			
		Station 1535 to 1599n (R. 449½).	Station 1599 to 1648 (R. 450).	Station 1681 to 1742 (R. 451).	Section 1 (R. 468).	Section 2 (R. 468).	Section 3 (R. 468).	Section 4 (R. 468).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Sterling Fort	40	43	69	20	20	20	22
2	W. L. Withers	....	....	....	21	19	21	....
4	Ernest Hyner	....	23	....	....	....	....	....
5	William R. Harvey	....	....	28	....	....	20	20
7	Jeffries & Dameron	27	29	29	20	18	18	18
8	Johnson, McLaughlin & Sullivan	30	37	37	21½	21½	21½	21½
10	Scottt & Russell	22	....	....	17¾	19½	19½	....
12	Hartnett & O'Brien	....	....	....	20	20	20	....
14	O. B. Crittenden	21½	....	24	....	....	....	....
16	J. S. McTighe & Co	29½	29½	29½	23	23	23	23
17	Sullivan & Lewis	21	....	....	15¾	15¾	15¾	15¾
19	Carlton & Bryan	....	....	....	21¾	19¾	19¾	19¾
20	Stripling & Wright	....	....	....	18	18	....	....
22	Ed. C. Manney	....	....	....	17¼	17¼	....	....
23	A. A. Arnold & Co	24½	23½	22½	19¾	19½	19½	18½
25	M. V. Henry	44	44	45	22	22	22	23
27	I. M. Worthington	20	22	21	16½	16	16	16
29	Isaac Henry & Co	....	....	....	19	19	22	21

Barge No. 220. Same ....
Barge No. 210. Same ....
Barge No. 226. Same ....
Warehouse No. 2. Moving part of old machine shop on bank and blocking it up above high water for use as a shed ....

Total .... 6[illegible]

Approximate value of plant belonging to the United States and used upon the Th[illegible] trict, Mississippi River, May 31, 1893.

Class of property.	Pieces.	Approximate value.	Class of property.	Pieces.	[illegible]
Steamboats, etc.			*Steamboats, etc.*—Continued.		
Etheridge	1	$9,000	Machine shop with outfit	1	[illegible]
Osceola	1	7,000	Floating dock	1	[illegible]
Vidalia	1	6,000	Camel dock	1	[illegible]
Vedette	1	4,000	Piled rivers and machinery	6	[illegible]
Meter	1	3,000	Small scow	1	[illegible]
Steam tug Parker	1	4,000	Yawls	7	[illegible]
Mattress boats	5	6,000	Skiffs	54	[illegible]
Headquarter boat	1	1,500	Tools and appliances		[illegible]
Quarter boats with outfit	12	7,200	Office furniture, safe, etc		[illegible]
Store boat	1	500	Dump scows	2	[illegible]
Hydraulic graders	2	16,000	Surveying instruments		[illegible]
Hydraulic graders (small)	1	1,000	Dredge boat Menge	1	[illegible]
Barges, model	10	15,000			
Square barges	90	85,000	Total value		[illegible]

List of civilian engineers employed on work of river and harbor improvement in c[illegible] Capt. C. McD. Townsend, Corps of Engineers, from June 1, 1892, to May 3[illegible] inclusive, under the river and harbor acts approved August 11, 1888, September [illegible] March 3, 1891, and July 13, 1892.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Work on which emp[illegible]
	Months.			
Arthur Hider, Greenville, Miss.	12	$250	Greenville, Miss	Care and repairs to pl[illegible] vetment at Louisia[illegible] La., Ashbrook Ne[illegible] and Greenville, Mi[illegible]
E. C. Tollinger, Greenville, Miss.	12	175	Arkansas City, Ark	Construction and prote[illegible] levees in Arkansas.
			Benoit, Miss	Construction and prote[illegible] levees in Mississippi.
H. St. L. Coppée, Vicksburg, Miss.	12	175	Vicksburg, Miss	Dredging in Vicksbur[illegible] bor.
John J. Hoopes, Arkansas City, Ark.	12	150	Arkansas City, Ark	Construction and protect levees in Arkansas.
J. D. Van Meter, Rosedale, Miss.	12	150	Benoit, Miss	Construction and prote[illegible] levees in Mississippi
			Arkansas City, Ark	Construction and prote[illegible] levees in Arkansas.
W. S. Brown, Lake Providence, La.	12	150	Millikens Bend, La.; Lake Providence, La.	Construction and prote[illegible] levees in Louisiana.

Abstract of proposals for levee work in Lower Yazoo levee district, received and ope[illegible] Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Station 2148 to 2380.	Station 2380 to 2480.	Station 2480 to 2550.	Station 2550 to 2638.	St[illegible] 265[illegible]
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cen[illegible]*
1	Sterling Fort	24	30	32	37	
5	Wm. R. Harvey	25				
6	John G. Sessions	25				
8	Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	
9	P. F. Lamb		25½			
11	C. F. DeGaris & Co	21	24	23	24¾	
16	J. S. McTighe & Co	22	22	22	23	
17	Sullivan & Lewis	22				

bstract of proposals for levee work in Lower Yazoo levee district, etc.—Continued.

Name of bidder.	Station 2700 to 2800.	Riverside, Station 2800 to 2900.	Land Side, Station 2800 to 2900.	Station 2900 to 2962.	Catfish Point Levee.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Sterling Fort	22	25		30	49
Wm. L. Withers		20		22	
Green Clay	21			22	
Wm. R. Harvey			24		24
John G. Sessions	22½	22		19½	
Johnson, McLaughlin & Sullivan	27½	27½	27½	27½	27½
C. F. DeGaris & Co	22	21		21	23
J. S. McTighe & Co	23	22		22	21
Sullivan & Lewis					24
M. V. Henry					33
C. A. Winter		25	24	24½	

stract of proposals for levee work in Upper Tensas levee district, received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

.	Name of bidder.	Closing crevasses.				Closing crevasses and enlarging Upper Leland (R. 469).	Raising and enlarging Middle Place Loop (R. 430).
		Panther Forest (R. 431).	Lower Leland (R. 484).	Lakeport (R. 496).	Brooks Mill (R. 506).		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Sterling Fort	59	*20	20		21	38
4	Ernest Hyner	34					
7	Jeffries & Dameron	39		22	19½	28	
3	Johnson, McLaughlin & Sullivan	37			25		
9	P. F. Lamb				22½		
0	Scott & Russell				17¾		
1	DeGaris & Arnold		24	23		24¾	27
3	John McGuire				19		
5	J. S. McTighe & Co	34	22	21	25	21½	24
7	Sullivan & Lewis				18		
8	Whitehill Co						25
0	Stripling & Wright		20			20	
3	A. A. Arnold & Co	32½			24¾		
5	M. V. Henry	46		30	24	31	35
7	I. M. Worthington			16	15½	23	
8	Jas. S. Peak			15¾	13 11/16		
9	Isaac Henry & Co			25	20		

* Contract awarded.

bstract of proposals for levee work in Upper Tensas District received and opened by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

o.	Name of bidder.	Raising and enlarging Panther Forest Levee.			Constructing Luna Levee.			
		Station 1535 to 1599n (R. 449½).	Station 1599 to 1648 (R. 450).	Station 1681 to 1742 (R. 451).	Section 1 (R. 468).	Section 2 (R. 468).	Section 3 (R. 468).	Section 4 (R. 468).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Sterling Fort	40	43	69	20	20	20	22
2	W. L. Withers				21	19	21	
4	Ernest Hyner		23					
5	William R. Harvey			28			20	20
7	Jeffries & Dameron	27	29	29	20	18	18	18
8	Johnson, McLaughlin & Sullivan	30	37	37	21½	21½	21½	21½
10	Scottt & Russell	22			17¾	19½	19½	
12	Hartnett & O'Brien				20	20	20	
14	O. B. Crittenden	21½		24				
16	J. S. McTighe & Co	29½	29½	29½	23	23	23	23
17	Sullivan & Lewis	21			15¾	15¾	15¾	15¾
19	Carlton & Bryan				21¾	19¾	19¾	19¾
20	Stripling & Wright				18	18		
22	Ed. C. Manney				17½	17½		
23	A. A. Arnold & Co	24⅝	23⅝	22⅝	19¾	19¾	19¼	18⅞
25	M. V. Henry	44	44	45	22	22	22	23
27	I. M. Worthington	20	22	21	16½	16	16	16
29	Isaac Henry & Co				19	19	22	21

Abstract of proposals for levee work in Middle Tensas Levee District, received and op[illegible] by Capt. C. McD. Townsend, Corps of Engineers, October 5, 1892.

No.	Name of bidder.	Milliken Bend to Cabin Teele.			
		Station 0 to 31 (R. 581).	Station 31 to 82 (R. 582).	Station 82 to 164 (R. 583).	Sta[illegible]
		Cents.	*Cents.*	*Cents.*	*C[illegible]*
7	Jeffries & Dameron	22	25	24	
8	Johnson, McLaughlin & Sullivan	22½	23½	24	
15	John Scott & Son	24	24	24	
16	J. S. McTighe & Co	29	29	29	
17	Sullivan & Lewis	....	....	....	
21	F. L. Maxwell	....	....	....	
24	J. C. Hodge	....	....	....	
25	M. V. Henry	19	19½	19½	
30	W. O. Flynn	23¾	25¾	22	
31	Dan. L. Hebron	22	....	23	

Abstract of proposals for levee work in Upper Tensas District, received and opened by [illegible] C. McD. Townsend, Corps of Engineers, November 24, 1892.

No.	Name of bidder.	Pastoria (R. 466).	Lak[illegible] (R. [illegible])
		Cents.	*C[illegible]*
1	Jeffries & Dameron	24	
3	C. F. De Garis	23	
4	Kilpatrick & Storer	....	
7	J. C. Hodge	....	
8	Z. T. Carlton & Co	24	....
10	Isaac Henry	....	
11	Timothy Sullivan	25	....

Abstract of proposals for levee work in Lower Yazoo Levee District, received and ope[illegible] Capt. C. McD. Townsend, Corps of Engineers, November 24, 1892.

No.	Name of bidder.	Stat[illegible] 2400 [illegible]
		Cent[illegible]
3	C. F. DeGaris	
5	W. E. Ringo	
6	C. A. Winter	
7	J. C. Hodge	
9	W. L. Withers	
10	Isaac Henry	
11	Timothy Sullivan	

tract of proposals for levee work in Lower Yazoo Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

Name of bidder.	Above Greenville. Station 0 to 250.	Station 450 to 580.	Station 808 to 900.	Station 900 to 1000.	Station 1000 to 1200.	Station 1200 to 1300.	Station 1300 to 1423.	Below Greenville—Leota.
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Jeffries & Dameron	26	19	23	35	25	20	24	18½
R. T. Martin	23	21	20½	39½	25	20	20	....
John G. Sessions	....	....	....	....	....	22½	21½	18½
Starling & Smith Co	19	20	19½	24	18	....	....	....
McTighe & Co	22	23	20	29	27	20	21	17
P. F. Lamb	22½	20½	23	....	21	....	19½	....
Robert Johnson	....	....	....	....	....	....	....	23
T. J. Bogue	....	....	18 45/100	....	....	18 34/100	17 74/100	....
W. L. Killebrew	27	20	28	31	27	19	24	19
Thomas Worthington & J. C. Nutt	....	....	....	....	....	20	20	....
John & Thomas O'Hearn	22½	32	28	28	28¾	19½	27½	....
W. L. Withers & Co	22	18½	17¾	23	18½	17½	17½	....
T. C. Ferguson	20½	....	....	....	....	....	....	....
Harvey & McGuire	20	20	22	40	22	20	19	18
Worthington, Nutt & Elkas	....	....	....	....	....	....	....	18½
Merritt Williams	....	....	....	....	....	....	....	14 48/100
Foley & McDouell	21½	19½	....	....	....	....	....	....
McLaughlin Bros	23½	24	27	....	....	....	24	....
Tim Sullivan	....	....	18	19	19	18	18	17
J. A. Deaton & Co	22 88/100	22 88/100	22 89/100	24 90/100	25 88/101	22	22 49/100	16 95/100
Stansill & Clay	27	25	25	30	21 88/100	23	22½	....
Arnold, De Garis & Co	19⅜	21⅝	24⅝	29⅝	24⅝	16⅜	18⅜	16⅜
J. B. Lewis	25	25	....	....	....	....	....	16
Connor & Lester	21½	19	19	....	....	....	....	....
Homan, McFadden & Cassidy	21 6/10	20 7/10	19 3/10	21	22 4/10	17 1/10	21 3/10	....

stract of proposals for levee work in Upper Tensas Levee District, received and opened by Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

	Name of bidder.	Opossum Fork, Station 374 to 414.	Bellview, Station 95 to 127.	Pastoria, Station 127 to 164.	Dulaney Loop, Station 624 to 690.	Leland, Station 690 to 790.	Vaucluse, Station 832 to 862.	Sunnyside to Lakeport, Station 1116 to 1216.
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
1	C. A. Winter	....	....	27	17	23⅞	31	16½
2	Jeffries & Dameron	35	23	36	23	24	37	16½
4	Jno. G. Sessions	....	19½	33¾	21⅞	31½	....	16½
5	Ed. D. Mantle	....	....	....	....	....	....	17⅞
6	Starling & Smith Co	*21	20	....	....	....	....	....
7	McTighe & Co	24½	19	28	27	22½	42½	19
8	P. F. Lamb	....	....	....	....	25	37	....
0	O. B. Crittenden	....	16 88/100	....	21	27	....	....
1	Chas. T. Worthington	....	....	....	....	....	88	....
3	T. J. Bogue	....	19 24/100	....	19 24/100	....	....	21
4	W. L. Killebrew	....	25	27	23	21	30	19½
8	Jas. H. Cary	27	....	27	....	23	34	....
2	John & Thomas O'Hearn	....	21½	33¾	19¾	28½	33	19½
4	W. L. Withers & Co	....	....	....	18½	30	36	20½
5	Stripling & Wright	....	32	40	21	33½	50	40
8	Will. H. Warner	....	17	....	....	....	....	....
9	Hartnett & O'Brien	....	19	....	20	....	....	19
5	McLaughlin Bros	....	24	....	17½	32	27	....
7	M. V. Henry	33	27	35	33	43	43	27
8	Hebron, Hebron & Buck	....	....	....	....	20¾	....	....
0	J. A. Deaton & Co	....	22	23	18 48/100	21	34½	16½
2	Arnold, De Garis & Co	24⅝	15⅝	29⅜	16⅜	21⅞	39¾	16⅝
3	Kilpatrick & Storer	....	17	34	15 24/100	22	....	....
4	Manning & Gibson	....	....	....	....	....	34	....
5	Ernest Hyner	....	....	....	*15 24/100	18 24/100	42	13 44/100
6	J. B. Lewis	24¾	22	40	23	24¾	39	21
0	Carlton & Bryan	....	18¾	30	21	29	....	....
1	John C. Hodge	....	....	....	16⅝	27½	35	23½
3	Whitehill Co	21	18½	20	17½	....	....	....
4	Ben Talley	....	24	23¾	19	23½	....	....

* Contract made.

Abstract of proposals for levee work in Upper Tensas Levee District, etc.—Continued.

No.	Name of bidder.	Lakeport. Station 1314 to 1350.	Lakeport. Station 1362 to 1368–06.	Below Lakeport. station [illegible] to 140.	Adams Front. Station 165 to 214.	Adams Front. Station 214 to 306.	Kiger Levee. Section 1, 50 stations.	Kiger Levee. Section 2, 30 stations.	[illegible]
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*C[illegible]*
1	C. A. Winter	14	13	25	18	15	14¾	14¾	[illegible]
2	Jeffries & Dameron	14	17	25	22	16	14¾	15	[illegible]
4	John G. Sessions	14½	16⅝	24½	21½	17	15½	16½	[illegible]
7	McTighe & Co	25	21	25	19	17	17	18	[illegible]
8	P. F. Lamb						15¾		
9	O. B. Crittenden	14[illegible]	16	21	16½	16			
10	Michael McTighe						18	19	[illegible]
11	Charles T. Worthington						14¾	14¾	[illegible]
12	Robert Johnson						15	15½	[illegible]
13	T. J. Boyle	20[illegible]	19	19[illegible]	18	17[illegible]			
14	W. L. Killebrew	17	19	24	20	19	20	18	[illegible]
16	James M. Sullivan	12½			20½	18¾	14½	15½	[illegible]
22	John and Thomas O'Hearn	16	21½	23½	34	34	15¾	15¾	[illegible]
24	W. L. Withers & Co	13	15	22	18	14½	16	15	[illegible]
25	Stripling & Wright	16	18						
29	Hartnut & O'Brien	15	21			18	15	16	[illegible]
32	James S. Peak	12	17½				12	15½	[illegible]
33	Hebron, Hebron & Buck	18½	15½				16½	16	[illegible]
35	McLaughlin Bros	17	19½		30	30	15	15	[illegible]
36	Tim Sullivan				17¾	16¾	13[illegible]	13[illegible]	[illegible]
37	M. V. Henry	27	27	33	33	33	17	17	[illegible]
38	Hebron, Hebron & Buck			2[illegible]				16½	
40	J. A. Deaton & Co	15½	16½	24[illegible]	18¾	16¾	16¾	16½	[illegible]
42	Arnold, DeGaris & Co	15½	16½	23½	15½	16½	15	15½	[illegible]
43	Kilpatrick & Storer				14[illegible]	14[illegible]			
44	Manning & Gibson						15	17	[illegible]
45	Ernest Hyner	13[illegible]	1[illegible]	17[illegible]	16[illegible]	15[illegible]			
46	J. B. Lewis	14½	*15	23	14½	14½	15½	16	[illegible]
48	Donovan & Daily	14[illegible]					16[illegible]	16[illegible]	
51	John C. Hodge		19½	22½	23½	22½			
53	Whitehill Company					16			
54	Ben Tailey						15½	15½	[illegible]

* Contract awarded.

Abstract of proposals for levee work in Middle Tensas district, received and opened [illegible] Capt. C. McD. Townsend, Corps of Engineers, January 16, 1893.

No	Name of bidder.	Villa Vista Levee. Upper section.	Villa Vista Levee. Middle section.	Villa Vista Levee. Lower section.	Salem Levee. Upper section.	Salem Levee. L[illegible] section.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cen[illegible]*
1	C. A. Winter	15	24	23		
2	Jeffries & Dameron	15	21	20	17	[illegible]
4	John G. Sessions	18[illegible]	24½	21½	21½	[illegible]
6	Starling & Smith Co				25	[illegible]
7	McTighe & Co	21	28	25	23	[illegible]
12	Robert Johnson	17½	18½	18	16½	[illegible]
14	W. L. Killebrew	19	22	25	23	[illegible]
15	Robert Nicholson				29	[illegible]
16	Jas. M. Sullivan	15½				[illegible]
17	Albert S. Colthorp			21[illegible]		
20	F. L. Maxwell	17½				[illegible]
21	Edmund T. White	28	28	25	22	[illegible]
23	Wm. J. McGinty	18				[illegible]
24	W. L. Withers & Co	15½	20½	*17	20	[illegible]
35	McLaughlin Bros	16	19	19	19	[illegible]
36	Tim Sullivan	15	24	22		
37	M. V. Henry	14[illegible]	18[illegible]	18¾	19[illegible]	[illegible]
39	John Scott & Son	14[illegible]	18[illegible]	17[illegible]	17[illegible]	[illegible]
40	J. A. Deaton & Co	16½	19	17	19	[illegible]
42	Arnold, DeGaris & Co	19½	23	21½	23½	[illegible]
44	Manning & Gibson	15			16	[illegible]
46	J. B. Lewis	16	23	21	24	[illegible]
48	Donovan & Daily	19[illegible]			19[illegible]	[illegible]
49	J. Stein & Co	15[illegible]	22[illegible]			
51	John C. Hodge	15½	19½	19½	19½	[illegible]

* Contract awarded.

tract of proposals for stone received and opened by Capt. C. McD. Townsend, Corps of Engineers, February 9, 1893.

Name of bidder.	Place of delivery.	Price per cubic yard.
Judge C. Musgrove	Greenville, Miss	$1.79 9/10
Jas. A. Deaton & Co	......do	1.80
	Arkansas City, Ark	1.90
	Little Red River, Arkansas	1.80
Alfred M. Julian & Co	Greenville, Miss	2.19
		2.21
Joseph Evans	White River, Arkansas; Little Red River, Arkansas	.54
J. B. & W. L. Killebrew	Greenville, Miss	*1.48 9/10
	Huntington, Miss	1.58 9/10
	Little Red River, Arkansas	*.49 9/10
	Yazoo River, Mississippi	1.54 9/10
W. E. Hunt & F. C. Dunn	Greenville, Miss	1.66
Carey & Shippey	......do	1.85
Fred Hanger	Arkansas City, Ark	1.51
	Little Red River, Arkansas	.71
J. W. Worthington & Co	Greenville, Miss	1.67½
		1.72½
Jno. E. & Thos. P. O'Hearn	......do	1.83½
	Little Red River, Arkansas	.61½
Edward Hely	......do	.78
J. S. McTighe & J. C. McIntyre.	Greenville, Miss	1.88
	White River and tributaries, Arkansas	.82½
Alexander Montgomery	Between White River and Louisiana Bend	1.94
	Between Louisiana Bend and Warrenton, Miss	2.19
Green B. Greer & John Atkins.	Little Red River, Arkansas	.47
		.57
		.74
DeGaris & Arnold	Greenville, Miss	1.74
	Little Red River, Arkansas	.73
Homan, McFadden & Cassidy.	Arkansas City, Ark	2.28
Manoah V. Henry	Greenville, Miss	1.87
	......do	1.83
	Arkansas City, Ark	1.97
	......do	1.93
	Memphis, Tenn	2.17

*Accepted and contract made.

›stract of proposals for two quarter boats, four mat barges, fifteen brush barges, yellow pine and oak lumber, received and opened by Capt. C. McD. Townsend, Corps of Engineers, March 10, 1893.

›.	Name of bidder.	Per quarter boat.	Per mat barge.	Per brush barge.	Per M feet, yellow pine.	Remarks.
1	Wiegel Bros			$3,175		
2	M. A. Sweeny Co	$4,400	$4,980	3,200		
3	Ed. J. Howard	5,650	5,350	3,250		
4	S. M. Flesher			2,970		Recommended for acceptance for 15 barges.
5	Woodward & Wight Co., limited.				$28	Rough lumber, recommended for acceptance.
					33	Decking, recommended for acceptance.

No bid received for oak lumber.

APPENDIX 6.

REPORT OF CAPT. JOHN MILLIS, CORPS OF ENGINEERS, UPON OPERATIONS IN FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1,

SIR: I have the honor to submit the following report upon works in charge of this office for the year ending May 31, 1893:

The office has charge of the Fourth district, Mississippi River, for the execution of works in accordance with the approved plans, specifications, and recommendations of the Mississippi River Commission. The district extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, and comprises 484 miles of the river.

The works under the Commission include improvements of the harbor of Natchez and Vidalia, Mississippi, and Louisiana; channel improvements at the junction of the Mississippi, Red, and Atchafalaya rivers near Turnbull Island, Louisiana; improvement of the harbor of New Orleans; the construction, repair and maintenance of a portion of the levee system of the district; the maintenance of gauges; and certain surveys, observations, and other special work.

HARBOR OF NATCHEZ AND VIDALIA.

The rapid caving of the bank in Giles Bend above Natchez has narrowed the cent neck so that there is danger that the river eventually will break through high water and form a permanent cut-off. Should such cut-off take place apprehended that the river may change its course below by rapid erosion of the west bank, accompanied by accretion on the east bank. This would result in destruction of a portion or all of the town of Vidalia and in injury to the water front and landings at Natchez. The object of the contemplated works is to and if possible prevent the formation of the threatened cut-off across Cowpen

By the river and harbor act of July 13, 1892, an appropriation of $80,000 was for this work.

On August 5 the Commission adopted the following resolution: "That in opinion of the Commission the amount appropriated for the harbor at Natchez Vidalia, Mississippi and Louisiana, is too small to justify beginning work at place and they accordingly recommend that the funds be held in reserve until shall be very largely increased by future appropriations."

On November 17, the following resolution was passed by the Commission:

"That it be recommended to the Secretary of War that the special appropriation for improving harbors of Natchez and Vidalia, or so much thereof as may be necessary, be expended in constructing a levee along the axis of Cowpen Point."

Upon recept of notice of approval of the above recommendation, preparations the necessary surveys were made and the first survey was made in February, direction of Assistant Engineer Douglas. A preliminary line was located, but survey developed many features of the locality which, owing to the dense undergrowth on the neck, were previously unknown, and indicated that a more economical line might be found. Additional lines were therefore surveyed in April. A location was adopted as the result of these surveys, and report and project for constructing the levee will be submitted before the next meeting of the Commission.

If the necessary right of way can be secured the levee will be built during the coming season.

Money statement.

Amount appropriated by act approved July 13, 1892	$80,000
May 31, 1893, amount expended during fiscal year	1,42[illegible]
June 1, 1893, balance unexpended	78,57[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895	250,000

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Assistant Engineer H. S. Douglas reports as follows upon the surveys made under his direction:

NATCHEZ, MISS., *May 31, 1893.*

SIR: At date of last report no work was in progress and no funds were available. The caving of the river banks in the concave bends had progressed at a rapid rate and the high water of 1892 had developed a tendency to cut channels across the neck of land above Natchez.

The improvement desired consists principally in the maintenance of existing conditions in the river fronts of the cities of Natchez and Vidalia. These conditions are seriously threatened by rapid caving of the river banks in Giles and Marengo bends and a prospective cut-off through the narrow strip of land between Giles and Cowpen bends on the east bank of the Mississippi River immediately above Natchez.

The river and harbor act approved July 13, 1892, appropriated the sum of $80,000 for the commencement of the work in accordance with the plans of the Mississippi River Commission.

The estimated cost of the necessary plant required for the work of bank protection revetment was $65,000, leaving too small a sum available to justify the beginning of actual construction of this portion of the work.

It was considered that the most immediate danger to the harbors, and one that would be irreparable, was the threatened cut-off through the neck of land between Giles and Cowpen bends. The land forming the neck is not high and at a stage of 38 feet on the Natchez gauge the river begins to run across through small channels of recent formation. At extreme high water there is a depth of 10 feet through these channels. The fall across the neck during high stages of the river is over 3 feet, causing a very rapid current with a decided tendency to scour where the land is free from standing timber, underbrush, and accumulated driftwood.

The approved project contemplated the construction of a spur levee, commencing at the line of bluffs or high land and extending out on a line generally parallel to the axis of the point sufficiently far to prevent the flow of the water across the neck during flood stages of the river. It has been decided to undertake the building of this levee.

The work of the last season has consisted in making careful surveys of the point to determine the best location for the proposed spur levee consistent with economy of construction and reasonable permanence. The topography of the point is very rugged, being made up of a few narrow cleared ridges separated by wide sloughs covered with a dense growth of timber and underbrush. This entailed the running of a great many lines, as each one developed some new feature and suggested another line that might be better, the result of all being to give a very thorough knowledge of the locality. The surveys developed among other things that what may be termed the effective width of the neck is much less than heretofore supposed, as the lower side is only a flat mud bar which would be of no value in preventing a cut-off. The width of high land which constitutes the effective width is only about 2,800 feet. One of the lines crossed a former channel or old river bed, which is about 2,000 feet wide and would require a levee about 26 feet high where the line crossed. The traverse of the bank line, or the upper side of the neck, compared with that made in 1891 showed that caving was progressing at the rate of about 150 feet per year, the maximum recession of the bank from February, 1891, to January, 1893, being 325 feet. Eighteen pits were dug at different points on the neck to determine the character of underlaying strata. These pits were generally about 6 feet deep, at which depth in most cases water prevented going deeper. The information obtained was that the foundation of the levee would generally be on very recent river deposit, and that great care would have to be exercised in preparing the base.

Fifteen and one-half miles of alternative lines for a levee have been surveyed, 9 miles of bank line traversed to ascertain extent and amount of caving, and 6 miles of meander lines ran to locate topography. The field work has been platted and careful estimates of cubical contents of levees on different lines made.

At the close of this report no material change had taken place in the condition of affairs, except the unusually rapid caving of the river bank in the Marengo Bend, which has opened the river fully into Lake Concordia.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

JUNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, NEAR TURN[illegible] ISLAND, LOUISIANA.

A detailed description of the difficulties in this vicinity which the improven[illegible] are designed to rectify will be found in the last annual report. In genera[illegible] these difficulties consist in the filling up of Old River, which is the only navi[illegible] entrance from the Mississippi to the Red and Atchafalaya rivers and their [illegible]taries, so that low-water navigation is impeded and at times entirely obstructe[illegible]

This filling up is attributable in part to the deposit of sediment during high w[illegible] caused by irregular variations in the strength and direction of the current in River, and in part to the caving in or sliding down of the soft banks adjacent t[illegible] channel during low water.

The complete system of works contemplated with a view to correcting these [illegible]culties comprises the following objects:

To check the enlargement of the Atchafalaya and limit its outlet capacity [illegible] system of low relief dams or sills located near the head of this outlet river an[illegible] below the point where the Bayou des Glaises comes in.

To separate the Red from the Atchafalaya during low water and up to mi[illegible] by means of a low dam at the west end of Turnbull Island, which for all [illegible] below the crest of the dam would deflect the Red around the upper side of Turn[illegible] Island through upper Old River.

To complete the separation by cutting a canal across Carrs Point and obstru[illegible] the lower end of upper Old River, thus making the Red a tributary and the At[illegible]falaya an outlet, separated from each other at medium and low stages; whil[illegible] conditions at high stages are not to be materially modified.

The plan also contemplates maintaining low-water navigation through lower River, if practicable, by dredging or otherwise, until the above system of work[illegible] completed.

The entire Red and Atchafalaya system, whose only outlet is now through [illegible] channels which these works are designed to improve and maintain, comprises a [illegible] length of about 4,300 miles of navigable river in those stages during which t[illegible] are at present no difficulties in lower Old River. In low water, when such diff[illegible]ties are experienced, the navigable portion of the Red and Atchafalaya syste[illegible] about 345 miles for a 3-foot draft and 132 miles for a 5-foot draft.

At the date of the last annual report the following work had been done:

Two sill dams near the head of the Atchafalaya, with the shore protection [illegible]necting levees and wing levees, had been completed.

The sill or foot mattress and shore protection work of the Red River dam [illegible] been finished and the dam constructed temporarily at a height of 3 feet above [illegible] zero of Barbres gauge with a view to increasing the effect of scour in upper [illegible] River during the falling stage of the river after the high water of 1891. The [illegible] was partly cut down again to afford a navigable channel over it for the low-w[illegible] season of 1891, leaving it at a height of about 5 feet above the zero of Bar[illegible] gauge for a width of 450 feet. No further work has been done on the dam.

The site of the Carrs Point Canal had been surveyed and the timber cut along [illegible] center line.

Some dredging had been done in upper Old River and the usual work of buil[illegible] temporary spur dikes and of dredging, with a view to maintaining low-water na[illegible]gation through lower Old River, had been done each low-water season.

A telegraph line connecting the Government depot at Barbres Landing with W[illegible] Melville, La., on the Texas & Pacific Railway, the nearest telegraph station, h[illegible] been constructed.

Bids for building or leasing a dredging plant for this work were invited by adv[illegible]tisement of June 1, 1892, under general specifications prescribing the conditi[illegible] which the plant was to fulfill, but leaving the detail of the plant to be proposed [illegible] the bidders. Bids were opened on August 1. Only one bid was received, that the San Francisco Bridge Company, of San Francisco, Cal., who proposed to bu[illegible] pump dredge for $98,000. The bid was considered too high, and rejected.

Advertisements for a dredging plant designed specially for securing and mainta[illegible]ing a low-water channel through lower Old River were issued on November 30, 1[illegible] and opened on January 30, 1893. The bid of the Bucyrus Steam Shovel and Dre[illegible] Company, of Bucyrus, Ohio, who proposed to build a pump dredge for $69,500, w[illegible] accepted. Contract was entered into and construction of the dredge has beg[illegible] It is to be delivered August 1, 1893. The hull of the dredge is to be of wood, ab[illegible] 95 feet long by 27 feet beam. The house will be double decked, the lower deck bei[illegible] occupied by dredging and propelling machinery, boilers, workshop, etc., and t[illegible] upper deck affording accommodations for the crew. The propelling power will co[illegible]sist of a stern wheel with a pair of driving engines, usual steamboat type. Th[illegible] dredge will have pilot house and regular steering gear.

The dredging apparatus proper is to consist of a centrifugal pump with 15-in[illegible] suction and discharge, driven by compound condensing engines and supplied wi[illegible] team from two horizontal cylindrical boilers with corrugated internal furnace flues. 'he suction pipe is supported on an "A" frame pivoted at the bow of the hull, which nables the dredge to work on 30 feet of water. At the end of the A frame is a conical ast-steel cutter head for loosening the material. This cutter head is supported on shaft and revolved by independent engines mounted on the forward deck through specially designed bevel gear. The discharge is to be through steel pipe supported n pontoons, or when working in low water through a length of pipe supported direct rom the hull. The dredge is to have a practical capacity of 300 cubic yards of soft nud per hour. Work during the past year was confined to dredging in lower Old River.

The dredge *Pah-Ute*, belonging to the plant, a Hayward bucket dredge, belonging o Wood, Bodley & Co., of Baton Rouge, and a clam-shell bucket dredge, the *Herndon*, with tug and scows, belonging to Rittenhouse, Moore & Co., of Mobile, Ala., were employed.

Dredging began on September 5 and was continued until October 1, when the water became so low that it was necessary to suspend operations and remove the dredge.

The steamer *J. E. Trudeau* passed through Lower Old River on September 30, but had difficulty in getting through. From that date until early in November, when a light-draft boat passed through, navigation was entirely suspended, and more or less difficulty was experienced until November 19, when navigation was practically restored by a rise of water and a current through the channel which removed the sand deposits. The dredge *Pah-Ute* worked on the clay lumps between Ash Cabin and Dead Tree from December 4 to December 19.

The gauge at the head of Turnbull Island being no longer of any practical use was discontinued on September 10.

The levee on the Simmesport side between the sill dams in the Atchafalaya River was repaired and partly rebuilt, and repairs were made to the telephone line connecting the Government depot at Barbres Landing with Melville.

The usual observations to determine the low-water discharge of the Atchafalaya at Simmesport were made during October. The minimum discharge found was 12,506.25 cubic feet per second on October 16, 1892. Observations are now in progress to determine the high-water discharge.

Abstract of proposals received in response to advertisement dated June 1, 1892, opened at New Orleans, La., August 1, 1892, by First Lieut. John Millis, Corps of Engineers, for building or leasing a dredging plant for use at the works of improvement at the junction of the Mississippi, Red, and Atchafalaya rivers, near Turnbull Island, Louisiana.

No.	Name and address of bidder.	Building.	Leasing.	Total.
1	San Francisco Bridge Co., New York City	$89,000	No bid.	$89,000

Amount available from act of September 19, 1890	$85,000
Amount available from act of July 13, 1892	80,000
Total	165,000

REMARKS.—Recommendation was made that the above bid be rejected and that new advertisement be issued.

Abstract of proposals received in response to advertisement dated November 29, 1892, opened at New Orleans, La., January 2, 1893, by Capt. John Millis, Corps of Engineers, for building or leasing a dredging plant for use at the works of improvement at the junction of the Mississippi, Red, and Atchafalaya rivers, near Turnbull Island, La.

No.	Name and address of bidder.	Building.	Leasing.	Total.
1	Bucyrus Steam Shovel and Dredge Co., Bucyrus, Ohio	$69,500	No bid.	$69,500
2	San Francisco Bridge Co., San Francisco, Cal	87,000	No bid.	87,000
3	H. S. Brown, Quincy, Ill. *			

* Informal letter—no bid.

January 25, 1893, balance available	$150,873.85
Amount covered by this abstract	69,500.00
Balance	81,373.85

REMARKS.—Bid No. 1 is the lowest received, and the bidders, being responsible, is recommended for acceptance.

Money statement.

June 1, 1892, balance unexpended	$89, [illegible]
Amount appropriated by act approved July 13, 1892	80, [illegible]
	169, [illegible]
May 31, 1893, amount expended during fiscal year to date	29, [illegible]
May 31, 1893, balance unexpended	139, [illegible]
May 31, 1893, amount covered by uncompleted contracts	69, [illegible]
May 31, 1893, balance available	70, [illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895	350, [illegible]

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

NEW ORLEANS HARBOR.

The harbor of New Orleans consists of a total length of about 13 miles of th[illegible] sissippi River and comprises four bends and four comparatively straight reach[illegible] 2 to 3 miles in length. At two of the bends the river changes its direction som[illegible] over 90 degrees, and the mean radius of curvature is about one and one-half [illegible] the river's width. The other two bends are less abrupt. The average width [illegible] bank lines at mid-stage is about 2,200 feet. At high water the average width [illegible] determined by the levees which are not in all cases immediately on the ban[illegible] somewhat greater. The maximum depth at low water varies on different [illegible] from 70 to 160 feet, and the maximum difference between low and extreme high [illegible] is about 19 feet. As the city is about 104 miles inland by the river from the G[illegible] Mexico, the effects of the tides are very slight and quite irregular, varying wit[illegible] stage of the river and the direction and force of the wind. The mean current [illegible] from 5.6 feet per second in high stages to a scarcely perceptible current at ext[illegible] low water. The river usually reaches its maximum stage between March 1 an[illegible] 30 and its minimum stage between September 1 and November 30, and the varia[illegible] in height are never abrupt.

The entrance to the harbor from seaward through South Pass affords a prac[illegible] depth of over 25 feet, the depth of the other Passes or mouths of the river not [illegible] sufficient for deep-draft sea-going vessels. From the head of the Passes t[illegible] throughout the harbor, the channel depth and width are ample, and in most port[illegible] of the river navigable depths exist close inshore. For a considerable portion [illegible] river front on both shores, continuous wharves exist, and there are detached wha[illegible] and landings at more or less frequent intervals over a greater part of the entire [illegible] front of the harbor.

The entire country in the vicinity of New Orleans is of recent alluvial formatio[illegible] disturbed by any subsequent geological changes, and it is consequently low and fla[illegible] ing highest at the river banks, and having a gentle and regular slope away fro[illegible] river. Borings made in this locality show alternate layers of sand and clay in va[illegible] ing thickness, to a great depth. During flood stages the river reaches a height [illegible] or 7 feet above the highest natural level in the city, and the levees, which are es[illegible] tial for the prevention of overflow, are as a rule necessarily built close to the [illegible] line in order to meet the requirements of the various interests along the river [illegible]

The use of regular docks or slips and piers in the harbor is generally impractica[illegible] owing to the variations in the height of the water, the unstable nature of the b[illegible] the swift current at high stages, and the tendency to deposit large quantities o[illegible] when the current is interfered with. Vessels are usually made fast alongside of [illegible] continuous wharves, and since there are no good anchorage grounds, particular[illegible] high water, owing to the current, the great depth and nature of the bottom, the [illegible] ditions generally in the harbor are such as to require an unusual developmen[illegible] water front to accommodate a given amount of shipping.

Although the condition of the river and its banks in this vicinity is one of co[illegible] parative stability when contrasted with the extraordinary changes which often o[illegible] in certain portions of the Mississippi above the mouth of Red River, the dam[illegible] which results from even slight changes of the river in a port like that of New Orle[illegible] becomes serious.

In general the action of the river is to erode and cut away and cause caving a[illegible] sliding down of the banks on the concave shore and for some distance below, resu[illegible] ing in the destruction of wharves, levees, streets, and sometimes of sheds and bu[illegible] ngs. When this action occurs on one bank a deposit of sediment and consequent shoaling and damage to the water front on the opposite shore usually takes place also. In certain localities caving of the bank has taken place in the straight reaches, and even on a convex shore. In such cases the action is attributable partly to the weight of large masses of sediment deposited under wharves during high water, which, when deprived by the fall of the river of the support which the water afforded during flood stages, causes large portions of the bank to crack off and slide down. Since caving on a straight or concave shore is not general and is irregular, the above theory as to the cause is not entirely satisfactory, and it must be largely influenced by some local cause.

Caving usually takes place only during falling and low stages of the river, but the erosion which is believed to be its main cause is undoubtedly most active during flood stages, and it seems to be well established that with the completion of the levee system there is a tendency of the river to enlarge its section and acquire the increased discharge capacity demanded of it.

In localities exposed to rapid erosion, where the bank is not protected, the danger of a breach in the levee during high water and an overflow into the city now necessitates building the levees at considerable distance from the bank line at such places.

The general object of the works of improvement in New Orleans Harbor is to check and if possible to prevent the detrimental action of the river as above described, and to maintain the river banks in a condition of permanency.

Under the approved project the work now in progress to accomplish these objects consists in the construction of submerged inclined spur dikes along the caving banks, which extend out normally to the bank line, and which have heretofore been placed at intervals of from 500 to 1,600 feet.

In addition to these dikes continuous bank revetment has been constructed in the intervals where the destructive forces have proved very active. This revetment has an average width of about 400 feet and extends from low-water line out to deep water, covering the entire bank slope. In building this revetment mattresses made of willow brush and poles and fastened with sawed timber and wire are first constructed in sections of convenient size and about 2 feet thick. These sections are then fastened together, forming a large mattress, which has a width of 130 to 150 feet and a length equal to the width of the revetment. This mattress is floated to position between lines of barges secured by mooring lines, and is sunk by loading it with rock evenly distributed over its surface. After it is sunk additional rock is deposited upon it. The spur dikes are built of successive layers of mattresses of diminishing width, constructed in a manner similar to that above described, except that they are made two to three times as thick, and the willows are so laid as to leave square "pockets" to receive and retain the rock. These mattresses or "cribs" are so designed that the top of the completed dike has a width of about 16 feet and a slope in the direction of the length of the dike of about 3 base to 1 perpendicular. Various side slopes have been given to the dikes, from 1 base to 1 perpendicular to 3 base to 1 perpendicular, the latter slope being now preferred. When the intervals have not been continuously revetted the dike rests on a foot mattress about 150 feet wide. In places in the harbor where the water front is required for docks the crest of the dike at the shore end is kept below the draft of vessels; at other localities the crest has been carried up to low-water line and continued up to the main levee by a spur levee built of earth and paved with rock.

The design is to begin sinking the mattresses during the end of the low-water season, but this has not always been practicable, and some of the work has been placed in comparatively high stages.

The effect which the continuous revetment is intended to produce is to cover the entire bank slope directly after the caving for the season has ceased and when the bank has presumably a form best adapted to stability and to protect it from further erosion. The dikes are designed to arrest caving by checking the velocity of the current and inducing a deposit and to support the bank. Spur dikes without immediate revetment have been successful in some of the straight reaches and on concave banks of large radius, but in the abrupt bends the dikes alone are only locally effective.

At the date of the last Annual Report the following work had been completed in general accordance with the project as above outlined. A continuous mattress 400 feet in length had been placed just above the caving bank in the Carrollton Bend. Five spur dikes had been built in the Carrollton Bend, two in the Greenville Bend, six in the Gouldsboro Bend, and eight in the third district reach.

All the above work remains in place and has proved successful, with the following exceptions: In the third district reach the caving was arrested and a general accretion took place along that portion of the bank covered by the four lower dikes built in 1889, except that a small cave has occurred between Dikes 3 and 4. Along that portion covered by the four upper dikes no further caving took place at the heads of the dikes, but caving continued in the intervals between Dikes 1 and 2, 2 and 3, and below 5. There has been no noticeable accretion. In this locality the in- between dikes are evidently too great, and intermediate dikes should be buil intervals protected with continuous revetments.

In the Gouldsboro Bend a small cave has occurred between Dikes 3 an otherwise the bank line has remained unchanged.

In the Carrollton Bend the five dikes all remained undisturbed and the ba at their head was maintained, but caving between the dikes continued, and it is evident that the radius of curvature of this bend is such that spur dikes al not effective unless built with such short intervals as to render the work exce expensive.

Destructive caving has also taken place along the water front between Carr and Exposition Wharf, at Eighth street, at the Soraparu Market, in the bend below the French Market, and at Algiers Point. No protection work has been these localities by the United States, but the city of New Orleans has construct work and wooden bulkheads with a view to arresting the caving near the Fr Market, at Algiers Point, and in the intervals between the third district spur This work has been partially successful.

By the act of July 13, 1892, $80,000 was appropriated for continuing the improvement in New Orleans, and a project was submitted on June 16, 1892, fo expenditure of this sum in constructing continuous bank revetment in the inter between the completed dikes in the Carrollton Bend at Southport and the pu of additional barges for carrying on the work. This project having been app advertisements were issued for six decked barges, but as the bids exceeded th mate contract was entered into for four only. The barges have been complet delivered.

Contract was made with R. M. White, of New Orleans, for supplying the w for the work, but as the delivery was too slow to meet the requirements a q boat with force of men was sent to Profit Island and cutting of willows by labor began on September 22, 1892. Mr. White supplied 1,135.09 cords of w and 54.06 cords of poles. The force at Profit Island furnished 3,690 cords of w and 72 cords of poles. Rock was obtained partly by contract with J. W. Wort ton & Co., of Birmingham, Ala., who shipped it by rail from their quarrie Birmingham and delivered it on board barges in the harbor for $2.50 per ton. supplied 3,749.25 tons of limestone rock of excellent quality. Nine hundr ninety-seven and ninety-seven one hundredths tons were obtained by open-m purchase of ships' ballast, delivered on board barges in the harbor at $1 per Lumber was supplied by the Brakenridge Lumber Company, Limited, and H. W Lumber Company, and wire nails by Woodward, Wight & Co., Limited, under tracts.

Owing to the late date at which the appropriation became available and the in the delivery of willows, sinking of the mattresses did not begin until Janu 1893. The river had then reached a comparatively high stage. The swift cur and eddies in the bend and the large amount of drift running made a consid portion of the operations of sinking difficult, but all the work was successfully p without loss. One small section of mattress broke away, but it was recover replaced with no material damage to plant. The work was finally finish March 9, 1893, and its successful completion, under the difficulties which encountered, reflect great credit on the assistant engineer in charge, Mr. W Garvin.

Six hundred and fifty-two thousand and twenty square feet of revetment constructed at a field cost of $0.08919 per square foot. The cost of similar work season was $0.09604 per square foot.

During July, August, and September a survey was made by Assistant Engin Garvin and Mott of the river front from Southport to the Exposition Wharf.

This survey was made on account of recent serious caving which had necessit building new levees and the sacrifice of much valuable property, and it is an pated that the protection work may be eventually extended down from Southp

Money statement.

Balance unexpended June 1, 1892	$4,78
Amount appropriated by act approved July 13, 1892	80,0
	84,78
May 31, 1893, amount expended during fiscal year	84,78
Amount that can be profitably expended in fiscal year ending June 30, 1895	300,00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

bstract of proposals received in response to advertisement dated October 1, 1892, opened at New Orleans, La., October 12, 1892, by Capt. John Millis, Corps of Engineers, for furnishing rock for New Orleans Harbor work.

o.	Name and address of bidder.	3,500 tons of 2,000 pounds.	Total.
		Per ton.	
1	Woodward, Wight & Co., Limited, New Orleans, La.	$3.15	$11,025
2	The Birmingham Mining and Manufacturing Co., Birmingham, Ala.	3.24	11,340
3	Gunning Gravel and Paving Co., Vicksburg, Miss	3.50	12,250

mount available	$51,205
mount covered by this abstract	11,025
Balance	40,180

REMARKS.—Recommended that all of the above bids be rejected and that new advertisement be ssued.

Abstract of proposals received in response to advertisement by poster, dated November 2, 1892, opened at New Orleans, La., November 15, 1892, by Capt. John Millis, Corps of Engineers, for furnishing 3,500 tons of rock.

No.	Name and address of bidder.	3,500 tons.	Total.
		Per ton.	
1	Frederick M. Cabot, Gate City, Ala.	$2.63	$9,205.00
2	W. L. Killebrew, Greenville, Miss. (Item No. 1)	$1.84\frac{9}{10}$	6,471.50
2	W. L. Killebrew, Greenville, Miss. (Item No. 2)	2.70	9,450.00
3	Woodward, Wight & Co., Limited, New Orleans, La. (Item No. 1)	3.10	10,850.00
3	Woodward, Wight & Co., Limited, New Orleans, La. (Item No. 2)	2.75	9,625.00
4	Gunning Gravel and Paving Co., Vicksburg, Miss	2.99	10,465.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 1)	2.00	7,000.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 2)	2.15	7,525.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 3)	2.50	8,750.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 4)	2.25	7,875.00
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 5)	2.50	8,750.50
5	J. W. Worthington & Co., Birmingham, Ala. (Item No. 6)	2.75	9,625.00

Amount available	$51,205
Covered by this abstract	8,750
Balance	42,455

REMARKS.—Bid No. 5, items Nos. 3 and 5, as may be selected, is recommended for acceptance; it is the lowest and most advantageous bid received and considered reasonable.

Abstract of proposals received in response to advertisement dated October 1, 1892, opened at New Orleans, La., October 12, 1892, by Capt. John Millis, Corps of Engineers, for furnishing willow brush and poles for New Orleans Harbor works.

No.	Name and address of bidder.	On United States barges at willow grounds.		On contractors' barges at Exposition Wharf.		Total.
		4,500 cords willow brush.	400 cords willow poles.	4,500 cords willow brush.	400 cords willow poles.	
		Per cord.	*Per cord.*	*Per cord.*	*Per cord.*	
1	Robert M. White, New Orleans, La.	$1.38	$3.00	No bid..	No bid..	$7,410
2	G. W. Reagan, Red River Landing, La	1.65	1.90	No bid..	No bid..	8,185
3	G. M. Long, Delta, La	1.70	2.17	No bid..	No bid..	8,518
4	Woodward, Wight & Co., limited, New Orleans, La.	2.00	3.00	No bid..	No bid..	10,200
5	Tobias Nagel, M. D., New Orleans, La.	2.15	3.25	No bid..	No bid..	10,975

Amount available	$58,615
Amount covered by this abstract	7,410
Balance	51,205

REMARKS.—Bid of Robert M. White is the lowest and is recommended for acceptance.

Abstract of proposals received in response to advertisement dated October 18, 18... at New Orleans, La., November 15, 1892, by Capt. John Millis, Corps of Engin... constructing six decked barges.

No.	Name and address of bidder.	Bids received.
1	Carbolineum Wood Preserving and Manufacturing Co., limited, New Orleans, La	$6,534.48 each
2	Pelican Saw Mill and Manufacturing Co., New Orleans, La	$3,287 each for 2
3	Fourchy & Fourchy, New Orleans, La	For the 6 barges
4	Christian Telson, sr., New Orleans, La	$3,650 each for 2
5	Huntington and St. Louis Towboat Co., Cincinnati, Ohio	Return blanks; can not bid

Amount available ....

Amount covered by this abstract ....

Balance ....

REMARKS.—Proposals of Pelican Saw Mill and Manufacturing Co. and Christian Telson, ... for two barges, being the lowest responsible bidders, are recommended for acceptance. It is ... mended that the building of the remaining two barges be deferred for the present.

Assistant Engineer Garvin reports as follows:

NEW ORLEANS, LA., *May 31, ...*

SIR: I have the honor to submit the following report on the works of which I ... been in local charge from May 18, 1892, to May 31, 1893:

The condition of the works on the former date was as follows: The plant ... been moved to laying-up quarters at Exposition Wharf and the necessary r... work to boats and barges was in progress. The repair work was carried on co... ously except for a few weeks, when the services of the master carpenter were re... to assist in sinking the mattress work in Southport.

The first barges were sent to the willow grounds on September 10. In the m... of September and October the old mattress ways or float were repaired a... incline ways set up and an additional set of mattress ways built. They were ... same dimensions as the old ways, capable of holding a section of mattress 105 ... in length by any required width.

Five barges of willows were received in October, and mattress construction ... commenced on the 21st.

The past season's work in the Southport Bend consisted of building ten matt... to cover the entire space between Spur Dikes Nos. 3 to 3½, 3½ to 4, 4 to 4½, and a ... tance of 150 feet below No. 4½.

In addition to the large mattresses for the above work, eight small mattresses ... built and sunk—one at the head of Spur Dike No. 4, two on the head of Spu... No. 4½, and five in the pocket cave between Spur Dikes Nos. 4 and 4½. The d... sions were as follows: Three mattresses 120 by 400 by 2.15 feet each, coverin... space from Spur Dike No. 3 to 3½, making a total of 144,000 square feet, 309,60... feet; three mattresses, 140 by 400 by 2.15 feet, covering the space from Spur D... to 4, making a total of 168,000 square feet, 361,200 cubic feet; three mattress... by 400 by 2.15 feet each, covering the space from Spur Dike No. 4 to 4½, mak... total of 156,000 square feet, 335,400 cubic feet; one mattress 105 by 150 by 2.15 ... below Spur Dike No. 4½, a total of 60,000 square feet, 129,000 cubic feet; one ... tress 105 by 150 by 2.15 feet, and one 60 by 105 by 3 feet on the head of Spur D... No. 4½, as shown on plan, making a total of 22,050 square feet, 52,762.5 cubic fe...

One mattress 105 by 150 by 2.15 feet, and four mattresses 60 by 105 by 3 ... each, in the cave between Spur Dikes Nos. 4 and 4½, as shown on plan, mak... total of 40,950 square feet, 109,462.5 cubic feet.

One mattress on head of Spur Dike No. 4; it was built to fit the angle forme... center line of spur dike and bank. The dimensions were: width, 70 feet; length, ... lower side, 200 feet; length, upper side, 172 feet; area, 61,020 square feet, 13... cubic feet.

The quantity and value of material was as follows:

,749 tons rock, at $2.50 per ton	$9,373.12
97.97 tons rock, at $1 per ton	997.97
0,000 feet, B. M., 3 by 6 lumber, at $12 per M	120.00
,320 feet, B. M., 3 by 6 lumber, at $11 per M	36.54
6,442 feet, B. M., 3 by 6 lumber, at $10.45 perM	694.32
,464 feet, B. M., lumber, at $10 per M	94.64
88,745 feet, B. M., 2 by 4 lumber, at $9.95 perM	1,878.01
0 pounds 9-inch steel wire nails, at 3 cents per pound	1.50
,450 pounds steel wire nails. 6-inch, at 2½ cents	30.45
50 pounds 3½-inch steel wire nails, at 2.45 cents	11.02
,900 pounds 9-inch steel wire nails, at 2½ cents	172.50
3,400 pounds 6-inch steel wire nails, at 1.95 cents	261.30
,600 pounds 3½-inch steel wire nails, at 2.4 cents	38.40
,961 pounds No. 10 wire, at 2.45 cents per pound	170,54
,825 cords willow brush, at $2.36 per cord	11,387.00
39 cords willow brush, at $1.9425 per cord	1,435.50
,135.09 cords willow brush, at $1.38 per cord	1,570.56
4.06 cords willow poles, at $3 per cord	162.18
,abor, superintendence, etc	18,585.80
'ugs, with crew, fuel, material, etc	5,649.95
'rovisions, with ice and fuel, for cooking	5,487.75
Total	58,159.05
'ubic feet of mattress work	1,428,618
square feet of mattress work	652,020
'ounds of rock per square foot to sink	14.56
'ost per square foot in place	$0.08919

The first mattress was completed November 6, and the first was sunk January 6, wo months after completion. The delay was caused by all the barges being engaged n transporting willows and rock.

The last large mattress was completed on December 31, 1892, and the last large nattress was sunk February 2, 1893. They were sunk in the following order: Between Spur Dikes 4 and 4½ from January 6 to 13; mattress below Spur Dike 4½ unk on January 17; mattress between Spurs 3½ and 4 sunk from January 21 to 26; nattress between Spur Dikes 3 and 3½ sunk from January 29 to February 2; mattress n head of Spur Dike 4 sunk February 6—the construction of this mattress was comleted on January 20; mattress 105 by 150 feet was sunk on head of Spur Dike 4½ 'ebruary 16, and mattress 105 by 60 feet on March 7.

The small mattresses in cave between Spurs 4 and 4½ were sunk from February 25 o March 9.

The construction of the mattresses were the same as those previously sunk in the Southport Bend, with the exception of the lower frame, which was built of 3 by 6 nch lumber to give greater strength to resist the strain of the downstream lowerng lines. No iron rods were used for strengthening the mattress, as they were 'ormerly; the top line of poles were all securely nailed and wired, and an additional ine placed near each toggle-pin, which gives all required strength and are cheaper han rods.

During the rise in December considerable difficulty was experienced in keeping he completed mattresses moored to the bank, owing to the large quantity of driftwood accumulating against them, and considerable washing was done to keep them loating until barges were available for sinking. During the sinking of the large nattresses the river was falling, no drift was running, and the weather was 'avorable for the work. The smaller mattresses were sunk during a rising river, with large quantities of driftwood running, and considerable difficulty was experienced in handling the mattresses and placing the barges in position, owing to the 'ross-currents and large accumulation of driftwood in the eddy between Spur Dikes and 4½.

The cost per square foot for mattress work was $0.00685 less than for the previous season; 3,749.25 tons of rock used was brought by rail from Alabama and loaded on he United States barges at New Orleans, the contract price being $2.50 per ton, lelivered on barges.

Nine hundred and ninety-seven and ninety-seven one-hundredths tons of rock was purchased from different sailing vessels in the harbor, at $1 per ton, loaded on the United States barges. A total of 1,143.91 tons was purchased in the harbor, of which 33.94 tons was unloaded on the bank at Southport.

One thousand one hundred and thirty-five and nine one-hundredths cords of brush and 54.06 cords of poles were cut by contract below New Orleans, and 4,825 cords of brush was cut by the United States employés at the willow grounds at F… Island; 739 cords was on hand at Southport.

On completion of work at Southport the plant was moved to laying up quar… at the Exposition wharf, all lines, tools, and other property cleaned and stor… the warehouses.

Repairs.—The tug *General Comstock* was entirely rebuilt and remodeled; the… was, labor on repairs, $3,476.83; material, $1,383.90; pay of crew, $337.35; fuel… repairs to machinery, $298.94. Total, $5,569.98. Previously reported, lab… repairs, $1,657.54; material, $603.32; making a total of $7,830.84 for repairs. … includes new house, new capstan, and propeller.

The tug was employed during the month of September on levees, under char… Assistant Engineer Douglas.

The cost of running the tug while under my charge, from October 1, 1892, to … 1, 1893, was: Material, $166.99; pay of crew, $1,459.95; fuel, $777.10; repair… machinery, $627.15; of this amount $2,404.04, or all excepting the repairs to machi… was charged to mattress construction.

Tug *Tilda* was employed on levees until June, when she was tied up at Ex… tion Wharf until September. During this time she was docked and the hull pa… and minor repairs to house and machinery; the cost was, labor for repairs, $… material, $172.17; pay of crew, $300.50; fuel, $352; a total of $1,114.99 for rep… The cost of running the tug during mattress construction was: Labor on rep… $71.75; material, $461.64; pay of crew, $1,617.42; fuel, $1,166.85; repairs to machi… $529.54; of this amount $3,245.91, or all except labor on repairs and repair… machinery, was charged to mattress construction.

The repairs on steamer *Gen. Newton* were done under my supervision, and consi… of extensive repair to deck forward and aft, new quarters for deck crew, mak… changes in cabin, putting down new steam capstan, repairs to machinery, new bre… ing and smokestacks and new woodwork of wheel, and minor repairs to cabin, ca… fenders, railing, nosing, and machinery at different times from date of last repor… March 31, 1893. The cost was, for labor, $1,632.24; material, $1,242.99; a tota… $2,875.23 for repairs.

Launch No. 5 was engaged with survey party during month of September, and … used on works for supplying steam to engine on deck, and for pumping barg… From December 3 to 12 she was engaged on levees with Assistant Engineer W… Hardee, and from January 6 to 24, 1893, on levees with Assistant Engineer W. Price. The launch was docked and hull cleaned and painted in July and Aug… 1892. The cost while under my supervision was, pay of crew, $244.59; fuel, $… repairs, $240.63; a total cost of $560.32.

Launch *Ruby*. The following repairs were made under my supervision in the mo… of June: New tubes were put in boiler, casing around furnace repaired and furn… rebuilt, pump repaired, new flooring put down in kitchen and fire room. Cost wa… Material, $68.30; labor, $80.27; repairs to machinery, tubes, etc., $165.25. In the mo… of October, 1892, the launch was put in dock, the hull tarred, calked, and paint… entire new rake planking of oak lumber put in, new woodwork in wheel, the wo… work on roof repaired, and new canvas put on roof, new breeching for smokesta… some new brasses, and rudder repaired. Cost was: Material, $55.96; labor, $3… a total of $688.28 for repairs.

Launch *Alaska* had extensive repairs to boiler and machinery; has been dock… twice and hull scraped and painted and new stern bearing put in, new fender str… put on; the house has been repaired and some minor repairs have been made to hou… The launch was engaged with Assistant Engineer W. J. Hardee on levees fifty-… days.

The principal service rendered in the harbor was towing small barges with mate… rial from Canal street to works. The cost was: Pay of crew, $275.27; fuel, $7… labor on repairs, $281.77; repairs to machinery, $431.50; a total cost of $1,061.04.

Barge No. 5: Repairs consisted of entire new sides, rakes, head blocks, deck bea… and deck. After completion of the new work the barge was turned over and … bottom calked. The cost was: Material, $450.99; labor, $2,366.43; a total of $2,817.4…

Barge No. 4: Repairs consisted of entire new sides, rakes, head blocks, deck bea… and deck. After completion of the new work the barge was turned over and t… bottom calked and repaired. The cost was: Material, $648.93; labor, $1,540.46; … total of $2,189.39.

Barges Nos. 9, 11, 12, and 14 were turned over, the bottoms calked and repaired. Th… cost was: Material, $302.19; labor, $1,342,49; making a total of $1,644.68.

Quarter boat *Beta:* Repairs consisted of new hull and minor repairs to house. Th… cost was: Material, $204.54; labor, $599.12; total, $803.66.

Quarter boat *Alpha:* Repairs consisted of new hull and minor repairs to house. Th… cost was: Material, $304.95; labor, $648.57; total, $953.52.

Quarter boat *New Orleans:* Minor repairs to house. The cost was: Material, $82.1… and labor, $93.13; total, $175.25.

Quarter boat *Gamma*, minor repairs to windows and head blocks. The cost was, material, $5.66; labor, $106.75; new cooking range, $104.20; total, $216.61.

Dredge *Pah-Ute*.—Repairs consisted of new deck and deck beams, new topsides, repairs to center black head, new braces under deck, and bucket crane and braces for same, new coal bunkers, new canvas roof, and other minor repairs to house. The repair was done during July and August, 1892, and the cost was: Material, $660.72; labor, $1,572.76; total, $2,233.48. The dredge worked in Old River during the low-water season of 1892 and was returned to New Orleans in February, 1893. The buckets and crane have been taken off the spud, post frames repaired and braced, the fender streak repaired, deck house strengthened, cylinder timbers put down, and Ball engine fastened in place. The cost was: Material, $29.73; labor, $482.36; total, $512.09.

Barge *B*.—Head blocks and deck were repaired. The cost was, for labor, $108.15.

Skiffs: Minor repairs were made to the different skiffs. The cost was: Material, $5.70; labor, 40.35; total, 46.05.

Dock barge was turned over and bottom repaired and calked. Two pieces of wharf timber 12 inches square and 75 feet long was bolted on bottom to give additional stiffness and strength to the bottom. The cost was: Material, $38.75; labor, $186.00; total, $224.75.

Barge *C*.—House was built on this barge to serve as quarters for engineers and inspectors on levees below New Orleans. The cost was: Material, $39.41; labor, $203.94.

The lumber used in building house was material left from levees, and no charge has been made for lumber.

Barge *A*.—This barge has been fitted up with pile-driver engine and all complete; the cost was: Material, $4.80; labor, $113.01; total, $117.81.

Care of plant: There has been expended for material, $1,160.17, and for labor, $2,970, a total of $3,130.17.

New plant.—Four new barges of the standard size have been constructed; two contracted for by the Pelican Sawmill and Manufacturing Company, built at their mill on the New Basin Canal which cost $3,287 each, and two contracted for by Christian Telson, built at the head of Louisiana avenue cost $3,650 each. The first barge was completed and delivered March 4, and the last completed and delivered on April 27, 1893. The total cost of the four barges was $13,874. The cost for inspection was $445.

Surveys.—Survey has been made of the Carrollton Bend extending from Spur Dike 3, Carrollton Bend, down to and including the exposition wharf. This survey includes the old and new levees, streets, and principal buildings; each section of sounding was carried out until the deepest portion of the river bottom was passed. The field work was done by Mr. G. Ed. Mott, during the month of July and August, 1892, with falling river.

Survey was also made during the months of January, February, and March, 1893, over the spur dikes in the Carrollton Bend and the mattresses sunk during the past season three lines of soundings were taken over each dike and mattress. The field work on these surveys cost $639.26.

Value of tools lost during season's work, $24.50; value of manilla and wire rope lost during the season's work, $192.44.

Very respectfully, your obedient servant,

WM. GARVIN,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

LEVEES.

The levee work of the fourth district having largely increased during the past year a redivision of the district into sections or sub-levee districts was suggested and approved by the commission at its meeting in August last. This subdivision is designed to afford greater convenience in making allotments, in executing the work of construction and repair, in maintaining the levees during high water, and to secure greater economy and efficiency in general administration of levee affairs, which have now become one of the most important parts of the work in charge of this district. The first season's experience under the new arrangement has been highly satisfactory.

The subdivisions now adopted are as follows:

The Lower Tensas Levee district, right bank, which extends from the upper limits of the fourth district, opposite Warrenton, to the mouth of Red River, and comprises 157¼ miles of the Mississippi River. In this district the levee system is continuous from the upper end down to a point 5 miles below Fairview Landing, a length of 130.5 miles of the river, leaving about 26 miles of river on this bank unleveed. For this distance the lands along the west bank are, therefore, now ject to overflow from the Mississippi, and they are also exposed to back water the lower Red, which is unleveed.

The Atchafalaya Levee district, right bank, which extends from the mouth of River to the head of Bayou Lafourche, a distance of 122 miles by river. The system in this district is continuous.

The Barataria Levee district, right bank, which extends from New Orleans t head of the passes, 102.5 miles. The levee system is practically continuous d the Jump, an opening through the bank of the main river about 10 miles abo head of the Passes. In the lower parts of the district, however, the strip of vated land is narrow and the variations in the height of the river become co tively slight and the levees are small affairs. The total length of river cover levees is 91.5 miles.

The Lafourche Levee district, right bank, which extends from the head of B Lafourche to New Orleans. The distance by river is 71 miles, and the levee s is continuous.

The Pontchartrain Levee district, left bank, which extends from New Orlea Baton Rouge. It comprises 123.5 miles of the river, and the levees are conti

The Lake Borgne Levee district, left bank, which extends from New Orleans t head of the Passes, 102.5 miles. The levee system only extends at present to Jackson, covering 82 miles of the river, and the same remarks concerning the portion of the Barataria Levee district apply to corresponding parts of the L Borgne Levee district.

Between Warrenton and Baton Rouge the river follows the general directi the bluff line on the left bank, being at no point at any great distance from the land. Numerous detached private levees exist along this portion of the river, w are more or less efficient, and which are designed solely for the local purpose of p tecting the cultivated bottom lands between the river and the bluffs from overfl Certain surveys having been directed by the commission between Warrenton Natchez on the left bank, the name Big Black Levee district has been adopte convenience to designate this locality. No work has been done in this distri the Federal Government.

Assistants have been assigned to the local charge of levee districts, as follows

Assistant Engineer H. S. Douglas to the charge of the lower Tensas and Big I Levee districts, in addition to his duties in charge of the work of improvem the harbor of Natchez and Vidalia, and of certain gauges.

Assistant Engineer W. J. Hardee to the charge of the Atchafalaya, Lafourche Pontchartrain Levee districts.

Assistant Engineer W. G. Price to the charge of the Barataria and Lake Bo Levee districts until February 16, 1893. Since that date Surveyor John Smyth been in temporary charge of these districts.

Up to the date of the last annual report levee construction and extensive repairs been done by the Federal Government in the fourth district at the following-na points:

Name of levee and levee district.	Bank.	Miles below Cairo.
Lower Tensas Levee district.		
Bedford	R.	606.5
Point Pleasant*	R.	624.0
Do*	R.	624.0
Hardtimes to Wilson	R.	631.0
Ships Bayou to Hardtimes	R.	633.0
Do	R.	633.0
Evergreen	R.	637.0
Hardscrabble	R.	639.0
Hardscrabble and Bondurant	R.	640.0
Kempe	R.	658.0
Do	R.	658.0
Do	R.	659.0
Do	R.	659.0
Gibsons	R.	683.5
Lake Concordia	R.	694.0
Do	R.	694.0
Ferriday	R.	694.0
Do	R.	694.0
Ferriday Break	R.	694.0
Arnauldia	R.	702.0
Hendersons	R.	713.0
Greens to Fairview	R.	720.0
Deer Park	R.	722.5
Do	R.	722.5

*Nearly all thrown out by new State levee.

Name of levee and levee district.	Bank.	Miles below Cairo.	Year.
Atchafalaya Levee district.			
Atchafalaya to Red River*	R.	765.0	1883
Hog Point to Raccourci*	R.	767.0	1883
Raccourci Crevasse*	R.	775.0	1883
Morganza*	R.	789.0	1887
Stewarts*	R.	791.0	1883
Nina	R.	806.5	1891
Highland Extension	R.	815.5	1892
Highland	R.	815.7	1891
Barroza	R.	824.0	1891
Mayflower—Union	R.	853.0	1892
Fortville	R.	855.0	1892
Evergreen	R.	857.0	1891
Dunboyne	R.	865.0	1892
Pontchartrain Levee district.			
Shannon	L.	837.0	1891
Martinez	L.	842.0	1891
Gay to Hollywood	L.	845.0	1891
Woodstock	L.	847.5	1891
Hermitage	L.	850.0	1891
Grenada to Mount Olive	L.	855.5	1891
Southwood Extension	L.	875.5	1892
Do	L.	875.5	1891
Ashland to Linwood	L.	878.0	1891
Dicharry	L.	882.0	1891
Irvine	L.	892.5	1891
Union	L.	893.5	1891
Lilly	L.	900.5	1891
College Point to St. Michael	L.	903.5	1890
Tessier—Bourgeois	L.	909.5	1892
Terre Haute to Hope	L.	919.5	1891
Cornland	L.	922.0	1891
Destrahan	L.	939.0	1891
Frellson to Almedia	L.	942.5	1891
Southport	L.	955.5	1892

* Afterwards extensively enlarged by State and partly abandoned, so identity of United States work no longer preserved.

The foregoing does not include work of minor repairs nor work done to assist in protecting and maintaining the levees during high water.

Protection work had been general throughout a greater portion of the district.

From the appropriation of July 13, 1892, a total of $655,000 was allotted for levee work in the fourth district. This was distributed among the several levee districts and reserves made for high-water protection, as shown in the accompanying money statements.

The localities at which the funds were to be applied were determined by the approved recommendation of the board of officers on building and repairing levees, whose recommendation was submitted on August 29, 1892, after a tour of inspection of the entire river from Memphis down to as far below New Orleans as contemplated work extended, and after consultation with numerous State and levee officials and with interested citizens.

The details of levee work completed up to the present date under the allotmentd from the appropriations of July 13, 1892, and balance on hand are given in condenses form in the following tables:

Fourth district levees, 1892-'93.

LOWER TENSAS LEVEE DISTRICT.

Name and levee.	Miles below Cairo and bank.		Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section. Crown.	Section. River slope.	Section. [illegible]
				Feet.	*Feet.*	*Feet.*	*Feet.*		
Hardscrabble, lower	640.4	R.	J. S. McTighe & Co.	5,348	4,650	2½	8	3 to 1	[illegible]
Bondurant	643.5	R.	Manning & Gibson.	3,417	2,550	2½	8	3 to 1	[illegible]
Grassmere to Wiccema.	693	R.	McLaughlin Bros.	26,400	5,500	2¼	8	3 to 1	[illegible]
Wiccema to Fletcher.	698	R.	Manning & Gibson.	26,313	4,500	2½	8	3 to 1	[illegible]
Fletcher to Minorca	699	R.	Rutherford & Dalgam.	18,399	12,000	2½	8	3 to 1	[illegible]
Minorca to Minors.	702	R.	Albert Henry Gillespie.	17,775	14,000	2½	8	3 to 1	[illegible]
Morville	710	R.	Manning & Gibson.	5,200	4,300	2½	8	3 to 1	[illegible]
Fish Pond	732	R.	William O. Flynn & Co.	6,365	4,000	2½	8	3 to 1	[illegible]

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavation. Cubic yards.	Filled excavation. Price per cubic yard.	Tile dr[illegible]. Linear yards.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Hardscrabble, lower	1.4	17.8	11.4	80,791.88	25	3,581.86	25	....
Bondurant	3.5	13.8	6.5	23,736.12	15$\frac{24}{100}$	None.	....	....
Grassmere to Wiccema	2.2	8.1	6.0	108,205.45	17½	206.03	16	....
Wiccema to Fletcher	1.2	10.2	7.2	125,996.46	16$\frac{48}{100}$	5,172.71	16$\frac{42}{100}$	7,29[illegible]
Fletcher to Minorca	3.7	12.6	7.0	117,789.84	15$\frac{1}{10}$	1,677.00	15$\frac{4}{10}$	....
Minorca to Minors	1.8	9.0	6.5	85,244.40	14	584.72	13$\frac{62}{100}$	....
Morville	2.3	9.7	5.9	28,040.86	14$\frac{24}{100}$	651.66	14$\frac{24}{100}$	....
Fish Pond	5.4	12.1	8.7	59,921.07	15½	789.69	15½	....

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work com[illegible]pleted.
	Lin. ft.					
Hardscrabble, lower	4,860	Oct. 31, 1892	Mar. 1, 1893	May 1, 1893	Nov. 8, 1892	Apr. [illegible]
Bondurant	None.	....do	Feb. 15, 1893	None.	Nov. 14, 1892	Dec. [illegible]
Grassmere to Wiccema.	194	Nov. 9, 1892	....do	June 30, 1893	Nov. 3, 1892	
Wiccema to Fletcher	2,880	Nov. 7, 1892	....do	Apr. 15, 1893	....do	Apr. 24 [illegible] 25, 18[illegible]
Fletcher to Minorca	3,059	Nov. 14, 1892	Mar. 1, 1893	June 1, 1893	Nov. 14, 1892	
Minorca to Minors	1,244	....do	....do	June 30, 1893	Nov. 15, 1892	
Morville	1,400	Oct. 31, 1892	Feb. 15, 1893	None.	Nov. 3, 1892	Dec. [illegible]
Fish Pond	None.	....do	Mar. 1, 1893	May 1, 1893	Feb. 15, 1893	May [illegible]

Name of levee.	Embankment, distance from center of levee to river bank. Min.	Max.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Hardscrabble, lower	1,500	2,450	1,975	Caving	New.
Bondurant	1,300	1,800	1,550	Caving rapidly	New.
Grassmere to Wiccema	2,200	16,000	16,000	Permanent on lake bank	Enlargement. Ti[illegible] not completed.
Wiccema to Fletcher	12,000	20,000	16,000	......do	New and enlarge[illegible]
Fletcher to Minorca	6,000	12,000	9,000	......do	New and enlarge[illegible] Tiling not comp[illegible]
Minorca to Minors	3,000	6,000	4,500	......do	New and enlarge[illegible] Tiling not compl[illegible]
Morville	1,200	1,400	1,300	Caving	New.
Fish Pond	3,300	3,600	3,450	Caving rapidly	New. Line to be e[illegible]tended.

Fourth district levees, 1892-'93—Continued.

ATCHAFALAYA AND LAFOURCHE LEVEE DISTRICT.

Name of levee.	Miles below Cairo and Bank.		Contractor.	Length of line.	Length of axis of river covered	Grade of levee above high water of 1892.	Section.		
							Crown.	River slope.	Land slope.
Atchafalaya district.				*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Barroza, upper	823	R.	Andrews Bros. Construction Co.	4,407	2,875	2½	8	3 to 1	2½, 4, & 6 to 1
Barroza, middle	823	R.	John Scott & Son	2,400	1,920	2½	8	3 to 1	2½, 4, & 6 to 1
Belair	828	R.	Timothy W. Scott	2,251	3,550	2½	8	3 to 1	2½ & 4 to 1
Eliza	842	R.	W. J. Bentley & Co.	2,609	2,780	2½	8	3 to 1	2½ & 4 to 1
Medora	852	R.	Sterling Fort	3,442	2,975	2½	8	3 to 1	2½ to 1 & 2½ & 4 to 1
Fortville, lower	855	R.	Ovide Lacour	2,055	1,680	2½	8	3 to 1	2½ & 4 to 1
Lafourche district.									
Buena Vista-Minnie.	896	R.	James M. Sullivan	4,370	3,540	2½	8	3 to 1	2½ & 4 to 1
Jamestown	897	R.	James N. Ogden	1,400	1,260	2½	8	3 to 1 and 2½ to 1	2½ & 4 to 1
St. James Church	901	R.	W. O. Flynn	8,462	8,690	2½	8	3 to 1	2½ to 1
St. James estate	902.5	R.	James M. Sullivan	1,325	1,375	2½	8	3 to 1	2½ to 1
Home Place	905.5	R.	Homan, McFadden & Cassidy.	3,482	3,380	2½	8	3 to 1	2½ & 4 to 1
Lone Star	941.5	R.	P. J. Coffman	4,415	4,030	2½	8	3 to 1	2½ & 4 to 1
Davis	948	R.	John E. Louque	1,909	1,660	2½	8	3 to 1	2½ & 4 to 1

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavation.		Tile drains.	
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Linear yards.	Price per linear yard.
Atchafalaya district.	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Barroza, upper	1.4	18.5	15.3	137,287.84	27½	2,886.10	27½	1,561	55
Barroza, middle	15.6	19.1	18.3	106,719.57	30¾	1,177.68	16	832½	30
Belair	1	12	11.6	42,851.91	19¾	208.01	10	......	......
Eliza	.6	12.4	11.8	47,737.36	18	353.72	18	......	......
Medora	.3	13.1	12.1	66,826.99	20	1,332.28	20	1,027½	50
Fortville, lower	.3	11.5	11.3	86,850.99	20½	1,244.69	20½	712	29
Lafourche district.									
Buena Vista-Minnie	.5	13.7	11.4	79,909.47	19½	2,363.19	19½	1,575⅝	50
Jamestown	.9	10.9	10.2	18,345.26	19 78/100	1,208	19 78/100	406⅓	40
St. James Church	2.5	10.5	9.3	98,748.55	17	5,121.59	17	2,889	40
St. James estate	3.2	10.3	9.4	15,133.01	18½	572.62	18½	......	50
Home Place	.9	13.4	11.5	63,653.78	19½	1,443.74	18	1,118⅜	30
Lone Star	2.3	12	10.1	60,921.53	20	2,541.21	14	1,539⅓	30
Davis	2.8	14.6	13	42,666.26	21	926.25	21	711⅓	50

Fourth district levees, 1892-'93—Continued.

ATCHAFALAYA AND LAFOURCHE LEVEE DISTRICT—Continued.

Name of levee.	Muck Ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	W[illegible]
Atchafalaya district.	*Lin. ft.*					
Barroza, upper	1,500	Nov. 7, 1892	Mar. 1, 1893	Apr. 16, 1893	Nov. 4, 1892	Apr
Barroza, middle	......	....do	....do	Apr. 15, 1893	Nov. 23, 1892	Apr
Belair	......	....do	Feb. 1, 1893	Mar. 1, 1893	Nov. 21, 1892	Feb
Eliza	......	Feb. 20, 1893	Apr. 1, 1893	....	Feb. 10, 1893	Apr
Medora	......	Nov. 7, 1892	Feb. 1, 1893	Apr. 7, 1893	Nov. 1, 1892	Apr
Fortville, lower	......	Nov. 4, 1892	....do	Feb. 10, 1893	Nov. 8, 1892	Feb.
Lafourche district.						
Buena Vista-Minnie	650	Oct. 31, 1892	Feb. 1, 1893	Apr. 20, 1893	Nov. 1, 1892	Apr
Jamestown	300	Nov. 7, 1892	Dec. 15, 1892	Dec. 31, 1892	Nov. 10, 1892	Dec
St. James Church	1,620	Oct. 31, 1892	Mar. 1, 1893	Apr. 15, 1893	Oct. 31, 1892	Apr
St. James estate	150	....do	Dec. 15, 1892	Jan. 5, 1893	Nov. 2, 1892	Jan
Home Place	......	Nov. 7, 1892	Feb. 1, 1893	Mar. 15, 1893	....do	
Lone Star	......	Nov. 5, 1892	Feb. 15, 1893	....	Nov. 29, 1892	Apr
Davis	......	....do	Feb. 1, 1893	Apr. 1, 1893	Nov. 2, 1892	Mar

Name of levee.	Embankment, distance from center of levee to river bank.			Nature of river bank.
	Min.	Max.	Mean.	
Atchafalaya district.	*Feet.*	*Feet.*	*Feet.*	
Barroza, upper	1,000	1,430	1,215	Caving bank at lower end.
Barroza, middle	1,150	1,490	1,320	Caving rapidly.
Belair	470	1,330	1,060	Washing bank.
Eliza	400	570	485	Washing and caving.
Medora	550	900	600	Caving, from appearance of map
Fortville, lower	450	550	500	Caving slowly.
Lafourche district.				
Buena Vista-Minnie	350	580	480	Caving bank.
Jamestown	160	400	330	Caving bank near upper end.
St. James Church	140	350	270	Washing bank.
St. James estate	240	300	250	Do.
Home Place	590	800	700	Caving rapidly.
Lone Star	160	400	250	Permanent bank.
Davis	340	530	435	Do.

PONTCHARTRAIN LEVEE DISTRICT.

Name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section.	
						Crown.	River slope.
			Feet.	*Feet.*		*Feet.*	
Lopez	844.5 L.	C. S. Jones	1,757	1,085	2½	8	3 to 1
Burtville	847 L.	Homan, McFadden & Cassidy.	4,727	3,610	2½	8	3 to 1
Towles	851 L.	E. W. Hanlon & Co.	1,339	1,210	2½	8	3 to 1
Billings	852.3 L.	....do	3,345	3,500	2½	8	3 to 1
Jolisant	858.8 L.	C. S. Jones	1,498	1,355	2½	8	3 to 1
Oakley to St. Gabriel.	862 L.	Homan, McFadden & Cassidy.	4,211	3,340	2½	8	3 to 1
Dicharry, lower	883 L.	James M. Sullivan	4,826	5,456	2½	8	3 to 1
Burnside	891 L.	Israel R. Bobbitt	3,520	2,850	2½	8	3 to 1
Union, upper	893 L.	P. J. Coffman	1,578	1,580	2½	8	3 to 1
Union, lower	893 L.	Jeffries & Dameron.	784	790	2½	8	3 to 1
Tippecanoe	894 L.	Israel R. Bobbitt	3,080	3,140	2½	8	3 to 1
Peytavin	894.5 L.	Jeffries & Dameron.	1,010	985	2½	8	3 to 1
White Hall	895 L.	McLaughlin Bros	590	1,040	2½	8	3 to 1
Tessier	909.5 L.	Jeffries & Dameron.	4,154	3,910	2½	8	3 to 1
Hope	916.5 L.	P. J. Coffman	4,700	8,600	2½	8	3 to 1
Trudeau	949 L.	....do	3,576	....	2½	8	3 to 1

Fourth district levees, 1892-'93—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment.		Filled excavation.		Tile drains.	
				Cubic yards.	Price per cubic yard.	Cubic yards.	Price per cubic yard.	Linear yards.	Price per linear yard.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*		*Cents.*
Lopez	1.4	10.3	10	22,184.30	18 3/10	114.77	18 3/10	......	......
Burtville	1.5	14	13.2	109,535.44	21	1,630.47	16	1,657⅜	29
Towles	0.8	9.8	9.5	15,866.32	19 25/100	352.94	15	......	......
Billings	0.8	10.5	9.8	39,490.21	19 3/10	374.19	15	......	......
Jolisant	2.7	11.2	10.1	20,090.18	18 3/10	236.07	18 3/10	......	......
Oakley to St. Gabriel	0.1	12.3	10.8	66,681.90	19	2,623.21	15	1,461⅜	27
Dicharry, lower	0.8	13.1	10.6	76,824.33	19	1,658.85	19	1,621¼	50
Burnside	0.3	11.9	8.8	40,025.52	17 88/100	1,587.20	12	1,294⅜	30
Union, upper	0.5	9.3	8.9	15,770.65	22	1,460.08	20	571	30
Union, lower	1.1	9.6	8.5	7,582.29	22	961.08	20	274⅓	30
Tippecanoe	0.6	9	8.2	28,356.47	19	289.41	16	......	......
Peytavin	0.9	7.7	7.2	7,191.66	20	629.86	20	350⅓	30
White Hall	0.7	8.1	7	4,889.15	21½	207.48	21½	......	......
Tessier	1.5	12.5	12	76,963.56	21¾	1,286.20	18	1,356⅓	30
Hope	2.5	12.1	9.6	57,394.11	18 44/100	2,248	18	1,681⅓	35
Trudeau	0.7	14.2	11.9	....	23	....	14	......	30

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Lin. ft.					
Lopez	......	Dec. 7, 1892	Mar. 1, 1893	Mar. 9, 1893	Dec. 9, 1892	Mar. 9, 1893
Burtville	......	Nov. 7, 1892	Mar. 1, 1893	Mar. 30, 1893	Oct. 31, 1892	Mar. 14, 1893
Towles	......	Jan. 9, 1893	Mar. 1, 1893	Mar. 8, 1893	Jan. 23, 1893	Mar. 8, 1893
Billings	......	Jan. 9, 1893	Mar. 1, 1893	Mar. 14, 1893	Jan. 6, 1893	Mar. 14, 1893
Jolisant	......	Dec. 7, 1892	Mar. 1, 1893	Mar. 15, 1893	Dec. 3, 1892	Mar. 15, 1893
Oakley to St. Gabriel	725	Nov. 7, 1892	Mar. 1, 1893	....	Nov. 14, 1892	Feb. 13, 1893
Dichary, lower	......	Oct. 31, 1892	Feb. 15, 1893	Mar. 15, 1893	Oct. 31, 1892	Mar. 10, 1893
Burnside	175	Nov. 7, 1892	Feb. 15, 1893	....	Dec. 5, 1892	Feb. 13, 1893
Union, upper	......	Oct. 29, 1892	Dec. 15, 1892	Jan. 12, 1893	Nov. 1, 1892	Jan. 11, 1893
Union, lower	......	Oct. 29, 1892	Dec. 1, 1892	Feb. 4, 1893	Nov. 18, 1892	Jan. 11, 1893
Tippecanoe	......	Nov. 8, 1892	Jan. 1, 1893	....	Oct. 27, 1892	Jan. 1, 1893
Peytavin	200	Oct. 29, 1892	Dec. 1, 1892	Jan. 14, 1893	Oct. 31, 1892	Jan. 14, 1893
White Hall	......	Nov. 14, 1892	Mar. 1, 1893	....	Nov. 9, 1892	Jan. 14, 1893
Tessier	......	Nov. 7, 1892	Feb. 15, 1893	Mar. 15, 1893	Dec. 5, 1892	Mar. 10, 1893
Hope	......	Nov. 5, 1892	Feb. 1, 1893	Mar. 1, 1893	Nov. 2, 1892	Apr. 10, 1893
Trudeau	800	Nov. 5, 1892	Feb. 15, 1893	....	Nov. 5, 1892	....

Name of levee.	Embankment, distance from center of levee to river bank.			Nature of river bank.
	Min.	Max.	Mean.	
	Feet.	*Feet.*	*Feet.*	
Lopez	220	340	310	Washing bank.
Burtville	340	850	600	Sloughing and caving.
Towles	210	270	240	No references as to nature of bank.
Billings	330	490	350	Do.
Jolisant	130	360	230	Caving below low end of levee.
Oakley to St. Gabriel	330	460	400	Sloughing and caving.
Dicharry, lower	600	860	650	Caving bank.
Burnside	180	310	245	Washing bank.
Union, upper	120	210	180	Do.
Union, lower	130	200	160	Do.
Tippecanoe	130	230	170	Do.
Peytavin	170	230	190	Do.
White Hall	350	550	450	Bank making sand bar.
Tessier	380	530	450	Small caves near lower end and crevasse in old levee.
Hope	240	960	600	Caving rapidly.
Trudeau*	240	430	330	Washing bank.

*Work 46 per cent completed when contract expired, February 15, 1893; contractor defaulted.

Fourth district levees, 1892-'93—Continued.

LAKE BORGNE LEVEE DISTRICT.

Name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered	Grade of levee above high water of 1892.	Section. Crown.	Section. River slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*	
Slaughterhouse	968.5 L.	Louis Louque	716	720	$2\frac{1}{2}$	8	2 and 4 to 1.
Slaughterhouse Extension.	968.5 L.	....	1,826	....	1.0	....	....
Roy	969 L.	Louis Louque	1,139	1,110	$2\frac{1}{2}$	8	2 and 4 to 1.
Bonzano	969 L.	....do	683	675	$2\frac{1}{2}$	8	2 and 4 to 1.
Chalmette Cemetery.	969.5 L.	....do	882	880	$2\frac{1}{2}$	8	2 and 4 to 1.
Deboushel	970 L.	....do	698	680	$2\frac{1}{2}$	8	2 and 4 to 1.
Pecan Grove	973 L.	James Byrne	1,466	1,500	$2\frac{1}{2}$	8	3 to 1
Story, upper	974 L.	S. D. Moody & Co	1,308	1,308	$2\frac{1}{2}$	8	3 to 1
Story, lower	975 L.	Robt. McNamara	4,670	4,725	$2\frac{1}{2}$	8	3 to 1
Repose	976 L.	John Cleary	1,454	1,600	$2\frac{1}{2}$	8	3 to 1
Caernarvon	979 L.	....	....	....	....	....	....
Orange Grove, upper.	980 L.	Philip J. Reilly	4,755	4,720	$1\frac{1}{2}$ to $2\frac{1}{2}$	8	3 to 1
Orange Grove, lower.	980 L.	....do	840	830	$2\frac{1}{2}$	8	3 to 1

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavations. Cubic yards.	Filled excavations. Price per cubic yard.	Tile drain. Linear yards.
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Slaughterhouse	1.3	4.5	2.5	1,319.93	$19\frac{99}{100}$	268.27	17	230.33
Slaughterhouse Extension	.4	2.2	1.0	3,037.00	....	....	....	....
Roy	1.8	7.8	6.9	7,806.22	$19\frac{99}{100}$	659.93	17	387.00
Bonzano	6.2	6.8	6.5	3,896.03	$19\frac{99}{100}$	325.53	17	227.00
Chalmette Cemetery	.9	8.5	6.5	4,724.78	$19\frac{99}{100}$	387.95	17	294.00
Deboushel	8.1	9.5	8.5	6,131.67	$18\frac{99}{100}$	375.84	17	251.66
Pecan Grove	4.0	9.7	7.5	12,042.00	$22\frac{1}{2}$	703.64	$22\frac{1}{2}$	(*)
Story, upper	2.8	5.6	4.2	5,793.60	$24\frac{7}{10}$	700.42	17	(*)
Story, lower	2.7	9.7	5.5	42,556.83	30	879.71	20	(*)
Repose	7.2	8.9	7.8	11,837.11	23	787.96	20	(*)
Caernarvon	....	....	....	....	....	....	....	....
Orange Grove, upper	7.7	11.3	10.0	58,521.82	23	1,103.88	20	(*)
Orange Grove, lower	6.9	8.2	7.5	6,927.95	$23\frac{1}{2}$	397.94	20	(*)

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Lin. ft.					
Slaughterhouse	....	Nov. 3, 1892	Mar. 1, 1893	....	Nov. 9, 1892	Jan. 12, [illegible]
Slaughterhouse Extension.	....	....	....	....	Feb. 6, 1893	Feb. [illegible]
Roy	1,139	Nov. 3, 1892	Feb. 1, 1893	Feb. 10, 1893	Dec. 7, 1892	Feb. 9, [illegible]
Bonzano	683	Nov. 3, 1892	Feb. 1, 1893	....	Dec. 9, 1892	Jan. 31, [illegible]
Chalmette Cemetery	582	Nov. 3, 1892	Feb. 1, 1893	....	Nov. 24, 1892	Jan. 31, [illegible]
Deboushel	698	Nov. 3, 1892	Feb. 1, 1893	....	Nov. 23, 1892	Jan. 31, [illegible]
Pecan Grove	1,466	Nov. 7, 1892	Feb. 15, 1893	....	Dec. 1, 1892	Feb. 10, [illegible]
Story, upper	....	Dec. 10, 1892	Mar. 1, 1893	....	Dec. 23, 1892	Feb. 24, [illegible]
Story, lower	1,185	Dec. 10, 1892	Mar. 1, 1893	....	Nov. 30, 1892	Feb. 17, [illegible]
Repose	1,454	Nov. 12, 1892	Mar. 1, 1893	....	Nov. 23, 1892	Feb. 17, [illegible]
Caernarvon	....	....	....	....	....	....
Orange Grove, upper	494	Nov. 8, 1892	Mar. 1, 1893	Mar. 25, 1893	Nov. 22, 1892	Mar. 24, [illegible]
Orange Grove, lower	840	Nov. 8, 1892	Mar. 1, 1893	Mar. 25, 1893	Dec. 22, 1892	Mar. 22, [illegible]

Fourth district levees, 1892-'93—Continued.

LAKE BORGNE LEVEE DISTRICT—Continued.

Name of levee.	Name of contractors.	Revetment. Linear feet.	Revetment. Price per linear foot.	Date of contract.	Work commenced.	Work completed.
		*	*Cents.*			
Slaughterhouse	Martin & Delaney	716	50	Jan. 12, 1893	Jan. 25, 1893	Feb. 11, 1893
Slaughterhouse Extension.		784				
Roy	Martin & Delaney W. L. Delaney	1,143	50	Jan. 12, 1893 Feb. 16, 1893	Mar. 10, 1893	Mar. 29, 1893
Bonzano	Martin & Delaney W. L. Delaney	682.6	60	Jan. 12, 1893 Feb. 16, 1893	Mar. 13, 1893	Mar. 28, 1893
Chalmette Cemetery.	Martin & Delaney W. L. Delaney	877	65	Jan. 12, 1893 Feb. 16, 1893	Feb. 22, 1893	Mar. 4, 1893
Deboushel	Louis Louque	678.75	69	Jan. 12, 1893	Feb. 15, 1893	Mar. 4, 1893
Pecan Grove						
Story, upper						
Story, lower						
Repose						
Caernarvon						
Orange Grove, upper.						
Orange Grove, lower.						

Name of levee.	Embankment distance from center of levee to river bank. Minimum.	Maximum.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Slaughter House	25	90	50	Washing bank.	Enlargement; open space to bank line; straight reach; levee runs along edge of street.
Slaughter House extension.				....do	Enlargement; straight reach; open space to river bank.
Roy	60	120	70	....do	Do.
Bonzano	90	110	100	....do	Do.
Chalmette Cemetery	30	100	80	Washing bank with one large slough near lower end of line which approaches berme of levee	New and enlargement; straight reach; open space to river bank.
Deboushel	55	110	80	Caving bank	New; breach of about 125 feet in old levee had occurred before new levee was built.
Pecan Grove	185	235	200	Washing bank.	New and enlargement; concave bank of slight bend; enlargement portion of this levee is protected by willows; new portion by old levee left standing.
Story, upper	120	160	140	....do	Enlargement; straight reach; this levee is protected from wave wash by willows.
Story, lower	160	400	250	....do	New and enlargement; straight reach; this levee is protected from wave wash by willows.
Repose	130	170	140	....do	New; concave reach; open space to river bank; levee is somewhat protected from wave wash by high batture.
Caernarvon				....do	Bids rejected considered too high. See Levee, 1893-'94.
Orange Grove, upper	180	420	300	....do	New; straight reach just below deep bend; new levee protected from wave wash by old levee still standing; willows on batture opposite upper portion of levee.
Orange Grove, lower	120	130	125	....do	New; straight reach, just below deep bend; new levee protected from wave wash by old levee still standing; willows on batture opposite upper portion of levee.

* Supplemental articles of agreement.

Fourth district levees, 1892–'93—Continued.

BARATARIA LEVEE DISTRICT.

Name of levee.	Miles below Cairo and Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section. Crown.	Section. River slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*	
Magnolia	980.5 R.	Robert McNamara	5,577	4,875	2½	8	2 and 4 to 1.
Fort St. Leon, upper.	981.5 R.	James N. Ogden	1,854	1,800	2½	8	3 to 1.
Fort St. Leon, lower.	982.5 R.	....do	918	900	2½	8	3 to 1.
Belle Chasse Crevasse.	983 R.	....do	742	703	2½	8	2 and 4 to 1.
Belle Chasse to Concession.	985 R.	....do	9,675	9,600	2½	8	2 and 4 to 1. 4 and 3 to 1
Concord	987 R.	....do	2,544	2,350	2½	8	3 to 1.
Oak Point	988.5 R.	....do	2,137	2,000	*2	8	3 to 1.
Live Oak	991.5 R.	....do	1,244	1,200	{†1 ‡2½}	8	2 and 4 to 1.
Happy Point	994 R.	....do	965	1,400	*2	8	3 to 1.

† Enlargement. ‡ New.

Name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavation. Cubic yards.	Filled excavation. Price per cubic yard.	Tile drain. Linear yards
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Magnolia	2.5	5.8	5.0	28,734.13	25	2,930.57	20	1,905¾
Fort St. Leon, upper	5.7	8.1	6.7	11,978.13	20	1,335.57	20	622¾
Fort St. Leon, lower	3.0	7.4	6.0	5,506.83	22	841.91	22	285¼
Belle Chasse Crevasse	2.5	11.7	7.5	4,035.48	23	334.96	20	271
Belle Chasse to Concession	.7	8.9	5.2	51,546.77	22	2,704.20	22	3,404¾
Concord	7.0	8.9	8.5	25,046.44	20	1,658.19	20	943¾
Oak Point	5.3	6.4	6.0	11,314.20	22	1,316.37	22	756¾
Live Oak	6.9	8.5	8.2	7,587.01	23	531.01	22	326¾
Happy Point	1.0	8.0	7.6	8,672.94	23	1,027.20	23	500

Name of levee.	Muck ditch.	Date of contract.	Contract time for completion.	Extension granted to—	Work commenced.	Work completed.
	Linear feet.					
Magnolia	4,700	Nov. 2, 1892	Feb. 1, 1893	Feb. 20, 1893	Nov. 14, 1892	Feb. [illegible]
Fort St. Leon, upper	1,854	Nov. 14, 1892	Mar. 1, 1893	....	Nov. 18, 1892	Dec. [illegible]
Fort St. Leon, lower	....	Nov. 2, 1892	Mar. 1, 1893	....	Nov. 2, 1892	Dec. 24 [illegible]
Belle Chasse Crevasse	183	Nov. 14, 1892	Feb. 1, 1893	....	Dec. 15, 1892	Jan. [illegible]
Belle Chasse to Concession	1,057	Nov. 2, 1892	Feb. 1, 1893	Feb. 20, 1893	Nov. 26, 1892	Feb. [illegible]
Concord	2,544	Nov. 14, 1892	Mar. 1, 1893	Apr. 21, 1893	Dec. 22, 1892	Apr. [illegible]
Oak Point	2,137	Nov. 2, 1892	Mar. 1, 1893	Mar. 10, 1893	Nov. 25, 1892	Mar. 1[illegible]
Live Oak	844	Nov. 2, 1892	Feb. 15, 1893	....	Jan. 3, 1893	Feb. 14 [illegible]
Happy Point	975	Nov. 14, 1892	Mar. 1, 1893	....	Dec. 12, 1892	Feb. 16 [illegible]

Fourth district levees, 1892-'93—Continued.

BARATARIA LEVEE DISTRICT—Continued.

Name of levee.	Name of contractors.	Revetment. Linear feet.	Revetment. Price per linear feet.	Date of contract.	Work commenced.	Work completed.
			Cents.			
Magnolia	W. R. Thompson		65	Jan. 21, 1893		
	Carbolineum Wood Preserving & Manufacturing Co., Limited.	4,239	74½	Feb. 23, 1893	Mar. 3, 1893	Mar. 24, 1893
Fort St. Leon, upper						
Fort St. Leon, lower						
Belle Chasse Crevasse						
Belle Chasse to Concession.	W. R. Thompson			Jan. 21, 1893		Mar. 24, 1893
	O. H. Parsons	8,174	65	Feb. 23, 1893	Feb. 7, 1893	
Concord						
Oak Point						
Live Oak	W. R. Thompson	838*	65	Annulled Feb. 22, 1893 Jan. 21, 1893	Commenced by United States Feb. 24, 1893.	Mar. 4, 1893
Happy Point						

Name of levee.	Embankment, distance from center of levee to river bank. Minimum.	Maximum.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Magnolia					Enlargement; concave reach; bank slightly caving near lower end of line; batture opposite upper portion grown up with willows.
Fort St. Leon, upper					New; straight reach; open space to river.
Fort St. Leon, lower				Washing bank; sand bar seemingly forming in front.	New; concave reach; open space to river.
Belle Chasse Crevasse				Slight cave during winter, but nothing more than usual wave wash.	New and enlargement; straight reach just below deep bend; batture densely grown up with willows.
Belle Chasse to Concession				Washing bank, but caving in bend above.	New and enlargement; upper portion protected from wave wash by old line; from 57 to 64 of lower section protected by willows; batture opposite all other points is open to new bank.
Concord	230	230	230	Washing bank	Straight reach; old levee from 30 to 40 feet from bank; new levee runs through cane and pea field; open space to river; new.
Oak Point	75	250	230	Slight cave near lower end of line.	New; straight reach; slight cavein bank at lower end of line from 20 to 50 feet from new bank; new levee through pea field; open space to new bank.
Live Oak	310	340	325	do	New and enlargement; washing bank; open space to river; new levee runs through field; upper section, enlargement, is about 90 feet from river bank, and bank shows some tendency to cave; batture is slightly grown with willows.
Happy Point	320	380	350	Washing bank	New and enlargement; new levee runs through field and garden; open space to river bank.

* Grade made less than 2½ feet above high water, 1892, through error.

Fourth district levees, 1892-'93—Continued.

SUMMARY.

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria	[illegible]
Earthwork.....cubic yards..	522, 349. 55	445, 477. 14	398, 554. 46	503, 505. 40	167, 180. 91	[illegible]
Embankment....linear feet..	109, 217	17, 164	25, 363	44, 695	25, 656	[illegible]
Axis of river covered...............do......	56, 500	15, 780	23. 935	42. 451	24, 828	[illegible]
Drain tiles...........do......	7, 292⅜	12, 398	22, 587	30, 804¼	27. 157	[illegible]
Revetment..........do......	None.	None.	None.	None.	12, 413	[illegible]

GRAND SUMMARY.

Earthwork..cubic yards.. [illegible]
Embankment...linear feet.. [illegible]
Axis of river covered...do...... [illegible]
Drain tiles..do...... [illegible]
Revetment...do...... [illegible]

In accordance with the approved recommendation of the Commission, [illegible] authority of the act of July 13, 1892, that contracts be entered into for lev[illegible] to be paid for from the appropriation for the fiscal year ending June 30, 1894, [illegible]tisements were issued and a number of contracts were entered into in anticipat[illegible] an appropriation to cover the allotments made for the coming fiscal year. [illegible] appropriation was made in the sundry civil act of March 3, 1893.

Contracts have been made for the following levees, the contracts providing [illegible] the works are to be completed by June 30, 1894:

Name of levee.	Bank and miles below Cairo.	Name of levee.	Ba[illegible] m[illegible] lo[illegible]
Lower Tensas Levee district:		*Pontchartrain Levee district:*	
Rifle Point..........................	700 R.	Houmas..........................	[illegible]
Atchafalaya Levee district:		Hester..........................	[illegible]
St. Francis Church..............	798 R.	St. Elmo..........................	[illegible]
Belle Vale..........................	825. 5 R.	Poche..........................	[illegible]
Missouri..........................	840 R.	Terre Haute..........................	[illegible]
Dubboine Upper..........................	865 R.	Prospect..........................	[illegible]
Belle Grove..........................	870 R.	*Barataria Levee district:*	
Celeste..........................	871. 5 R.	Magnolia, new and enlargement..	[illegible]
Mount Salem..........................	872 R.	Fort St. Leon, middle..........	[illegible]
Babin..........................	879 R.	Kearney..........................	[illegible]
Lafourche Levee district:		St. Anne, enlargement..........	[illegible]
Melancon-Lemanville..............	893 R.	Oakville..........................	[illegible]
Jamestown Lower..............	898 R.	Belle Chasse..........................	[illegible]
St. Emma..........................	904 R.	Dobard..........................	[illegible]
Magnolia..........................	911 R.	Star..........................	[illegible]
White Rose..........................	918 R.	Ironton..........................	[illegible]
Providence..........................	932 R.	Oakland..........................	[illegible]
Flagtown..........................	936. 5 R.	*Lake Borgne Levee district:*	
Speransa..........................	937 R.	Battle Ground, new and enlargement..........................	[illegible]
Ashton..........................	940 R.	Irving..........................	[illegible]
Pontchartrain Levee district:		Caernarvon..........................	[illegible]
Shannon Lower..........................	837 L.	Orange Grove..........................	[illegible]
Maryland..........................	872 L.	English Turn..........................	[illegible]
Rescue..........................	874 L.	St. Clair..........................	[illegible]
Southwood Upper..........................	874. 7 L.	Mon Plaisir..........................	[illegible]
Belle Helene..........................	879 L.		

Fourth district levees, 1893–'94.

LOWER TENSAS, ATCHAFALAYA, AND LA FOURCHE LEVEE DISTRICTS.

Levee district and name of levee.	Miles below Cairo, and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Section. Crown.	River slope.	Land slope.
Lower Tensas district:			*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Rifle Point	700 R.	J. S. McTighe & Co.	16,974	16,500	2½	8	3 to 1	2½ to 1
Atchafalaya district:								
Belle Vale	825.5 R.	W. J. Bontley & Co.	3,484	....	2½	8	3 to 1	2½ and 4 to 1.
Missouri	840 R.	Jno. Scott & Son	4,574	....	2½	8	3 to 1	2½ and 4 to 1.
Celeste	872 R.	W. L. Killebrew	2,888	....	2½	8	3 to 1	2½ to 1
Mount Salem	872½ R.	W. L. Killebrew	2,100	....	2½	8	3 to 1	2½ to 1
Lafourche district:								
White Rose	918 R.	Jeffries & Damon	1,623	....	2½	8	3 to 1	2½ to 1
Flagtown	936.5 R.	Andrews Bros. Construction Co.	1,953	1,760	2½	8	3 to 1	2½ to 1
Speranza	937 R.	Andrews Bros. Construction Co.	2,245	....	2½	8	3 to 1	2½ and 4 to 1.

Levee district and name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavations. Cubic yards.	Filled excavations. Price per cubic yard.	Muck ditch.
Lower Tensas district:	*Feet.*	*Feet.*	*Feet.*		*Cents.*		*Cents.*	*Lin. ft.*
Rifle Point	2.7	7.2	4.8	68,000	$15\frac{24}{100}$	....	$15\frac{24}{100}$	None.
Atchafalaya district:								
Belle Vale	0.4	12.8	12.3	71,524.85	16¾	211.05	13	58
Missouri	0.8	13.2	12.8	98,816.24	$16\frac{22}{100}$	361.71	$16\frac{22}{100}$	
Celeste	7.5	10.5	9.9	36,527.20	$14\frac{22}{100}$			
Mount Salem	0.8	10.8	9.8	24,944.71	$14\frac{24}{100}$	230.36	14	
Lafourche district:								
White Rose	0.7	13.3	9.5	19,248.04	15	63.65	15	
Flagtown	8.2	9.0	7.3	15,415.06	$14\frac{24}{100}$	22.44	$14\frac{24}{100}$	
Speranza	0.3	12.5	10.5	83,064.40	$14\frac{74}{100}$	842.79	$14\frac{74}{100}$	

Levee district and name of levee.	Date of contract.	Contract time for completion.	Work commenced.	Work completed.
Lower Tensas district:				
Rifle Point	Feb. 6, 1893	June 30, 1894	....	....
Atchafalaya district:				
Belle Vale	Feb. 6, 1893	....do	Apr. 10, 1893	....
Missouri	Feb. 20, 1893	....do	Apr. 7, 1893	....
Celeste	Feb. 11, 1893	....do	Mar. 21, 1893	....
Mount Salem	....do	....do	Mar. 22, 1893	....
Lafourche district:				
White Rose	Feb. 7, 1893	....do	Apr. 14, 1893	....
Flagtown	....do	....do	Apr. 8, 1893	Apr. 26, 1893.
Speranza	....do	....do	Apr. 27, 1893	....

Levee district and name of levee.	Embankment, distance from center of levee to river bank. Min.	Max.	Mean.	Nature of river bank.	Remarks.
	Feet.	*Feet.*	*Feet.*		
Lower Tensas district:					
Rifle Point	2,200	8,000	5,500	Not stated	New and enlargement.
Atchafalaya district:					
Belle Vale	300	500	400	Caving bank	On May 31 35 per cent completed.
Missouri	400	750	600	Caving and sloughing.	On May 31 83 per cent completed.
Celeste	360	550	450	Caving bank	On May 31 43 per cent completed.
Mount Salem	340	440	395	....do	On May 31 81 per cent completed.
Lafourche district:					
White Rose	270	390	330	Sloughing bank	On May 31 70 per cent completed.
Flagtown	310	410	360	Washing bank.	
Speranza	160	240	200	....do	Work suspended May 3, 1893; 20 per cent completed.

Fourth district levees, 1893-'94—Continued.

PONTCHARTRAIN LEVEE DISTRICT.

Levee district and name of levee.	Miles below Cairo and bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above high water of 1892.	Sect[illegible] Crown.	River slope.
			Feet.	*Feet.*	*Feet.*	*Feet.*	
Maryland	872 L.	Alex. Eltringham	4,570	....	$2\frac{1}{2}$	8	3 to [illegible]
Rescue	874 L.	......do	1,457	....	$2\frac{1}{2}$	8	3 to [illegible]
Hester	908.5 L.	S. D. Moody & Co., limited.	5,466	....	$2\frac{1}{2}$	8	3 to [illegible]
St. Elmo	910 L.	......do	1,812	3,275	$2\frac{1}{2}$	8	3 to [illegible]
Poche	911 L.	Jeffries & Dameron	2,521	2,710	$2\frac{1}{2}$	8	3 to [illegible]
Terre Haute	921 L.	H. C. Brown	4,347	....	$2\frac{1}{2}$	8	3 to [illegible]

Levee district and name of levee.	Least net fill.	Greatest net fill.	Average net fill.	Embankment. Cubic yards.	Embankment. Price per cubic yard.	Filled excavations. Cubic yards.	Filled excavations. Price per cubic yard.	[illegible]
	Feet.	*Feet.*	*Feet.*		*Cents.*		*Cents.*	
Maryland	2.7	10	9.5	53,549.19	$14\frac{73}{100}$	175.91	$14\frac{73}{100}$	[illegible]
Rescue	1.0	13.7	....	....	15	....	15	[illegible]
Hester	.5	14.4	13.1	122,625.60	$15\frac{1}{4}$	1,356.96	$15\frac{1}{4}$	[illegible]
St. Elmo	4.0	12.1	11.8	31,764.77	$15\frac{1}{2}$	232.36	$15\frac{1}{2}$	[illegible]
Poche	1.3	8.8	8.4	24,125.66	15	157.71	15	[illegible]
Terre Haute	1	9.8	9.1	47,235.23	$14\frac{88}{100}$	263.61	10	[illegible]

Levee district and name of levee.	Contract time for completion.	Work commenced.	Work completed.	Embankm[illegible] Distance from levee to riv[illegible] Minimum.	Maximum.
				Feet.	*Feet.*
Maryland	June 30, 1894	May 11, 1893	....	230	[illegible]
Rescue	....do	....do	....	450	[illegible]
Hester	....do	May 23, 1893	....	510	[illegible]
St. Elmo	....do	Feb. 16, 1893	....	640	[illegible]
Poche	....do	Mar. 17, 1893	Apr. 13, 1893	150	[illegible]
Terre Haute	....do	May 9, 1893	....do	210	[illegible]

Levee district and name of levee.	Nature of river bank.	Remarks.
Maryland	Sloughing bank; no cavings.	Work 2 per cent completed May 31, [illegible]
Rescue	Caving bank	Work 20 per cent completed May 31, [illegible]
Hester	......do	Work 1 per cent completed May 31, 18[illegible]
St. Elmo	Caving rapidly	
Poche	Washing bank	
Terre Haute	Sloping bank	Work 18 per cent completed May [illegible]

Summary for levees built under allotment for fiscal year ending June 30, 1893.

	Levee district.		
	Atchafalaya.*	Lafourche.	Pontchartrain.
arthwork placed to June 1, 1893 (approximate)....cubic yards..	119,920	42,635	72,166
mbankment completed ....linear feet..	....	1.953	4,333
xis of river covered ....do....	....	1,760	5,985

*No levees completed.

GRAND SUMMARY.

arthwork placed to June 1, 1893 (approximate)....	cubic yards..	234,721
mbankment completed (approximate)....	linear feet..	6,286
xis of river covered	do....	7,745

Upon the recommendation of this office, submitted March 8, 1893, advertisements or further work under the appropriation for the fiscal year 1894 have been postponed until after June 30, 1893.

In addition to the foregoing work of construction numerous minor repairs to the evee have been made in the way of restoring embankments injured by wave wash nd the action of rains, repairing weak places, stopping leaks, clearing of weeds, etc.

Levee construction and repairs by the State and the local levee district organizaions have been very active during the year in all parts of the fourth district, xcept in the Lower Tensas Levee district (fifth Louisiana Levee district), where omparatively little work excepting that under direction of this office has been one.

	Levee district.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Lake Borgne.	Barataria.
ggregate yardage in levees on Mississippi River, June 30, 1892.	9,392,000	9,292,000	3,752,000	6,079,700	1,370,500	1,226,300
dded by United States to May 1, 1893....	522,350	445,500	393,554	503,500	168,200	167,200
dded by others to May 1, 1893...	40,000	650,000	636,350	305,600	363,500	138,400
Sum	9,954,350	10,387,500	4,780,904	6,888,800	1,902,200	1,531,900
ost by caving or abandonment, June 30, 1892, to May 1, 1893....	149,300	384,500	456,000	409,600	219,800	79,500
Aggregate remaining May 1, 1893	9,805,050	10,003,000	4,324,904	6,479,200	1,682,400	1,452,400

Percentage of length of existing levee system built to date by the United States.

	Per cent.
ower Tensas Levee district	47
tchafalaya Levee district	8
afourche Levee district	6½
ontchartrain Levee district	18
arataria Levee district	5½
ake Borgne Levee district	3½
ercentage of total length of existing levee system, fourth district, built by the United States	13½

The following report on high water of 1892 was submitted May 4, 1893:

UNITED STATES ENGINEER OFFICE,
New Orleans, La., May 4, 1893.

SIR: I have the honor to submit the following special report on the flood of 1892, in compliance with the Commission's resolution of November 17, 1892:

In general terms the flood of 1892 in the fourth district, as compared with the great floods of previous years, was characterized as follows:

It was unusually late in the season and of prolonged duration, the river maintaining a very high and approximately uniform stage throughout the entire mo May and June. The water reached a height averaging about five-tenths of below the highest previously recorded stage (flood of 1890) in the upper part district from Warrenton to Red River Landing.

At Red River Landing the highest stage was about the same as the high viously recorded, that of 1890. Below that point the actual heights reached exc all previous records by from 1 foot to $1\frac{7}{10}$ feet, though the maximum heights modified at many of the gauge stations by large crevasses.

The weather conditions during the flood were generally favorable, as there few storms or long periods of high winds. The flood was attributable to unu heavy and prolonged rainfall, which was general and nearly simultaneous throu the great basins claimed by the main river and its tributary system.

In the organization for applying the funds available for protecting and main ing the levees Assistant Engineer Douglas was placed in immediate charge of portion of the district from Warrenton to Red River Landing, with stati Natchez, and Assistant Engineer W. J. Hardee was assigned to the immediate ch of the portion of the district below Red River Landing. All the steamboats, quarter boats, barges, and other plant of the district available were utiliz protection work, and in addition the tug *Laurel*, chartered for the purpose employed. Such inspectors and other employés necessary were engaged an tioned as their services required, under direction of the assistant engineer in charge. The general plan of operations contemplated, first, holding all levees by the United States, so as to relieve the local authorities of the expense of care; second, rendering such assistance on State levees, by use of floating plant distribution of material, as was practicable with funds available.

As a general rule all labor and a greater portion of the material required to State levees were supplied by the State and local authorities, and these author supervised the important work of closing crevasses.

The results may be briefly summarized as follows:

No break occurred in the entire line of levees from Warrenton to Red River La ing, and this was the first serious flood during which the levees were success held in that portion of the district. The greatest trouble was experienced or Lake Concordia levees, extending from opposite Natchez to Bullitts Bayou, a tance of about 17 miles.

Below Red River Landing a total of twenty-five breaks occurred of a more or serious nature, but all of them except five were successfully closed before any gr amount of damage was done.

The Belmont and Sarpy breaks in the Ponchartrain Levee district developed disastrous crevasses. The Anchor crevasse, also in this district, did comparati little damage.

The injury resulting from the Story and Villere crevasse, on the left bank be New Orleans, though serious, was only local, except that the New Orleans a Southern Railroad was interrupted.

Particular attention is invited to Assistant Engineer Hardee's report on the m ods successfully adopted for closing crevasses and to the sketch herewith. N before in the history of levee work in this district has there been such a large mea ure of success in closing breaks as in the flood of 1892.

As to the difficulty experienced in holding the levees, it was principally du low grade, exposure of the levee to wave wash, or concealed defects in the emb ment, usually attributed to crayfish or muskrat holes. There was very little tro from sloughing of the embankment alone, or from mere deficiency of section, an only one case was a levee ruptured by the caving of the bank. Low-grade lev were easily held, though of course at considerable expense, by layers of sacks fi with earth, or by driving stakes along the crown, placing boards against them edge, and backing them with earth. In case of very low levees two parallel li of boards were put up on the crown and the space between filled with earth. I some cases the levees were raised as much as 3 feet by this method. No br occurred from overtopping of the levee.

Where levees were exposed to wave wash they were maintained by protect them with wooden revetment, or with sacks filled with earth and laid along slope near the water surface. With proper attention no break need occur fr wave wash.

The greatest source of danger, however, and the one that produced nearly all breaks, was the existence of holes or vacant spaces in and through the levee ne its base, as indicated by serious leaks. The method usually resorted to in these ca was to throw earth, either loose or in sacks, on the river slope of the levee oppo where a dangerous leak might be found. This was sometimes effective, but not un formly so, as the record of breaks shows.

The principal points of interest, in connection with holding or protecting th levees during the flood season, which were developed or confirmed by the experience during the flood of 1892 are briefly as follows:

During flood seasons a complete and effective organization to patrol and watch the levees is of great importance, and the most careful vigilance should be exercised during the time of danger.

A sufficient provision of floating plant, consisting of barges for material, quarter boats for workmen, and steam tugs or tow boats, is a most valuable auxiliary, and indeed is absolutely necessary to give any chance of success in an attempt to close breaks after they occur. In such cases other means of communication and of transporting material are liable to be absolutely cut off, and everything must be moved by water.

Embankments of comparatively small section, if firm and free from holes and leaks, can be safely held even if deficient in height, and levees of standard section have a larger factor of safety and are less endangered by wave wash or sloughing than is usually supposed.

It is highly important to devise some more effective method of holding a levee which developes weakness from holes or serious leakage near the base than has been heretofore generally applied.

The loss and damage resulting from seepage or general leakage through or under a levee frequently becomes serious even if no break occurs. Finally, it may be observed, that with the completion of the levee system the problem of holding the levees below Red River Landing and providing for the safe and free passage of the water of a flood to the Gulf will perhaps become more serious than has heretofore been supposed, and I believe that the indications are that this problem will demand most careful consideration in the near future.

I deem it proper to add the following copy of a resolution passed by the senate and house of representatives of the State of Louisiana:

"Whereas the flood water in the Mississippi River along the Louisiana front from a combination of unprecedented causes has reached a higher elevation than ever known, and that the levee system in its present incomplete condition, with the exception of a few places which gave way from local causes, has been on the whole made to withstand the said flood; and

"Whereas the success thus far attained has been largely due to the timely aid given by the United States through the allotments made by the Mississippi River Commission:

"*Resolved*, That the thanks of the people of this State be extended to the United States Government for the liberal appropriations made, and also to Engineers Capt. Curtis Mc D. Townsend and Lieut. John Millis, and their corps of civil assistants, E. C. Tollinger, W. S. Brown, H. S. Douglas, and W. J. Hardee, for their individual efforts and energy in rendering timely aid and assistance to the State and local authorities.

"I, George Spencer, assistant secretary of state of the State of Louisiana, do hereby certify that the above and foregoing is a true and correct copy of a resolution passed in the senate and house of representatives of the State of Louisiana at the regular session of the general assembly for the year 1892."

"Given under my signature and the seal of the State of Louisana at the city of Baton Rouge, this 26th day of March, 1892.

[SEAL.]

"GEO. SPENCER,
"*Assistant Secretary of State.*"

I do not consider any further comment necessary as to the manner in which the employés under this office discharged the laborious and exacting duties which the flood season required, except to say that all, including those whose services were not of a character to bring them prominently to the notice of the public, are deserving of equal commendation.

Annexed hereto are the reports of Assistant Engineers H. S. Douglas and W. J. Hardee.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Col. C. B. COMSTOCK.
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

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

NATCHEZ, MISS., *June 30, 1892.*

SIR: I have the honor to submit the following report on protection of levees, Tensas Basin, fourth district, for the year ending June 30, 1892:

On April 14, 1892, the river had risen to the danger line at Vicksburg (41.0 feet) and reports of heavy rains and rising tributaries indicated a flood of unusual height in the Mississippi River.

Reasonable precaution suggested that preparations for levee protection work in this district should be at once undertaken, and they were. On May 1, 1892, the United States quarter boat *Delta* and barge with outfit of material necessary to levee protection work arrived at Natchez, Miss., in tow of steamer *Newton*. The United States quarter boat *Gamma* and barge with material and tools arrived at Natchez on May 6, 1892.

Some work had been done on Henderson levee (713 R) and Lake Concordia levee (693 R) prior to the arrival of the quarter boats, but the most active and energetic steps were at once taken to protect and save the entire line if possible with the means at hand.

The quarter boat *Delta* and barge with the necessary material, tools, etc., and an organized force of trained employés on board, was transferred from levee to levee as the emergency demanded, and rendered very efficient service.

The quarter boat *Gamma* was held at Natchez as an emergency boat available in case of disaster, which fortunately did not occur.

As rapidly as possible an efficient corps of inspectors, composed of employés who had had previous experience on levees in this district, was organized. The inspectors were stationed at such points as seemed to be the most advantageous. Although the responsible duty of guarding and patrolling the line of levees was, in accordance with the resolution of the Mississippi River Commission, left to the local authorities, the territory from Point Pleasant (622.2 R) to Fairview (726.6 R), a distance of about 106 miles, was almost daily inspected by a representative of the United States.

The duties of these inspectors were to investigate all places reported to be dangerous when considered necessary to inform the assistant engineer in local charge, to employ the requisite force on United States levees and have such work done as was required to secure dangerous or weak places, and to attend to the usual routine work of making reports, keeping time of force, and having pay rolls signed.

Considering results, the plan and organization would appear to have reached a point approximating perfection, for I have the pleasure of reporting that after an unexpected flood of unusual height and duration not a single break now exists in the line of levees, Tensas Basin, fourth district, a line 135 miles long of the highest, most dangerous and inaccessible levees on the Mississippi River.

When the exigencies of the service permitted, the assistant in local charge was provided with a Government boat. At other times he was authorized to charter; but under either condition prompt response was made to all calls of assistance in holding the line of levees.

I consider it proper to state that the residents in threatened localities have invariably rendered willing and efficient assistance service, and to them as well as to the employés of the United States the credit of maintaining the line of levees is due.

I give a brief statement of protection work done and the causes thereof, taking the levees in detail from the head of the district to Fairview, the end of the lower line:

Bedford Levee (*U. S. 606 R.*).—No protection work was necessary. At this levee the embankment had been reinforced by "banquettes," and no weakness was shown.

From Bedford to Hardtimes-Wilson (*State levees*).—No work of consequence was necessary and no material was furnished by the United States.

Hardtimes-Wilson Levee (*U. S. 631 R*).—This levee gave no trouble. It is a high-grade levee and was not a cause of anxiety at any time.

Hardtimes Levee (*U. S. 633 R.*).—The base of the large dike across the foot of Lake St. Joseph became very soft and threatened to slough. A force was put to work to repair the weakness. As the country in the vicinity was submerged, earth had to be boated on a barge from abandoned levees to secure the levee across the lake. This made the work expensive, but by May 30 all weak places had been permanently repaired. No further work was necessary during the flood.

Evergreen Levee (*U. S. 637 R.*).—No work was necessary.

Hardscrabble Levee (*U. S. 639 R.*).—The original levee withstood the flood, and the water did not come against the new levee of 1891–'92. But little work was required. A few low places had to be raised to prevent the water flowing over, but beyond this no weakness was developed.

Bondurant Levee (*U. S. and State 643 R.*).—But little of the original United States levee remains, owing to destruction by caving banks. No protection work was necessary.

From Bondurant to Kempe (*all State levees*).—But little work was required, and this portion of the line was cared for by the local authorities.

Old Kempe Levee (*U. S. 657 R.*).—At the upper end of this embankment several sand boils or crayfish holes caused apprehension. They were checked by a liberal use of sacks. The levee at the threatened point is about 22 feet high.

New Kempe Levee, upper, middle, and lower sections (*U. S. 659 R.*).—This levee was completed this year. When the river rose and came against the new embankment, which was composed principally of sand, several incipient sloughs occurred. They were thoroughly and permanently repaired, by reinforcing the embankment on the river side with earth at the threatened points.

From Kempe to Gibsons Landing Levee (all State work).—No protection work was necessary the greater portion of the line having been raised and enlarged by the local authorities since the flood of 1890.

Gibsons Landing Levee (U.S. 683. 5 R.).—This new high-grade levee required but little work. There were some indications of a slough at the upper end, but this weakness was promptly repaired. The great dike across Lake St. John, the largest piece of levee in the district gave no signs of weakness.

From Gibsons Landing Levee to Lake Concordia (all State levees).—Of low grade, considerable work was necessary. Material was furnished by the United States and labor by local authorities.

Lake Concordia Levee (U. S. 693 R.).—This is the worst United States levee in the district. It is of low grade, riddled with crayfish holes, composed of poor material, and exposed to wave wash. It was only held during the flood by the most extraordinary exertions. At times night work was necessary. Five incipient crevasses occurred and were closed. During storms the waves of the lake rolled over the top of the levee for about 5 miles to such a degree that the lands were overflowed and a railroad track partially submerged. In holding this levee, which is about 19 miles long, more material and money was used than on all the other United States levees in this district.

Lake Concordia to Arnauldia (All State levees).—Some work to prevent wave wash and prevent overflow in front of the town of Vidalia was done, the United States furnishing material and labor being paid for by local authorities.

Arnauldia Levee (U. S. 709 R.).—No work was necessary.

Arnauldia to Henderson (all State levees).—Some work was done by the local authorities. At the highest stage of the river there were several low places that were seriously threatened.

Henderson Levee (U. S. 713 R.).—At an early date of the flood this levee commenced to slough on the upper wing. Prompt action was taken and the weak points effectually repaired and strengthened.

From Henderson to Greens to Fairview (all State levees).—This is a stretch of low-grade levees, and but for protection work done would have been overtopped by the flood. Considerable work was necessary; the United States furnishing material and the local authorities paying for the labor.

Greens to Fairview including as loop Deer Park Leveee (U. S. 725 R.).—With the exception of the Deer Park loop this is a low grade levee and would have been overtopped by the flood but for work done. Protection work was necessary at several places on account of lack of height or incipient sloughs.

The material used for protection work has been confined to sacks of which 26,000 have been used, distributed as follows:

	Sacks.
Hardscrabble	1,000
Kempe	3,000
Kempe to Lake Concordia	3,000
Lake Concordia	15,000
Lake Concordia to Arnauldia	500
Henderson	1,000
Hendersons to Greens to Fairview	1,000
Greens to Fairview including Deer Park	1,500
Total	26,000

The river reached to danger line (41 feet) at Vicksburg, April 14, 1892, and on June 30, 1892 is 46.6 above it, a period of seventy-seven days. On May 10, 1892 the flood reached 48.4 on the Vicksburg Gauge, only seven-tenths below the high-water mark of 1890. It continued without variation at this stage until June 4, 1892, a period of twenty-four days. At Natchez, on June 26, the gauge read 48.10 feet, only 0.5 foot below 1890, and the river reached and remained above the 48-foot stage from June 21 to 29, inclusive, a period of nine days.

Considering the duration and height of the flood of 1892, the strain on the levees has been almost unprecedented, but not a single break now exists in the 135 miles of levees comprising the Tensas Basin, fourth district.

The foregoing data is, I believe, sufficient to indicate what has been accomplished in the line of protection of work on levees under my local charge.

Very respectfully, your obedient servant,

H. S. Douglas,
Assistant Engineer.

Lieut. John Millis,
Corps of Engineers, U. S. A.

REPORT OF MR. W. J. HARDEE, ASSISTANT ENGINEER.

BATON ROUGE, LA., *July 13, 1892.*

SIR: I have the honor to submit the following report upon protection of levees below Red River for the flood period of 1892:

When the usual period of high water was reached the river was well within its banks and there were no indications that an extreme flood would be experienced. Towards the end of April the river commenced rising, and steadily increased in elevation until maximum heights were reached at respective localities as indicated in the following table:

Locality.	Distance between.	1890.		1892.		Difference.
		Date.	Reading.	Date.	Reading.	
	Miles.		*Feet.*		*Feet.*	*Feet.*
Red River Landing	....	Apr. 23	48.80	June 27	48.67	[illegible]
Bayou Sara	34.7	Apr. 21	41.26	June 26	42.25	[illegible]
Baton Rouge	33.5	Apr. 21	36.75	June 28	38.45	[illegible]
Plaquemine	20.5	Apr. 22	31.90	June 28	33.40	[illegible]
Donaldsonville	32.2	....	....	June 13	30.15	....
College Point	17.8	Mar. 16	23.90	June 13	25.40	[illegible]
Carrollton	55	Mar. 17	16.10	June 12	17.25	1[illegible]
Fort Jackson	82.2	....	....	June 16	6.60	....

Frequent inspections were made of the United States levees. They were in excellent condition and did not require the presence of anything like organized force to look after them. During the latter days of the flood, as a result of the water having stood so long against them, some became saturated and showed a disposition to slough. To correct this a small drainage ditch was excavated in the rear of all portions of the Gay to Hollywood, Woodstock, Hermitage, Ashland to Linwood, Dicharry and Tessier section of Tessier Bourgeois levees. In addition to this ditching the only other work found to be necessary was the construction of about 1,500 feet of rough plank revetment backed with earth laden sacks at the Mayflower Union Levee to check the wave washing of the front slope of that levee at an exposed point.

Prior to 1890 there was in existence 16.4 miles of levee south of Red River which was all the levee that had been wholly or in part built by the United States up to that date on that portion of the river and which length formed a portion of the levee system. After the flood of 1890 the State and local authorities adopted for the standard of future levee building a section designed to have an elevation from 1 feet to 3 feet above the high water of that year, and an 8-foot crown with side slopes of 3 to 1 on both sides.

The Atchafalaya Basin Levee Board, a local organization in pursuance of a general plan adopted by it, enlarged 13.4 miles of levee originally built by the United States to conform to the new standard. The Stewarts Crevasse Levee (791.5 feet), measuring 0.6 miles was abandoned by construction of a new line.

All levees built by the United States since 1890 were likewise built to the new standard. To the fact that these levees were so small well above the high water of 1892 and had so wide a crown and base is due the small amount expended to care for them and not to any particular excellence of construction or individual merit possessed by them as compared with lines built by other parties.

There were 37.6 miles of levee built wholly or in part by the United States below Red River, and the small amount of $897, which includes labor and material, was all that was necessary to expend to maintain and keep in good condition that length of line during the recent flood.

The same can be said relatively of all the levees built since 1890 by both State and local authorities. There was an occasional increase of expenditure for protection made necessary at localities where the work was new and exposed, at which places board or sack revetments were constructed. Where the levees were not of standard section immense sums were expended to maintain them. Much of the large amount of money expended was used in raising the low lines of levees. Owing to the unprecedented height reached by the flood the water would have overtopped many miles of the levees on both banks but for such raising. Long lengths of levee were from 0.5 to 1.5 feet lower than the extreme flood elevation and had to be raised to keep the water from running over the tops. The general plan to secure this result was accomplished by driving perpendicular pieces, usually 2 by 4 inches, into the top of the levee at intervals of about 5 feet. To these pieces inch planks were nailed in horizontal position to form a wall to serve the double purpose of breaking the waves and to retain in position the sacks of earth placed behind it. The extent of the "walling" and "sacking" was determined by the height to which the work had to be brought. In some places where as much as 2 feet of raising was necessary, a line of "walling" was also erected in the rear, forming a box as it were to hold sacks and earth.

Work of this character having to be executed at all hours of night and day as well as in all kinds of weather, was necessarily expensive. To show the expensiveness of this work may be cited the case of the Burtville Levee (847.3 L), which was too low and of insufficient section, and though less than 1,500 feet long, something like $7,200 was expended in strengthening and holding it.

There are no means of obtaining actual cost of the protection work on the 501 miles, which includes both banks below Red River, as the work was done by and through so many agencies. From observation and careful consideration of the subject I should estimate $190,000 to be a conservative approximation of the cost of the protection work proper. This estimate does not include the amounts expended in closing crevasses.

The assistance rendered the local authorities by the United States was confined to delivery of lumber, sacks and nails, and the service of boats in towing materials and labor.

The following tabular statement shows the amounts of material expended, localities, purpose, etc.:

Locality.	Distance below Cairo.	Lumber.	Sacks.	How used.
	Miles.	*Ft., B. M.*	*No.*	
Red River Landing*	766 R.	30,000	600	Bulkhead to check sloughing
Nina*	806.5 R.	....	200	Checking wave wash.
Burtville	847.3 L.	....	3,500	Do.
Mayflower-Union*	853 R.	4,360	2,450	Do.
Ascension	882.5 R.	30,500	....	Closing crevasses.
Hermitage	886.5 L.	26,100	5,000	Do.
New Hope	897 R.	21,232	3,000	Do.
Delogny	906.5 R.	54,651	2,500	Do.
Tessier	909.7 L.	20,000	10,600	Do.
Anchor	929.6 L.	25,000	....	Cribs to hold end.
Villere	972 L.	11,015	300	Stopping crayfish leaks.
Corinne	972.5 L.	....	1,750	Do.
Pecan Grove	974 L.	5,479	1,000	Raising and stopping leaks.
Sakenholm	974.5 L.	5,479	....	Do.
Repose	976 L.	1,006	....	Stopping crayfish leaks.
Merritt	976.5 L.	5,051	....	Do.
Bank	977 L.	1,000	....	Do.
Poydras	977.5 L.	8,056	....	Do.
Caernarvon	978.5 L.	16,181	....	Do.
Belle Chasse	983.5 R.	....	5,000	Closing crevasse.
Scarsdale	984 L.	6,009	....	Stopping crayfish leaks.
Concession	985.2 R.	11,813	1,000	Stopping wave wash and leaks.
Lilly	986 R.	....	2,000	Stopping leaks.
Augusta	989 R.	2,000	2,000	Raising and stopping leaks.
Cedar Grove	989.5 R.	7,386	3,000	Raising.
Oakville	990 R.	1,000	2,500	Stopping leaks and wave wash.
Star	994.2 R.	....	100	Stopping wave wash.
Bayhi	997 R.	....	1,000	Stopping leaks.
La Ruisite	998 R.	....	1,000	Do.
Monsecour	999 L.	16,198	....	Do.
Myrtle Grove	1,001 R.	....	1,000	Do.
St. Sophie	1,002 R.	13,082	1,000	Stopping leaks and wave wash.
Wood Park	1,002.2 R.	....	1,000	Do.
Harlem	1,003 R.	30,284	5,000	Stopping leaks and closing crevasse.
West Point-a-la-Hache	1,012 R.	....	1,000	Stopping leaks.
Riceland	1,016 R.	....	1,000	Do.
Jane Butler	1,017.5 R.	....	3,000	Do.
Texas Settlement	1,030 R.	....	1,000	Do.

* United States levees.

In addition to the United States boats the tug *Laurel* was chartered. The boats were used in making inspections, moving materials, towing barges, etc. They rendered particularly efficient and valuable assistance at the crevasses where they moved men and material. The principal service was where they moved loaded sacks from where they were filled to the point at the crevasse from which they were transferred to the crib work.

The service of the boats was as follows:

	Days.
U. S. steamer *General Newton*	17
U. S. steamer *Ruby*	13
U. S. tug *Tilda*	51
Tug *Laurel* (chartered)	50½
Five United States decked barges	35

Despite the large expenditure of money and the unremitting and indefatigable efforts of the local levee organizations, assisted by the riparian owners and residents, disaster could not be averted and a number of breaks occurred, the details of which will be found in the following tabular statement:

Tabular statement of crevasses, compiled from data collected between July 8 and 12, 1892.

Name.	Distance below Cairo.	Date of occurrence.	Cause of crevasse.	Size of levee.			Water below top of levee at time of break.	Maximum width of crevasse.	Approximate maximum of discharge per second.	Crib work.		Water against crib.			Date of closure.	Closing.	Approximate cost of closing.
				Height.	Crown.	Base.				Length.	Average width.	Maximum.	Minimum.	Average.			
	Miles.	1892.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	1892.	*Hours.*	
Ascension	882.5 R.	June 6	Crayfish hole]	8.2	6.6	41	—1.4	148	17,200	593	24	8	4	5.2	June 9	57	$10,000
Hermitage	886.5 L.	June 21	....do	7.8	5.4	36	—2.4	63	9,500	510	14	5.5	2.5	4	June 23	49	6,800
New Hope	897 R.	June 1	....do	8.8	4.6	51	—1.2	160	19,100	452	26	9	3	4.2	June 6	132	12,500
Delogny	906.5 R.	June 23	....do	7.8	5.6	54	—1.6	126	16,400	563	30	8	4.6	5.4	June 28	118	13,100
Belmont	908 L.	June 12	....do	10.5	6.5	58	—0.9	1,427	139,846	......	......	......	......	......	......	......	......
Tessier	909.75 L.	May 22	....do	8.1	6	52	+0.6	204	25,520	473	30	10.6	5.5	7.4	May 29	171	19,800
Anchor	929.6 L.	May 16	Unknown	8.2	3.5	47	—2.8	306	21,000	......	......	......	......	......	......	......	......
Sarpy	937 L.	June 13	Crayfish hole	10.2	3.5	64	—0.8	1,380	115,920	......	......	......	......	......	......	......	......
Avondale	952 R.	June 13	....do	10.4	6	58	—1.3	139	16,120	604	37	7	3	4.5	June 19	146	13,700
Villere No. 1	972 L.	May 3	....do	5.5	4	32	—0.5	15	742	46	5	4	2.5	3	May 4	20	245
Villere No. 2	971.9 L.	June 11	....do	5.5	4	32	—0.5	124	1,816	......	......	......	......	......	......	......	......
Story No. 1	975 L.	May 28	....do	7	5	38	—1.2	23	952	181	7.5	7	4	5	May 30	46	710
Story No. 2	974.75 L.	June 11	....do	7.6	5.4	38	—0.8	114	16,560	......	......	......	......	......	......	......	......
Merritt	976.5 L.	June 13	....do	7.4	6	44	—2	96	13,500	510	7	8	2	4	June 19	142	3,900
Belle Chasse	982.5 R.	June 3	....do	7	5	42	—1.2	107	14,186	808	14	4.5	2.5	3.5	June 15	290	5,700
Cedar Grove	989.5 R.	May 24	Old rice flume	4	3	18	+1.2	26	686	120	7	4	2.5	3	May 28	92	450
Belair	995 L.	May 24	Crayfish hole	8.2	5	43	—1.4	62	8,700	1,406	11	6.5	2	3	May 28	90	4,700
Monsecour No. 1	998.9 L.	May 11	....do	6.5	6	32	—1.6	24	2,100	245	5	4	1.5	2.5	May 11	18	325
Monsecour No. 2	999 L.	May 29	....do	6.5	6	32	—1.6	26	2,280	227	7	4	2.5	3.5	June 4	142	375
Happy Point	993 R.	May 18	Rice flume	4.6	3	26	—1	51	6,750	227	14	3.5	3.5	5	May 28	138	2,275
Monsecour No. 3	999.1 L.	June 7	Crayfish	6	6	32	—1.6	37	2,785	193	5	4.5	3	3.5	June 18	260	400
Harlem *	1,002 L.; 1,003.2 L.	May 12 to June 10	Muskrat and crayfish holes, and rice flume.	6	4	26	—1	441	22,050	1,280	8	6	2	4.5	May 15 to July 1	......	7,200
Miller	1,011.7 L.	May 31	Muskrat	4.4	4	19	—0.6	39	5,985	161	7	4.4	2	3.8	June 14	360	660
Octave	1,012 L.	May 14	....do	4.6	3.5	20	......	35	5,600	186	6	4.8	2	4	May 14	20	360
Martin	1,013.5 L.	June 26	Caving bank	4	6	26	—1.4	194	3,492	394	2	3	2	2.5	July 2	140	425

*In a distance of 6,000 feet there were 11 breaks at Harlem, and figures presented are aggregates.

At Belmont a large force amply supplied with material started to work within a few hours after its occurrence to try and close the crevasse. The break occurred at 1 p.m. The batture or space between the levee and the river bank was about 100 feet wide. By daylight a deep channel had washed through this batture. The ends of the levee washed rapidly, and in a few hours receded to the points where the line of crib work had been started. The break was considered hopelessly a crevasse and abandoned.

It was not considered impossible but impracticable to close the Anchor Crevasse. The levee is located in the midst of a thick growth of willows and about 700 feet back from the river bank. Though of sand the levee showed no disposition to wash rapidly, owing to the effect produced by the willows on both sides of it. Those on the river side served to check the flow, while those on the land side caught the discharging waters and banked them up, thus decreasing the slope of the throat of the crevasse, and so reducing the draft as to destroy much of its erosive force, resulting in slow enlargement of the break.

The major portion of the discharge sought an easy and but little obstructed passage to Lake Pontchartrain, 5 miles distant through the channels created and left by the Bonnet Carre Crevasse of 1874. In consequence of this the water did not spread north of the crevasse at all, and only to a small extent below, submerging but about one-half the plantation adjoining it and barely touching the rear edge of the cultivated land on the next place below.

The tracks of both the Louisville, New Orleans and Texas Railroad and the Illinois Central Railroad are well removed from the break, neither being nearer than 2 miles, and both were but slightly affected by the break.

The interests affected were too small to justify the expenditure necessary to close the crevasse, which would have amounted to a large sum on account of the location of the break and the inaccessibility of earth with which to fill sacks. It was considered advisable, however, to build a crib spur extending at an angle of about 60° from the levee on both sides of the crevasse to protect the ends from washing. The United States contributed to this work. The railroad authorities at a later date built a strong line of cribbing all the way around the break on the front side. The willows were then cut and allowed to float against the cribbing, making a "drift jam." This not only controlled the further enlargement of the crevasee but served to decrease the discharge fully 30 per cent.

At Sarpy a large force promptly started the work of closing, which was feasible, but at a cost probably of something like $30,000. Work was continued and good progress was made up to the time Belmont Crevasse was declared abandoned. The railroads then withdrew their forces and assistance, and the crevasse was abandoned for want of money to do the work.

Of the thirty-five crevasses four were above New Orleans on the right bank and were all closed. Below New Orleans there were three on the right bank, all of which were closed. Five were on the left bank above New Orleans, of which two were closed. On the left bank below New Orleans, twenty-six, of which twenty-four were closed.

The actual loss of levee by crevasses was 5,457 feet. At the breaks which were closed 2,016 feet of levee was washed away, having a value of less than $5,000. To stop the flow of water through that length of opening about $103,625 was expended.

Crevasse closing.—Never before in the history of levees and crevasses was so much success achieved in closing breaks as during the flood of 1892.

Below New Orleans the levees are small and usually built of stiff clay, the soil of the country being of that general character. There is at all points a wide space of batture between the levee and the river bank, generally covered by a thick growth of willows. The battures are annually elevated by deposit from the river, and it is often times the case that a levee will be 7 feet high on the land side and less than 3 feet high on the river side. To a combination of these facts is due the absence of large crevasses in this section of the river and the promptness and small cost attending the closing of them. Though many of these breaks, where allowed to run for weeks, they never enlarge beyond the size acquired within a few hours after occurrence, owing to the general stability of the earth comprising the levee and surrounding ground.

Above New Orleans, however, the conditions are rather the opposite. There the levees are large, the battures narrow and low, and both the levees and banks are composed of unstable material.

During the flood of 1892 larger crevasses were closed than ever known before under a rising river and more adverse circumstances than had ever been encountered previously on similar work.

It is impossible to close any crevasse where the ends wash away and the break widens rapidly or the batture scours fast. As a general thing such does not follow in less than sixty to seventy-five hours after the break occurs, so that success, even where labor and material is forthcoming, is certainly dependent on expedition.

To the interest manifested by the recently created levee boards and rai- and the assistance rendered by them in promptly responding to the call of the- ers is due the principal success of the crevasse closing.

The appended drawings, showing location, side, front, and ground eleva- serve to illustrate the general plan employed in closing the crevasses.

The plan has been studied out and the drawings are presented as an ideal pla- fulfilling all the requirements.

Very few of the cribs were constructed in strict accordance with it, owing t- of organization and confusion attending the construction, working at night w- out sufficient light, inexperienced labor, absence of exact-size timbers, and a l- knowledge of the strength required, and a desire to make sure of same.

At some localities there was a remnant of old levee in front of and parallel - line in which was the break. The plan at such places was to close the crevas- three distinct lines, utilizing the remnant of old levee as one and connecting i- new levee with lines of cribbing above and below the break.

The general plan was as shown on diagram, and consisted of a circular li- crib work around the break on the river side.

The ideal plan is to construct the cribs of a width ranging from 4 to 5 fee- when completed to have three times as much base as there is depth of water a- the cribbing. The principle of the cribs is to form compartments in wh- deposit the sacks and is essential to retain the sacks exactly where desired. very lightest cribbing that will accomplish this purpose should be construct- the strength of the cribbing figures to but a small extent after it is filled - sacks, the mass of sacks affording the necessary lateral strength by virtue - own weight. There is, on the contrary, great objection to driving any more ti- into the batture than is absolutely necessary, for the reason that each piece d- breaks and loosens up the soil, thereby disturbing and causing it to wash, on maintenance of which so largely depends the success of closing the crevasse.

The correct method of sacking the cribs seems never to have been properly un- stood heretofore, but was developed at the Tessier Crevasse and operated suc- fully at the subsequent breaks.

As soon as an obstruction is offered to the passage of water through a cri- when some sacks are thrown into it, there is immediately produced a miniatur- aract or overfall of water from out of it into the next crib behind. This - destructive agency and must be controlled. It is accomplished by starting a- levee on each side and sacking the rear or inside crib about 1 foot high unt- two forces meet. The overfall produced by this line of sacking will be harml- it will strike the ground well in the rear of the foot of the timbers and any e- there will not weaken the cribbing. When the rear line has been sacked al- way across, the forces are put in the adjoining crib and it filled about 1 foot h- than the first. The overfall in this crib will be caught by the sacks in th- behind it, and falling on the sacks, which it can not disturb, there will be no er- and consequently no weakening of the crib work. This process is carried on c- tinuously until the front crib is reached.

If the height of that "stop" is lower than the surface of the water, fall - into the first crib and sack it and bring up each of the other cribs a little high- turn until the front crib is brought up above water and it has been entirely sh-

This method does not close the water off entirely at the ends first, and as they - brought together forcing the flow through a narrow channel and producing - scour as to destroy and wash out the cribbing. It on the contrary reduces that - to a minimum, besides building base in proportion as the pressure increases.

When the sacking has been completed there is more or less leakage through- To cut this off entirely a line of sheet piling, composed of 1-inch by 12-inch bo- is driven perpendicularly or at slight inclination with a hand maul about 12 - inches in the ground about 6 or 10 feet (according to height) in front of the c- bing. This is tied to the cribbing with lateral bracing. It is filled with earth a- tamped and called a "mud box."

Very respectfully, your obedient servont,

W. J. HARDEE,
Assistant Engineer

Lieut. JOHN MILLIS,
Corps of Engineers, U. S, A.

LOCATION OF LEVEES, GRADES, AND SECTIONS.

The general question of the most judicious location for the new levees in this - trict, particularly in the case of those below the mouth of Red River, has be- perplexing one, and the proper grades and sections to be adopted present prob- scarcely less simple than the matter of location. Any attempt at a theoretical an-of these questions involves such a multiplicity of conditions, many of which are iable and indeterminate, as to lead to great complications and to result in no nite conclusions of general or practical value.

o deduce theoretically the most judicious and economical location for a levee ıld involve consideration of the following conditions: The present cost of the r work; the probable cost at the time it might become necessary to renew it; the ent of immediate damage to private property; the value of products of land rificed; the probable life of the new levee, which is determined by present caving bank and probable rate in future; the exposure of the levee to the destructive ion of wave wash and of crayfish; and in many cases numerous other conditions uliar to the locality. When to the above are added the objections and prejudices property holders and questions of policy which not infrequently have to be conered, it will be understood that theory or fixed rules are of very little assistance determining the location of a levee, but that the problem is one to be solved mainly tact and judgment, based on experience and a full knowledge and careful study all the conditions in each individual case.

The grades to which the new levees are to be built is a matter of great importance, t only as affecting their stability during high water, but as determining the length embankment that can be built with a given amount of money, as will appear ıen it is remembered that the cost per unit of length increases approximately as e square of the height. No absolute standard or grade has yet been adopted in is district, either by this office or by the State engineers, but it has been customy heretofore to build to a grade of from 2½ to 3 feet above the highest previously ıown water, though in certain special cases a higher grade has been adopted in ate work. Since the "highest previously known water" is subject to change ith each season's flood and appears to be constantly increasing as the levees are ade more nearly perfect, this is at best a variable and uncertain standard.

By the time the allotments for levee work under the appropriation of July 13, 1892, ıally becomes available it was urgently necessary to get a large amount of work ıder way at the earliest practicable date, in order to close crevasses, strengthen eak places, raise deficient levees to a height which the flood of 1892 showed would necessary, and apply the entire amount available so as to get the benefit of it ıring the succeeding flood season.

In order to comply with the instructions of the Commission it was also necessary advertise and enter into contract for a considerable portion of the work under ıe allotment for the fiscal year 1894. The work consisted of a large number of small etached pieces of levee, scattered over the greater portion of the entire district, ıd it was necessary to adopt some grade which would at least approximate to the quirements, but which had to be determined in the absence of detailed informaon and without sufficient time to attempt a careful analysis and study of the subct, in order to get the work under contract without delay.

The considerations which determined the grades adopted may be briefly stated as ollows: In the flood of 1892 the entire levee system of the lower Tensas District vas successfully held without crevasses for the first time. The same was true of the Yazoo Basin levees on the left bank above, while there were several breaks in the Upper and Middle Tensas Basin districts on the right bank, the water from which lowed down the Tensas Basin, and could not reënter the Mississippi above the nouth of the Red.

The relative flood heights in the Lower Tensas Basin in 1892 might therefore be fairly assumed as normal. The absolute height which the water attained at Vicksburg was 0.7 foot less than the highest recorded in the great flood of 1890, but since there were several crevasses in the Yazoo Basin system this year, the water from which returned to the Mississippi in the vicinity of Vicksburg; the actual height reached may have been greater than would have been the case if the Yazoo Basin levees had held as they did in 1892, and it was considered that the weak condition of the levees in the Upper and Lower Tensas districts on the right bank might reasonably be depended upon to restrict the height at Vicksburg in succeeding great floods for a number of years.

At the mouth of Red River the flood height in 1892 was the same as in 1890, and below that point the heights reached in 1892 exceeded all previous records. The flood heights below the Red were, however, modified by two large crevasses, the Belmont and Prospect, but these were in the lower portion of that section of the river between Baton Rouge and New Orleans, where the total annual variation in the height of the river is less, and where the absolute increase in flood height in future may consequently be expected to be less than in the upper portions. Below New Orleans numerous small crevasses took place in 1892, so that the actual height reached must have been generally less than the normal. While the total variation and the increase in flood heights to be expected with the completion of the levees is still less below New Orleans than in the lower portion of the La Fourche and Pontchartrain districts, and the net height of the levees is less, the greater exposure of the lower river to storms and the frequent passing of large ocean steamer[s] the embankments more liable to injury by wave wash, and a somewhat gre[ater relative] excess in height above the flood level of the river is desirable, even w[hen they] are protected with revetments.

The State authorities have in general adopted a net grade of 3 feet ab[ove] highest known water, but their system of inspection and requirements a[s to] grades to provide for shrinkage are necessarily somewhat less rigid than is [possi]ble in the case of work done by the Federal Government.

There are several objections to adopting at this time a very high gr[ade]. length of levee that can be built with a given sum rapidly diminishes with a[n increase] in height, and there is manifestly no advantage in building comparativ[ely short] detached pieces of levee of great length so long as so large a proportion of [the] system is in such a condition that it must give way long before the water c[an reach] a height to tax the new work to anything like its full resisting power. Ex[perience] shows that a sound and properly constructed levee with good width of crow[n can be] successfully held by temporary work in case of emergency against a flood [a foot or] more above its crown, though of course such a deficiency of grade is not to [be con]sidered safe. On the other hand it may be said that for levees on a perman[ent loca]tion it is less expensive to build them at once to the maximum grade that w[ill prob]ably be necessary than to stop short at that grade and raise and enlarge th[em after]wards. This would be true if the cost of levee work was to remain a consta[nt quan]tity, but it is a constantly decreasing one and likely to continue so for some [time to] come.

As a practical approximation to the conditions above outlined a net grad[e of 3] feet above the flood of 1892 was adopted for the work of last season in all p[arts] of the district. This grade makes the work done by this office at least e[qual in] strength and efficiency to the larger part of the State levees, and it ena[bles the] greatest length of levee to be built with funds available that is consiste[nt with] safety. It is believed that for a long time to come the new levees built [to this] grade will have an excess of grade and a very large excess of strength and [resist]ance over the major portion of the levee system, and that when the time co[mes for] providing some means for definitely limiting the flood height of the lower r[iver it] will be found that the policy of adopting moderate grades at this time w[as not] inconsistent with efficiency and economy.

As to the form of cross section for levees a great variety has been used in [previ]ous years in this district, but at the beginning of last season's work the secti[on] had been generally adopted, both by the State engineers and by this offic[e, of] crown width of 8 feet and side slopes of 3 base to 1 perpendicular. For levee[s of] a net height of over 10 feet the land slope was often made less steep than 3 to [1, and] in many cases a banquette, with horizontal top 20 feet wide or more, was b[uilt on] the land side as a reënforcement, but all slopes were made continuous.

With a view to a reduction in cost and an increase in efficiency the subje[ct was] revised at the beginning of last season's work, and the sections adopted for th[e dis]trict are described as follows:

Where levee not exposed to serious wave wash and where permanent revet[ments] are not required:

For average net height of 5 feet or less.—Normal section: Crown width, 6 feet; [river] slope, 3 to 1; land slope, 2 to 1.

Where conditions are less favorable than average: Make land slope less steep. 3 to 1; crown width and river slope same as normal.

Where conditions are more favorable than average: Diminish crown width [to] 4 feet; river and land slopes same as normal.

For average net heights from 5 to 10 feet.—Normal section: Crown width, 8 feet; slope, 3 to 1; land slope, $2\frac{1}{2}$ to 1.

Where conditions are less favorable than average: Make land slope less stee[p], $3\frac{1}{2}$ to 1; crown width and river slope same as normal.

Where conditions are more favorable than average: Diminish crown width if height less than 8 feet; river and land slopes same as normal.

For average net height of 10 to 15 feet.—Normal section: Crown width, 8 feet; r[iver] slope, 3 to 1; land slope, 4 to 1 up to 5 feet below crown, then $2\frac{1}{2}$, to 1 up to cro[wn].

Where conditions are other than a fair average special instructions will be g[iven].

For average heights from 15 to 20 feet.—Normal section: Crown width, 8 feet; r[iver] slope, 3 to 1; land slope, 6 to 1 up to 14 feet below crown, then 4 to 1 to 7 feet b[elow] crown, then $2\frac{1}{2}$ to 1 up to crown.

Where conditions are other than a fair average special instructions will be g[iven].

For average net heights exceeding 20 feet.—Instructions will be given.

Where levee is exposed to serious wave wash and material is such as to req[uire] permanent revetments:

For average net heights from 5 to 10 feet.—Normal section: Crown width, 8 f[eet];

iver slope, 4 to 1 up to 4 feet below crown, then 2 to 1 up to crown, the upper slope o be protected by board revetment; land slope, 2¼ to 1.

Where average net height is less than 5 or more than 10 feet and where conditions are other than fair average special instructions will be given.

The material found in levee work in the fourth district consists of clay or "buckshot" and fine sand, varying in proportions. Pure sand or earth consisting of a very large proportion of sand is not often met with in this district, but clay with a very small portion of sand occurs not infrequently. Well-defined layers of sand and clay are rare.

Besides withstanding the direct pressure of the water during high river the levee embankment must resist the deteriorating influences of the weather and fulfill a variety of other conditions. These conditions impose upon it a form and dimension which give it a large excess of stability when considered merely as a wall or barrier exposed to the side pressure of the water and prevented from overturning by its own weight and from yielding laterally by friction on its own foundation, so that an analysis of these forces is of no value in discussing the subject of section. As a matter of practical experience the causes of a levee yielding or failing are as follows: The embankment sloughs or slides down, caused by penetration of water and a softening and increase in weight of the material so that the particles become disassociated and the material flows or "sloughs" under the action of gravity.

Holes and leaks through or under the embankment may become enlarged by the scour of water flowing through in high water, so that finally the levee breaks. Such holes are due to defective foundations or to crayfish or other burrowing animal.

The embankment may be washed by the action of the waves in high water and breached at the top, thus starting a flow which enlarges the opening and develops a crevasse.

Sandy material is liable to be washed and cut by the action of rain. This in some cases has resulted in such injuries as to call for special devices to prevent it.

Of the above, sloughing and weakness due to the leaks are the most serious and difficult to remedy in high water.

In considering the slopes to be adopted, long experience has shown that a 3 base to 1 perpendicular is practicably stable for the river side of the levee. Although this slope is more liable to become soft than the land slope, it has the support of the water to assist in sustaining it and the river side of a levee built on this slope rarely if ever sloughs even on high embankments. On some accounts a broken or hollow slope would be advantageous for the river side, but these advantages are offset by the greater liability to wave wash during high stages, if the upper part of this slope were made steeper than the lower.

A uniform slope of 3 to 1 has therefore been adopted for the river side of all levees not revetted.

For the land side, in the case of levees of small height, a somewhat steeper slope has been found to be permissible, and this slope is made, under favorable conditions, as steep as 2 to 1, with a view to as great economy as is consistent with strength. With greater heights, however, there is an increased tendency to slough on the land side due to the longer periods during which the water is liable to be against the lower part of the levee, the greater pressure and increased tendency to become soft at the base of the rear slope, and the increased weight of earth above. A broken slope has therefore been adopted for the land side of high levees, which is comparatively steep towards the top and very flat at the base. It approximates to the form which the land side of a sloughing levee assumes. All these slopes are of an inclination which resists the eroding action of rain wash with fairly good material and permits the growth of grass.

Assuming that the distance to which water penetrates into the embankment is proportional to the pressure and depth below the surface, a levee section might be designed by starting with a sufficient width of base to resist the pressure at that point and to permit side slopes not steeper than experience has shown to be necessary, and to give the section a triangular shape with a height equal to the flood height of the river. This would give a thickness of earth everywhere proportional to the depth and pressure, but would manifestly be impracticable without a certain excess in height above the highest water to be expected, to insure a proper degree of safety.

But even such excess in height would not be long maintained in case of a levee with a triangular section and a sharp crest.

The crest must, therefore, be given a considerable width and made horizontal or nearly so, in order that the original grade of the levee may be not materially reduced by the action of the elements, to enable the levee to resist the wave action, and to give room to work and place and handle material in case of needed repairs during high water. If, however, with a flat crown of considerable width the rear slope is made continuous to the base, the ratio of thickness to water pressure is no longer constant throughout the height, and the embankment has an excess of strength and thickness towards its top, while such excess should be towards the botto exists at all.

For low levees which have a large excess of strength at all points of the this is hardly a material consideration, and difficulties in construction r unadvisable to attempt an approximation to the theoretical section. Leve feet in height, or less, are therefore given a regular slope on the land side somewhat steeper than the river slope, and a width of crown varying w height, but not exceeding 8 feet.

Levees of more than 10 feet in height have the broken slope above de which is designed to give a section of more nearly uniform strength and pe resist sloughing, with greater economy of material than that heretofore used

The width of crown for all heights is limited to 8 feet. This is sufficient necessary facilities for protection work and to resist ordinary wave wash. low levees, where earth and other material can be placed on the crown f ground surface, a less width is allowable. For high levees the strength embankment is neither uniformly nor economically increased by an increase of width alone.

In that part of the district below New Orleans the country is generally and open, and the river is exposed to winds and storms. Large ocean stea also frequently pass, and the levees are much exposed to the destructive a waves. They are usually low embankments, rarely as much as 10 feet high. tion has been adopted for these levees having an 8-foot crown, a land slope 1, and a broken slope on the river side. This slope is made quite flat, 4 to 1 the foot of the revetment. Where the slope is entirely protected from wa made 2 to 1, or as steep as may be expected to stand under the ordinary actio elements.

LEVEE REVETMENT.

The revetments so far constructed by this office have been built of a fair of cypress lumber. Posts and connecting rails are first placed to form a and backing for the revetment. The planks are then driven close, edge along the front of the levee at the top of the lower slope. The planks are inclination towards the levee and are driven down to the natural ground. are sawed even with the top of the levee, side pieces spiked on to secure th and braces fastened from the top of the completed revetment to stakes dri the crown of the levee.

This form of revetment seems to be effective, but the exposed portion of slope having been reached by the rising water before the grass could cove been in most cases partly washed away. It may be found necessary to mak slope much flatter than 4 to 1 or to omit it altogether.

TILE DRAINS FOR LEVEES.

The detrimental effect of seepage water or water which seeps or filters th the body of the levee in high water often becomes serious. The land slope a ground in the rear is kept soft and wet, increasing the danger of sloughing; are rendered impassable, and in several cases large areas of cultivated land been covered with seepage water, resulting in great loss. Since a levee fail of serving its purpose, in so far as it fails to keep the water of the river off the adjacent, a remedy for the difficulty becomes a proper subject for investiga connection with levee building. The trouble from this cause is most serious lower part of the district where the land is generally cultivated and the roa numerous. Plantation ditches and facilities for drainage are also more fre than above.

Heretofore open ditches have frequently been cut along the base of the levee, bu rapidly fill up and have to be frequently cleaned out. They are also ineffect account of want of accuracy in grades, and with a slight fall that is usually av they have proved very unsatisfactory. It is therefore decided to try tile drains, a number of levees built during the past year a line of 6-inch tile drains were just at or near the base of the land slope and from 1 to 3 feet below the su The greatest care was required in excavating and grading the bottom of the and placing and covering the tiles in order to secure good work and accura grades. The tiles were usually carried across the road in the rear of levee and lets placed connecting with the existing drains of the adjacent plantations or available sloughs. Thus far the results have been highly satisfactory, and wh these tiles have been placed the land slope and ground at the levee and the have been kept dry and hard, while in many cases the new levee built without dra have shown the usual effects of seepage water.

Other new features which have been introduced into levee construction during the ast year are as follows:

Greater care has been exercised in requiring the excavations in the borrow pits to e so made and connected by cuts that they may be effectually drained towards the .ver in low water, with a view to diminishing the crayfish evil. In several cases ıe wings of new levees or portions connecting the main line with existing embankıent have been built with a reduced grade and section.

In the history of levee building on the lower river it is found, that a new work, in he majority of cases, consists of a main line or "curtain" running parallel to the iver and two "wings" connecting the main line with the existing levee above and elow.

The curtain has, of course, the longest life, for in the course of time with continued ecession of bank line, the wings are abandoned long before the main line ceases to e useful.

It is therefore allowable to economize on the wings and give to them a less factor f safety than to the curtain.

Locations in the lower portion of the river have not always been made with a view o leaving the old levee undisturbed to act as a breakwater for the new work as was ›reviously the custom, but in many instances the old levee has been entirely removed ınd used to build the new levee, and the sacrifice of private property has been thus educed.

In raising and enlarging existing levees it has heretofore been the practice to break ıp the surface of the old levee and then to bring it to the required height and secion by adding earth without further disturbance of the old embankment. This ›ractice has been modified by requiring the old levee to be cut down and spread out o the full width of base for the new work bringing the work to a level surface, and hen completing it by adding fresh earth to the top. The object is to discover and emedy defects in the old embankment and to avoid unequal settling and cracking ›f the embankment.

The cutting of muck or base ditches within the base of the levee has been largely liscontinued.

EXPERIMENTAL MACHINE FOR LEVEE BUILDING.

The Commission having authorized experiments with a view to developing mechancal appliances for levee work, as outlined in a report from this office of August 29, 1892, a high speed engine transferred by Capt. Roessler, in charge of the first and sec›nd districts, has been set up on the dredge boat *Pah-Ute*, connected with main boiler ınd placed in running order. The dredge will be used as a floating power station from which to operate the earth-handling apparatus. A portion of the material to construct the latter has been procured, but progress has been delayed by the great pressure of other work and by present flood. The experiments will be resumed as soon as the water subsides.

In conclusion, I think it can be said that there has been a material advance in the methods of levee construction during the past year, and that the results have been generally satisfactory.

Money statement.

LEVEES, TENSAS BASIN.

June 1, 1892, balance unexpended	$11,672.02
May 31, 1893, amount expended during fiscal year	11,672.02

PROTECTION OF LEVEES, TENSAS BASIN.

June 1, 1892, balance unexpended	8,103.17
May 31, 1893, amount expended during fiscal year	8,103.17

LEVEES, RIGHT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended	2,061.94
May 31, 1893, amount expended during fiscal year	2,061.94

PROTECTION OF LEVEES, RIGHT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended		$[illegible]
May 31, 1893, amount expended during fiscal year		[illegible]

LEVEES, LEFT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended		[illegible]
May 31, 1893, amount expended during fiscal year		[illegible]

PROTECTION OF LEVEES, LEFT BANK, BELOW RED RIVER.

June 1, 1892, balance unexpended		4,[illegible]
May 31, 1893, amount expended during fiscal year		4,[illegible]

LOWER TENSAS LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$150,[illegible]
May 31, 1893, amount expended during fiscal year:		
Construction and repairs of levees	$130,909.24	
Protection of levees	2,415.33	
		133,[illegible]
May 31, 1893, balance unexpended		16,[illegible]
May 31, 1893, amount covered by uncompleted contracts		15,[illegible]
July 1, 1893, balance available		1,[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895		137,[illegible]
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

ATCHAFALAYA LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$155,[illegible]
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$126,809.59	
For protection of levees	707.12	
For levee machine	366.96	
		127,[illegible]
June 1, 1893, balance available		27,1[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895		152,[illegible]
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

LAFOURCHE LEVEE DISTRICT.

Amount allotted from act approved July 13, 1892		$90,000.[illegible]
May 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$74,681.62	
For protection of levees	425.02	
		75,106.[illegible]
May 31, 1893, balance unexpended		14,89[illegible]
May 31, 1893, amount covered by incomplete contracts		10,72[illegible]
May 31, 1893, balance available		4,167.[illegible]
Amount that can be profitably expended in fiscal year ending June 30, 1895		90,000.[illegible]
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

PONTCHARTRAIN LEVEE DISTRICT.

mount allotted from act approved July 13, 1892		$150,000.00
ay 31, 1893, amount expended during fiscal year:		
For construction and repairs of levees	$131,226.73	
For protection of levees	944.70	
		132,171.43
ay 31, 1893, balance unexpended		17,828.57
ay 31, 1893, amount covered by uncompleted contracts		12,991.49
ay 31, 1893, balance available		4,837.08
Amount that can be profitably expended in fiscal year ending June 30, 1895		150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

LAKE BORGNE LEVEE DISTRICT.

mount allotted from act approved July 13, 1892	$50,000.00
ay 31, 1893, amount expended during fiscal year:	
For construction and repairs of levees	49,704.81
ay 31, 1893, balance unexpended	295.19
une 1, 1893, balance available	295.19
Amount that can be profitably expended in fiscal year ending June 30, 1895	50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

BARATARIA LEVEE DISTRICT.

mount allotted from act approved July 13, 1892		$60,000.00
ay 31, 1893, amount expended during fiscal year:		
For construction and repair of levees	$56,794.95	
For protection of levees	771.21	
		57,566.16
ay 3, 1893, balance unexpended		2,433.84
une 1, 1893, balance available		2,433.84
Amount that can be profitably expended in fiscal year ending June 30, 1895		60,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 15, [illegible]

A.—*Abstract of proposals received in response to advertisement dated September [illegible] opened this day by Capt. John Millis, Corps of Engineers, for the construction [illegible] in fourth district, improving Mississippi River, viz:*

No.	Name and address of bidder.	Lafourche levee district. Buena Vista—Minnie. Embankment, 76,690 cubic yards.	Base ditches, etc., 1,182 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	St. James Ch[illegible] Embankment, 112,000 cubic yards.	Base ditches, etc., 2,946 cubic yards.	Tile drains, 3,000 linear yards.	Total cost of levee.
		Cents.	*Cts.*	*Cts.*		*Cents.*	*Cts.*	*Cts.*	
1	Thos. O'Malley, Baton Rouge, La	32	35	50	$25,704.50	35	......	......	[illegible]
3	W. J. Bentley & Co., Green's Store, La	......	......	......	......	21½	15	50	[illegible]
4	Homan, McFadden & Cassidy, Baton Rouge, La	......	......	......	......	19.7	20	27	[illegible]
6	J. A. McTighe & Co., Memphis, Tenn	29	25	90	23,885.60	28	25	90	[illegible]
7	Scott & Russell, Memphis, Tenn	23	17	35	18,864.64	21	17	35	[illegible]
8	W. O. Flynn & Co., Baton Rouge, La	22¼	17	40	18,247.91	*17	*17	*40	[illegible]
10	James N. Ogden, Baton Rouge, La	22	20	30	17,558.20	23.95	18	30	[illegible]
11	Jeffries & Dameron, Stovall, Miss	25	20	30	19,858.90	20	20	30	[illegible]
12	Jno. Scott & Son, St. Louis, Mo	23½	12	25	18,588.99	22.49	12	25	[illegible]
13	Andrews Bros. Construction Co., Baton Rouge, La	19½	30	90	16,467.52	......	30	90	
14	J. M. Sullivan, Memphis, Tenn	*19½	*19½	*50	15,935.04	21½	21½	50	[illegible]

No.	Name and address of bidder.	Lafourche levee district. St. James estate. Embankment, 16,500 cubic yards.	Base ditches, etc., 372 cubic yards.	Tile drains, 466 linear yards.	Total cost of levee.	Pontchartrain levee district. Dicharry, lower [illegible] Embankment, 78,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 1,700 linear yards.	Total cost of levee.
		Cents.	*Cts.*	*Cts.*		*Cents*	*Cts.*	*Cts.*	
1	Thos. O'Malley, Baton Rouge, La	......	......	......	......	30	......	......	[illegible]
3	W. J. Bentley & Co., Green's Store, La	......	......	......	......	27	20	50	[illegible]
4	Homan, McFadden & Cassidy, Batou Rouge, La	......	......	......	......	21	21	27	[illegible]
5	P. J. Coffman, Burnside P. O., La	......	......	......	......	20	18	30	16[illegible]
6	J. A. McTighe & Co., Memphis, Tenn	25	25	90	$4,637.40	29	25	90	24[illegible]
7	Scott & Russell, Memphis, Tenn	21	17	35	3,691.34	23	17	35	18[illegible]
8	W. O. Flynn & Co, Baton Rouge, La	......	......	......	......	23	17	40	18[illegible]
9	P. Harnan, New Orleans, La	*24.9	26	37	......				
11	Jeffries & Dameron, Stovall, Miss	20	20	30	3,514.20	22	20	30	17[illegible]
13	Jno. Scott & Son, St. Louis, Mo	21½	12	25	3,708.64	26	12	25	20[illegible]
14	J. M. Sullivan, Memphis, Tenn	*18½	*18½	*50	3,354.32	*19	*19	*50	15[illegible]

	Lafourche levee district.	Pontchartrain levee district.
Amount available	$84,000.00	$144[illegible]
Amount covered by this abstract	40,030.18	28[illegible]
Balance	43,969.82	115[illegible]

REMARKS.—All proposals marked thus (*) being lowest and bidders responsible, are recommended for acceptance, except tile drains for Tippecanoe levee, which are recommended for rejection.

A.—Abstract of proposals received in response to advertisement, etc.—Continued.

No.	Name and address of bidder.	Pontchartrain levee district. Union, upper. Embankment, 10,500 cubic yards.	Base ditches, etc., 488 cubic yards.	Tile drains, 533 linear yards.	Total cost of levee.	Union, lower. Embankment, 8,500 cubic yards.	Base ditches, etc., 178 cubic yards.	Tile drains, 266 linear yards.	Total cost of levee.
		Cents.	Cts.	Cts.		Cents.	Cts.	Cts.	
2	I. R. Bobbitt, Baton Rouge, La	21	16	57	$2,586.89	22	16	57	$2,050.10
5	P. J. Coffman, Burnside P. O., La	*22	*20	*30	2,567.50	......	......	......	....
6	J. A. McTighe & Co., Memphis, Tenn	29	25	00	3,647.10	25	25	90	2,408.90
11	Jeffries & Dameron, Stovall, Miss	22	20	30	2,567.50	22	20	30	1,985.40
12	Jno. Scott & Son, St. Louis, Mo	23	12	25	2,606.81	23	12	25	2,042.86

No.	Name and address of bidder.	Pontchartrain levee district. Tippecanoe. Embankment, 31,500 cubic yards.	Base ditches, etc., 875 cubic yards.	Tile drains, 1,033 linear yards.	Total cost of levee.	Peytavin. Embankment, 8,000 cubic yards.	Base ditches, etc., 278 cubic yards.	Tile drains, 400 linear yards.	Total cost of levee.
		Cents.	Cts.	Cts.		Cents.	Cts.	Cts.	
1	Thos. O'Malley, Baton Rouge, La	......	......	......	....	26	......	......	$2,080.00
2	I. R. Bobbitt, Baton Rouge, La	*19	*16	*57	$6,713.81	23	17	60	2,127.26
5	P. J. Coffman, Burnside P. O., La	22	20	30	7,414.90	......	......	......	....
6	J. A. McTighe & Co., Memphis, Tenn	26	25	90	9,338.45	26	25	90	2,509.50
7	Scott & Russell, Memphis, Tenn	22	17	35	7,440.30	......	......	......	....
11	Jeffries & Dameron, Stovall, Miss	19½	19	30	6,697.40	*20	*20	*30	1,775.60
12	Jno. Scott & Son, St. Louis, Mo	22	12	25	7,293.25	22	12	25	1,893.36
14	J. M. Sullivan, Memphis, Tenn	20	20	50	6,991.50	......	......	......	....

REMARKS.—All proposals marked thus (*) being lowest and bidders responsible, are recommended for acceptance, except tile drains for Tippecanoe levee, which are recommended for rejection.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October [illegible]

B.—*Abstract of proposals received in response to advertisement dated Septem*[illegible] *1892, opened this day by Capt. John Millis, Corps of Engineers, for constr*[illegible] *levees in fourth district, Mississippi River.*

No.	Name and address of bidder.	Atchafalaya levee district. Barrosa, upper. Embankment, 100,000 cubic yards.	Base ditches, etc., 800 cubic yards.	Tile drains, 960 linear yards.	Total cost of levee.	Barrosa, [illegible] Embankment, 100,000 cubic yards.	Base ditches, etc., 800 cubic yards.	Tile drain, 800 linear yards.	[illegible]
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss	32	25	30	$32,495.00	36	28	30	[illegible]
6	Sullivan & Johnson, Memphis, Tenn	30½	30½	50	31,224.50	33½	33½	50	[illegible]
13	John Scott & Son, St. Louis, Mo	28	16	30	28,414.00	*30½	*16	30	[illegible]
14	James A. Andrews, Baton Rouge, La	*27½	*27½	*55	28,242.50	31	31	55	[illegible]
15	Timothy W. Scott, Memphis, Tenn	42	26	40	42,585.00	.....	.....	.....	.....
17	J. S. McTighe & Co., Memphis, Tenn	42	25	40	42,585.00	45	25	45	[illegible]

No.	Name and address of bidder.	Atchafalaya levee district. Belair. Embankment, 40,500 cubic yards.	Base, ditches, etc., 80 cubic yards.	Total cost of levee.	Medora. Embankment, 70,000 cubic yards.	Base, ditches, etc., 946 cubic yards.	Tile drains, 1,166 linear yards.	[illegible]
		Cts.	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss	23	20	$9,333.00	24	20	30	[illegible]
2	Sterling Fort, Greenville, Miss	.....	.....	.....	20	20	50	[illegible]
4	I. R. Bobbitt, Baton Rouge, La	22	16	8,924.40	.....	.....	.....	.....
5	Iverson G. Batchelor, Smithland, La	24.95	24.95	10,127.20	.....	.....	.....	.....
6	Sullivan & Johnson, Memphis, Tenn	21½	21½	8,726.85	22½	22½	50	[illegible]
9	Jas. N. Ogden, Baton Rouge, La	33	33	13,394.70	.....	.....	.....	.....
11	Noble W. Irish, Carlyle, Ill	.....	.....	.....	22½	19	50	[illegible]
12	Ovide Lacour, Raccourci, La	21	15	8,518.50	24	20	25	[illegible]
13	John Scott & Son, St. Louis, Mo	24	16	9,734.40	24	16	30	[illegible]
14	James A. Andrews, Baton Rouge, La	24	24	9,741.60	21	21	55	[illegible]
15	Timothy W. Scott, Memphis, Tenn	*19¾	*10	8,007.75	24	10	35	[illegible]
16	Homan, McFadden & Cassidy, Baton Rouge, La	21½	18	8,723.70	.....	.....	.....	[illegible]
17	J. S. McTighe & Co., Memphis, Tenn	35	25	14,197.50	37	25	45	[illegible]

B.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Lafourche levee district. Jamestown. Embankment, 20,500 cubic yards.	Base ditches, etc., 468 cubic yards.	Tile drains, 466 linear yards.	Total cost of levee.	Pontchartrain levee district. Tessier. Embankment, 82,000 cubic yards.	Base, ditches, etc., 1,372 cubic yards.	Tile drains, 1,433 linear yards.	Total cost of levee.	Pontchartrain levee district. Hope. Embankment, 61,500 cubic yards.	Base ditches, etc., 1,311 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Jeffries & Dameron, Stovall, Miss	.....	.....	.....	.....	*21⅜	*18	*30	$15,511.86	*20	18	30	$12,985.96
3	W. O. Flynn & Co., Baton Rouge, La	.....	.....	.....	.....	24⅞	18	40	21,217.66	18⅜	18	40	12,136.60
6	Sullivan & Johnson, Memphis, Tenn	21	21	50	$4,636.28	25	25	50	21,559.50	21½	21½	50	14,254.36
7	Thos. O'Malley, Baton Rouge, La.	25	25	50	5,475.00	25	25	50	21,559.50	25	25	50	16,452.75
8	P. Harnan, New Orleans, La	23	23	35	4,985.74	.....	.....	.....	.....	.....	.....	.....	.....
9	Jas. N. Ogden, Baton Rouge, La.	*19.70	*19.70	*40	4,317.10	.....	.....	.....	.....	22	20	40	14,392.20
10	P. J. Coffman, Burnside, La	20¾	19	35	4,505.77	28	20	30	23,664.30	*18.45	*18	*35	12,107.73
11	Noble W. Irish, Carlyle, Ill	21½	19	50	4,729.42	.....	.....	.....	.....	.....	.....	.....	.....
13	John Scott & Son, St. Louis, Mo	22	16	30	4,724.68	23½	16	30	19,919.42	23½	16	30	15,112.26
16	Homan, McFadden & Cassidy, Baton Rouge, La.	.....	.....	.....	.....	23.7	20	28	20,109.60	18.7	18.7	35	12,270.66
17	J. S. McTighe & Co., Memphis, Tenn	30	25	45	6,476.70	35	25	45	29,687.85	30	25	45	19,452.75

	Atchafalya levee district.	Lafourche levee district.	Pontchartrain levee district.
Amount available	$140,000.00	$43,969.82	$115,078.69
Amount covered by this abstract	81,890.45	4,317.10	30,619.59
Balance	58,109.55	39,652.72	84,459.10

REMARKS.—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October [illegible]

C.—*Abstract of proposals received in response to advertisement dated September* [illegible] *opened this day by Capt. John Millis, Corps of Engineers, for the construction* [illegible] *in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Atchafaylaya levee district. Hickey, upper. Embankment, 125,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 900 linear yards.	Total cost of levee.	Hickey, lower. Embankment, 125,000 cubic yards.	Base ditches, etc., 1,400 cubic yards.	Tile drains, 1,100 linear yards.	[illegible]
		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.	
1	Jeffries & Dameron, Stovall, Miss	28	18	30	$35,468.00	23	18	30	[illegible]
4	J. S. McTighe & Co., Memphis, Tenn	45	25	55	57,020.00	38	25	55	[illegible]
5	Scott & Russel, Memphis, Tenn	.....	.....	.....	.....	35	16	35	[illegible]
6	John Scott & Son, St. Louis, Mo	30	16	30	37,946.00	24½	16	30	[illegible]
11	Sullivan & Johnson, Memphis, Tenn	31½	25	45	40,055.00	27½	25	45	[illegible]
16	W. J. Bentley & Co., Green Store, La	*27	*25	*45	34,430.00	24	25	45	[illegible]

No.	Name and address of bidder.	Atchafayla levee district. Fortville, lower. Embankment, 35,000 cubic yards.	Base ditches, etc., 578 cubic yards.	Tile drains, 700 linear yards.	Total cost of levee.	Lafourche levee district. Home Place. Embankment, 63,500 cubic yards.	Base ditches, etc., 987 cubic yards.	Tile drains, 1,167 linear yards.	[illegible]
		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.	
1	Jeffries & Dameron, Stovall, Miss	.....	.....	.....	.....	22	18	30	[illegible]
2	James N. Ogden, Baton Rouge, La	.....	.....	.....	.....	19.70	19.70	35	[illegible]
4	J. S. McTighe & Co., Memphis, Tenn	28	25	55	$10,328.25	28	25	55	[illegible]
5	Scott & Russel, Memphis, Tenn	20½	15	85	7,505.95	.....	.....	.....	
6	John Scott & Son, St. Louis, Mo	25	16	30	9,051.68	22	16	30	[illegible]
8	I. R. Bobbitt, Baton Rouge, La	21	16	40	7,721.68	.....	.....	.....	
9	Ovide Lacour, Raccource, La	*20½	*20½	*29	7,495.46	.....	.....	.....	
10	P. J. Coffman, Burnside, La	.....	.....	.....	.....	20½	17	25	[illegible]
11	Sullivan & Johnson, Memphis, Tenn	25	25	45	9,208.25	22½	15	45	[illegible]
12	Andrews Bros. Construction Co., Baton Rouge, La	21	21	50	7,820.33	20½	20½	55	[illegible]
14	Homan, McFadden & Cassidy, Baton Rouge, La	.....	.....	.....	.....	*19½	*18	*30	[illegible]

C.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.											
		Burtville.				Oakley to St. Gabriel.				Burnside.			
		Embankment, 98,000 cubic yards.	Base ditches, etc., 1,484 cubic yards.	Tile drains, 1,667 linear yards.	Total cost of levee.	Embankment, 68,000 cubic yards.	Base ditches, etc., 1,260 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	Embankment, 41,000 cubic yards.	Base ditches, etc., 1,964 cubic yards.	Tile drains, 1,166 linear yards.	Total cost of levee.
		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.	
1	Jeffries & Dameron, Stovall, Miss	23	18	30	$23,307.22	25	18	30	$17,676.80	22	18	30	$9,723.32
2	James N. Ogden, Baton Rouge, La	21.45	21.45	35	21,922.77	22	22	35	15,762.20	18.90	18.70	35	8,442.37
3	P. Harnan, New Orleans, La	.....	.....	.....	.....	27	25	39	19,260.00	23.9	24	36	10,690.12
4	J. S. McTighe & Co., Memphis, Tenn	33	25	55	33,627.85	26	26	55	18,832.60	24	24	55	10,952.66
5	Scott & Russel, Memphis, Tenn	.....	.....	.....	.....	20½	15	35	14,484.00	21	15	35	9,312.70
6	John Scott & Son, St. Louis, Mo	28	16	30	28,177.54	26	16	30	18,331.60	21	16	30	9,274.04
7	Noble W. Irish, Carlyle, Ill	.....	.....	.....	.....	21⅞	18	46	15,791.80	20⅞	18	46	9,448.63
8	I. R. Bobbitt, Baton Rouge, La	.....	.....	.....	.....	19	16	40	13,721.60	*17.99	*12	*30	7,961.38
10	P. J. Coffman, Burnside, La	24	18	35	24,370.57	21	17	35	15,019.20	18	16	35	8,102.34
11	Sullivan & Johnson, Memphis, Tenn	25	25	45	25,621.15	21½	21½	45	15,565.90	21	15	45	9,429.30
12	Andrews Bros. Construction Co., Baton Rouge, La	22	22	55	22,803.33	19½	16	50	14,041.60	19	16	50	8,687.24
13	W. O. Flynn & Co., Baton Rouge, La	25⅜	18	40	25,801.42	20	18	40	14,426.80	18	18	40	8,199.92
14	Homan, McFadden & Cassidy, Baton Rouge, La	*21	*16	*27	21,267.53	*19	*15	*27	13,514.00	18	16	27	8,009.06
15	Mike Kane, Baton Rouge, La	.....	.....	.....	.....	.....	.....	.....	.....	19	19	38	8,606.24

REMARKS.—Proposals marked thus (*) being lowest and bidders responsible, are recommended for acceptance. No bid for Hickey lower levee is recommended for acceptance under amount now available owing to lack of funds.

	Atchafalaya levee district.	Lafourche levee district.	Pontchartrain levee district.
Amount available, Abstract B	$58,109.55	$39,652.72	$84,459.10
Amount covered by this abstract	41,925.46	12,901.26	42,742.91
Balance	16,184.09	26,751.46	41,716.19

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 15, [illegible]

D.—*Abstract of proposals received in response to advertisement dated October 1, [illegible] and opened this day by Capt. John Millis, Corps of Engineers, for constructing [illegible] in fourth district, Mississippi River.*

No.	Name and address of bidder.	Lower Tensas Levee district.									
		Hardscrabble, lower.			Bondurant.		Morville.		Fish Po[illegible]		
		Embankment, 90,000 cubic yards.	Base ditches, etc., 1,790 cubic yards.	Total cost of levee.	Embankment, 23,978 cubic yards.	Total cost of levee.	Embankment, 30,000 cubic yards.	Total cost of levee.	Embankment, 110,000 cubic yards.	Base ditches, etc., 3,455 cubic yards.	To[illegible]
		Cts.	*Cts.*		*Cents.*		*Cents.*		*Cts.*	*Cts.*	
1	Hanlon & Dowdell, Legonier, La	....	....	....	.....	....	18	$5,400.00	21	18	$2[illegible]
2	Augustus P. Martin, Waterproof, La	39	35	$35,726.50	21	$5,034.33	22	6,600.00	22	22	24.9[illegible]
3	J. S. McTighe & Co., Memphis, Tenn	*25	*25	22,947.50	22	5,274.06	22	6,600.00	23	25	26.1[illegible]
4	J. M. Sullivan, Memphis, Tenn	....	....	....	.....	....	.....	....	18	18	20.[illegible]
5	John J. Quinn and Nat P. Philips, Red River Landing, La., and Merricks, La	....	....	....	16	3,835.68	15¾	4,725.00	18.7	16	21.[illegible]
6	Rutherford & Dalgarn, Natchez, Miss	45	45	41,305.50	21.5	5,154.19	17¾	5,325.00	21½	21½	24.[illegible]
7	W. O. Flynn & Co., Baton Rouge, La	....	....	....	.....	....	17	5,100.00	15⅞	15¾	1[illegible]
8	Ernest Hyner, Greenville, Miss	28	19	25,540.10	.....	....	.....	....	18	18	20.[illegible]
9	Manning & Gibson, Natchez, Miss	....	....	....	*15.94	3,821.30	*14.94	4,482.00	20	20	22.[illegible]
10	Ignatz Friedler, Vidalia, La	....	....	....	.....	....	15	4,500.00	....	....	......
11	James S. Fleming and Samuel H. Landin, jr., Natchez, Miss	....	....	....	.....	....	18	5,400.00	....	....	......
12	William Curry, St. Joseph, La	....	....	....	17	4,075.41	.....	....	....	....	......

	Lower Te[illegible] sas Le[illegible] distr[illegible]
Amount available	$116.[illegible]
Amount covered by this abstract	48,[illegible]
Balance	67,5[illegible]

REMARKS.—Proposals marked thus (*) being the lowest, and bidders responsible, are recommen[illegible] for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 17, 1892.

E.—Abstract of proposals received in response to advertisement dated October 2, 1892, and opened this day by Capt. John Millis, Corps of Engineers, for construction of levees in fourth district, Mississippi River.

No.	Name and address of bidder.	Barataria Levee district.											
		Fort St. Leon, upper.				Fort St. Leon, middle.				Belle Chasse crevasse.			
		Embankment, 11,900 cubic yards.	Base ditches, etc., 2,386 cubic yards.	Tile drains, 617 linear yards.	Total cost of levee.	Embankment, 18,700 cubic yards.	Base ditches, etc., 4,897 cubic yards.	Tile drains, 1,266 linear yards.	Total cost of levee.	Embankment, 4,320 cubic yards.	Base ditches, etc., 863 cubic yards.	Tile drains, 223 linear yards.	Total cost of levee.
		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.		Cts.	Cts.	Cts.	
1	J.S. McTighe & Co., Memphis, Tenn	25	25	45	$3,849.15	27	25	45	$6,842.95	35	35	45	$1,914.40
2	Robert McNamara, New Orleans, La	23	23	40	3,532.58	27	25	40	6,779.65	39	25	40	1,989.75

No.	Name and address of bidder.	Barataria Levee district.							
		Concord.				Oakville.			
		Embankment, 27,000 cubic yards.	Base ditches, etc., 3,326 cubic yard.	Tile drains 860 linear yards.	Total cost of levee.	Embankment, 28,160 cubic yards.	Base ditches, etc., 6,000 cubic yards.	Tile drains, 1,546 linear yards.	Total cost of levee.
		Cts.	Cts.	Cst.		Cts.	Cts.	Cts.	
1	J. S. McTighe & Co., Memphis, Tenn	32	32	45	$10,091.32	28	28	45	$10,260.50
2	Robert McNamara, New Orleans, La	24½	24½	40	7,773.87	30	30	40	10,366.40

REMARKS.—By telegram of October 18, 1892, to the Chief of Engineers U. S. A., recommended rejection of all bids, being too high.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 18, [illegible]

F.—*Abstract of proposals received in response to advertisement dated October* [illegible] *opened this day by Capt. John Millis, Corps of Engineers, for the construction of* [illegible] *in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Barataria Levee district.											
		Magnolia, enlargement.				Fort St. Leon, lower.				Belle Chasse [illegible] cession, new [illegible] largement.			
		Embankment, 7,200 cubic yards.	Base ditches, etc., 10,700 cubic yards.	Tile drains, 2,767 linear yards.	Total cost of levee.	Embankment, 7,200 cubic yards.	Base ditches, etc., 1,187 cubic yards.	Tile drains, 307 linear feet.	Total cost of levee.	Embankment, 39,050 cubic yards.	Base ditches, etc., 16,500 cubic yards.	Tile drains, 4,[illegible] linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Robert McNamara, New Orleans, La	*25	*20	*40	$9,296.80	23	20	40	$2,016.20	23	20	40	[illegible]
2	J. S. McTighe & Co., Memphis, Tenn	28	28	55	11,293.85	32	32	55	2,852.69	33½	33½	55	[illegible]
3	Jas. N. Ogden, Baton Rouge, La	25	25	40	9,831.80	*22	*22	*40	1,967.94	*22	*22	*40	[illegible]

No.	Name and address of bidder.	Barataria Levee district.							
		Oak Point.				Live Oak, new and enlargement.			
		Embankment, 12,310 cubic yards.	Base ditches, etc., 2,743 cubic yards.	Tile drains, 712 linear yards.	Total cost of levee.	Embankment, 9,880 cubic yards.	Base ditches, etc., 1,868 cubic yards.	Tile drains, 483 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Robert McNamara, New Orleans, La	23	20	40	$3,684.70				
2	J. S. McTighe & Co., Memphis, Tenn	28	28	55	4,606.44	32	32	55	[illegible]
3	Jas. N. Ogden, Baton Rouge, La	*22	*22	*40	3,596.46	*22	*22	*40	[illegible]

	Barataria Levee district.
Amount available	$57,[illegible]
Amount covered by this abstract	31,[illegible]
Balance	25,[illegible]

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 19, 1892.

G.—***Abstract of proposals received in response to advertisement dated October 4, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in the fourth district, improving Mississippi River.***

No.	Name and address of bidder.	La Fourche Levee district.											
		Providence.				Lone Star.				Davis.			
		Embankment, 34,500 cubic yards.	Base ditches, etc., 629 cubic yards.	Tile drains, 733 linear yards.	Total cost of levee.	Embankment, 63,500 cubic yards.	Base ditches, etc., 1,358 cubic yards.	Tile drains, 1,500 linear yards.	Total cost of levee.	Embankment, 43,000 cubic yards.	Base ditches, etc., 605 cubic yards.	Tile drains, 667 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John E. Louque, Carrollton, La					20	20	50	$13,721.60	21*	21*	50*	$9,490.55
2	P. J. Coffman, Burnside, La					20*	14*	30*	13,340.12	24	18	35	10,662.35
3	Jno. Scott & Son, St Louis, Mo	24	16	30	$8,600.54	22	16	30	14,637.28	24	16	30	10,616.90
4	J. S. McTighe & Co., Memphis, Tenn	30	30	55	10,941.85	31	30	55	20.917.40	35	35	55	15,628.60
5	J. N. Ogden, Baton Rouge, La	18.7	18.7	30	6,789.02	21.95	18	30	14,632.69				
6	James A. Brennan, New Orleans, La												
7	John Cleary, Carrollton, La												

No.	Name and address of bidder.	La Fourche Levee district.				Pontchartrain Levee district.			
		Fairfield.				Trudeau.			
		Embankment, 32,500 cubic yards.	Base ditches, etc., 445 cubic yards.	Tile drains, 533 linear yards.	Total cost of levee.	Embankment, 63,000 cubic yards.	Base ditches, etc., 986 cubic yards.	Tile drains, 1,200 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John E. Louque, Carrollton, La								
2	P. J. Coffman, Burnside, La					*23	*14	*30	$14,988.04
3	Jno. Scott & Son, St. Louis, Mo	26	16	30	$8,681.10	25	16	30	16,267.76
4	J. S. McTighe & Co., Memphis, Tenn	35	35	55	11,823.90	32	32	55	21,135.52
5	J. N. Ogden, Baton Rouge, La								
6	James A. Brennan, New Orleans, La	24.91	20	50	8,451.25				
7	John Cleary, Carrollton, La					28	20	35	18,257.20

	La Fourche Levee district.	Pontchartrain Levee district.
Amount available, Abstract C	$26,751.46	$41,716.19
Amount covered by this abstract	22,830.67	14,988.04
Balance	3,920.79	26,728.15

REMARKS.—Proposals marked thus * (Lone Star, Davis, and Trudeau levees) are recommended for acceptance, being the lowest and the bidders responsible. All proposals for Providence and Fairfield levees are recommended for rejection, owing to insufficiency of funds.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 19, [illegible]

H.—*Abstract of proposals received in response to advertisement dated October [illegible] opened this day by Capt. John Millis, Corps of Engineers, for the construction of [illegible] in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne Levee district. Slaughter House. Embankment, 1,360 cubic yards.	Slaughter House. Base ditches, etc., 446 cubic yards.	Slaughter House. Tile drains, 238 linear yards.	Slaughter House. Total cost of levee.	Roy. Embankment, 8,356 cubic yards.	Roy. Base ditches, etc., 708 cubic yards.	Roy. Tile drains, 879 linear yards.	Roy. Total cost of levee.	Bonzana. Embankment, 4,624 cubic yards.	Bonzana. Base ditches, etc., 473 cubic yards.	Bonzana. Tile drains, 227 linear yards.	Bonzana. T[illegible]
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La.	......	......	......	......	......	......	......	......	......	......	......	......
2	Louis Louque, New Orleans, La.	*19.99	*17	*50	$466.68	*19.99	*17	*50	$1,980.22	*19.99	*17	*50	[illegible]
3	Robert McNamara, New Orleans, La.	30	20	40	592.40	44	20	40	3,969.84	44	20	40	[illegible]

No.	Name and address of bidder.	Lake Borgne Levee district. Chalmette Cemetery. Embankment, 5,128 cubic yards.	Chalmette Cemetery. Base ditches, etc., 548 cubic yards.	Chalmette Cemetery. Tile drains, 294 linear yards.	Chalmette Cemetery. Total cost of levee.	Debouchel. Embankment, 6,790 cubic yards.	Debouchel. Base ditches, etc., 434 cubic yards.	Debouchel. Tile drains, 232 linear yards.	Debouchel. Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La.	......	......	......	......	22.50	22.50	40	$1,7[illegible]
2	Louis Louque, New Orleans, La.	*19.99	*17	*50	$1,276.04	*18.99	*17	*50	1,4[illegible]
3	Robert McNamara, New Orleans, La.	34	20	40	1,970.72	26	20	40	1,9[illegible]

	Lake Borgne Levee district.
Amount available	$47,0[illegible]
Amount covered by this abstract	6,5[illegible]
Balance	40,6[illegible]

REMARKS.—Proposals marked thus (*) being the lowest received and considered reasonable, and the bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 21, 1892.

I.—*Abstract of proposals received in response to advertisement dated October 8, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district. Pecan Grove, new and enlargement. Embankment, 12,620 cubic yards.	Base ditches, etc., 91? cubic yards.	Tile drains, 488 linear yards.	Total cost of levee.	Story, upper, enlargement.* Embankment, 5,000 cubic yards.	*Base ditches, etc., 1,000 cubic yards.	Tile drains, 433 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La ...	22½	22½	42	$3,249.66	......	......	......	....

No.	Name and address of bidder.	Lake Borgne levee district. Story, lower, new and enlargement.* Embankment, 32,520 cubic yards.	Base ditches, etc., 3,390 cubic yards.	Tile drains, 1,548 linear yards.	Total cost of levee.	Repose.* Embankment, 13,200 cubic yards.	Base ditches, etc., 904 cubic yards.	Tile drains, 495 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James Byrne, Baton Rouge, La ...	......	......	......	....	......	......	......	....

	Lake Borgne levee district
Amount available, Abstract H	$40,688.11
Amount covered by this abstract	3,249.66
Balance	37,438.45

* No bid.

REMARKS.—Proposal for Pecan Grove levee is the only bid received. It is considered reasonable and the bidder responsible, and is recommended for acceptance. Authority to readvertise Story, upper, Story lower, and Repose levees has been received from the Department by telegram dated October 22, 1892.

UNITED STATES ENGINEER OFFIC[illegible]
New Orleans, La., October 24, [illegible]

J.—*Abstract of proposals received in response to advertisement dated October 1*[illegible] *opened this day by Capt. John Millis, Corps of Engineers, for the construction o*[illegible] *in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee distri[illegible]—Grassmere to Wiccoma. Embankment, 83,000 cubic yards.	Base ditches, etc., 7,400 cubic yards.	Tile drains, 9,000 linear yards.	Total [illegible] of [illegible]
		Cents.	*Cents.*	*Cents.*	
1	McLaughlin Brothers, Memphis, Tenn	*17½	*16	*35	$1[illegible]
2	Ernest Hyner, Greenville, Miss	18¾	18½	40	[illegible]
3	Jeffries & Dameron, Stovall, Miss	18¾	18¾	35	2[illegible]
4	Noble W. Irish, Carlyle, Ill	18$\frac{7}{10}$	18	45	2[illegible]
5	John Scott & Son, St. Louis, Mo	20	16	30	[illegible]
6	Manning & Gibson, Natchez, Miss	21½	21½	38	2[illegible]
7	Hanlon & Dowdell, Legonier, La	17	15	42	19,[illegible]
8	Augustus P. Martin, Waterproof, La	16¾	16¾	....	1[illegible]
9	Rutherford & Dalgarn, Natchez, Miss	19½	19¾	38	21,[illegible]
10	C. F. De Garis & Co., Memphis, Tenn	18½	17⅝	38	19,[illegible]

	Lower Te[illegible]sas lev[illegible] distr[illegible]
Amount available, Abstract D	$67,[illegible]
Amount covered by this abstract	18,[illegible]
Balance	48,[illegible]

REMARKS.—No. 8, Augustus P. Martin, does not bid on tile drains. Proposal marked thus (*) [illegible] the lowest received, and considered reasonable and bidder responsible, is recommended for accep[illegible]

UNITED STATES ENGINEER OFFICE,
New Orleans, La., October 25, 1892.

K.—*Abstract of proposals received in response to advertisement dated October 14, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district.				Lake Borgne levee district.			
		Wiccema to Fletcher.				Caernarvon.			
		Embankment, 117,410 cubic yards.	Base, ditches, etc., 7,700 cubic yards.	Tile drains, 9,000 linear yards.	Total cost of levee.	Embankment, 30,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Tile drains, 700 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	Ernest Hyner, Greenville, Miss	17½	17½	40	$25,181.47	.....	.....	.....	....
2	Manning & Gibson, Natchez, Miss	*16.49	*16.49	35	23,780.64	.....	.....	.....	....
3	Noble W. Irish, Carlyle, Ill	17.4	17.4	40	25,369.14	.....	.....	.....	....
4	P. M. Harnan, New Orleans, La	.....	.....	.....	....	30	25	59	$9,588.00
6	W. O. Flynn & Co., Baton Rouge, La	23	17	40	31,913.30	.....	.....	.....	....
7	James Cotten, Raccourci, La	18.45	18	42	26,828.14	.....	.....	.....	....
8	Augustus P. Martin, Waterproof, La	17	17	.....	21,268.70	.....	.....	.....	....
9	C. F. De Garis & Co., Memphis, Tenn	17⅞	17½	38	25,754.54	.....	.....	.....	....
10	Rutherford & Dalgarn, Smithland, La	18.9	18.9	35	26,795.79	.....	.....	.....	....
11	Sullivan, Johnson & McLaughlin, Memphis, Tenn	17.74	17.74	.....	24,894.51	.....	.....	.....	....
12	Hanlon & Dowdell, Legonier, La	17.49	16½	20	24,180.82	.....	.....	.....	....
13	John Scott & Son, St. Louis, Mo	18	16	30	25,065.80	.....	.....	.....	....
14	Iverson G. Batchelor, Smithland, La	18	18	40	26,119.80	.....	.....	.....	....

No	Name and address of bidder.	Lake Borgne levee district.							
		Orange Grove, upper.				Orange Grove, lower.			
		Embankment, 70,000 cubic yards.	Base ditches, etc., 1,100 cubic yards.	Tile drains, 1,567 linear yards.	Total cost of levee.	Embankment, 23,700 cubic yards.	Base ditches, etc., 900 cubic yards.	Tile drains, 900 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
4	P. M. Harnan, New Orleans, La	.....	.....	.....	....	28½	25	59	$7,510.50
5	P. J. Reilly, New Orleans, La	*23	*20	*44	$17,009.48	*23½	*20	*44	6,145.50

	Lower Tensas levee district.	Lake Borgne levee district.
Amount available, Abstracts J and I	†$48,484.72	‡$37,438.45
Amount covered by this abstract	23,780.64	23,154.98
Balance	24,704.08	14,283.47

† Abstract J. ‡ Abstract I.

REMARKS.—All proposals marked thus * (Wiccema to Fletcher, Orange Grove, upper and lower levees) being lowest, and bidders responsible, are recommended for acceptance. Proposal No. 4, of P. M. Harnan, for Caernarvon levee, recommended for rejection; bid too high. No. 8, Augustus P. Martin, did not bid on tile drains.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 2, 1[illegible]

L.—*Abstract of proposals received in response to advertisement dated October 1[illegible], [illegible] opened this day by Capt. John Millis, Corps of Engineers, for the construction of [illegible] in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district. Fletcher to Minorca, new and enlargement. Embankment, 80,000 cubic yards.	Tile ditches, etc., 5,800 cubic yards.	Tiledrains, 6,600 linear yards.	Total cost of levee.	Minorca to Minorca, new and enlargement. Embankment, 84,000 cubic yards.	Tile ditches, etc., 6,200 cubic yards.	Tiledrains, 7,300 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	John Scott & Son, St. Louis, Mo	18	16	30	$17,308.00	18	16	30	$18,302.[illegible]
2	A. P. Martin, Waterproof, La	16¾	16¾	30	16,351.50				
3	James Cotten, New Orleans, La	18	12½	32	17,237.00	17.49	12½	32	17,[illegible]
4	G. W. Reagan, Red River Landing, La	17.44	20	40	17,752.00				
5	Manning & Gibson, Natchez, Miss	15.50	15	25	14,920.00	17.75	17.75	35	18,[illegible]
6	Quinn & Phillips, Merrick, La	16½	16	30	16,108.00	19	16½	30	19,17[illegible]
7	Hanlon & Dowdell, Legonier, La	17	9	20	15,442.00				
8	Iverson G. Batchelor, Smithland, La	16½	16	25	15,578.00				
9	C. F. De Garis & Co., Memphis, Tenn	16⅞	16	36	16,804.00	16⅛	16	35	17,512.[illegible]
10	Albert Henry Gillespie, Vidalia, La					*14	*13.50	*29	14,714.[illegible]
11	McLaughlin Bros., Memphis, Tenn	16	16	35	16,038.00	16.99	16.99	35	17,879.[illegible]
12	J. L. Kingsbury, Red River Landing, La					17	26½	16	17,[illegible]
14	Noble W. Irish, Carlyle, Ill	16⅜	15	35	16,280.00	15⅛	15	34	16,747.[illegible]
15	Rutherford & Dalgarn, Natchez, Miss	*15 4/10	*15 4/10	*20	14,533.20	16 4/10	16 4/10	25	16,617.[illegible]
16	Kilpatrick & Storer, Collins, La	15	13	35	15,064.00	16	13	35	16,801.[illegible]

No.	Name and address of bidder.	Pontchartrain levee district. Whitehall. Embankment, 3,500 cubic yards.	Total cost of levee.	Barataria levee district. Happy Point, new and enlargement. Embankment, 8,030 cubic yards.	Base ditches, etc., 940 cubic yards.	Tile drains, 503 linear yards.	Total cost of levee.
		Cts.		*Cts.*	*Cts.*	*Cts.*	
1	John Scott & Son, St. Louis, Mo	22	$770.00				
11	McLaughlin Bros., Memphis, Tenn	*21½	752.50				
13	James N. Ogden, Baton Rouge, La			*23	*23	*30	$2,214.00

	Lower Tensas levee district.	Pontchartrain levee district.	Barataria levee district.
Amount available, Abstracts K, G, and M	†$24,704.08	‡$26,728.15	§$15,685.04
Amount reserved for other needed repairs to levees not now foreseen	20,000.00		
Total available	44,704.08	26,728.15	15,685.04
Amount covered by this abstract	29,247.20	752.50	2,214.00
Balance	15,456.88	25,975.65	13,471.04

REMARKS.—All proposals marked thus (*), being the lowest and the bidder responsible, are recommended for acceptance.

† Abstract K. ‡ Abstract G. § Abstract M.

M.—*Abstract of proposals received in response to advertisement dated October 20, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Barataria levee district. Fort St. Leon, upper. Embankment, 11,900 cubic yards.	Base, ditches, etc., 2,386 cubic yards.	Tile drains, 617 linear yards.	Total cost of levee.	Fort St. Leon, middle enlargement. Embankment, 18,700 cubic yards.	Base, ditches, etc., 4,897 cubic yards.	Tile drains, 1,266 linear yards.	Total cost of levee.	Belle Chasse crevasse, new and enlargement. Embankment, 4,320 cubic yards.	Base, ditches, etc., 863 cubic yards.	Tile drains, 223 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James N. Ogden, Baton Rouge, La.	*20	*20	*30	$3,042.80	22	20	30	$5,473.20	*23	*20	*30	$1,233.10
2	Richard Rielly, Chicago, Ill.	21½	21½	44	3,342.97	22½	20	44	5,743.94				

No.	Name and address of bidder.	Barataria levee district. Concord. Embankment, 27,000 cubic yards.	Base, ditches, etc., 3,326 cubic yards.	Tile drains, 860 linear yards.	Total cost of levee.	Oakville, new and enlargement. Embankment, 28,160 cubic yards.	Base, ditches, etc., 6,000 cubic yards.	Tile drains, 1,546 linear yards.	Total cost of levee.
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	James N. Ogden, Baton Rouge, La.	*20	*20	*30	$6,323.20	19	19	30	$6,954.20
3	John Cleary, New Orleans, La.	22	22	35	6,972.72				
4	Thomas C. Dennis, Jesuits Bend, La.	21½	21½	39	6,855.49	23½	23½	39	8,630.54

	Barataria levee district.
Amount available (abstract F)	$25,433.64
Amount covered by this abstract	10,899.27
Balance	14,534.37

REMARKS.—Proposals marked thus (*), being the lowest and bidders responsible, are recommended for acceptance. Proposals for Fort St. Leon, Middle, and Oakville levees are not recommended for acceptance, owing to insufficiency of funds. Amount of work on least important levees to be limited so as to enable more important work, including revetment, to be completed.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 1, 1[illegible].

N.—*Abstract of proposals received in response to advertisement dated October 2[illegible], opened this day by Capt. John Millis, Corps of Engineers, for the construction of le[illegible] fourth district, Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district.											
		Story, upper enlargement.				Story, lower new, and enlargement.				Repose.			
		Embankment, 5,000 cubic yards.	Base, ditches, etc. 1,000 cubic yards.	Tile drains, 4[illegible]3 linear yards.	Total cost of levee.	Embankment, 32,520 cubic yards.	Base, ditches, etc., 3,[illegible]0 cubic yards.	Tile drains, 1,348 linear yards.	Total cost of levee.	Embankment, 13,200 cubic yards.	Base, ditches, etc., 904 cubic yards.	Tile drains, 485 linear yards.	T[illegible]
		Cts.	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
1	C. S. Jones, New Orleans, La	32.49	32.49	40	$2,122.60	32.49	32.49	40	$12,286.36	32.49	32.49	49	$4,7[illegible]
2	John Cleary, New Orleans, La									*23	*20	*35	3,3[illegible]

	Lake Bor[illegible] levee di[illegible]
Amount available, Abstract K	$14,[illegible]
Amount covered by this abstract	3,[illegible]
Balance	10,[illegible]

REMARKS.—Proposals marked thus (*), being the lowest and bidder responsible, are recommen[illegible] acceptance. Proposals for Story, upper and lower levees, are recommended for rejection, bei[illegible] high.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 5, 1[illegible].

O.—*Abstract of proposals received in response to advertisement dated October [illegible], opened this day by Capt. John Millis, Corps of Engineers, for the construction of le[illegible] in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district, left ba[illegible] Caernarvon.			
		Embankment, 30,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Tile drains, 700 linear yards.	Total c[illegible] of le[illegible]
		Cents.	*Cents.*	*Cents.*	
1	Patrick Harnan, New Orleans	28	25	59	$8,9[illegible]
2	C. S. Jones, New Orleans	28.49	26.49	40	8,4[illegible]
3	John Cleary, New Orleans	25	25	35	7,[illegible]

	Lake Bor[illegible] levee dis[illegible]
Amount available, Abstract N	$10,836.[illegible]
Amount covered by this abstract	
Balance	10,836.[illegible]

REMARKS.—The proposal of John Cleary (No. 3) is the lowest received, but is not recommended [illegible] acceptance under allotment now available on account of insufficient funds to do this work, and [illegible] at Story Upper and Story Lower levees, which is regarded as of more importance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 15, 1892.

P.—*Abstract of proposals received in response to advertisement dated November 6, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district.							
		Story, upper, enlargement.				Story, lower, new, and enlargement.			
		Embankment, 5,000 cubic yards.	Base ditches, etc., 1,000 cubic yards.	Tile drains, 433 linear yards.	Total cost of levee.	Embankment, 32,520 cubic yards.	Base ditches, etc., 3,390 cubic yards.	Tile drains, 1,548 linear yards.	Total cost of levee.
		Cents.	*Cents.*	*Cents.*		*Cents.*	*Cents.*	*Cents.*	
1	Columbus S. Jones, New Orleans, La	29.44	20.44	40	$1,939.60	29.44	29.44	40	$11,191.11
2	Robert McNamara, New Orleans, La	24.5	24.5	40	1,643.20	*30	*20	*40	11,053.20
3	Thomas O'Malley, Baton Rouge, La	26.5	50	25	2,033.25	28½	50	25	11,350.20
4	Noble W. Irish, Carlyle, Ill	31.5	17	28	1,866.24	31½	17	28	11,253.54
5	S. D. Moody & Co., limited, New Orleans, La	*24.7	*17	*40	1,578.20	31	21	40	11,412.30

	Lake Borgne levee district, left bank.
Amount available, Abstract N	$10,896.92
Amount covered by this abstract	8,462.67
Balance	2,434.25

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance. It is proposed to limit the amount of work on Story Lower Levee to bring the total cost of levee work in the Lake Borgne district under the limits of the funds available. The lowest bidder, Mr. Robert McNamara, has given his written consent to this.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 19, 1892.

Q.—*Abstract of proposals received in reponse to advertisement dated November 11, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Ponchartrain levee district.			
		Lopez.		Jolisaint.	
		Embankment, 17,000 cubic yards.	Total cost of levee.	Embankment, 20,000 cubic yards.	Total cost levee of.
		Cents.		*Cents.*	
1	Columbus S. Jones, New Orleans, La	18.30	$3,111.00	18.30	$3,660.00
2	Homan, McFadden & Cassidy, Baton Rouge, La	20	3,400.00	21	4,200.00

	Pontchartrain levee district.
Amount available, Abstract L	$25,975.65
Amount covered by this abstract	6,771.00
Balance	19,204.65

REMARKS.—Proposal of Columbus S. Jones (No. 1) being the lowest received and considered reasonable, and bidder responsible, is recommended for acceptance. Bid No. 2 was received at 12 m., after the time set for opening.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 29, 18[illegible].

R.—*Abstract of proposals received in response to advertisement dated December 1[illegible], [illegible] opened this day by Capt. John Millis, Corps of Engineers, for the construction of [illegible] in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district.					
		Towles.			Billings.		
		Embankment, 16,000 cubic yards.	Base ditches, etc., 80 cubic yards.	Total cost of levee.	Embankment, 37,700 cubic yards.	Base ditches, etc., 160 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Columbus S. Jones, New Orleans, La.	22.40	10	$3,592.00	21.40	10	$8,[illegible]
2	Andrews Bros., Baton Rouge, La.	23	16	3,692.80	20	20	7,[illegible]
3	E. W. Hanlon & Co., New Orleans, La.	*19.95	*15	3,204.00	*19.90	*15	7,52[illegible]

	Pontchartrain levee district.
Amount available, Abstract Q	$19,204.[illegible]
Amount covered by this abstract	10,73[illegible]
Balance	8,4[illegible]

REMARKS.—Proposals marked thus (*) being lowest, and the bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 19, 1892.

No. 1.—*Abstract of proposals received in response to advertisement dated November 28, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lower Tensas levee district. Rifle Point, new and enlargement. Embankment, 35,000 cubic yards.	Base ditches, etc., 500 cubic yards.	Total cost of levee.	Atchafalaya levee district. Belle Vale. Embankment, 73,000 cubic yards.	Base ditches, etc., 190 cubic yards.	Total cost of levee.	Atchafalaya levee district. Rebecca. Embankment, 92,000 cubic yards.	Base ditches, etc., 971 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	S. D. Moody & Co., Limited, New Orleans, La	....	....	....	21½	20	$15,733.00	22	20	$20,434.20
2	John Scott & Son, St. Louis, Mo	....	....	....	16.99	16.99	12,434.98	*16.74	*16.74	15,563.34
3	W. J. Bentley & Co., New Orleans, La	....	....	....	*16¾	13*	12,252.20	17½	14	16,235.94
4	Homan, McFadden & Cassidy, Baton Rouge, La	....	....	....	20	15	14,628.50	20½	18	19,034.78
6	E. W. Hanlon & Co., New Orleans, La	16.74	15	$5,934.00	23.8	20	17,412.00	....	....	....
7	Robert Johnson, Memphis, Tenn	....	....	....	19½	19½	14,272.06	20	20	18,594.20
8	Rutherford & Dalgarn, Natchez, Miss	17.4	15½	6,167.50	....	....	....	....	....	....
9	Isaac Henry, Millikens Bend, La	25	20	8,850.00	19	17	13,902.30	19	18	17,654.78
10	Alexander Eltringham, Natchez, Miss	16.75	16.75	5,946.25	....	....	....	28½	25½	26,467.60
11	Samuel L. James, Jr., Baton Rouge, La	....	....	....	16.99	16.99	12,434.98	19	19	17,664.49
12	W. F. Barbour & Co., Lucy P. O., La	....	....	....	23¾ 22¾	(†) (†)	17,337.50 16,607.50	....	....	....
13	James N. Ogden, Baton Rouge, La	....	....	....	20	20	14,638.00	21	21	19,523.91
15	Albert H. Gillespie, Vidalia, La	19.90	16	7,045.00	....	....	....	....	....	....
16	J. S. McTighe & Co., Memphis, Tenn	*15.94	*15.94	5,658.70	18½	18½	13,540.15	20½	20½	19,059.05
17	W. L. Killebrew, Greenville, Miss	16.9	16.9	5,999.50	18½	18½	13,540.15	19.9	19.9	18,501.23
18	P. J. Coffman & Co., Baton Rouge, La	....	....	....	23	18	16,824.20	....	....	....
19	Ernest Hyner, Greenville, Miss	21	16	7,430.00	18	18	13,174.20	18	18	16,734.78
20	James A. Andrews & Co., Baton Rouge, La	....	....	....	18.24	18.24	13,349.86	21¾	21¾	20,221.19
21	Jeffries & Dameron, Hester, La	....	....	....	18¾	18¾	13,723.12	20	20	18,594.20
22	Manning & Gibson, Natchez, Miss	16½	16½	5,857.50	20	20	14,638.00	....	....	....
23	Green, Rogers & Co., New Orleans, La	....	....	....	20	10	14,619.00	22½	13½	20,716.08
24	Bogue & Co., Beulah, Miss	....	....	....	21.71	17	15,880.00	21.71	17	20,138.27

† No bid.

No. 1.—*Abstract of proposals received in response to advertisement, etc.*—Cont'd.

No.	Name and address of bidder.	Atchafalaya levee district. Missouri. Embankment, 104,000 cubic yards.	Base ditches, etc., 424 cubic yards.	Total cost of levee.	Barataria. Fort St. Leon middle. Embankment, 18,700 cubic yards.	Base ditches, etc., 8,000 cubic yards.	Total cost of levee.	Oakville. Embankment, 28,100 cubic yards.	Base ditches, etc., 5,600 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	S. D. Moody & Co., Limited, New Orleans, La	21	20	$21,924.80						
2	John Scott & Son, St. Louis, Mo	*16.99	*16.99	17,741.64						
3	W. J. Bentley & Co., New Orleans, La	17¼	14	17,999.36						
4	Homan, McFadden & Cassidy, Baton Rouge La	21	18	21,916.32						
6	E. W. Hanlon & Co., New Orleans, La	28	25	29,226.00						
7	Robert Johnson, Memphis, Tenn	19	19	19,840.56						
9	Isaac Henry, Millikens Bend, La	17	15	17,743.60	19¾	19¾	$5,273.25	19¾	19¾	[illegible]
10	Alexander Eltringham, Natchez, Miss	27½	25½	28,708.12	20½	20½	5,473.50	18½	18½	[illegible]
11	Samuel L. James, Jr., Baton Rouge, La	19	19	19,840.56						
12	W. F. Barbour & Co., Lucy P. O., La	22	(†)	22,880.60						
13	James N. Ogden, Baton Rouge, La				*20	*17	5,100.00	22	20	[illegible]
16	J. S. McTighe & Co., Memphis, Tenn	22.94	22.94	23,954.86	22	22	5,874.00	21.94	21.94	[illegible]
17	W. L. Killebrew, Greenville, Miss	20.9	20.9	21,824.62	27	27	7,209.00	*17.9	*17.9	[illegible]
18	P. J. Coffman & Co., Baton Rouge, La	27	18	28,156.32						
19	Ernest Hyner, Greenville, Miss	18	18	18,796.32						
20	James A. Andrews & Co., Baton Rouge, La	17.94	17.94	18,733.67						
21	Jeffries & Dameron, Hester, La	21	21	21,929.04						
23	Greene, Rogers & Co., New Orleans, La	23	11¼	23,967.70	20¼	19½	5,346.75	19¾	19	[illegible]
24	Bogue & Co., Beulah, Miss	21.71	17	22,650.48						
25	Philip J. Reilly, New Orleans, La				22¾	22¾	6,074.25	22	22	[illegible]

† No bid.

No. 1.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Barataria levee district.								
		Star.			Ironton.			Oakland.		
		Embankment, 17,000 cubic yards.	Base ditches, etc., 7,000 cubic yards.	Total cost of levee.	Embankment, 6,200 cubic yards.	Base ditches, etc., 3,800 cubic yards.	Total cost of levee.	Embankment, 4,100 cubic yards.	Base ditches, etc., 2,100 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
5	H. B. Turcan, Jesuits Bend, La	21	21	$5,040.00	.....	.....	....	.....	.....	....
9	Isaac Henry, Millikens Bend, La	*19¾	*19¾	4,740.00	*19¾	*19¾	$1,975.00	*19¾	*19¾	$1,224.50
10	Alexander Eltringham, Natchez, Miss	22⅜	20	5,203.75	.....	.....	....	.....	.....	....
13	James N. Ogden, Baton Rouge, La	20	20	4,800.00	25	25	2,500.00	24	24	1,488.00
16	J. S. McTighe & Co., Memphis, Tenn	23	23	5,520.00	24½	24½	2,450.00	25	25	1,550.00
17	W. L. Killebrew, Greenville, Miss	22.9	22.9	5,496.00	25.9	25.9	2,590.00	25.9	25.9	1,605.80
23	Green, Rogers & Co., New Orleans, La	21¼	19¾	4,995.00	20¾	19½	2,027.50	20	19½	1,229.50
25	Philip J. Reilly, New Orleans, La	22	22	5,280.00	23	23	2,300.00	22	22	1,364.00

No.	Name and address of bidder.	Lake Borgne levee district.		
		Caernarvon.		
		Embankment, 32,000 cubic yards.	Base ditches, etc., 700 cubic yards.	Total cost of levee.
		Cents.	*Cents.*	
9	Isaac Henry, Millikens Bend, La	*19¾	19¾	$6,458.25
14	Patrick Harnan, New Orleans, La	24.9	24.9	8,142.30
16	J. S. McTighe & Co., Memphis, Tenn	25	25	8,175.00
17	W. L. Killebrew, Greenville, Miss	25	25	8,175.00
3	Green, Rogers & Co., New Orleans, La	25	20	8,140.00
25	Philip J. Reilly, New Orleans, La	24½	24½	8,011.50

Remarks.—All proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

	Lower Tensas levee district.	Atchafalaya levee district.	Barataria levee district.	Lake Borgne levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894	$123,800.00	$136,800.00	$54,000.00	$45,000.00
Amount covered by this abstract	5,658.70	45,557.18	19,082.50	6,458.25
Balance	118,141.30	91,242.82	34,917.50	38,541.75

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 21, [illegible]

No. 2.—*Abstract of proposals received in response to advertisement dated Novemb[illegible] 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construc[illegible] levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain levee district. Shannon, lower. Embankment 94,500 cubic yards.	Shannon, lower. Base ditches, etc., 500 cubic yards.	Shannon, lower. Total cost of levee.	Maryland. Embankment 55,000 cubic yards.	Maryland. Base ditches, etc., 250 cubic yards.	Maryland. Total cost of levee.	Reserve. Embankment 26,850 cubic yards.	Reserve. Base ditches, etc., 150 cubic yards.	Reserve. Total cost of levee.
		Cts.	Cts.		Cts.	Cts.		Cts.	Cts.	
1	Rutherford & Dalgarn, Natchez, Miss	20¼	16	$19,216.25	17½	16	$9,665.00	17	15	$4,[illegible]
2	Manning & Gibson, Natchez, Miss	16.94	16.94	16,093.00	16.25	16.25	8,978.12	17.25	17.25	4,[illegible]
3	W. L. Killebrew, Greenville, Miss	17.9	17.9	17,005.00	15.9	15.9	8,784.75	17.9	17.9	4,[illegible]
4	Edmond P. White, New Orleans, La	20	20	19,000.00	20	20	11,050.00	......	......	......
5	Homan, McFadden & Cassidy, Baton Rouge, La	16.4	16	15,578.00	17.8	16	9,830.00	18.7	16	5,[illegible]
6	Israel R. Bobbitt, Baton Rouge, La	......	......	......	17½	15	9,662.50	18	15	4,[illegible]
7	Manoah V. Henry, Birmingham, Ala	*15	*13	14,240.00	15½	14	8,560.00	15.99	14	4,[illegible]
8	Thos. O'Malley, Baton Rouge, La	19¾	19¾	18,762.50	22	22	12,155.00	22	22	5,[illegible]
9	J. S. McTighe & Co., Memphis, Tenn	19	19	18,050.00	17½	17½	9,668.75	17½	17½	4,[illegible]
10	Ovide Lacour, Raccourci P. O., La	19.99	10	18,940.55	16.45	10	9,072.50	......	......	......
11	W. H. O'Connell, New Texas P. O., La	......	......	......	17.85	17.85	9,862.12	......	......	......
12	G. W. Reagan, Red River Landing, La	......	......	......	......	......	......	......	......	......
13	Jas. N. Ogden, Baton Rouge, La	19.9	19.9	18,905.00	19.9	19.9	10,994.75	19.9	19.9	5,[illegible]
14	S. L. James, jr., Baton Rouge, La	15.99	15.99	15,190.50	16	16	8,840.00	......	......	......
15	H. C. Brown, New Orleans, La	17.24	17.24	16,378.00	16.40	12	9,050.00	21	21	5,[illegible]
16	Jno. Scott & Son, Baton Rouge, La	20½	20½	19,475.00	17.45	17.45	9,641.12	18	18	4,[illegible]
17	E. W. Hanlon & Co., New Orleans, La	17.35	15	16,470.75	15.85	10	8,742.50	16	10	4,[illegible]
18	Alex. Eltringham, Natchez, Miss	16.45	14	15,615.25	*14.73	*14.73	8,138.32	15	15	4,[illegible]
19	P. J. Coffman & Co., Baton Rouge, La	18.94	14	17,968.30	18.94	14	10,452.00	21	16	5,[illegible]
20	Jeffries & Dameron, Hester, La	17½	17½	16,625.00	15	15	8,287.50	18	18	4,[illegible]
21	W. F. Barbour & Co., Lucy P. O. La	20¾	20¾	19,712.50	17½	17½	9,668.75	16½	16.20	4,[illegible]
22	McLaughlin Bros., Memphis, Tenn	20¼	20	19,236.25	18½	18½	10,221.25	20	20	5,[illegible]
23	Greene, Rogers & Co., New Orleans, La	20½	10	19,422.50	17.45	10	9,622.50	16.94	10	4,[illegible]
24	W. L. Withers, Victoria, Miss	19	15	18,030.00	18½	15	10,212.50	18¾	15	5,[illegible]
25	S. D. Moody & Co., limited, New Orleans, La	......	......	......	14.95	14.95	8,250.87	15.95	15.95	4,[illegible]
26	Jas. A. Andrews & Co., Baton Rouge, La	16.94	16.94	16,093.00	23.50	16	12,965.00	20	20	5,400[illegible]
27	Edw. D. Leche, Island P. O., La	......	......	......	18	18	9,945.00	......	......	......

No. 2.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

No.	Name and address of bidder.	Pontchartrain levee district.								
		Southward, upper.			Belle Helene.			Houmas.		
		Embankment, 32,850 cubic yards.	Base ditches, etc., 150 cubic yards.	Total cost of levee.	Embankment, 53,000 cubic yards.	Base ditches, etc., 255 cubic yards.	Total cost of levee.	Embankment, 31,000 cubic yards.	Base ditches, etc., 166 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	Rutherford & Dalgarn, Natchez, Miss	17.9	16	$5,904.15	*16.40	*15	$8,730.25	17.90	16	$5,575.56
2	Manning & Gibson, Natchez, Miss	18	18	5,940.00	......	......	....	......	......	....
3	W. L. Killebrew, Greenville, Miss	17.9	17.9	5,907.00	22.9	22.9	12,720.95	16⅜	16⅜	5,103.43
4	Edmond P. White, New Orleans La	......	......	....	......	......	....	18½	15	5,759.90
5	Homan, McFadden & Cassidy, Baton Rouge, La	19.5	16	6,429.75	36	25	19,143.75	......	......	....
6	Israel R. Bobbitt, Baton Rouge, La	18½	15	6,099.75	......	......	....	16.75	15	5,217.40
7	Manoah V. Henry, Birmingham, Ala	16	14	5,277.00	27	27	14,378.85	15½	13	4,826.58
8	Thos. O'Malley, Baton Rouge, La	22	22	7,260.00	22	22	11,716.10	22	22	6,856.52
9	J. S. McTighe & Co., Memphis, Tenn	19½	19½	6,435.00	28	28	14,911.40	16.99	16.99	5,295.10
10	Ovide Lacour, Raccourci P. O., La	19.99	10	6,581.72	......	......	....	17.74	10	5,516.00
11	W. H. O'Connell, New Texas P. O., La	......	......	....	......	......	....	......	......	....
12	G. W. Reagan, Red River Landing, La	......	......	....	......	......	....	16½	15	5,139.90
13	Jas. N. Ogden, Baton Rouge, La	17.9	17.9	5,907.00	......	......	....	19.9	19.9	6,202.03
14	S. L. James, jr., Baton Rouge, La	......	......	....	22	22	11,716.10	16	16	4,986.56
15	H. C. Brown, New Orleans, La	21	21	6,930.00	33	33	17,574.15	20	20	6,233.20
16	Jno. Scott & Son, Baton Rouge, La	16.99	16.99	5,606.70	22	22	11,716.10	19	19	5,921.54
17	E. W. Hanlon & Co., New Orleans, La	15.90	10	5,238.15	......	......	....	......	......	....
18	Alex. Eltringham, Natchez, Miss	*15.43	*14	5,089.75	16.93	15¼	9,011.78	*15.43	*14	4,806.54
19	P. J. Coffman & Co., Baton Rouge, La	21	18	6,925.50	29.75	20	15,818.50	19.75	17	6,150.72
20	Jeffries & Dameron, Hester, La	18	18	5,940.00	22	22	11,716.10	16	16	4,986.56
21	W. F. Barbour & Co., Lucy P. O., La	17	17	5,610.00	18.7	18.7	9,958.68	19	19	5,921.54
22	McLaughlin Bros., Memphis, Tenn	19	15	6,264.00	23	20	12,241.00	18½	18½	5,765.71
23	Greene, Rogers & Co., New Orleans, La	17¾	10	5,845.88	22½	10	11,950.50	16	10	4,976.00
24	W. L. Withers, Victoria, Miss	19.99	15	6,589.21	......	......	....	19¼	14	5,990.74
25	S. D. Moody & Co., limited, New Orleans, La	17.95	17.95	5,923.51	......	......	....	16.95	16.95	5,282.64
26	Jas. H. Andrews & Co., Baton Rouge, La	18.24	18.24	6,019.20	25¾	16	13,688.30	17¼	17¼	5,376.13
27	Edw. D. Leche, Island P. O., La	......	......	....	......	......	....	......	......	....

	Pontchartrain levee district.
Allotment from appropriations to be made for fiscal year ending June 30, 1894	$135,000.00
Amount covered by this abstract	45,054.86
Balance	89,945.14

REMARKS.—All proposals marked thus (*) being the lowest, and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December [illegible]

No. 3.—Abstract of proposals received in response to advertisement dated N[illegible] [illegible], opened [illegible] on Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.

No.	Name and address of bidder.	Lafourche Levee District: M[illegible]—[illegible]ville. Embankment [illegible] yards.	Lafourche Levee District: M[illegible]—[illegible]ville. Base [illegible] yards.	Lafourche Levee District: M[illegible]—[illegible]ville. Total cost of levee.	Lafourche Levee District: Ja[illegible]. Embankment [illegible] yards.	Lafourche Levee District: Ja[illegible]. Base [illegible] yards.	Lafourche Levee District: Ja[illegible]. T[illegible]
		Cents.	Cents.		Cents.	Cents.	
1	W. F. L[illegible] & Co., L[illegible], La	15.94	15.94	$8,736.88	16.74	16.74	[illegible]
2	Jas. A. A[illegible] & Co., Baton Rouge, La	21	16	11,5[illegible]	17.74	14	[illegible]
3	Isaac Henry M[illegible], La	19[illegible]	1[illegible]	10,76[illegible]	19[illegible]	[illegible]	[illegible]
4	W. L. K[illegible]	1[illegible]	16.9	9,[illegible]	16.9	16.9	[illegible]
5	M. Lang[illegible] Bros., M[illegible], Tenn	19½	19½	1[illegible]	[illegible]	[illegible]	[illegible]
6	J[illegible] & Dan[illegible], La	15	15	[illegible]	17	17	[illegible]
7	J. S. M[illegible] & Co., M[illegible], Tenn	17	17	9,[illegible]	1[illegible]	[illegible]	[illegible]
8	F. W. H[illegible] & Co., New Orleans, La	15.9	12	8,7[illegible]	17.95	12	[illegible]
9	Greene, Rogers & Co., New Orleans, La	17½	10	9,507.[illegible]	1[illegible]	10	[illegible]
10	S. D. Moody & Co., limited, New Orleans, La	14.94*	14.94	8,246.88	15.94	15.94	[illegible]
11	H[illegible] M. Fadden & Cassidy, Baton Rouge, La	1[illegible]	15½	8,41[illegible]	16[illegible]	16[illegible]	6[illegible]
12	A[illegible], N[illegible], Miss	14.25	12	7,[illegible]	16.24	14	[illegible]
13	[illegible], La	*14	*10	7,7[illegible]	*14.9[illegible]	*10	[illegible]
14	J[illegible] N. [illegible], Baton Rouge, La	17.9	17.9	9,[illegible]	16.9	16.9	[illegible]
15	Thos. O. M[illegible]ey, Baton Rouge, La	19½	19½	10,764.00	19½	19½	7[illegible]
							La[illegible] district.

Allotment from appropriation to be made for fiscal year ending June 30, 1894	$8[illegible]
Amount covered by this abstract	1[illegible]
Balance	67,[illegible]

REMARKS.—All proposals marked thus (*) being lowest, and bidder responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 6, 1893.

No. 4.—*Abstract of proposals received in response to advertisement dated December 15, 1892, opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Pontchartrain Levee district.								
		Hester.			St. Elmo.			Poche.		
		Embankment, 130,500 cubic yards.	Base ditches, etc., 860 cubic yards.	Total cost of levee.	Embankment, 36,000 cubic yards.	Base ditches, etc., 248 cubic yards.	Total cost of levee.	Embankment, 24,500 cubic yards.	Base ditches, etc., 85 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	S. D. Moody & Co. limited, New Orleans, La	*15½	*15½	$20, 360. 80	*15¾	*15¾	$5, 709. 06	16	16	$3, 933. 60
2	J. N. Ogden, Baton Rouge, La	15. 99	15. 99	21, 004. 46	16. 99	16. 99	6, 158. 54	17	17	4, 179. 45
3	Robt Johnson, Memphis, Tenn	18	18	23, 614. 80	17	17	6, 162. 16	19	19	4, 671. 15
4	McLaughlin Bros., Memphis, Tenn	16¾	15	21, 987. 75	16½	15	5, 977. 20	16½	15	4, 055. 25
5	W. J. Bentley & Co., New Orleans, La	16. 7	15	21, 922. 50	16. 7	15	6, 049. 20	22	15	5, 402. 75
6	Greene, Rogers & Co., New Orleans, La	18½	13	24, 254. 30	18	13	6, 512. 24	16	11	3, 929. 35
7	Israel R. Bobbitt, Burnside, La	16. 90	15	22, 183. 50	17. 40	15	6, 301. 20	15½	15	3, 810. 25
8	E. P. White, New Orleans, La	20	20	26, 272. 00	18	18	6, 524. 64	16	16	3, 933. 60
9	Andrews Bros. Construction Co., Baton Rouge, La	19¼	14	25, 241. 65	19¾	15	7, 147. 20	16¼	14	3, 933. 15
10	Homan, McFadden & Cassidy, Baton Rouge, La	19. 8	18	25, 993. 80	17. 3	17. 3	6, 270. 90	16. 2	16. 2	3, 982. 77
11	A. P. Martin, Waterproof, La	20	20	26, 272. 00	19	19	6, 887. 12	18	18	4, 425. 30
12	Ovide Lacour, New Orleans, La	21	15	27, 534. 00	19. 95	15	7, 219. 20	19. 95	15	4, 900. 50
13	Sterling Fort, Greenville, Miss	......	......	....	......	......	....	16. 9	16	4, 154. 10
14	W. H. O'Connell, New Texas, La	26½	26½	34, 810. 40	......	......	....	......	......	....
15	S. L. James, jr., Baton Rouge, La	......	......	....	......	......	....	17	17	4, 179. 45
16	Jeffries & Dameron, Hester, La	16¾	16¾	22, 002. 80	16	16	5, 799. 68	*15	*15	3, 687. 75
17	P. Harnan, New Orleans, La	......	......	....	24½	20	8, 869. 60	22	20	5, 407. 00
18	Chas. T. Worthington, Leota, Miss	15¾	15	20, 682. 75	......	......	....	......	......	....
19	E. W. Hanlon & Co., New Orleans, La	16. 89	15	22, 160. 45	16. 49	15	5, 973. 60	15. 9	18	3, 906. 55

	Pontchartrain levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract 2	$89, 945. 14
Amount covered by this abstract	29, 757. 61
Balance	60, 187. 53

REMARKS.—Proposals marked thus, (*) being the lowest and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January [illegible].

No. 5.—*Abstract of proposals received in response to advertisement dated Decem*[illegible] *1892, opened this day by Capt. John Millis, Corps of Engineers, for the cons*[illegible] *of levees in fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lafourche Levee district. St. Emma. Embankment, 53,000 cubic yards.	St. Emma. Base ditches, etc., 160 cubic yards.	St. Emma. Total cost of levee.	Magnolia. Embankment, 43,000 cubic yards.	Magnolia. Base ditches, etc., 95 cubic yards.	Magnolia. T[illegible]
		Cents.	Cents.		Cents.	Cents.	
1	Israel R. Bobbitt, Burnside, La	10¾	15	$8,901.50	17.44	15	[illegible]
2	Homan, McFadden, & Cassidy, Baton Rouge, La	18	15	7,564.00	18	15	[illegible]
3	Sterling Fort, Greenville, Miss	15.9	15	8,451.00	15.9	15	[illegible]
4	Andrews Bros. Construction Co., Baton Rouge, La	16½	14	8,634.90	18½	14½	[illegible]
5	Edmond P. White, New Orleans, La	18	18	9,568.80	15	15	[illegible]
6	W. J. Bentley & Co., New Orleans, La	16.7	15	8,875.00	17.7	15	[illegible]
7	C. D. Leeper & Co., Baton Rouge, La	....	....	....	22½	25	[illegible]
8	P. J. Coffman & Co., Baton Rouge, La	21	18	11,158.80	....	....	
9	P. Harnan, New Orleans, La	23	20	12,222.00	23	29	[illegible]
10	Jeffries & Dameron, Hester, La	16	16	8,505.60	16½	16½	[illegible]
11	Chas. T. Worthington, Leota, Miss	*14½	*14	7,707.40	14½	14	[illegible]
12	E. W. Hanlon & Co., New Orleans, La	15.9	13	8,447.80	*14.49	*13	[illegible]
13	Greene, Rogers & Co., New Orleans, La	18½	12½	9,825.00	18½	12¾	[illegible]
14	Isaac Henry, Millikens Bend, La	22	22	11,[illegible].20	21	21	[illegible]

	Lafourche Levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 3	[illegible]
Amount covered by this abstract	[illegible]
Balance	[illegible]

REMARKS—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 9, 1893.

6.—*Abstract of proposals received in response to advertisement dated December 23, 1892, ened this day by Capt. John Millis, Corps of Engineers, for the construction of levees fourth district, improving Mississippi River.*

Name and address of bidder.	Pontchartrain Levee district. Terre Haute. Embankment, 48,500 cubic yards.	Terre Haute. Base ditches, etc., 300 cubic yards.	Terre Haute. Total cost of levee.	Prospect. Embankment, 50,500 cubic yards.	Prospect. Base ditches, etc., 390 cubic yards.	Prospect. Total cost of levee.
	Cents.	*Cents.*		*Cents.*	*Cents.*	
James Cotten, Raccourci, La	23½	23½	$11,468.00	23½	23½	$11,959.15
Jas. N. Ogden, Baton Rouge, La	16.9	16.9.	8,247.20	16.9	16.9	8,600.41
Edmund P. White, New Orleans, La	18	15	8,775.00	22	22	11,195.80
E. W. Hanlon & Co., New Orleans, La	17.9	15	8,726.50	17	15	8,643.50
Israel R. Bobbitt, Burnside, La	15½	15	7,562.50	18¼	15	9.274.75
H. C. Brown, New Orleans, La	*14.90	*10	7,256.50	17.40	10	8,826.00
Andrews Bros, Construction Co., Baton Rouge, La	15.49	15.49	7,559.12	17¾	17¾	9,032.97
Greene, Rogers & Co., New Orleans, La	17½	11¼	8,521.25	18½	11½	9,387.35
Homan, McFadden & Cassidy, Baton Rouge, La	15¾	15¾	7,686.00	*16	*16	8,142.40
Isaac Henry, Millikins Bend, La	20½	20½	10,004.00	29½	20½	10,432.45
Jeffries & Dameron Hester, La	17	17	8,296.00	20	20	11,188.00
F. A. Brock, Galveston, Tex	23	23	11,224.00	22	22	11,195.80
P. J. Reilly, New Orleans, La	18¼	18¼	8,906.00	....	....	....
P. J. Coffman & Co., Baton Rouge, La	17¾	16	8,656.75	19½	16	9,909.90
S. L. James, jr., Baton Rouge, La	18	18	8,784.00	....	....	....

Name and address of bidder.	Lafourche Levee district. White Rose. Embankment, 21,200 cubic yards.	White Rose. Base ditches, etc., 70 cubic yards.	White Rose. Total cost of levee.	Barataria Levee district. Belle Chasse. Embankment, 71,800 cubic yards.	Belle Chasse. Base ditches, etc., 1,800 cubic yards.	Belle Chasse. Total cost of levee.
	Cents.	*Cents.*		*Cents.*	*Cents.*	
James Cotten, Racconrci, La	25	25	$5,317.50	23	23	$16,928.00
Jas. N. Ogden, Baton Rouge, La	20	20	4 254.00	18.45	18.45	13,579.20
Edmund P. White, New Orleans, La	18	18	3,828.60	....	....	....
E. W. Hanlon & Co., New Orleans, La	15.95	13	3,390.50	22	15	16,066.00
Israel R. Bobbitt, Burnside, La	18	15	3,826.50	....	....	....
H. C. Brown, New Orleans, La	17.29	10	3,672.48	*14.87	*10	10,856.66
Andrews Bros. Construction Co., Baton Rouge, La	17.24	17.24	3,666.95	....	....	....
Greene, Rogers & Co., New Orleans, La	18	10	3,823.00	....	....	....
Homan, McFadden & Cassidy, Baton Rouge, La	17	17	3,615.90	....	....	....
Isaac Henry, Millikens Bend, La	24	24	5,104.80	26	26	19,136.00
Jeffries & Dameron, Hester, La	*15	*15	3,190.50	....	....	....
F. A. Brock, Galveston, Tex	24	24	5,104.80	20	20	14,720.00
P. J. Reilly, New Orleans, La	....	....	....	20	18	14,684.00
P. J. Coffman & Co., Baton Rouge, La	19½	15	4,144.50	21	21	15,456.00
S. L. James, jr., Baton Rouge, La	18	18	3,828.60	....	....	....

	Pontchartrain Levee district.	Lafourche Levee district.	Barataria Levee district.
tment from appropriation to be made for fiscal year ding June 30, 1894:			
Amount available, Abstracts 4, 5 and 1	†$131,312.25	‡$53,581.23	§$38,541.75
Amount covered by this abstract	15,398.90	3,190.50	10,856.66
Balance	115,913.35	50,390.73	27,685.09

† Abstract 4. ‡ Abstract 5. § Abstract 1.

:MARKS.—Proposals marked thus (*) being the lowest and bidders responsible, are recommended for ptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 9, 18[illegible].

No. 7.—*Abstract of proposals received in response to advertisement dated December 15, 18[illegible], opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees, fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Atchafalaya levee district.								
		St. Francis Church.			Dunboine, upper.			Belle Grove.		
		Embankment, 33,000 cubic yards.	Base ditches, etc., 235 cubic yards.	Total cost of levee.	Embankment, 45,000 cubic yards.	Base ditches, etc., 240 cubic yards.	Total cost of levee.	Embankment, 57,000 cubic yards.	Base ditches, etc., 235 cubic yards.	Total cost of levee.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
1	Ovide Lacour, Raccourci, La.	18.49	15	$6,136.95	18	15	$8,136.00	17.74	15	$10,14[illegible]
2	W. J. Bentley & Co., New Orleans, La.	......	......	....	17	17	7,690.80	16	16	9,1[illegible]
3	Noble W. Irish, Carlyle, Ill.	......	......	....	21	17	9,490.80	21	17	12,[illegible]
4	Donovan, Daley & Co., St. Gabriel, La.	19	13	6,300.55	15.99	13	7,217.70	15.97	13	9,1[illegible]
5	W. L. Killebrew, Greenville, Miss.	16⅜	15	5,439.00	14.99	14	6,788.60	15.75	15	9,0[illegible]
6	Jas. N. Ogden, Baton Rouge, La.	20	20	6,647.00	18	18	8,143.20	18	18	10,3[illegible]
7	Geo. M. D. Grigsby, Jefferson, Tex.	......	......	....	*14.73	*14¼	6,662.70	*14.73	*14¼	8,4[illegible]
8	Andrews Bros. Construction Co., Baton Rouge, La.	15.74	15.74	5,231.19	16.94	16.94	7,663.66	16.94	14	9,6[illegible]
9	Edmund P. White, New Orleans, La.	17	17	5,649.95	......	......	....	......	......	....
10	A. P. Martin, Waterproof, La.	19	19	6,314.65	19½	19½	8,821.80	18½	18½	10,5[illegible]
11	Jeffries & Dameron, Hester, La.	17	17	5,649.95	15	15	6,786.00	15½	15½	8,8[illegible]
12	Greene, Rogers & Co., New Orleans, La.	......	......	....	16¾	12¼	7,566.90	17½	11½	9,7[illegible]
13	S. L. James, Baton Rouge, La.	18	18	5,982.30	18	18	8,143.20	......	......	....
14	W. H. O'Connell, New Texas, La.	27¾	27¾	9,222.71	......	......	....	......	......	....
15	E. W. Hanlon & Co., New Orleans, La.	15.99	14	5,309.60	18.50	15	8,361.00	21	15	12,0[illegible]
16	Jos. S. McLaughlin, Memphis, Tenn.	17	14	5,642.90	16½	16	7,463.40	16½	16	9,44[illegible]
17	Manning & Gibson, Natchez, Miss.	*15	*15	4,985.25	15½	15½	7,012.20	16½	16½	9,44[illegible]
18	Homan, McFadden & Cassidy, Baton Rouge, La.	17	15	5,645.25	18	18	8,143.20	16½	16½	9,44[illegible]

o. 7.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

Name and address of bidder.	Atchafalaya levee district.							
	Celeste.		Mount Salem.			Babin.		
	Embankment, 30,500 cubic yards.	Total cost of levee.	Embankment, 18,000 cubic yards.	Base ditches, etc., 185 cubic yards.	Total cost of levee.	Embankment, 13,000 cubic yards.	Base ditches, etc., 40 cubic yards.	Total cost of levee.
	Cts.		*Cts.*	*Cts.*		*Cts.*	*Cts.*	
Ovide Lacour, Raccourci, La	15.75	$4,803.75	15.49	15	$2,815.95	15.99	15	$2,084.70
W. J. Bentley & Co., New Orleans, La	16	4,880.00	16	16	2,909.60	......	......	....
Donovan, Daley & Co., St. Gabriel, La	15.47	4,718.35	15.97	13	2,898.65	19	13	2,575.20
W. L. Killebrew, Greenville, Miss	*14.99	4,571.95	*14.94	*14	2,715.10	15⅜	15	2,004.75
Jas. N. Ogden, Baton Rouge, La	16	4,880.00	18	18	3,273.30	18	18	2,347.20
Andrews Bros. Construction Co., Baton Rouge, La	......	....	16.99	14½	3,083.30	17¼	17¼	2,249.40
Edmund P. White, New Orleans, La	17	5,185.00	17	17	3,091.45	......	......	....
A. P. Martin, Waterproof, La	18¾	5,718.75	18¾	18¾	3,409.66	18	18	2,347.20
Jeffries & Dameron, Hester, La	15	4,575.00	15	15	2,727.75	*15	*15	1,956.00
Greene, Rogers & Co., New Orleans, La	17	5,185.00	18	10	3,258.50	18	10	2,344.00
S. L. James, Baton Rouge, La	18	5,490.00	18	18	3,273.30	......	......	....
E. W. Hanlon & Co., New Orleans, La	16	4,880.00	16	13	2,904.05	16	13	2,085.20
Jos. S. McLaughlin, Memphis, Tenn	16½	5,033.30	16½	16	2,929.60	16½	16	2,151.40
Manning & Gibson, Natchez, Miss	15½	4,727.50	15½	15½	2,818.67	15½	15½	2,021.20
Homan, McFadden & Cassidy, Baton Rouge, La	15.8	4,819.00	15	15	2,727.75	......	......	....

	Atchafalaya levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 1	$91,242.82
Amount covered by this abstract	29,320.59
Balance	61,922.23

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., January 11, 1[illegible].

No. 8.—*Abstract of proposals received in response to advertisement dated December 2[illegible], opened this day by Capt. John Millis, Corps of Engineers, for the construction of levees [illegible] fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lafourche levee district. Providence. Embankment, 49,900 cubic yards.	Base ditches, etc., 226 cubic yards.	Total cost of levee.	Flagtown. Embankment, 17,000 cubic yards.	Base ditches, etc., 171 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	E. W. Hanlon & Co., New Orleans, La.	14.99	13	$7,509.39	15.49	13	$2,6[illegible]
2	C. D. Leeper & Co., Baton Rouge, La.	18.70	10	9,353.90	....	....	....
3	P. J. Reilly, New Orleans, La	18	14	9,013.64	18	14	3,[illegible]
4	Ovide Lacour, Raccourci, La	16	16	8,020.16	16	16	2,[illegible]
5	Jeffries & Dameron, Hester, La	18	18	9,022.68	16	16	2,[illegible]
6	Isaac Henry, Millikens Bend, La	25	25	12,531.50	25	25	4,[illegible]
7	W. L. Killebrew, Greenville, Miss	15¾	14	7,703.76	15	14	2,[illegible]
8	Andrews Bros. Construction Co., Baton Rouge, La	14.94	14.94	7,488.82	*14.94	*14.94	2,5[illegible]
9	Geo. M. D. Grigsby, Jefferson, Tex	*14.77	*14.77	7,403.61	15.88	15.88	2,[illegible]
10	J. A. Carson & Co., Baton Rouge, La	16	16	8,020.16	17	17	2,[illegible]
11	Israel R. Bobbitt, Burnside, La	15.40	15	7,718.50	15.40	15	2,[illegible]
12	C. S. Jones, New Orleans, La	14.81	14	7,421.83	16.20	16	2,[illegible]
13	E. P. White, New Orleans, La	20	15	10,013.90	20	15	3,[illegible]
14	Greene, Rogers, & Co., New Orleans, La	17½	10	8,630.35	17½	10	2,[illegible]
15	J. N. Ogden, Baton Rouge, La	16.9	16.9	8,471.29	18.9	18.9	3,[illegible]

No.	Name and address of bidder.	Lafourche levee district. Speranza. Embankment 14,500 cubic yards.	Base ditches, etc., 114 cubic yards.	Total cost of levee.	Ashton. Embankment 36,000 cubic yards.	Base ditches, etc., 310 cubic yards.	Total cost of levee
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	E. W. Hanlon & Co., New Orleans, La.	15.49	13	$2,260.87	15	13	$5,441.[illegible]
2	C. D. Leeper & Co., Baton Rouge, La.	....	....	....	18	12	6,5[illegible]
3	P. J. Reilly, New Orleans, La	17.7	14	2,582.46	17.7	14	6,4[illegible]
4	Ovide Lacour, Raccourci, La	16	16	2,338.24	16	16	5,8[illegible]
5	Jeffries & Dameron, Hester, La	17	17	2,484.38	17½	17	6,[illegible]
6	Isaac Henry, Millikens Bend, La	25	25	3,653.50	25	25	9,[illegible]
7	W. L. Killebrew, Greenville, Miss	15	14	2,190.96	15¾	14	5,57[illegible]
8	Andrews Bros. Construction Co., Baton Rouge, La	*14.74	*14.74	2,154.10	15.44	15.44	5,6[illegible]
9	Geo. M. D. Grigsby, Jefferson, Tex	15.99	15.99	2,336.77	*14.77	*14.77	5,[illegible]
10	J. A. Carson & Co., Baton Rouge, La	18	18	2,630.52	17	17	6,1[illegible]
11	Israel R. Bobbitt, Burnside, La	16½	15	2,373.35	15½	15	5,62[illegible]
12	C. S. Jones, New Orleans, La	16.20	16.12	2,367.37	17.40	17	6,31[illegible]
13	E. P. White, New Orleans, La	20	15	2,917.10	20	15	7,24[illegible]
14	Greene, Rogers, & Co., New Orleans, La	18½	11	2,695.04	18½	13	6,7[illegible]
15	J. N. Ogden, Baton Rouge, La	18.9	18.9	2,762.04	17.9	17.9	6,5[illegible]

	Lafourche levee district.
Allotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 5	$67,049.5[illegible]
Amount covered by this abstract	17,48[illegible]
Balance	49,56[illegible]

REMARKS.—Proposals marked thus (*) being the lowest, and the bidders responsible, are recommended for acceptance.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., February 4, 1893.

No. 9.—*Abstract of proposals received in response to advertisement dated January 24, '93, opened this day by Capt. John Millis, Corps of Engineers, for the construction of vees in the fourth district, improving Mississippi River.*

D.	Name and address of bidder.	Barataria levee district.					
		Magnolia, new and enlargement.			Kearney.		
		Embankment, 19,933 cubic yards.	Base ditches, etc., 810 cubic yards.	Total cost of levee.	Embankment, 20,634 cubic yards.	Base ditches, etc., 677 cubic yards.	Total cost of levee.
		Cents.	*Cents.*		*Cents.*	*Cents.*	
1	Johnson & Sullivan, Memphis, Tenn	21	21	$4,356.08	21½	21½	$4,581.86
2	J. F. Coleman, New Orleans, La	24	24	4,978.32	20	20	4,262.20
3	Philip J. Reilly, New Orleans, La	18	18	3,733.74	18	18	3,835.98
4	C. S. Jones, New Orleans, La	19.40	19.40	4,024.14			
5	Chas. P. Worthington, Leota, Miss	21	20	4,347.93	21	20	4,468.54
6	W. L. Killebrew, Greenville, Miss				19.9	15	4,207.72
7	E. W. Hanlon & Co., New Orleans, La.	24	15	4,905.42	16.94	14	3,590.18
8	Jeffries & Dameron, Hester, La	*15	*15	3,111.45	*14¾	*14¾	3,143.37
9	Greene, Rogers & Co., New Orleans, La.	21	15	4,307.43	25	15	5,260.05
0	Frank M. McLaughlin, Memphis, Tenn.	16½	16½	3,422.59	16¾	16¾	3,569.59

o.	Name and address of bidder.	Barataria levee district.				
		St. Anne enlargement.		Dobard.		
		Embankment, 8,000 cubic yards.	Total cost of levee.	Embankment, 26,590 cubic yards.	Base ditches, etc., 965 cubic yards.	Total cost of levee.
		Cents.		*Cents.*	*Cents.*	
1	Johnson & Sullivan, Memphis, Tenn	23	$1,840.00	20½	20½	$5,579.88
2	J. F. Coleman, New Orleans, La	25	2,000.00	20	20	5,511.00
3	Philip J. Reilly, New Orleans, La	18¾	1,500.00	18½	18½	5,097.67
4	C. S. Jones, New Orleans, La			19.40	19.40	5,345.67
5	Chas. P. Worthington, Leota, Miss	22	1,760.00	21	20	5,776.90
6	W. L. Killebrew, Greenville, Miss	17.9	1,432.00	20.9	18	5,731.01
7	E. W. Hanlon & Co., New Orleans, La.	24	1,920.00	16.94	14	4,639.45
8	Jeffries & Dameron, Hester, La	25	2,000.00	*15	*15	4,183.25
9	Greene, Rogers & Co., New Orleans, La.	22	1,760.00	19	16	5,206.50
0	Frank M. McLaughin, Memphis, Tenn.	38	3,040.00	17.99	17.99	4,957.14

	Barataria levee district.
llotment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 6	$43,143.34
Amount covered by this abstract	11,820.07
Balance	31,323.27

REMARKS.—Proposals marked thus (*) being the lowest and the bidders considered responsible, are commended for acceptance.

UNITED STATES ENGINEER OFFI[illegible]
New Orleans, La., February [illegible]

No. 10.—*Abstract of proposals received in response to advertisement dated Ja[illegible] 1893, opened this day by Capt. John Millis, Corps of Engineers, for the constr[illegible] levees in the fourth district, improving Mississippi River.*

No.	Name and address of bidder.	Lake Borgne levee district. Battle Ground, new and enlargement. Embankment, 24,075 cubic yards.	Battle Ground. Base ditches, etc., 1,052 cubic yards.	Battle Ground. Total cost of levee.	Irving. Embankment, 44,864 cubic yards.	Irving. Base, ditches, etc., 1,847 cubic yards.	Irving. Total cost of levee.	Orang[illegible]. Embankment, 15,777 cubic yards.	Orang[illegible]. Base ditches, etc., 984 cubic yards.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*
1	Johnson & Sullivan, Memphis, Tenn	23	23	$5,779.21	27½	27½	$12,845.52	21	[illegible]
2	J. F. Coleman, New Orleans, La	23	22	5,527.94	24	24	11,210.64	22	22
4	Philip J. Reilly, New Orleans, La	18¼	18¼	4,585.68	18¼	18¼	8,524.76	19	19
5	C. S. Jones, New Orleans, La	.....	.....	....	22	22	10,276.42	19	19
6	Charles T. Worthington, Leota, Miss	23	20	5,747.65	22	20	10,239.48	22	20
7	W. L. Killebrew, Greenville, Miss	.....	.....	....	.....	.....	....	21	[illegible]
8	E. W. Hanlon & Co., New Orleans, La	18.4	13	4,566.56	20	15	9,249.85	16.74	[illegible]
9	Jeffries & Dameron, Hester, La	18	18	4,522.86	19⅞	19⅞	9,283.81	*16	*16
10	Greene, Rogers & Co., New Orleans, La	21	21	5,276.67	20½	19	9,548.05	21	15
11	John Cleary, New Orleans, La	18	.....	4,333.50	18	.....	8,075.52	.....	.....
12	Frank M. McLaughlin, Memphis, Tenn	*17¼	*17¼	4,334.41	22	22	10.276.42	17	17

No.	Name and address of bidder.	Lake Borgne levee district. English Turn. Embankment, 24,555 cubic yards.	English Turn. Base ditches, etc., 1,085 cubic yards.	English Turn. Total cost of levee.	St. Clair. Embankment, 28,500 cubic yards.	St. Clair. Base ditches, etc., 2,403 cubic yards.	St. Clair. Total cost of levee.	Mon Pla[illegible]. Embankment, 14,600 cubic yards.	Mon Pla[illegible]. Base ditches, etc., 1,045 cubic yards.
		Cts.	*Cts.*		*Cts.*	*Cts.*		*Cts.*	*Cts.*
1	Johnson & Sullivan, Memphis, Tenn	19¼	19¼	$4,938.40	20½	20½	$6,335.11	21	21
2	J. F. Coleman, New Orleans, La	20	20	5,128.00	20	20	6,180.60	21	21
3	James Byrne, Baton Rouge, La	22½	22½	5,768.90	.....	.....	....	22½	22½
4	Philip J. Reilly, New Orleans, La	15½	15½	3,974.19	14.91	14.91	4,607.64	15.4	15.4
6	Charles T. Worthington, Leota, Miss	22	20	5,619.10	23	20	7,035.60	23	20
7	W. L. Killebrew, Greenville, Miss	18.99	15	4,825.74	27	27	8,343.81	16.9	16.9
8	E. W. Hanlon & Co., New Orleans, La	16.74	12	4,240.71	16.74	12	5,059.26	16.74	12
9	Jeffries & Dameron, Hester, La	*14½	*14½	3,717.79	*14	*14	4,326.42	*14	*14
10	Greene, Rogers & Co., New Orleans, La	19	17	4,849.90	19	19	5,871.57	19	15
12	Frank M. McLaughlin, Memphis, Tenn	16½	16½	4,230.59	16.73	16.73	5,170.07	17	17

. 10.—*Abstract of proposals received in response to advertisement, etc.*—Continued.

	Lake Borgne levee district.
otment from appropriation to be made for fiscal year ending June 30, 1894:	
Amount available, Abstract No. 1	$38,541.75
Amount covered by this abstract	25,555.25
Balance	12,986.50

REMARKS.—Proposals marked thus (*) being the lowest regular bids and the bidders considered respon- le, are recommended for acceptance. Bid of John Cleary incomplete.

The reports of assistants in local charge of the different levee districts are as fol- ws:

EPORT OF ASSISTANT ENGINEER DOUGLAS, IN LOCAL CHARGE OF THE LOWER TENSAS LEVEE DISTRICT.

NATCHEZ, MISS., *May 30, 1893.*

SIR: I have the honor to submit the following report on the work under my local iarge for the period from June 1, 1892, to May 30, 1893:

LOWER TENSAS DISTRICT LEVEES.

Construction.—At date of last report no work was in progress, all levee construc- on undertaken having been completed.

The general condition of the work was fair, as has been proved by the passing of ie flood of 1892 without a break in the line of levees. Some levees were threatened y caving banks and others were deficient in section or low in grade.

During the past season the construction or extensive enlargement of 22.4 miles of vees was undertaken. Of this, 6.5 miles was new embankment and 15.9 miles aising and enlargement of existing levees.

The special features of construction of levee embankments this season have been ie limited use of muck ditches, the cutting down or leveling off of old levees before nlargement, the variation of the land slope in proportion to the height, and the se of tile drains to carry off seepage water from the toe of the land slope.

All the conditions have been favorable, and with the experience of past years as a uide the several levees were surveyed, let to contractors, commenced, prosecuted, nd completed without incident of considerable interest. I give in detail such infor- iation as will be of value.

Hardscrabble (641 R.).—New levee; length, 5,360 feet; height above natural surface, rom 7.5 to 16.1 feet; grade, 3 feet above high water of 1892; crown, 8 feet; side lopes, 3 to 1 on river side and 2½ and 4 to 1 on the land side; contents, 84,373.74 ubic yards. The embankment was built with the broken back or hollow slope on he land side made by giving the bank an inclination of 2½ to 1 for the first 5 feet elow grade, and thence 4 to 1 to the natural surface. This levee was an extension own stream of the Hardscrabble levee of 1891–'92, and its construction was rendered ecessary by the continued caving of the river bank in the Hardscrabble bend. The ontractors commenced operations November 22, 1892, but prosecuted the work rather lowly during the favorable working season. The usual spring rains came on, labor ecame scarce, and when the contract date of completion March 1, 1892, arrived the mbankment was only about half completed. Fortunately the front levee still held nd the river did not rise to a dangerous height. The contract was extended to pril 1, to April 15, and again to May 1, 1893. The levee was finally finished April 7, 1893.

Bondurant (643.5 R.).—New levee; length, 3,422 feet; height above natural surface, rom 3.5 to 13.8 feet; grade, 3.7 feet above high water of 1892; crown, 8 feet; side lopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 23,795.92 cubic ards.

In 1882–'83 the United States built a levee at this point, and almost every year ince the rapid caving of the river bank has necessitated the construction of a new evee either by the General Government, State, or local authorities. During 1883 nd 1884 the bank line receded 1,700 feet in eighteen months, the most rapid caving hat I have ever heard of. The present levee is the last but one that it would be racticable to build between the Mississippi River and Lake Bruin. Work was ommenced November 14, 1892, and the levee was completed December 30, 1892, forty- even days in advance of contract time.

Grassmere to Wiccoma (692 R.).—Enlargement work; length, 26,400 feet; above natural surface, from 4.8 to 20.5 feet; grade, 2½ feet above high water; crown, 8 feet; side slopes, 3 to 1 on river side and 2½ to 1 on the land side; to date, 108,411.48 cubic yards. This levee is to be tile drained. Under the Grassmere to Wiccoma was undertaken the first section of the general enlargement of the United States Lake Concordia Levee, constructed in The whole of the line around the lake, a distance of about 18 miles, has been of great expense for protection during high water, as it was low in grade in section. Crevasses occurred in 1884, 1890, and 1891. The work done this was recommended as far back as 1885. The contractors began work Nov 1892, and completed embankment work April 10, 1893. The difficulty of tiles and their non-delivery until the river became too high to place them vented the completion of this portion of the work. The delay necessitated extensions of the contract time, and the work is not yet finished.

Wiccoma to Fletcher (693 R.).—New and enlargement work; length, 23, height above natural surface, from 5.1 to 30.5 feet; grade, 2½ feet above h of 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the side; contents, 131,169.17 cubic yards. This levee is tile drained and is the section of the Lake Concordia enlargement. The stretch covers what termed the "bayou region," when all the crevasses of recent years have It is generally rather heavy work, as there are several dikes closing bayous others the Bayou Cocodrie. Construction was commenced November 18, the levee, including the tile drains, completed April 24, 1893. The contr was repeatedly extended, the last extension being to May 15, 1893.

Fletcher to Minorca (699 R.).—New and enlargement work; length, 18,4 height above natural surface, from 5.6 to 16.7 feet; grade, 2½ feet above high 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the la contents to date, 119,837.68 cubic yards. Tile drains were to be used. This is section of the raising and enlarging of Lake Concordia levee. Contract menced work November 14, 1892, and the embankment was completed April Fourteen hundred and forty linear feet of tiling has been laid, but on a delay in delivery of tiles this portion of the work has not been completed remains on this levee a short piece of old embankment which was not enlarged, as it is intended to replace it by a piece of entirely new levee 939 As was the case on other levees that were to be tile drained, the contract to be repeatedly extended on account of difficulty in obtaining tiles. The is still in force at date of report.

Minorca to Minors (702 R.).—New and enlargement work; length, 17, height above natural surface, from 4.7 to 14.8 feet; grade, 2½ feet above high 1892; crown, 8 feet; side slopes, 3 to 1 on the river side and 2½ to 1 on the side; contents to date, 86,058.98 cubic yards; levee to be tile drained. fourth and last section of the Lake Concordia enlargement. The length of as projected was 21,549 feet, but on account of scarcity of funds 3,774 feet old levee remains untouched.

Some of the untouched work is to be new levee, but the greater portion is ment. Work was commenced on November 14, 1892, and all of the embank which there were funds to pay for finished March 10, 1893. The laying of drains was delayed by non-receipt of tiles, and this portion of the work is pleted. Sixteen hundred and twenty-six feet (linear) of tiling has been laid delay in receipt of additional tiles has necessitated the repeated extension contract time, and the work is not yet completed.

Morville (710 R.).—New levee; length, 5,200 feet; height above natural from 3.8 to 9.7 feet; grade, 2½ feet above high water of 1892; crown, 8 slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 28,592 yards.

The old levee in front was on the immediate edge of the river bank point had partly caved in. The bank is caving gradually and the destruc front line a question of but short time.

The contractors began operation on the new levee November 3, 1892, and pleted it on December 9, 1893, sixty-eight days in advance of the contract time

Fish Pond (725 R.).—New levee; length, 6,365 feet; height above natural from 5.5 to 15.4 feet; grade, 2½ feet above high water of 1892; crown, 8 slopes, 3 to 1 on the river side and 2½ to 1 on the land side; contents, 60,710.76 yards. A rather unusual condition of affairs has developed at this locality. the United States has built several levees under different names, the first 1882-'83-'84, under the name of Greens to Fairview. A portion of this line breached by caving banks in 1887, and a loop levee under the name of Deer Park to be built in 1890-'91. This latter levee still holds, but at the time of its construction the funds were limited and the lower wing could not be carried as far stream as would have been desired. After the subsidence of the flood of 1892 it

:onsidered that the caving of the river bank would breach this lower wing before the ıigh water of 1893, and an extension 10,365 feet long of the curtain of the levee of .890-'91 was surveyed and let under the name of Fish Pond Levee. There were ›ome objections on the part of property owners as to the location of the line, which lelayed matters so that it was not until February 14, 1893, that the contractors comnenced work. In the meanwhile the condition of affairs as regards the existing line ıad materially changed. The caving bank instead of breaching the lower wing of :he Deer Park levee of 1890-'91 had eaten in with great rapidity toward the curtain ›r main portion of that levee, promising its early destruction from end to end. Jnder the circumstances all work on the upper 4,000 feet of the Fish Pond Levee was ›uspended, pending a change of line and extension upstream. This survey can not ›e made for final location until the subsidence of the high water of 1893 and the cavng of the river bank recommences. Work on the remaining 6,365 feet of levee was ›ushed and it was completed April 28, 1893.

Repairs.—The repair work during the past season has been confined principally to ›wo of the largest United States levees in the district—Hard Times (633 R.) and Gibsons Landing (683.5 R.), the former crossing the foot of Lake St. Joseph and the atter the foot of Lake St. John. It was desired to place the very large dikes crossng these lake beds in as nearly an absolutely secure condition as possible, for if :hey should be destroyed by a crevasse it would be almost impossible to rebuild :hem.

The work was done by hired labor. A force averaging about 60 men was organzed and placed on the quarter boat *New Orleans* on November 22, 1892, and the 'epairs to the Gibsons Landing Levee (683.5 R.) were commenced. The levee was generally repaired where gullied by rain wash, but the major portion of the work vas done on the dike crossing Lake St John. The length of the dike is about 1,700 'eet with water on both sides. In consequence earth had to be hauled from either ›ank of the lake, which made the work slow and expensive. The dike was, how›ver, thoroughly repaired and enlarged, the work being completed January 17, 1893.

The quarter boat and force were then transferred to Hard Times levee (633 R.), and vork on the dike across Lake St. Joseph commenced. This dike has always given rouble on account of the embankment sinking into the soft lake bed. It had been 'epeatedly raised, but without proportionate enlargement of base, and the result vas a narrow crown and hollow slopes. These defects were thoroughly repaired for ı distance of about 1,000 feet, and as the sinking appears to have ceased the dike is ıow probably stronger than the levees in the vicinity. Here also the work was ılow and expensive on account of the difficulty in obtaining earth, which had to be vheeled long distances. The repairs contemplated by the hired labor force were ›ompleted February 28, 1893, and the force discharged. The quarter boat was 'eturned to Natchez and laid up in readiness for high-water protection work should t be necessary.

A portion of the Hardscrabble Levee (639 R.) of 1891-'92, had sloughed and settled ›elow grade. It was a small affair and repaired by placing 382 cubic yards of earth ›n the low place, under an informal agreement. This levee work was done in March, .893.

SURVEYS LOWER TENSAS LEVEE DISTRICT.

An unusually large amount of this sort of work has been done, and a survey ›arty has been almost constantly in the field.

The work has been somewhat varied, consisting of the necessary surveys for cur'ent levee construction, surveys for work to be done under the allotment for 1893-'94, ınd preliminary surveys where existing levees were threatened by caving banks. Several extensive preliminary surveys or examinations were made in accordance vith resolutions of the Commission, to obtain data as to condition of existing evees, cost of closing gaps, and practicability and cost of new levee behind Lake Bruin and St. Joseph should it become necessary to abandon existing front line, etc.

I give the work in detail, not in the order in which it was done, but from the ıpper limits of the district south, taking the right bank first:

At *Reid Levee* (605 R.) the existing line is seriously threatened by the caving of the 'iver bank. A careful survey was made and 22,598 feet of new levee staked out. The old levee was traversed for 33,000 feet and about 6¼ miles of bank line run.

The Commission had made an allotment of $5,000 towards the raising and enlargng of the levee on Davis Island (622 R.). Here the existing levee was traversed for 5 miles and leveled and cross-sectioned for 22,469 feet.

Hardtimes Levee (633 R.) the upper end of the old *Hardscrabble* (638.5 R.) and lower *Evergreen* (637.5 R.) were traversed, cross-sectioned, leveled for raising and enlargenent for a distance of about 12,000 feet, and 9,000 feet of shore line was traversed.

The lower or new Hardscrabble Levee (641 R.) 5,360 feet long, was surveyed and staked out.

At *Bondurant* (642 R.) the old levee was traversed, leveled, and cross-se preparatory to raising and enlarging for a length of 8,300 feet, and the new B rant Levee (643.5 R.), 3,422 feet long surveyed and staked out. A prospectiv sion of this line 5,630 feet long was also surveyed and staked out. The old was traversed for about 3 miles and 30,000 feet of bank line run.

A resolution of the Commission directed that a survey be made for a levee b lake St. Joseph (632 R.) and Lake Bruin (643 R.). This survey was made an feet of levee line located, leveled, and topography taken. Four miles of sho in front of Lake Bruin was traversed.

It was thought that a new levee might be required at Cottage Home (649 R reconnoissance of existing levee and bank line was made, from the results of it was decided that a new levee was not required at present.

At *Upper Kempe* (657 R.) the caving of the river bank had recommenced an cated that a prospective new levee would be required in the near future. T levee was traversed for 20,000 feet and 3 miles of bank line run. Prelimina vey of 22,000 feet of new levee line was made for estimating contents, cost, an location for prospective new line.

The Gibson Landing Levee (683.5 R.) was traversed and leveled to determ tlement for 13,888 feet, and the dike crossing Lake St. John cross-section repair work for about 2,000 feet.

Rifle Point Levee (690 R.) was traversed, leveled, and cross-sectioned for a l of 16,974 feet.

The whole line of Lake Concordia Levee (692 R. to 702 R.) was surveyed, the length of line being 93,711 feet. Of this 10,059 feet was new line to replace ing levee where too close to the lake bank, and the remaining 83,652 feet cross tioning of old levee for raising and enlargement. The levee being very irreg shape, the field work was very tedious, requiring something over 1,100 cross tions.

Between *Arnauldia* and *Moro* (702 R. to 709 R.) extensive surveys were made. eral alternative levee lines, aggregating 36,600 feet in length, were staked out old levee, for a distance of 46,000 feet, was traversed, and it was cross-section a length of 29,000 feet. Eight miles of bank line was meandered.

At *Morville* (710 R.) the new levee, 5,200 feet long, was surveyed and stake and about 2 miles of shore line and old levee traversed.

The old levee from *Morville* (710 R.) to Greens (721 R.), a distance of 28,4 was traversed and cross-sectioned for raising and enlarging.

Fish Pond Levee (723 R.), 10,365 feet long, was located and staked out and a 3 miles of bank line meandered.

Preliminary surveys of proposed levee lines were made between Fairview (and Union Point (742 R.), including the Bougere Crevasse (739 R.). The len line surveyed was 93,370 feet, and 6 miles of shore line was traversed.

This completes surveys in the lower Tensas Levee district, but other work done on the left bank in what has been termed the

Big Black Levee district.—A resolution of the Commission directed that a s be made from the bluff just below Warrenton Landing (606.7 L.) to Grand (636.2 L.), and from Rodney (652 L.) to Coles Creek (672 L.) to ascertain the tion of present levees and estimate the cost of restoration.

These surveys have been made. Between Warrenton and Grand Gulf 17 of levee was traversed and leveled, old levees were located and cross-sectioned, preliminary locations for new levees were made. About 7 miles of shore line run.

Between Rodney and Coles Creek 13½ miles of line was traversed, leveled crossed-sectioned; existing levees were located and preliminary lines for levees run.

Sketch maps, profiles, and estimates of all field work were made by the sur party while in the field.

I summarize the work as follows:

	M
New levees (lines located in detail)	[illegible]
Old levees cross-sectioned for enlargement	[illegible]
Old levees traversed for topography, etc	[illegible]
Shore or bank lines run for topography, etc	[illegible]
Preliminary surveys for levee lines	[illegible]
Total	[illegible]

SUMMARY.

To summarize results it can be stated that the general condition of the leve the Lower Tensas Levee district has been greatly improved by the work done ing the past season, and a long step made in the direction of a safe and reason permanent line. There are yet long stretches of levee low in grade and weak in section that would be a source of anxiety during extreme floods. Caving banks threaten some portions of the line, and foreshadow the abandonment of many miles of existing effective levee, but all the defects are known and will probably be remedied.

The special features of levee construction tried during the past season appear to have been successful. The tile drains have done the work expected of them, and the land base of the levee kept dry and hard by the seepage water being carried off through the tiling. The omission of the muck ditch has resulted in economy of construction without any injury to the levees, and the broken back or flattening of the lower portion of the land slope in high levees, while not yet tested, will be of undoubted benefit to levees exposed for a long time to the strain of extreme high water.

The total length of effective levees in the Lower Tensas district is now 125 miles. Of this 55.7 miles are levees built by the United States, being 47 per cent of the whole in reference to the length.

The total estimated cubical contents of existing effective levee in the district is 7,000,000 cubic yards, of this 4,000,000 cubic yards is contained in the United States levees, being 57 per cent of the whole in reference to quantity.

As the United States levees are, generally, very heavy ones, crossing old lake beds and low, heavily timbered swamps, I estimate their present value at $1,000,000. They have cost more.

In the Lower Tensas district, during the past season, 5.3 miles of new levee has been built, and 15.4 miles of old levee extensively enlarged, a total of 20.7 miles of levee containing 642,950.25 cubic yards of earth.

Very respectfully, your obedient servant,

H. S. DOUGLAS,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The report of Assistant Engineer William J. Hardee, in local charge of the Atchafalaya, Pontchartrain, and Lafourche levee districts, is as follows:

BATON ROUGE, LA., *May 31, 1893.*

SIR: I have the honor to submit the following report for works under my local direction for the year ending May 31, 1893:

Between the mouth of Red River and New Orleans the flood of 1892 attained a maximum of 1.7 feet above the highest previously known flood.

At the close of the annual report that flood had practically subsided and the river was generally falling rapidly.

Right bank below Red River.—The levees on the right bank below Red River, though tested to their utmost capacity, were intact, all crevasses having been closed within a few days after their occurrence, but the lines were considerably washed and worn by the long strain put upon them.

Shortly after the river had returned to within its banks a careful inspection disclosed that the levees constructed by the United States had suffered but slight injury.

The Highland Extension (814.5 R.) and Mayflower-Union (835 R.) were wave-washed in places and the sod on the front slope, where covered by water, had failed to grow. These were the only levees requiring repair; all others were found in good condition.

Left bank below Red River.—The general line of levees on the left bank below Red River had suffered badly from the flood of 1892 and five crevasses existed, through which the water continued to flow until the water reached a low elevation. The United States levees, like those on the right bank, were carefully inspected and found to be in generally good condition. No material damage, necessitating repair, existed.

GENERAL METHODS.

Assignment.—On August 17, 1892, I was assigned to local direction in the Atchafalaya Section, extending on the right bank of the Mississippi River from the mouth of Red River to the north bank of Bayou Lafourche, a distance of 122 miles; the Lafourche Section, extending on the right bank of the Mississippi River from the south bank of Bayou Lafourche (Donaldsonville) to the city of New Orleans, a distance of 79 miles, and the Pontchartrain Section, extending on the left bank of the Mississippi River from the city of Baton Rouge to the city of New Orleans, a distance of 132 miles.

Surveys.—On August 24 and 25, 1892, the Board of U. S. Engineer Officers on the Building and Repair of Levees made an examination of the points suggested by the local authorities as requiring new levees.

In accordance with instructions received on August 17, 1892, two survey parties, stationed on the U. S. quarter boat *Alpha*, which was moved by the launch *Alaska*, were organized, and on September 6, 1892, commenced surveying and staking new levee lines designed to be built from the 1893 allotments and to have a net grade of 2½ feet above the flood of 1892, conforming to drawings and written instructions received from you. Their cross sections vary according to height. With a net fill of 15 feet or more, crown 8 feet, river slope 3 to 1, land slope 2½ to 1 for first 6 feet below grade, 4 to 1 for next 6 feet, and 6 feet to 1 for remaining height. This section is classed A in this report. With a net fill ranging from 10 to 15 feet, crown 8 feet, river slope 3 to 1, land slope 2½ to 1 for first 5 feet below grade, and 4 to 1 for remaining height. This section is classed B in this report.

With a net fill of less than 10 feet, crown 8 feet, river slope 3 to 1, land slope 2½ to 1. This section is classed C in this report.

As soon as surveys had been made to the extent of the 1893 allotment the same survey parties were moved to Picayuneville (795.5 R.), near the head of the Atchafalaya district, and commenced the location of levees to be built under 1894 allotment.

Tile drainage.—In general the tiles were laid parallel to the line of the levee, near its rear base. The mains were designed to discharge into the existing open plantation ditches, and suitable cross drains were laid from the mains under the public road to secure outlets into these ditches.

The tile drains were estimated to secure the best results at a depth of about 3 feet below the natural surface of the ground, for the reason that the soil near the surface of the ground is generally porous, susceptible of easy percolation, and admits of greater transpiration than the body of an embankment built and compacted by the travel of teams. Owing to the shallowness of the plantation ditches into which they are made to discharge, the majority of the drains were placed near the surface of the ground. Where placed within a less depth than 1.5 feet below the natural surface they were laid a few feet within or under the base of the levee, to secure for them a sufficient covering as a protection against crushing by passing heavily loaded vehicles. The success of the tile drains would, in my opinion, be better assured if the plantation open ditches were of greater depth, for then the tiles could be placed at a lower elevation and given more inclination.

Muck or base ditches.—The plan practiced up to within one year ago of indiscriminately and universally cutting muck or base diches was, as was done last season, discontinued, such ditches being required to be dug only in localities where the surrounding conditions suggested the existence of hidden substances likely to eventually impair the integrity of the levee, and which called for removal.

Supervision.—The method of supervision employed consisted of 3 traveling surveyors, 1 at $125 per month, 2 at $100 per month each, whose duty it was to visit the several levees as required and execute all instrumental work. An inspector was placed in local charge of one or more levees, according to their proximity and his ability to properly supervise the work. It was the duty of the inspector to see that the general specifications and detailed instructions governing the work were properly executed, and to keep a daily journal or record of the force employed and other transactions at his levee; also to submit weekly reports of same. These men were paid $60, $75, or $90 per month, according to the number and size of levees under supervision.

Inspection.—From time to time, as the boats were assigned to duty under my direction, the steamers *Newton* and *Ruby* and tug *Comstock* and launch *Alaska* were used for short periods in making inspections of levees.

ATCHAFALAYA SECTION.

Allotment and disposition.—An allotment of $155,000 was made for levee work in this district for the fiscal year ending June 30, 1893, and $152,000 for the fiscal year ending June 30, 1894.

In accordance with the instructions received from you, lines for new levee were surveyed and staked at Barroza (823 R.), Belair (828 R.), Hickey Upper (841 R.), Medora (825 R.), and Fortville Lower (855 R.), for construction under 1893 allotment.

Construction.—Work was started on all of the above soon after receipt of notice that contracts had been made, except on Hickey Lower, which was omitted for lack of funds.

Large forces were employed and the contractors were generally energetic in prosecuting their contracts. The weather was favorable throughout the winter, and ssisted materially in the accomplishment before high water season of the large mount of work undertaken and commenced so late in the season.

By the 1st of March the embankment at the majority of the levees was completed. ll were completed by April 1. Much difficulty was experienced by the contractors n securing tiles for the drains.

Only a small supply was on hand at the factories tributary to this section. These vere soon exhausted, and the factories promptly set to burning more. In the meanime quantities of refuse, consisting of under-burnt, over-burnt, and misshapen iles, were sent or brought to the levees for placement by some of the factories, who ndeavored to take advantage of the inexperience of the contractors. Such tiles, f course, were rejected, resulting in the delay attending the receipt of new shipments. The delay in reception and placement of tiles is responsible for the long apse of contract time at most of the levees.

The contractors for the Hickey Upper Levee experimented with a mechanical device for constructing the embankment. While the principle appeared sound, the nachine contained many defects and weaknesses, resulting in frequent breakdowns nd consequent delays.

The contract for Hickey Upper Levee was annulled on January 23, 1893. A new out short levee was badly needed a short distance below Eliza (842 R.). It was warded to W. J. Bently & Co. by circular letter proposal, and work was promptly started.

Muck or base ditch.—Of the 17,164 feet of levee built in this district 1,500 feet of nuck ditch, measuring 4 feet at top, 2 feet at bottom, and 3 feet deep, was dug, being about 9 per cent of the total length of the line.

Surveys.—During November and December, 1892, and January and February 1893, surveys were made at the following places with a view of constructing such lines as night recommend themselves as necessary to be paid for under and to the extent of the 1894 allotment:

New Texas (786 R.), Picayuneville (795.5 R.), St. Francis Church (798 R.), Allendale (825 R.), Belle Vale (825.5 R.), Viola (827.5 R.), Missouri (840 R.), St. Delphine (840.5 R.), Medora Upper (851 R.), Rebecca (857 R.), Dunboyne Upper (865 R.), Belle Grove (870 R.), Celeste (872 R.), Mount Salem (872 R.), and Babin (879 R.).

Of the foregoing levees, St. Francis Church, Belle Vale, Missouri, Rebecca, Dunboyne Upper, Belle Grove, Celeste, Mount Salem, and Babin were placed under contract. Some of these works were commenced as early as March, 1893.

General effectiveness.—Depending on location (sometimes in bend, sometimes on a point, or again, owing to location, in reach), method of construction, and obstacles anticipated, which regulate the price of work, the tabular statement and summary does not furnish an accurate conception of the value and importance of the work executed respecting its relation to the levee system.

To better illustrate, it is further stated that, based on the lineal length of the river, the channel taken as the line of effectiveness, the 17,164 feet of embankment in this district represents 15,780 feet of actual protection. The lengths for individual levees will be found in a tabulated statement.

And, again, the general line of levee in this district on the basis of new grade and section is estimated to average 12 feet high. Taking the contents of embankment for that height as a basis, the 17,164 feet of embankment actually constructed represents 22,383 feet of levee if applied at other points where the average prevails.

Tile drains.—The minimum grade or inclination given tile drains in this district is 0.1 foot to the 100 feet. The longest line placed with the minimum grade is 1,132 feet; the shortest, 300 feet.

The maximum inclination is 0.3 foot to the 100 feet. The longest line placed on this grade is 368 feet; the shortest is 249 feet.

The average inclination or grade is 0.17 foot to the 100 feet.

Results of tile drains.—At the date of the closure of this report, May 31, the water is against all of the levees in this district under which tile drains have been placed.

An inspection of the tile drains disclosed that the discharge ends of the major portion of them had been choked with silt washed by rains from the embankments.

This was promptly corrected and the tiles cleared of all obstructions.

The drains are running freely everywhere, keeping the back slope of the embankment and the ground in the rear perfectly dry, indicating clearly the practicability and usefulness of such system of drainage.

At those levees, where no tiles were laid the seepage is free and the base ditches at the foot of the land slope have been dug to effect the removal of the seepage which was saturating the embankment.

Repairs.—The experience of previous years has shown the value of proper drainage of borrow pits, that no water may stand in them when the river returns to within its banks.

A large amount of standing water thrusts just so much additional weight upon the bank, keeps the bank saturated, and tends to aggravate caving. This standing water is further objectionable as it affords a harbor and breeding place for crayfish and other amphibious burrowing animals, well known and dangerous enemies to the integrity of a levee. The contracts for this year provide for the removal of this water. Where levees of this year adjoin levees of previous years' construction, in the borrow pits of which large quantities of water stood, ditches were cut by hired labor to effect drainage. This was done at Barroza (823 R.), Mayflower-Union (853 R.), and Fortville (855 R.).

The wave-washed slopes of Highland Extension (814.5 R.) and Mayflower-Union (853 R.) levees were restored and resodded by hired labor.

Abandonment and condition.—During the year all the Stewarts Crevasse Levee (791.5 R.), and a portion of Nina (806.5 R.), Barroza (823 R.), and Fortville (855 R.) levees were abandoned by construction of new levees. At the close of the year ending May 31, 1893, there are 123,462 feet of existing levee built in whole or in part by the United States in this district.

State and district board work.—During the year the following work was executed by the local authorities:

By the Atchafalaya Basin Levee board: New levees, 3.5 miles, 286,579 cubic yards, costing $57,405.78.

Enlargement 7.45 miles, 189,194 cubic yards, costing $30,682.40. A large amount of repairs, consisting of a large amount of cutting out crayfish holes, leaks, etc., and restoring wave wash was done at a cost of $38,750.37.

All work done by the State authorities in this district, amounting to about $30,000, was on the Bayou La Fourche levees.

In addition to the work stated above the Atchafalaya Basin Levee board spent a large amount of money on the Bayou La Fourche and Atchafalaya River levees.

Protection.—At the close of this report, May 31, the river is out of its banks and against all the levees. It still lacks an average of 3 feet of equaling the flood height of 1892, but the indications all point to a higher river than now exists.

As a preliminary step in the direction of protection service barges having on each 1,500 empty sacks have been stationed at Bayou Sara, Baton Rouge, Plaquemine, Donaldsonville, Lutcher. The tug *General Comstock* has also been placed under my direction for inspection purposes and to move the barges as may be required. The tugs and barges are not assigned for duty in this district alone, but will render service in both the La Fourche and Pontchartain districts.

The local authorities have organized and already a considerable amount of work has been done in the way of board revetment to arrest wave wash and the repair and reënforcement of the embankments where sloughing or leaks have appeared.

Their organization consists in the distribution of lumber, sacks, and nails at points throughout the district having the advantage of rail and river facilities for transportation.

All operations are conducted by parishes under the direct supervision of the levee board commissioner of the parish. Night and day guards have been stationed and patrol the weak and dangerous levees.

LA FOURCHE SECTION.

Allotment and disposition.—An allotment of $90,000 was made for levee work in this district for the fiscal year ending June 30, 1893, and a like amount for the fiscal year ending June 30, 1894.

In accordance with the instructions received from you, lines for new levees were surveyed and staked at Buena Vista-Minnie (896 R.), Jamestown (897 R.), St. James Church (901 R.), St. James Estate (902.5 R.), Home Place (905.5 R.), Providence (932 R.), Lone Star (941.5 R.), Davis (943 R.), and Fairfield (955 R.) for construction under allotment for 1893.

Construction.—Work was started on all the above soon after receipt of notice that contracts had been made except at Providence and Fairfield, which were omitted for lack of funds.

Large forces were employed, the weather during the winter was favorable, and the contractors, like those in the Atchafalaya section, were energetic and succeeded in completing the large amount of work undertaken well in advance of the spring flood.

All of the embankment in this district was completed before February 20, but full completion of the contracts was delayed on account of the tile drains, for same reasons and under similar circumstances as in the Atchafalaya section.

On or about January 27 P. J. Coffman, contractor for the Lone Star, left for parts unknown. He was diligently sought for, for a reasonable time. His absence was taken as an evidence of his abandonment of his contract and arrangements were made with Mr. Charles J. Reddy to complete the remaining 25 per cent of embankment, sodding of the entire levee, and placing of tile drains.

The oscillation of the river throughout this section averages about 25 feet. By the 1st of March the river was pretty generally out of its banks and standing several feet against the levees. Anticipating a prompt receipt of tiles, contractors for Buena Vista-Minnie and Lone Star levees had excavated the tile ditch. This became filled with seepage and rain water, rendering its sides and bottom soft and making it impracticable to construct the drains with any certainty of executing the work in such manner as to secure permanent results. At Lone Star 920 feet of tiles had been laid when operations were suspended.

As an experiment, the tiles at Buena Vista-Minnie were laid on 2 by 6 inch cypress boards to which was tacked two laths in horizontal position to create a groove, as it were, to maintain the tiles in position. The boards were in lengths of about 16 feet and where they joined a short length of plank was placed to provide against uneven settlement of the main boards. During April the river had receded sufficiently to reduce the seepage, and the work of laying tile drains at Lone Star levee was resumed and completed.

Muck or base ditches.—On the 27,316 feet of levee built in this district 2,720 feet of muck or base ditch, measuring 4 feet on top, 2 feet on bottom, and 3 feet deep was dug, being about 10 per cent of total length of lines.

Surveys.—During November and December, 1892, and January and February, 1893, surveys were made at the following places with a view to building such levees as might recommend themselves as necessary, to be paid for under and to the extent of the 1894 allotment: Cofield (889 R.), Melancon-Lemanville (893 R.), Brookstown (896.5 R.), Jamestown Lower (897.5 R.), St. Emma (904 R.), Magnolia (911 R.), White Rose (918 R.), Providence (932 R.), Flagtown (936.5 R.), Speranza (937 R.), Ashton (940 R.), and Coopersville (944 R.).

Of the above, Melancon-Lemanville, Jamestown Lower, St. Emma, Magnolia, White Rose, Providence, Flagtown, Speranza, and Ashton were placed under contract. Some of these works were commenced as early as April, 1893.

General effectiveness.—The 27,316 feet of levee built in this district represents 25,695 feet of actual protection, the channel of the river taken as the line of effectiveness. The lengths of individual levees will be found in tabulated statement.

The general line of levee in this district is estimated to average 10 feet high. If applied at points where the average prevails, the 27,316 linear feet of levee constructed would represent 28,525 linear feet.

Tile drains.—The minimum grade or inclination given tile drains in this district is 0.1 foot to the 100 feet. The longest line placed with the minimum grade is 1,378 feet; the shortest, 358 feet.

The maximum inclination is 0.5 foot to the 100 feet. The longest line placed with this grade is 435 feet; the shortest is 435 feet.

The average inclination or grade is 0.19 foot to the 100 feet.

Results of tile drains.—The same conditions existed as in the Atchafalaya Section, and the experience and observations relative to the tiles in place were similar.

Drainage.—For like reasons the same care was taken for effective drainage of borrow pits as was done in the Atchafalaya Section.

Repairs.—No levees or parts of levees having been previously built by the United States in this district, no work of this character was done.

State and district levee work.—During the year the following work was executed by the local authorities:

By the Lafourche Basin levee board: New levees, 2.84 miles; enlargement, 23.12 miles; total, 25.96 miles; 705,111 cubic yards, at a cost of $123,648.40. A large amount of repairs, consisting of cutting out crayfish holes, leaks, etc., restoring wave wash, and revetting, was done at a cost of $37,503.87.

By State authorities: New levees, 4.08 miles, 158,775 cubic yards, costing $19,870.48; enlargement, 3.71 miles, 88,572 cubic yards, costing $10,490.23; total, 7.99 miles, 247,347 cubic yards, costing $30,360.71.

A considerable amount of work was executed by both the State and levee board on the Bayou Lafourche levees.

Protection.—The conditions in this district at the close of this report, May 31, are the same as in the Atchafalaya district, except that the river lacks an average of about 2 feet of being as high as 1892 water, and similar preliminary steps for protection service has been taken.

The organization and method of execution of protection work by local authorities is also the same as in that district.

PONTCHARTRAIN SECTION.

Allotment and disposition.—An allotment of $150,000 was made for levee work in this district for the year ending June 30, 1893, and an allotment of same amount for fiscal year ending June 30, 1894.

In accordance with the instructions received from you, lines for new levees were surveyed and staked at Burtville (847 L.), Oakley to St. Gabriel (862 L.), Dicharry

Lower (883 L.), Burnside (891 L.), Union Upper (893 L.), Union Lower (893 L.), Tippecanoe (894 L.), Peytavin (894.5 L.), Whitehall (895 L.), Tessier (909.5 L.), E— (916.5 L.), Anchor (928.5 L.), and Trudeau (949 L.).

Construction.—Work was started on all of the above soon after receipt of notice that contracts had been made except on Anchor, which it was considered advisable to omit, and which accordingly was not advertised.

A balance remains unapplied. At later dates contracts were made for the construction of levees at Lopez (844.5 L.), Jolisant (858 L.), Towles (851 L.), and Bil— (852.3 L).

Large forces were employed everywhere but at Trudeau, and the contractors were generally energetic in the prosecution of their contracts. Favorable weather was experienced and by March 10, 1893, all embankment was completed.

As in the other districts, much difficulty was experienced in securing acceptable tiles, and to the delay in their receipt must be credited the extended dates at which levees were fully completed.

Several shipments of inferior tiles were received at levees in this district and were rejected as a whole.

During the last week in January, P. J. Coffman, the contractor for Trudeau Levee, disappeared and inquiry failed to determine his whereabouts.

But a small force was employed and the work was far behind. Repeated notifications, calling for additional force, had no effect. The contract was to expire on February 15, 1893. As that date approached the river was rising rapidly and it was a question if the levee could be completed before the river left its banks. The new and existing levee lines are too close together to admit of sufficient building material being obtained during the wet season between the two. The anticipated breach in the existing levee had not occurred; the banks were in good condition and examination of them justified the opinion that it would be wiser to let the completion of the levee remain over until the succeeding season than to use the existing levee, which would have to be done, and in the face of a rising river. The Trudeau contract was therefore allowed to expire by limitation. No extension was granted and when operations were suspended the levee was between 35 per cent and 40 per cent completed.

Muck or base ditches.—On the 45,452 feet of levee built in this district 1,100 feet of muck or base ditch, measuring 4 feet on top, 2 feet on bottom and 3 feet deep, was dug, being about 4 per cent of the total length of the lines.

Surveys.—During November and December, 1892, and January, February, and March, 1893, surveys were made at the following places with a view of constructing such lines as might be considered necessary, to be paid for from the 1894 allotment:

Shannon Lower (837 L.), Conrad (840 L.), Ben Hur (846 L.), Towles to Billings (851.5 L.), Plaquemine Point (854 L.), Lorio (867 L.), Point Clear (867.5 L.), Maryland (827 L.), Rescue (847 L.), Southwood Upper (847.7 L.), Belle Helene (879 L.), Houmas (890.05 L.), Hester (908.5 L.), St. Elmo (910 L.), Poche (911 L.), Angeline (915 L.), Terre Haute (921 L.), and Prospect (936 L.).

Of the foregoing levees, Shannon Lower, Maryland, Rescue, Southwood Upper, Belle Helene, Houmas, Hester, St. Elmo, Poche, Terre Haute, and Prospect were placed under contract.

Some of these works were commenced as early as February, 1893.

General effectiveness.—The 45,452 feet of levee built in this district represent 48,436 feet of actual protection, the channel of the river taken as the line of effectiveness. The lengths for individual levees will be found in tabulated statement.

The general line of the levees in this district is estimated to average 10 feet high. If applied at points where the average prevails, the 45,452 linear feet of levee constructed would represent 48,000 linear feet.

Tile drains.—The minimum grade or inclination given tile drains in this district is 0.1 foot to the 100 feet. The longest line placed with the minimum grade is 1,5— feet; the shortest is 325 feet.

The maximum inclination is 0.6 foot to the 100 feet. The longest line placed with this grade is 390 feet. The shortest, 390 feet.

The average inclination of grade is 0.22 foot to the 100 feet.

Results of tile drains.—The same thing is to be said relative to observations and results of tile drains in this district as is reported for the Atchafalaya and Lafourche districts.

Drainage.—As in the two preceding levee districts, the same care was exercised to secure proper drainage of borrow pits.

Repairs.—The levees previously built by the United States in this district were generally in good condition and required no extensive repairs. Owing to difference of the method of construction of the several portions of the levee, about 1,800 feet of the Woodstock (847.5 L.) levee and all of the Union (893 L.) and Irvine (894.2 L.) levees had settled unevenly both on top and sides.

These levees were raised about 1.5 feet, and the slopes correspondingly filled out to bring the whole to a uniform grade and section; the work being executed by a force employed under open-market agreement, that being the most advantageous method of doing the work.

Drainage ditches for the removal of water from the borrow pits at Woodstock (847.5 L.) levee were dug by hired labor.

At the Trudeau levee, abandoned by Contractor Coffman, a drainage ditch had been cut along the inside base of the existing levee to secure drainage into the river. The two outlet ditches were refilled by the agents of the contractor who had cut them. On March 8, during a storm, one of them washed out and occasioned a small crevasse. I was notified almost immediately, went to the locality with lumber and sacks and in a few hours had the water shut off and the place made secure.

It was considered that the drainage ditch in the rear of the existing levee had weakened it and trouble would be occasioned by it in the event of a high stage of river. Consequently the U. S. quarter boat *Delta*, with a force averaging 50 men, was sent to the Trudeau levee and employed from March 28, 1893, to April 6, 1893, in draining the ditch, refilling and tamping it, which fully restored the integrity of the levee as far as it had been impaired.

ABANDONMENT AND CONDITION.—During the year all of Bourgeois Section (910 L.) and portions of the Woodstock (847.5 L.), Hermitage (850 L.), Southwood (875.5 L.), Dicharry (882 L.), Union (893 L.), Irvine (894.2 L.), and Tessier Section (969.5 L.) were abandoned by construction of new levees. At the close of the year ending May 31, 1893, there were 133,030 feet of existing effective levee built in whole or in part by the United States in this district.

STATE AND DISTRICT BOARD WORK.—During the year the following work was executed by the local authorities:

By the Pontchartrain Basin Levee Board: New levee, 3.57 miles, 448,810 cubic yards, costing $125,644.82; enlargement, 20.12 miles, 276,075 cubic yards, costing $64,388.08; total 23.69 miles, 724,885 cubic yards, costing $190,032.90. A large amount of repairs, consisting of cutting out crayfish holes and leaks, restoring wavewash, and strengthening wooden revetment, was done at a cost of $38,626.87.

By State authorities: New levees, 1.55 miles, 76,345 cubic yards, costing $9,008.71; enlargement, 3.01 miles, 69,785 cubic yards, costing $8,234.63; total, 4.56 miles, 146,130 cubic yards, costing $17,243.34.

Protection.—At the close of this report, May 31, the river lacks an average of about 2.5 feet of being as high as the water of 1892.

The same preliminary steps for protection service have been taken in this district as are defined in report for Atchafalaya District.

The local authorities are also organized and working in the same manner as described in that report.

Simmesport Levee (under the appropriation for improving Red and Atchafalaya rivers).—It was considered advisable to repair and strengthen this levee, and $800 was allotted for the purpose to cover the cost of work, supervision, incidentals, etc. Circular letter proposals were invited, and the contract awarded to E. W. Hanlon & Co.

An inspector who could run levels and measure the work in progress as well as otherwise supervise the repairs was stationed at the levees in local charge.

Work was commenced on January 4, 1893. Only a small force was operated, and work was commenced on February 18, 1893.

The work consisted of cutting out and refilling all leaks. Where there was a succession of leaks forming a continuous line or chain, the entire levee was cut away and a ditch of 5 feet deep sunk through the natural ground to cut and close up all leaks beneath the surface. The embankment was rebuilt to a grade of 2½ feet higher than the 1892 water, 6-foot crown, river slope 3 to 1 and land slope of 2½ to 1. This made the section of the levee so rectified approximately three times larger than it previously was.

Of the 1,300 feet of levee, 438 feet were rectified, embracing 3,669.89 cubic yards, which was all that could be accomplished with funds available.

Very respectfully, your obedient servant,

W. J. HARDEE,
Assistant Engineer.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

REPORT OF SURVEYOR JOHN SMYTH, JR., IN LOCAL CHARGE OF THE LAKE BO AND BARATARIA LEVEE DISTRICTS.

NEW ORLEANS, LA., *May 31,*

SIR: I have the honor to submit the following report on the surveys, con tion and repair of levees, Barataria and Lake Borgne levee districts, for the year ing May 31, 1893.

Assistant Engineer W. G. Price was in local charge of these districts until F ary 17, when he was granted leave of absence.

I was assigned to duty as surveyor in these districts on December 8, 1892, February 17 I was directed to take local charge, relieving Mr. Price.

June 1, 1892, no work had been done in these districts by the United States.

SURVEYS AND INSPECTIONS.

The board of district officers on building and repairing levees, Mississippi Ri accompanied by the chief of Louisiana Board of State Engineers, passed thr these districts on the U. S. steamer *Titan* between August 26 and August 28, making personal examination of localities where it was proposed to apply the all funds.

On September 2, 1892, Assistant Engineer W. G. Price and Surveyor A. F. Wo jr., reported at New Orleans, La., for duty in these districts, and commenced ins tion of existing levees. Mr. Woolley was transferred to other works on Decem 8, 1893.

On September 26, 1892, a decked barge from the New Orleans Harbor was tr ferred to these districts and fitted up as temporary quarter boat for use of su party then engaged in staking out lines for proposed new levees. This quarter b was kept in service until January 23, 1893, when it was returned to New Orlea Harbor, and survey party was reduced to one surveyor and one rodman with Ass ant Engineer Price in local charge.

Lines were staked out for the following proposed levees, new and enlargeme Slaughter House (968.5 L.), Bonzano (969 L.), Chalmette Cemetery (969.5 L.), boushel (970 L.), Pecan Grove (973 L.), Story Upper (974 L.), Story Lower (975 L. Repose (976 L.), Cærnarvon (979 L.), Orange Grove Upper (980 L.), Orange Gr Lower (980 L.), Magnolia (980.5 R.), Fort St. Leon Upper (981.5 R.), Fort St. L Lower (982.5 R.), Belle Chasse (983 R.), Belle Chasse Crevasse (984 R.), Belle Cha to Concession (985 R.), Concord (987 R.), Oak Point (988.5 R.), Oakville (990.5 R. Live Oak (991.5 R.), Happy Point (994 R.), Star (998 R.), Ironton (1,002.5 R.), Oa land (1,006 R.).

Preliminary surveys were made for the following levees to be built with funds the fiscal year ending June 30, 1894: Battle Ground (969.5 L.), Irving (976 L. Orange Grove (979 L.), English Turn (982 L.), St. Clair (983 L.), Mon Plaisir (984 L. Magnolia (980.5 R.), Kearney (983 R.), St. Anne (984.5 R.), Deboushel Dobard (99 R

BARATARIA DISTRICT—CONSTRUCTION.

Magnolia Levee (*980.5 R.*).—This consists of two pieces of enlargement. Upp section 4,570 feet long and lower section 1,000 feet long. There is a line of levee 2,100 feet long between these sections which it was contemplated to enlar but owing to lack of funds and tendency of river bank to cave along this line, wo was abandoned, nothing having been done except clearing.

One thousand nine hundred and five and two-thirds linear yards of 6-inch poro tiles were put in toe of land slope where levee was enlarged. Maximum depth tiles below surface of ground is 4.9 feet, minimum 2 feet, mean 2.4 feet; maxim slope per 100 feet 0.40 foot, minimum 0.10 foot, mean 0.15 foot. These drains ha outlets as follows: At Station 4, double; at 19 plus 90, double; 23 plus 92, sing 35 plus 50, double; 39 plus 90, 66 plus 10, double.

Four thousand two hundred and thirty-nine linear feet of revetment, in accord ance with plan hereafter described, was built on new slope of levee as follow From Station 5 plus 11 to 21 plus 22, 1,528 feet; 25 plus 67 to 42 plus 9, 2,024 feet; plus 91 to 69 plus 72, 686 feet. This revetment is still in good condition, though 4 to 1 slope of embankment has been washed in places by waves from passin steamers.

Fort St. Leon Upper (*981.5 R.*).—This is a new line. The old levee abandoned b this line is of low grade and inferior section.

Six hundred and twenty-eight and two-third linear yards of 6-inch porous til were put in toe of land slope. Maximum depth 2.7 feet, minimum 1.4 feet, mean 2 maximum slope per 100 feet 0.2 foot, minimum 0.1 foot, mean 1.7. This drain has three double outlets, one at 2 plus 97, one at 9 plus 48, and one at 15 plus 40.

Revetment was not built on this levee as embankment is protected from serious wash by willows and high batture.

Fort St. Leon Lower (*982.5 R.*).—This is a new levee built back of an old and insufficient embankment which was too near the river bank to justify the enlargement.

Two hundred and eighty-five and one-third linear yards of tile drains were put in the toe of the land slope. Maximum depth 3 feet, minimum 2 feet, mean 2.5 feet; mean slope per 100 feet 0.1 foot. Outlets as follows: One at 2 plus 50 single, one at 5 plus 40 double. Revetment omitted for similar reason as at Fort St. Leon Upper.

Belle Chasse Crevasse (*983 R.*).—This levee consists of 650 feet of enlargement above and below bank, and 92 feet of new levee across opening. It was built on original line of old levee to close crevasse of 1892.

Two hundred and seventy-one linear yards of tiles drains, 6-inch porous, were put in toe of land slope; maximum depth 2.5 feet, minimum 2 feet, mean 2.1; maximum slope .20 foot, minimum .10 foot, mean 0.18 foot. This drain has two single outlets, one at 203 and one at 208 plus 65.

Levee is protected from wave wash by dense growth of willows and batture revetment was therefore omitted.

Belle Chasse to Concession (*985 R.*).—This consists of three sections. Upper line is a new section 641 feet long, built back of an old embankment which is immediately on river bank. Openings were made in old levee to drain borrow pits into river. No embankment built on this section as new is protected by old levee. Middle section is 4,918 feet of enlargement and 416 feet of new levee. Lower section is 3,700 feet of enlargement. Owing to difficulty in procuring earth on account of baggase on batture in front of Belle Chasse Sugar House, extension of time of completion was granted. Old levee was cut down prior to enlargement, in both middle and lower sections.

Thirty-four hundred and four and two-thirds linear yards of 6-inch porous tiles were put in toe of land slope; maximum depth 4 feet, minimum 1.8 feet, mean 2 feet; maximum slope per 100 feet 0.20 foot, minimum 0.10 foot, mean 0.20 foot. These drains have outlets as follows: Upper section, one double outlet at 2 plus 80; middle section, one single outlet at 273 plus 40, one double outlet at 275 plus 80, one single outlet at 280 plus 90, one double outlet at 285 plus 70, one single outlet at 3 plus 80, one double outlet at 0 plus 40, one double outlet at 2 plus 80, one double outlet at 18 plus 50, one double outlet at 25 plus 90, one double outlet at 34 plus 60; lower section, one double outlet at 67 plus 60, one single outlet at 69, one single outlet at 74, one single outlet at 89, one single outlet at 94.

Eight thousand one hundred and seventy-four linear feet of revetment was built on river slope of levees as follows: from 269 plus 50 to 37, 5,280 feet; from 65 to 92, 2,894 feet. This revetment is in good condition though the 4 to 1 slope of the embankment has been washed in many places and slight wash has occurred on embankment inside of revetment between stations 30 and 31. The lumber used in constructing the revetment was green and since drying there are places of about three-eighths inch between planks, through which water ebbs and flows. The height of revetment is about 4 feet, top being about even with net grade of embankment.

Concord Levee (*987 R.*).—This is a new levee built back of an old and insufficient embankment which was raised with mud box to withstand high water of 1892, and was so near river bank as to justify enlargement. Owing to bad weather and accumulation of sipe water in borrow pits extension of contract time for completion was recommended.

Old front levee is still intact, but as there are many crayfish holes through it the water in borrow pits has, since completion of new line, assumed level of that in the river.

This work was commenced with small force, on December 23, 1892, but owing to bad weather it was abandoned after little had been done. Work was not resumed until February 1, 1893, when the river had risen to within 1 to 2 feet of surface of batture, making the obtaining of earth therefrom very difficult.

On March 4, 1893, U. S. quarterboat *Delta* with force of 55 wheelbarrows was put on this levee to insure completion before usual flood season. This force, together with that of the contractor, was employed in embankment construction until March 25, 1893, when quarterboat was needed on delinquent work above New Orleans.

Embankment here being within 1 to 1½ feet of gross grade and old levee still intact, all was considered safe and quarterboat with the force thereon was moved elsewhere. Levee was finally completed on April 21, 1893.

Nine hundred and forty-three and two-thirds linear yards of 6-inch tile drains (porous tiles) were put in toe of land slope; maximum depth 3.6 feet, minimum 2.0 feet, mean 2.8 feet; maximum slope per 100 feet 0.20 feet, minimum 0.10 feet, mean 0.14 feet. This drain has five double outlets as follows: At 2 plus 70, 6 plus 30, 14 plus 60, 19 plus 60, 23 plus 70; new levee protected by old; revetment omitted.

Oak Point Levee (*988.5 R.*).—This is a new levee built back of an old one which was too near the river bank to justify enlargement. Embankment was completed within contract time, but extension was granted until March 10, 1893, as tile fact- unable to furnish tiles owing to a freeze during January, 1893, having ca- loss of two kilns of tiles while drying.

Seven hundred and eighty-six and two-thirds linear yards of porous til- 5-inch, 6-inch, and 7-inch, were put in a toe of land slope, the size of tiles in- as they neared the outlets; maximum depth 2.6 feet, minimum 2 feet, mean 2. maximum slope per 100 feet 0.40 foot, minimum 0.10 foot, mean .12 foot. Th- has three double outlets. One at 3 plus 83, one at 13 plus 44, and one at 2- This is the only place in the district at which tiles of different sizes were u- while all tiles put in at other levees seem to be draining very well, I am believe that there may be some advantage in increasing size of tiles toward especially in the case of a long drain with few outlets. New levee is prote- old one. Revetment omitted.

Live Oak Levee (*991.5 R.*).—This consists of two sections. Upper section largement 400 feet long, and being only preparatory work the old line was down.

Lower section is new levee 844 feet long, built back of an old and insuffici- bankment which was too near river bank to justify enlargement. There is a of 830 feet of old levee between these sections which is of moderately good and height, and has been revetted lately by the local district levee board.

Three hundred and twenty-six and two-thirds linear yards of 6-inch poro- were put in toe of land slope of lower section; maximum depth 2.7 feet, mum 1.9 feet, mean 2.1 feet; maximum slope per 100 feet 0.20 foot, minimum foot, mean 0.11 foot. This drain has one outlet at 7 plus 40.

Eight hundred and thirty eight linear feet of revetment was built along the slope from 0 to 8 plus 44, entire length of lower section. Upper section is pr- from serious injury by high batture.

Happy Point Levee (*994*).—This consists of 414 feet of enlargement and 1,3- new levee, continuous line. Portion of old levee abandoned was used in c- struction of the new line.

Five hundred linear yards of 6-inch porous tiles were put in toe of land maximum depth 3.1 feet, minimum 2 feet, mean 2.1 feet; maximum slope p- feet 0.20 foot, minimum 0.10 foot, mean 0.14 foot. This drain has two o- double, one at 8 and one at 11. Revetment omitted, high batture in front.

LAKE BORGNE LEVEE DISTRICT—CONSTRUCTION.

Slaughter-house Levee (*968.5 L.*).—This is enlargement built on line of old after the same had been cut down.

Two hundred and thirty and thirty-three one-hundredths linear yards of porous tiles were put in toe of land slope to carry off the sipe water. Maximum of tiles below surface of ground is 3.7 feet, minimum 1.4 feet, mean 2 feet. Mea- of drain per 100 feet is 0.15 foot. This drain has but one outlet, which is lower end of the line.

Seven hundred and sixteen linear feet of revetment was built on river sl- levee from 0 plus 7 to 0 to 7 plus 16. This revetment is in good condition, al- the 4 to 1 slope (of levee) outside of revetment has been washed away.

Roy Levee (*969 L.*).—This is a new levee, built immediately back of an ol- insufficient embankment. Old levee was used in construction of new. The new runs along the original line of Chalmette Cemetery shell road, and much tim- consumed in removing shells, which necessitated extension of contract tim- completion. However, after shells were removed work progressed favorably.

Three hundred and eighty-seven linear yards of 6-inch tiles were put in land slope; maximum depth 3.0 feet, minimum 2 feet, mean 2.2 feet; mean per 100 feet 0.10 foot. This drain has one double outlet at 0 plus 50, near upp- of line.

Eleven hundred and forty-three linear feet of revetment was built on river slope 0 to 11 plus 39. This revetment is in good condition, excepting at 0 plus 20, wher- 12-inch planks in facing have been washed loose at foot. The top of this reve- is about 6 feet below net grade of embankment. It was so constructed th- posts and facing might find good footing in solid ground. Notwithstanding the above-mentioned slight damage has been done, principally by waves from ing steamers, and the 4 to 1 slope on the river side of revetment has been wa- away along the entire line.

Bonzano Levee (*969 L.*).—This is a new levee and, like Roy, was built back of a- one. It crosses Chalmette Cemetery shell road in two places, but removal of did not cause much delay in progress of work. Old levee was used in constru- of new.

Three hundred and twenty-seven linear yards of 6-inch porous tiles were p- toe of land slope; maximum depth 2.2 feet, minimum 2 feet, mean 2.1 feet; me ope per 100 feet 0.10 foot. This drain has one double outlet 96 feet from upper end f line.

Six hundred and eighty-two and one-half linear feet of revetment was built on ver slope from 0 to 6 plus 83. This revetment is in good condition, though the 4 to slope of levee has been washed badly in places.

Chalmette Cemetery Levee (*969.5 L.*).—This consists of 300 feet of enlargement and 32 feet of new levee. Old levee was used in construction of new.

Two hundred and ninety-four linear yards of 6-inch porous tiles were put in toe f land slope; maximum depth 3.1 feet, minimum 1.8 feet, mean 2 feet; maximum ope 0.20 foot, minimum 0.10 foot, mean 0.12 foot. This drain has two double outts, one at 2 plus 60 and one at 6 plus 75.

Eight hundred and seventy-seven linear feet of revetment was built on river slope, rom 0 to 8 plus 82. This revetment is in good condition, and owing to the high atture in front little damage has been done to the 4 to 1 slope. Top of revetment about level with net grade of embankment.

Deboushel Levee (*970 L.*).—This is a new levee, built immediately back of an old mbankment, 125 feet of which had caved into the river. Remaining portion was sed in the construction of new work.

Two hundred and fifty-one and sixty-six one-hundredths linear yards of 6-inch orous tiles were put in toe of land slope, of maximum depth 2.5 feet; minimum, feet; mean, 2.2 feet. Maximum slope per 100 feet is 0.20 feet; minimum, 0.10 feet; ıean, 0.14. This drain has two double outlets, one at 0 plus 63 and one at 5 plus 66.

Six hundred and seventy-eight and seventy-five one-hundredths linear feet of evetment was built on river slope from 0 to 6 plus 98. This revetment is in very ood condition, although the 4 to 1 slope of embankment has been washed away. 'he top of this revetment is about 0.8 feet below grade of embankment, and stood riginally about 3.2 feet above ground. Now in many places as much as 6 feet of acing stands above ground on the river side.

Pecan Grove Levee (*973 L.*).—This consists of 730 feet of enlargement and 732 feet f new levee. Old levee was used in construction of new. This levee is protected y high batture and willows; revetment omitted.

Story Upper Levee (*974 L.*).—This is enlargement of an old levee after the same had een cut down; protected by willows, high batture, and remains of an old levee in ront; revetment omitted.

Story Lower Levee (*975 L.*).—This consists of 3,498 feet of enlargement and 1,185 eet of new levee. Old levee abandoned by new was used in construction. When nlarged it was cut down prior to placing of new earth. This levee, like Story Upper, is protected from serious wave wash; revetment omitted.

Repose Levee (*976 L.*).—This is a new levee, built back of an old embankment which was too near the river bank to justify enlargement. Old levee was used in the contruction of the new. This levee is partially protected from wave wash by high atture at upper end of line. It should, however, have been revetted but for lack f funds.

Orange Grove Upper Levee (*980 L.*).—This is a new levee, built back of an old and nsufficient embankment which was raised with mud box to withstand the high water of 1892, and too near the river bank to justify enlargement. Old levee is till standing, but, owing to its being practically honeycombed by crayfish, serves only to prevent wave wash of new embankment; revetment omitted.

Orange Grove Lower Levee (*980 L.*).—This is a new levee, built back of an old mbankment which was immediately on the river bank. Openings were made in he old levee to drain borrow pits into river. Old levee still standing; revetments mitted.

REPAIRS.

Slaughter-house extension (*968.5 L.*).—Raising and enlarging levee 1,826 feet long; verage net fill 1.5 feet. Crown is now 8 to 10 feet wide; slopes approximate 2½ to 3 o 1. Approximate amount of earth placed on this levee is 3,037 cubic yards. Cost o United States, including 784 linear feet temporary revetment and 1,381 linear feet of 3-wire fence, $1,171.64. This work was done by force on the U. S. quarter boat *Delta*. The wire fence was built along toe of land slope to protect levee from being njured by cattle going to and from stock landing.

Where revetment was built the following plan was adopted: The facing was made of planks 8 feet long, 1¼ inches thick, and not more than 12, nor less than 6 nches wide. These were nailed to two rails 2 inches by 6 inches by 18 feet, one lush with and one 4 feet below top of facing. The rails were firmly nailed to 3-inch by 4-inch by 9-foot posts driven 9 feet apart in river slope of levee at a point 12 feet rom center line of embankment. These posts have each one brace 2 inches by 6 inches by 13 feet, which extends 6 inches over top rail of revetment facing and notched to it down over top rail, thereby giving more strength to resist pressure from river side. The braces were nailed to posts, the upper edge of brace being about flush with top of post. The other end of brace was nailed to stakes driven (... inches by 3 feet) in center of crown on opposite sides of brace. There was a stake driven 1 foot to land side of center of crown and against end of ... butting stake, in order that any jar received by revetment facing from floa... etc., might not be thrown entirely upon nails in the two stakes before me... After facing posts and braces had been securely fixed in place an additional ra... inches by 18 feet, was nailed on outside of and flush with top of facing to ... planks forming the same being easily removed.

Nails used in securing braces to posts and stakes and rails to posts were ... wire nails; those used in securing facing to rails were 16-penny wire nails. L... used was sound cypress, free from shakes or loose knots.

Plan of construction.—A trench was dug in river slope of levee 12 feet from ... line, about 1 foot wide and 2½ feet deep. The side of trench against which re... was to rest was made straight and of proper slope, *i. e.*, 1 foot to 8 feet. Pos... placed in trench and driven 2 feet into earth which had not been disturbed. ... nailing on the two rails the boards for facing were driven about 1½ feet below ... of trench; braces, etc., were fixed in place, and trench filled with earth tho... tamped.

No batting was used on seams in facing, planks having been leveled at p... driven closely.

When embankment was over 7.5 feet net height revetment was lowered in ... that facing might be driven into original earth. This proved successful, for in ... cases the 4 to 1 slope has been entirely washed away.

LEVEES 1893–'94, BARATARIA LEVEE DISTRICT.

Magnolia Levee (980.5 *R.*).—This consists of two sections. Upper section i... a new levee, approximately 2,130 feet long, connecting Magnolia Upper and L... levees of 1892–'93.

Lower section is to be enlargement, approximately 636 feet long, connecting M... nolia Lower and Fort St. Leon Upper leevees of 1892–'93.

Fort St. Leon Middle (982 *R.*).—This as originally intended was 3,300 feet ... largement, connecting Fort St. Leon Upper and Lower levees of 1892–'93.

Kearney Levee (983.5 *R.*).—This is to be a new levee approximately 2,010 fee...

St. Anne Levee (984.5 *R.*).—This is to be enlargement, approximately 2,0... long. It will connect middle and lower sections of Belle Chasse to Conc... Levee of 1892–'93.

Belle Chasse (983 *R.*).—This is to be a new levee approximately 5,462 feet lo...

Oakville Levee (990.5 *R.*).—As originally surveyed, this consists of 3,493 ... new levee line and 1,500 feet of enlargement, making a total of 4,993 feet.

Dobard Levee (992 *R.*).—This is to be a new levee 2,896 feet long.

Star Levee (998 *R.*).—This is to be enlargement 5,568 feet long.

Ironton Levee (1002.5 *R.*).—This is to be enlargement, approximately 2,84... long.

Oakland Levee (1006 *R.*).—This as now contemplated will be two pieces of enl... ment, one 1,050 feet long and one 1,840 feet long, separated by 200 feet of old ... which is of good section and moderately good height. Total length of line ... feet.

LEVEES 1893–'94, LAKE BORGNE LEVEE DISTRICT.

Battle Ground Levee (969.5 *L.*).—This as now contemplated will consist of fou... tions as follows: Enlargement, approximately 415 feet long, connecting Ro... Bonzano Levees of 1892–'93. Enlargement, approximately 340 feet long an... levee approximately 1,000 feet long, connecting Bonzano and Chalmette Ceme... levees of 1892–'93. New levee, approximately 332 feet long, connecting Chal... Cemetery and Deboushel levees of 1892–'93. New levee, approximately 1,6... long, and enlargement, approximately 1,489 feet long, running from lower e... Deboushel Levee of 1892–'93 down to Sugar House Point.

Irving Levee (976 *L.*).—This will consist of approximately 4,625 feet of new le... and 800 feet of enlargement. This levee runs from lower end of Story Lower Le... of 1892–'93 down to Lake Borgne Canal. Work was commenced on lower porti... this levee on April 12, 1893, with small force and has progressed favorably. A... 20,000 cubic yards of earth has been put in place.

Caernarvon Levee (979 *L.*).—This is to be a new levee 2,100 feet long.

Orange Grove Levee (980.5 *L.*).—This consists of two pieces of new levee, one 1... feet long, connecting Orange Grove Upper and Lower levees of 1892–'93, and one ... feet long connecting Orange Grove Lower Levee of 1892–'93 with large State l... just below.

English Turn Levee (982 *L.*).—This is a new levee 2,660 feet long.

Work was commenced on this levee April 17, 1893, and finally completed May 29, 1893.

St. Clair Levee (*983 L.*).—This levee as staked out is a new levee 7,332 feet long, 6,219 feet on batture and 1,113 feet back of existing levee.

Mon Plaisir Levee (*984 L.*).—This is to be a new levee 2,780 feet long.

HIGH-WATER PROTECTION.

At date of this report the river reached a stage of 16.1 feet at New Orleans, 1.5 feet below highest previous record.

BARATARIA LEVEE DISTRICT.

Defects in levees so far developed are as follows:

Magnolia Levee (*980.5 R.*).—Some sipage through levee near upper end of line caused by defective plantation drain ditches into which tiles along toe of slope empty. There is a supposed crayfish leak in lower section of this levee, and as it seemed to be washing, work was commenced May 30, 1893, and flow of water stopped May 31, 1893, cost of labor being $49. Large leak in old line just above here was stopped, cost of labor being $18.50.

Belle Chasse Crevasse Levee (*983 R.*).—There is a crayfish leak at about Station 208 plus 40, discharge was clear though strong. Some earth was put in on river side of levee by planters, and flow of water has been lessened.

At a point about 1,000 feet below the Belle Chasse Crevasse Levee there are a number of crayfish holes. Loose earth was put in on river side, and crib built on land side and filled with earth. This was done by plantation owner, and result is satisfactory at present stage of the river.

Belle Chasse to Concession Levee (*985 R.*).—Slight wave wash on upper section, and at a few points in middle and lower sections there is slight wash inside of revetment.

There are numerous crayfish leaks in State and district levees from Concession plantation down to end of lower line. The worst place is about 400 feet above Junior, Plaquemines Parish, in State levee. The embankment is small and very much softened by water. Some work has been done by planters in the vicinity but have not visited the levee since.

Disposition made for protection work.—The U. S. tug *Tilda* was assigned for use in this district during high water. A large decked barge from New Orleans Harbor, loaded with lumber and sacks, was on May 20 towed by tug *Tilda* to Story Lower Levee (974 L.) in the Lake Borgne Levee district, and will be used whenever necessary.

Four hundred sacks had been previously distributed at various points in the district and on May 30, 1893, took one thousand sacks with wheelbarrows and shovels from New Orleans Harbor for use at Magnolia Levee (980.5 R.).

Local boards have inspectors along entire line and cars loaded with lumber and sacks stationed at different points throughout the district.

HIGH-WATER PROTECTION, LAKE BORGNE LEVEE DISTRICT.

Defects in levees so far developed are as follows:

Slaughter-house Levee Extension (*968.5 L.*).—Wave wash from passing steamers has damaged the temporary revetment, and in consequence the levee has been badly washed in several places. However, sacks of earth were placed wherever washed seriously, and there seems no longer any danger at present stage of the river. This work was done by citizens in the vicinity.

Roy Levee (*969 L.*).—Revetment has been slightly damaged by waves from steamers, and embankment has been slightly washed. Sacks of earth have been put in by citizens to prevent further injury to levee.

Pecan Grove Levee (*973 L.*).—Some crayfish leaks have developed; the largest has been worked on by railroad hands. Cribbing was built on river side of embankment and filled with loose earth. The result is not satisfactory.

Story Upper Levee (*974 L.*).—Some crayfish leaks near lower end of line and slight wave wash near Story crevasse of 1892, but so far nothing serious.

Story Lower Levee (*975 L.*).—Slight wave wash between Stations 1 and 8. State levee about 2,000 feet above Mexican Gulf Canal; shows some small crayfish leaks.

Repose Levee (*976 L.*).—Slight wave wash. Large crayfish leak in State levee, near store on Caernarvon plantation, has been stopped with crib on the river side; filled with loose earth. This was done by planters in the vicinity.

Much sipage and many small crayfish leaks from Caernarvon to Stella plantation, State levee. At Stella the front levee has badly washed by waves from steamers. In two places wash extends almost to land edge of crown, and revetment so damaged

as to be practically worthless. However, there is an old abandoned levee ab
to 250 feet back that might be held should front levee give away.

The same plan in the distribution of inspectors and material for levee pro
by local authorities as in the Barataria Levee district.

U. S. barge A, transferred from New Orleans harbor, with material there
been used in this district. The U. S. tug *Tilda* used for towing and trips of
tion.

Disposition made for protection work.—The same plan in distribution of
by local boards, as in the Barataria district. United States barge with ma
thereon will be used in this district also. Tug *Tilda* used for towing and
inspection.

Owing to limited funds in this district no work by Government force has
done. Assistance rendered to local authorities will consist principally of tow
the furnishing of expendable material. Eleven hundred sacks have alread
distributed in this district.

Very respectfully, your obedient servant,

J. SMYTH, JR.,
Surv

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

FLOOD OF 1893.

At the date of this report the water at Vicksburg has reached the extreme h
of 48.3 feet, 0.8 foot less than the record for 1890, and exceeding the highest
of 1891 by 0.2 foot, while it is 0.1 foot less than the highest point reached in
Recent large crevasses in the Middle Tensas Levee district have however affor
least temporary relief to the river below, and a fall of over a foot and a hal
taken place at Vicksburg.

In anticipation of a dangerous flood the following instructions were issued t
assistant engineer in charge of the Atchafalaya, La Fourche, and Pontchartrain L
districts:

In the event of the river reaching a dangerously high stage this season, the
lowing will be the general plan of operations in applying the funds available f
protection of levees in the Atchafalaya, La Fourche, and Pontchartrain Leve
tricts.

The large decked barges belonging to the Fourth district plant are to b
tributed at points accessible by rail and telegraph, which affords supplies o
and lumber, and from which the barges may be readily moved to threatened p
with a probability of downstream rather than upstream towing.

The points selected for the present are Bayou Sara, Baton Rouge, Plaquem
Donaldsonville, and Lutcher. Barges may be placed at intermediate points sh
necessity arise later.

On these barges will be placed a quantity of lumber and sacks to be read
immediate use.

You are instructed to provide for the care of the barges while waiting ca
their station, in the most economical manner practicable.

The tug *General Comstock* is also assigned for duty in connection with prote
work in the above-named districts, under your direction for purposes of to
barges, making inspections, etc. An additional tug or towboat will be provi
needed. The barges, tugs, and material are to be considered as available fo
protection service required, both on United States and on State levees, in coöpera
with the protection service of the State and district authorities. As it is impr
cable to assign barges for service exclusively on one side of the river only it wil
be expedient to receive material on them which can not in case of emergency be
at any point of threatened danger in the vicinity and in case material provide
one State levee district is placed on a United States barge and it becomes neces
to use it in another district, the matter of adjusting accounts will be left to the d
trict authorities.

Owing to the limited funds available for protection the assistance rendered by th
office will be confined principally to the barge and tug service, and the purcha
expendable material, leaving the providing of tools and labor to the local auth
ties.

You will keep this office fully informed as to the location and movements of barg
and tugs and the application of material.

It must be definitely understood that this office assumes no special responsibil for old levees in front of proposed or incomplete United States levees, but that the assistance to be rendered will be general and directed towards the maintenance of the entire line as far as practicable.

When barges are taken from their stations for service they should be in charge of an employé of this office until returned.

Similar instructions were issued to assistants in local charge of the other districts, and the disposition of barges, steamboats, etc., contemplated has been made.

A few weak places have developed and some protection work has been done, but at this date no crevasses have taken place in the fourth district.

On the new Lake Concordia levee experiments have been made in stopping leaks through or under the base of the levee by means of sheet piling driven with a floating pile driver. These experiments have been partially successful.

SURVEYS, GAUGES, AND OBSERVATIONS.

Sections have been laid off and soundings taken at different stages of the river, beginning with last low-water season, in the vicinity of the Belmont and Prospect Crevasses of 1892 and also in the straight reach in the river above College Point. These surveys have been under the local charge of Surveyor A. F. Woolley, jr. They were undertaken to determine what changes take place in the river bottom in the vicinity of a crevasse, and also what temporary changes, if any, occur in the river section during the varying stages, in a locality not influenced by crevasses and where the banks are practically permanent.

In addition to the usual low and high water discharge observations near the head of the Atchafalaya, observations to determine the flood discharge of the Mississippi at Red River Landing and at New Orleans are being made.

New features in the high-water discharge work now in progress are the double section, observations being taken on two parallel sections from one-half to 1 mile apart. Accurate observations are also made to determine the actual shape of the river surface at the section. The object of the double sections is to discover and obviate certain discrepancies which have heretofore existed when the observations were confined to a single section.

The river surface of the section has heretofore been assumed to be a straight line and generally a horizontal one. Accurate level observations are being made to test the accuracy of this assumption.

By direction of the commission, surveys were made in January to determine the condition of the levees and cost of restoring them between Warrentown and Grand Gulf, and between Rodney and Coles Creek, on the left bank in what has been designated the Big Black Levee District. No special allotment was made for this survey, and its cost was therefore charged to surveys, gauges, and observations.

In compliance with instructions from the commission, a survey was made in March by Mr. E. B. Geddes, under direction of Assistant Engineer Douglas, to determine the cost of a levee behind Lake Bruin and St. Joseph and the value of the land that would be thrown out. The results of this survey, together with an estimate for bank protection at Hard Times, and opposite the end of Lake Bruin, were submitted in a report of May 2, 1893, with map. Rapid caving near Lake Bruin still continues and attention is again invited to the need of adopting some measures to prevent the river from destroying the levee and breaking into Lake Bruin.

The only regular gauges now maintained under the direction of this office are the ones at Barbres Landing and West Mellville. Their cost is borne from the appropriation for works near Turnbull Island.

Money statement.

June 1, 1892, balance unexpended	$1,381.53
Amount allotted from act approved July 13, 1892	12,000.00
	13,381.53
May 31, 1893, amount expended during fiscal year	6,828.44
May 31, 1893, balance unexpended	6,553.09
Amount that can be profitably expended in fiscal year ending June 30, 1895 / Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	12,000.00

The following reports of assistants under allotment for surveys, gauge[illegible] servations are submitted:

Report of low-water discharge measurements in the Atchafalaya River, at Simmes[illegible]

Date.	Direction and force of wind.	Simmesport gauge.	Area.	Velocity per second.	[illegible]
1892.		*Feet.*	*Square feet.*	*Feet.*	[illegible]
Oct. 1	Light down stream	6.43	25,290.22	.746	[illegible]
2	......do	6.08	25,710.92	.861	[illegible]
3	......do	5.66	25,232.55	.879	[illegible]
4	Very light cross stream	5.20	25,041.65	.853	[illegible]
5	Brisk down stream	4.80	24,785.30	.961	[illegible]
6	Calm	4.37	24,430.28	.824	[illegible]
7	......do	3.90	24,089.08	.775	[illegible]
8	Brisk cross stream	3.47	24,003.60	.765	[illegible]
10	Light cross stream	2.63	22,796.94	.684	[illegible]
13	Stiff down stream	1.78	22,205.85	.672	[illegible]
15	Strong cross stream	1.57	22,200.00	.603	[illegible]
16	Stiff down stream	1.61	22,137.88	.565	[illegible]

Respectfully submitted.

G. Ed. Mott.
Assistant Eng[illegible]

REPORT OF MR. A. F. WOOLLEY, JR., SURVEYOR, ON SURVEYS, GAUGES, AN[illegible] SERVATIONS.

Barbres Landing, May 31, 1[illegible]

Sir: I have the honor to submit the following report on surveys, gauges, an[illegible] servations from November 7, 1892, to May 31, 1893:

Prospect Crevasse sections.—By your order of November 6, 1892, I left the [illegible] Borgne and Barataria levee districts and went to Prospect crevasse and ass[illegible] charge of survey in that vicinity.

Thirteen sections were established normal to the river, and extended fro[illegible] land side of levee on left bank to the land side of levee on the right bank.

A section was established in the center of the crevasse and one at each end [illegible] Four sections were established above the crevasse and six below it, the ext[illegible] upper section being 1½ miles above and extreme lower section being 2¼ miles b[illegible] the crevasse.

The greatest distance between sections was 4,200 feet, and are nearer togeth[illegible] the crevasse is approached, being only 600 or 700 feet apart near the crevasse.

Levels were taken on these sections from land side of levee to water's edg[illegible] each bank. Three sets of soundings were taken on each section; the first set [illegible] taken at low water, the second at medium stage of water, and the third when [illegible] water was at the top of its banks.

Two large range signals were placed on shore on each side of a section, and [illegible] soundings were taken from a boat which was run above the section, where the [illegible] was cast overboard, and the boat backed just fast enough to have the lead [illegible] plumb at the time the section was crossed.

The angle to the lead line, where on section, was recorded with a transit fr[illegible] shore. No attempt was made to locate stations on the section and take so[illegible] ings on these sections at each successive set of soundings, as the bank, at qui[illegible] number of the sections, was covered with a thick growth of willows, and w[illegible] have necessitated so much clearing to mark the station range.

The soundings were taken sufficiently near together to insure a correct profi[illegible] each section. The stage of water was noted as each section was sounded, and [illegible] lead line tested often enough to insure good results.

Belmont Crevasse sections.—Thirteen sections were established and sounded, [illegible] the same plan followed as at Prospect Crevasse. Assistant Engineer G. Ed. M[illegible] established these sections, took shore levels and first set of soundings; the sec[illegible] and third were taken by me.

All of these sections were to determine the effect of a crevasse on the bed of t[illegible] river in the vicinity of the crevasse. As yet all sections have not been plotted, a[illegible] the result is not definitely known.

"*College Point Reach sections.*"—Two sections were established in "College P[illegible] Reach," about 7 miles above the Belmont Crevasse, and were to determine t[illegible] changes, if any, which take place in the river bed at a point immediately removed from the influence of the crevasse. These sections were little more than half a mile apart, and were located and sounded in the same way as those at "Prospect" and "Belmont." Soundings have not all been plotted, and the result is not known.

During low water the steamer *Ruby* was used for this work and the tug *General Comstock* was used during the high stages of water.

The survey party employed on these surveys consisted of three men and myself, until the shore work was completed; after that I had only two men exclusive of boat's crew.

"Old River."—Between the dates of April 28 and May 3, 1893, I took three sets of mid-channel soundings around Turnbulls Island and out to the Mississippi. There were two points in Lower Old River, between the foot of the island and Ash Cabin Light, which were less than 5 feet below the zero of Barbres gauge. After being plotted over a previous set of soundings, the soundings last taken indicate a deeper channel generally through both "Lower Old River" and "Upper Old River." The steamer *Ruby* was used on this survey.

"Discharge observations, Mississippi River," Red River Landing, La.—This work was begun on May 15, 1893. The original section at Red River Landing was resounded and 23 observation stations were located, being two more than formerly used.

In addition to the original section at Red River Landing, I located a section about half a mile above, and established 23 observation stations on this section also. The discharge of both these sections was always taken on the same day, so that they might be a check against each other. The water was just coming over the banks when I commenced this work and much difficulty in putting up ranges was encountered.

These discharges are yet underway, as the highest stage of water has not yet passed. Up to date only seven discharges for the Mississippi have been taken, and none have been computed, as the amount of field work I have had to perform has left me no time for computations.

"Discharge observations, Atchafalaya River," Simmesport, La.—The original discharge section at this point was used, and additional section about half a mile downstream was established as a check against the original section. The discharge for both these sections are taken on the same day.

Precise levels are taken at each end of section for water surface at time of discharge, and water surface not assumed to be same elevation all the way across the section as heretofore done.

In taking these levels, correction for curvature and refraction was made. These levels were taken for both Mississippi and Atchafalaya discharge.

The *Lotus* was first used for taking these discharges, but her pump broke on the 27th of May, and the work is being continued with the *Ruby*. Up to date only three discharges of the Atchafalaya, and none of them have been computed.

Respectfully submitted.

A. F. WOOLLEY, JR.,
Surveyor.

Capt. JOHN MILLIS,
Corps of Engineers, U. S. A.

The results of the above surveys will be reported when completed by soundings during next low-water season.

COMMERCIAL STATISTICS.

The statistics relating to the foreign commerce of the port of New Orl[illegible] kindly furnished by Hon. H. C. Warmoth, collector of customs.

Statement showing the approximate receipts and shipments of freight by river from [illegible] 1892, to June 1, 1893.

[Compiled from information derived from the commercial exchanges of the representative [illegible] the several business houses and landings where the steamboats receive and discharge [illegible] from the records of the custom-house, port of New Orleans, La.]

NATCHEZ, MISS.

Articles.	Quantity.	Tonnage.	Va[illegible]
Receipts.			
Cotton .... bales..	12,602	2,520	[illegible]
Cotton seed .... sacks..	45,000	2,225	[illegible]
Coal .... bushels..	2,400,000	85,990	[illegible]
Flour .... barrels..	20,460	2,041	[illegible]
Corn .... sacks..	50,820	3,811	[illegible]
Oats .... do...	80,532	7,247	[illegible]
Lumber .... feet, B. M..	6,500,080	11,375	[illegible]
Miscellaneous .... packages..	92,638	8,565	[illegible]
Total	....	123,784	[illegible]
Shipments.			
Cotton .... bales..	8,520	1,704	[illegible]
Corn .... sacks..	41,822	3,075	[illegible]
Cotton-seed meal .... do...	18,534	1,080	[illegible]
Flour .... barrels..	15,767	1,600	[illegible]
Lumber .... feet, B. M..	1,500,000	2,625	[illegible]
Oats .... sacks..	70,885	6,390	[illegible]
Miscellaneous .... packages..	404,407	9,920	[illegible]
Total	....	26,394	[illegible]

For comparison the statistics of 1891 and 1892 are also given. In connection [illegible] with see foot notes.

NATCHEZ, MISS.

	1891.	1892.	18[illegible]
Number of steamboats in the trade	38	32	
Number of times arrived	819	1,008	
Number of times departed	717	1,008	
Number of barges	53	49	
Total cargo received .... tons..	106,961	123,830	[illegible]
Value of same	$1,734,027.00	$1,988,169.30	$1,46[illegible]
Total cargo shipped .... tons..	28,104	30,786	
Value of same	$1,095,890.00	$1,037,281.66	$1,16[illegible]
Total cargo received and shipped .... tons..	135,065	154,616	[illegible]
Value of same	$2,829,917.00	$3,025,550.96	$2,6[illegible]

NOTE.—The general business at Natchez has decreased about 5 per cent since last year, [illegible] attributed by the authorities to the protracted high water of 1892, which had considerable effect [illegible] trade. The tonnage received for Natchez, however, seems to be very nearly the same as in p[illegible] reports, and is probably due to the increased coal business, which forms an important item.

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

VIDALIA, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts and shipments.			
Cotton .... bales..	5,000	1,000	$150,000
Cotton seed .... sacks..	47,000	2,350	23,500
Corn .... do....	6,500	487	11,375
Coal .... bushels..	30,000	1,050	3,750
Flour .... barrels..	2,100	210	6,300
Molasses .... do....	200	60	3,000
Lumber .... feet, B. M..	225,000	393	3,375
Staves	300,000	4,350	49,500
Oats .... sacks..	5,500	495	13,750
Miscellaneous .... packages..	26,060	1,072	196,760
Sugar .... barrels..	450	73	6,750
Total	....	11,540	468,060

	1891.	1892.	1893.
Number of steamboats in the trade	33	32	29
Number of times they have landed	819	1,008	828
Number of barges	2	12	3
Total cargo received and shipped .... tons..	12,392	17,329	11,540
Value of same	$781,976.75	$887,137.00	$467,060.00

NOTE.—The general business at Vidalia has decreased about 5 per cent since last year, and it is attributed by the authorities to the protracted high water of 1892, which had considerable effect on local trade. The tonnage received for Vidalia, however, seems to be very nearly the same as in previous reports, and is probably due to the increased coal business, which forms an important item.

BAYOU SARA, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
Cotton .... bales..	350	70	$10,530
Corn .... sacks..	3,000	225	5,250
Coal .... bushels..	250,000	8,750	8,750
Flour .... barrels..	4,500	450	13,500
Lumber .... feet, B. M..	75,000	141	1,125
Molasses .... barrels..	400	120	6,000
Oats .... sacks..	8,500	765	21,250
Rice .... barrels..	650	78	7,800
Sugar .... do....	2,200	362	33,000
Cotton ties .... bundles..	2,700	75	3,375
Miscellaneous .... packages..	50,607	3,402	197,312
Total	....	14,438	307,892
Shipments.			
Cotton .... bales..	2,200	440	66,000
Cotton seed .... sacks..	75,000	3,750	37,500
Corn .... do....	2,100	157	3,675
Coal .... bushels..	78,000	2,730	9,750
Flour .... barrels..	1,450	145	4,350
Lumber .... feet, B. M..	360,000	630	5,400
Molasses .... barrels..	65	19	975
Oats .... sacks..	7,000	630	17,500
Rice .... barrels..	110	13	1,320
Sugar .... do....	310	50	4,650
Cotton ties .... bundles..	900	25	1,125
Miscellaneous .... packages..	26,838	1,831	126,292
Total	....	10,420	278,587

Statement showing the approximate receipts and shipments of freight, etc.—Co[ntinued].

BAYOU SARA, LA.—Continued.

	1891.	1892.
Number of steamboats in the trade	48	40
Number of times arrived	1,019	800
Number of times departed	747	685
Number of barges	17	18
Total cargo received ....tons	29,321	14,641
Value of same	$1,113,719	$360,374
Total cargo shipped ....tons	19,940	11,090
Value of same	$1,193,396	$129,455
Total cargo received and shipped ....tons	49,261	25,731
Value of same	$2,307,115	$489,829

BATON ROUGE, LA.

Articles.		Quantity.	Tonnage
Receipts.			
Cotton	bales	725	145
Cotton seed	sacks	126,500	6,325
Corn	do	50,000	3,750
Coal	bushels	1,000,000	35,000
Flour	barrels	65,000	6,500
Lumber	feet, B. M.	15,500,000	27,125
Molasses	barrels	1,200	300
Moss	bales	5,525	207
Oats	sacks	70,300	6,300
Rice	barrels	1,200	144
Sugar	do	8,300	536
Cotton ties	bundles	8,600	240
Miscellaneous	packages	252,972	11,982
Total			98,614
Shipments.			
Cotton	bales	12,300	2,460
Cotton-seed meal	sacks	13,300	798
Cotton seed	do	18,000	900
Coal	bushels	900,000	31,500
Corn	sacks	75,000	5,625
Flour	barrels	27,630	2,763
Lumber	feet, B. M.	3,500,000	6,125
Moss	bales	5,330	199
Molasses	barrels	5,620	1,686
Oats	sacks	29,450	2,655
Rice	barrels	830	100
Sugar	do	20,000	3,250
Cotton ties	bundles	1,500	42
Miscellaneous	packages	3,003,715	82,419
Total			140,522

BATON ROGUE, LA.

	1891.	1892.
Number of steamboats in the trade	49	37
Number of times arrived	895	732
Number of times departed	693	552
Number of barges	106	146
Total cargo received ....tons	23,313	346,068
Value of same	$2,257,360	$3,280,558
Total cargo shipped ....tons	60,787	65,684
Value of same	$1,737,434	$1,252,394
Total cargo received and shipped ....tons	84,100	411,932
Value of same	$3,994,794	$4,532,952

NOTE.—The decrease in the receipts at Baton Rouge is attributed, by the authorities, to railro[ad com]petition, the immense falling off of the coal business due to labor difficulties and the discontin[uance of] one of the lumber mills. The increase in shipments probably can be accounted for by the [large number of] levee contractors in the vicinity, who consumed large quantities of grain feed and provisions.

Statement showing the approximate receipts and shipments of freight, etc.—Continued.

PLAQUEMINE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
orn .... sacks..	12,000	900	$21,000
otton-seed meal .... do....	6,800	408	5,100
oal .... bushels..	875,000	13,125	46,875
'lour .... barrels..	16,320	1,632	48,960
Iolasses .... do....	630	189	9,450
Ioss .... bales..	50	2	25
ats .... sacks..	12,000	1,080	30,000
ice .... barrels..	2,850	342	34,200
ugar .... do....	1,500	243	22,500
Iiscellaneous .... packages..	118,640	6,216	377,313
Total	....	24,137	595,423
Shipments.			
oal .... bushels..	1,000,000	85,000	125,000
orn .... sacks..	2,800	210	4,900
umber .... feet, B. M..	6,238,324	10,916	9,570
Iolasses .... barrels..	8,000	2,400	120,000
Ioss .... bales..	2,500	93	1,250
ats .... sacks..	6,200	558	4,960
ice .... barrels..	850	102	10,200
ugar .... do....	1,380	224	20,700
'lour .... do....	7,800	780	23,400
Iiscellaneous .... packages..	828,974	12,110	319,134
Total	....	62,393	1,264,614

PLAQUEMINE, LA.

	1891.	1892.	1893.
umber of steamboats in the trade	50	53	39
umber of times arrived	453	428	560
umber of times departed	388	402	560
umber of barges	52	66	80
otal cargo received .... tons..	61,110	82,214	24,137
alue of same	$819,176	$1,023,243	$595,423
otal cargo shipped .... tons..	57,899	45,234	62,393
alue of same	$596,899	$833,479	$1,264,614
otal cargo received and shipped .... tons..	119,009	127,448	86,530
alue of same	$1,416,075	$1,856,722	$1,860,037

NOTE.—The decrease in the receipts at Plaquemine is attributed to successful railroad competition nd immense falling off in the receipts of coal due to labor troubles at the mines during the year.

DONALDSONVILLE, LA.

Articles.	Quantity.	Tonnage.	Value.
Receipts.			
orn .... bushels..	8,300	622	$14,525
oal .... do....	1,425,000	119,875	428,125
lour .... barrels..	720	72	2,160
umber .... feet, B. M..	5,000	8	75
Iolasses .... barrels..	20	6	300
ats .... sacks..	12,600	1,138	31,500
ice .... barrels..	1,030	123	12,360
ugar .... do....	500	81	7,500
Iiscellaneous .... packages..	15,680	880	107,994
Total	....	122,805	604,539
Shipments.			
oal .... bushels..	3,675,000	128,625	459,375
Iolasses .... barrels..	45,000	13,500	675,000
ugar .... do....	180,000	29,250	2,700,000
ice, rough .... sacks..	82,000	2,460	164,000
Iiscellaneous .... packages..	2,831	817	10,407
Total	....	174,652	4,008,782

Statement showing the approximate receipts and shipments of freight, etc.—Contin[illegible]

DONALDSONVILLE, LA.—Continued.

	1891.	1892.	18[illegible]
Number of steamboats in the trade	41	36	
Number of times arrived	963	884	
Number of times departed	591	376	
Number of barges	104	132	
Total cargo received ..... tons..	105, 172	158, 296	[illegible]
Value of same	$929, 570	$1, 829, 128	[illegible]
Total cargo shipped ..... tons..	6, 059	113, 265	[illegible]
Value of same	$482. 700	$2, 201, 460	[illegible]
Total cargo received and shipped ..... tons..	111, 231	271, 501	[illegible]
Value of same	$1, 412, 270	$4, 030, 568	[illegible]

NOTE.—General depreciation of receipts due to successful railroad competition. The ship[illegible] sugar and molasses have increased, and the coal business is also enlarging rapidly, due to [illegible] that Donaldsonville is becoming yearly more generally adapted as a shipping station for in[illegible] sumers and those along Bayou La Fourche; hence the marked increase in the shipments as [illegible]

The above towns are, strictly speaking, "way points" and not termini. [illegible] net tonnage or carrying capacity of the steamboats that do business at those [illegible] is not given, as it would not show the proper relation between what would [illegible] be made the possible tonnage and actual tonnage brought.

All New Orleans steamboats are counted "arrived" when they stop on their [illegible]ney up river, and "departed" when they stop on their way down to New Orlea[illegible]

The St. Louis and Ohio River steamboats are counted "arrived" when they [illegible] on their journey down the river, and "departed" when they stop on their wa[illegible] stream.

Statement showing the amount and value of commerce passing out of Red River an[illegible] tributaries through Old River into the Mississippi River.

[Compiled from the river column of the New Orleans Daily States and from information furnish[illegible] the commercial exchanges of New Orleans, La.]

OLD RIVER.

Articles.	Quantity.	Tonnage.	Va[illegible]
Cotton ..... bales..	95, 694	19, 138	[illegible]
Cotton seed ..... sacks..	196, 174	9, 808	[illegible]
Cotton-seed meal ..... do....	104, 059	5, 202	[illegible]
Cotton-seed oil ..... barrels..	1, 941	242	[illegible]
Lumber ..... feet, B. M..	8, 636	5	[illegible]
Molasses ..... barrels..	15, 628	4, 688	[illegible]
Moss ..... bales..	2, 571	96	[illegible]
Rice ..... sacks..	20, 499	1, 537	[illegible]
Sugar ..... hogsheads..	2, 444	1, 466	[illegible]
Sugar ..... barrels..	34, 466	5, 600	[illegible]
Staves (oak) ..... number..	1, 104, 419	5, 522	[illegible]
Miscellaneous ..... packages..	15, 092	554	[illegible]
Total	....	53, 858	[illegible]

	1891.	1892.	18[illegible]
Number of steamboats in the trade	17	24	[illegible]
Trips made by them	501	279	[illegible]
Net tonnage of same	101, 604	91, 043	[illegible]
Number of barges	24	8	
Net tonnage of same	14, 400	7. 600	[illegible]
Total tonnage of steamboats and barges	116, 004	98. 643	[illegible]
Total cargo brought ..... tons..	92, 222	90, 886	[illegible]
Value of same	$10, 951, 106	$9, 458, 901	$4, [illegible]

NOTE.—This does not include the upstream freights, which must be nearly equal to the downs[illegible] in value.

Statement showing the receipts, by river, at New Orleans, La.

Compiled from the river column of the New Orleans Daily States and from information furnished by the commercial exchanges of New Orleans.]

Articles.	Quantity.	Tonnage.	Value.
Above the city.			
Coal.....bushels..	4,428,000	154,980	$553,500
Cotton seed.....sacks..	891,080	44,554	668,310
Cotton.....bales..	190,419	38,083	5,717,570
Cotton-seed meal.....sacks..	126,077	6,300	144,969
Cotton-seed oil.....barrels..	3,783	472	75,660
Flour.....do....	209,416	20,941	628,248
Flour.....one-half barrels..	31,700	1,585	55,475
Flour.....sacks..	71,780	1,794	53,835
Corn.....bushels..	4,016,744	112,468	2,410,046
Oats.....do....	352,417	5,654	141,366
Cotton ties.....	400,000	12,000	5,000
Lumber.....feet, B. M..	10,536	15	126
Molasses.....barrels..	190,506	57,151	1,857,590
Moss.....bales..	7,443	372	18,607
Rice.....barrels..	659	79	7,908
Rice.....sacks..	227,085	17,027	454,070
Sugar.....hogsheads..	39,859	23,915	1,913,232
Sugar.....barrels..	433,306	70,412	6,489,590
Staves.....	1,750,724	8,753	262,608
Wheat.....bushels..	2,273,516	158,205	3,955,137
Miscellaneous.....packages..	857,684	72,086	2,244,918
Total.....	....	806,846	27,662,765
Below the city.			
Molasses.....barrels..	4,553	1,335	66,795
Moss.....bales..	321	12	160
Rice, clean.....barrels..	10	1	120
Rice, rough.....sacks..	29,523	2,224	59,046
Sugar.....barrels..	17,818	2,896	267,270
Miscellaneous.....packages..	181,858	31,184	363,160
Total.....	....	37,652	759,551

	1891.	1892.	1893.
Above the city.			
Number of steamboats.....	51	54	51
Trips made by them.....	1,417	1,090	1,203
Net tonnage of same.....	665,610	450,031	542,156
Towboats.....	45	39	32
Trips made by them.....	134	168	106
Net tonnage of same.....	51,810	90,544	46,357
Number of barges.....	929	1,042	568
Net tonnage of same.....	418,050	468,900	255,600
Number of luggers (sailing).....	18	20	25
Trips made by them.....	162	240	650
Net tonnage of same.....	4,860	5,400	3,900
Total tonnage (steamboats, towboats, barges, and luggers).	1,140,330	1,014,875	848,013
Total cargo brought.....tons..	1,343,061	1,303,628	806,846
Value of same.....	$54,332,685	$56,076,160	$27,662,765
Below the city.			
Number of steamboats in local trade.....	6	6	6
Trips made by them.....	321	174	266
Net tonnage of same.....	31,039	17,916	26,077
Luggers (sailing in local trade).....	218	278	100
Trips made by them.....	4,250	2,392	2,600
Net tonnage of same.....	130,000	73,672	15,600
Total tonnage (steamboats and luggers).....	161,839	91,588	41,677
Total cargo brought.....tons..	22,422	8,632	37,652
Value of same.....	$1,729,092	$741,155	$759,551

Statement showing the receipts, by river, at New Orleans, La.—Continued.

RECAPITULATION.

	1891.	1892.	[illegible]
Total arrivals (steamboats tow boats, barges and luggers) above and below the city	7,193	5,393	[illegible]
Total net tonnage above and below	1,502,169	1,1[illegible],463	[illegible]
Total cargo brought above and below .... tons	1,[illegible] 4[illegible]	1,312,[illegible]60	[illegible]
Value of same	$56,061,000	$56,817,315	[illegible]

The foregoing includes simply the freights brought to New Orleans by st[illegible] boats and barges and luggers on the Mississippi River and does not inclu[illegible] large and valuable freights that they take away. No record is kept of this, a[illegible] is impossible to furnish even a reasonably accurate estimate of its value. It [illegible] amount to a very large sum in the aggregate, probably more than 40 per ce[illegible] the value of freights received at New Orleans.

Foreign commerce, port of New Orleans.

Vessels.	Entrances.			Clearances.		
	1890–'91.	1891–'92.	1892–'93.	1890–'91.	1891–'92.	18[illegible]
Steam	1,005	1,245	1,131	1,007	1,242	[illegible]
Sail	154	161	135	141	136	[illegible]
Total	1,159	1,406	1,266	1,148	1,378	[illegible]

Total tonnage of above:

	T[illegible]
1890–'91	2[illegible]
1891–'92	3[illegible]
1892–'93	2[illegible]

EXPORTS AND IMPORTS.

	1891.	1892.	18[illegible]
Total value of exports of foreign merchandise to foreign countries	$1,099,259	$1,911,081	$4[illegible]
Total value of exports of domestic merchandise to foreign countries	108,007,428	130,183,916	81,[illegible]
Grand total of exports of foreign and domestic merchandise to foreign countries	109,106,687	132,094,997	82,29[illegible]
Total value of imports from foreign countries:			
Free	13,211,083	14,878,800	22,[illegible]
Dutiable	7,041,959	5,442,415	3,[illegible]
Specie	513,294	305,402	[illegible]
Grand total	20,766,336	20,626,617	27,41[illegible]

TOTAL DUTIES COLLECTED.

1891	$2,106,6[illegible]
1892	1,[illegible]
1893	1,50[illegible]

pproximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, Fourth district, May 31, 1893.

Class of property.	Value.	Class of property.	Value.
eamer General Newton	$12,000	One warehouse barge	$2,200
eam launch Ruby	4,000	One warehouse barge	200
eam tug General Comstock	7,000	Fifteen row boats	200
eam tug Tilda	6,000	Tools and appliances	16,000
eam launch Alaska	3,500	Office furniture	2,000
eam launch No. 5	2,000	Surveying instruments	2,000
ie dredge boat	10,000	Drawing instruments	200
ur dump scows	8,000	Railway cars and tracks	1,900
ve quarter boats	12,000		
irty barges	58,734	Total	148,534

ist of civilian engineers on work of river and harbor improvements in charge of Capt. John Millis, Corps of Engineers, to May 31, 1893, inclusive.

Name and residence.	Time employed.		Compensation per month.	Where employed.	Work on which employed.
	Mos.	*Days.*			
S. Douglas, Natchez, Miss.	12	0	$200	Natchez, Miss	Levees, Lower Tensas and Big Black levee districts, and gauges.
. G. Price, New Orleans, La.	6	16	200	New Orleans, La	Levees, Lake Borgne and Barataria levee districts.
. J. Hardee, Baton Rouge, La.	6 5	16 14	175 200	Baton Rouge, La	Levees, Atchafalaya, Lafourche, and Pontchartrain levee districts.
illiam Garvin, New Orleans, La.	12	0	175	New Orleans, La	Improving harbor at New Orleans, La.
Ed. Mott, New Orleans, La.	5	15	150	Red River Landing and Simmesport, La.	Surveys, gauges, and observations.

The following maps and drawings accompany and form part of this report:

PLATE I.—Harbor of Natchez and Vidalia, Mississippi and Louisiana.
PLATE II.—Turnbull Island and vicinity.
PLATE III.—Carrollton Bend, New Orleans Harbor.
PLATE IV.—Southport to Exposition Wharf, New Orleans Harbor.
PLATE V.—Lower Tensas and Big Black levee districts.
PLATE VI.—Atchafalaya, LaFourche, and Pontchartrain levee districts.
PLATE VII.—Barataria and Lake Borgne levee districts.
PLATE VIII.—Method of closing crevasses.
PLATE IX.—Levee sections.
PLATE X.—Area of overflow, flood of 1892.

Very respectfully, your obedient servant,

JOHN MILLIS,
Captain of Engineers.

Col. C. B. COMSTOCK,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

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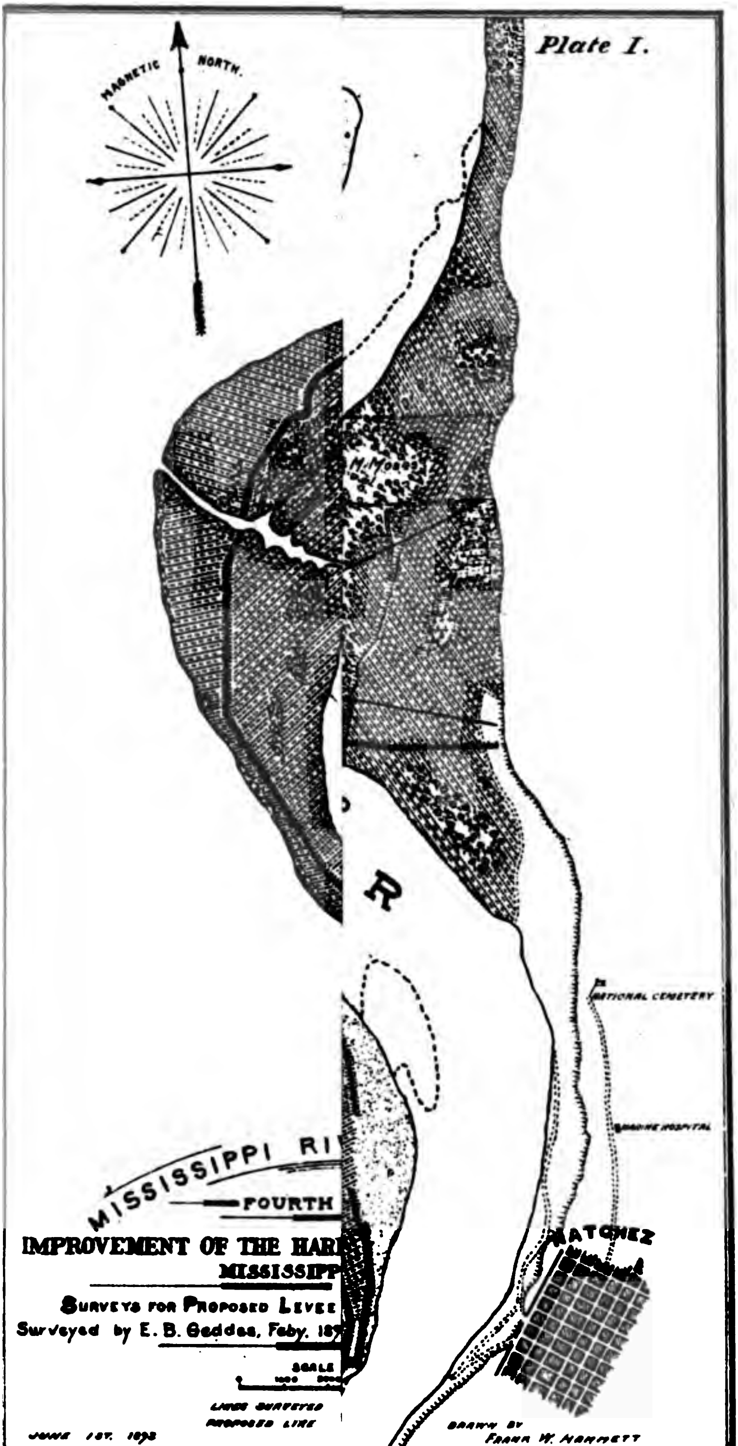

Plate I.
MAGNETIC NORTH.
R
NATIONAL CEMETERY
MISSISSIPPI RI
FOURTH
IMPROVEMENT OF THE HAR
MISSISSIPP
SURVEYS FOR PROPOSED LEVEE
Surveyed by E. B. Geddes, Feby. 18
SCALE
NATCHEZ
DRAWN BY
FRANK W. HAMMETT

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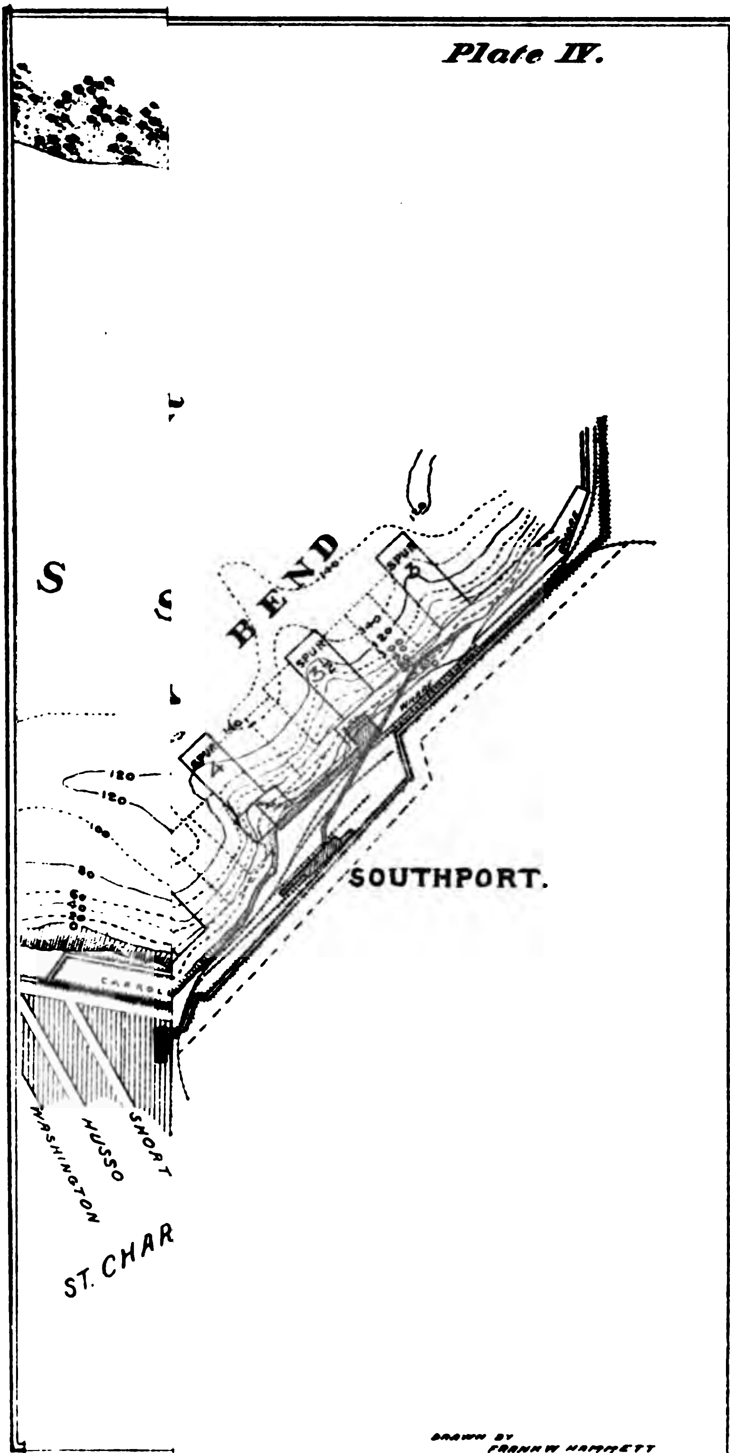
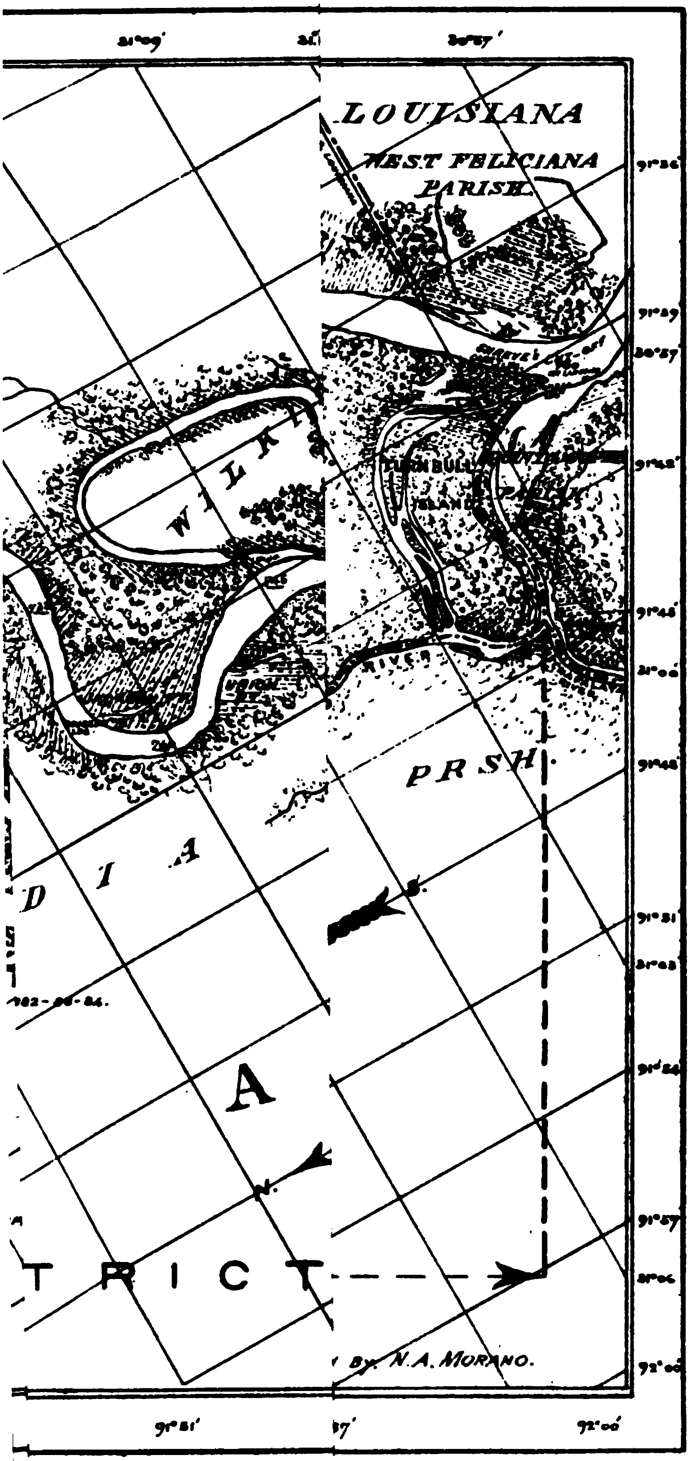


Plate IV.
S
BEND
SPUR 3
SPUR 3½
SPUR 4
120
120
100
80
SOUTHPORT.
CARROLL
WASHINGTON
HUSSO
SHORT
ST. CHAR
DRAWN BY
FRANK W. HAMMETT


LOUISIANA
WEST FELICIANA
PARISH
TURNBULL
ISLAND
RIVER
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TRICT
BY N.A. MORANO.

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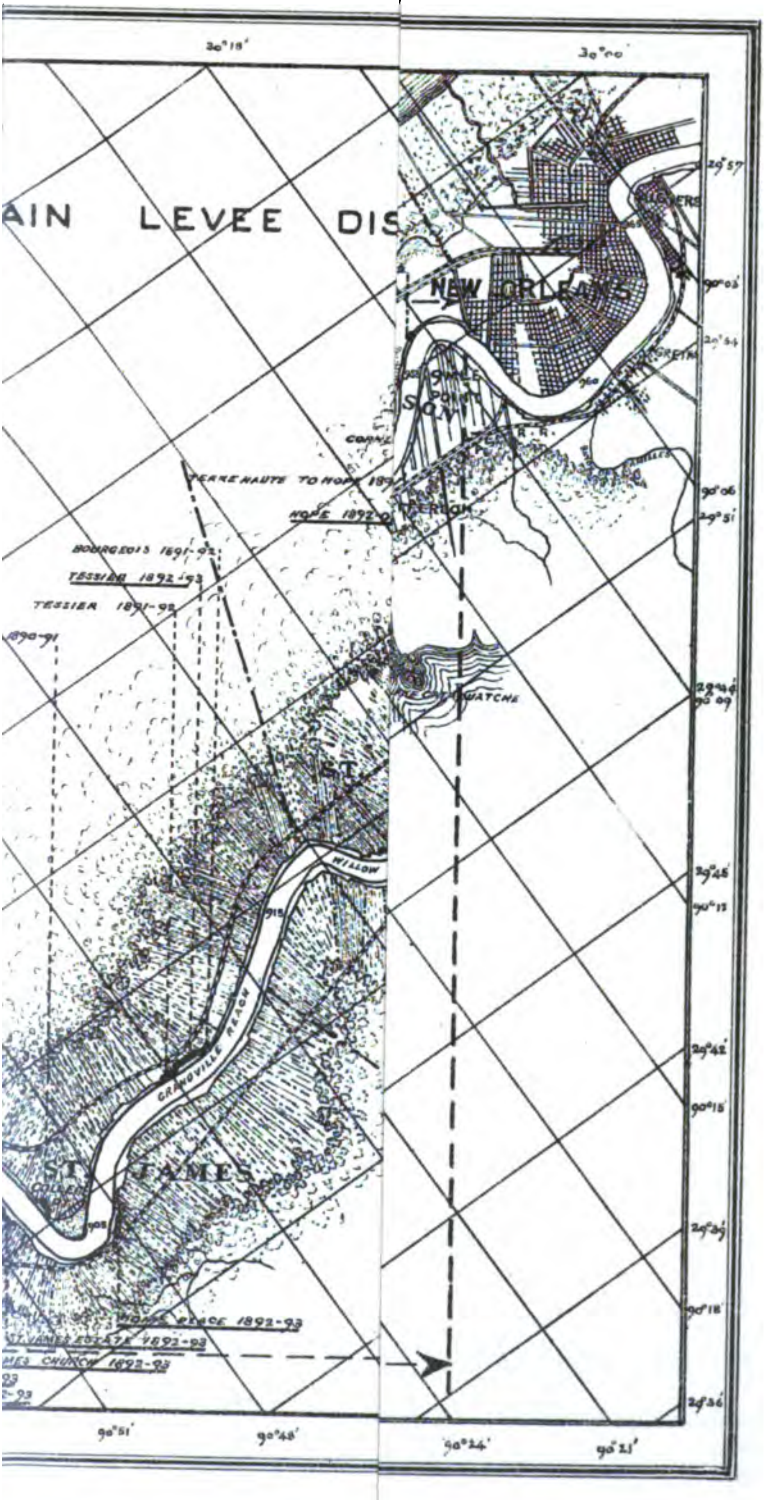

30°15'
30°00'
AIN LEVEE DIS
NEW ORLEANS
29°57'
29°54'
90°03'
90°06'
29°51'
29°48'
90°09'
29°45'
90°12'
29°42'
90°15'
29°39'
90°18'
29°36'
TERRE HAUTE TO HOPE 189
HOPE 1892-9
BOURGEOIS 1891-92
TESSIER 1892-93
TESSIER 1891-92
1890-91
WILLOW
GRANDVILLE REACH
ST. JAMES
HOME PLACE 1892-93
ST. JAMES ESTATE 1892-93
MES CHURCH 1892-93
90°51'
90°48'
90°24'
90°21'


Plate VII.
SIPPI RIVER
FOURTH DIST
LAKE BORGNE
ILT BY UNITED ST
until Feby. 16. '93; Survey
SCALE OF MI
0 1 2 3 4 5
EVEE
N E
ISTRIC

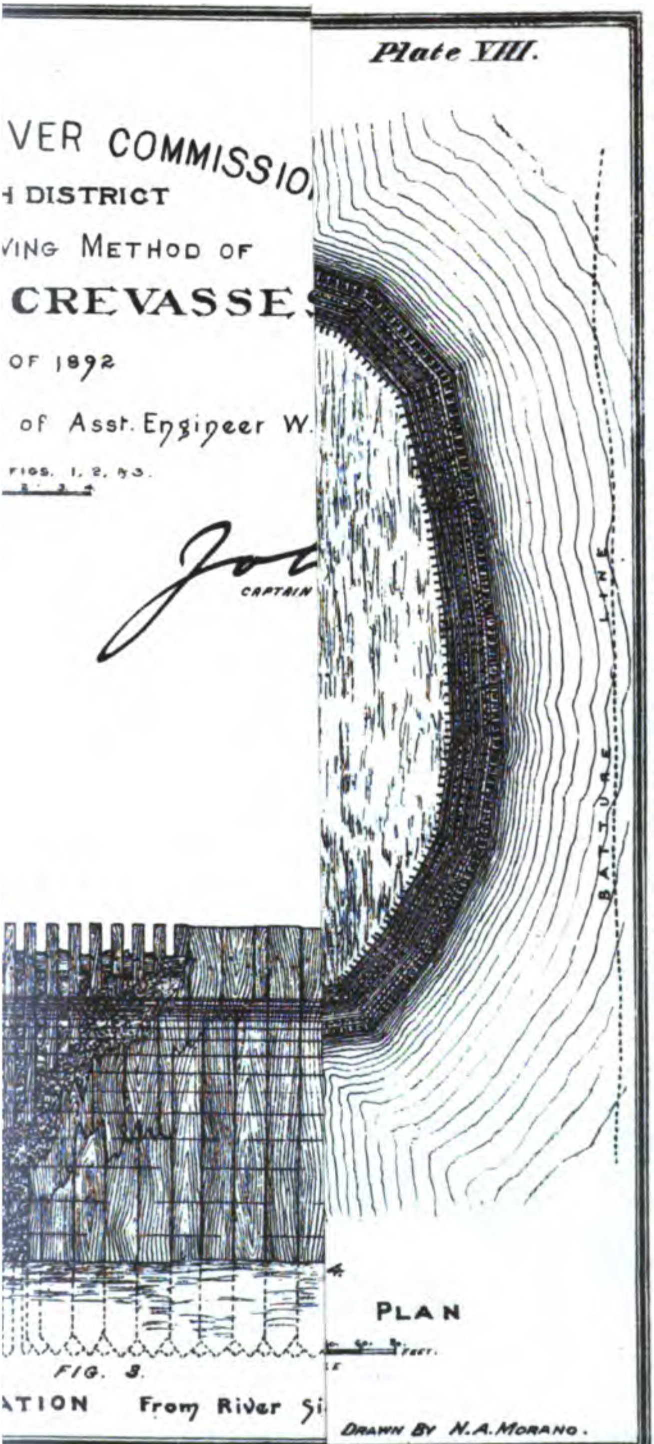
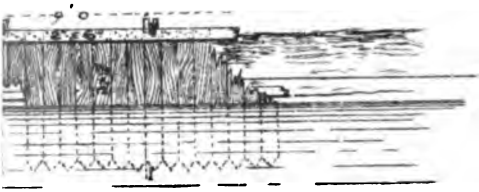


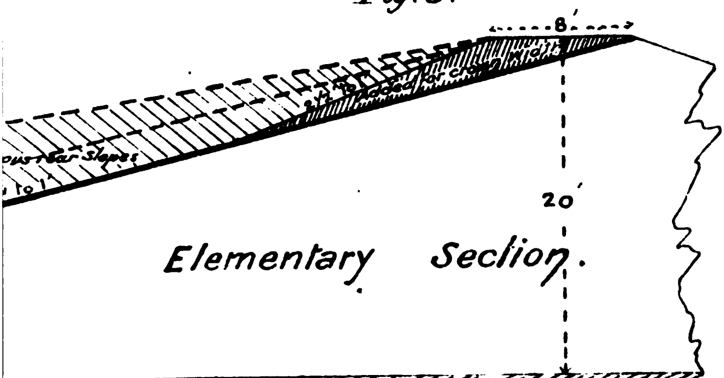
Plate VIII.
VER COMMISSIO
H DISTRICT
VING METHOD OF
CREVASSES
OF 1892
of Asst. Engineer W.
FIGS. 1, 2, & 3.
CAPTAIN
BATTURE LINE
FIG. 3.
ATION From River Si
PLAN
DRAWN BY N.A. MORANO.

Plate IX.



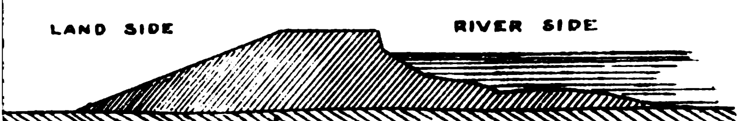
N OF REVETMENT.

Fig. 8.



Elementary Section.

SECTION OF LEVEE WAVE WASHED
FLOOD 1892.
Fig. 10.



Drawn by B.J. OLIVEIRA.

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