61ST CONGRESS, 1st Session } HOUSE OF REPRESENTATIVES { DOCUMENT No. 50

REPORT

BY A SPECIAL BOARD OF ENGINEERS

ON

SURVEY OF MISSISSIPPI RIVER

FROM ST. LOUIS, MO., TO ITS MOUTH

WITH A VIEW TO OBTAINING A CHANNEL 14 FEET DEEP AND OF SUITABLE WIDTH

INCLUDING A CONSIDERATION OF

THE SURVEY OF A PROPOSED WATERWAY FROM CHICAGO, ILL., TO ST. LOUIS, MO.

HERETOFORE REPORTED UPON

SUBMITTED BY THE CHIEF OF ENGINEERS
TO THE SECRETARY OF WAR



WASHINGTON
GOVERNMENT PRINTING OFFICE
1909

MISSISSIPPI RIVER FROM ST. LOUIS TO ITS MOUTH, AND WATERWAY FROM CHICAGO TO ST. LOUIS.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORT BY A BOARD OF ENGINEERS OF SURVEY OF MISSISSIPPI RIVER FROM ST. LOUIS, MO., TO ITS MOUTH, INCLUDING A CONSIDERATION OF THE SURVEY OF A PROPOSED WATERWAY FROM CHICAGO, ILL., TO ST. LOUIS, MO., HERETOFORE REPORTED UPON.

NOV 17 1910

JUNE 10, 1909.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, June 9, 1909.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, U. S. Army, dated June 7th instant, submitting a report of the board of engineers constituted under authority of an item in section 1 of the river and harbor act approved March 2, 1907, of a survey of the Mississippi River from St. Louis, Mo., to its mouth, with a view to obtaining a channel 14 feet deep and of suitable width, including a consideration of the survey of a proposed waterway from Chicago, Ill., to St. Louis, Mo., heretofore reported upon.

In view of the widespread interest in this proposed work, and the value and importance of the data furnished, it is recommended that these reports, with accompanying maps and other appendixes, be ordered printed in their entirety.

Very respectfully,

J. M. DICKINSON,
Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, June 7, 1909.

SIR: I have the honor to submit herewith, for transmission to Congress, a report dated March 20, 1909, by a board of five members constituted under authority of an item in section 1 of the river and harbor act approved March 2, 1907, making provision for examination of the Mississippi River from St. Louis to the mouth, as follows:

The Secretary of War may appoint a board of five members, to be composed of three members of the Mississippi River Commission, one of whom shall be the president of such commission, and two engineer officers of the United States Army, to examine the Mississippi River below Saint Louis and report to Congress, at the earliest date by which a thorough examination can be made, upon the practicability and desirability of constructing and maintaining a navigable channel fourteen feet deep and of suitable width from Saint Louis to the mouth of the river, either by the improvement of said river or by a canal or canals for part of said route. In its report the board shall cover the probable cost of such improvement, the probable cost of maintenance, and the present and prospective commerce of said waterway, both local and general, upstream as well as downstream, and the said board may consider in connection with the examination herein provided for, the survey of a proposed waterway from Chicago to Saint Louis, heretofore reported; it shall also report whether other plans of improvement can be devised by which the probable demands of traffic, present and prospective, can be adequately met, and the sum of one hundred and ninety thousand dollars, or so much thereof as may be necessary, is hereby appropriated for the making of such survey, of which amount only one hundred thousand dollars shall be available, unless in presenting a plan for such waterway it shall be necessary, in the judgment of said board, to make a survey for a lateral canal or canals; and the force, plant, and records of the Mississippi River Commission shall be available for the use of said board in making said examination; and said board shall also at the earliest date practicable report upon the following:

First. What depth of channel is it practicable to produce between Saint Louis and Cairo at low water by means of regulation works.

Second. What depth will obtain in such regulated channel at the average stage of water for the year.

Third. For what average number of days annually will fourteen feet of water obtain in such regulated channel.

Fourth. What increase of depth will be obtained over the natural flow of water in such regulated channel by an added volume of ten thousand cubic feet per second; also fourteen thousand cubic feet per second.

Fifth. And the board shall consider further the practicability of producing at all seasons of the year a depth of fourteen feet in such regulated channel by the aid of locks and dams similar to those projected and in use on the Ohio River improvement.

Sixth. And the said Board shall also report upon any water power which may be created in the portion herein directed to be surveyed, as well as in the proposed waterway from Saint Louis to Chicago heretofore surveyed, and the value thereof, and what means should be taken in order that the Government of the United States may conserve the same or receive adequate compensation therefor, and upon any lands which may be drained by the construction of either of said proposed waterways, and shall also report what steps, if any, shall be taken to cause the cost of the improvement to be defrayed, in whole or part, by means of such water power or lands.

The membership of this Board at the date of its report was as follows: Col. W. H. Bixby, Corps of Engineers, president of the Mississippi River Commission; Lieut. Col. C. McD. Townsend, Corps of Engineers; Lieut. Col. J. G. Warren, Corps of Engineers; Mr. Henry B. Richardson, member of the Mississippi River Commission, and Mr. Homer P. Ritter, assistant, United States Coast and Geodetic Survey, and member of the Mississippi River Commission.

This report has been referred, as required by law, for consideration and recommendation by the Board of Engineers for Rivers and Harbors, organized in pursuance of the provisions of section 3 of the river and harbor act approved June 13, 1902, and attention is respect-

fully invited to the report [a] by this permanent Board dated June 3, 1909, which is also herewith.

These are reports upon a proposed channel to lead from the Great Lakes near Chicago by way of the valleys of the Des Plaines and Illinois rivers, and the Mississippi River, to the Gulf of Mexico. The portion of this route from Lake Michigan to the Mississippi River at St. Louis was reported upon in 1905 by a special board convened pursuant to section 1 of the river and harbor act of June 13, 1902. The greater part of the work performed by the special Board whose report is now submitted has had to do with that portion of the route between St. Louis and the Gulf of Mexico. In order therefore that the project may be understood in its entirety, it is necessary to consider in connection with the reports transmitted herewith the report of the special Board submitted in 1905, and printed in House Document No. 263, Fifty-ninth Congress, first session.

In the present reports consideration is given to various methods of securing a 14-foot channel to the mouth of the Mississippi River, all the methods proposed for securing this result being considered by both boards as practicable from an engineering standpoint, except the method of improvement by means of storage reservoirs.

The Chief of Engineers approves the opinions expressed with respect to the methods of improvement considered, with the exception that a long study of the conditions existing on the sediment-bearing Mississippi River leads him to believe that it will not be practicable to obtain a minimum depth of 14 feet of water between St. Louis and Cairo by means of locks and movable dams. The structures might be built, but their efficiency is problematical, and, in the opinion of the Chief of Engineers, the chances of favorable operation are very remote. Nor is the Chief of Engineers prepared to recommend that it is practicable from an engineering standpoint to secure and maintain a 14-foot depth at low water in the section from St. Louis to the mouth of the Ohio River by any method of open-river improvement.

The special board concludes that the most practicable means of obtaining and maintaining a navigable channel of 14 feet depth from St. Louis to the mouth of the Mississippi River is by the combined method of dredging and regularization works in the open river. The estimated cost of this plan of improvement is $128,600,000, with $6,500,000 annually for maintenance after completion of the work. In order to arrive at a correct understanding as to the estimated cost of securing a 14-foot channel from the Great Lakes to the Gulf of Mexico by the route under consideration it is necessary to add to the figures just given those contained in the report submitted in 1905 for that portion of the route from Chicago to St. Louis, namely, $30,097,462 for first cost and $310,000 for annual maintenance, giving a total estimated cost of a 14-foot waterway from Lake Michigan to the Gulf of Mexico of $158,697,462, with an estimated annual cost of $6,810,000 for maintenance.

The Chief of Engineers is in accord with the views expressed by the Board of Engineers for Rivers and Harbors as follows:

It is not desirable to construct a navigable channel 14 feet in depth from St. Louis to the mouth of the Mississippi River, or from Chicago to the mouth of the Mississippi River.

The present demands of commerce between St. Louis and the mouth of the Mississippi River are adequately met by the existing projects, having for their object to obtain and

[a] See page 525.

maintain an 8-foot channel from St. Louis to the mouth of the Ohio and a channel of not less than 9 feet in depth below the mouth of the Ohio.

The Board believes that an 8-foot channel from Chicago to St. Louis, corresponding to the present 8-foot project from St. Louis to Cairo, is the least that would adequately meet the demands of commerce, and believes such a waterway would be desirable, provided its cost is reasonable.

Present and prospective demands of commerce between Chicago and the Gulf will be adequately served by a through channel 9 feet in depth, which may be obtained without violent changes of existing methods of improvement.

It should be stated that the report of the special board is regarded as incomplete to the extent that it contains no estimate for channels of 8 feet depth and 9 feet depth from Lake Michigan to the mouth of the Ohio River, and no such estimate is included in the report submitted in 1905, hereinbefore referred to. However, on account of the urgent general demand for such information as is available on the subject the reports are forwarded at this time in their present form. An estimate will be promptly made, however, of the cost of a 9-foot channel from Lake Michigan to the mouth of the Ohio River, which in connection with the present project depth of 9 feet below the mouth of the Ohio River will provide a depth of 9 feet from Chicago to the Gulf of Mexico; an estimate will also be made of the cost of an 8-foot channel from Lake Michigan to the Mississippi River at St. Louis, which latter, in connection with the present 8-foot project for that portion of the Mississippi River between St. Louis and Cairo, will provide for a least depth of 8 feet from Lake Michigan to the mouth of the Ohio River. It is expected that these additional estimates will be ready for submission to Congress before its next session. The Chief of Engineers is not prepared to state definitely for consideration by Congress that the construction of either of these channels is desirable until after accurate estimates are made.

In view of the widespread interest in this proposed work and the value and importance of the data furnished, it is recommended that these reports and the accompanying maps and other appendixes be printed in their entirety.

Very respectfully,

W. L. MARSHALL,
Chief of Engineers, U. S. Army.

The SECRETARY OF WAR.

REPORT BY A SPECIAL BOARD OF ENGINEERS ON SURVEY OF MISSISSIPPI RIVER FROM ST. LOUIS, MO., TO ITS MOUTH, WITH A VIEW TO OBTAINING A NAVIGABLE CHANNEL 14 FEET DEEP AND OF SUITABLE WIDTH, INCLUDING A CONSIDERATION OF THE SURVEY OF A PROPOSED WATERWAY FROM CHICAGO, ILL., TO ST. LOUIS, MO., HERETOFORE REPORTED UPON, AND A REPORT WITH REFERENCE TO WATER POWER AND TO LAND DRAINAGE ALONG THE ROUTES HEREIN MENTIONED.

ST. LOUIS, MO., *March 20, 1909.*

SIR: The Board created by act of Congress approved March 2, 1907, to make an examination of the Mississippi River from St. Louis, Mo., to its mouth, having completed the investigations and studies assigned to it, has the honor to submit the following report.

The constitution and duties of the Board are set forth in the portions of the act of Congress referred to, reading:

An Act Making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby, appro-

priated, to be paid out of any money in the Treasury not otherwise appropriated, to be immediately available, and to be expended under the direction of the Secretary of War and the supervision of the Chief of Engineers, for the construction, completion, repair, and preservation of the public works hereinafter named:

* * * * * * *

The Secretary of War may appoint a board of five members, to be composed of three members of the Mississippi River Commission, one of whom shall be the president of such commission, and two engineer officers of the United States Army, to examine the Mississippi River below Saint Louis and report to Congress, at the earliest date by which a thorough examination can be made, upon the practicability and desirability of constructing and maintaining a navigable channel fourteen feet deep and of suitable width from Saint Louis to the mouth of the river, either by the improvement of said river or by a canal or canals for part of said route. In its report the board shall cover the probable cost of such improvement, the probable cost of maintenance, and the present and prospective commerce of said waterway, both local and general, upstream as well as downstream, and the said board may consider in connection with the examination herein provided for, the survey of a proposed waterway from Chicago to Saint Louis, heretofore reported; it shall also report whether other plans of improvement can be devised by which the probable demands of traffic, present and prospective, can be adequately met, and the sum of one hundred and ninety thousand dollars, or so much thereof as may be necessary, is hereby appropriated for the making of such survey, of which amount only one hundred thousand dollars shall be available, unless in presenting a plan for such waterway it shall be necessary, in the judgment of said board, to make a survey for a lateral canal or canals; and the force, plant, and records of the Mississippi River Commission shall be available for the use of said board in making said examination; and said board shall also at the earliest date practicable report upon the following:

First. What depth of channel is it practicable to produce between Saint Louis and Cairo at low water by means of regulation works.

Second. What depth will obtain in such regulated channel at the average stage of water for the year.

Third. For what average number of days annually will fourteen feet of water obtain in such regulated channel.

Fourth. What increase of depth will be obtained over the natural flow of water in such regulated channel by an added volume of ten thousand cubic feet per second; also fourteen thousand cubic feet per second.

Fifth. And the board shall consider further the practicability of producing at all seasons of the year a depth of fourteen feet in such regulated channel by the aid of locks and dams similar to those projected and in use on the Ohio River improvement.

Sixth. And the said board shall also report upon any water power which may be created in the portion herein directed to be surveyed, as well as in the proposed waterway from Saint Louis to Chicago heretofore surveyed, and the value thereof, and what means should be taken in order that the Government of the United States may conserve the same or receive adequate compensation therefor, and upon any lands which may be drained by the construction of either of said proposed waterways, and shall also report what steps, if any, shall be taken to cause the cost of the improvement to be defrayed, in whole or part, by means of such water power or lands.

* * * * * * *

Approved, March 2, 1907.

To comply with this law, the following order was published by the Chief of Engineers, U. S. Army:

SPECIAL ORDERS, No. 10.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, March 16, 1907.

By authority of the Secretary of War, and in accordance with the provisions of the river and harbor act of March 2, 1907, a Board to consist of the following-named officers of the Corps of Engineers: Col. Clinton B. Sears, president, Mississippi River Commission, Lieut. Col. William H. Bixby, Lieut. Col. Curtis McD. Townsend, and the following members of the Mississippi River Commission: Mr. Henry B. Richardson, and Mr. Homer P. Ritter, Assistant, U. S. Coast and Geodetic Survey, is hereby appointed to examine the Mississippi River and report as prescribed in the said act.

The Board will assemble at St. Louis, Mo., upon the call of the senior member, and is authorized to visit such other points as it deems necessary for the proper performance of its duties.

Upon the completion of the duty assigned them, the members of the Board will return to their proper stations.

The travel directed is necessary in the military service.

* * * * * * *

By command of Brig. Gen. Mackenzie:

FREDERIC V. ABBOT,
Lieut. Col., Corps of Engineers.

By Special Orders, No. 13, of the same series, dated March 28, 1907, Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary and disbursing officer of the Mississippi River Commission, was detailed as recorder and disbursing officer of the Board.

Subsequently, by authority of the Secretary of War, the following changes occurred in the personnel of the Board:

Col. Wm. H. Bixby, Corps of Engineers, U. S. Army, president, Mississippi River Commission, became, on April 25, 1908, senior member of the Board, vice Col. Clinton B. Sears, Corps of Engineers, U. S. Army, president, Mississippi River Commission, on account of absence on leave of the latter because of illness, and in anticipation of his retirement from active service on June 2, 1908. To fill the vacancy on the Board thus caused, Lieut. Col. James G. Warren, Corps of Engineers, U. S. Army, was appointed.

On November 30, 1908, Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, was relieved by First Lieut. C. H. Knight, Corps of Engineers, U. S. Army, as disbursing officer of the Board. Captain Lukesh continued as recorder of the Board.

Having been unable to make the necessary investigations and studies in time to complete its report by the first Monday in November, 1908, the Board so reported to the Chief of Engineers, with reasons, on October 16, 1908, to comply with the paragraph of the act referred to, reading:

All surveys and examinations provided for by this act, and the reports thereon, shall either be completed on or before the first Monday in November, nineteen hundred and eight, or else a preliminary report be made in which the reasons for delay shall be stated: *Provided*, That all reports of preliminary examinations and surveys which may be prepared during the recess of Congress, and be ready for printing, shall, in the discretion of the Secretary of War, be printed by the Public Printer as documents of the following session of Congress.

On November 25, 1908, the Board submitted a progress report of its operations to that date.

While the Board has been aware of the importance of submitting its conclusions at as early a date as practicable it has considered the problems assigned to it of such vast importance to the country and so difficult of solution as to warrant most careful consideration in preparing a report. A report of field and office operations under the Board is given in Appendix No. 21. To comply with the Board's interpretation of the law, required surveys and investigations that necessarily involved a greater time than was at its disposal prior to the first Monday in November, 1908. These surveys were completed in January, 1909, and the Board has submitted its report as soon as it was practicable to analyze the data before it and formulate its conclusions.

The data of the Mississippi River Commission, placed at the Board's disposal by law, give much valuable information in regard to the physical characteristics of the entire stretch of river under consideration, and the records of the United States Engineer Office at St. Louis

added much for the portion from St. Louis to Cairo. The Board, however, found it necessary to augment such information by a comprehensive survey of the river between St. Louis and Cairo, including topography, hydrography, and an investigation of the depth of bed rock and character of overlying strata; to extend this survey over the entire breadth of the alluvial valley from St. Louis to Cairo; to make a survey of caving banks between Cairo, Ill., and the mouth of the Red River, and also to determine the number of bars below Cairo having less than 14 feet channel depth.

The survey above Cairo was begun with all available plant and field work covering some 200 miles of river and 600 square miles of valley with 136 borings, part in the river and part on land, was finished August 10, 1908. Below Cairo the work could not be completed until the end of the dredging season, in January, 1909.

DESCRIPTION OF THE MISSISSIPPI RIVER.

The physical characteristics of the Mississippi River are described in Appendix No. 1 of this report. Most of the matters bear directly on the subject of the Board's investigations, and a few of the more important points follow, but attention is invited to the entire statement as worthy of notice in connection with this report. This statement covers the following features: Drainage area of the river, its extent, precipitation, soil, etc.; influence of ice on navigation and works of improvement; thickness of alluvium; extent of the alluvial valley; lengths and direction of different stretches of the river; widths and variation in widths of the river; slope of surface at high and low water; depths and changes in depths; floods; volumes of discharge at various points along the river and on the tributaries; sediment in suspension, and character of bed and banks of the river with special attention to caving and erosion, their causes, rates, and effects on the regimen of the river and channel depths.

Attention is especially invited to the following points of this statement:

As to climate; the table of precipitation at selected stations in the drainage basin, compiled by the Weather Bureau from records of sixteen to sixty-two years, shows that the seasonal and geographical variation in the rate of precipitation in the different secondary basins is very great; for example, in the Missouri Basin for a period of twenty-seven years the January and February precipitations averaged but 0.7 inch each, while for June they averaged 5.3 inches. The minimum mean monthly rate in that basin, 0.7 inch in January and 0.7 inch in February, corresponds to a minimum of 2.6 inches in the Ohio Valley at Cairo, Ill., in September and the same in October at Chattanooga, on the Tennessee River. The minimum mean monthly rate shown occurred in the Missouri Basin as mentioned above, and the maximum occurred in the Central Basin at Helena in April, 6.7 inches, as well as at New Orleans in June. The minimum mean annual rate is given at 19.8 inches at Dodge City, Kans., in the Arkansas Basin, and the maximum at 60.3 inches at New Orleans. In the winter months the precipitation at the northern sources of supply is very light and at the southern it is very heavy.

The records of the United States Weather Bureau of rainfall at the various stations in the Mississippi Valley are quite complete for

recent years, but however complete they may be they can afford only a partial index of the amount of water delivered into the streams; permeability of soil, temperature of the air, and many other conditions affecting percolation and evaporation, being factors in determining the ratio of precipitation to river discharge. Thus the Ohio Valley is very different in this respect from the Missouri, where owing to the highly absorptive sandy soil and drying winds, a much smaller percentage of the rainfall finds its way to the main river.

The Missouri, notwithstanding the immense area of its basin, is less important than the upper Mississippi and the Ohio rivers, as concerns the volume of flow throughout the year, but its flood volume is large, and it contributes more sediment than any other tributary.

Ice influences extend as far south as Memphis and at great intervals even farther, interrupting navigation at St. Louis about one month a year, but they decrease as more southern latitudes are reached, until below Cairo interruptions occur in but occasional years, and for but a few weeks.

As to soil and foundations; it appears that the average depth of bed rock below low water is between 50 and 100 feet between St. Louis and Cairo and much greater below Cairo. The margin for securing a 14-foot waterway by deepening its channel is thus ample without recourse to rock excavation. Only at one place, between Thebes, Ill., and Commerce, Mo., was bed rock disclosed within 20 feet of the low water surface, and even there it appears that there is a margin of at least 17 feet below low water over a width of at least 500 feet. On the other hand, the overlying strata were found to be unsuitable as foundation for such heavy structures as fixed dams; and only in the stretch between Thebes and Commerce where this bed rock existed near low water, could suitable foundation be found at a practicable depth.

As to the hydraulics of the river; the variation in the low and high water widths along the course of the river is extreme. Above the mouth of the Ohio River low-water widths have been found ranging from 650 feet to 4,000 feet, and bankfull widths from 1,550 feet to 6,800 feet. Below Cairo low-water widths range from about 1,000 feet to about 6,000 feet, and bank-full widths from less than 2,000 feet to over 10,000 feet.

The area subject to overflow has been much decreased of late years, especially below Cairo, by the construction of levees. It was formerly about 5 miles in width between St. Louis, Mo., and Grays Point, Mo., where the bluffs on either side come close to the river banks and continue so as far as Commerce; below Commerce the area subject to overflow averaged some 40 miles in width, but through the restriction of floods by levees the area above Red River is now but 5 to 10 miles wide, except at the mouths of the larger tributaries where the levee system is incomplete.

The average slope of stretches of the river at high and low stages is given in Appendix No. 1 in tabular form. Reference to the table shows the maximum slope to occur between St. Louis and Cairo, about 0.6 of a foot per mile, gradually decreasing to a high-water slope of about 0.2 foot and low-water slope of about 0.025 foot between Red River and Carrollton, La. Below the latter point the low-water slope is eclipsed by tidal oscillations and the high-water slope is about 0.1 foot per mile.

The average depths along the thalweg of the stream are at low water about as follows:

	Feet.
St. Louis to Cairo	18
Cairo to Memphis	31
Memphis to Vicksburg	37
Vicksburg to Red River	48
Red River to New Orleans	84

A natural 14-foot channel obtains between St. Louis and Cairo for an average period of about one and one-half months, during the months of April to July. Below Cairo the period is much greater, lasting from about January to July, sometimes beginning in December and sometimes lasting into August.

Descriptions of the various classes of caving banks found along the Mississippi River are also given and the general subject of formation of river bars, rise and fall of river bed during changes of water stage, and erosion of banks is treated at considerable length, on account of the importance of this subject in relation to the improvement of the river. It is an important fact that a rise in stage does not produce a corresponding increase in channel depth, for example, a 22-foot stage of water at St. Louis does not produce more than 14 feet available depth between St. Louis and Cairo.

The maximum and minimum observed discharges of the Mississippi at Grafton, St. Louis, Columbus, Helena, Arkansas City, Vicksburg, Red River Landing, and Carrollton, also of the following tributaries, Missouri, Ohio, St. Francis, White, Arkansas, Yazoo, Red, Ouachita, and of the Atchafalaya will be found tabulated in Appendix No. 1. All available discharge data for the Mississippi River between Grafton and Red River will be found tabulated in Appendix No. 18.

PRESENT PROJECTS FOR IMPROVEMENT.

Projects now in force, and those in force in past years for the improvement of the river below St. Louis and the amounts heretofore expended in connection therewith are given in Appendix No. 2. From it the following extracts are taken:

Between St. Louis and Cairo.—The present project is that adopted in 1881 approved by letter of the Chief of Engineers dated March 31, 1881, with some later modifications relative to temporary expedients.

This project contemplated the confinement of the flow of the river to a single channel having an approximate width of 2,500 feet at bank-full stage, this result to be sought by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for this purpose permeable dikes or hurdles of piling to collect and hold the solid matter that is held in suspension or rolled on the bottom of the river; the banks both new and old to be revetted or otherwise protected where necessary to secure permanency. The object of the improvement was to obtain ultimately a minimum depth, at standard low water, of 8 feet from St. Louis to Cairo.

Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent improvement, the low-water channel would be improved by the use of

dredges and other temporary expedients, but the river and harbor act of March 3, 1905, made a radical departure from the project above outlined, practically confining the work of improvement to dredging.

By joint resolution of Congress approved June 29, 1906, the Secretary of War was authorized to expend available balances for the repair or completion of improvements underway, or for the construction of other works in accordance with general plans already made or approved.

The river and harbor act of March 2, 1907, reaffirmed dependence upon dredging as the principal means of improvement; although, as subsidiary thereto, it provided also for the maintenance and repair of existing works of permanent improvement, and finally for the construction of similar works with any portion of the appropriation not necessary for the accomplishment of the improvement by dredging. But as the annual appropriation was reduced to about 40 per cent of that theretofore made, the expenditure in any one year being limited to about $250,000, the only work in present progress is that of dredging.

Between the Ohio River and the Head of Passes.—The improvement of the Mississippi River below Cairo has been in charge of the Mississippi River Commission since 1879. The original project submitted by the commission provided for the narrowing of the low water channel way to an approximately uniform width of 3,000 feet by means of dikes and the revetment of caving banks; these works to be supplemented by levees to confine the flood discharge of the river approximately to its river bed.

The work of improving Plum Point and Lake Providence reaches was undertaken, and the highly beneficial results obtained in improving channel depths in those reaches confirmed the soundness of the theory upon which the work was based, but also demonstrated that the permanent improvement of the channel by contraction and revetment works would necessarily consume a long period of time.

The act of Congress approved June 3, 1896, authorized the use of hydraulic dredges for obtaining and maintaining a channel in the Mississippi River below Cairo with a width of 250 feet and a depth of 9 feet throughout the year, except when the river is closed by ice; and since their construction 10 hydraulic dredges have succeeded in maintaining the project depth and width except for short periods in 1903, 1904, and 1908.

PRACTICABILITY OF CONSTRUCTING AND MAINTAINING A NAVIGABLE CHANNEL 14 FEET DEEP.

The survey for a 14-foot waterway from Chicago to St. Louis, which the Board is to consider in connection with its report, provides for a channel in the Illinois River with a bottom width of 200 feet and in the canal section a width of 160 feet. For the gentle slopes that will exist in the Illinois River and in the canal the Board is of the opinion that these widths will afford a channel that it is practicable to navigate, but that to provide as effective navigation in the swift currents of the Mississippi will require channel widths not less than 500 feet.

MAP OF

MISSISSIPPI RIVER

BETWEEN

ST. LOUIS, MO. AND CAIRO, ILL.

SHOWING IN OUTLINE

THE METHODS OF IMPROVEMENT

CONSIDERED IN

REPORT OF MARCH 20, 1909

BY THE

BOARD ON EXAMINATION AND SURVEY OF MISSISSIPPI RIVER

CREATED BY RIVER AND HARBOR ACT OF MARCH 2, 1907.

SCALE OF MILES

0 6 9 12 18

JUNE 1909

OPEN RIVER IMPROVEMENT BY COMPLETE REGULARIZATION

FOR DETAILS SEE APPENDIX NO. 5 AND ACCOMPANYING DRAWINGS

——— Indicates Natural Banks.

—·—·— Indicates proposed Bankfull Limits.

– – – – Indicates proposed Low Water Limits.

RIVER IMPROVEMENT BY LOCKS AND MOVABLE DAMS

FOR DETAILS SEE APPENDIX NO. 6 AND ACCOMPANYING DRAWINGS

LATERAL CANAL ALONG ENTIRE RIVER-SECTION

FOR DETAILS SEE APPENDIX NO. 7 AND ACCOMPANYING DRAWINGS

COMBINATION OF LATERAL CANALS WITH MOVABLE DAMS.

FOR DETAILS SEE APPENDIX NO. 7 AND ACCOMPANYING DRAWINGS

See Appendix No. 5.

See Appendix No. 6.

See Appendix No. 7.

See Appendix No. 7.

See Chart No. 1.

See Chart No. 2.

See Chart No. 3.

See Chart No. 4.

See Chart No. 5.

See Chart No. 6.

See Chart No. 7.

See Chart No. 8.

See Chart No. 9.

See Chart No. 10.

See Chart No. 11.

See Chart No. 12.

See Chart No. 13.

See Chart No. 14.

See Chart No. 15.

See Chart No. 16.

ILLINOIS

MISSOURI

Kaskaskia Island

Alternate Route.

Grand Tower

Cape Girardeau

Grand Chain

Grand Pt.

Commerce

Mound City

Cairo

Ohio River

Mississippi River

Missouri River

Meramec River

Chester

Craigs Island

Locks and Dams Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9

Locks Nos. 1, 2, 3, 4, 5, 6, 7

Dams Nos. 1, 2, 3

Cairo Bridge

Thebes Bridge

Chain of Rocks Canal

Merchants Bridge

Eads Bridge

Free Bridge

City of Saint Louis

Columbia Bottom

Chain of Rocks

Piasa Bird

Fort Kaskaskia

Fort Chartres

Fort Ellis

Fort Gage

Fort Jefferson

Fort Massac

Fort Defiance

Fort Holmes

Fort Jackson

Fort Kaskaskia

Fort Chartres

Fort Ellis

Fort Gage

Fort Jefferson

Fort Massac

Fort Defiance

Fort Holmes

Fort Jackson

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To obtain and maintain the 14-foot channel on which the Board has to submit its report, the following methods have been suggested and considered:

First. Dredging.
Second. Regularization.
Third. Canalization with movable dams.
Fourth. Canalization with fixed dams.
Fifth. Lateral canals.
Sixth. Reservoirs.
Seventh. Combination of methods.

Dredging.—The surveys of the Board show that between St. Louis and Cairo there existed in 1908 as many as 68 localities that would require dredging to obtain a 14-foot channel and that to dredge a channel 500 feet wide and 14 feet deep at low water would necessitate the removal of 35,000,000 cubic yards of material. Channels thus formed would have a tendency to refill not only on every rise of the river, but on any change in the regimen such as would be produced by an ice gorge, so that extensive dredging operations would be required not only on a falling river, but every spring on the opening of navigation.

To cover such dredging a project has been prepared which shows that to insure the maintenance of such channels, so that navigation will not be obstructed, would require a plant capable of removing about 17,500,000 cubic yards per month. This would necessitate the acquiring of 20 dredges of the type at present used on this stretch of river, with its accompanying plant, at an estimated cost of $6,000,000. The cost of operating and maintaining such a plant is estimated at $2,000,000 per year. The estimates are based upon ten years' practical experience with the St. Louis engineer district dredging plants in this part of the river. Details of this project will be found in Appendix No. 4.

From Cairo to the mouth of Red River, below which an ample depth of channel exists, the surveys made by the Board showed 42 localities in 1907 at which dredging would have been required to obtain a 14-foot channel, and 88 localities during the season of 1908. The period during which dredging operations are required to maintain channels is, however, much shorter in the lower river than above Cairo.

To cover such dredging a project has been prepared which shows that a 14-foot waterway can be maintained between Cairo and Red River by 28 dredges, with their accompanying plant, at an estimated first cost of $9,000,000 and an annual expenditure of $2,100,000 for operation and maintenance. These estimates are based upon many years' experience of the Mississippi River Commission in this part of the river. Details of this project will be found in Appendix No. 9.

Regularization.—Both the project of 1881 for improving the river from St. Louis to Cairo and that of the Mississippi River Commission from Cairo to the Gulf originally provided for its improvement by partial regularization. The river was to be confined to a single channel, caving banks revetted, and the width of channel contracted in wide reaches. By these means the motion of bars downstream was to be prevented and the river currents given such directions as to maintain the proposed depth over the bars, which for the portion of

the river between Cairo and St. Louis was to be 8 feet and below Cairo 10 feet. These projects contemplate no violent change in the regimen of the river, which is allowed to follow the sinuous course to which it naturally tends, with deep pools in the bends, and on the crossings bars which rise and fall with variations in gage height.

There is an ample water supply for a channel 14 feet deep and 500 feet wide from St. Louis to the Gulf at the lowest stages of the river and on existing slopes, but great care will have to be exercised in making so great a contraction as would be necessary to confine the river to a 14-foot channel. As a river is reduced in width and increased in depth a much smaller proportion of the discharge comes in contact with the river bed, and the velocity of the river currents rapidly increases. A condition soon obtains where instead of the bar being alternately scoured out and filled up as the river discharge decreases and increases, there is a constant scour. The dam which nature has placed between the pools is then destroyed. The material which formed this dam is washed into the lower pool, tending to raise it, while the upper pool tends to fall to the same level. If those dams between pools were destroyed for long distances, as between St. Louis and Cairo, a very serious change in the regimen of the river would result. Its slope would be diminished, immense quantities of material would be washed down into the lower river, adding enormously to its bars, filling up its pools, raising its flood levels, and making necessary expensive additions to its levee system; and falls or rapids might be created at the Chain of Rocks above St. Louis, which would be destructive to the navigation of this portion of the river.

A comparison of discharge measurements taken at St. Louis in 1880 and 1881 with those taken in recent years, 1900 to 1904, which are shown graphically in Appendix No. 17, indicates a tendency toward the lowering of the river bed at St. Louis under the existing project, and if the river is further contracted so as to obtain and maintain a depth of 14 feet without dredging, it will be necessary in some manner to limit the process of bar deepening described above.

For this purpose a project has been prepared which proposes to remove local irregularities in the regimen of the river from St. Louis to Cairo. Above Commerce the river is to be given a uniform minimum width of 500 feet at a depth of 14 feet below a zero stage, a width of 1,700 feet at the zero stage, and 3,000 feet at the bank-full stage for most of its length. The bars are to be scoured or dredged to the required depth and the pools are to be filled or allowed to fill so as to produce as nearly as practicable a uniform slope of 0.55 of a foot to the mile, which is the present average slope from St. Louis to Commerce. Below Commerce the bottom width is to be 500 feet, the width at a zero stage 1,500 feet, and at a bank-full stage 2,750 feet, with a uniform slope of 0.76 of a foot to the mile, which is the present average low-water slope between Commerce and Cairo.

To prevent a further deepening of the river, it is proposed to construct submerged dams of brush and rock, whose crests will conform to the section it is desired to give the river below the zero stage, these dams to be spaced at distances varying from three-fourths to 5 miles. The river is to be contracted above low water by permeable and solid wing dams as in the existing project and caving banks are to be revetted; but more care is to be exercised in producing uniform slopes in the river bed for the purpose of directing in the proposed

channel at all stages, the portion of the river current having the maximum velocity.

By this method of improvement considerable dredging will be necessary during the first few years of work; but the amount of dredging will rapidly diminish as the improvement nears completion. The estimated cost of the work is $53,216,480 including maintenance during construction. After completion the annual cost of maintenance is estimated at $500,000. These estimates are based upon over twenty-five years' practical experience with partial regulation in the St. Louis engineer district. Details of this project will be found in Appendix No. 5.

Canalization with movable dams.—In further compliance with the resolution of Congress the Board has considered a plan for obtaining at all seasons of the year 14 feet in the river between St. Louis and Cairo by means of locks and dams similar to those projected and in use on the Ohio River. This project provides for the construction of locks and dams at localities shown on the maps of the Board's survey. The locks have interior dimensions of 600 by 80 feet, conforming to the dimensions of the locks on the 14-foot waterway proposed from Chicago to St. Louis. The movable dams have navigable passes closed by Chanoine wickets having a length of 19.5 feet. These wickets are 1 foot 8 inches longer than those used on the Ohio River, which provide for only a 9-foot navigable channel, and are therefore larger than any that have heretofore been built for river canalization. The regulating weirs constituting the remainder of the dam will also be closed by Chanoine wickets of varying lengths.

The estimated first cost of this project is about $25,000,000, and of its maintenance about $400,000 per year. These estimates are based upon many years' practical experience with similar dams on the Ohio River. Details of this project will be found in Appendix No. 6.

Canalization with fixed dams.—The Board has had an extensive system of borings made throughout the valley from St. Louis to Cairo, and has found but one locality where satisfactory foundations for masonry dams exist except at depths so great as to preclude economic construction. Between Thebes and Commerce a limestone foundation underlies the river within reasonable depth, and a high masonry dam could be constructed that would materially reduce the slopes that exist in the river above as far as St. Louis.

When first constructed such a dam would give the desired 14-foot waterway, but as the reduction in slopes and increase in area of cross section of the river would necessarily diminish the velocity of discharge, there would be a deposit of sediment which would rapidly fill the reservoir thus created. The existing slopes have resulted from natural laws which would remain in operation after the dam was constructed, and the ultimate effect of building a solid masonry dam at this locality would be to raise the entire bed of the river above. Such a dam would moreover largely increase the height of floods, and the cost of the land it would be necessary to condemn would add enormously to the cost of the work.

But if instead of a solid masonry dam which allowed water to flow only over its crest, there were constructed a dam with large openings through it, controlled by suitable valves, through which the entire river discharge could pass even at extreme floods, a large amount of

the sediment instead of being deposited above the dam would flow through it. There would, however, still be a tendency for the river bed above to rise, but at a greatly reduced rate.

The amount of dredging that would be required to maintain a 14-foot waterway under this project would be no greater than with the system of movable dams above described, and this project would possess the great advantage that it would develop water power which could be utilized for industrial purposes.

The Board has investigated in a general way the possibilities of such a project. It has ascertained that such a dam would cause to be flooded 30 towns and villages in the Mississippi Valley, over 240,000 acres of farming land, and over 220 miles of railroad. It is believed that the mere cost of this property would exceed the total cost of the system of movable dams described above. Therefore no project nor estimates for such a dam have been submitted.

Lateral canals.—The Board has also had estimates prepared for the construction of a lateral canal on the Illinois side of the river, from the terminus of the proposed Alton-St. Louis canal to Cairo. The canal is planned to have a bottom width of 160 feet and slopes of one vertical to two horizontal. The locks are to be constructed of concrete and to have clear interior dimensions of 80 by 600 feet. For a single continuous canal the first cost of the work is estimated at about $102,000,000, and the annual cost of maintenance at about $600,000. A large item in the cost of such continuous canal consists of the land damages and cost of bridges in the vicinity of East St. Louis, and the cost of the very heavy excavation on the Illinois side through bluffs above and below Chester and also through the gorge of the river between Thebes and Commerce, and the cost of an aqueduct bridge across the Kaskaskia River. By crossing the river to avoid the heavy excavation near Chester and the aqueduct over the Kaskaskia and placing a short section of the canal on the Missouri side of the river, the first cost of the above canal project can be reduced to about $76,600,000. These two projects have not been worked out in detail because the costs were considered excessive.

By using a portion of river near East St. Louis, another portion opposite the Kaskaskia and Chester, and a third from near Cape Girardeau to Commerce, the cost can be much further reduced. Careful estimates of cost have been made for such a combined canal and river route with three canal sections connected with three river sections in pools held up by dams, the canals being located entirely on the Illinois side of the river.

According to this latter project there are 18.1 miles open river from the Eads Bridge to the Meramec River, thence a canal 39.8 miles in length to the Kaskaskia River, thence open-river navigation for 16.1 miles to the foot of Crains Island, thence a canal 45.2 miles to head of Devils Island, thence 18.9 miles of open-river navigation to Commerce, thence 15.5 miles of canal to Pond Lily Crossing, and thence by river to mouth of Ohio River 7.7 miles, the river navigation to be secured by three movable dams. The location of the works is shown on the maps accompanying this report. The estimated first cost is about $36,000,000, and the annual cost of maintenance about $450,000. The estimates conform to the same general conditions as to construction and prices as were adopted for the similar proposed canal from

Alton, Ill., to St. Louis, reported upon in 1905. Details of these projects will be found in Appendix No. 7.

Reservoirs.—The theory of the method of improvement of a river by reservoirs is that the flood waters can be impounded in large quantities at the headwaters of the streams in such way as to reduce flood heights in the lower reaches of the same streams; and that these waters, stored until the low-water season, can then be so discharged as to raise the low-water surface of the river and increase the navigable depths. This method of improvement was introduced many years ago on the upper Mississippi River above St. Paul, and five reservoirs have been built with an area of 480 square miles, and a storage capacity of over 93,000,000,000 cubic feet. More reservoirs and more storage capacity were at first recommended, but so far Congress has not considered favorably the extension of the system. This system of artificial reservoirs is one of the largest in the world so far constructed for regulating river discharge for navigation purposes, and yet the increase in height thereby obtained at St. Paul during the low-water period, about ninety days, averages only 14 inches, the results so far noted ranging from 40 inches maximum increase in height in 1900 to 5 inches minimum increase in 1903. The river at St. Paul has a low-water width of only 400 feet and an average low-water discharge during the season of navigation of but 2,500 cubic feet per second. The effect of the reservoir system diminishes as the river becomes wider, and finally disappears at the head of Lake Pepin, 51 miles below St. Paul.

In order to obtain the effects above named as reported at St. Paul, it has been found necessary to commence the discharge of water from the reservoirs considerably in advance of the low-water stage at St. Paul, owing to the length of time that is necessary for the water to traverse the intervening river. After the discharge has been commenced at Lake Winnibigoshish, its effect is not specially felt at Lake Pokegama, the distributing reservoir, 63 miles farther downstream, until after an interval of twenty-one days at low water, nor at St. Paul, 351 miles below Lake Pokegama, until after a further interval of ten days. In order to use this reservoir system for the benefit of the improvement of the river below St. Louis, it would be necessary to commence the discharge at the reservoirs at least two months before it was needed at St. Louis, and a still greater interval would be necessary for the benefit of improvement of the river below Cairo. Experience does not justify such long forecasts, and the service of the reservoirs would necessarily have to be based on general annual averages, an unreliable and unsatisfactory basis. There have been occasions in the past when unexpected floods in the summer time would have been aggravated by any large additions from upper reservoirs. In order that reservoirs may give reliable service, they should be so located as to diminish time of water flow to a minimum. In the case under consideration this would necessitate the location of the reservoirs in the lower valleys of the tributaries, where the land is of great value, and such location would add enormously to the cost of the reservoir system, even if it were practicable.

While this method of improvement has been successful on the upper Mississippi near St. Paul to the limited extent above described, a further extension of its application to a river of the dimensions of

the Mississippi below St. Louis is attended with serious difficulties and must necessarily give results much less beneficial.

Theoretically a water supply is available above St. Louis sufficient to increase largely the low-water discharge of the Mississippi River at and below St. Louis. Special investigations recently made as to the maximum possibilities of the Mississippi River reservoir systems above the mouth of the Missouri River, with special view to water power development by private parties, gave results shown in Appendix No. 8. It there appears that the maximum reservoir facilities of the river, including 10,000 cubic feet per second that may come through the Chicago Sanitary Canal and Illinois River, as recommended by the International Waterways Commission, amount to about 69,500 cubic feet per second for ninety days, equal to about 540,000,000,000 cubic feet total storage.

Moreover, a dam could be constructed across the mouth of the Illinois River, with a height of only 27 feet above low water, to produce a reservoir over 227 miles in length in a valley in which over 400,000 acres have been subject to overflow in the past during extreme floods.

Investigations by the Corps of Engineers have shown that such reservoir systems in the Allegheny River Basin would cost about $415 per million cubic feet total storage, in the Monongahela River Basin about $416, and in the Kanawha River Basin about $370. While the reservoirs at the headwaters of the Mississippi River have been constructed at low cost, the location of reservoirs at such points as would promise any reliable supply of water to the lower river would have to be under conditions as to cost similar to those just named.

In the Upper Mississippi River near St. Paul, where the river banks and bed are of comparatively solid material, an increase of 14 inches, or even 40 inches, in gauge heights, does not produce sufficient current to cause serious motion in the gravel bars which there largely form the bed of the river, so that the increase in depth produced near St. Paul is a direct function of the river discharge; but in the Mississippi River below St. Louis any increase of discharge accelerates the currents and sets in motion the light sands which constitute its bed, to the injury of the channel, as verified by a careful examination of a great number of reliable soundings made in the Mississippi River below St. Louis. The results of these examinations, as shown by diagram accompanying the report on physical characteristics of the river (Appendix No. 1), indicate between St. Louis and Cairo a rise of the river bed on the controlling bars equal to about one-half the rise of water stage until at least 14 feet depths are reached, which corresponds to a 22-foot stage on the St. Louis gauge. Such rise of the river bed indicates that the maximum of 540 billion cubic feet total storage which might be obtained by reservoirs in the Mississippi River Basin from the Illinois River upward could not maintain throughout the year more than 8 feet available depth between St. Louis and Cairo, the increased discharge from the reservoirs tending to create a wider channel rather than a deeper one, and being useful, therefore, only as an auxiliary to other methods of improvement. To hold the water stage at St. Louis at 22 feet, the stage corresponding to a controlling depth of 14 feet between St. Louis and Cairo, would require over 5,000 billion cubic feet annual storage, or about ten times what has yet been found possible.

Combination of methods.—The Board has considered the securing and maintaining of a channel of 14 feet depth between St. Louis and Cairo by completing the project of 1881 for 8 feet depth and then securing the additional 6 feet depth by dredging instead of by further contraction. The estimated cost of completing the project is $21,000,000 (see Appendix No. 3) and the cost of dredging plant for obtaining the additional 6 feet is estimated by the Board at $3,600,000, and the cost of maintaining the improved channel at $1,500,000 per year.

Considering the stretch of the river below Cairo, a project has been prepared to secure permanence of bank lines and channels during progress of the dredging previously estimated, by which such dredging will be reduced. This work has been estimated to cost $95,000,000, with an annual maintenance charge of 5 per cent of the amount expended (see Appendix No. 9). The estimate for dredging is $9,000,000 for plant and $2,100,000 annually for operation. These estimates are based upon many years' experience of the Mississippi River Commission in this part of the river; but the maintenance of the bank protection so far done has included that of much experimental work which has necessarily required excessive repair, and it is believed by the Board that in the comprehensive plan proposed the maintenance charge should be largely reduced; moreover, the cost of dredging will materially diminish as the bank protection progresses, and the total annual cost of maintenance should not exceed $5,000,000 when the bank protection is complete.

Discussion and conclusions.—The estimates of cost accompanying the several projects considered by the Board have been prepared with great care and based upon the best data available. In works of such magnitude of this nature, however, it is not possible to make estimates which can be fairly considered as more than approximations of the most general character.

As already stated, the Mississippi River has in the regular boat channel at low water an average depth through pools and across bars of about 18 feet from St. Louis to Cairo, thence 31 feet to Memphis, thence 37 feet to Vicksburg, thence 48 feet to Red River Landing, and over 80 feet below Red River Landing. But the depths which control navigation are the depths over the worst bars; and if all improvements should be stopped so as to allow the river to revert to a natural condition, such controlling depths would be at low water about 4.5 feet in the reach from St. Louis to Cairo, and about 6.5 feet in the reach from Cairo to Red River.

The quickest and most economical method of deepening any bar is by dredging, until the amount of excavation becomes excessive. The four dredges now in service between St. Louis and Cairo have for many years, through the entire season of navigation, except occasionally for a few days, successfully maintained a good channel of at least 8-feet depth throughout the entire reach. The nine dredges in service below Cairo have for many years maintained a good channel of at least 9-feet depth under similar conditions. The Board considers that these controlling depths can, with reasonable certainty, be increased up to 12 and possibly 14 feet at the lowest stages of water throughout the reach above Cairo and to 14 feet below Cairo, in the manner described under the head of dredging. But any improve-

ment obtained by dredging alone must be recognized as temporary in its results.

In order to secure permanence of channel in open-river navigation it must be protected by works of regularization, after which the annual dredging may be reduced in amount and restricted mainly to emergencies. The existing project of 1881, from St. Louis to Cairo, is one of river regularization, well adapted to this part of the river. The Board considers that this 1881 project, if completed as originally proposed, should permanently increase the controlling depth at low water to 8 feet, and that a further increase to 14 feet can be secured by dredging. But if permanent depths greater than 8 feet at low water are to be obtained the bed of the river, as well as its banks, must be protected.

The Board considers that the method of improving the open river below St. Louis by regularization is feasible, in harmony with all past successful river improvement in the United States and Europe, can be applied first to the worst sections of the river, and will give the best permanent results to navigation attainable in the river.

The Board does not recommend slack-water navigation obtained by the use of dams, either fixed or movable, for the river below St. Louis.

The Board is of the opinion that 14 feet depth can be obtained with certainty by a lateral canal; but a continuous canal from St. Louis to Cairo is considered altogether too expensive, a river crossing would be of doubtful permanence, and the project making partial use of the river is considered open to the objections applying to improvement by dams; the same objections apply more forcibly to a canal below Cairo.

The Board considers the method of improvement by reservoirs, for reasons stated under that heading, to be at the present time impracticable. There is no case on record known to the Board where such method adopted solely or even principally for purposes of navigation has given results commensurate with the expenditure.

As stated later, in the discussion of the desirability of a 14-foot waterway, the Board is of the opinion that the proposed waterway is adapted to neither lake nor ocean vessels, and that if constructed would be followed by an immediate demand for a channel of greater depth. In case it should become necessary to obtain increased depth, canals, dams, and complete regularization works would have to be modified under great difficulties and at great cost. Canal locks would have to be rebuilt and canal trunks deepened and partially relocated. Movable dam wickets, already larger than any yet built, would become more difficult of manipulation and their operation perhaps impracticable, and the substructure would have to be rebuilt. Cross sills of complete regularization work would have to be taken out and rebuilt at lower levels in the channel way, or extensively raised outside the channel way. In each case the difficulty and cost of securing the increased depth would, of course, be much greater than if the extra depth were obtained at the time of first construction. The method of improvement by partial regularization, combined with dredging, will be the method least seriously affected by future changes in depth, breadth, and location of the navigable channel.

After considering the advantages and defects of all the methods of improvement proposed, the Board concludes that the most prac-

ticable method of obtaining and maintaining a navigable channel of 14 feet depth from St. Louis to Cairo is by the completion of the project of 1881 for partial regularization in such way as to secure a permanent controlling depth of 8 feet, and then to rely upon dredging for securing and maintaining any further increase of depth; the side contraction works to be so located as to be in harmony with further works of improvement by complete regularization, if in future such works be found necessary and advisable.

The Board rejects, as opposed to all reason, all propositions requiring the abandonment of the already good open-river navigation or the substitution of a lateral canal for any part of the river below Cairo. The surveys of the Board and Mississippi River Commission indicate that nearly 1,000,000,000 cubic yards of material annually fall into the river from caving banks, an amount greatly in excess of the sediment brought into the river by all its tributaries. While but a comparatively small percentage of this material is deposited on the bars, the prevention of such an enormous mass of silt from entering the river must eventually reduce the amount of dredging required. No permanence of channel depth or of location of channels, levees, wharves, landing places, or other terminal facilities can be expected until after the banks have been effectively protected. Dredging and bank protection, with the addition at certain localities of contraction works, as an auxiliary, will achieve these results which can not be obtained by dredging alone, and is therefore, in the opinion of the Board, the most practicable method of improvement.

The estimated cost of this work above Cairo is $24,600,000, and $1,500,000 per annum for maintenance; and below Cairo $104,000,000, and not exceeding $5,000,000 per annum for maintenance.

PRESENT AND PROSPECTIVE COMMERCE.

The Mississippi River Commission collects and reports annually the commerce of the river below St. Louis. The Bureau of Statistics of the Department of Commerce and Labor makes similar reports of the entire river and tributaries. These reports are considered by the Board the most reliable ones obtainable; and extracts from these are given in Appendix No. 20. During the calendar year 1908 an actual shipment of about 1,300,000 tons of coal came out of the Ohio River, of which about 180,000 tons went up the Mississippi to St. Louis. Outside of the Ohio River coal, the average movement of water freight during the year at all points on the river between St. Louis and New Orleans was about 400,000 tons downstream and 300,000 tons upstream. This commerce of the river has been rapidly diminishing in recent years. The total river tonnage of St. Louis was, in 1886, 1,332,885 tons; in 1896, 1,244,175 tons; in 1906, 416,855 tons; and in 1908, 365,920 tons, of which not over 49,530 tons was with towns on the Mississippi below Cairo. The entire commerce of the Mississippi River system, including all tributaries except the Ohio, was reported in 1889 as 12,492,535 tons; while in 1906 it was only 4,304,288 tons; showing a loss of two-thirds. The 1908 river commerce of the system, so far as reported, shows a slight decrease as compared with that of 1906, except as to a few of the minor tributaries.

Although, as explained in Appendix No. 20, the Board has sought to obtain from the commercial organizations along the route from Chicago

to New Orleans, information as to the prospective commerce which requires a 14-foot navigation, it has received very little definite information in that direction. No actual large future development of commerce is yet in sight. The demand for increased depth appears to be more conjectural than real, and to be based mainly upon the idea that a deep-water channel will of itself cause development of commerce, and that the Federal Government should consequently provide depth considerably in excess of what is actually needed, on the ground that business follows facilities, and that the rivers and harbors doing the largest business and doing it most efficiently are those that have kept their facilities ahead of actual requirements.

The Chicago public (see 1909 reports of the Chicago Harbor Commission) claims that Chicago is destined to become one of the greatest commercial and industrial centers of the United States, and that with its free access to the Great Lakes, and a deep waterway to the Gulf, it will be able to send to South America and to the Pacific Ocean, via the Panama Canal, large quantities of manufactured articles (especially those of iron and steel) from factories to be established at the south end of Lake Michigan. They claim also that the existence of a 14-foot depth outlet from the Great Lakes to the ocean through Canada demands a similar outlet through the United States, and that this should be by way of the Mississippi Valley; and further, that the opening of a 14-foot route, even to empty boats, would allow a transfer of lake boats, now idle through the winter, to southern waters, and so cheapen and develop commerce between Gulf ports.

The Upper Mississippi public claims that a deep waterway from the mouth of the Illinois River to the Gulf will encourage the shipment down the Mississippi River of ores and flour from Minnesota and Iowa, and coal from Illinois, along with miscellaneous manufactured goods. The Missouri River Valley public, together with the people of the States of the Great Plains, claim that a deep waterway below St. Louis will, after the Missouri River has been further improved, facilitate the shipment of farm products, oil, and minerals, from the Western States to the Gulf.

Indiana has coal which it hopes to deliver to a southern market.

The people of the States bordering on the lower Mississippi appear to claim that a deep waterway will facilitate the present shipments of coal, steel, and manufactured products from the Ohio River down the Mississippi, and will also encourage an upstream navigation, at least as far as St. Louis, of ore and other minerals from Alabama and the neighboring States, as well as cotton, tobacco, sugar, agricultural implements, fertilizers, and foreign imports; some parties assuming that cotton will be sent for manufacture to northern mills, rather than to mills to be established later in the South; also that the Mississippi River Valley (including the Ohio and Missouri), rich in natural resources, still sparsely settled, and but little developed compared with Atlantic States, is susceptible of rapid and great further development with influx of population and money.

The St. Louis Lakes-to-the-Gulf Deep Waterway Association and the St. Louis Merchants Exchange (see letters in Appendix No. 20) claim that a large amount of the commerce now carried by rail parallel to the Lakes-to-the-Gulf route would be transferred to a deepened river, and that this transfer would leave the railroads free to take up an equal quantity of freight which they are now unable to handle

because of restricted transportation facilities; and also that a deeper waterway between St. Louis and Cairo would bring more coking coal from the Ohio to St. Louis.

The prospect of an early completion of the Panama Canal also appears to be a prominent argument for deeper draft, the idea being generally that this canal will put the Mississippi Valley, in such easy connection with South America and the Pacific as to cause a great development of export trade, a large part of which Chicago and St. Louis hope and expect to control.

DESIRABILITY OF A 14-FOOT WATERWAY.

If a 14-foot waterway from Chicago to the Gulf would enable vessels of the Great Lakes to carry freight to cities and towns of the Mississippi Valley and the Gulf of Mexico, and enable ocean commerce to be carried up the river without breaking bulk at New Orleans, both general and local commerce would be greatly benefited.

The Board on the survey of a 14-foot waterway from Lockport to St. Louis invited attention to the fact that two-thirds of the tonnage of vessels entering the Chicago River were of so great a draft that they would be unable to utilize a 14-foot waterway if constructed.

This Board has further investigated this subject.

During the season of 1907 of a freight tonnage of 58,217,214 tons which passed through the canals at the Sault Ste. Marie, only 800,000 tons were in vessels of a registered draft of 14 feet or less, 10,400,000 tons were in vessels of a registered draft of from 14 to 19 feet, and 47,000,000 tons in vessels of 19 feet registered draft or over, of which 33,000,000 tons were carried in vessels capable of being loaded to depths exceeding 21 feet. The navigation through the locks at Sault Ste. Marie was congested, and as many vessels as possible were locked through the Weitzel lock, which is capable of handling vessels not exceeding 15 feet in draft; 27 per cent in number of the vessels passed through this lock having a gross tonnage of 13 per cent, but carrying only 3 per cent of the total freight (1,772,701 tons). Most of this tonnage was of vessels without cargoes.

When the Illinois legislature in 1889 advocated a 14-foot waterway from Chicago to the Gulf, Canada could reach the upper lakes by the Welland Canal, 14 feet deep, and the navigation of the Great Lakes was generally in vessels which might possibly utilize such a channel, but the rapid increase in depths of the harbors and channels of the Great Lakes has radically changed conditions. Since 1902, bulk freighters have been launched at the various shipyards of the Great Lakes, having an aggregate tonnage of over 1,500,000 tons, and capable of carrying in a season on the Great Lakes over 30,000,000 tons of freight. On a 14-foot waterway these vessels could barely carry the necessary fuel supply required for a trip of about 1,600 miles from Chicago to the Gulf.

At the present time the value to commerce of a 13-foot harbor on the Great Lakes is entirely incommensurate with the cost of maintenance. To be accessible to even the smaller available vessels, a harbor should have a depth of at least 16 feet.[a]

During the past twenty years the channels to harbors along the Atlantic and Gulf coasts have been excavated to even greater depths than those of the Great Lakes, and but a comparatively small por-

[a] See Report of Chief of Engineers, 1908, p. 1965.

tion of the ocean-borne commerce of the United States could utilize a 14-foot waterway. Nor are ocean and lake vessels as economic a means of transporting products on rivers and canals as barge tows. Due to the necessity of building the ocean vessel of sufficient strength to resist violent storms her cost in the United States is about $71 for each ton of freight carried. On the Great Lakes vessels are exposed to storms of less violence, and the cost is about $41.50 per ton of freight carried. A Mississippi River steamboat and ten barges capable of transporting 10,000 tons of freight on an 8½-foot draft can be built for about $12 per ton of freight carried.

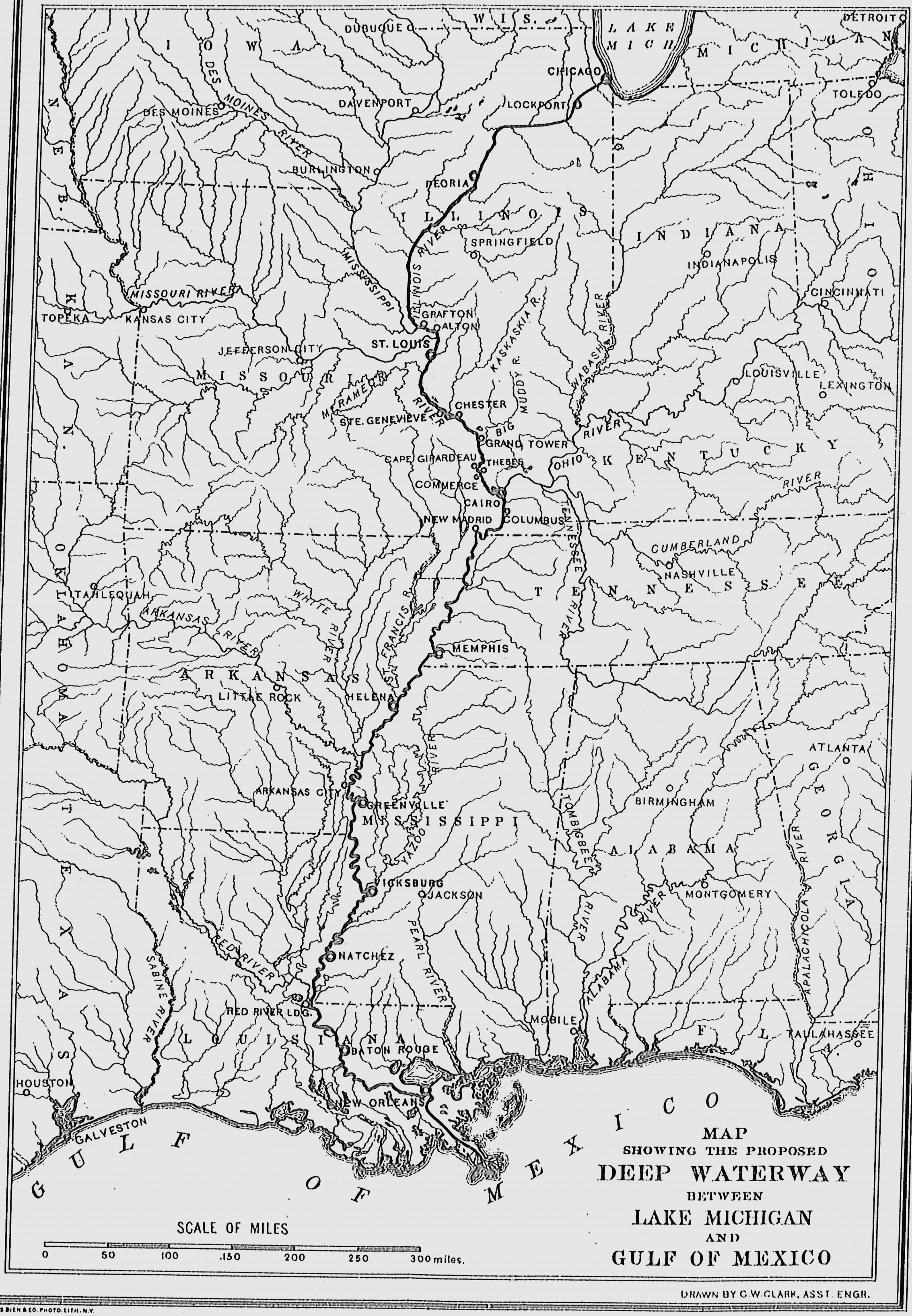
A modern lake freighter, moreover, is poorly constructed for navigating a tortuous river with a swift current. The ratio of length to beam is too great and the rudder power insufficient. Such vessels have been developed for a special purpose, and while affording a most economic method of transporting freight on the Great Lakes, would be a failure if employed in either ocean or river navigation.

The Board is of the opinion that a 14-foot waterway is suitable for neither existing lake nor ocean vessels; that freight originating on lake or gulf will require transshipment to vessels adapted to its navigation, and that its principal value will be to provide for commerce that originates along its banks, or those of its tributaries, until the introduction of some form of vessel adapted to all conditions of navigation. When such a vessel shall be designed, there will be an immediate demand for a channel of greater depth than 14 feet.

WHETHER OTHER PLANS OF IMPROVEMENT CAN BE DEVISED BY WHICH THE PROBABLE DEMANDS OF TRAFFIC, PRESENT AND PROSPECTIVE, CAN BE ADEQUATELY MET.

It is the opinion of the Board that the present demands of traffic are adequately met by the existing projects for improving the river, and that only the creation of a commerce, which must originate from sources that do not at present ship by river, would justify the great cost of a 14-foot waterway. The present condition of this waterway appears to have been generally overlooked, and few people who have not specially examined it realize what has already been accomplished.

In the Mississippi River, as at present improved, there usually exists, and has existed since 1901, a good navigable channel of at least 8 feet depth over at least 200 feet width for the 182 miles of river between St. Louis and the mouth of the Ohio River; and of 9 feet depth and 250 feet width for the 790 miles from the mouth of the Ohio River to just below the mouth of the Red River; and of at least 30 feet depth and several hundred feet width for the remaining 320 miles to the Gulf. During the low-water season when the shoaling of some crossing took place suddenly through rapid fluctuations in river stage at a time when the dredging plant was engaged elsewhere minor deficiencies in channel depths for short periods have occasionally occurred. In the winter season navigation has been interfered with by ice for periods aggregating, above Cairo, only about one month per year, and from Cairo down to Memphis only a few weeks in occasional years. A good channel of at least 14 feet depth can usually be found every year between St. Louis and Cairo during from



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one to two months, and between Cairo and the Gulf during from five to eight months.

The existing improved waterway of the Mississippi River below St. Louis fully equals, and over the greater part of its extent far excels, in depth and duration of unobstructed use, the existing river systems of Europe where the nontidal sections are usually given depths of only 3 to 9 feet, 9 feet being exceptional and 10.5 feet a maximum.

The immense commerce of the Rhine could be carried more readily and cheaply on the Mississippi to-day than on the Rhine, if such commerce were available for transportation by water and demanded such transportation.

The decline in the commerce of the river has not arisen from its lack of navigability but from the reduction in amount of material available for shipment. When a large proportion of the grain was raised east of the river, St. Louis was a natural outlet to grain and other farm products seeking Gulf ports, and a flourishing commerce existed between St. Louis and New Orleans by water, but at the present day 70 per cent of the wheat and 50 per cent of the corn of the country are raised west of the Mississippi. Kansas City, Omaha, and Minneapolis have become the great grain centers. Grain and other farm products seeking Gulf ports find a rail line from Kansas City to Galveston which is cheaper than a rail transportation to St. Louis increased by the cost of river transportation from St. Louis to New Orleans, and the only grain that can move down the river is that locally consumed along its banks.

The Mississippi River from St. Louis to New Orleans flows through a sparsely settled country. According to the census of 1900 there was between these points but one town on its banks of over 15,000 inhabitants (Memphis), and but six others with a population exceeding 5,000. The manufacturing industries, or demands for manufactured articles, in so thinly a settled region are slight. There are no mineral deposits along its banks, and its agricultural products are principally corn, cotton, sugar cane, and rice. The alluvial soil of the Mississippi Valley, with the heavy rainfall of this region, renders its common roads almost impassable, so that a long haul to or from the river bank becomes very expensive, and confines the commerce of the river to those products raised or expended on its immediate banks.

While the Panama Canal may have a tendency to divert more commerce to a northerly and a southerly direction than heretofore, it will be principally in high-grade articles, and not in crude products, which experience has shown are adapted to water transportation.

Ninety-seven and one-half per cent of the commerce which passed through the canals at Sault Ste. Marie in 1907 consisted of iron, coal, lumber, and grain. In a thickly settled community, such as is found along the Hudson River, a heavy water-borne commerce may develop in building material, such as stone, brick, lime, and cement, but with the small population in the Mississippi Valley below St. Louis, the transportation of these items would be insignificant. It is considered probable that if a deeper waterway existed from Chicago to the Gulf, the principal additions to existing commerce would be coal from Illinois moving toward New Orleans and lumber from the South toward Chicago.

As was shown in a report on a survey of the Ohio River, House of Representatives Document No. 492, Sixtieth Congress, first session,

products can be cheaply transported on barges having a draft of 8½ feet. It has been estimated that coal can be shipped in barges from Pittsburg to New Orleans on a 9-foot canalized river at 0.376 of a mill per ton-mile, while the estimated cost of transportation on the ocean in vessels of 21 feet draft is 0.35 of a mill per ton-mile.

Finished products seek rail transportation, and the only effect of navigable waterways upon their transportation is a possible reduction or control of freight rates. The existing improvement of the Mississippi River has had a marked effect on freight rates between St. Louis and New Orleans, reducing them nearly to those between St. Louis and New York. These latter rates have resulted from the influence of the Great Lakes and the Erie Canal on the competing Chicago rates; similarly, the influence of the Mississippi River on southern rates from St. Louis affects those from Chicago south, and but little reduction can be expected from a further deepening of the river.

The Board is of the opinion that the development of the waterways of the Mississippi Valley into a harmonious system will be of immense value to the country, but the Ohio Valley has been and probably will continue to be the line of greatest commerce; and probable demands of commerce, present and prospective, for many years to come, can be adequately met by a channel of 9-feet depth between Chicago and Cairo, of dimensions similar to those proposed for the Ohio River, a project which requires no violent change in existing methods of improvement, and which will not necessitate the diversion from the Great Lakes of a water supply which will injuriously affect the channels through which its immense commerce passes.

SPECIFIC QUESTIONS OF CONGRESS.

So far as known to the Board, the greatest depth so far sought by regulation in a nontidal river is 3 meters (9.8 feet), to which depth the lower Rhine is at present being improved. The Board is of the opinion that the Mississippi River from St. Louis to Cairo is susceptible of improvement to the same depth; but to obtain a greater increase in depth by regulation works alone is problematical and without precedent.

A plate at the end of Appendix No. 1 shows graphically the changes in the heights of bars due to fluctuations in water stage in the Mississippi River from St. Louis to Cairo between the years 1896 and 1909 and indicates under present conditions 1 foot average rise of bar for every 2 feet rise in the river, giving for the average stage (12.6 feet) of the river a controlling depth of about 9 feet, and showing that a stage of 22 feet is necessary for a 14-foot channel. The conditions are much the same from Cairo to Red River. Basing its opinion on the above and other local conditions, the Board reports on the specific questions contained in the act of March 2, 1907, as follows:

First. It is practicable to produce between St. Louis and Cairo at low water by means of regulation works a channel of at least 10 feet depth.

Second. A depth of at least 14 feet will obtain in such regulated channel at the average stage of water for the year, 12.6 feet on the St. Louis gauge.

Third. Fourteen feet depth of water will obtain in such regulated channel for at least an average of 163 days annually.

Fourth. The increase of depth which will be obtained by an added volume of water over the natural flow in such regulated channel will be much less than the increase in water stages, and between St. Louis and Cairo this increase in depth at low-water stages will be not more than 6 inches for 10,000 cubic feet per second nor more than 8 inches for 14,000 cubic feet per second, while at high-water stages the increase will be less. Below Cairo this increase in depth will be much reduced for low-water stages and will be inappreciable at high-water stages.

With the banks revetted, so that the supply of material to the bars is reduced to a minimum, the height which bars will attain during floods should materially diminish. On the improved Rhine River the ratio of the rise of bar to the increase in gauge height is reported as 1 to 3. What the ratio would be on an improved Mississippi must remain conjectural until actually tested.

Fifth. It will not be practicable to produce at all seasons of the year a depth of 14 feet in such regulated channel by the aid of locks and dams similar to those projected and in use on the Ohio River improvement without extensive annual dredging.

Sixth. Regarding the water power to be created and the lands to be drained in the portion of the Mississippi River which the act of March 2, 1907, directed to be surveyed and in the proposed waterway from Lockport, Ill., to St. Louis, Mo., heretofore surveyed, the Board reports as follows:

This Board submits no project for creating water power, nor does it propose to drain any lands on the portion of the river directed to be surveyed.

The Board which submitted a report in 1905 upon a waterway from Lockport, Ill., to St. Louis, Mo., recognized the riparian rights of property holders and proposed a channel which would interfere with those rights as little as practicable, and its plans did not contemplate the drainage of any lands in the Illinois Valley. On the contrary, the Board invited attention to the fact that the diversion of 10,000 cubic feet per second from Lake Michigan into the Illinois River would cause extensive damage to the lands subject to overflow, for which the sanitary district of Chicago would be liable; and its estimates appear to have been prepared on the assumption that this district was to settle such claims for damages. The Board evidently considered the diversion of more than 10,000 cubic feet per second as unnecessary and undesirable. It further stated that with the limited discharge of about 4,200 cubic feet per second which was all that had been authorized prior to 1905, 224 suits had already been brought against the trustees of the district, the claims aggregating $4,409,180.

A large water power can be developed by the diversion of either 10,000 or 14,000 cubic feet of water per second from Lake Michigan into the Illinois River, but its utilization as at present proposed by the State of Illinois will require radical changes from the project contained in the 1905 report, and will involve serious legal difficulties if the Government of the United States attempts to conserve such power.

An available horsepower, aggregating 173,000 between Lockport and Utica with a discharge of 14,000 cubic feet per second, is to be developed under a project submitted by the Internal Improvement Commission of Illinois, February 27, 1907, and subsequently indorsed

by the governor and the people of the State; but this project is a most radical departure from the project of 1905, and contemplates a lowering of the level of the river below Utica of about 10 feet. The nine locks of the Board's project are to be replaced by five with a corresponding increase in the heights of dams, and while the Board proposed to disturb the flood conditions as little as possible, the State asserts that "these should be disturbed as much as possible," and apparently assumes that the United States will accept responsibility for damages caused by overflow in the Illinois Valley. The proposed lowering of the river bed of about 10 feet below Utica will render necessary instead of the excavation of the 27,535,805 cubic yards of material, estimated by the Board as necessary between Utica and Grafton, at first the excavation of some 190,000,000 cubic yards of material ultimately to be increased to between 300,000,000 and 400,000,000.

It is only by some such modified project that the lands in Illinois Valley can be drained by gravity, but the Board can suggest no method by which the cost of the improvement can be defrayed, in whole or in part, by the land benefited. On the contrary, it is of the opinion that if the United States accepts such a proposition it might be compelled to pay for the lands on which it would have to deposit this immense mass of dredged material, and to pay also for supposed damages from floods.

Under such circumstances, the Board considers that the question of land reclamation and of the conservation of the same, between Chicago and the mouth of the Illinois River, should be left entirely to the State of Illinois; that the Federal Government should neither require nor accept from the State or the sanitary district any payment for any increase in valuation of such lands, and that it should in no way relieve the State or the sanitary district from the responsibility for overflow of lands by the Lake Michigan water diversion, the cost of flowage damages being a proper charge against the income from the available water powers developed by such water diversion.

The sites available for power purposes on the Des Plaines and Illinois rivers are now owned by the State of Illinois, the sanitary district of Chicago, large corporations, and private individuals, and their titles to power rights will have to be extinguished before the Government can intervene to conserve the power it is proposed to develop. By modifications in the project submitted by the former Board that will be in harmony with its report, this Board is of the opinion that 100,000 horsepower can be developed by the diversion of 10,000 cubic feet per second.

The experience of the General Government in renting power rights has not heretofore been such as to justify the Board in assigning in general a fixed value per horsepower year for such rights. Water powers are reported to have been leased by the Federal Government at rates as low as about $0.65 per horsepower year by the Forestry Bureau, for the first five years, at the Cascade Mountains, and $0.53 to $2.65 by the War Department on the Muskingum River, Ohio, these low rates being accepted because they were the best offered. In other cases, as on the White River, Arkansas, where water power was available for lease and coal was sold at about $3.75 per ton in car-load lots, the best offers (not accepted) have been from $0.50 to $1 per gross horsepower year. On the other hand, where water power is in great demand, and can be sold in small quantities, a net horsepower

at the turbines is understood to have brought as high as $75 per year. Water power is particularly valuable near large commercial centers like Chicago. The Sanitary District of Chicago and the State of Illinois, in presenting the matter to the public for vote on the question of a $20,000,000 bond issue, have valued this water power between Chicago and the Illinois River as worth at reasonable valuation, $25 per horsepower year, these figures being indorsed not only by the sanitary district of Chicago, but by the Illinois State Internal Improvement Association and by the governor. Under such circumstances, it seems proper that the Federal Government should assume, in its dealings with the sanitary district of Chicago and the State of Illinois, the principal beneficiaries, that the net horsepower developed by 10,000 cubic feet per second diverted from Lake Michigan should produce a revenue of $2,500,000 per year.

The Board considers that the property owners along the canal and Illinois River are equitably entitled to the water power due to the natural flow alone of the Des Plaines and Illinois rivers, and that any power which results from an added flow diverted from Lake Michigan belongs to the people of the United States and Canada.

The Board is of the opinion that the United States will receive adequate compensation for the water-power created by the diversion of the water of Lake Michigan now authorized by the United States War Department to the Sanitary District of Chicago, and the latter will also be adequately compensated for its expenditures upon canal and water power, by an agreement between the United States and the Sanitary District under which the canal shall be opened to free navigation and so maintained by the district, said district to enjoy free use of the power so created, until the aggregate value of said power shall equal the cost of canal and power construction; after which the United States shall receive from the beneficiaries a percentage of the net profits from the water power so developed as a compensation for the resulting injury to navigation on the Great Lakes and connecting waters and loss of water power on the Niagara and St. Lawrence rivers, such percentage to be fixed by Congress.

In conclusion the Board deems it fitting to express its appreciation of the ability, energy, and care with which its recorder, Capt. G. R. Lukesh, Corps of Engineers, has performed the arduous duties devolved upon him in directing the field work, office computations, mapping, and compilations necessary to the preparation of this report.

Respectfully submitted.

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The CHIEF OF ENGINEERS, U. S. ARMY.

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NOTE.—Duplicate set of maps[a] of the Mississippi River below Cairo published by the Mississippi River Commission on a scale of 1 inch to 1 mile, Sheets Nos. 1 to 32, inclusive, is forwarded with the report for the use of reviewing officers.

[a] Not printed.

APPENDIX NO. 1.

PHYSICAL CHARACTERISTICS OF THE MISSISSIPPI RIVER.

[Prepared by the recorder under direction of the Board.]

In connection with its report on the improvement of the Mississippi River below St. Louis, the Board deems it desirable to give the following brief statement of those physical characteristics of the Mississippi Valley that are pertinent to the subject-matter of the investigations assigned to it:

The drainage basin of the Mississippi River extends from the Alleghony Mountains to the Rocky Mountains and from Winnipeg and the St. Lawrence watersheds to the Gulf of Mexico. The area of the basin is given at 1,240,050 square miles, about 41 per cent of the area of the United States exclusive of Alaska and outlying possessions.

The areas of the secondary basins that go to form the Mississippi River Basin are given in the volume entitled "Floods of the Mississippi River," 1897 (U.S. Weather Bureau), as:

Designation.	Area.	Percentage of whole.
	Sq. miles.	
Missouri Basin	527,150	43
Ohio Basin	201,700	16
Arkansas Basin	186,300	15
Upper Mississippi Basin	165,900	13
Red Basin	90,000	7
Central Valley	69,000	6
Total	1,240,050	100

The Central Valley is the basin of the Mississippi River proper between the Missouri River and the Gulf of Mexico. This part of the river is frequently considered in two sections, that between the Missouri and Ohio rivers being designated as the "middle Mississippi," and the part below the Ohio being called the "lower Mississippi;" the section above the Missouri River is called the "upper Mississippi." The middle Mississippi receives drainage from about 14,000 square miles of the Central Valley.

Of the great basins forming the Mississippi Valley the Missouri is by far the largest, but is, comparatively, a dry region, in part even arid; the upper Mississippi has a moderate rainfall; the Ohio Basin is within the zone of heavy precipitation, and though its area is less than half as great as that of the Missouri Basin it contributes about three times as much water to the Mississippi River during the year.

The table on page 32 gives the average monthly precipitation at selected stations in the secondary basins; it will be noticed that the annual rainfall is very different at these various stations and that at the same station the monthly rate varies during the seasons, the greatest variation being in the Missouri Basin. The average rainfall shown for these stations does not, of course, necessarily give the averages for the whole basins.

The records of the United States Weather Bureau of rainfall at the various stations in the Mississippi Valley are quite complete for recent years, but however complete they may be they can afford only a partial index of the amount of water delivered into the streams; permeability of soil, temperature of the air, and many other conditions affecting percolation and evaporation being factors in determining the ratio of precipitation to river discharge. Thus the Ohio Valley is very different in this respect from the Missouri, where, owing to the highly absorptive sandy soil and drying winds, a much smaller percentage of the rainfall finds its way to the main river.

Normal monthly and annual precipitation, in inches, at selected stations in the basin of the Mississippi River.

Drainage basin.	Station.	Years of record.	Jan.	Feb.	Mar.	Apr.	May.	June.
Missouri River	Omaha	27	0.7	0.7	1.5	3.1	4.5	5.3
Upper Mississippi	St. Paul	39	1.0	.9	1.5	2.5	3.5	4.1
Do	Davenport	26	1.7	1.6	2.2	2.8	4.2	4.2
Central Mississippi Valley	St. Louis	60	2.2	2.7	3.4	3.7	4.7	5.0
Do	Memphis	26	5.5	5.2	5.9	5.4	4.4	4.6
Do	Helena	20	6.1	5.2	6.6	6.7	4.5	4.7
Do	Vicksburg	42	5.3	4.9	5.5	5.3	4.4	3.9
Do	Baton Rouge	24	5.1	4.6	5.0	4.7	4.5	5.0
Do	New Orleans	26	5.1	4.4	5.3	5.2	4.8	6.7
Ohio	Cincinnati	62	3.3	3.3	3.5	3.3	4.0	4.4
Cumberland	Nashville	32	5.0	5.0	5.2	4.7	3.9	4.3
Tennessee	Chattanooga	18	6.4	5.6	5.8	4.5	4.1	4.7
Ohio	Cairo	25	3.7	3.9	3.8	3.8	4.1	4.4
Arkansas	Dodge City, Kans.	22	.4	.6	.9	1.8	3.1	3.3
Do	Little Rock	16	4.9	5.3	5.2	4.8	5.8	4.3
Red	Shreveport	25	4.7	4.2	4.6	5.2	4.2	3.7

Drainage basin.	Station.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Missouri River	Omaha	4.6	3.3	3.0	2.6	1.1	1.0	31.4
Upper Mississippi	St. Paul	3.3	3.8	3.2	2.0	1.3	1.1	28.2
Do	Davenport	3.6	3.6	3.2	2.6	2.0	1.6	33.3
Central Mississippi Valley	St. Louis	3.8	3.5	3.1	2.8	3.1	2.8	40.8
Do	Memphis	3.4	3.5	3.1	2.7	4.8	4.1	52.6
Do	Helena	4.5	3.5	3.9	2.4	4.8	4.6	57.5
Do	Vicksburg	4.5	3.4	3.3	2.6	4.7	4.9	52.7
Do	Baton Rouge	6.3	5.9	4.2	3.2	5.5	5.6	59.6
Do	New Orleans	6.4	6.0	4.6	3.3	4.1	4.4	60.3
Ohio	Cincinnati	3.9	3.8	3.0	2.8	3.3	3.5	42.1
Cumberland	Nashville	4.3	3.6	4.1	2.7	3.9	3.5	50.2
Tennessee	Chattanooga	4.1	4.1	3.7	2.6	4.0	4.3	53.9
Ohio	Cairo	3.4	2.8	2.6	2.7	4.2	3.2	42.6
Arkansas	Dodge City, Kans.	3.2	2.8	1.3	1.3	.5	.6	19.8
Do	Little Rock	4.0	4.1	3.2	2.5	5.3	4.3	53.7
Red	Shreveport	3.4	2.1	3.7	3.2	4.7	4.5	48.2

It will be noticed in this table that in the winter months at the northern sources of supply the precipitation is very light, while at the more southerly stations the winter precipitation is very heavy. Very rarely does the maximum precipitation occur simultaneously at both northern and southern stations, and there is no recorded instance when heavy rains have occurred over the whole watershed of the Mississippi at the same time.

In the Ohio Basin the annual rainfall is 43 inches, and the proportion of rain which goes into the rivers is about 30 per cent. The Upper Mississippi has a rainfall of 34.7 inches with a run-off ratio of 27 per cent. The Missouri has respectively 19.6 inches and 12 per cent.[a] From these figures it appears that the Missouri, notwithstanding the immense area of its basin, is the least important of the three great tributaries in regard to volume of flow throughout the year; but its flood volume is large and it contributes also the greatest amount of solid matter, in the form of sediment, to the Mississippi River.

The northern part of the St. Louis to the Gulf section of the river is subject to the influence of ice; it is reported to have been frozen over as far south as Memphis, Tenn. But the principal interference with navigation and injury to works of river improvement from this source are due to running ice. Periods of running ice occur almost every year, of varying length, depending upon weather conditions. During the past forty-two years navigation has been suspended in the vicinity of St. Louis on account of ice as early as November and as late as March. The average length of time per year is thirty-one days according to the records of the St. Louis Merchants' Exchange. Below St. Louis conditions in this respect improve, and south of the Ohio River interference with navigation by ice is of quite rare occurrence.

Borings made by different boards of engineers and by the Mississippi River Commission show that the alluvial bed of the river, especially south of Cairo, is of great

[a] Rainfall and run-off taken from Greenleaf's "Hydrology of the Mississippi."

thickness. It seems to be only in a few isolated localities that the present river scours down to bed rock, and that throughout there is a considerable margin in the alluvium for an increase in channel depth. A line of borings made by this Board along the channel from St. Louis to the mouth of the Ohio disclosed no bed rock within 40 feet of the low-water line of the river except between Thebes, Ill., and Commerce, Mo., where (considering a channel 500 feet in width), in places along some 3 miles of river bed rock approaches to within about 17 feet of low-water surface. Beaver Dam rock, 1 mile below Commerce, is a sandstone formation, believed to be isolated and to overlie the clay. Bacon rock, a formation said to be similar to the chalk bluffs at Columbus, Ky., and an obstruction to navigation in the Ohio River near its mouth, was removed many years ago. Old surveys show another isolated rock formation, in the old channel of the Mississippi River above the mouth of the Ohio River. There is also a stratum of ferruginous sandstone near Memphis, the top of which is above extreme low water; the rock in the river bed about 5 miles below Memphis, known as Nonconnah rock, is probably a fragment of this formation. Above Cairo and below St. Louis the general depth of bed rock below low water is from 50 to 100 feet; a profile accompanying the Board's report gives the information in detail.

In the stretch below Cairo, the greater depth of bed rock is evident from borings and investigations, reports on which will be found in the Annual Report of the Mississippi River Commission for 1881, pages 139–168. A discussion of the "Blue Clay of the Mississippi River," by Doctor Little, will be found in the Annual Report of the Chief of Engineers for 1883, pages 2315–2339, and an analysis of the borings, by Professors Hilgard and Hopkins, in the Annual Report of Chief of Engineers for 1884, pages 2885–2903. Further information will also be found in the annual reports of the Mississippi River Commission for 1882, 1889, and 1903.

The river for the entire distance from St. Louis to Commerce, Mo., flows through an alluvial valley of a fairly uniform width of about 5 miles, except for the "gorge" between Grays Point and Commerce, where the width is less than 1 mile. From just below the Missouri to Ste. Genevieve, about 70 miles, the river follows the Missouri bluffs; it then crosses to the Illinois bluffs, which it skirts fairly closely for about 14 miles; returning to Missouri bluffs at Red Rock it follows them at a distance of less than a mile down to Cape Girardeau, some 42 miles. Between Cape Girardeau and Grays Point the river passes for 4 miles the low land forming the head of the St. Francis Basin, and at the latter point enters the "gorge," where the river is closely confined between bluffs on either bank. The gorge is about 7 miles in length. The bluffs on either side are generally of limestone with some sandstone formation. Below Commerce the alluvial valley widens out and takes in the extensive St. Francis Basin on the right bank, then the White River Basin on the same bank, then the Yazoo on the left and again the Tensas and Atchafalaya basins on the right bank, an average width of about 40 miles.

The low-water channel length of the river from St. Louis to the mouth of the Ohio (2 miles below Cairo gauge), as determined by the Board's survey, is 182 miles, the air-line distance is 125 miles. In this section the river flows in a generally southeasterly direction. From Cairo to the mouth of Red River, about 790 miles, channel distance, and 440 miles, air line, the direction is generally southwesterly; thence to the mouth 321 miles by river, channel distance, and 210 miles, air line, the direction is southeasterly. The general direction of the river from its source in Minnesota to its mouth is southerly, and it is contained within the meridians 89° W. and 95° W., and the parallels 48° N. and 29° N.

An important feature of the Mississippi River below St. Louis is the variations in its widths along its course. Between St. Louis and Cairo the recent survey made by this Board showed a low-water width corresponding to the zero stage on the St. Louis gauge as small as 650 feet, as at Ables Point (170.5 miles below Eads Bridge, St. Louis), and as great as 4,000 feet, about 1 mile above Prices Landing (153.4 miles below Eads Bridge). Similarly the ordinary or "standard" low water (4-foot stage on the St. Louis gauge) shows widths in the stretch ranging from 800 feet at Ables Point to 4,900 feet at the head of Grand Tower Island (104.3 miles below Eads Bridge). The bank-full stage (30 feet on St. Louis gauge) varies from 1,550 feet just below Devils Backbone (89.6 miles below Eads Bridge) to 6,600 and 6,800 feet at the head of Grand Tower Island, and at Greenleaf Bend (169 miles below Eads Bridge) and at other localities. The freshet stage widths are considerably greater, the flood of 1844 extending practically from bluff to bluff, an average distance of about 5 miles. This flood width has since been gradually encroached upon in places by levees and other artificial structures, but only to a small extent.

Below Cairo similar variations in widths are found. Low-water widths as small as 1,000 to 1,500 feet and as great as 6,000 to 7,500 feet have been found at several locali-

ties. At bank-full stages the widths likewise vary from less than 2,000 feet up to 10,500 feet. Generally speaking, the width of the river becomes more uniform in the lower section, and averages somewhat less than the widths in the upper reaches. The area below Cairo subject to overflow was formerly of an average width of some 40 miles, but is now, through the construction of a general levee system, much reduced. Through a large part of the distance the river floods are confined within levees along and near both banks, and through another large part between a levee on one bank and highlands skirting the other, giving an average restricted flood width of about 5 to 10 miles, decreasing to about 2 miles in the lower section. Where the levee system is not wholly effective, as at the mouths of the larger tributaries, the freshet widths increase through backwater; and failure or overtopping of the levee would, of course, increase the freshet width through overflow to an extent, possibly 10 to 30 miles, dependant on the flood height and the character of the topography surrounding the point of failure.

The average slope of river surface in different sections below St. Louis, Mo., is shown in the following table:

Station.	Distance between stations (mid-bank).	Stage above Gulf level.		Slope between stations.	
		High water.	Low water.	High water.	Low water.
	Miles.	*Feet.*	*Feet.*	*Foot per mile.*	*Foot per mile.*
St. Louis, Mo.		421.82	377.90		
	175			0.563	0.616
Cairo, Ill.		323.21	270.04		
	230			.429	.385
Memphis, Tenn.		224.47	181.52		
	369			.341	.384
Vicksburg, Miss.		98.64	39.66		
	154			.291	.238
Mouth of Red River.		53.77	2.97		
	192			.180	.024
Carrollton, La.		19.29	−1.73		
	82			.154	
Fort Jackson, La.		6.62	−1.38		
	17			.079	
Near Head of Passes.		5.27			

NOTES.—The low-water slope St. Louis to Cairo in the above table is affected by ice; free of such influence, it is slightly greater.

The low-water slope below Red River is masked by the Gulf tide and is therefore omitted.

The average low-water depth along the thalweg of the stream is as follows:

	Feet.
St. Louis to Cairo	18
Cairo to Memphis	31½
Memphis to Vicksburg	37
Vicksburg to Red River	48½
Red River to New Orleans	84

A natural channel depth of 14 feet or more may, in the St. Louis to Cairo stretch, be expected to occur during the months of April to July, with occasional periods of brief duration at other times of the year. The average length of time is about one and one-half months per year. Below Cairo a channel of such least depth obtains during a greater period of the year, from about January to July, sometimes as early as December and as late as August, with occasional short intervals during other months. The average period is from six to seven months.

[As an illustration of depths that are to be found in the river below Cairo, the following tables have been prepared, giving the periods when 8 to 14 feet channel depths occurred. It should be remembered that the Mississippi River Commission was carrying on dredging operations to maintain a 9-foot channel, and that but for these operations less depths than those shown would doubtless have occurred and the duration of depths less than 9 feet would have been greater.]

Low-water season, 1908, between Cairo and Memphis.

Date.	Stage above mean low water, Fulton gauge.	Corresponding least depths in stretch of river.	Navigation.							
			Closed by ice.	Limited by river having less depths than—						
				14 feet.	13 feet.	12 feet.	11 feet.	10 feet.	9 feet.	8 feet.
1908.	*Feet.*		*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days*
July 22	14	15.5								
July 27	13	13.5								
August 2	12	12.5								
August 5	11	11.5								
August 11	10	10.8								
August 14	9	10.5								
August 19	8	10.5								
August 27	7	10.2								
September 4	6	11.0								
September 11	5	9.0								
September 15	4	9.0								
September 20	3	9.0								
September 25	2	8.0								
October 5	1	9.0	None.	[a] 163	157	149	139	61	14	None.
October 27	0	9.0								
November 1	1	10.0								
November 2	2	10.3								
November 4	3	10.5								
November 10	4	10.7								
November 14	3	10.5								
November 18	2	10.4								
November 23	1	10.0								
December 2	2	10.0								
December 4	3	11.0								
December 7	4	11.0								
December 14	5	11.0								
December 19	4	10.5								
December 21	3	10.6								
December 28	3	11.0								
December 31	4	12.0								
1909 January 10	4	14.0								

[a] The duration of depths given in these columns does not agree exactly with the corresponding intervals in the second column on account of slight oscillations in stage which are not evident with 1-foot intervals.

REMARKS.—From January 1, 1908, to July 25, 1908, depths greater than 14 feet at all times, except that a decline of the river, beginning about January 24 and ending about February 7, resulted in least depths of 13.5 feet at Island 35 Crossing and 11 feet at Corona and Uzzells according to surveys of that date. The duration of depths less than 14 feet was probably less than a week.

NOTE.—Fulton gauge was selected on account of being nearest the controlling bars—M. L. W.=mean of lowest waters of the years 1892–1901, inclusive, and =+3.5 on Fulton gauge.

Least depth in stretch derived from a table of most authoritative least depths observed throughout the season (July 22, 1908, to January 15, 1909) by assuming uniform change in depths between observations.

Low-water season, 1908, between Memphis and Red River.

Date.	Stage above mean low water, Memphis gauge.	Corresponding least depths in stretch of river.	Navigation.									
			Closed by ice.	Limited by controlling bars having less depth than—								
				14 ft.	13 ft.	12 ft.	11 ft.	10 ft.	9 ft.	8 ft.	7 ft.	6 ft.
1908.	*Feet.*		*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*	*Days.*
July 28.....	17	20.2										
August 3.....	16	18.4										
August 5.....	15	16.2										
August 11.....	14	14.0										
August 14.....	13	12.5										
August 18.....	12	10.8										
August 22.....	11	9.9										
August 29.....	10	9.9										
September 8.....	9	9.2										
September 13....	8	8.6										
September 16....	7	8.3										
September 20....	6	7.8										
September 25....	5	7.2										
October 5.....	4	6.4										
October 17.....	3	6.2										
November 1.....	3	8.2	None.	140	137	134	122	71	54	40	23	None.
November 2.....	4	9.0										
November 3.....	5	9.4										
November 4.....	6	10.0										
November 12.....	7	10.6										
November 14.....	6	11.0										
November 18.....	5	10.3										
November 24.....	4	9.2										
December 4.....	5	9.0										
December 5.....	6	9.0										
December 7.....	7	9.0										
December 14.....	8	9.0										
December 20.....	7	9.0										
December 22.....	6	9.0										
December 27.....	5	12.0										
December 30.....	6	14.0										

REMARKS.—There is no record of depths less than 14 feet between January 1, 1908, and August 12, 1908, but they may have occurred at one or two bars for a few days in February during the exceptional decline of river in that month.

NOTE.—Memphis gauge was selected on account of being nearest the controlling bars—M. L. W.=mean of lowest waters of the years 1892–1901, inclusive, and =+0.9 on Memphis gauge.

Least depth in stretch derived from table of most authoritative least depths observed throughout the season (July 22, 1908, to January 15, 1909) by assuming uniform change in depths between observations.

Although the floods of the river do not form the subject of the Board's report, yet, on account of their influence on the low-water channel and on regulation works, they can not be left out of consideration.

The natural result of the greater volume of water flowing in the river at the higher stages is to produce immediately greater channel depths, to the advantage of navigation. But the high-water channel rarely coincides with the low-water channel, and not only does an increase in stage usually fail to give an equal increase in the low-water channel depth, but a return to lower stages frequently finds the former low-water channel wholly or partly obliterated. Until the scouring effect of the water can produce a new low-water channel, or, sometimes, combine many minor channels, the controlling depth is less than at an equal stage before the rise. The new low-water channel on the crossings, the critical localities from the viewpoint of navigation, is usually in approximately the same position as before the rise, but often is above or below and at times at considerable distance from its former position—this, of course, at localities where works of improvement are not present to guide the stream into its proper channel.

The most injurious effects on the controlling low water depths result from a speedy fall in the river after a prolonged and considerable rise, the most beneficial effects of scour are produced by a uniform moderate flow of long duration.

The influence of the shifting character of the sides and bottom on channel depths is set forth at greater length later in this paper.

The Ohio and its affluents form a system by themselves, lying for the most part in the ordinary paths of the moisture-laden Gulf storms which sweep from the southwest in the early months of the year. The upper Mississippi and the Missouri are generally frozen during the early rises of the Ohio and usually have their floods about the time those of the Ohio have run out, but cause high water in the Mississippi River between the Missouri and the Ohio rivers and moderately high stages below the Ohio. The Mississippi River below Cairo is thus usually maintained at high or moderately high stages by successive contributions from different sources and this high and medium stage period generally lasts from about the beginning of the year to about August. Between St. Louis and Cairo the river is at or above medium stages from about April to August.

The greatest reliably recorded flood in the Missouri and Upper Mississippi rivers, and in the Middle Mississippi as far down as Price Landing (mile 153), that of 1844, did not produce as high a stage at Cairo as those produced by the Ohio River floods of 1882, 1883, 1884, and many other years. The flood of 1858 was caused by the combined floods of the Middle Mississippi and Ohio rivers (Humphrey and Abbot's Report), but was not as high as a number of later floods at Cairo.

Floods that pass Cairo frequently meet others coming from the lower tributaries producing greatly increased flood effects in the lower river.

The following table gives the greatest and least measured discharges at selected stations on the Mississippi River and its principal tributaries, with corresponding gauge heights. As the measurements were not always, especially in the earlier years, taken at highest or lowest stage, a column of extreme gauge readings at the corresponding points is given for reference. In appendix 18 will be found tabulated all available discharge data pertaining to the Mississippi between Grafton and the Red River.

Maximum and minimum observed discharge of Mississippi River at selected stations.

Station.	Discharge (cubic feet per second).						Highest and lowest known stages.		
	Date.	Gauge reading.	Channel.	Overbank.	Total of river.	Mean velocity in feet per second.[a]	Date.	Gauge reading.	Referred to Gulf level.
		Feet.						*Feet.*	
Grafton, Ill.	June 11, 1903	28.70	317,000	48,000	366,000	2.79	June 11, 1903	28.70	432.99
	January 11, 1881	2.50	25,000	.....	25,000	1.19	December 9, 1895	− .90	403.39
St. Louis, Mo.	May 21, 1892	35.20	1,146,000	.....	[b]1,146,000	12.15	June 28, 1844	41.40	421.82
	February 5, 1900	0.00	35,000	.....	[c]35,000	2.45	January 2, 1900	− 2.52	377.90
Columbus, Ky.	February 22, 1882	48.60	1,603,000	.....	1,603,000	8.14	February 26, 1883	45.58	312.54
	November 8, 1897	2.20	71,000	.....	71,000	1.11	November 6–8, 1895	.05	267.01
Helena, Ark.	Feb. 3, 1907	49.90	1,631,000	60,000	1,691,000	7.49	April 4, 1897	51.75	193.93
	October 24, 1895, p. m.	− 1.10	88,000	.....	88,000	2.44	November 8–9, 1895	− 3.00	139.18
Arkansas City, Ark.	March 16, 1903	50.40	1,737,000	7,000	1,743,000	7.54	March 27–8, 1903	52.96	149.65
	October 12, 1895, a m.	− .70	103,000	.....	103,000	2.32	November 9–10, 1895	− 3.60	93.15
Vicksburg, Miss.	April 15, 1897	51.95	1,746,000	31,000	1,777,000	7.02	April 16, 1897	52.48	98.64
	October 26, 1895	− 4.70	97,000	.....	97,000	2.50	November 13–4, 1895	− 6.50	39.66
Red River Landing, La.	March 31, 1882	48.30	1,595,000	.....	(d)	6.78	May 14–15, 1897	50.20	53.77
	November 17, 1895	− .30	94,000	.....	94,000	2.16	November 14, 1895	− .60	2.97
Carrollton, La.	May 21, 1897	18.60	1,351,000	2,000	1,353,000	7.48	March 29 April 5–6, 1903	19.42	19.29
	December 30, 1904	.15	158,000	.....	158,000	1.10	December 27, 1872	− 1.60	− 1.73

[a] Overbank discharge not considered.

[b] This observation is not regarded as reliable as others in this table. The maximum discharge at St. Louis, under favorable conditions, was 611,000 measured July 3, 1903, at a stage of 31.3 feet on the St. Louis gauge. The maximum above Cairo for 1903 was measured at Thebes, about 142 miles below St. Louis, on June 14, and was 1,014,000, corresponding to a stage of 38 feet on the St. Louis gauge.

[c] Another observation made December 9, 1897, St. Louis gauge reading −0.1 foot, gave 24,000, but is considered less reliable than the one here given.

[d] At higher stages the entire discharge of the Mississippi River does not pass Red River Landing, but part reaches the Gulf by way of Old River and the Atchafalaya.

NOTE.—The gauge reading given is that of the standard gauge at the station unless otherwise noted.

Maximum and minimum observed discharge of principal tributaries of the Mississippi River.

Station.	Discharge (cubic feet per second).						Highest and lowest known stages.		
	Date.	Gauge reading.	Channel.	Overbank.	Total of river.	Mean velocity in feet per second.[f]	Date.	Gauge reading.	Referred to Gulf level.
		Feet.						*Feet.*	
Missouri River at St. Charles, Mo.	June 19, 1908, p. m.	30.32	543,000	3,000	546,000	9.44	High water, 1844	39.95	454.11
	February 20, 1879	6.30	24,060	.....	24,060	2.79	1879	3.50	417.56
Ohio River at Paducah, Ky.	January 21, 1882	46.40	1,233,000	.....	1,233,000	5.76	February 23, 1884	54.25	340.51
	November 3, 1882	3.10	54,000	.....	54,000	1.30	October 30-November 4, 1895.	−0.70	285.56
St. Francis River near mouth.	March 8, 1883	[a] 46.90	373,000	.....	373,000	7.80	April 14, 1897	[a] 51.75	193.93
	November 17, 1896	[a] 6.90	768	.....	768	.50	November 8-9, 1895	[a] −3.00	139.18
White River at Clarendon, Ark.	April 6, 1906	33.08	72,906	137,134	210,040	4.02	March 20, 1890	36.63	175.73
	June 20, 1879	6.80	5,962	.....	5,962	1.09	November 22, 1887	4.07	143.17
Arkansas River at Little Rock, Ark.	June 11, 1904, p. m.	29.40	440,089	.....	440,089	9.95	May 21, 1892	31.20	252.93
	October 20, 1897	2.60	1,160	.....	1,160	.91	October 23-24, 1879	1.80	223.53
Yazoo River near Chickasaw Bayou.	March 18, 1884	[b] 46.50	161,322	.....	161,322	3.82	April 16, 1897	[b] 52.48	98.64
Yazoo River near mouth.	November 20, 1897	−2.60	2,462	.....	2,462	2.86	November 13-14, 1895	[b] −6.50	39.66
Red River at Alexandria, La.	July 2, 1908	41.50	205,000	5,000	210,000	5.79	July 5-6, 1908	41.80	85.98
	November 19, 1894	−1.80	3,143	.....	3,143	1.12	September 29, 1881	−3.70	40.48
Ouachita River at Monroe, La.	June 1, 1892	37.80	56,182	.....	56,182	2.24	1874	49.10	80.07
	1872	[c] 1.00	800	.....	800	.....	September, November, 1897, 1899, 1901.	0.00	30.97
Atchafalaya River at Simmesport, La.	May 12, 1890	[d] 44.40	479,908	.....	479,908	7.46	May, 1897	[d] 47.32	53.11
Neita, La.	December 23, 1904	[e] 3.60	10,586	.....	10,586	.59	November 12-13, 1894	[e] 1.00	1.44

[a] Helena gauge.
[b] Vicksburg gauge.
[c] Above low water.
[d] Simmesport gauge.
[e] Melville gauge.
[f] Overbank discharge not considered.

NOTE.—The gauge reading given is that of the standard gauge at the station unless otherwise noted.

The area of the alluvial valley below Commerce, Mo., overflowed during the 1882–1884 floods was estimated at 29,740 square miles; during the flood of 1903 the overflowed area was but 6,820 square miles, the reduction being due to the extension and improvement of the levee system during intervening years.

The levee system, now still nearer completion, held successfully the floods of 1907 and 1908 over the entire stretch from Cairo to the mouth except at the mouths of large tributaries, where the resulting overflow is attributable to the floods of the tributaries and backwater from the main river. A crevasse, it may be remarked, occurred below New Orleans in 1907, and another in 1908 and the water also escaped through 5 small gaps below New Orleans made by the Gulf storm of September, 1906, but the overflowed territories were of insignificant area.

The levee system by confining the flood waters of the river, and its auxiliary works of bank protection by reducing caving of banks exert a beneficial influence on the channel depths, which influence may be expected to increase as the levee system approaches perfection.

The early maps of the Mississippi River, by Lieutenant Ross, 1765, by Captain Pitman, 1768, by Captain Young, 1821, and by General Collot, 1826, compared with maps of surveys of the Mississippi River Commission shows that the river has been materially shortened by cut-offs during the intervening century, largely compensated by erosion at other points. The "Navigator," a pilots' guide published at Pittsburg in the early part of the last century, gives much information concerning the river of that period, and it is believed was the first authority to designate islands below Cairo by numbers.

The Mississippi River from St. Louis to the Gulf is typically a river with an unstable bed—that is, one of caving banks and shifting bottom. No river in the world, under improvement for purposes of navigation, equals it in the magnitude of its bed disturbances. The same conditions of unstable bed extend up its principal tributary, the Missouri, from St. Louis to the mouth of the Yellowstone; also, in a lesser degree, up the Ohio River to Louisville; and in a still lesser degree up into the Upper Mississippi River a considerable distance above the mouth of the Missouri, but the differences between the conditions in the Missouri and the Upper Mississippi are so great that the unstable conditions of the latter are of comparatively small account.

The extent and variety of caving banks on the Mississippi are not realized, as a rule, even by members of the engineering profession, unless they have had the opportunity of inspecting the river during all its stages, high, mean, and low; and the subject is even less understood by the general public. On this account a brief description of such banks seems advisable.

Caving banks may very properly be classified as eroding banks, slumping banks, sinking banks, and sliding or slipping banks, and these four classes of banks are markedly different from each other in general appearance, origin, or both.

An eroding bank is one where the whole side of the river bank from the water surface downward to the foot of such bank on the river bottom, in the channelway next such bank, is gradually wearing away under the scour of the moving water. The typical eroding bank is one whose soil is not cohesive enough to withstand the attack of the ordinary currents natural to the mean and low water stages of the river. Erosion is not dependent upon high water and freshets, but is to be expected at any stage of water wherever the river current approaches the river bank at a decided angle with the general line of bank in straight reaches, and with the tangent to the curve of the bank in bends. Little erosion is to be expected where the river current is parallel to a straight bank, even though it be close to such bank. The erosion increases with the current, and especially with the angle of its approach. Unless an eroding bank be specially protected, any increase of stage will usually increase the erosion. In bends the maximum erosion is either at the point of first impact of the current or else near that part of the bend about, or a little below, the center, where the current is strongest. In uniform bends and homogeneous soil the erosion often proceeds uniformly, quietly, and steadily throughout the entire length of the bend; but if a deep gouge suddenly occurs at any point, the full current then striking the lower side of the gouge will extend it rapidly downstream till its depth gradually decreases to nothing. In aggravated cases within the past twenty-five years the erosion has been known to cut the bank back a distance of 500 feet in three months at one place, 800 feet in a single year at another, and 1.5 miles in sixteen years at a third place, all at points of severest attack, and in some cases to affect a continuous length of as much as 8 miles of bank in a single bend. Existing Mississippi River Commission maps of the river valley indicate that similar erosion in past centuries has been responsible for river bends which have gradually cut as much as 5 or 6 miles into what was originally solid bank.

The erosion of banks on the Mississippi is much more extensive than is realized by casual observation from passing boats. What the casual observer notices is mainly the

erosion of the visible bank, which rarely stands more than 20 to 40 feet high above the low-water line. The main and most serious erosion is that of the unseen submerged bank below the low-water line, reaching from that line down to the deepest part of the channel, a distance which may easily be from 20 to 45 feet vertically between St. Louis and Cairo, 30 to 90 feet between Cairo and the mouth of the Red River, Louisiana, and from 50 to 140 feet between there and the Head of the Passes, giving a depth of erosion little imagined by the general public. The slope of the eroding bank below low-water line depends on the nature of soil and force of the current, and while commonly about 1 on 2 (1 foot vertically for every 2 feet horizontally) between St. Louis and the Gulf, may vary anywhere between 1 on 4 in soft soils with gentle currents to 1 on 1 in stiffer soil and stronger currents and even to a vertical or overhanging bank in tough soil or semirock.

As the erosion progresses the bank becomes undercut at the water surface until the upper portions break away and fall into the river. Eroding banks are therefore usually manifest to passengers on passing boats in the shape of low earth bluffs; in which case the freshness of its broken surface and sometimes the height of a bluff serve as a partial measure of the progress of the erosion; the volume of eroded material being, however, mainly dependent on the depth of erosion below the water surface.

Should the upper portions of the eroding bank, below the water surface, be protected from such erosion by tougher strata or a covering of any sort, then only the lower portions of the bank erode and the upper portions are undermined until they tumble down and in their broken condition are carried off by the current; after which the uniform erosion proceeds gradually as before.

During erosion a small part of the soil is actually dissolved by the water and remains permanently in solution; a large part (the lighter portion) is taken up as sediment in suspension; and the rest (the heavier portion) is rolled along the bed of the river until it gets away from the full force of the current, when it piles up on the river bed in the form of a bar. Wherever the current slackens, the heavier sediment is deposited to assist in the bar formation or to build up the river banks on the noneroding side of the river.

As the river rises in freshet the total erosion increases somewhat, the increase being due to the increased area exposed directly to the action of the water as well as to the increased current; but, since the freshets and high waters are limited in duration while the low-water erosion continues steadily throughout the year, it is the low-water erosion which is most to be feared and which needs the most attention. Wherever the erosion below the low-water line can be stopped, the erosion above the low-water line can usually be easily handled.

In some cases where the river slope is unusually steep or the river width unusually contracted, the erosion may extend over the river bed itself and sometimes even from bank to bank, especially if the bed is of less resistant material than the banks. In such cases the erosion occurs sometimes only at high water, filling up again at low water; sometimes at low water, filling up at high water; and sometimes at one or the other stage without ever refilling to its original height.

The greatest danger to the regimen of a navigable river, due to eroding banks, is when such a bank in one bend approaches another eroding bank on another bend across an intervening neck of land. In such cases the junction of the two eroding banks produces a cut-off of the river by which the end of the intervening neck of land is converted into an island; after which the river adopts the cut-off as a new channel, the river length is shortened very appreciably, sometimes many miles, the river currents are greatly increased, extensive new caving is started, extensive new deposits and bars are created, and the new river channel is rendered especially unstable and eccentric for many years until the former fairly permanent conditions of river slope (fall and length), river breadth, and channel direction and depths can again be reestablished. Similar danger, usually however of lesser magnitude, exists where the erosion undermines and cuts through a levee behind which there exists a large area of low ground or a waterway affording a new short drainage route to the main river below.

The enormous injury to the regimen of the Mississippi River, and to its navigation interests, which arises from a cut-off across the neck of a point of land between two bends, is not well understood nor realized by the mass of the United States public. One specially good past illustration of such effects is to be found in the case of the Commerce Cut-off and Bordeau Chute Cut-off (at points 270 and 280 miles below Cairo), as shown in considerable detail on sheet No. 9, Mississippi River Commission maps, scale 1 inch to 1 mile, published in 1890, and revised in 1906. The Commerce Cut-off, which occurred in 1874, across the neck of Linwood Point, left Council Bend at one side of the resulting river channel, shortened the river at this point about 10 miles, and consequently greatly increased the river currents in its imme-

diate neighborhood both above and below; and these increased currents gradually led up to excessive caving of the river banks in the adjoining bends and excessive scouring of the river bottom in near-by bends and chutes. Following the Commerce Cut-off (at mile 270), and as a direct result therefrom, Ashley Point on the right bank (at mile 275) was rapidly eroded; the full force of the water was then thrown into the bend near Mhoons Landing on the left bank (at mile 276), and rapidly eroded Bordeau Point; the overflow across Bordeau Point and the increased current in Bordeau Chute (at about mile 281) developed this chute into a second cut-off and left Walnut Bend outside the main river, thereby shortening the river at this point an additional 5 or 6 miles, the violence of the increased current being then such as to fling the river with full force into the right bank near Rogers Landing (at about mile 281), cutting back the bank for a distance of over a mile and eroding an area of nearly 2,000 acres to an average depth of over 60 feet; the river, after leaving Walnut Bend, was then flung back into the left bank above Fox Island (at about mile 284), after which Hardins Point on the right bank (at about mile 288) was considerably eroded and similar cavings and erosions, though to a lesser extent, followed at Harbarts Landing on the left bank (at about mile 292), and at Shoo Fly bar on the right bank (at about mile 294). All these caving banks in the bends and all these erosions of points are clearly a result of the Commerce Cut-off of 1874, followed by the Bordeau Chute Cut-off of a little later date. Omitting any movement of earth and river channel which occurred before 1884, and confining discussion to the changes shown on the Mississippi River Commission charts (sheet No. 9), between 1884 and 1906, a period of twenty-one years, it is found that these cut-offs caused the destruction of over 6,000 acres or nearly 10 square miles of property, and the erosion of a total volume of over 600,000,000 cubic yards of earth, equivalent to a pile of earth 1 mile square and nearly 600 feet high, all of which material was washed into the newly forming river channel and deposited in bars farther downstream, from which much has already been dredged, and more will have to be redredged in later years, in order to maintain a channel of navigable depth through this section of the river. The destruction of property at this point was, during these twenty-one years, in the neighborhood of over $1,000,000, and the extra work thrown upon the United States in preserving and maintaining the river channel during the past years and during the next few coming years may safely be estimated at over $2,000,000, and may easily exceed $3,000,000. At the present time the advance of the caving bank in Walnut Bend is still so rapid, and has reached so far into Lee County, that even the new levees are in danger of being cut through, and special bank revetment was necessarily begun during the past year and will probably require future extension. All of this trouble has resulted primarily from the single cut-off at Commerce, followed by the secondary cut-off at Bordeau Chute. The derangement of the regimen of the river was seriously felt over at least 25 miles and the difficulties of river navigation were seriously increased during a period of at least twenty-five years. It is quite possible that an expenditure of $1,000,000 prior to 1874 would have saved the entire situation, and would have not only saved the loss of property and all the cost of subsequent improvement work, but would have left the river channel over these 25 miles in far better condition for navigation than it is at present.

In addition to the damage to the regimen of the river that may be caused by cut-offs, there is also a further serious financial damage possible wherever (as near Greenville, Miss.) the cut-off might leave a town or city several miles away from the new river channel, requiring the establishment of new railway connections and terminals and possibly the abandonment of the old city and the development of a new one.

The slumping bank is one whose origin is almost entirely due to freshets or ordinary high waters. Such a bank, usually steep and perhaps vertical on the side next to the river, becomes dry and perhaps cracked by evaporation during a continued low-water season, becomes thoroughly soaked and filled with water during freshets and other high waters, and then, as the water falls and the support given it temporarily by the water pressure is taken away, its front breaks off from the dryer or tougher portions of the bank behind and it slides down into the low-water bed of the river. The material from the slumping bank reaches the flowing water in such broken and soft condition that it is easily picked up and carried away by the river currents. As the slumping bank is composed almost always of material from above low water, it rarely changes the condition of the river bank below low-water level, except so far as it adds débris thereto. The slumping bank merely throws into the river all at once materials which would otherwise go in gradually at a later date by ordinary erosion. These slumping banks are often the ones which attract the greatest attention from the steamboat traveler. Yet they are not in themselves the most serious caving banks of a river, as the slumping process is merely a natural grading of the river bank above its low-water lines. After a bank has once slumped and assumed its natural slope above

such low-water lines, it will usually remain undisturbed indefinitely until the bank below it is so cut away that when the new upper bank becomes saturated it in its turn is liable to fall from want of support.

The sinking bank is one where a large mass of earth material rests upon a layer of very soft material, or of quicksand, which may be squeezed out by the pressure of the superincumbent earth or may be washed out by the river currents or by flowing water passing through the soft layer under considerable hydrostatic head, from any pool, artificial or natural, in rear of the river bank. In such case the entire bank may settle uniformly, or nearly so, for any depth from a few inches to many feet, its top surface remaining practically horizontal, trees and structures resting on such surface still retaining their vertical position. On the Lower Mississippi River sinking banks have been found where the drop has been fully 20 feet, over a length of nearly a mile up and down the river, and extending over a width of several hundred feet from the water's edge. In such cases the stratum of quicksand or other soft material, washed out or forced out, is usually many feet below the ordinary water surface of the river, and such sinking banks are therefore liable to be developed at any stage of water from extreme low up to extreme high, being dependent mainly upon heavy rainfall and poor run-off behind the bank, except in a few cases where the hydrostatic head is due to pondage from recent river overflows. The sinking bank, as a rule, is of no serious injury or danger to navigation, except so far as its soft strata may be forced out into the river, or so far as the bank itself, by being broken up, is thereby rendered more easily eroded by the river currents.

The sliding or slipping bank is one where a large mass of material, mainly from above high-water level, slides down the bank into the river. The slide is usually due to the fact that material of considerable weight rests upon a smooth inclined surface, either of rock or other slippery material, such as clay or quicksand, and under influence of heavy rainfall by which the earth or rock is saturated or covered with water, the earth mass slides as a unit until its foot reaches some solid point of support farther down the bank, usually the base of the bank in the river bed. In such cases trees or other objects standing upon the original surface of the sliding mass may retain their upright position during the sliding motion; or the mass may break into a series of steps, the trees on the surface of each step still remaining vertical. Such slides may be found on the upper Missouri River, covering in some cases several thousand feet of length, and extending back from the high-water line 600 to 1,000 feet, and they may be occasionally found on the Mississippi River below St. Louis, although much less frequently and covering much smaller areas than on the Missouri River. Slides are usually entirely independent of freshets, and dependent almost entirely upon heavy rainfall and poor run-off back of the river bank. In some cases on the lower Mississippi the slipping surface may, however, be of quicksand, made slippery by the water flow from behind the river bank coming from a temporary pond, due to preceding overflows of the river. Such slips or slides are apt to occur at any stage of the water between high and low. The sliding bank is of no injury to navigation or to the river conditions until it reaches below the water level, in which case it may serve to form a short artificial dike, causing the river channel to shift, or it may offer to the flowing water a large amount of loose material in favorable condition for rapid erosion.

The shifting bottom of the Mississippi attracts attention mainly by the rise and fall of its river bars. An erosion of the bed or a change of depth of the river in deep pools between bars, is rarely noticed by anyone but the surveyor, as such change seldom directly affects navigation. But the river bars, especially those across the main channel, are constantly in evidence as they directly limit the draft of passing boats.

River bars on the Mississippi below St. Louis are mainly deposits of material coming originally from eroding banks; although augmented somewhat by material eroded originally from the river bed itself in contracted portions or specially steep portions of the river, where at certain stages the current exceeds that which the river bed can resist. River bars are usually to be expected below each caving bank at the point where the curvature disappears, or at any point of a straight reach where the river is unusually broad, the bar being due generally to the slackening of the current at such point and to the consequent local deposit of rolling or suspended matter. A river bar rarely maintains a location square across the river, because in such case it is exposed to the full direct attack of the water flow which then usually cuts a fairly deep channel through it. As a rule every bar is soon forced into a position diagonally across the river, such that its length may be two or three times the breadth of the river, and such that the water flows sideways across it from the up-river boat channel on one side to the down-river boat channel on the other side, making the crossing specially difficult for large boats and tows; moreover, in such a case the length of the bar is usually so great that a very small depth thereon is sufficient to pass all the water flow of the river without increasing the water velocity to the scouring point and the available

boat draft is correspondingly reduced. These oblique bars, which exist at nearly every channel crossing in straight reaches and sometimes at the head and foot of bends and which determine the available depth of the river for boat navigation, are bars which usually build up rapidly and cut away slowly. A bar once formed does not usually remain stationary, but often moves gradually downstream, its upstream material being washed down by the current and redeposited on its downstream side, its height diminishing as it moves along and its old location in many cases being later occupied by a new bar as troublesome as itself originally. Such traveling bars, as actually found in the lower river and measured, have shown heights as great as 22 feet, distance between crests as great as 1,000 feet, and daily travel downstream as great as 40 feet, and have been found in depths of water as great as 90 feet.

Moreover, between St. Louis and Cairo the amount of material rolling along the bottom is so great that where the bottom is scoured out at one stage of river (even if to 20 feet depth, as sometimes near Grand Tower and Thebes) it may be filled up again regularly at the next opposing stage, and where reaches of two or more miles length show continuous deep pools along the best channel in one year these pools may be found converted into shoals and the converse after an interval of a few years. (See profile accompanying this report as Appendix No. 11.)

In the Mississippi River, the bed constantly changing as shown above, reaches a fairly stable condition only in dry seasons and at the end of a long low-water season. At such times the erosion of the banks, though still active, is at a minimum, and the river bars, though high along most of their length, have usually been cut through at some one place with a channel way of fair depth.

As the water rises in the river the first action is a slight additional scour in the deep-water channel across the bar, but the extra depth so gained is usually more than balanced by the extra amount of rolling material brought down from the eroding banks immediately upstream. As the river rises still farther the increased current picks up or rolls from the river bed a great deal of the loosest material of the bars, leveling them down somewhat and largely filling up the former deep channel across them in much the same way as a strong wind will blow loose drifting snow into and fill up a recently excavated pathway through a snowbank. As the river rises still farther to a medium stage it gathers up in this way an enormous amount of rolling material and sediment deposited during the low-water stage, and it becomes full of shifting material ready to be deposited in new places at the first slackening of the current. Should the river stop rising at this time and commence to fall, the deposit is liable to be so rapid as to force the river currents into new channels and to leave the available depth over the new bars hardly, if at all, greater than was the former depth in the well-formed channel at extreme low water. Such changes in the river bed are typically shown every year on the upper Missouri River where it passes through North and South Dakota, and where at extreme low stages there is a good continuous channel of about 4.5 feet over the bars; but where after the river has risen about 10 feet and then fallen to a stage of 5 feet above low water the best channel across the numerous river bars instead of being the sum of 4.5 feet original depth increased by the 5-foot stage, making 9.5 feet in all, is actually found to be only about 2.5 feet in all, showing a rise of 7.5 feet in the bar crossing, which therefore actually stands 2.5 feet higher than the original surface of the water at its extreme low-water stage. In 1907–8 on the lower Mississippi River between Memphis and Greenville there were five bars which at river stages of between 7 and 12 feet above low water showed for a while in the best boat channel a depth of only 6.5 to 9 feet, and even as far down the river as Natchez and the mouth of Red River, where the river is over 3,000 feet wide between banks and where at least 7 feet channel depth exists at low water, there are other bars which rise at least annually, and sometimes at nearly every sharp rise and fall of the river, so as to show at 7 to 17.5 foot stages sometimes a best depth in the boat channel of only from 6.5 to 13 feet, proving the rise of the bar surface at the crossing at these places and stages to have been nearly as much as the rise of the water surface, and in at least one case 0.5 foot more, and thereby making evident but small gains and even losses in navigable depth although accompanied by an increase of water flow varying from more than 80,000 to 250,000 cubic feet per second. Repeated measurements (see graphical plot hereto appended) on the bar crossings of the Mississippi between St. Louis and Cairo show that up to a stage of about 20 feet above low water the available depth across the new bar is increased on an average only about one-half foot for every foot in the rise of water. (Between Cairo and Red River similar measurements show even less increase in navigable depth per foot of rise of water surface.) At a 22-foot stage (St. Louis gauge) the water flow above Cairo amounts to about 320,000 cubic feet per second and the natural depth over some bars is about 14 feet. As the water flow at ordinary low water (4-foot stage) amounts to about 65,000 cubic feet per second and gives ordinarily about 6 feet on the bars, it follows that a 14-foot depth on these bars, obtained by

water flow alone, unaided by dredging or other methods of improvement, arrives only after the low-water flow has been increased by about 255,000 cubic feet per second, or an average of about 32,000 cubic feet per second for each foot increase in controlling depth. Although the water flow for each foot of gain in depth may be locally less in the contracted portions of the river, yet it must necessarily be much greater in all broad shallow portions of the river.

Similar conditions of small increase of navigable depth in spite of great rise of river surface were noticed long ago on European rivers, for example, on the Dnieper (second longest river in Europe), where the natural navigable depth at low water was 0.80 meter, the corresponding depth at high stage (7.25 meters) was found to be only 2.60 meters, showing a gain in navigable depth only about one-quarter the rise of the water surface. (See Jasmund, in Hague International Congress of Navigation, reports of 1894.)

Should the water continue rising to the top of the natural banks, that is, to 25 or 30 feet above low water, the upper portion of the dry bank becomes water-soaked and the bank erosion becomes especially active. As the water recedes from a bank-full stage, after having been against the bank for many days, the upper portions of the water-soaked bank slump into the river as the water recedes, adding considerably to the amount of earth readily washing away from the eroding banks. It is at this stage of the river, while the water is commencing to fall and the current to slacken, that the suspended material is deposited most rapidly, and the river bars are enormously augmented and are changed in location. As the water still continues to fall, the total deposit increases gradually, new banks are built up rapidly on the sides of the river bed away from the main current, and the bars scour off slowly if at all; so that at a stage of from 8 to 5 feet above low water the channels over the bars are not much better than they were originally at low water. As the water still continues to fall to extreme low water, the river currents begin to select a single passage across the newly developed bars, and to deepen this single passageway down to its former good condition.

It is at this stage of river with falling water that the aid of the dredges becomes most useful in assisting the river current to select a proper bar crossing and to hasten the development in depth. Without the aid of dredges the ruling depth on the bars from St. Louis to Cairo would hardly exceed 5 feet, perhaps not more than 4 feet, as in former days; but with the assistance of dredges, an 8-foot depth has been maintained for many years throughout the navigation season, with an occasional interruption of a few hours, or a day or two, while a dredge was being moved to a newly formed bar at some distance from the last station of the dredge; such short, temporary delay as a rule not having actually interfered with the use of the river by existing boats.

Above Cairo during the winter season the above river conditions are considerably affected by floating ice, and especially by ice dams forming across the river, pooling the water above the ice dam, and draining the river below the dam to a level lower than ordinary low water.

The river conditions below Cairo differ from those above Cairo mainly in magnitude; in the lower river the eroding banks rising higher above and extending deeper below low water, and furnishing more local material for new bar and new bank formations; these bars and banks being larger; the volume of water in motion being greater; the river bends and stretches being longer; the shifting of bars and the recession of banks under erosion being more rapid and violent when once started; the bars carrying a little more water over them at low stages and being spaced at greater distances, but being longer measured in the direction of the river current, and being much broader; the rise of the bars during rising water and during the first stage of falling water, and the cutting away of bars during the middle and last stages of falling water, following practically the same rules as in the upper river.

The above river conditions are not peculiar to the Mississippi River alone, but are general for almost all other rivers of unstable beds. The distinguishing feature of the Mississippi River is merely the magnitude of these conditions.

While the limit of river depth available to navigation in the Mississippi River below St. Louis is evidently due to the height of the river bars at channel crossings, it is evident from the above that such height of bars is itself primarily due to the material coming from caving banks, and especially from the eroding banks, and that it is the erosion which goes on all the time out of sight below the low-water line to depths of from 30 to 70 feet which has always been the main cause of the final deposit in the river of the enormous quantities of earth that fill up its bed, that lead to the formation of its bars, and that destroy its otherwise good general regimen. The extent of such erosion was hardly thoroughly understood and realized even by engineers until the United States Engineer Department and the Mississippi River Commission, about 1879, began a long series of measurements of the suspended sediment of the Missouri

and Mississippi rivers, followed in 1891 by other measurements of caving banks. An examination of all caving banks between Donaldsonville and Cairo, a distance of about 885 miles, measured along the midstream, made in 1892, under special orders of the commission (see p. 3110, Annual Report, Chief of Engineers, 1892) gave results as follows:

Average annual amount of caving on both banks, Mississippi River, Cairo to Donaldsonville.

Locality.	Area.	Height from river bottom to top of bank.
	Square yards.	*Feet.*
Cairo to Memphis	6,112,000	53
Memphis to Helena	2,978,000	47
Helena to Arkansas City	4,137,000	62
Arkansas City to Vicksburg	12,024,000	67
Vicksburg to Natchez	9,371,000	76
Natchez to Red River	3,106,000	73
Red River to Donaldsonville	1,263,000	84
Total	38,991,000	[a] 66

[a] Annual average, 66 feet.

Annual averages per mile, 43,810 square yards=9½ acres, 1,003,579 cubic yards.

The text of that report gives so much information that it is quoted in full, as follows:

Report of Assistant Engineer J. A. Ockerson on caving banks from Cairo to Donaldsonville, with tabulated results, and plat.[a]

OFFICE MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., May 31, 1892.

CAPTAIN: I have the honor to submit the following tabulated results derived from a study of the recent caving-bank survey of the Mississippi River from Cairo to Donaldsonville, and a comparison of the same with previous surveys.

In order to make a ready and accurate comparison the shore line of the survey of November, 1891, to March, 1892, was platted on the detail charts of the old surveys, mostly made from 1879 to 1883, and the area between the shore lines was carefully measured with a planimeter. This gave the area of caving.

The data for the depth of caving were derived from the old detail charts, which show the height of bank above datum, elevation of water surface, and depth of water. From this the height of the bank above the bed was easily deduced. Where the river had maintained its width and the channel lay close to the caving bank the height of the bank deduced was measured from the deepest part of the bed to the top of the bank. Where the channel lay some distance from the bank and the caving had widened the stream without shifting the channel materially, then the average depths between the thalweg and the depth near shore were taken as the depths of the bed and the heights of bank deduced accordingly.

The dates of the surveys of each section considered are given in the table and from them the average amount of erosion per annum was derived.

An inspection of the maps shows that caving rarely occurs on both banks of the river at the same time in the same locality. It shifts from bank to bank, and as it ceases on one side it begins on the other, so that the caving areas often slightly overlap each other. The total length of caving banks from Cairo to Donaldsonville, a midstream distance of 885 miles, is 921 miles. About 15 miles of this pertains to islands.

With a very few exceptions there is more or less caving at all of the bends, but the amount of caving does not seem to bear any definite relation to the curvature. The maximum caving occurs in comparatively straight reaches, such as Leota, Raleigh, Milliken, Carlyle, Oak Bend, etc., while the extraordinary bends above Greenville show caving far below the maximum. Darnell Point, 80 miles from Cairo, is an example of excessive caving in a long, straight reach of river.

[a] The plat of original report, showing area of caving in square yards, has been replaced by a new plat showing volume of caving in cubic yards.

The annual erosion per mile of river reaches its maximum in the vicinity of Raleigh. In the vicinity of Oak Bend, below Vicksburg, it reaches nearly the same amount. After passing Natchez the erosion becomes rapidly less and from the Red River down is quite small in amount.

The character of vegetation on the banks has no apparent influence on the extent of the erosion. In a caving bend which is partly cultivated and partly timbered the shore-line curve is smooth and regular, showing that they are eroded with equal facility.

Of 37 localities between Cairo and Vicksburg, where depths of less than 10 feet were reported in 1891, 21 were found to be at the foot of or immediately below rapidly caving banks.

The amount of erosion given in these tables is doubtless considerably less than the total movement. In some localities where rapid caving was going on at the time when the first surveys were made now we find a heavy fill.

Opposite Commerce, Miss., is a case of that kind, where a caving bank in 1879 has filled about 2,000 in width and about 5 miles long, a part of which is now cultivated.

It is not improbable that there are places where the process of scour and fill has been repeated several times during the intervals between the surveys. The total movement by erosion would probably exceed the amount given in tables by about 15 per cent.

The average annual amount of erosion, as derived from the tabulated results, is found to be about 9½ acres in area by 66 feet deep for each mile of river, or a total for the river between Cairo and Donaldsonville of 10 square miles by 86 feet in depth annually.

Erosion does not necessarily mean a widening of the bed of the river. The eroded bank is generally followed by an equivalent fill on the opposite bank, and in some localities of excessive erosion the bed has actually grown narrower.

The composition of the banks is not given in sufficient detail to determine the relation, if any, between character of banks and erosion. In the region of excessive caving the banks are largely composed of sand. In some localities where the banks are described as being clay the erosion has been but slight.

Respectfully submitted.

J. A. OCKERSON,
Assistant Engineer.

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

New estimates of the area and volume of caving banks computed by the Board during the past year from the Commission maps of the river between Cairo and Arkansas River, about 400 miles, show for the period 1891–92 to 1902–1904 an annual volume of caving approximating that of the earlier period, indicating that from Cairo to the Arkansas River, a stretch where little revetment work has been done, the rate of caving has been practically unchanged since 1876–1882.

Measurements of the length of caving banks from Cairo all the way to the mouth of Red River made by this Board show a total length of 749 miles of caving along a river channel of about 790 miles. Only banks actually caving were measured.

Similar measurements were made during the present year (1908–9) as to the extent of caving banks on the river between Cairo and St. Louis, by which it was shown that the volume of earth falling into the river from that reach averaged annually 64,000,000 cubic yards from 1879–1889; nearly 48,000,000 cubic yards from 1889–1899; and about 49,500,000 cubic yards from 1899–1907, the diminution of such caving in the last eighteen years evidenced thereby being considered due to the extensive revetments that were built along this reach between 1881 and 1905.

Experiments conducted in 1879 under the direction of the St. Louis U. S. Engineer Department at the mouth of the Missouri River to determine the amount of sediment coming into the Mississippi River from the Missouri above St. Louis (p. 1653, Annual Report Chief of Engineers, 1881, and p. 3090, Annual Report Chief of Engineers, 1887) showed that the floating sediment alone, resulting from caving banks in the Missouri itself, amounted to 187,000,000 cubic yards during nine months of the year. As these observations took no account of the heavier matter in the foot of depth nearest the bottom, nor of the solid material (such as sand or gravel) driven along the actual bed of the river by its currents, Colonel Suter considered it safe to assume that fully 400,000,000 cubic yards of material then came out of the Missouri River in twelve months. It is probable that at least the same amount of material is still coming out of the Missouri River at the present time. Other observations by the U. S. Engineer Department and the Mississippi River Commission indicate an outflow of sediment and rolling material of about 36,000,000 cubic yards per year from the Ohio River, about 5,000,000 cubic yards per year from the Arkansas River, and about 6,000,000 cubic yards per year from the Red River.

By the above showing, the amount of material originating from caving banks which the Mississippi River, between St. Louis and permanently deep water in the river

below Donaldsonville, must carry along and dispose of every year, amounts to more than one and one-fourth billion cubic yards. This is over twenty times as much as is carried annually by the Danube, Dnieper, Volga, Rhone, Nile, Hooghly or La Plata, and over fifty times as much as by the Loire and Durance, although these foreign rivers are considered specially difficult of improvement because of their silt and other water-borne material. This one and a quarter billion cubic yards of material coming every year into the river from caving banks along the Mississippi and lower Missouri rivers is equivalent to a volume 1 mile square and almost 1,200 feet high, and this amount must necessarily be picked up by the water currents of the Mississippi below the mouth of the Missouri and carried down the river until it is deposited by some freshet at other places above low-water level, or reaches the Gulf of Mexico.

Until the caving of banks can be stopped in the Mississippi River below St. Louis, either entirely or to a large extent, it is practically hopeless to expect any improvement of low-water conditions in the open river. The bank erosions must continually bring about new conditions of river bends and river channels, and the loosened material as it goes down the river must necessarily continue to form obstructing bars, shifting with every change of water conditions and requiring constant removal. As above explained, sliding banks and sinking banks are mainly independent of river conditions, and the slumping banks occur only intermittently at high-water stages; but the eroding banks, especially below low water, are constantly in action. Under such circumstances any increase in water flow near low-water stages is liable to do as much damage by extra erosion of banks as it is to do good by adding increased channel depth. The only known remedy for eroding banks is their protection both below and above low water by some form of continuous revetment. The experience of the government engineers during many past years has shown that protection of banks by mattress below low water and by paving above low water can be secured anywhere along the Missouri and the Mississippi rivers.

In the above description of caving banks and shifting bottom of the Mississippi River little has been said of the river below the mouth of Red River, since in this section of the river the boat channel has always had several hundred feet of width over a depth far in excess of that at the river mouth, and no work of channel improvement has been necessary except the removal of occasional snags and the protection of caving banks along city wharves and landings and at a few places where an undermining of the levee might cause exceptional danger to the river from crevasses. For a long term of years all ocean steamers able to go from the Gulf through the Passes up the Mississippi River to New Orleans have been able to go fully 175 miles farther up the river with perfect ease and safety to and past the cities or towns of Donaldsonville, Plaquemine, Baton Rouge, and Bayou Sara.

APPENDIX NO. 2.

MEMORANDUM OF PROJECTS FOR IMPROVEMENT OF THE MISSISSIPPI RIVER FROM ST LOUIS, MO., TO THE GULF.

[Prepared by Assistant Engineer Kivas Tully, under direction of the recorder.]

The first general projects for the river from the mouth of the Missouri River to New Orleans were submitted in connection with an examination of transportation routes to the sea under act of Congress approved June 23, 1874. That portion of the river between the mouth of the Missouri River and the Ohio was included in the project of Col. J. H. Simpson, Corps of Engineers, and from Cairo to New Orleans in that of Maj. C. R. Suter, Corps of Engineers, members of the Board appointed under that act. In the absence of reliable data at that time these projects were stated to be merely tentative.

Under authority of act of Congress of June 28, 1879, creating the Mississippi River Commission, and subsequent laws relating to the subject, a detailed survey of the Mississippi River from the Head of Passes to its headwaters has been completed; also extensive hydrometrical and other observations have been made and valuable data collected, all of which have been available for the purposes of the present Board.

The present and past projects for the improvement of the Mississippi River below the mouth of the Missouri will be referred to separately in the following order:

(1) Mouth of the Missouri River to the Ohio River.
(2) Mouth of the Ohio River to the Head of Passes.
(3) The Passes.

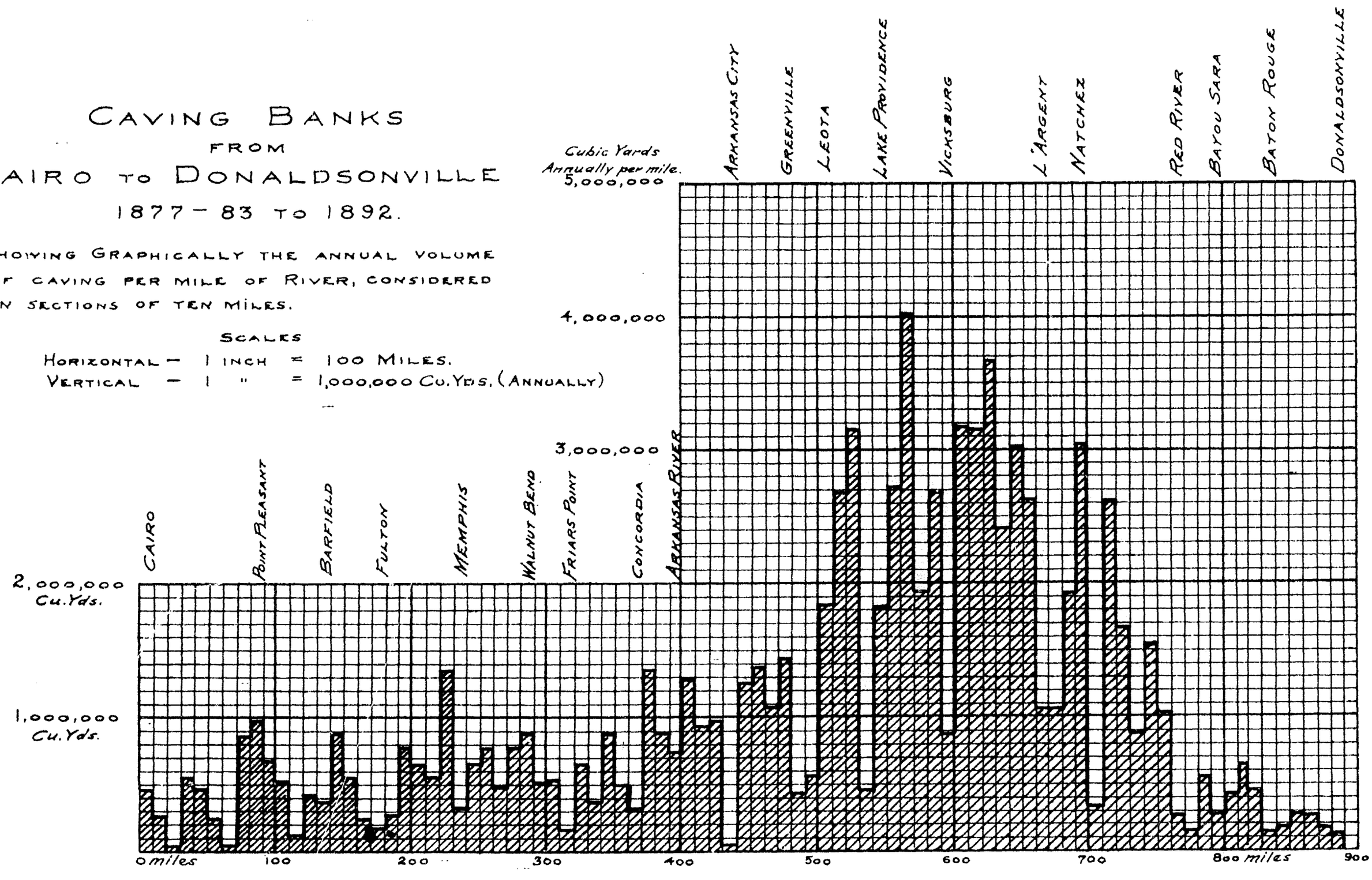
(1) *Mississippi River between the Missouri and Ohio rivers.*—In 1836 Congress appropriated $15,000 for improving St. Louis harbor. As this was insufficient for the pur-

CAVING BANKS
FROM
CAIRO TO DONALDSONVILLE
1877-83 TO 1892.

SHOWING GRAPHICALLY THE ANNUAL VOLUME OF CAVING PER MILE OF RIVER, CONSIDERED IN SECTIONS OF TEN MILES.

SCALES

HORIZONTAL — 1 INCH = 100 MILES.
VERTICAL — 1 " = 1,000,000 CU. YDS. (ANNUALLY)



JULIUS BIEN & CO. PHOTO LITH. N.Y.

House Doc. No. 50 ; 61st Cong., 1st Sess.

Curves Showing

RELATIONS of RIVER STAGE

to

BAR HEIGHTS and DEPTHS LIMITING NAVIGATION

in the

Mississippi River between St. Louis and Cairo

Compiled for the

Board on Examination and Survey of Mississippi River

From the records of the

U. S. Engineer Office, St. Louis, Mo.

For the years 1896-1908.

The curve of MEAN DEPTHS shows for each foot of stage the average of the best depths found in the channel crossings of all bars between St. Louis and Cairo, and indicates the relation between MEAN BAR HEIGHT and STAGE: the total number of soundings represented by each (⊗) being stated opposite thereto.

The curve of CONTROLLING DEPTHS shows in like manner for each foot of stage, the average of the least channel depths, one for each through trip between St. Louis and Cairo, found by tow-boats operated by the U. S. Engineer Office, and indicates the relation between CONTROLLING DEPTH and STAGE; the least depth of each trip being shown as (o) and the mean of all depths within a half-foot of each foot of stage being shown as (⊙).

Stage in Feet - SAINT LOUIS GAGE

NUMBER OF SOUNDINGS

Navigation

limiting Depths

Depths on Bars

Mean

NUMBER OF SOUNDINGS

DEPTHS ON BARS in Feet

377 TOTAL

30483 - TOTAL.

JULIUS BIEN & CO. PHOTO LITH. N.Y.

House Doc. No. 50 ; 61st Cong., 1st Sess.

5573

pose, $35,000 additional was appropriated in 1837. These funds were applied to a system of works projected by Lieut. R. E. Lee, Corps of Engineers, which, by the assistance of the city of St. Louis, resulted in closing the chute east of Bloody Island. The next appropriation for St. Louis was $25,000, June 11, 1844, for removing obstructions to navigation in that harbor.

Improvement work was continued at St. Louis in 1872 under the appropriation of that year for the section of the river from mouth of Missouri River to the mouth of the Maramec River; the appropriation was made in accordance with recommendations submitted by a board of army engineers April 13, 1872. This practically began the work on the Mississippi River between the mouth of the Missouri River and Cairo, and work was continued for several years as appropriations were made by Congress.

Before work was begun this section of the river had a channel depth of only 3½ to 4 feet at low water. These first works consisted of dikes and dams of brush and stone, erected with a view to confining the low-water volume to a single channel, and of revetments to hold and preserve the banks where it was deemed necessary. This improvement work was in progress in 1875, and was along the lines of the project for this portion of the river submitted by Col. J. H. Simpson, Corps of Engineers, January 20, 1875, in connection with the examination of transportation routes to the sea.

The project followed up to the present time, with some later modifications relative to temporary expedients, has been that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881.

This project contemplated the confinement of the flow of the river to a single channel having an approximate width of 2,500 feet at bank-full stage (the natural width in many cases being a mile or more at mean high water), this result to be sought by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for this purpose permeable dikes or hurdles of piling that collect and hold the solid matter that is carried in suspension or rolled on the bottom of the river; the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency.

The object of the improvement is to obtain ultimately a minimum depth, at standard low water,[a] of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to Cairo.

The act of Congress approved June 3, 1896, modified the project of 1881 by making the appropriation for this section of the river, and any balance of former appropriations, or so much thereof as might be necessary, available for the construction and operation of dredge boats, portable jetties, and other suitable appliances, with the view of ultimately obtaining and maintaining a navigable channel from St. Louis to Cairo.

The next river and harbor act, June 13, 1902, made appropriation for carrying on the systematic improvement of this section of the river. It also authorized the Chief of Engineers to operate one or more of the dredges then under control of the Mississippi River Commission, operating expenses to be paid from the appropriation for this section of the river. This authority was not exercised, however.

A board of engineers constituted under the act of Congress approved June 13, 1902, in its report dated November 12, 1903, estimated the cost of the work remaining to be done at $20,000,000, with annual expense of $400,000 for maintenance, but it was hoped that the cost might be materially reduced by a more extensive use of dredging, which was made one of its recommendations.

The river and harbor act of March 3, 1905, made a radical departure from the project of 1881 as previously outlined, confining the work of improvement to dredging and temporary expedients and providing for the construction of two additional hydraulic dredges of the most approved type.

By joint resolution of Congress approved June 29, 1906, the Secretary of War was authorized, in his discretion, to expend any portion of the balance then remaining to the credit of this improvement for the repair or completion of improvements under way, or for the construction of other works in accordance with general plans already made or approved.

The river and harbor act of March 2, 1907, reaffirmed dependence upon dredging as the principal means of improvement, and, as subsidiary thereto, provided also for the maintenance and repair of existing works of permanent improvement, and finally for the construction of similar works with any portion of the appropriation not necessary for the accomplishment of the purposes first named. The annual appropriation was reduced to about 40 per cent of that hitherto made, continuing contracts to the amount of $750,000 were authorized, and the expenditure in one year limited to about $250,000.

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[a] Standard low water reads 4 feet on the St. Louis gauge.

A partial improvement of the entire extent of the river from St. Louis to Cairo has been accomplished under the foregoing projects and navigable channel depths have been materially increased.

The total amount appropriated by Congress for the Mississippi River from mouth of the Missouri River to Cairo is approximately $12,778,579.92.

(2) *Mouth of Ohio River to Head of Passes.*—The commission of engineers appointed by act of Congress, approved June 22, 1874, to report upon the best system for the permanent reclamation of the alluvial basin of the Mississippi River from inundation submitted a report in January, 1875, recommending: First, keeping open the Atchafalaya and La Fourche and possibly reopening the Plaquemine; second, a general levee system extending from the head of the alluvial region to the Gulf, including the valleys of the tributary streams. The main lines to be of sufficient height and strength to restrain the floods, and where reasonable security against caving requires large areas of front lands to be thrown out, protection against ordinary high waters to be given by low front levees closely following the bends. This board also recommended that an elaborate survey be made as soon as possible by the General Government to furnish data for carrying out the plans recommended. The board also suggested that a central governing body, composed of representatives from the several local levee boards, be organized in order to secure uniformity of action throughout the different districts.

Extensive levees had been built prior to that time by private or local and state authorities; these levees, however, were originally of insufficient height and cross section, and had been built without regard to a uniform grade line.

The report of this board is particularly mentioned here as the building of a complete levee system is now regarded as necessary to give ease and safety to navigation as well as to fulfill the purpose for which the board recommended it. The subject will be again referred to further on.

Maj. C. R. Suter, Corps of Engineers, in his report dated February 18, 1875, in connection with navigation routes to the sea, before referred to, suggested that a thorough survey be made of the river from Cairo to the mouth of Red River and states further: "To increase the low-water depths from 4½ feet to 6 feet is, in my opinion, about as much as should for the present be attempted. This, in all ordinary seasons, will probably guarantee 8 feet, except for, probably, at the most, a few days in each year."

The report recommended the appropriation of $200,000 for improvement work for the following season, and of $25,000 for a survey from Cairo to Reeves bar, 250 miles below.

A board of engineer officers was appointed July 8, 1878, to consider the improvement of the low-water navigation of the Mississippi River below Cairo, and submitted a report on January 25, 1879, containing the following recommendations:

"First. That an appropriation of $600,000 be asked for the improvement of Plum Point reach.

"Second. That the improvement be effected by narrowing the shoal and wide portions of the low-water river to about 3,500 feet and by protecting caving banks where necessary. This narrowing and limiting of the low water to be effected if possible by constructions of much lighter and cheaper character than those heretofore used if, after thorough experiment, such shall be found efficient; if not, then in last resort, by ordinary dikes of brush and fascines, stone and gravel, used in such works in this country and Europe."

By act of Congress approved June 28, 1879, The Mississippi River Commission was created and certain duties assigned to it. Among these were to direct and complete such surveys of the Mississippi River between the Head of Passes, near its mouth, and its headwaters as were then in progress. To take into consideration and mature such plan or plans as will permanently locate and deepen the channel and protect the banks of the Mississippi River; improve and give safety and ease to the navigation thereof; prevent destructive floods, and promote and facilitate commerce and the postal service.

On February 17, 1880, the Mississippi River Commission made a preliminary report in which various plans of improvement were discussed and the plan of the Low Water Board in the first and second recommendations, as given above, was substantially approved, recommending, however, a low water width of 3,000 feet.

The project recommended by the Mississippi River Commission for the systematic improvement of the river from Cairo to the Head of Passes was practically adopted by act of Congress, approved March 3, 1881. This contemplated ultimately obtaining a channel depth of at least 10 feet at low water below Cairo.

Under this project work has been done principally in two reaches known as Plum Point reach, 147 to 186 miles below Cairo, and Lake Providence reach, 517 to 552 miles below Cairo. These reaches were selected purposely as they included some of the places of most difficult low-water navigation on the river at that time.

The methods of improvement employed under this project consisted mainly of contraction works and bank revetment.

In Plum Point reach the works comprise about 67,400 feet of bank revetment, the closure or partial closure of chutes by brush and stone dams and pile dikes, and a levee along the left bank to confine the flood waters more nearly to the low-water channel. As a result of all these works the banks have remained practically fixed and the navigable depth at low water has been materially increased since the works approached completion. Some revetment work is now being done at Osceola, Ark., and at Fletchers Bend above Wolverton Eddy where some abatis dike work is also in process of construction.

In Lake Providence reach the works consisted mainly of pile dikes for the contraction of the width and revetment of banks to prevent erosion. A considerable deepening of shallow crossings has resulted from this work, though most of the structures, which were comparatively weak, have been destroyed. The cost of revetment work has been gradually increased as more substantial methods of construction have been devised in order to secure better results.

At present, work of this kind is mainly confined to maintenance of existing works and revetment of caving banks where important levees or river interests are threatened by erosion. Dependence for maintaining the low-water depths for navigation is now placed upon the improved hydraulic dredges which have been constructed since the modified project of 1896 was adopted.

Prior to 1881 levees had been built by private owners of land and by local and state authorities, as previously mentioned, and always for protection against overflow. During the war of 1861–1865 the levees were destroyed in many places and for some years thereafter were allowed to deteriorate still more.

Since 1881 the building of levees has been carried on extensively by the United States as part of the general project for the improvement of the river below Cairo, with some restrictions in the appropriation acts prior to that of September 19, 1890. State and local levee organizations have also aided extensively in levee building, the work done by all parties of late years has been in conformity with the grades and methods of construction adopted by the Mississippi River Commission, and the present efficiency of the levee system has been largely due to this fact. The extension of this levee system on the right bank up to Cape Girardeau, Mo., was authorized in 1906.

The system of levees existing at present comprises a total length of 1,486 miles with a content of about 220 million cubic yards of earthwork, including that built by state and local authorities. During the high water of 1908, which was of unusually long duration, the flood waters were carried from Cairo to the Gulf without any breaks occurring in the levees.[a] Much work still remains to be done in order to complete this levee system.

In accordance with the act of Congress approved June 3, 1896, a modified project was adopted for obtaining and maintaining by means of hydraulic dredges a channel in the Mississippi River below Cairo having a width of 250 feet and a depth of 9 feet throughout the year, except when the river is closed by ice.

Under this project ten hydraulic dredges have been constructed and operated below Cairo and have succeeded in maintaining the project depth and width except for short periods in 1903, 1904, and 1908.

During the low-water seasons of 1907 and 1908 dredging was done at three selected localities in order to test the feasibility of maintaining a channel 500 feet wide and 14 feet deep at low water. (See Appendix No. 8.)

Work of harbor improvement below Cairo has been carried on at the following places, the number in parentheses being the distance in miles of each place below Cairo:

Columbus, Ky. (21), Hickman, Ky. (36), New Madrid, Mo. (71), Caruthersville, Mo. (110), Osceola, Ark. (163), Memphis, Tenn. (230), Helena, Ark. (306), Greenville, Miss. (478), Vicksburg, Miss. (600), Natchez, Miss., and Vidalia, La. (700), New Orleans, La. (957 to 964).

Rectification work has also been done at the mouth of Red River. This has mainly consisted of sill dams near the head of the Atchafalaya. Bank revetment has been done for the protection of important levees at the following places:

Old Town Bend, Ark. (324), Bolivar, Miss. (417), Panther Forest, Ark. (487), Longwood, Miss. (500), Lake Providence, La. (542), Fitlers Bend, Miss. (552), Reid-Bedford Bend, La. (605), Bondurant Chute, La. (644), Kempe Bend, La. (658). Revetment work and abatis dikes were also constructed at Walnut Bend, Ark. (281), in connection with the prevention of a cut-off into the St. Francis River and for the protection of the levee.

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[a] An unconfirmed press report states that a small break, quickly closed, occurred about 8 miles below New Orleans.

At all of the harbors, except Memphis, Helena, Greenville, Natchez, and New Orleans, the improvement works have mainly consisted of mattress work and bank paving. The Vicksburg Harbor work has included the canal work from the Yazoo River into the old river bend.

At Memphis about 14,800 linear feet of bank is now protected by mattress revetment and spur dikes. At Helena the work consists of about 4,900 linear feet of bank protection, of which 1,400 feet is dike work and 3,500 feet continuous revetment. At Greenville the first work done in 1887–88 consisted of spur dikes. Additional spur dikes were placed in 1890. Some of these dikes were washed out in 1891 and the plan was changed to continuous revetment work in that year. About 12,500 linear feet of bank is now effectively protected by revetment. At Natchez the work has mainly been confined to the protection of Cow Pen Neck to prevent a cut-off just above Natchez. At New Orleans work under the present project was begun in 1883 and has continued since as funds were available. The steep banks and great depths make the preservation of the banks difficult and expensive. The method of piling used by municipal and private corporations has not been successful, and the methods used by the Mississippi River Commission, consisting of spur dikes and mattress revetment, are now recognized as the best and are used at present—about 5¼ miles of bank have been so protected.

These works generally have given satisfactory results as far as they have been carried; in many cases the work is still in progress.

The total amount expended on the improvement of the Mississippi River from the mouth of the Ohio to the Head of Passes, including the general survey to the headwaters, is, approximately, $58,714,191.28.

The above does not include the locks at Plaquemine, La.

Passes at the mouth of the Mississippi River.—At present three passes branch from the main river. These are, named in the order of their importance, Southwest Pass, South Pass, and Pass a Loutre.

South Pass has been improved and has been the main pass for navigation for the last thirty years, with a central depth of 30 feet. Southwest Pass improvements are now nearing completion and will give this pass a depth of 35 feet. Detailed statements of the work done at the Passes and the results accomplished will be found in the annual reports of the Chief of Engineers.

The improvement of the bars at the mouth of the Mississippi dates from 1837.

The present method of improvement, by "parallel jetties at the mouth of the Passes combined with the closure of lateral outlets if necessary," was recommended to Congress by a special board of United States engineers in 1852. The recommendations of this board were as follows:

First. That the process of stirring up the bottom by suitable machinery should be tried.

Second. If this failed, that dredging by buckets should be tried.

Third. If both these modes failed, that parallel jetties should be constructed, 5 miles in length, at the mouth of the Southwest Pass, to be extended into the Gulf annually, as experience should show to be necessary.

Fourth. Should it then be needed, that the lateral outlets should be closed.

Finally, should all these fail, a ship canal might be resorted to.

The act of Congress of August 30, 1852, appropriated $75,000 for improvement by stirring up the bottom and dredging, in accordance with the first and second recommendations above given, with the requirement, however, that the work should be done by contract; this money was spent at the Southwest Pass with as successful results per dollar as any dredging of its day. No additional funds were appropriated by Congress for this work for several years thereafter, and the channel gradually filled up again.

In 1856 Congress made a further appropriation of $330,000, for opening and keeping open for five years the Southwest Pass and the Pass a Loutre, with the requirement, as before, that the work should be done by contract; this money being spent in accordance with the third recommendation of the United States Engineer Board of 1852, upon the construction of parallel jetties on the bars combined with the closure of the minor passes. The failure of the contractors to do the promised work and the war of 1861–1865 put a stop for several years to any continuation of the system of improvement by jetties and dredging.

Capt. A. A. Humphreys, Corps of Engineers (later Chief of Engineers), in a report of February 25, 1860, attributed the failure to obtain the desired depths to insufficient appropriations, coupled with the requirement in the act of 1856 that "the work must be done by contract."

The subsequent improvement of the Passes by Mr. Eads, beginning in 1875, and in accordance with the third recommendation of the 1852 United States Engineer Board,

proves the correctness of the judgment of that board. All subsequent improvement of the Passes, up to to-day, has followed those recommendations.

The present projects for the improvement of the Passes provide for depth of 26 feet over 200 feet of bottom width, with a central depth of 30 feet at the South Pass, and 35 feet depth over 1,000 feet bottom width at the Southwest Pass. The channel at the South Pass, commenced in 1875 by Mr. Eads, was practically completed by him in 1879, and, with the help of annual dredging, has been practically maintained up to date. The channel at the Southwest Pass, commenced in 1900, is now nearly completed, but, like the other, will probably require constant redredging.

The total amount expended to date for improvement of the Passes of the Mississippi River, including surveys, is, approximately, $16,713,109.15.

Recapitulation of appropriations for improvement of the Mississippi River from the mouth of the Missouri River to the Gulf of Mexico:

Mouth of the Missouri to mouth of the Ohio	[a] $12,778,579.92
Mouth of the Ohio to Head of Passes	[b] 58,714,191.28
The Passes	16,713,109.15
Total	88,205,880.35

NOTE.—The above amounts have been compiled from official records. House Executive Document No. 64, Forty-eighth Congress, first session, and House Document No. 421, Fifty-seventh Congress, second session, except as noted above, to 1903, and from that date on from the appropriation bills.

In the Mississippi River, as at present improved, there usually exists, and has existed since at least 1901, a good navigable channel of at least 8 feet depth over at least 200 feet width for the 182 miles of river between St. Louis and the mouth of the Ohio River; and of 9 feet depth and 250 feet width for the 790 miles from the mouth of the Ohio River to just below the mouth of the Red River; and of at least 30 feet depth and several hundred feet width for the remaining 320 miles down to the Gulf. Minor deficiencies in channel for a few hours or days (until a dredge could reach the locality and dredge the crossing) have occasionally occurred during the low-water season when the shoaling of some crossing took place suddenly through rapid fluctuations in river stage while the dredging plant was engaged elsewhere; but deficiencies for more than a few days at a time have occurred only in the winter season when navigation was closed by ice or fear of ice, aggregating above Cairo about one month per year, and from Cairo down as far south as Memphis only a few weeks per year in occasional years. A good channel of at least 14 feet depth can usually be found every year between St. Louis and Cairo during from one to two months, and between Cairo and the Gulf during from five to eight months.

The existing improved waterway of the Mississippi River below St. Louis fully equals, and over the greater part of its extent far excels, in depth and duration of unobstructed use, existing river systems of Europe, where the nontidal sections are usually given depths of only 3 to 9 feet, 9 feet being exceptional and 10½ feet a maximum.

APPENDIX 3.

Work done and remaining to be done to complete improvement under project of 1881, improving Mississippi River between Ohio and Missouri rivers.

[United States Engineer Office, St. Louis, Mo.]

DISTRICT, OHIO RIVER TO MISSOURI RIVER, 190 MILES.

Rock banks	miles..	75
Banks protected by hurdles in construction works	do...	71
Banks protected by hurdles in construction works, proposed	do...	30
Banks protected by revetment	do...	60
Banks protected by revetment, proposed	do...	54
Banks which will not require protection (city fronts, sheltered points, etc.)	do...	90
Total	do....	380

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[a] $12,703,579.92 from 1872 to date, from statement of district engineer's office; $75,000 appropriated prior to 1872 from H. R.

[b] Includes general survey, Head of Passes to the headwaters.

Island sloughs already closed	22
Island sloughs open	6

	Above Grand Tower 116 miles.	Below Grand Tower 74 miles.
Hurdles built (average length 1,400 feet) ....no..	243	24
334,888 linear feet above Grand Tower.		
37,640 linear feet below Grand Tower.		
372,528 linear feet total.		
Hurdles now in order....do....	220	17
200,396 linear feet above Grand Tower.		
25,410 linear feet below Grand Tower.		
225,806 linear feet total.		
Hurdles probably required....do....	100	70
150,000 linear feet above Grand Tower.		
105,000 linear feet below Grand Tower.		
255,000 linear feet total.		
Bank protection built (304,043 linear feet)....miles..	41.0	16.6
Repairs built 11 per cent.		
Bank protection now in order ....do....	30.7	14.0
161,868 linear feet above Grand Tower.		
74,290 linear feet below Grand Tower.		
236,158 linear feet total.		
Banks which may yet need protection....do....	29.0	25.0
Banks which may yet need protection, in front of hurdles....miles..	60.0	12.0
Banks which may yet need protection, in front of proposed hurdles....miles..	14.0	16.0
Total banks which may yet need protection...do....	104.0	53.0

COSTS.

Construction between Illinois and Missouri rivers.....	$201,420.06	
Dikes and dams; prior to 1881, 28,771 linear feet (average cost, $24.05).....	691,893.46	
Hurdles, 372,528 linear feet (average cost, $17.37 per linear foot), inclusive of maintenance.....	6,471,352.56	
Protection, 304,043 linear feet (average cost, $10.50 per linear foot), inclusive of maintenance.....	3,192,822.16	
Jetties (temporary expedients).....	114,603.53	
Dredging.....	662,203.25	
Surveys.....	289,327.60	
		$11,623,622.62
Property on hand.....		722,917.59
Material on hand.....		72,138.40
Depreciation, care, and sundries for plant (thirty-five years).....		643,991.59
Appropriation unexpended June 30, 1908.....		376,703.86
Total.....		13,439,374.06

PROBABLE COST TO COMPLETE.

Hurdles, 300,000 linear feet, at $22.50	$6,750,000
Bank protection, 900,000 linear feet, at $15	13,500,000
Repairs, maintenance, etc	1,000,000
Total	21,250,000

APPENDIX No. 4.

LETTER OF ASSISTANT ENGINEER WM. S. MITCHELL.

ENGINEER OFFICE, U. S. ARMY,
St. Louis, Mo., January 21, 1909.

COLONEL: I have the honor to transmit herewith a memorandum on a project for obtaining and maintaining by hydraulic dredging alone a navigable channel, 14 feet in depth by 500 feet in width, in the Mississippi River between St. Louis, Mo., and the mouth of the Ohio River, in accordance with the resolution of the Board on Examination and Survey of Mississippi River, convened in third session, May 7 and 8, 1908, reading:

"*Resolved*, That estimates be prepared of the cost of improving the Mississippi River from St. Louis to Cairo."

* * * * * * *

"Second, by obtaining and maintaining, by dredging, a depth of 14 feet for at least 500 feet width in the open river;"

the preparation of the required memorandum and estimate having been assigned to me.

Very respectfully, your obedient servant,

WM. S. MITCHELL,
Assistant Engineer.

Col. W. H. BIXBY,
Corps of Engineers, U. S. Army,
Senior Member, Board on Examination and Survey of
Mississippi River, St. Louis, Mo.

MEMORANDUM ON A PROJECT FOR MAINTAINING BY HYDRAULIC DREDGING ALONE A NAVIGABLE CHANNEL 14 FEET IN DEPTH BY 500 FEET IN WIDTH IN THE MISSISSIPPI RIVER BETWEEN ST. LOUIS AND CAIRO, AND THE MOUTH OF THE OHIO RIVER.

[Prepared by Assistant Engineer Wm. S. Mitchell.]

The natural depths of channel throughout the river section in discussion do not reach or exceed the 14 feet desired except at stages above 20 feet on the St. Louis gauge, a height but a few feet below that of mean annual high water (26.5 feet).

These high stages may, and do occasionally, occur as the result of sudden freshets at any time of year, but they are unusual except during the annual high water of the spring and summer, between the latter part of April and the early part of July, a period of about two and one-half months. High stage, however, is not sustained throughout this entire period, but owing to fluctuations aggregates about one and one-half months.

For this length of time, therefore, artificial aid for the maintenance of the 14-feet depth will probably be unnecessary.

Again, at low water navigation is usually suspended intermittently because of ice during December, January, and February, but in the aggregate the suspension is rarely for longer than one-third to one-half of the winter season.

During the remainder of the year, July to December and February to April, reliance for maintenance of the desired channel depth must be placed upon artificial means, which, in the project under consideration, is by dredging, and throughout these periods any dredging plant provided will have to be in commission continuously, and at work continuously or intermittently as may be needed.

During the winter the formation of ice gorges will probably partially or wholly obliterate the channels which may be secured by dredging during the fall low-water period, compelling, during the spring period referred to—about two months—a repetition of a part or of the whole of the work of the former season.

This short spring season will most likely test fully the total dredging capacity of the plant, which, therefore, must be based upon performance of the full amount of work required during that time.

Nevertheless the major part of the year's work of dredging will probably be done during the long low-water period of each year commencing in early July, almost immediately upon the beginning of fall in stage from annual high water, and continuing until the appearance of ice in early December, a period of about five months.

The two main sources of supply of sedimentary matter passing through this river section and forming within it the obstructive bars are the Missouri River and the caving banks of the reach. From the former it is estimated that between 250,000,000 and 400,000,000 cubic yards are annually received and from the latter one-fifth to one-fourth as much.

Measurements of the erosion of the banks by ten-year periods for the thirty years during which bank-protection works have been in progress show annual losses as follows:

1879–1889, 921 acres, 64,000,000 cubic yards.
1889–1899, 633 acres, 48,000,000 cubic yards.
1899–1907, 676 acres, 49,500,000 cubic yards.

Although the direct relationship is unknown, the decrease in caving in the latter two periods may be credited to the extension of protection works, which, at the mid periods 1885, 1895, 1905, had reached totals of 66,000 linear feet, 106,000 linear feet, and 289,000 linear feet, respectively, of banks protected.

The bars formed of the materials thus brought into the river fluctuate in height with the river stages, and examination of the channel soundings of the past thirteen years shows that for each foot in rise of water surface only about 0.6 foot is gained in navigable depth throughout the district, which means that the crests of one or more of the bars within the reach rise correspondingly about 0.4 foot.

Owing to these fluctuations in bar heights and to the influence of duration of stage upon channel depths, estimation of the full amount of excavation and its removal to one side of the channel that may be necessary to secure 14 feet depth of channel at all stages above zero on the St. Louis gauge, can not be exact; but as based upon the soundings and profiles of the Board on Examination and Survey of the Mississippi River, which are thought to represent typical conditions, removal of 35,000,000 cubic yards will be required from 68 localities or bars within the district of 175 miles, and the total length of excavated channel will be 61 miles.

Mean annual low water is, however, about 2.2 feet above zero, St. Louis gauge, and such average condition of stage would reduce the excavation to 20,000,000 cubic yards from 61 localities, and the length of excavated channel to 47 miles.

The present project to obtain 8 feet depth for 200 feet in width of channel requires excavation at zero stage of only 2,300,000 cubic yards from 39 localities, and a length of excavation of 19 miles.

Using the largest quantity, 35,000,000 cubic yards, of excavation required and the shortest time, two months, for its accomplishment, the dredging plant must have capacity for the removal of 17,500,000 cubic yards per month.

At least one-third of the time in commission of each dredge must be spent in maneuvering on each bar, in traveling from bar to bar, in minor repairs, in cleaning boilers, and in many incidental interruptions to actual dredging. The dredging time, therefore, will probably be reduced to only twenty days per month, and the total capacity of plant must be correspondingly increased to about 900,000 cubic yards per day, or 40,000 cubic yards per hour, which for its accomplishment will require at least 20 dredges, each in capacity as great as the dredge *Harrod* of the Mississippi River Commission (2,000 cubic yards per hour) and even this number of dredges will be able to work simultaneously upon less than one-third of the number of bars which may become obstructive.

The cost of such a plant, including the attendant vessels, shops, etc., necessary, is based upon costs of vessels in existence of the various types indicated, and will be as follows:

Twenty steel-hull dredges, *Harrod* type, at $250,000 each	$5,000,000
Forty wood-hull fuel barges, 500 tons capacity, at $6,000 each	240,000
Three steel-hull towboats, *King* type, with sufficient power to tow to repair depot a disabled dredging plant, two of the steamers to be used ordinarily for distribution of fuel and supplies, and one for channel examination and inspection, at $75,000 each	225,000
Four steel-hull survey boats or tenders, at $20,000 each	80,000
One engineer depot for supplies and repairs, with stores buildings, machine and boiler shops, forges, etc	50,000
One marine ways at engineer depot	50,000
Tools and appliances, office and survey outfits, etc	25,000
Contingencies and miscellaneous	330,000
Total cost of plant	6,000,000

It is not probable that so great a plant can be fully assembled in less than five years, because of the small number of building yards on the Mississippi and Ohio rivers, and the time required may be much longer.

The annual operating expense is based upon the expense of dredges under this office during the past ten years, with charges for fuel, deterioration, etc., suited to the larger dredges contemplated; the whole plant to be—

In commission and operation during nine months of the year, at $10,000 per month for each dredge	$1,800,000
And laid up in fleet undergoing repairs, etc., three months, at $2,000 per month for each dredge	120,000
Administration, contingencies, etc	80,000
Total annual expense for operation	2,000,000

This charge is equivalent to an average annual expenditure of $100,000 per dredge, and includes deterioration and all charges for the use of subsidiary vessels, plant, and forces.

As the fluctuations in river stage and channel depths are frequent and sudden, reference need hardly be made to the difficulties of organization and manning quickly and efficiently such a number of dredges for work of intermittent character and at points remote from labor supply, unless the crews are retained continuously, thus greatly increasing the expense for operation.

Very respectfully,

WM. S. MITCHELL,
Assistant Engineer.

ENGINEER OFFICE, U. S. ARMY,
St. Louis, Mo., January 21, 1909.

APPENDIX NO. 5.

PROJECT FOR THE IMPROVEMENT OF THE MISSISSIPPI RIVER (MIDDLE SECTION) BETWEEN ST. LOUIS, MISSOURI, AND CAIRO, ILLINOIS, TO PRODUCE A WATERWAY HAVING A CHANNEL DEPTH OF 14 FEET AT LOW WATER IN THE OPEN RIVER, BY MEANS OF COMPLETE REGULATION WORKS; WITH ESTIMATES OF THE COST OF CONSTRUCTION, OF MAINTENANCE, AND OF THE PROBABLE TIME REQUIRED FOR COMPLETION; AND STATEMENT OF A PROPOSED USE OF HYDRAULIC DREDGING IN CONNECTION WITH THE PERMANENT REGULATION WORKS TO MAINTAIN THE DESIRED DEPTH, IN ADVANCE OF THE COMPLETION OF THOSE WORKS.

[Prepared under the direction of the Board on Examination and Survey of Mississippi River, by Wm. M. Penniman, Assistant Engineer.]

TOPICS OF COMPLETE REGULATION WORKS PROJECT.

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OUTLINE OF PROJECT, WITH COMMENT ON METHODS AND NEEDS.

On this section of the Mississippi the interests of navigation would at all times be best served by an open river; it is believed a 14-foot channel can be obtained therein at a cost commensurate with prospective through commerce between the Great Lakes and the Gulf of Mexico, with the interior traffic that would be developed throughout the length of such a waterway, and with the regulative effect that it would have on freight rates over a large section of country.

If the project adopted gives a channel that is not only practicable for single vessels of the seagoing type, but that is also available for the larger towboats with their barge fleets unbroken, that meets the needs and has the resulting confidence of water trans-

portation interests, a large traffic would be assured immediately on obtaining a sufficient channel depth.

For a waterway such as is now contemplated, the most feasible project is one that not only gives the required depth on completion, but affords that depth at the earliest possible moment after work is started. This desideratum is met by the project for permanent improvement by complete regulation works, dredging being used to give the desired depth in connection with the permanent improvements as installed, the amount of dredging being reduced as the works extend, until, on their completion, it would take its proper secondary place and become a branch of the general work of maintenance for the quicker removal of temporary shoals.

To promote commerce on the open river it is not sufficient to have merely the requisite depth and width of stream; this would serve only the demands of through commerce between large centers that can maintain proper terminal facilitites.

Whatever the method devised, there must be a permanency not only of channel but also of bank lines, and landings must become definitely located points not liable to erosion or separation from the navigable channel through accretions. And any project adopted should have this in view as an ultimate result in order to meet successfully the requirements of local traffic, to promote commerce, and to develop towns and cities along the improved waterway. If only the needs of through commerce were considered in the adopted project, and a method of accomplishing the desired end evolved that did not result in permanence of bank lines, landings, and position of channel, such project, though affording the requisite depth, could not, if the question were ever to arise, warrant the assessment of benefits against the owners of reclaimed riparian lands, as they would derive practically nothing of benefit from an improved river with variable channel—a river equally liable to diverge from their lands and leave their shipping improvements valueless, or to attack and totally engulf their property.

No matter how attractive other methods of creating an inland waterway—a Lakes-to-the-Gulf channel—may at first appear, a more deliberate consideration of natural conditions in the immediate alluvial valley of the Mississippi River clearly manifests and definitely shows the greater advantage and desirability of complete regulation.

It seems fitting to mention the accepted advantages an improved open river has over all other methods that are, under the conditions, applicable for obtaining a 14-foot channel: It has capacity for practically unlimited traffic; it affords equal access to either side of the stream at definitely assured points; it would offer the means of reclaiming, wholly or in part, large areas of land which must eventually become valuable; it offers no locks (liable to inflict or suffer damage) to delay the movement of boats; it interposes no delay at the opening of each season of navigation to close secondary channels that may be opened through the action of ice gorges, nor to remove by dredging the deposits formed during the winter. With the location of channel once fixed, landings and warehouses can be permanently located with necessary conveniences for the loading and unloading of vessels; the time when navigation is suspended on account of ice would be minimized; and whether or not of profit to the country at large, which only its construction and use can definitely show, the cost of producing such a waterway would be a safe investment in this respect, that it would not be in jeopardy of serious injury or of complete annihilation from the ravages of the river when in flood. In addition, with the danger of their grounding eliminated by the definite location of the channel, the use of large ice-breaking boats becomes practicable; a very few such craft would maintain an open river below St. Louis during all except the most rigorous winters.

But the particular benefit to be derived from a completely improved and regulated open river is that the high-water season annually converts the 14-foot waterway into a 20-foot ship channel for about one hundred and seventy consecutive days, comprehending the season of wheat harvest.

That any one method of improvement has given best results in some special locality, even on this stream, is not sufficient warrant for its general adoption, but the merits of each system as applicable to the particular case under consideration must be carefully determined.

Whatever project is adopted, the river will require the construction and maintenance of regulation works if to be of service as a navigable stream for local commerce. If the project be one of lateral canals, security of river banks will be necessary to insure the safety of the artificial waterway. If a system of locks and dams for slack-water navigation within the river is chosen, bank protection will also be necessary, wing dams will be required to regulate the channel width and to remove obstructing sand bars, and the further aid of dredging may also be required.

For open-river improvement a combination and modification of methods now in vogue must be developed to meet general and local conditions throughout the district. Treatment unusual in this country, possibly unprecedented, will be required to

make thoroughly navigable as an open stream and at the same time keep within due bounds this difficult section of a most unruly river.

That the desired result can be attained is shown by past experience on the Mississippi River, and by the conditions that have been produced on this river through regulation; also by the successful improvement of the lower 200 miles of the Rhone with systematic training works, where even before their completion the navigable depth of an alluvial stream was more than trebled, and this betterment was accomplished over a section having a mean slope of more than four times that of the middle Mississippi.

The plans here outlined are, in the main, based on the thirty years' experience of the United States Engineer Office, St. Louis, with this section of the river. If a reliable channel in the open river, of the requisite depth, permanent in location even under flood conditions, is ever to be obtained, it will be through regulation, with works so designed that the entire transverse section of the stream may be controlled.

A depth of 14 feet or more has generally been obtained at localities in this district where works have been placed to narrow the stream and remove obstructing bars. The objectionable accompanying feature is that depths much in excess of those required for navigation are produced in the reaches so improved, causing a flattening or local loss of slope that must be compensated at the ends of the stretch to the detriment of the regimen there and in the reaches above and below, the total fall for the district not being susceptible of change.

As illustrating the conditions to be ameliorated in this district, assume the case of a bar composed of ordinary Mississippi River alluvium—mud, sand, and a little gravel—one such as may readily be cut with the modern suction dredge; also assume it to be a pool-controlling bar having only 3½ feet of water on it at low stages. If a well-defined channel 14 feet in depth is made across it by any means, the velocity of flow in that channel will be about doubled, and as a result of that increase the bar will gradually be cut away to a depth much greater than desired and will cease to exist at that point, the former shallow becoming a deep. Usually a compensating bar will form at the nearest favorable place above or below (perhaps at both places a lesser bar), but if no new bar be so formed, a general flattening of the slope or lowering of plane must result, causing marked disturbances of regimen. The requisite depth may thus be created by narrowing or by dredging, but the avoidance of a disastrous deeper erosion can be assured only by giving to the bottom of the stream the additional needed resistance to erosion.

Under such circumstances, no regulation works can be considered complete that govern merely the side boundaries of the channel; the general slope of the low-water surface must be regulated by fixing in elevation and position the crests of controlling bars or their artificial equivalent.

This requirement seems to call for such construction works as shall at all stages, from low water to bank full, give the required narrowing of the stream, permanently fixing all unstable banks on such alignment and with such slope as is requisite, and secure complete regulation by controlling at necessary intervals the hydraulic mean radius of the stream, and to do this without materially changing the mean slope for natural subdivisions of the river; and if flood control is also to be involved, as it must if any lands are reclaimed, the works should facilitate the river discharge at over-bank stages, but must not at any time create excessive velocities interfering with upstream navigation.

Such a system of regulation would embrace three forms of permanent construction, each distinct in its own function, but all closely interdependent as applied to the improvement of this section of river; and in the order of their effects in the producing and maintaining of sufficiently great controlling depths and of creating and preserving uniform slope they are:

I. Side contraction.—The building of new banks to the height of the bank-full stage on the projected alignment and slope, thus securing the contraction of the stream necessary to produce the required depth; to be accomplished by works of side contraction—wing dams, permeable or solid.

II. Bank protection.—The protection of all concave banks in alluvium, whether natural or created by induced accretion, also when required to preserve alignment of some sections of straight and slightly convex banks; to be accomplished either by low training walls or by revetments.

III. Stream-bed control.—The regulation of the entire bed of the stream by fixation, in sufficient number and on predetermined slope, of the crests of controlling bars, whether these bars be natural or artificial, thereby equalizing the fall and preserving a uniform recurrence of neither more nor less than the required depth and width of cross section at these determining points for complete regulation; to be accomplished

by sill dams or cross weirs, thus maintaining the desired depth of channel when obtained by the works of side contraction and bank protection.

Although hydraulic dredging is not in itself a part of a system of regulation works, although it is not essential to the success of a project for obtaining and maintaining the requisite depth by regulation works, the permanent works in themselves being fully adequate for the accomplishment of such purpose, yet hydraulic dredging is, under certain conditions, an adjunct of such value that it is included among the features of this project as the instrument by which the required depth can be made available in advance of the completion of the permanent works and can be quickly regained at any time thereafter in case of emergencies.

Not only during the construction period, but later during maintenance work, after all the permanent works have been placed in position, dredging would be of service to hasten the removal of temporary shoals caused by sudden freshets with fall so rapid as not to allow even an improved river to correct itself simultaneously with decrease in stage.

That the association of the above-named three forms of construction, combined with dredging, will be very much more effective, more certain, and at the same time less expensive than the use of any one by itself alone, and that such association is necessary to insure the desired result, is clearly shown by an examination of the defects inherent in each when used alone.

Considering side contraction by itself, the most serious objection to its use is the inevitable lowering of plane and flattening of slope due to excessive erosion of river bed. Not only is an abnormally steep slope produced at the upper end of any long alluvial stretch where increased depth is so obtained, but the decreased fall and unnaturally narrowed river obstructs the free discharge of floods, and thus aids in obliterating the low-water channel. Such lowering of slope and delay to the passage of flood waters results in a greater than normal range between the high and low water planes and adds to the time required for establishing a final equilibrium between slope and discharge, both being disadvantages from the view point of navigation alone.

The river could by side-contraction works be narrowed to increase the depth, but any added depth so obtained may not be permanent, probably will not, and for such works that might extend to bed rock the cost would be prohibitive, considering the indefiniteness of any result so obtained.

If the river from St. Louis to Cairo were continuously narrowed to any considerable degree without control of the bottom of the stream, erosion would be expected to continue till a new equilibrium between slope, discharge, and character of bed obtained everywhere. This erosion might go to bed rock at certain localities, thus creating at each a natural weir, and the slope being materially reduced a good navigable river would result if the slope would remain fairly uniform. On this hypothesis the low-water plane at the upper end—that is, at St. Louis—would be lowered indeterminately, causing rapids at the Chain of Rocks above the Merchants Bridge that would completely obstruct open-river navigation to the upper Mississippi and the Missouri rivers and necessitating an additional lift by means of locks between the lower and the upper rivers.

It is obvious that bank protection by itself, if applied to the natural banks, would not give a permanent or a navigable channel of greater than natural depth, since on most crossings a more than average width already prevails; the channel on such crossings is continually shifting and the desired depth is lacking. Moreover, if the alignment of the banks and their separation, were that necessary to afford the depth now required, and if such banks themselves were completely protected, even then bank protection unaided by other works could not secure permanence of depth, because it would fail to accomplish its own purpose, for the reason that to be permanently effective on this river the subaqueous portion of a revetment must extend to the line of deepest scour; and as production of the required depth calls for a cross section narrower than that naturally formed in alluvium on crossings by this stream, erosion of the bottom, not only below the former line of maximum scour but generally below the line to which scour might be desirable, is under these conditions unavoidable and will continue until followed by its inevitable consequence—either a decrease in river slope and lowering of its plane or the settling and destruction of the revetment, with its attendant recession in bank line, resulting later in greater widths and consequent shallower depths than those contemplated in the project.

Though in general successfully maintained in this district, several sections of revetments have been completely destroyed, mainly by reason of lack of stability of river bottom, resulting in local increase of river slope and variation in direction of attacking currents that greatly increase the erosive power of the stream.

This might not happen in every selected case, nor in general throughout the entire district, because the extent of scour would depend on the resistance of the bottom,

but that it would occur in some places with considerable injury to the regimen of the stream and with serious interference to navigation is evident, and is proved by experience.

In a similar way it is obvious that bed protection alone would be insufficient, no matter how extensive and effective were the protection works on the bottom, designed merely to equalize the slope and limit vertical erosion. While pools of unusual depth could not exist, the river would be liable to widen proportionately, until, if not restrained by contraction works within definite side lines, the river would ultimately silt up, and then, shifting away from such bottom protection alone, seek a new channel through the alluvium, where the natural alternate pool and crossing characteristics of the river could again prevail.

The ideal regulation works for a stream of this nature may be described as consisting, essentially, of recurring sections of stream-bed control, flume like in character, through which the stream is directed by intermediate works of side contraction and bank protection, the combined result being at all times to lead the channel flow, and the water at all except flood stages, through an aqueduct of which the walls are for the most part composed of the natural banks of the stream after they have been aligned by induced accretion or directed erosion produced by side contraction, and after their protection with revetments or training walls. The bottom of this aqueduct is the natural stream bed strengthened, at the intervals requisite to result in evenness of fall, by the placing of completely controlling cross weirs in sufficient number to maintain uniformity of slope and water prism, and to prevent scour of the bottom beyond that needed to obtain the desired channel depth.

All the difficulties mentioned as pertaining to the individual use of the three forms of permanent works will be overcome by their combination, using each to produce its special effect only, reliance being placed on their combined action for obtaining all required results—the desired depth, width, and permanent location of the steamer channel—whether it be for an 8, a 14, or a 16 foot channel.

Even this last depth could be obtained on first construction by placing the sills of the cross weirs lower and decreasing the area of the low-water prism, the width of which would probably still be sufficient for navigation; or after the completion of 14-foot improvement, by sufficient contraction to produce the additional depth, with in either case but little effect on river slope and higher stages of water and with but slight increase in current velocity.

With the river rapidly falling after the occurrence of high stages, especially following a rise of the silt-bearing Missouri, it is almost certain there will exist, temporarily and in isolated places, depths somewhat shallower than those that the actual stage normally indicates as existing in the improved river. These temporary and comparative shoals will be eroded and washed out of the regulated channel by the current as soon as the river falls sufficiently to permit the side-contraction works to exert their greatest influence; but if immediate relief is needed, dredging will afford the means of such relief by assisting the diminished discharge, already properly directed by the permanent works, in cutting away and in removing the deposit.

Summation.—Briefly stated, this project for open-river improvement by a regulated channel with sill dams or cross weirs is intended to equalize and render more uniform the water prism at all points throughout the length to be improved and at all stages below the bank-full stage; to reorganize, but not radically to alter, the bed of the stream, transforming the bad passages into good passages by substituting for the natural controlling bars or sluices artificial bars or weirs, which shall maintain a fairly uniform slope and constant gauge height for a given volume of discharge, and to smooth out the present great irregularities of the stream, both as to the varying width and depth now obtaining, in such way as to produce and maintain at low water a practicable channel with a navigable depth of 14 feet. The places where too great width and insufficient depth now exist will be replaced by a regulated channel of the proper width to produce the requisite depth at the present available low-water discharge and without material change in the elevation of any stage.

And through all details of this project the idea has ever been kept in mind that in this large sediment-carrying alluvial stream with its shifting bed the normal condition of the river should be changed as little as possible, the natural forces should be opposed as little as possible, and that these same forces—destructive, erosive, and land-building—should be utilized in such way that they will serve a single definite purpose in the attainment of the conditions sought.

CONDITIONS AND GENERAL FEATURES OF THE PROJECT.

The most characteristic feature of the Mississippi River between St. Louis and Cairo is the facility with which it changes, or may be made to change, the position of the channel and its bed, which is, for the greater part, in alluvium.

From St. Louis to Ste. Genevieve the river practically follows the Missouri bluffs, a distance of 59 miles; thence crosses the valley to Fort Gage (the cut-off into Kas-

kaskia River occurring in 1881), and for 14 miles flows near the Illinois bluffs to Liberty Island; returns to the Missouri bluffs at Red Rock, follows them closely (with Fountain and Grand Tower bluffs for about 5 miles on the left bank) to Grays Point, a river distance of 48 miles; and then flows though a gorge, 7 miles, to Commerce, where the bluffs on both sides sharply diverge from the river. The total length of rock bank thus available is about 140 miles (more than equivalent to one permanent bank from St. Louis to Grays Point), which the river could be made to follow if it were desirable to shorten it and slightly to increase the slope. Owing to accretions, some naturally caused, some resulting from works of improvement, at certain localities the river leaves the bluffs, but returns to them a short distance below after making considerable bends in the opposite banks. At the present time the channel flow is closely adjacent to 73 miles of rock bank, and by a judicious arrangement of regulation works this length can be increased to 77 miles without material increase of mean slope.

In this district damaging erosion and caving of banks usually occur at the lower rather than at the higher stages, especially after an overflow when a falling river has receded within saturated banks unable to stand unsupported. When underlying bank strata are composed of easily eroded materials the vertical face of the bank offers less resistance than does the flat slope of the bed, and erosion is then generally rapid until the normal width of channel and equalization of slope have been produced.

One particular example of a bank that caves rapidly at high as well as at low stages may be cited, especially as this case also shows the necessity for systematic bank protection and the need of levees at certain localities.

During the last ten years the right bank of the Mississippi River in Dogtooth Bend (161 miles below Eads Bridge, St. Louis) has receded to such an extent that the concave bank of this bend now lies in the dry bed of former Big Bayou; whenever the river reaches a 25-foot stage St. Louis gauge, water flows across a narrow neck of land through Big and Stevenson bayous, discharging through the latter into the river opposite the lower part of Cairo. At higher stages, when this bayou can no longer accommodate the volume of water that pours over the bank in Dogtooth Bend and into the bed of old Big Bayou, the overflow water then spreads out, and as the land for some distance above the mouth of the bayou and below Hurricane Field (mile 173)—that is, the land lying between the bayou and the Mississippi River—is lower than the banks adjacent to the bayou, this water is discharged into the main river above Cairo, falling over the bank in Hurricane Field Bend, and has been the principal cause of the destruction of about 1 mile of revetment in that locality. The caving of this bank is especially rapid under the double attack of the main river currents in front and the over-fall water from the rear, and a cut-off may be expected ultimately unless the necessary steps are taken to prevent it.

In such case the distance by river from Dogtooth Bend to Eliza Point (West Cairo, mile 177) would be shortened from 16 miles to but little more than 3 miles, and the immediate result, with the Ohio River moderately low and the Middle Mississippi only moderately high, would be a slope of about 4 feet per mile. The effect such a cut-off would have upon the city of Cairo, situated on the alluvial peninsula almost directly opposite or just below the point of threatened cut-off, may be left to imagination.

There should be a marked tendency toward decreased erosion at lower stages if a practically uniform slope is substituted for the very irregular local slopes now obtaining for such stages, and when the cross section, slope for total natural fall, and consequently the flow throughout the entire district, are made uniform, there will exist no problem as to the ready disposition of even the great quantity of silt brought down by the Missouri River (about 400,000,000 cubic yards annually), that is apparently the cause in itself of remarkable deposits wherever the current is considerably slackened, although these deposits are without any doubt much influenced by, if not mainly due to, the erosion within the district itself, in which, for the last twenty-eight years, the mean rate of bank caving is an area of 1.2 square miles to a depth of 44 feet, or about 54,000,000 cubic yards per annum for this form of erosion.

That the Missouri River sediment, *per se*, causes but little change in river bed between St. Louis and Cairo is shown by the fact that low-water stages of the last fifty years and a comparison of profiles (surveys of 1884–1889 and of 1907) indicate that the thalweg of the river bed when considered as a whole over the entire district has not materially changed in elevation during these fifty years; the profiles show there has been no great change since the earlier survey, and the evidence of the survey observations for the latter part of this period warrants the assumption, on the support of the stage records, that the elevation of the channel bed has remained practically the same during that entire period. From this it may be concluded that no more material has been brought in and deposited than has been eroded and washed out, and conversely. Therefore great discretion should be exercised in adopting

any method of improvement that involves a reduction of slope and velocity—the prime factors in sediment transportation—which would permit the channel to silt up, or of any method resulting in steeper slope and increased velocity which would cause greater erosion of materials. There seems to be a well-established balance between discharge and slope and sedimentary deposits and erosion, which should not be disturbed.

In further support of the deductions from the low-water stages and profiles may be adduced the results of actual sediment observations made in 1879 on the Missouri River at St. Charles, Mo., and on the Mississippi River at Columbus, Ky., which fully confirm the conclusions drawn from the other data. (See Annual Report of the Chief of Engineers, 1887, pp. 3090–3096.)

This report shows that during a portion of the time when sediment observations were taken at St. Charles a series of observations were taken on the Mississippi River at Columbus, Ky. Diagrams accompanying the report show that the agreement between the total sediment at St. Charles and at Columbus is very marked, and that with the exception of short periods of erratic variation, all variations in the amount of sediment passing St. Charles were reproduced at Columbus, with the resulting conclusion that the sediment carried by water reaching Columbus from sources other than the Missouri River was very small in comparison with the amount reaching that point with the water from the Missouri River, and that very close to the same amount of sediment in suspension in the Missouri River is still carried by the water of that stream when it reaches Columbus, with the natural resulting conclusion that it is practically the same sediment carried in permanent suspension between those points.

The mean slope per mile of the upper Mississippi River (lower 100 miles) is a little less than 0.5 foot; of the Missouri River (lower 100 miles) about 0.8 foot; of the combined rivers (between the Missouri and Ohio rivers) a little less than 0.6 foot; and below the Ohio River (230 miles) about 0.4 foot. The mean discharge in cubic feet per second for the eleven years 1880–1890 at Grafton (Mississippi River) is 100,000; at St. Charles (Missouri River) 85,000; and at St. Louis the total discharge is 185,000. (Results deduced from discharge curves and gauge records for the three stations.) While the area of the Missouri River basin is more than three times that of the upper Mississippi River, the mean annual rainfall (inches) and the ratio of run-off to precipitation are considerably greater in the latter than in the former, because of the Missouri basin's more absorptive soil and dryer air.

For St. Louis and for stages of the Market street gauge the volume of discharge in cubic feet per second (according to the discharge curve of 1897–1904) is: At normal low water (0.0 feet), 34,000; at "standard low water" (4 feet), 66,000; at mean stage of river (12.6 feet), 158,000; at bank-full stage (30 feet), 606,000; for the flood of 1903 (38 feet), about 950,000, and for that of 1844 (41.3 feet), about 1,360,000 (this volume estimated).

The slope for the flood crest of 1844 between St. Louis and Grays Point (134 miles) is 0.57 foot per mile, and for the lowest recorded stages at these points it is less, the total fall being 74.4 feet. At St. Louis the range between lowest recorded stage and extreme high water is 43.8 feet; at Grays Point, 41.9 feet; and at Cairo, due to Ohio River floods, it is 53.6 feet.

The maximum recorded fall between St. Louis and Cairo (high water, September, 1905) is 109.6 feet, and the mean fall for the 13 floods since 1858 (exceeding bank-full stage) is 101 feet. The difference in elevation between the means of 49 lowest annual stages at St. Louis and the same number at Cairo is 107.2 feet, and the difference in elevation of extreme low waters is 108.3 feet.

The following table of slopes of the Mississippi River between St. Louis and Cairo shows, at gauge stations, the determinations for low-water and flood planes and (mean determinations) for intermediate characteristic stages with reference to the St. Louis gauge, the records of which are continuous for forty-eight years:

Table showing slopes of Mississippi River between St. Louis, Mo., and Cairo, Ill., for low and flood stages and for intermediate characteristic stages with reference to the St Louis gauge.

Gauges and localities.	Miles from Eads Bridge.		Elevation of gauge zero.	Extreme low water.		Normal low water 0.0′.		Standard low water 4.0′.	
	Mid-bank	Low water.		Gauge reading.	Elevation Memphis datum.	Gauge reading.	Elevation Memphis datum.	Gauge reading.	Elevation Memphis datum.
Chain of Rocks	9.7	10.4	321.18	74.6	395.8	76.0	397.2	79.1	400.3
Bissell Point	3.3	3.3	320.36	66.5	386.9	67.7	388.1	71.8	392.1
Eads Bridge	0.0	0.0	.....	.....	.....	.....	.....	.....	.....
St. Louis (Market street).	0.4	0.4	387.10	−2.5	384.6	0.0	387.1	4.0	391.1
United States Engineer Depot	3.2	3.2	386.75	−2.6	384.2	−0.1	386.7	3.8	390.6
Jefferson Barracks	10.8	10.8	384.81	[a]−1.3	383.5	−0.2	384.6	2.9	387.7
Waters Point	21.5	22.4	377.54	−0.5	377.0	1.4	378.9	5.0	382.5
Cornice Rock	31.4	32.7	373.19	−3.0	370.2	−0.9	372.3	2.7	375.9
St. Nicholas Rock	33.0	34.3	220.84	.....	[b]369.2	150.5	371.3	154.0	374.8
Brickeys	43.8	45.6	364.84	.....	[b]363.0	0.6	365.4	3.0	367.8
Little Rock Landing	53.9	56.5	220.84	135.4	356.2	138.2	359.0	141.4	362.2
East Kaskaskia	63.1	66.1	350.84	−3.6	347.2	−1.6	349.2	1.8	352.6
Chester	69.6	72.9	348.13	−4.0	344.1	−0.5	347.6	1.9	350.0
Red Rock	84.9	89.2	335.84	[d]0.0	335.8	2.3	338.1	5.3	341.1
Grand Tower	98.9	103.3	329.04	[e]1.1	330.1	3.4	332.4	5.6	334.6
Moccasin Springs	112.7	116.8	320.84	[f]1.7	322.5	3.7	324.5	6.4	327.2
Cape Girardeau	126.5	130.8	311.84	0.8	312.6	3.0	314.8	6.1	317.9
Grays Point	132.4	136.8	[c]308.15	[g]1.0	309.1	3.6	311.8	6.8	315.0
Commerce	139.4	143.7	308.84	−0.5	308.3	2.2	311.0	4.7	313.5
Hacker Towhead	151.5	156.5	220.84	81.7	302.5	82.9	303.7	84.7	305.5
Thompson Landing	157.2	163.7	294.55	1.3	295.9	2.3	296.9	5.9	300.5
Beechridge	162.5	169.5	289.73	1.4	291.1	1.2	290.9	5.7	295.4
Birds Point	173.2	181.4	279.19	2.2	281.4	1.8	281.0	8.2	287.4
Mouth Ohio River	174.8	182.5	.....	.....	.....	.....	.....	.....	.....
Cairo	.....	.....	277.71	−1.4	276.3	2.8	280.5	9.1	286.8

Gauges and localities.	Mean stage of river 12.6′.		Mean of highest daily stages 25.5′.		Bank-full stage 30.0′.		Flood plane 1903, elevation Memphis datum.	Flood plane 1844, elevation Memphis datum.
	Gauge reading.	Elevation Memphis datum.	Gauge reading.	Elevation Memphis datum.	Gauge reading.	Elevation Memphis datum.		
Chain of Rocks	85.1	406.3	96.7	417.9	101.1	422.3	431.8	[b]434.0
Bissell Point	80.3	400.7	93.8	414.2	98.8	419.2	428.7	[b]430.6
Eads Bridge	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis (Market street).	12.6	399.7	25.5	412.6	30.0	417.1	425.1	428.4
United States Engineer Depot	12.1	398.9	24.8	411.6	28.5	415.3	423.2	[b]427.1
Jefferson Barracks	11.2	396.0	23.7	408.5	26.4	411.2	418.0	[b]422.5
Waters Point	12.4	389.9	23.9	401.4	27.0	404.5	411.1	416.4
Cornice Rock	11.3	384.5	22.5	395.7	25.8	399.0	406.3	[b]410.2
St. Nicholas Rock	162.4	383.2	173.0	393.8	176.5	397.3	404.9	[b]408.9
Brickeys	11.3	376.1	22.6	387.4	26.1	390.9	397.7	403.3
Little Rock Landing	148.4	369.2	159.4	380.2	162.6	383.4	390.3	397.1
East Kaskaskia	11.0	361.8	23.8	374.6	27.4	378.2	386.2	392.8
Chester	10.2	358.3	21.9	370.0	25.8	373.9	381.5	388.0
Red Rock	13.6	349.4	25.5	361.3	29.4	365.2	374.4	[b]379.8
Grand Tower	13.6	342.6	24.4	353.4	27.8	356.8	362.8	370.4
Moccasin Springs	14.3	335.1	24.5	345.3	27.9	348.7	354.7	[b]361.9
Cape Girardeau	15.0	326.8	26.1	337.9	29.6	341.4	348.3	354.4
Grays Point	15.0	323.2	25.8	334.0	29.1	337.3	343.6	352.1
Commerce	11.7	320.5	21.1	329.9	23.9	332.7	338.2	341.2
Hacker Towhead	92.0	312.8	102.0	322.8	106.1	326.9	332.1	[b]334.3
Thompson Landing	12.4	307.0	23.9	318.5	29.1	323.7	329.0	[b]331.0
Beechridge	14.2	303.9	26.0	315.7	31.6	321.3	327.0	[b]329.5
Birds Point	15.8	295.0	29.9	309.1	39.0	318.2	321.6	[b]324.0
Mouth Ohio River	.....	.....	.....	.....	.....	.....	.....	.....
Cairo	16.5	294.2	30.4	308.1	37.7	315.4	320.5	[b]321.5

[a] Low water of 1872.
[b] Derived from slopes.
[c] Precise levels in 1908 indicate an elevation of 309.25 for zero of Grays Point gauge.
[d] Doubtful on account of ice; lowest reliably recorded 1.0.
[e] Doubtful; lowest reliably recorded 2.0.
[f] Doubtful on account of ice; lowest reliably recorded 2.3.
[g] Doubtful; lowest reliably recorded 1.3.

Elevations refer to the Memphis datum plane.
Readings given for "Extreme low water" are the lowest recorded since the establishment of the gauge.
Mean of lowest daily stages, St. Louis, is 0.45 foot above standard low water of the United States Engineer Office, St. Louis.
Cairo gauge is in Ohio River, and 2 miles above the mouth (mile 182.5).
Flood plane 1844, Hacker Towhead to Cairo, is derived from slope, Price Landing, Mo., to Columbus, Ky.

As to be expected, the greater depths exist in the narrower sections of river, but even in the sections where these greater depths occur they do not prevail over a bottom that is in any way constant; not only do they vary with stage, but, like the depths in the wider parts of the river, they are subject to variation from the rise and fall of the stream bed. In a comparatively narrow reach at La Cours Island (95 miles below St. Louis) a line of channel soundings taken at a flood stage in 1908, when compared with the low-water soundings of 1907, indicate a scour of about 12 feet over three-fourths of a mile of river. In 1907, a low-water depth of 52 feet was found at Grand Tower (mile 103), where the width is 1,400 feet, and in 1884 a corresponding depth of 104 feet was found very near the same point, showing that even in a gorge alternate scour and fill is going on.

In a narrower section at Devils Bake Oven (about 1 mile above Grand Tower) the low-water depth of the thalweg is only 35 feet, while below Devils Backbone (90 miles below St. Louis), in one of the narrowest sections of the river, that depth is 63 feet. At Ables Point (mile 171)—the narrowest low-water section in 1907—a depth of 40 feet below low water was found (width, 650 feet).

Least depths, with which alone navigation is concerned, are found on the steamer crossings, and during the progress of the Board's survey, when a continuous line of channel soundings was made, the least depth found on crossings was 8 feet at a stage of 4.8 feet, St. Louis gauge (only one-half foot above the lowest stage of the season, which occurred a few days later). In the fall of 1908 a lower stage prevailed (3.4 feet, St. Louis gauge), and a depth of 8 feet was maintained by dredging until a sharp rise caused a temporary silting up of the channel, which was again improved by dredging.

Greatest widths of clear waterway at the bank-full stage are found immediately above islands or tow-heads; for example, at Kaskaskia and at Grand Tower islands and at Thompsons and at Grand Lake tow-heads. The width at each of these places is about 6,750 feet, the widest being 6,800 feet at the last-named place.

Within less than 2 miles upstream from each of these sections of maximum bank-full width, unusually narrow low-water widths occur, and a similar condition exists at ten other localities where bank-full widths varying from 4,000 to 6,600 feet are preceded by low-water widths of from 1,300 to 650 feet. But an unusually wide bank-full section is not always preceded by a very narrow low-water section, and in a very few cases reversal of this order is found, and the narrow low-water section occurs downstream from a very wide high-water section, as shown in the narrow section above Grays Point occurring below the wide section in Cape Girardeau Bend. Hence, it appears that places extremely wide at the bank-full stage are, in their natural state, generally closely preceded by, but may be followed, though rarely, by abnormally narrow low-water sections, and the number of these cases found in the district indicates some relationship as to cause and effect between these conditions. Whether the wide bank-full sections are caused by the narrow low-water sections above, or the converse, the smoothing out of either the bank-full or the low-water lines on regular alignment and with uniform width can have none except a beneficial effect upon the other, and an especial effect will undoubtedly follow the correction if the realignment of both is effected.

In a stream with unstable alluvial bed the deep water is always found in the bends and sometimes in the straight reaches. Submerged bars are the natural stream regulators, building out from convex banks, incidentally aiding in the caving of concave banks, following them into the bends, causing further shifting of the channel and forming natural dams across the river, generally in wide sections below the pools and always between successive concave banks on opposite sides of the river; that is, on the inflections of the line of the navigable channel. On these latter bars are the steamer "crossings" from pool to pool, either squarely across or obliquely from shore to shore.

Between St. Louis and Cairo there are approximately 60 such crossings (56 during low water, 1907) over which the channel depth may decrease to 8 feet or less at low water. Their distribution is fairly even, it being practically one to every 3 miles of river, and during low water any one of them may become a menace to 8-foot navigation, although not more than ten or twelve have heretofore become troublesome at the same time or during one low-water season.

In a letter to Capt. C. J. Allen, Corps of Engineers, and Assistant Engineer R. E. McMath, dated February 16, 1873, Maj. Chas. R. Suter, Corps of Engineers, gave a brief discussion of a few places in the river which were shoal at low water, in connection with the holding-up effect of bars on river depth and the distance this effect extended up the stream:

* * * * * * *

"There are a few places in this reach of river which always become very shoal and generally in each low-water season one or two of these places form the principal obstructions.

"These places are Turkey Island, Liberty Island, Hat Island, Crawfords, Powers Island, Dog Tooth Bend, and Greenleafs. The three last go together and are mainly dependent on the stage of water in the Ohio.

"The intermediate shoal places generally have more water than those in the above list. As a general rule whenever one or the other of these places gets bad it remains so throughout the season and sometimes for several consecutive seasons. Thus in 1868 and 1869 Hat Island was the worst shoal. In 1870 the main bar was at Liberty Island, and in 1871 it had shifted up to Turkey Island. When the main bar is as far up the river as this, the water is sensibly backed up as far as St. Louis and all the intermediate bars are drowned, as was the case in 1871, when there was but 4 feet at Turkey Island and 6 feet on all the bars above.

* * * * * * *

"When the main bar is at Hat Island, the river is generally in its worst shape, as this place is about halfway, and its influence does not extend up as far as Turkey Island, etc. In 1872 the worst bar was at 'Horsetail,' at the mouth of the river Des Peres. This bar was so far up the river that the bar at Devils Island was also uncovered and gave much trouble. Between these points was comparatively good navigation."

* * * * * * *

It will be seen that Major Suter's judgment of the effect of a controlling bar on backwater was not based on a uniform condition prevailing during the period of his observation, but that changes in the locations of the controlling bars extending over a number of years gave him ample evidence as to the varying effects from the several more important bars he mentions.

When the channel has a shifting tendency, as in wide reaches, these natural dams or submerged bars have a gradual downstream motion, due to the transfer of material from their upstream to their downstream faces, and their crests are often suddenly raised by deposits of sediment caused by the decreased velocity of a rapidly falling river and also by caving banks above, but when the main confining banks are stable the general locations and forms of these bars undergo only slight changes. The effect of a high stage, with consequent excess of sediment, especially if long continued, is to obliterate the generally narrow and sinuous low-water channel. Hence during a rapid decline following a rise abnormal shoals (sometimes several well-defined but shallow channels occurring) are found on the bars in wide reaches, and it frequently happens that lesser channel depths are found on a bar at high stages than at a low stage after the diminished discharge has been concentrated to form a good low-water channel.

According to Janicki—

"The status, the general character of a river, therefore, depends on the united action of these three factors: The discharge, which is variable; the magnitude of the slope, which is likewise variable; and the nature of the soil, which is variable in different localities.

"That a river may be navigable it is necessary that it should have a sufficiently deep channel throughout its entire length. A river may have much water, but if the fall is considerable and the soil unstable it can not have a deep channel. On the other hand, there are rivers with a relatively small discharge and great fall which are yet quite suitable for navigation owing to their hard bottom.

"In undertaking works of regularization on any river with a view of improving its navigability, we should not rely altogether on the fact that it has a plentiful supply of water, and think that by sufficiently contracting its bed we can always obtain the desired depth. We must first satisfy ourselves, and this is indispensable, that the amount of fall and the nature of the bed are not opposed to regularization, for no palliative will remedy incompatible conditions.

" * * * Hagen * * * demonstrates * * * that the removal of a bar occasions a distribution of the fall over a great extent of water; that is to say, causes a lowering of the water level above the bar; and he recommends that in undertaking works of contraction a careful examination of the longitudinal profile of the river should first be made, to see if the lowering of level which would follow would not bring out new obstructions in the pool above, by exposing shoals previously covered with a sufficient depth of water." (Merrill's translation, pp. 17 and 19.)

Modern French practice, as given by Professor Fourrey (1906) of the Special School of Public Works (Paris) in his text-book upon improvement of rivers with free flow of current, basing his instructions upon the results of the improvement works of 1882–

1905 upon the lower Rhone, states the necessity of preserving and regularizing bars, as follows:

" * * * by narrowing * * * in a river with a freely movable bottom, unless the erosion of the bottom be limited by means of appropriate works, the low water level will be notably lowered (p. 123). Principle: * * * We admit * * * the conservation of bars and the conservation of the staircase shape of the profile along the axis of the river * * * (p. 124). The method * * * has simply for its object, to change back all bad crossings to good crossings. The work to be done to secure this result consists in:

"First. Concentrating all the low-water flow into a single bed.

"Second. Making permanent in position the pools and bars within this bed.

"Third. Regulating the orientation of bars. The constructions employed for such purpose are * * * and transverse spurs. These spurs have different names according to their purpose: * * *

"Fourth. If they protect the bottom of the bed over a considerable part of its breadth, crossing the thalweg, they are bed-sills." (Pp. 126, 127.)

The gorge between Grays Point and Commerce exemplifies the effect of natural conditions similar to those that should be produced by artificial control; for 7 miles the river is confined between stable banks, the low-water and bank-full widths compare favorably with corresponding mean widths for the district, and the slope is only slightly less than the mean slope; at certain places the bottom is fixed, or practically so, resulting in a nonchanging cross section, and except for isolated bowlders and reefs, the required width and depth are found.

Permanent navigable depths not only exist throughout that reach, but extend for 3 to 4 miles above and below.

It is proposed to create an essentially parallel condition by means of works for complete regulation in parts of the river where the cross section varies from the one required to maintain a navigable depth of 14 feet.

For such localities, the required cross section having been determined, the boundary lines of the stream will be conformed to that section by the building or erosion of the banks to the desired alignment by side-contraction works, the protection when necessary of all unstable banks, whether naturally or artificially produced, and the determining in elevation of the bottom at the necessary intervals by sill dams or cross weirs. To obtain this result, the weirs will be placed across the alluvial bed of the stream and approximately normal to the chosen thread of channel. The relative position of the thalweg of the stream and of the weirs crossing the entire stream bed to the bank-full stage may be described as resembling a broad arrow pointed upstream, in which the shaft lies along the thalweg and the barbs indicate the two sections of a cross weir meeting at a very flat angle in the proposed channel. The flat angle thus formed by the two spurs will have the necessary effect on the spill over them to train the currents into a central channel. Thus, with predetermined form of cross section, the low-water channel would always be over the same portions of the weirs, the "navigable pass sills," with crests placed on uniform slope.

As to necessity and shape of bed sills, Professor Fourrey states:

"Wherever the bottom is very easily eroded, it is made permanent over its entire breadth by * * * bed sills; they are given the shape of a chevron, the point turned upstream and placed on the axis of the channel, whose position it determines by their fixing the maximum depth." (P. 138.)

As far as practicable the natural cross section of the stream and the existing low-water channel are to be utilized. The thalweg would then be trained along the concave banks, approximately as they may be found when the improvement is undertaken, and in so doing would cross the stream bed wherever a reverse curve occurs in its general direction.

At these places occur the bars or natural dams previously mentioned, which, as regards navigation, may be classed as "bad crossings" or "good crossings." A bad crossing or passage is generally found where the river is excessively wide, the bar extending across the stream on a long diagonal line, over which at low stages the water spreads out in a thin, broad sheet, and the ends of the successive pools extend along the separating bar far past each other, hugging opposite banks. At such localities the channel (generally undefined at low and medium stages) is found on a line almost squarely across the stream or approximately normal to the separating bar and anywhere between its ends.

Deficient depth and abrupt changes in bottom and surface and in channel direction result in sharp local fall over the reef and render such a crossing extremely difficult for navigation.

A good crossing or passage is found where the low-water channel is confined in a bed not too wide; conditions are the reverse of those on the bad crossing; the bar,

instead of the channel, extends almost squarely across the stream, and the ends of the pools, being on the same axis, permit direct and concentrated flow from the upper pool to the lower.

The improvement of any stream with unstable alluvial bed, to obtain for it a fairly uniform cross section, slope, and depth, and with the same volume of discharge, to increase the depth over that normal for the stream—that is, to add to the navigable depth over crossings—requires the regulation of the entire bed of the stream and not merely of a part of the bed, as is done by side-contraction and bank-protection works alone.

Wherever in contracted reaches the bed is ignored in designing regulation works and the building of new banks is given an undue importance, the bottom will be subjected to deep erosion, resulting in the detriment of regimen in the reaches above and below.

Jacquet holds that—

"In a water course with variable cross section, discharge, and velocity there can be no permanent equilibrium from the moment that the discharge is sufficient to act on the gravel composing the bed. As a general thing the bed is constantly in motion." (Merrill's translation, p. 49.)

Of attempted regulation by contraction alone, Janicki says:

"Regularization by contractions is seductive at first sight, because it seems to exactly meet the necessities of the case. It is also seductive by its simplicity; but in reality it is a bastard system that has only one undeniable merit, that of being readily defended. Its defenders do not pretend to deny its lack of success, but for any given case they have characteristic explanations.

"Regularization, with bank protection, is often indispensable in order to defend bottom lands from scour; but this is all it is good for, and the improvement of the navigation of the river must not be expected.

" * * * in a river with movable bottom, works of contraction cause a deepening of the bed at the shallow places, thus inevitably producing a lowering of the level in the pool above, and spoiling the pools still farther up, which formerly were deep enough." (Merrill's translation, pp. 181, 186, and 193.)

The creation of troublesome recurring steps of sharp local fall has long been recognized, and the ultimate result of cutting down an upper step to remedy conditions at any one point is well expressed by Pasqueau:

"If we remove one step of the stairway in order to get rid of this annoying obstruction, the preceding step becomes still more troublesome; and if we suppress several consecutive steps, we find ourselves confronted by a veritable wall, which it is impossible to surmount by any means.

"Scour in a homogeneous soil caused by contraction will continue indefinitely, whatever may be the initial height of the dikes, if the slope remains constant.

"The deepening of bars by contractions * * * has, as a necessary and inevitable consequence, a progressive and indefinite lowering of the water plane which renders it impossible to improve rivers with movable bottoms by these methods." (Merrill's translation, pp. 71, 74, and 76.)

Jacquet clearly brings out the difficulty of producing only the proper depth of scour by the mere narrowing of an alluvial stream:

"By forming a sufficiently contracted low-water channel we can always bring to bear a scour powerful enough to cut away the bar, and to secure a depth of water greater than that required for navigation. But the difficulty consists in restricting this action within proper limits, and as we can not avoid doing more than is strictly necessary, we must try to go only so far as not to compromise the ultimate improvement of the whole section." (Merrill's translation, p. 44.)

Sill dams or bottom ridges as a means of controlling stream lines and for the purpose of improving navigable depths have been in use for many years, especially on European rivers, and in certain instances they appear to have been evolved from the indiscriminate use of side-contraction works, and adopted to remedy the inevitable consequences resulting from such use of those works, as the necessary means again to distribute over a longer stretch the rapids and prohibitive slopes caused by attempting regulation without complete control of streams with beds of a yielding nature.

In commenting on works designed solely for the protection of the bottom of the stream, Jacquet says:

"It ought not to appear more extraordinary to try to regulate the bottom of a river than it is to attempt the rectification of its banks. For * * * all rivers with movable bottoms, experience has made it clear that instability of the bottom is one of the greatest obstacles to a lasting improvement. The Germans understood this long ago, and by 'grundschwellen' they have obtained on their rivers a regularity which each day makes more perfect." (Merrill's translation, p. 168.)

No case so extreme as to constitute an absolute barrier has thus far occurred on the river section here considered, nor immediately above St. Louis, at the Chain of Rocks, where the worst conditions as to fall exist; hence it is thought that cross weirs placed about 1¾ miles apart would effect the satisfactory improvement of this reach, and it seems safe to predict that with the same spacing of weirs an almost uniform slope can be maintained in the other reaches of the district where the regimen has been but little if at all affected, and where the only changes in the natural slopes, and those changes but slight, will be a readjustment for natural river subdivisions rather than an actual alteration.

In this project the discussion is devoted mainly to an elucidation and accentuation of the use of cross weirs for stream-bed protection as a most important feature of the improvement of an alluvial river by regulation. On account of their function in controlling the transverse profile, and of their interdependence and effect in maintaining the requisite slope, to which end they will extend across the entire stream bed to the bank-full stage, they have, in this project, been called "cross weirs;" this is justified, it is thought, not only to avoid confusion of terms, but also by the fact that, in this country at least, they have not yet been used in so extensive a plan nor on so large a scale as now proposed.

Construction works for the narrowing of the stream, and revetments or other works designed for the protection of the resulting, or of the existing, bank lines, and their use, either separately or in combination, for the closing of chutes and secondary channels, are not only so well known on this section of river, but are in such general use on other rivers that a fuller or more detailed statement of the purpose served and the results attained by them has not been deemed requisite in a preliminary determination of the possibility and feasibility of holding the channel depth by means of the cross weirs after it has been obtained by the usual contraction works with their necessary accompanying bank protection. Nor are any further details than are given considered necessary to show the place in this project occupied by hydraulic dredging as an accessory in accomplishment of the final result or as an aid in maintenance.

The side-control and bank-protection works proposed—wing dams and revetments—would serve as follows: Wing dams built from the convex banks would give the required narrowing; revetments or bank protections would hold the concave banks. Stability of banks might also be materially increased by draining near-by swamps and lowlands.

Schlichting's comments on the placing of works for side regulation are thought to cover the entire field concisely:

"In practice it is often found that while the main banks are essentially straight, the channel is tortuous and wandering from one bank to the other, so that in practice concave and convex shores have almost always to be taken into consideration. Speaking, then, with reference to the channel of a stream, the convex bank will be built out with long spurs, the concave will be held by training walls or bank protection, and thus the double advantage is gained that the bars which are already connected with the shore will be retained in position, while the deep water which will follow the training walls will be at a distance from the heads of the spurs." (Abbot's translation, p. 174.)

The complete control effected with the works for side contraction and bank protection and the cross weirs will limit erosion of river bed, bottom, and banks; energy of flowing water and resistance of river bed will be in practical equilibrium; uniformity of slope at all stages will be approached; an ideal river regimen will result, followed by permanence of navigable depths.

The nature and effect of the submerged dikes in particular, and of the entire system of bank-protection and side-contraction works when used with them is described by Vernon-Harcourt, with reference to the actual use of such combination, as follows:

"These submerged dikes are kept below the limit of the navigable depth; and they serve, like the submerged spurs projecting in front of the concave longitudinal training walls, to regulate the depth of the channel, just as the other works regulate the width. Their form, moreover, directs the main current into a central course. By the judicious and gradual adaption of these different forms of training works to the various requirements of the channel, the fall, depth, width, and course of the low-water channel have been regulated * * * without unduly interfering with the natural condition of the river." (The Training of Rivers, p. 9.)

Preliminary calculations and the study of a large number of cross sections indicate that by means of permanent works for narrowing the stream, holding the banks in position, and conserving the slope by protecting the bottom, a channel having a depth of 14 feet below low water and a width of 500 feet can be produced and maintained in the river section under discussion at a reasonable cost, considering the end

attained, and this without material increase in mean velocities or undesirable change in the elevation of any water surface from extreme low to the bank-full stage.

Higher stages might be confined within levees permitting a river width of about 1 mile, which would raise the extreme flood plane a few feet in localities not now protected by levees. Cross levees, following the principal creeks, would act as checks in case the main levees were topped or broken by floods. No estimate for levees is included here, as it is thought all old sloughs and river beds should be gradually filled giving banks of fairly uniform gauge height, before a levee project is considered.

The nature of the proposed works when in situ would be such as to obviate any possibility of their requiring reconstruction except for two reasons: One, a required change in location of the navigable channel, can almost certainly never arise, and could be considered only for such cause as would justify the expense of reconstruction; the other, the obtaining of depths greater than 14 feet, can, to the extent of about 2 feet, be met by slight additional works without removing any part of the original construction, by sufficiently narrowing the low-water channel to secure such further depth at that stage, without changing the elevation of the sills. This would raise the plane of low water throughout the entire district. Immediately above St. Louis the slope would be reduced, and for a short distance above the Ohio River it would be increased, and there, if necessary, it could be adjusted to the requirements of navigation by a movable dam or by a further extension of the cross-weir system.

The river and harbor act of March 2, 1907, specified the consideration of an added flow of 10,000 or 14,000 cubic feet per second. After the proposed regulation works have been fully completed, 10,000 cubic feet would add about 1½ feet to the navigable depth over the weirs at low water, and 14,000 about 2 feet. But without complete regulation of the river—controlling stream bed and water planes—the increase of depth due to any added flow is indeterminate.

Pilot I. H. Baldwin published a statement, over his signature, that when the river had fallen to the bank-full stage after the flood of 1844 he with difficulty found a 9-foot channel between St. Louis and the Ohio. (Report, Mississippi River Commission, 1881, p. 243).

By combination of side contraction of the cross section at weirs, and of the added flow, the plane of the zero stage discharge could be raised about 4 feet, or to the present plane of "standard low water," thus giving an 18-foot channel for every day in the year unaffected by ice, and a 20-foot channel for the greater part of the year. The effects on high and flood stages from contraction of the low-water prism and from the added flow would be but slight.

The flood problem should be carefully considered before adopting any particular method of improvement. Unfortunately we have no direct measurement of volume for the great flood of 1844, estimated by two writers as 1,360,000 and as 1,200,000 cubic feet per second; but several of the original marks of that flood, determined in elevation for the first time by the Board's survey, show that, in parts of the valley where present bank conditions are about the same as those that existed in 1844, this flood was 6 feet higher than that of 1903, although at St. Louis, in the contracted reach, the 1903 flood lacked only 3.3 feet of the height actually reached by the 1844 flood at a time when there were no other than natural restrictions to the width of the stream. The flood of 1844 spread out from bluff to bluff (3 to 7 miles apart) from St. Louis to Grays Point, and was about 10 feet above the river banks. At Grays Point it was 8.6 feet higher than the gauge elevation for the flood of 1903. The flood of 1785 was equal in height and probably in crest volume to that of 1844. The recurrence of such a flood would, because of the contracted part of St. Louis Harbor, seriously threaten the proposed east side levee, as well as existing improvements, and the Eads Bridge superstructure would be greatly endangered by the effects of accumulated drift on the crest of such a flood, abnormally raised; but this could not damage regulation works such as are here proposed, as the uniform slope, and clear, regular river bed would have a tendency to reduce the flood plane without increasing the mean velocities.

Entirely outside the question of the available depths, there naturally occur, in this section of the river, and at different seasons, certain other interferences that either tend to restrict or totally prevent navigation, hence a project for the improvement of the open stream should, if possible, provide for the overcoming, or at least for the minimizing, of these troubles.

Of these, the simultaneous occurrence of low water and ice constitutes the only obstacle of really serious magnitude. It is therefore almost exclusively the low-water regimen and its attendant difficulties that are to be considered.

The only other troubles are fogs and extraordinary floods. Only brief delays are caused by fogs; navigation is not stopped by them. They are not preventable, and the only provision that might be made for them lies purely within the regulations governing navigation and does not pertain to a project for improvement.

Floods exceeding 35 feet, St. Louis gauge, are uncommon, and generally of brief duration. In the last sixty-four years there have occurred only 5 such floods, total duration sixty days; and in the same period only 15 floods, including the 5 extraordinary floods mentioned above, have exceeded the bank-full stage, with a total duration for all over-bank stages of 284 days in the sixty-four years. Except for such extraordinary floods, with great quantities of drift and increased channel velocities, navigation is not seriously interrupted by floods.

There is no method known for obviating these troubles, but permanence of the general river conditions as to location of thalweg and fixation of controlling bars will do much toward lessening the practical difficulties presented.

As a rule, ice interfering for a period of varying length with the movements of boats, even if not entirely suspending traffic, occurs each year.

From 1865 to 1908, forty-three winters, the river at St. Louis remained entirely open thirteen winters, but navigation has been stopped by ice 43 times in thirty different winters for a total of 1,305 days, giving for the years in which navigation was thus suspended an average closed period of 43.5 days. The longest closed season, 78 days, occurred during the winter of 1880–81. Considering the entire period of forty-three years, the average closing of navigation by ice was 30.35 days per annum. (This data is taken from the records of the St. Louis Merchants' Exchange.) Severest ice conditions generally occur at very low stages. Ice forming along the river bank at a temperature of about 20° F. and less is continually detached by the current, the quantity increasing as the temperature falls, and very rapidly if a heavy precipitation of snow accompanies. By attrition it is reduced to the form of mush ice, and heavy masses are cemented together by regelation. The moving mass is often several feet in thickness, and when in this state it arrives at a part of the river unusually narrow or shoal the ice is compacted on the surface and very quickly solidified under pressure. Other ice following adds to the mass above and below until a complete dam or ice gorge is formed, arresting both ice and water till the accumulated head furnishes energy either to break through or cut around the gorge, or else to lift it high enough and detach it from the sides, unless these effects are anticipated by a thaw. The heavy runs of ice from the upper rivers thus generally pass out on medium and sometimes on high stages.

It is not thought possible entirely to prevent the formation of ice gorges by any human device, but a method of improvement that in general smooths the passages and reduces the inequalities of the river will diminish the tendency to the formation of such gorges by the removing of the natural conditions that aid them and by the freer flow of deeper bodies of water.

The plans outlined are believed to be conservative and safe; they contain nothing wholly untried, being based upon rational combinations of tested river improvement methods; they are reasonably sure of success and will give the required navigable depth without disturbing the equilibrium of the river. The problems of construction do not involve new features, and work can be carried on continuously during all seasons and at all stages without being retarded except by extreme floods or by ice. By conducting operations at various distributed parts of the district improvement of navigable depths will be immediate as the works are installed, and the required depth of 14 feet below low water can be obtained throughout the district long before their final completion, their effects prior to that time being supplemented by dredging to obtain the required depth at unimproved localities, and the permanence of depths so obtained would be assured by extension of the works.

All forms of construction involved are of a reasonably permanent nature, especially below the low-water line, almost indestructible by floods and suffering but little from ice; above that line, though slight settling may occur through deterioration of wood-constructed parts, they will become reasonably permanent as the desired grade is produced and paved with stone.

In the actual execution of this project advantage would be taken of all construction works now existing in the river that would in any manner aid the proposed works, and it is probable that nearly all the present works, though not coinciding definitely with the lines of the new project, will in one or another feature, by constituting in effect a reenforcement of the different works—an additional line of defense against the various destructive agencies—lend a greater security to the permanent regulation works of this project.

Profiles, maps, and cross sections.—A complete set (in 20 sheets) of maps, profiles, and a sheet of typical cross sections—submitted in portfolio form—shows the proposed regulation works and an improved open river throughout the district. There has also been prepared and follows herewith, as a part of the project, a small scale map with cross sections and profile of a typical stretch of the river, showing conditions before and after the proposed improvement has been effected.

THE LOW-WATER PLANE AND SLOPE.

As the successful improvement of the river under this project must to a considerable extent depend on the low-water plane proposed, one that is safe but not needlessly low should be selected and need only be low enough to comprehend all stages when navigation is not obstructed by ice, as the selection of a lower stage would have no practical advantage. A zero stage, St. Louis gauge, volume of discharge about 34,000 cubic feet per second (discharge curve, 1897–1904) is considered amply low. Such a stage occurred in 1904, at a time when there was no ice in the district nor within 200 miles. And as this is the lowest stage of which there is authentic record, with the river open to navigation, it will be used as a basis in determining such low-water plane. Lower stages are always caused by ice.

The available data on low-water slopes, gauge records, and discharge measurements in St. Louis Harbor indicate that the low-water plane at the Market Street gauge has lowered about 2 feet during the last thirty-five years.

The restoration of the former low-water plane would exert a beneficial influence in the reaches above and below the harbor and would be of especial benefit to the navigation interests in the former reach, since at Chain of Rocks the channel could be deepened to 14 feet whenever required without the otherwise inevitable detriment to the regimen still farther upstream. The restoration of the former plane is entirely feasible, and as the top boundary of the volume now passing at the present zero stage would be fixed at 2 feet on the St. Louis gauge, this mark has been selected as the upper controlling point of elevation for the proposed low-water plane in the St. Louis-Cairo district.

At the mouth of the Ohio River a corresponding and equally safe low-water plane for navigation must lie between the lowest recorded stage (when the river was probably closed by ice), and the mean of lowest annual stages, and as the determination must in a measure be arbitrary rather than exact, the stage registering 2 feet on the Cairo gauge (in Ohio River 2 miles above its mouth) is chosen for control at the lower end of the district, and the allowance for a mean slope of 0.2 foot per mile between Cairo and Columbus, Ky., determines the elevation for the proposed low-water plane at the mouth of the Ohio River.

The mean of 49 lowest annual stages at Cairo, including 6 prior to 1859, given in Humphrey and Abbot's Report, is 4.4 feet. The lowest waters recorded are —1.44 feet in 1855 and —1 foot December, 1871.

That a zero stage, St. Louis gauge, approximates a 2.8-foot stage (Cairo), when the Ohio River is correspondingly low may be derived from gauge records and hydrographs.

A zero stage, St. Louis, occurred in 1904, when the Cairo gauge read 3.1 feet, and was one of the lowest known navigable stages in the Mississippi River. One of the lowest boating stages in the Ohio River occurred during the summer of 1908, when the Cairo gauge read 4.3 feet, but the middle Mississippi was not remarkably low, there being 3.4 feet on the St. Louis gauge.

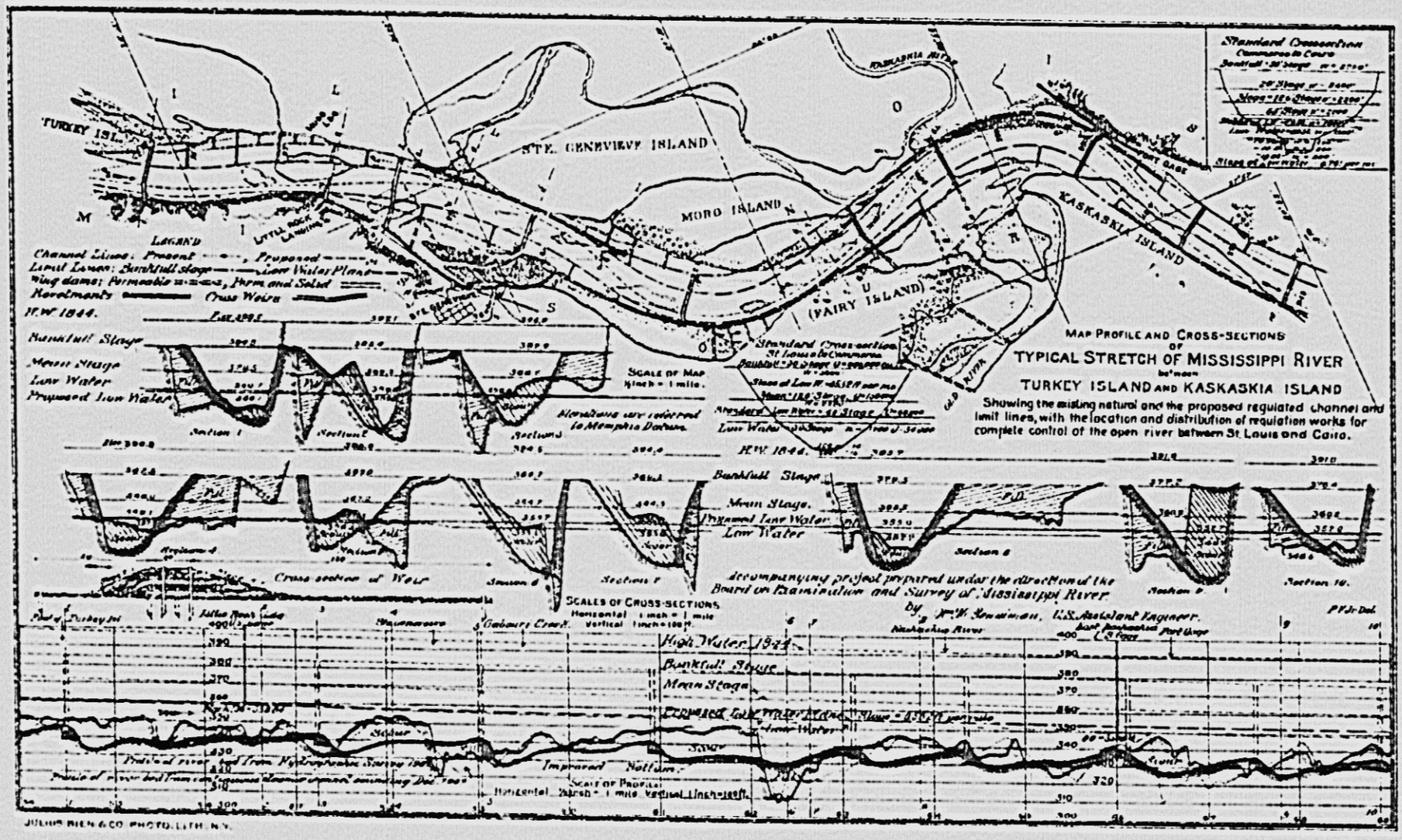
On the profile accompanying the report on "Examination of Ohio River, 1908," approximate low water from Louisville to Cairo is shown, having a gauge height of about 2.3 feet at the latter point.

That the selected elevation, 2 feet on the Cairo gauge, will adequately meet the requirements is further indicated by the action of the Mississippi River Commission in tentatively assuming the 4-foot stage at Cairo as a standard low-water plane of reference for dredging operations.

The top boundary of this low-water volume having been fixed at the ends of the district, an intermediate controlling point must be determined, as a uniform slope of low-water plane between these two end points of control would involve lowering the plane 7 feet in the 7-mile gorge between Grays Point and Commerce, and although desirable is considered impracticable. This gorge, some sections of which are fixed, or practically so, naturally divides the district as regards mean slope, and the section of river below the gorge is different in character from that above, owing to absence of rock banks and to the influence of the greater fluctuations in stage of the Ohio River.

The existing low-water plane as regards mean slope is relatively lower at Grays Point than at Commerce, and as the 2-foot mark on the Commerce gauge corresponds to the stage of the 34,000 cubic feet per second discharge at St. Louis, it is selected as the intermediate point of control.

These three fixed points, adopted as determining the low-water plane on which the proposed regulation works for the district are based, give, with the new alignment, a mean slope of 0.552 foot per mile in the upper, and of 0.761 foot per mile in the lower section of this river district, the lower end of the 7-mile gorge being the natural division point.



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House Doc. No. 50 ; 61st Cong., 1st Sess.

Examinations of cross sections and profiles showing low-water plane, river bed, and bed rock, demonstrate the entire practicability of establishing a uniform slope throughout each of the two natural subdivisions.

The data for the determination of the existing low-water plane of irregular slope and of the proposed low-water plane—natural mean slope line—are given in the following table:

Low-water plane of Mississippi River.

ST. LOUIS, MO. (BISSELL POINT) TO CAIRO, ILL. (MOUTH OF OHIO RIVER).

Stations.	Channel distance in miles from Eads Bridge.		Elevation in feet above Memphis datum plane.		Differences in elevation, in feet, for proposed plane.
	Low water, 1907.	Proposed alignment.	Present low-water plane (discharge 34,000 cubic feet per second).	Proposed low-water plane (discharge 34,000 cubic feet per second).	
Bissell Point	3.30	3.3	388.1	391.2	+3.1
Eads Bridge	0.00	0.0	.....	.....	.....
St. Louis (MARKET STREET)	0.40	0.4	387.1	389.1	+2.0
United States Engineer Depot	3.20	3.2	386.6	387.6	+1.0
Jefferson Barracks	10.82	10.8	384.6	383.4	−1.2
Waters Point	22.40	21.5	378.9	377.4	−1.5
St. Nicholas Rock	34.30	33.1	371.3	371.0	−0.3
Brickeys	45.60	44.3	365.4	364.9	−0.5
Little Rock Landing	56.45	54.8	359.0	359.1	+0.1
East Kaskaskia	66.07	64.5	349.2	353.7	+4.5
Chester	72.95	71.2	347.6	350.0	+2.4
Bishop Landing	82.28	80.0	342.3	345.1	+2.8
Red Rock	89.20	86.8	338.1	341.4	+3.3
Grand Tower	103.30	101.2	332.4	333.4	+1.0
Moccasin Springs	116.80	114.8	324.5	325.9	+1.4
Cape Girardeau	130.78	129.0	314.8	318.1	+3.3
Grays Point	136.82	135.4	311.8	314.5	+2.7
COMMERCE	143.67	142.2	311.0	310.8	−0.2
Hacker Towhead	156.48	155.3	303.7	300.8	−2.9
Thompson Landing	163.70	162.8	297.0	295.1	−1.9
Beechridge	169.45	170.3	290.9	289.4	−1.5
Bird Point	181.36	182.3	281.0	280.3	−0.7
Cairo (MOUTH OHIO RIVER)	182.50	183.6	280.1	279.3	−0.8

Controlling points in capitals.
Proposed mean slope in upper section, 0.5522 foot per mile.
Proposed mean slope in lower section, 0.7609 foot per mile.
Mean slope between existing low-water plane at Chain of Rocks and proposed low-water plane at Bissell Point is 0.80 feet per mile.
Memphis datum plane is 190.84 feet below the zero of the United States engineer gauge at Memphis, Tenn., 420.84 feet below St. Louis City Directrix, and approximately 6.8 feet below mean Gulf level.

The existing low slope in the gorge (about 0.3 foot per mile) will be increased to the proposed mean slope, and the existing mean slope in the reaches above correspondingly decreased.

The lowering of the plane in the places indicated is entirely practicable and well within observed changes in the low-water plane. It is proposed to raise the plane at the only points of critical influence—in the gorge above Commerce, in the vicinity of Grand Tower, and at St. Louis to improve the Chain of Rocks passage. The greatest change of plane—a raise—occurs at East Kaskaskia, where disturbances, due to a cut-off occurring in 1881, have been only partly readjusted by nature, and the reestablishment here of a uniform mean slope will greatly improve a place that is, so far as navigation is concerned, one of the worst on the river. The proposed plane at East Kaskaskia agrees closely with the low-water plane of 1872 for that locality. The plane is lowered most at Hacker Towhead, a section of river wholly alluvial, the depth to bedrock being 100 feet or more; and at this locality the low-water plane of 1872 was below the proposed plane.

The mean slope in the lower section, 0.761 foot per mile (38 per cent greater than in the upper section), is obtained from a distribution of the same total fall as is now found between Commerce and Cairo over a somewhat longer distance produced by the new alignment. Only occasionally are towboats obliged under the present conditions to divide tows and double trip upstream a part of the way to Commerce,

and the proposed mean slope, occurring only as a maximum, and then only when influenced by an unfavorable combination of stages in the two rivers, will be a distinct improvement over the present irregular slope.

In the upper section the existing mean slope from St. Louis to Commerce is 0.531 foot per mile, and the proposed mean slope gives the but slight increase of 0.021 foot per mile over that, with the very great advantage of uniformity instead of the present alternation of flat and steep slopes, these latter in general considerably exceeding the proposed mean slope.

DEPTHS AND WIDTHS.

That a navigable depth of 14 feet with the natural low-water discharge and the bottom width of 500 feet prescribed by the Board for a regulated channel can be obtained by narrowing the river and fixing the bottom and banks, is generally conceded by those familiar with the Mississippi River and works for its improvement. A slope comparatively steep for so large a river constitutes the principal obstacle to producing and maintaining the required depth, but it is believed even this difficulty will be overcome by the proposed improvement works.

At low water the mean depth of the proposed controlling cross sections, that is, over cross weirs, will be, for any subdivision of the river, considerably less than the existing mean low-water depth of that subdivision.

The crests of the navigable pass sills or horizontal portions of the cross weirs that establish the controlling least depths of the thalweg are to be placed at a depth of 15 feet below the adopted low-water plane which will be maintained at or a little above its theoretical elevation by decreasing, if necessary, the projected cross-sectional area of the low-water prism over the cross weirs. A sufficient decrease in area for this purpose may be accomplished without interfering with the requirements of navigation by making the side slopes steeper in the lower part of the cross section and flatter in the upper part.

The dimensions to be given to the cross-sectional area of the river at cross weirs are susceptible of considerable change and may be modified toward increased depth with almost no increase of cost. A narrowing of bottom width to 300 feet, or even the adoption of a triangular cross section, are possibilities worthy of consideration.

Between weirs the deeper pools will have a tendency to fill with the heavier materials pushed and rolled along the bottom, but there also will be a counteracting tendency for the depths to be greater than on the weirs since in the low-water bed (uniformly narrowed by side-contraction works) will be found mean depths greater than would obtain in the same section of natural river, and they will create enough velocity to cause scour of the river bed, thereby increasing the cross-sectional area sufficiently to influence the velocity, which will then gradually diminish until it is in equilibrium with the resisting power of the material composing the bed.

A profile along the thalweg of the river when so improved will present a series of gradual and fairly uniform ridges or undulations, their crests being the sills of the cross weirs, followed by slopes quite abrupt, the anterior slopes being correspondingly flattened. This downward pitch and upward slope of the thalweg, in any particular section of the river, will of course largely depend on the character of the materials composing the bed of that section and on the current velocities obtaining for different stages of the river, but in general the profile of the thalweg when the river is completely regulated will closely resemble the typical or probable river bed, as shown on the profiles and cross sections.

A depth of 15 feet should result at all navigable times. According to records of the St. Louis gauge for the last forty-eight years a stage of at least 5 feet obtains from March to August, assuring positively a ship channel of 20 feet depth for about one hundred and seventy consecutive days per annum (more than half the period normally open to navigation), and probably for three hundred days, under this method of improvement.

In the forty-eight years the consecutive days in each year when the stage has been 10 feet or more on the St. Louis gauge have been as many as two hundred and sixty-seven, and as few as fifty, the average being one hundred and seventy-two; and there have been only five years in that time when a 10-foot stage did not continuously prevail for at least one hundred and twenty days. That the increase in channel depth would not always be indicated by the gauge height is very probable; but under this method of improvement, with the river uniformly narrowed and with only a limited amount of local erosion to form obstructive bars, a 24-foot channel should obtain for from fifty to one hundred and fifty days annually.

To maintain a 14-foot depth to a landing that is not on the same side of the river as the steamer channel, or to landings on opposite banks when the channel is in mid-

stream, occasional or continuous dredging may be required. The cost of such dredging must be borne by the interests affected, the United States undertaking only to supply the trunk line for navigation between the principal cities, towns, and natural landings.

Widths for low-water, bank-full, and intermediate characteristic stages have been determined from the conditions of slope and discharge by observing the widths assumed by the natural bed at various stages and at controlling sections and from actual known results in the district from the use of side-contraction works. A large number of cross sections of the river bed, especially in those reaches where the local slope approximates the mean slope for the entire river section under consideration, furnished valuable data in deducing the mean uniform widths. For the upper, the St. Louis-Commerce section, the widths tentatively adopted for the low-water and bank-full stages are 1,700 and 3,000 feet, respectively; for the lower, the Commerce-Cairo section, with its steeper slope, they are 1,500 feet and 2,750 feet. In St. Louis Harbor these widths have already been fixed by the Secretary of War at 1,500 and 2,000 feet.

Widths for intermediate stages and dimensions of controlling low-water sections in the two subdivisions are shown on the sheet of typical cross sections.

Elements of the cross sections studied in connection with velocity formulæ indicate that these normal widths afford a sufficiently narrow low-water bed to give the required depth, and, for higher stages, a bed of sufficient capacity for unobstructed flow.

These normal widths should be carefully maintained in crossing from one bank to the other, and the proposed works have been designed with that object in view. But uniformity of widths is not intended to be absolute, nor are the widths as shown on the maps always uniform, and at certain localities, as Chester, Grand Tower, and Grays Point, it may never be considered practicable to remove all portions of the high banks lying within the proposed prism, although, to a certain extent, they constitute obstructions to uniform mean slope and flow. Until such changes in widths do become necessary the natural and deeper sections at these places will be utilized, but all obstructions within the standard cross sections and within the limit lines, as shown, should be removed by dredging, blasting, or otherwise as soon as may be required.

The following opinions by Jacquet concerning requirements for the successful training of rivers are considered worthy of quotation:

"The action of a river upon its bed depends upon its discharge, and, for any given discharge, upon its duration. The most permanent state corresponds to that of a moderate discharge of sufficient magnitude to sensibly act upon the bed, and sufficiently long continued for this action to be quite efficacious. We can imagine that a mean bed is thus formed (that is to say, a mean position and profile of the thalweg) for a certain mean condition of the river. This bed is modified in one way (successive scour and fill) by high water, and in an opposite way (successive fill and scour) by low water. Therefore the low-water navigable bed should be contained within the mean bed, and as the stages below the mean stage can not generally have a very energetic modifying action, we immediately conclude that the low-water bed ought to be established as far as possible on the same thalweg as the mean bed. So, also, in order that the mean bed may be securely fixed and not liable to be completely demoralized by the higher stages or by extraordinary floods, it is advisable that it should not materially differ from the thalweg of higher stages, and, as far as possible, it should make but a slight angle with the direction of the current during overflow.

"We are thus led to formulate into a rule the requirement of concentrating as far as possible during low water the entire river into a sufficiently narrow low-water bed, and, on the other hand, of giving the river its full width for the flow of water when above the height at which the depth required for navigation is assured." (Merrill's translation, pp. 49 and 52.)

Should more complete hydrological data and actual experiments in construction prove that the widths should be changed, this may be done without vitiating the project in any degree, nor will it increase the estimated total cost, this being ample for such a contingency; moreover, an increase or decrease in length and cost of wing dams would practically be offset by an equivalent value in cross weirs correspondingly decreased or increased, and the required amount of revetment would be practically unchanged for any reasonable width of river.

In the following tables (for the surveys of 1907, Board on Examination and Survey of Mississippi River, and of 1884–1889, Mississippi River Commission) are shown for certain river subdivisions or stretches the mean widths and depths as derived from the measurement of a large number of cross sections; also mean velocities obtained from the areas of those sections and the known discharges for the stages considered.

MISSISSIPPI RIVER, ST. LOUIS, MO., TO CAIRO, ILL.

Table of mean depths, widths, and velocities, by river stretches, derived from the cross sections of the hydrographic survey of 1907. Also the total fall and the fall per mile, as derived from the normal low-water plane.

Subdivision of district.	Length of stretches.	Number of cross sections considered.	Normal low water (0.0 feet, St. Louis gauge, 34,000 second-cubic feet).			Mean stage of river (12.6 feet, St. Louis gauge, 158,000 second-cubic feet).			Bank-full stage (30.0 feet, St. Louis gauge, 606,000 second-cubic feet).			Fall in feet.	
			Mean depth.	Mean width.	Mean velocity.	Mean depth.	Mean width.	Mean velocity.	Mean depth.	Mean width.	Mean velocity.	Total.	Per mile.
	Miles.		*Feet.*	*Feet.*	*Ft. per sec.*	*Feet.*	*Feet.*	*Ft. per sec.*	*Feet.*	*Feet.*	*Ft. per sec.*		
St. Louis (Market street) to Waters Point	22.0	109	11.92	1,776	1.60	18.79	2,595	3.24	27.35	3,618	6.13	8.2	0.373
Waters Point to Little Rock Landing	34.1	152	11.41	1,802	1.65	16.24	3,036	3.20	23.36	4,407	5.89	19.9	.584
Little Rock Landing to Chester	16.5	80	11.13	1,597	1.91	14.83	3,181	3.35	22.66	5,248	5.10	11.4	.691
Chester to Grand Tower	30.4	131	12.53	1,690	1.61	17.33	2,740	3.33	27.32	3,746	5.92	15.2	.501
Grand Tower to Grays Point	33.5	141	11.11	1,758	1.74	15.44	3,261	3.14	24.21	4,464	5.61	[a] 19.6	.583
Grays Point to Commerce	6.9	29	14.22	1,891	1.27	20.20	2,557	3.06	30.16	2,984	6.73	[a] 1.8	.270
Commerce to Beechridge	25.8	102	10.32	1,828	1.80	14.61	3,486	3.10	23.04	4,998	5.26	20.1	.780
Beechridge to mouth of Ohio River	13.1	38	10.54	1,249	2.58	14.76	2,511	4.26	24.19	4,363	5.74	10.8	.828
St. Louis (Market street) to Commerce (total above Commerce)	143.3	642	11.75	1,745	1.66	16.73	2,925	3.23	25.25	4,145	5.79	76.1	.531
Commerce to mouth of Ohio River (total below Commerce)	38.8	140	10.38	1,668	1.96	14.65	3,219	3.35	23.35	4,819	5.38	30.9	.796

[a] Gauge record at Grays Point has been corrected +1.1 feet.

The mean depth of a single cross section is obtained by dividing its measured area by the measured top width of the cross section at the water surface; the mean depth of a river subdivision is assumed at the average of the mean depths of all the cross sections in that subdivision; and the mean width of a subdivision is assumed at the quotient obtained by dividing the sum of all the areas by the sum of all the mean depths of that subdivision; and the mean velocity of a subdivision is assumed at the quotient obtained by dividing the discharge for a given stage at St. Louis (discharge curve, 1897–1904, United States Engineer Office, St. Louis) by the average of all the areas of that subdivision for that stage.

Table of mean depths, widths, and velocities, by-river stretches, derived from the cross sections of the Mississippi River Commission hydrographic surveys (1884–1889).

Subdivision of district.	Length of stretches.	Number of cross-sections considered.	Normal low water (0.0 feet St. Louis gauge, 34,000 second cubic feet.)			Mean stage of river (12.6 feet, St. Louis gauge, 158,000 second cubic feet).			Bank-full stage (30.0 feet, St. Louis gauge, 606,000 second cubic feet).		
			Mean depth.	Mean width.	Mean velocity.	Mean depth.	Mean width.	Mean velocity.	Mean depth.	Mean width.	Mean velocity.
	Miles.		*Feet.*	*Feet.*	*Ft. per sec.*	*Feet.*	*Feet.*	*Ft. per sec.*	*Feet.*	*Feet.*	*Ft. per sec.*
St. Louis, Market street, to Waters Point	22.0	109	10.25	1,638	2.02	16.62	2,713	3.50	26.70	3,734	6.08
Waters Point to Little Rock Landing	34.1	152	9.43	1,819	1.98	14.51	3,312	3.29	23.14	4,687	5.59
Little Rock Landing to Chester	16.5	80	11.41	1,673	1.78	15.71	3,022	3.33	22.18	5,351	5.11
Chester to Grand Tower	30.4	131	12.51	1,793	1.60	17.49	2,746	3.29	27.29	3,824	5.81
Grand Tower to Grays Point	33.5	141	10.68	1,878	1.70	16.03	3,185	3.09	25.87	4,104	5.71
Grays Point to Commerce	6.9	29	13.64	1,975	1.26	19.84	2,671	2.98	31.32	2,939	6.58
Commerce to Beechridge	25.8	102	7.45	2,238	2.04	13.11	4,332	2.78	23.79	5,268	4.83
Beechridge to mouth of Ohio River	13.1	38	9.23	1,502	2.45	15.02	2,676	3.94	27.94	3,963	5.47
St. Louis, Market street, to Commerce (total above Commerce)	143.3	642	10.91	1,765	1.77	16.20	2,985	3.27	25.44	4,173	5.71
Commerce to mouth of Ohio River (total below Commerce)	38.8	140	7.93	2,007	2.12	13.63	3,837	3.02	24.92	4,871	4.99

NOTE.—In the above table the same cross-section lines and the same stage lines have been used as in the preceding table, and the depths, widths, and velocities are derived in the same manner as in that table (p. 76).

ALIGNMENT AND LIMIT LINES.

The proposed thalweg of the stream—the central line of the improved channel—conforms as far as practicable with the existing low-water channel; also the new boundary lines for the bank-full and for the low-water stages agree in all their salient features with the corresponding natural lines of bank. Along a very markedly concave bank the high and the low stage limit lines are characterized by a comparatively small lateral separation, their distance apart being generally from 60 to 300 feet, the central channel line lying about 300 feet from this shore, while along the opposite, the convex bank, the foreshore is relatively broad, about 1,200 to 1,000 feet. In the adjacent bends, conditions are the same but changed to the opposite bank; and midway between bends, where inflections of the channel occur, the proposed cross section is approximately symmetrical. It is at these places, where the predetermined cross section must be maintained as perfectly as possible, that the necessity for a rational and well-planned alignment becomes apparent.

The alignment is made up of practically straight reaches and of bends with easy curvature, the general trend being toward sinusoids rather than tangents and circular arcs. In certain instances where bluffs are to be followed, the straight reaches are of considerable length, and provision has been made for revetments as required when new banks have been built on the opposite shore.

Where the channel follows, or is to be made to follow a rock bank, the natural high and low water lines, smoothed to a certain extent, have been drawn along that bank, or rather, the lines with easy curves have been drawn through salient points in the rock banks with the intention of building new banks from the deeper indentations to the limit lines, and removing some of the bolder projecting points, while the corresponding lines along the alluvial bank have been drawn parallel and at the previously specified distances from the rock-bank lines.

Modifications of the proposed general alignment have been found necessary for certain localities where established limits or fixed portions of opposite banks in narrow sections of river determine the location of the limit lines. Such places are found at St. Louis (fixed harbor lines); Claryville, Mo.; above Grand Tower, Ill.; and below Grays Point.

Where such river widths differ from those proposed as at the localities just mentioned, and at Commerce, Mo., where the change in mean slope occurs, the changes in width have been gradually effected, the limit lines converging or diverging as required to effect the changes in the least abrupt manner possible.

That the proposed new alignment is entirely practicable and that the proposed changes are generally insignificant, when compared with the natural lateral movements of the river, is shown by a comparison of the present shore lines with those of 1884–1889 survey, which have been placed on the maps. The greatest proposed changes from the course of the present low-water channel generally occur in bends where the areas to be eroded are actually parts of the river bed and have no real value as land. As compared with the low-water channel of 1907, an increase of 2½ miles in the channel length is thus obtained in the Commerce-Cairo section. This is a distinct improvement, which ought to be carried still further when regulation of this section with its steep slope is undertaken and, especially where lands beyond the old high banks have but little value, three or four bends could be eroded to a more than ordinary extent by means of wing dams extended from the convex banks and the resulting increase in length of channel would give a further and very positive betterment of conditions.

As stated, the limit lines generally contain the present low-water channel, but when possible to obtain better alignment without destroying valuable lands, this has been done, especially when the channel can be deflected against a rock bank.

The only reaches materially shortened are those below Red Rock, Mo. (mile 89 below Eads Bridge, St. Louis), and below Grand Tower, Ill. (mile 104), where deep bends in the left bank have been eliminated in favor of the nearly straight rock bank on the right shore. A slight loss in channel length thus occurs between St. Louis and Commerce, but this loss is more than offset by the increase of 2½ miles in the section below Commerce, where it is most needed, and the result is a net increase of 1 mile for the district.

A comparison of areas between the existing and the proposed high bank lines shows that when the proposed works are fully completed, about 5 square miles—only a small part of which is cultivated—will have been eroded, but more than 36 square miles will have been wholly or partly reclaimed, a balance of about 20,000 acres of valuable land in favor of this method of improvement.

The proposed alignment presents only 34 crossings of the channel from bank to opposite bank, which reduced number of crossings constitutes an additional argument

in favor of artificial weirs as a regulative instrument to be substituted for the natural controlling bars.

Conditions that are found naturally to exist on the Mississippi River and the problem created by the removal of the controlling river bars, are stated by Assistant Engineer R. E. McMath, as:

"* * * A very perfect system of automatic dams and sluices exists which holds the reservoir action of the channel in reserve, and regulates the discharge so effectively that it must be recognized as an important conservative agent.

"The specific purpose of channel regulation, as commonly advocated, is to destroy the shoals which constitute the dams of this system. It is therefore prudent to inquire what conservative agent can be substituted for them.

"The area and impounded volume above every variable bar in the river may not be so important singly, but when the aggregate is taken it is enormous." (Report of Mississippi River Commission, 1881, p. 256.)

The proposed channel line, limit lines, wing dams, revetments, and cross weirs depicted on the maps have been laid down for the purpose of presenting a comprehensive plan of improvement, and are not intended to indicate exactly the final locations and alignment to be followed in construction.

All lines are subject to a certain small amount of change as they merely represent a system of complete regulation works equivalent to those which will be required in such a project.

In sections of the river following the bluffs and partly improved, there would probably be no material future alteration in the projected lines, but in a section including a bend in an alluvial bank no one can predict where the channel of the river will be a year hence. The channel could be forced out of a deeply eroded bend, and a formerly existing bank line restored, but the more economical plan to follow is to hold the bends approximately as they may be found when the improvement is undertaken, and to extend the side-contraction works from the convex banks.

SIDE CONTRACTION.

Building of new banks to the required alignment and slope from the bottom of the river to the bank-full stage by means of permeable hurdle dams closing the chutes and secondary channels, and by wing dams—permeable hurdles and spur dikes—extending to the low-water lines, will give the required side contraction and confine the river to a single channel.

Wing dams have been projected to extend from the natural high banks to the limit lines, approximately normal thereto, but directed slightly upstream. The narrowing may generally be done from the convex banks, but in nearly straight reaches, or where necessary to correct the natural alignment, this may be accomplished from either bank or from both.

The wing dams, as permeable hurdles, are to be built to the bank-full stage from the high banks to the bank-full lines, thence in the form of solid or permeable spur dikes as needed; each will slope on its required transverse profile to the adopted low-water line and flatten on a broad foundation at that line. The submerged outer ends of these sloping spur dikes can be more economically and successfully held against attacks of the river than could the abrupt ends characteristic of the old-style hurdles built to a 25-foot stage and terminating in a piling and stone tee head, or ice buttress.

Except those dictated by practical experience on this section of the Mississippi River, no specific rules have been followed in the spacing of wing dams as shown on the maps. They are closer along a straight or slightly curved concave shore, while on a convex shore the separation is greater, depending on the degree of curvature. The least intervening space between the wing dams of a series is 525 feet, and the greatest, 5,000 feet; a fair average would be about 1,500 feet.

Some of these wing dams extend from the present high banks to the bank-full limit lines only, especially along a rock shore where a good foundation is readily to be obtained; also on convex shores where the tendency of the river is to form a broad fore shore with flat slope. But in a greater number of instances, owing to reaches being partly improved, only the sloping spur dikes are required. Spur dikes have been shown on the maps in addition to the revetments in several bends, so as to provide ample resistance against erosion for those banks which will be subjected to the incessant attack of the river currents. Some of these dikes may be constructed to restore or to extend a section of bank to the required alignment, but most of them would actually serve as submerged spurs and deflect the attacking currents from the protected bank slope.

For producing accretion by arresting silt, building up new banks, incidentally reclaiming land, and for causing erosion and scour by concentration of water flow, the

permeable wing dam or hurdle will be adopted. In the form that has been used on this section of the river, primarily for contracting the stream and deepening the channel by removing obstructive bars, this construction consists essentially of one to three rows of piling or clumps of piling, driven on a line about normal to the currents and to the desired stage height, generally penetrating and holding in place a foundation mattress of the needed dimensions. Usually the piles are so placed when driven that they may be then drawn together and fastened in clumps of three or four piles each. Occasionally a wattling or vertical curtain of brush is conjointly used to hasten the formation of deposits below the hurdle, but such construction is more liable to act as a training wall and either cause scour immediately above the hurdle or undermine its foundation, and the better practice is merely to lessen the force of the current at first with piles or clumps and then promptly to sink, with mattress and stone, the large bodies of drift so common in this river as they collect above the hurdles.

For a single hurdle dam by which a long chute is closed to the bank-full stage, an effective and durable structure, capable of sustaining a head of 4 to 5 feet of water, may consist of 3 or 4 rows of pile clumps, reinforced by stringers between the rows whereby the strength is more evenly distributed in resistance. Wide foundation mattresses and a liberal amount of stone for ballasting them and for two or three sinkings of drift must be provided for such construction. The foundation mattress of a wing dam may be of saplings or of sound cull lumber woven continuously along the proposed line from the shore to the outer end in one piece; in two full-length pieces overlapping along that line; or in short overlapping sections. The overlapping of the full-length pieces, laid clapboard-wise, the piling being driven through both, affords the strongest construction; while in swift water the short section, constructed parallel with the current, is the most advantageous form for successful sinking. The area covered by the foundation—the width of mattress to be placed both above and below the hurdle or dike line proper—will depend on the depth of water and the nature of the materials composing the stream bed, and as a part of the local survey, test-borings should always be made. Thus gravel beds whose existence might not otherwise be known may wholly or in part be utilized as subfoundations for the mattresses, and bodies of quicksand avoided altogether or guarded against by stronger and more extensive foundations. Enormous deposits of silt occurring wherever the current is slackened will add greatly to the strength of all proposed works, and, because of the great volume of sediment in this river, the permeable hurdles or other silt-arresting devices may be used with a greater separation than would be permissible for accomplishing the deposit of suspended matter on almost any other stream, and still prove more effective.

The slight upstream trend of the line of piling will usually cause masses of drift to be held against wind and current until such accumulations can be sunk, and also will induce a more rapid fill near the old high bank where bank-full accretions are slowest to form.

The sinking of drift is a most important adjunct to the action of permeable hurdles and wing dams in producing accretion, adding greatly to the permanence and effectiveness of the constructed works, increasing the rate, and enhancing the solidity of the deposit.

In areas to be built to the bank-full stage it will be necessary to build the wing dams or hurdles only to the stage (20 feet to 25 feet) at which the Missouri willow grows, and the high banks will then form naturally. Between the bank-full lines and such levees as may be built, which should not restrict the freshet width to anything less than a mile, no reclamation should be permitted until the banks have been built to the desired stage. Until then the growth of willows and dense underbrush should be encouraged. This also applies to revetments above the vegetation line. Bermuda grass and the trumpet creeper (Tecoma radicans), being tenacious, spreading rapidly, and rooting deeply, are particularly suited for this purpose. After the high banks have been formed only partial reclamation of the high-water bed should be permitted—that is, the lands adjacent to the river may be cultivated or used for pasturage, but there should be no levees except, as stated, about 1 mile apart.

In some localities it may be best to build the side contraction works by stages, the formation of land being hastened at and above the stage at which the desired vegetation and brush will thrive by merely encouraging such growth. In this manner more uniform accretions would be obtained, in some cases lessening the cost of the improvement. The use of "silt weeds," as on Indian rivers, and the anchoring of large snags, and combinations of the two, in deep pools to be partially filled and in areas to be reclaimed are forms of construction at least worthy of trial.

Every known device for the stoppage of stream-borne solid matter that has been tried on this section of the river has proved, in greater or less degree, to be efficacious, and it would seem that possibly other combinations than the types most used in the district might be applied to the problem with advantage, on an experimental scale at first, and then in greater extent, as their success in use may justify their adoption.

BANK PROTECTION.

Bank protection, a revetment or training wall, is to be placed at every alluvial concave bank when that bank, whether natural or artificial, shall have reached the proposed limit line. Some banks will be permitted to wear away considerably, and in some cases erosion will be directed to produce the desired alignment.

Especially when the channel is to be trained near them, banks composed of sand and light alluvium should be revetted continuously to the top, while those consisting of clay or clay and gravel mixed may be allowed to grade themselves under the action of the water, and above the low-water protection they may not need further attention for several years, in which instance more urgent work may be taken up to advantage.

The lengths of the bank needing protection have been tentatively determined for the proposed alignment, which, with a distance of 187 miles between the Merchants Bridge and the mouth of the Ohio River, gives a total of 374 miles of bank. Of the about 300 miles in alluvium, 70 will require the combination of wing dams and revetments; the application of wing dams and sheltered points will effect the protection of 126 miles, and revetments either alone or with submerged spur dikes will serve for the remaining 104 miles.

Revetments are proposed and shown along every concave bank in alluvium which the channel will naturally follow; 55 sections, containing in all 551,450 linear feet, are so planned. Included in the estimate of cost, but not fully shown on the map, are 16 additional sections, totaling 92,684 linear feet, to be used at localities marked "R" on the maps, either as ordinary bank protection, as low training walls connecting the ends of spur dikes, as sections of paved bank when the desired grade shall have been obtained on the broad foreshore, or even as additional spur dikes, equivalent in cost.

The first item of revetment, 551,450 linear feet, provides for a contingent quantity amounting to 65,000 linear feet of revetment, or its equivalent in cost in other forms of construction. That reserve, considered ample to meet any unforeseen emergency, is obtained in this manner: There are 42,000 linear feet of old revetment in good condition that is now in place on the proposed alignment, permitting the cost of this amount to be saved; 23,000 linear feet of new revetment, intended to protect the ends of certain cross weirs, has been counted in measurement and in cost as both bank protection and weir construction to provide for any possible need of additional strength at these points.

Revetments will generally consist of a foundation mattress of required width (about 150 feet or less, depending on the configuration and character of the bank to be protected), placed below the low-water line and heavily ballasted, and of a pavement of stone on the upper bank section when graded on a slope not steeper than two horizontal to one vertical from the subaqueous portion of the revetment to the bank-full stage. Until a cheaper but equally effective form of construction may be devised, the mattress will be of the woven type of green saplings or sound cull lumber, which have been used in this district for several years with satisfaction. When in place and properly ballasted, the woven mattress of brush or lumber has the advantage that it will outlast the fascine type, which may break up when the cables used in that form of construction deteriorate. In mattress construction provision should be made for a thoroughly substantial method of fastening the top and cross poles to the mattress proper, as on these fastenings and their durability depends the preservation of the "pockets," or cribs, that hold the stone in place as distributed. Retaining the ballast in these pockets is a very important matter, because on steep banks, and especially when scour and settlement take place, much of the stone will otherwise roll off the mattress and be lost. Even though considerable settling takes place in a mattress so constructed and evenly ballasted, it will not break up, but will accommodate itself to the natural unevenness of the bank and to small caves which may be scoured under its outer edge. The use of bronze in place of iron fastenings for holding the top poles and stone cribs secured in place is a construction detail worthy of mention, and reenforced concrete slabs for protecting the bank slopes above the low-water line may eventually prove more effective and cheaper in use than stone alone.

In revetment work hydraulic dredging would aid in preparing the bank below the low-water line to receive the mattress, by cutting off the "false points" of harder formation less rapidly eroded, that would otherwise give irregular alignment; by grading the bank in places too steep for effective subaqueous protection, and by cutting an artificial shore terrace of a uniform grade and a regular alignment on which the inner edge of the mattress may be placed at the low-water line.

CROSS WEIRS OR SILL DAMS.

The cross weirs will effectively replace the natural dams or submerged bars, regulating the flow, and for a given volume of discharge absolutely controlling the surface plane and imparting an ideal, though partly artificial, regimen to the stream, as the side contraction works in the wide reaches and bends will prevent obstructive deposits forming permanently in the channel between weirs. The low-water flow will always be confined to the same part of the weir, the navigable pass sill, which will be scoured clear by a falling river, and will probably remain so during medium and high stages. A permanent "lead" will be established from each weir to the next, insuring fixation of "crossings" and their guiding marks for navigation.

The number of cross weirs necessary to produce a 14-foot channel might exceed the total number of natural submerged dams (about 60), any one of which might have heretofore become obstructive to 8-foot navigation. One hundred weirs should be more than adequate, and that number would allow them to be placed about 1¼ miles apart, the mean fall between weirs being 1.1 feet. From Ruehlmann's functions and formulæ for backwater it appears that should the crest of any such weir be raised 1 foot at low water the backwater effect would extend about 10 miles; also that a raise of weir crest of 0.12 foot at that stage would give a corresponding rise of 0.08 foot at the next weir above. The results of these calculations are cited to show the systematic interrelation of the weirs, the desirability of equalizing the fall throughout the district, and that with the tentatively chosen separation they would form a practically continuous fixed river bed giving an almost uniform water plane. As the work of installing the weirs progressed, experience would probably demonstrate that this separation could be increased by placing, say, about two weirs to each crossing (new alignment) which would reduce their total number and estimated cost about 40 per cent.

Jacquet well describes the action and effect of the cross weirs in his general statement that—

"* * * just as the new banks of the minor bed form and regulate themselves by the deposits which the river drops between the spurs, so likewise the bottom rises and levels itself by the deposits which the current drops between the successive grundschwellen. Success, being due to the same causes, is the same in both cases, and it only needs a little experience, which is very rapidly acquired, to determine what ought to be the distance between the works in order to insure the deposits which are to form the bank or the bottom of the regulated bed." (Merrill's translation, p. 152.)

The action of spurs in producing new banks by accretion is well established on this stream; the results from the cross weirs will depend on their separation, and the "little experience" needed to determine the spacing of the bottom protection works is furnished in the case of the Mississippi River by the stream itself in the number of natural crossings found in the district.

Modern French practice as to the number and arrangement of regularized bars to be left in the river to secure good results is stated by Professor Fourrey (1906) as follows:

"The position of bars can not be arbitrary; they constitute in effect a halting place where water-borne material should lodge when the waters fall. Neither can the distance between two bars be arbitrary, for it depends essentially upon the regimen of the river. It is determined from observation of a river section where analogous slopes and discharge exist, conserving very closely the number of bars which naturally form in such section; if we are led to modify slightly such number, it is better to increase it rather than to diminish it in order to secure the smallest possible fall over each bar. * * * In order to orient the bar suitably, the channel should be given the cross sections which are observed at bars of good river crossings; and this cross section is formed by means of submerged spur dikes, which, placed in deep water low enough not to interfere with movement of boats, produce an enlargement of the channel and at the same time prevent excessive erosion on each side of the crossing" (pp. 135, 136).

Professor De Mas, National School of Bridges and Highways, Paris, France, in his text-book (p. 343 of 1899 edition) uses almost the same words as regards points of inflection of the improved river channel, assuming a regularized bar at each inflection.

In a river naturally so good as the Mississippi it seems probable that the number of bed sills or regularized bars can be safely reduced to the number of the channel crossings.

The distance of about 3 miles that exists between the natural crossings can not be used as an accurate guide to be followed in spacing the cross weirs, as the purpose of their artificial control is to replace the variable slope now produced by the natural controlling points, which are separated by practically the same intervals, and instead, regardless of horizontal spacing, to establish vertical steps over which the total fall for the district will be so distributed as to create an approximately uniform slope, and

their location as to horizontal separation will therefore depend on the new alignment of the channel and on the local conditions of slope that are to be corrected.

The latter part of the general proposition expressed by Vernon-Harcourt, in his statement that "an overfall weir * * * is very efficient in preserving a fixed minimum water level above it, but is not suitable for the rapid discharge of flood waters," does not apply to the use of cross weirs in the special manner under consideration, particularly on the Mississippi River with its discharge at low water very small as compared with that when in flood; the main object of the cross weirs in this regulation scheme being the maintenance of a definite low-water plane for a known volume of discharge to give a specified depth for a certain stage height, and above that low-water plane to give the water prism a cross section that will permit the free discharge of the higher stages and of floods. And Hagen, quoted by Janicki, said:

"* * * in no case will regularization allow the free and full attainment of a proposed result. * * * We have, then, to obtain a sufficient channel depth in times of low water, and so-called regularization works are in themselves usually powerless to give a suitable depth unless the water level is raised by means of dams or other similar constructions." (Merrill's translation, p. 20.)

The purpose of the cross weirs being to maintain the requisite depth at the lowest known navigable stage and to aid in preservation of river regimen by limiting erosion of the bed, and not primarily to elevate the water plane at any or at all higher stages, the cross-sectional area of the proposed water prism will be so arranged as to correspond at high stages with the mean of the controlling cross sections in the natural river, and to accommodate the same volumes now passing at these high stages without increasing their elevation; hence there will result no interference with the passage of flood waters.

The proposed number of cross weirs (97) given in the estimate of cost and shown on the maps and on profile No. 1 is to a certain extent an arbitrary maximum.

The cross weirs shown on the maps are indicated on profile No. 1 by vertical broken lines below the bank-full stage and by shaded areas (exaggerated horizontal scale) which represent transverse sections through the pass sills, the grade or bottom slope line connecting these pass-sill crests or controlling least depths of thalweg being 15 feet below the proposed low-water plane.

The profile also shows the channel bed in 1907 as compared with that of about twenty years ago; and what would generally be noticed first in a study of this comparative section along the thalweg is that pools occurred in many places in 1907 where during the earlier survey the more troublesome shoals existed; and this fact in itself, if such demonstration were needed by one not familiar with this characteristic of the Mississippi River, would show that existing shallows may be converted into deeps, and the reverse, as such change may be required, by means of complete regulation.

As the effect of a controlling bar on this section of river extends at low water a long distance upstream (from Turkey Island to St. Louis, as cited by Major Suter, or 10 miles for 1 foot of bar rise, as indicated by backwater formulæ) the number of cross weirs that will actually be required to secure absolute control of the low-water plane—the water surface over the artificial bars and the pools between them—should be much less than the maximum number of cross weirs that has been proposed. To produce and maintain uniformity of slope from weir to weir and to hold the water in the intermediate pools, the nonchanging cross weirs, with permanent location and definite elevation of crest, should, in fact, be fewer than the natural crossing bars that normally exist, which are continually changing in height as well as in position, with consequent variation in effect and loss of influence.

Profile No. 2 shows the cross weirs that would be imperatively needed, and that would be constructed first; and the intermediate cross weirs that would be subsequently placed to furnish in artificial stream-bed control the equivalent of the natural bars removed. Thirty-one such weirs have been deemed absolutely essential, and have been located, one near the middle of each actual crossing, according to the proposed alignment, except at Arsenal Island, Chester, and Grand Tower, where they are not needed, and numbers have been placed below the depicted weirs (profile No. 2) to indicate the crossings in their order below St. Louis. The Chester and the Grand Tower crossings (Nos. 13 and 20) are merely indicated on the profile, as is also crossing No. 1 at Arsenal Island. To restore in effect the normal number of controlling bars an additional 29 cross weirs may be required, and these have been located according to the seeming necessity for them, as shown in profile No. 2, and are not numbered.

Should experience demonstrate that this alternative may be adopted, and that not to exceed 60 cross weirs will suffice to accomplish the purpose they are built for, and that the two other forms of permanent construction will effectively serve for the stream regulation and control of the bank in certain sections, a reduction of $5,561,000 in the total estimated cost would take place.

It is reasonable to assume that this sum can be saved on the one item of cross weirs, not alone through reduction in number below the estimated maximum, but as well by marked decrease in the actual below the assumed unit cost, which has been made more than ample.

The absence of crossings which will result in certain cases where the channel is directed along a rock bank for a distance greater than the normal separation between natural crossings is compensated by placing cross weirs at the necessary intervals to control or hold up the low-water plane.

There will be a static head on each cross weir, especially at low stages, but with the slope made uniform by the proper distribution of weirs it will be much less than that obtaining on the greater number of the natural submerged bars which now produce a variable slope. A boat going upstream will therefore have less difficulty in crossing such a weir than in mounting a natural reef that might require an oblique approach.

At low water a static head will be indicated at each weir by a slight ripple in the water surface over it, the local fall probably amounting to three-tenths of a foot in a channel distance of 300 to 500 feet; the remaining fall between the successive stair-like weirs will be found on an almost uniform slope of about five-tenths of a foot per mile, a slope that in this section of the river is conducive to mean depths greater than are actually required.

The slope of the cross weirs should be made quite flat on the downstream side—say a slope of one on six—and the mattress protection, with heavy ballasting of rubble, or other reinforcement, may be continued downstream, as required, beyond the foot of the weir to prevent the bed of the river from being scoured by the overfall. On the upstream side of the weir a slope of one on two is considered flat enough.

Whenever a section of shoal river bed on the site of a proposed cross weir becomes scoured to the desired depth as side-contraction works are placed, the foundation for the cross weir will be promptly laid over that section. When the sills are to be placed across deep pools in the main channel, deposits may be advantageously induced by proper determination as to which wing dams of a series should be built first, or by the use of silt weeds as mentioned under side contraction.

It is probable that there will be no rock cutting needed to place the sills or any part of the cross weirs, but if any is necessary it will be required only to a very small extent.

The construction of a cross weir would consist, essentially, of a submerged dam of wood and stone, the length and elevation of which is governed by the width and depth required for the low-water channel. The ends of the dam, from low water to the bank-full stage, except when joining a rock bank, would be connected with the improved high banks by construction similar to that in the dam, thus giving the required cross-sectional area and desired side slopes for the calculated prism, with revetments protecting the adjacent banks so built up. These revetments are not shown on the map, but are included in the estimate of cost of the cross weirs.

SUMMARY OF CONSTRUCTION.

I. A broad foundation of special construction laid according to the required alignment and cross section and as nearly as practicable to the profile grade of that cross section.

(*a*) Fills to be made as required by aid of permeable dikes in secondary channels and by solid dikes or dams in the main channel. The fills may be effected in stages, accretion meantime taking place.

(*b*) Cuts necessary to place the foundations to be made by aid of wing dams or dredging.

II. The weir would be brought to final transverse section, profile and grade, by means of piling, grillage mattresses, crib and stone works.

(*a*) Portions below low water to be substantially capped with timber and stonework as required.

(*b*) Portions above low water to be revetted with stone on the required slope and profile.

III. Bank protection to be placed as required above and below the revetted ends of the weirs.

The advantages of concrete when used as a capping in connection with the wood and stone of the general construction, and in particular when so used below the low-water line, are such that it may profitably be used when it can be applied without much increase of cost, and also in such cases as its greater strength offsets the slightly higher expense of such construction. Considering the controlling cross section at low water, and at higher stages as well, the strongest scour will be on the pass sill of the cross weir; and here will also occur the greatest violence of attack by ice gorges if formed.

In the estimate of construction costs provision has been made to cover the additional use of 1 cubic yard of concrete for each linear foot of cross weirs.

ORDER OF WORK IN EXECUTING THE PROJECT.

On the premise that ample funds are available for commencing operations on an extensive scale, and at as early a date as the engineering and constructional problems involved will permit, and will continue available in quantity as needed until its completion, the project can and should be considered as a whole, and a systematic order of work decided on that will earliest and at the least cost produce the desired depth and width of channel.

With ample funds, and assured supplies of material and labor, economy of time is possible through employment of a large number of construction parties, and no increase in the total cost of the improvement results, provided the localities for work are selected in such order that the regulation works at one point will not exert on unregulated portions of the river a detrimental influence that could be avoided by continuous improvement.

As the general position of the works is here predetermined and is not dependent on empiric deductions as installed (they could be placed over the entire district with no discrimination as to locality and without affecting the ultimate result), the point of origin from which work is carried on becomes of interest and value only when it influences either immediate benefits or the time of final completion, and as both will to a very considerable degree be affected by the direction in which the construction advances and the places from which this work is started, the order of work becomes a most important integral part of this project.

If there exist any points in the district at which there will be no change made from the present elevation of the low-water plane, whether cross section be altered or not, it is evident that work can be started at such points without injurious effect on the regimen in any other locality, even temporarily. The low-water plane being fixed for these points, the advancement of the works therefrom would either raise or lower it to the predetermined height at intermediate points.

With the proposed low-water plane such points are found at or near both ends of the district—Arsenal Island and the mouth of the Ohio River—at Commerce, at Grand Tower, and at Little Rock Landing, thus effecting the subdivision of the district into four sections or subdistricts, in each of which construction work could be advantageously commenced, and, if thought necessary, at both ends, advancing toward the middle portions until completion.

As a general proposition, however, work should start at the lower end of each construction section or subdistrict and be continued without interruption. In this manner of working any injury to the improved portions of the same subdistrict will be the least liable to occur, as, in general, the influence of regulation works in an alluvial stream extends mainly downstream. And working upstream from the points where no change is made in the elevation of the low-water plane affords an opportunity which it would be advisable to utilize, to determine from actual results the position and number of the cross weirs that must be constructed.

The backwater effects from the weirs as placed could have no other than a beneficial effect on the regimen of the other reaches farther above those where they are being placed, and the added flow, if available, would further greatly assist in carrying off the natural sediment of the stream.

The principal advantage in downstream progression of construction work, that with each modification of the river channel the far-reaching effects upon the river lower down may be allowed time to develop and their consequences carefully studied, does not have the weight in a project such as this that it might have in a system of empiric improvement for immediately apparent results; as the course of treatment and the ultimate conditions, for any stretch or for any locality, so far as the elevation of the low-water plane and the alignment of banks is concerned, is practically determined from the beginning.

Besides, the permeable hurdles and the catchment areas between them would be ready, successively, to stop and retain their full share of the volume of silt made up of that normally in suspension and of that eroded from shoal reaches above, as the construction of side-contraction works gradually extended upstream; and with works for complete regulation of the bottom and banks of the river being carried on continuously in this direction the heavier material eroded from the reaches farther upstream and rolled along the bottom would have much less tendency to deposit in an improved channel than in an unimproved river bed.

But while in each independent subdistrict regulation works should be installed from the lower end, yet the treatment for each locality within the subdistrict must be determined from local conditions, and in some cases, as in training the thalweg from a concave bank on one side of the stream to a concave bank on the other, a downstream progress of work may give the best result.

Beginning operations at the lower end of a reach and working upstream leaves an improved river through which normal sediment and that from directed erosion during construction farther above will pass more readily than through the natural stream. That subdivision of the entire district and the commencement of work at various points creates alternate improved and unimproved sections is recognized and while to some extent this reduces the benefit derived from the conditions mentioned it does not entirely offset the advantages of upstream work, as even, though not continuous, the regulated portions eliminate from the problem their own extent of otherwise troublesome natural river.

If there be doubt as to the provision of ample funds and regular appropriations, it would be well to restrict work to one subdivision at a time, commencing with the one at that time most troublesome to navigation.

ESTIMATES OF THE TOTAL TIME FOR CONSTRUCTION OF PERMANENT WORKS, AND FOR PRODUCING THE REQUIRED DEPTH IN ADVANCE OF THEIR COMPLETION; OF THE TOTAL COST OF SUCH WORKS, INCLUDING MAINTENANCE; OF THE AMOUNT AND COST OF AUXILIARY DREDGING THAT MAY BE NEEDED; AND STATEMENT AS TO THE AMOUNTS OF FUNDS THAT SHOULD BE PROVIDED.

TIME REQUIRED TO COMPLETE CONSTRUCTION AND TO OBTAIN THE REQUIRED DEPTH.

It is believed the entire project for permanent improvement can be completed within fifteen years, and that a reasonable amount of dredging to aid the partly-completed regulation works in the production of increased depths will render a navigable 14-foot channel available in about seven years from the start of active work.

Such depth will certainly be found throughout the greater part of the district after the worst localities have been improved by the three forms of permanent construction that assure complete control of the river, and after some of the intermediate regulating works have been placed; and the maintenance of this depth where existing, and the creation of an equal depth where necessary, can undoubtedly be accomplished by dredging when this condition of improvement arrives. The time specified for such occurrence, seven years after operations are commenced, is thought to be safely conservative.

ESTIMATE OF COST OF PERMANENT WORKS.

Character of estimate.—The quantities given for all classes of work or forms of construction are believed to be ample—more than sufficient to install the permanent works needed to give the required result. The unit costs are safe and conservative also, being based on the actual costs of the same and similar classes of work constructed in this district.

These unit costs are comprehensive, including as they do all charges for material, labor, plant, supply depot, shipyard, repair shops, superintendence, engineering, and contingencies.

UNIT COSTS.

Wing dams and revetments.—The average costs to the United States engineer office, St. Louis, of similar classes of construction since 1870 have been used in estimating the unit costs, per linear foot, of $25 for permeable hurdle dams and wing dams; $23 for sloping spur dikes, permeable and solid; and $20 for revetments, an increase having been made in each respectively of about 50, 33, and 100 per cent to allow for possible higher prices for labor and materials and for more substantial forms of construction, insuring a higher degree of permanency.

Cross weirs.—The unit cost per linear foot of $60 is based on the actual cost of sill dams and is estimated for the navigable pass sill, necessarily the strongest part of the cross weir, involving for each unit:

23 cubic yards, wood and stone, at $2	$46.00
1 pile, at $7	7.00
1 cubic yard, concrete, at $7	7.00
	60.00

It may not be necessary to incur the expense item of concrete, but to provide for its use when more advantageous it has been included to make the estimate comprehensive.

MAINTENANCE OF THE PERMANENT WORKS.

Based on the assumption that fifteen years will be required to complete the project, the cost of maintenance during construction—the item covering the preservation of works until their completion—may advantageously be considered in five three-year periods.

No expenditure for maintenance should be required during the first period (when the necessary plant would be assembled, the organization perfected, and the work only fairly well begun), and probably only a very small charge, if any, would be necessary during the second period, since no part of any one of the three forms of the proposed permanent works should be considered as finished prior to that time.

At the close of the third and fourth periods the works may safely be assumed to be one-half and three-fourths completed, and for these periods, respectively, annual appropriations of $220,000 and of $330,000 will be required. Probably the greatest changes in river regimen will be taking place in the early part of the last period, and thoroughly to maintain the efficiency of the works an annual appropriation of $440,000 may be required for the last three years.

Thus the total estimated cost of the maintenance of the regulation works during the fifteen-year period of their construction is $2,970,000, an average annual expenditure of about one-half of one per cent of their estimated cost.

After completion of the project, the maintenance of permanent works, of accretions, and the alignment of banks and channel, and the maintenance of the required channel depth, including the dredging of temporary shoals, will require an annual expenditure of less than $500,000.

The actual maintenance charge when the works are in place should, however, be much less than the sum named, but to provide for the possibilities incident to construction works of this nature and on such a stream the estimate has been made amply large.

Estimate of cost of complete regulation works, showing the cost of improvement by subdivisions, and the total cost for the district.

Class of work.	Number.	Linear feet.	Unit cost.	Amount.	Total amount.
Subdivision No. 1 (Merchants Bridge, St. Louis to Little Rock Landing, 58 miles):					
Wing dams, permeable	155	81,820	$25	$2,045,500	
Wing dams, permeable and solid	137	84,840	23	1,951,320	
Revetments	16	131,410	20	2,628,200	
Cross weirs	27	75,000	60	4,500,000	
Maintenance				753,572	
					$11,878,592
Average cost per mile, $204,803.					
Subdivision No. 2 (Little Rock Landing to Grand Tower, 40½ miles):					
Wing dams, permeable	112	94,900	25	2,372,500	
Wing dams, permeable and solid	108	52,000	23	1,197,380	
Revetments	19	159,700	20	3,194,000	
Cross weirs	22	66,000	60	3,900,000	
Maintenance				726,399	
					11,450,279
Average cost per mile, $240,243.					
Subdivision No. 3 (Grand Tower to Commerce, 41 miles):					
Wing dams, permeable	102	85,660	25	2,141,500	
Wing dams, permeable and solid	75	53,840	23	1,238,320	
Revetments	13	112,844	20	2,256,880	
Cross weirs	21	63,000	60	3,780,000	
Maintenance				637,855	
					10,054,555
Average cost per mile, $245,233.					
Subdivision No. 4 (Commerce to mouth of Ohio River, 41½ miles):					
Wing dams, permeable	90	97,600	25	2,440,000	
Wing dams, permeable and solid	75	38,360	23	882,280	
Revetments	23	240,180	20	4,803,600	
Cross weirs	27	74,250	60	4,455,000	
Maintenance				852,174	
					13,433,054
Average cost per mile, $323,688.					
District St. Louis to Cairo (187 miles):					
Wing dams, permeable	459	359,980	25	8,999,500	
Wing dams, permeable and solid	395	229,100	23	5,269,300	
Revetments	71	644,134	20	12,882,680	
Cross weirs	97	278,250	60	16,695,000	
Maintenance				2,970,000	
Estimated total cost				46,816,480	46,816,480

Average cost per mile, for the district, $250,355.

In the preceding table the items covering revetments include 16 sections totaling 92,684 linear feet not fully shown on the maps, but to be placed if required at places marked "R;" also 23,000 linear feet to be placed at ends of cross weirs and covered in estimate therefor, and 42,000 linear feet now in place on the required alignment; a total of 157,684 linear feet of revetment, or an equal value in other forms of construction, available for use at places marked "R" or elsewhere as may be required.

COST OF OBTAINING AND MAINTAINING DEPTHS BEFORE THE REGULATION WORKS ARE COMPLETED.

Production of the required depth during the latter part of the period of construction—to be accomplished by dredging as previously outlined—may also be considered in three-year periods.

On the conservative judgment that the use of eight dredges will, in connection with such works as can be placed during the first seven years of construction, be able to maintain the desired channel depth, the availability of the proposed depth of 14 feet is almost definitely assured early in the third three-year period, and the purchase of four new dredges which is involved may be considered as the part of the project that bears on the production of the required depth at the earliest possible date after work is started.

That such depth at all except the very low stages, will be found throughout the district in the seventh year is based on the condition that about one-third of the permanent works being then completed, the worst places would be improved, and that dredging would then be effective in producing greater navigable depths.

Four dredges are now available, and if the construction of the four additional dredges were completed prior to that time, or even if they were obtained by purchase or loan, at the end of the third year (as provided for in estimate) an increase of channel depth could be obtained earlier, or as soon as the regulation of the bad crossings had been accomplished and the eight dredges placed in service.

Eight dredges, if available at the beginning of the second three-year period, would at least maintain a depth of 9 feet from the commencement of their operation, and very probably a depth of 13 feet prior to the close of that period.

So far as it affects 14-foot navigation, there would be no special advantage in having the entire fleet of eight dredges at the commencement of operations, as the value of this expedient in hastening the production of the 14-foot depth lies solely in its use in augmenting the effects of the partial improvement of the stream through correcting the worst places by regulation.

The absolute attainment of a 14-foot depth should not be expected before one-half the permanent works were in place, but the presence on the field of operations of the entire fleet of eight dredges when commencing work would have the secondary advantage that during the first and second years of construction they could easily maintain a channel of not less than 9 feet over the entire district; thereafter, until the fifth or sixth year, a channel depth of 9 to 13 feet would be produced; and after that time, a practical 14-foot channel would exist.

It is thought that the production of the required depth even at the beginning of the seventh year gives the necessary channel somewhat in advance of the possibilities of any other project except such as involves the use, first subject to possible delay in procuring the requisite plant, of a large number of dredges, and the regulation project has the further advantage that there need be no provision for the renewal of a large floating plant on account of its deterioration through age or decreased efficiency through accident, and the time when the dredges are to be in service approximates the estimated life of a dredge of the type that would be used.

Now on hand in this district and available for service under a new project are four dredges, two of them being nearly new, the others about ten years old, so the decrease in number toward the end of the construction period is in accordance with the probable life of a dredge in actual and continuous use, and does not involve the dropping from use of serviceable dredges.

Estimate of cost of dredging required for fifteen years in conjunction with and until completion of proposed complete regulation of the Mississippi River between St. Louis, Mo., and Cairo, Ill.

First three years, resulting depth 8 to 9 feet:

Operation and maintenance of four dredges, at $75,000 each, annual appropriation, $300,000 (Four dredges now in district and available for use.)	$900,000
Purchase of four new dredges, at $250,000 each, one appropriation, $1,000,000	1,000,000

Second three years, resulting depth 9 to 13 feet (regulation works one-fourth to one-third completed at end of period):	
Operation and maintenance of eight dredges, at $75,000 each, annual appropriation, $600,000	$1,800,000
Third three years, resulting depth 13 to 14 feet (regulation works fully one-half completed at end of period):	
Operation and maintenance of six dredges, at $75,000 each, annual appropriation, $450,000	1,350,000
Fourth three years, depth 14 feet (regulation works three-fourths completed at end of period):	
Operation and maintenance of four dredges, at $75,000 each, annual appropriation, $300,000	900,000
Fifth three years, depth 14 feet (regulation works completed):	
Operation and maintenance of two dredges, at $75,000 each, annual appropriation, $150,000	450,000
Total cost for fifteen years' dredging	6,400,000

AVAILABILITY OF FUNDS.

About $5,000,000, available in full as soon as the improvement is undertaken, would be needed to prevent possible delay to the procuring of floating and other plant, and to the organization of construction forces; of this sum $3,700,000 would be for construction work, $1,000,000 for dredging plant, and $300,000 for operation of dredges.

The sum that would thereafter be needed each year to execute the work under this project is about $3,500,000, this sum becoming available annually until the permanent construction is all in place, when the funds required yearly will be to cover only the expense of maintenance.

APPENDIX NO. 6.

THE SLACK-WATER PROJECT.

[By Assistant Engineer J. W. Woermann.]

ST. LOUIS, MO., *January 15, 1909.*

COLONEL: I have the honor to submit herewith my report upon a project for obtaining a 14-foot channel from St. Louis, Mo., to Cairo, Ill., by means of locks and dams in the Mississippi River.

The fifth stipulation in the river and harbor act of March 2, 1907, which provides for the present board, reads as follows: "And the board shall consider further the practicability of providing at all seasons of the year a depth of fourteen feet in such regulated channel by the aid of locks and dams similar to those projected and in use on the Ohio River improvement."

When I began work on this project in September, 1908, the survey had been made and the charts were well advanced toward completion.

THE PROFILE.

A profile had been prepared, based upon a line of continuous channel soundings, taken in December, 1907. Upon comparing this profile with the transverse soundings, or ranges, I found that this profile did not always follow the "thalweg," or deepest channel, and authority was obtained from the board for the preparation of a new profile.

The deepest practicable channel was then sketched in upon the charts, as indicated by the lines of transverse soundings taken during this survey. Taking the Eads Bridge as the origin, the distances were marked upon this line from St. Louis to Cairo. A new profile was platted to a scale of 5,000 feet to the inch, representing a longitudinal section along this line. The total distance from the Eads Bridge to the mouth of the Ohio River by this line is 182.5 miles, and the total fall at a zero stage on the St. Louis gauge is 107.3 feet. This is an average of 0.59 foot per mile, or approximately 7 inches per mile. This slope is not uniformly distributed however. From the Eads Bridge to Jefferson Barracks, a distance of 10.8 miles, the slope is only 0.20 foot per mile, while from Blackbird Island to the mouth of the Ohio River, a distance of 26 miles, the fall is 0.91 foot per mile. Shorter reaches can be selected where the differences are still greater.

GENERAL DESCRIPTION OF THE PROJECT.

Upon this profile as a basis a project was blocked out which provides for a system of 10 locks and 10 dams.

Between St. Louis and Cairo there are about 60 bars or crossings where the depth is less than 8 feet at a zero stage, and about 110 where the depth is less than 14 feet. These vary in elevation even more radically than the surface slopes, and are responsible in a large measure for the variations in the lengths of the pools and the lifts of the locks. For example, Dam No. 5 is located on a bar which is 8.5 feet higher than the bar just below it, while Dam No. 7 is located on a bar which is 9 feet higher than the one just below it.

In selecting the locations for the dams, however, the heights of the banks, width and depth of the river, proximity of tributaries, and other local features were taken into account.

In order that there may be ample discharging capacity over the sills, during extreme floods, no site was selected where the width was less than 3,000 feet at the time of the recent survey.

In my opinion, it is also undesirable to locate a movable dam just below a large tributary, for the reason that local freshets may require more frequent lowering of the wickets, and at the same time may cause deposits on or against the movable portions of the dam. For this reason Dam No. 1 was located above the mouth of the Meramec River, and Dam No. 4 above the mouth of the Kaskaskia River, rather than at the points suggested by the profile.

Dam No. 10 is located above Eliza Point, about 5.9 miles above the mouth of the Ohio River. On account of the steeper slope in this vicinity at low water, the length of the pool above this dam is only 6.8 miles. The other nine pools vary from 12.9 to 26.9 miles in length. The average length of the ten pools is about 18 miles.

The greatest lift also occurs at Dam No. 10, due to the fact that it is the last in the series, and consequently there is no backwater effect from any dam farther down. The lift on this lock when the river is at a zero stage on the St. Louis gauge is 15 feet. The lock has been designed for this lift, but it is my opinion that with the addition of 10,000 cubic feet per second from the Chicago Drainage Canal, the stage will not fall below 1.5 feet during the navigation season, in which case the maximum lift would be 13.5 feet. The lifts at the other locks vary from 5.2 feet at Lock No. 9 to 11.8 feet at Lock No. 5. The average lift for the ten locks, at a zero stage, is 9.87 feet.

In the spring or early summer, when the natural depths approach 14 feet, the dams would be raised as required, and as the volume decreased the lift would gradually increase from zero up to the maximum heights given in the table of data relating to the proposed locks.

The project as laid out provides for a small amount of dredging at five bars, as indicated on the profile and in the table just referred to. To eliminate the dredging at these bars would require a system of 11 locks and 11 dams. An approximate estimate shows that it is much cheaper, both in first cost and maintenance, to do a small amount of dredging at these bars than to provide an extra lock and dam.

The location of each lock and dam, length of pool, lift of each lock, and other data in regard to the project are given in the tables relating to locks and dams, and on the accompanying maps and profile.

BACKWATER.

One of the most difficult questions to determine in connection with this project is the backwater curve above each proposed dam. An exhaustive search has been made of the literature on this subject, but very little actual data have been found. The most complete data I have been able to find relate to the dam at Hameln on the River Weser. Nine different formulæ which have been found in the various works and papers on hydraulics, have been applied to this stream, and the results compared with the actual elevations above the dam as determined by levels.

Without giving all the details of this comparison, it may be said that Neville's formula gives results which are very much too small. Next in order come the formulæ of Bélanger and Bresse (see Merriman), with values a little larger. Next come the formulæ of Rankine and Ruehlmann (see Molitor), with results almost the same, but still too small. Then we have the Chezy formula with Kutter's coefficients, the Chezy formula with Bazin's coefficients (see Frizell), and the St. Guilhem formula (see D'Aubuisson). Bazin gives closer results at some cross sections and St. Guilhem at others. Of the 9 formulæ which were investigated, that of Poirée is the only one which gave results too high.

It does not follow, however, that these formulæ will approximate the truth in the same order on all other rivers. For example, in the Report of the Chief of Engineers for 1887, part 2, page 1316, it is shown, in the case of the Kentucky River, that at

low stages the Poirée formula gives elevations which are too high, as in the case of the Weser, but at high stages the same formula gives elevations which are too low.

In applying some of these formulæ much depends upon the investigator's judgment in deciding upon the values of the various coefficients which are used, and in the selection of proper cross sections.

In applying these formulæ to the Mississippi River the discharge has been taken at 47,000 cubic feet per second, being based upon a natural low-water discharge of 37,000 cubic feet per second at St. Louis, corresponding to a zero stage, with 10,000 cubic feet per second added as the contribution from the Chicago Drainage Canal.

As has already been pointed out, the different stretches vary considerably in character, but from the investigations which have been made it is believed that the following slopes are conservative values for this project. Proceeding upstream from each dam:

Section.	Slope in 5 miles.	Total slope.	Total distance.
	Foot.	*Feet.*	*Miles.*
First 5 miles	0.2	0.2	5
Second 5 miles	.3	.5	10
Third 5 miles	.4	.9	15
Fourth 5 miles	.5	1.4	20
Fifth 5 miles	.6	2.0	25

THE LOCKS.

The size of locks adopted by the previous 14-foot waterway board, for that portion of the waterway from Chicago to St. Louis, has been adopted by the present board, viz, 80 feet in width and 641 feet between hollow quoins, or a clear length of 600 feet between gates. The length over all, exclusive of wing walls, is 866 feet.

The designs and estimates prepared by the writer for that portion of the waterway from Chicago to the Mississippi River have been followed in the present report, except as to foundations. The locks along the Des Plaines and Illinois rivers are all on rock foundations, while those between St. Louis and Cairo are all on pile foundations.

The borings which were taken during this survey indicate that at the lock sites, bed rock is at a depth of about 100 feet below the low-water surface. It is therefore impracticable to carry the piles to bed rock. The locks which are now in use at La Grange and Kampsville on the Illinois River are founded on similar material, viz, silt, sand, and clay, and they have been used as the basis of the present foundation estimates.

The piles used are 20 feet in length, except at the upper end of the lock, where they will average 40 feet in length. The sustaining power of the soil has been taken at 3,000 pounds per square foot and of the piles at 20,000 pounds per pile. Triple Wakefield sheet piling, 30 feet long, has been provided across the ends of each lock and along the full length of the river wall.

The floors and walls of the locks are of Portland cement concrete. The floors are designed as inverted arches, with a thickness of 3 feet under the lock chamber, 8 feet in the vicinity of the gates, and 13 feet at the miter sills. The lowest portion of the invert is 6 feet below the springing line. By using reinforced concrete instead of plain concrete the floors may be made level and the cost of construction be reduced.

The walls at the upper portion of each lock, and also the guide piles in the upper approaches, have been carried 1.5 to 2.5 feet above the highest water on record, viz, that of 1844. Except in the vicinity of St. Louis and Cairo this flood was about 6 feet higher than that of 1903. This plan has not been followed on the Ohio River, but is in conformity with my plans and estimates for the Des Plaines and Illinois rivers. In my opinion this is the better practice, as the walls and guide piles will not become a menace to navigation during high water, and are always available as a base of operations for dam manipulations.

The coping of the main portion of each lock is carried up to 24 feet above the sill of the adjacent dam, so that it is available for service whenever the lock is required for navigation.

Longitudinal culverts for filling and emptying the locks are provided in the main walls. The sizes of these culverts vary from 5 by 9 feet to 6 by 10 feet. Smaller transverse openings run from the main culverts to the lock chamber at frequent intervals.

In the following table and in my detailed estimates, the upper miter sill has been placed 14 feet below the crest of the dam, which is the ordinary pool level. I believe

it would be better, however, to place the upper miter sill at the same elevation as the sill of the dam. The cost would not be much different, as the increase in the cost of the upper gates would be counterbalanced approximately by the reduction in the amount of masonry.

The elevation of the lower miter sill has been placed 14 feet below the backwater level below the dam.

Five pairs of steel mitering gates are provided for each lock, viz, one pair of upper guard gates, 18 feet high; one pair of upper lift gates, as high as the highest portion of the masonry; two pairs of lower lift gates, of the same height as the lock chamber walls, and one pair of lower guard gates, carried to the same height as the upper guard gates.

The upper guard gates can be used as upper lift gates, in case of an accident to the regular upper lift gates, but the lower guard gates open downstream, and are to be used only when it becomes necessary to pump out the lock for repairs.

The gates are of the single skin type, with horizontal girders, straight lower faces, and curved upper faces. The weights were computed by the formulæ derived by the Board of Engineers on Deep Waterways between the Great Lakes and Atlantic Tide Waters.

The miter sills, contact sills, miter posts, and quoin posts are of oak. This is for the purpose of taking up shock, and also for the purpose of securing more water-tight joints. The hollow quoins are of heavy cast iron.

The following table gives the location, lift, and principal elevations in connection with each of the 10 locks in this project. A detailed estimate for each lock is given in the appendix to this report.

Data relating to proposed locks.

No. of lock.	General location.	Distance from Eads Bridge.	Elevation of upper miter sill.	Elevation of lower miter sill.	Lift in feet at low water.	Top of walls at upper end.
		Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	1 mile above Meramec River	18.7	382.0	375.0	7.0	420.0
2	St. Nicholas Rock Gauge	34.3	374.0	366.0	8.0	411.0
3	Above Fort Chartres Landing	48.9	365.0	354.8	10.2	403.0
4	2.2 miles above mouth of Kaskaskia River	61.8	354.0	344.7	9.3	397.0
5	Foot of Liberty Island	84.5	343.0	331.2	11.8	384.0
6	Hanging Dog Creek	111.4	329.0	317.3	11.7	367.3
7	3 miles below Cape Girardeau	134.4	315.5	305.5	10.0	350.0
8	Head of Buffalo Island	154.7	304.0	293.5	10.5	338.0
9	Beechridge Gauge	169.8	292.5	287.3	5.2	332.3
10	Above Eliza Point	176.6	286.5	271.5	15.0	330.0
	Mouth of Ohio River	182.6				

No. of lock.	General location.	Top of walls at lower end.	Height of walls at upper end above chamber floor.	Height of walls at lower end above chamber floor.	Average elevation of bottom of river.	Original stage corresponding to zero at St. Louis.	No. of chart.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	1 mile above Meramec River	402.0	44.0	26.0	375.0	381.2	3
2	St. Nicholas Rock Gauge	394.0	44.0	27.0	368.0	372.2	4
3	Above Fort Chartres Landing	385.0	47.2	29.2	352.0	363.1	5
4	2.2 miles above mouth of Kaskaskia River	374.0	51.3	28.3	350.0	353.7	6
5	Foot of Liberty Island	363.0	51.8	30.8	334.0	341.2	8
6	Hanging Dog Creek	349.0	49.0	30.7	320.0	327.3	11
7	3 miles below Cape Girardeau	335.5	49.5	29.0	290.0	313.5	13
8	Head of Buffalo Island	324.0	43.5	29.5	294.0	304.7	15
9	Beechridge Gauge	312.5	44.0	24.2	276.0	290.8	16
10	Above Eliza Point	306.5	57.5	34.0	272.0	285.5	17

THE DAMS.

As provided in the act of Congress under which this work is being done, estimates were prepared for movable dams of the Chanoine wicket type. The movable parts of the dam are the wickets, the horses, and the props. The wickets are usually made of timber, bound with steel, but may be made entirely of steel. They are 3 feet 9 inches wide, with 3-inch spaces between them for clearance. The wickets are sup-

ported just below their centers by the horses, about which the wickets are free to swing. The horses, which are made of structural steel, are hinged to the foundation at their lower ends and to the wickets and props at their upper ends. The props are steel forgings, made very heavy at the lower end. The hurters are iron castings, fastened to the downstream part of the foundation. They have seats which support the props when up and grooves which guide them in their ascent and descent. Further details as to their construction and operation may be found in the reports of the Chief of Engineers and in the current engineering literature.

On the Ohio River it is the practice to divide the dam into three or four sections, separated by masonry piers. The section with the lowest sill is usually placed adjacent to the lock, and is called the "navigable pass." This is the sill which is shown on the accompanying profile, and which is referred to in the following table.

The other sections have their sills at higher elevations, and are designated as "weirs." In raising a dam the longest wickets, which are the most difficult to handle, are generally raised first, leaving the shorter lengths to be raised as the head on the dam is increased. In lowering a dam the reverse order is followed. Ordinary fluctuations in stage are controlled by raising or lowering the proper number of wickets on the weirs.

The Ohio River practice has been followed in the present project. The elevations of the sills of the navigable passes are shown on the accompanying profile and in the following table. For the present it has not been considered necessary to determine the proper length and elevation of each weir.

In order to have the number of locks and dams as small as possible it is desirable to have the lifts as great as possible. The greatest vertical height of wickets so far used on the Ohio River is 16.75 feet at Dams No. 2 and No. 3. The vertical height used in each of the ten dams in this project is 18 feet, which was the maximum adopted between Chicago and St. Louis. The 16 foot 9 inch wickets have been operated successfully on the upper Ohio, and there is no reason to believe that the limit has been reached. An additional height of 1 foot and 3 inches is considered a reasonable proposition.

The movable portion of each dam is supported upon a foundation of concrete about 40 feet wide and 6 to 12 feet thick. This in turn is supported upon piles 20 to 30 feet long. Leakage under the dams is prevented by a row of triple-lap sheet piling, 30 feet in length, along the upstream edge of the concrete. Underscour on the downstream side is prevented by heavy cribwork, filled with stone, adjacent to the concrete, and a mattress of standard design beyond the cribwork.

No provision has been made for service bridges from which to operate the dams, as the later experience on the Ohio River has demonstrated that the dams can be safely and readily operated from service boats built for that purpose.

In order to avoid increasing the flood height and flood velocity it is not proposed to carry the abutments and banks above high water, but instead, to allow the flood water to pass out over the banks, the same as it does in its present condition. The necessary bank protection would be provided above, below, and behind the locks and abutments to prevent a washout from behind.

Of the movable dams on the Ohio River, 6 have been completed and 8 are under construction. At Dam No. 8 the estimated cost per linear foot of dam, including service boat, based upon the contract prices, is $447. This is not a typical case, however, as the prices at this dam are higher than at any other dam on the river. At Dam No. 11 the cost per linear foot is just a little above $400. At all other dams the cost is less than $400 per linear foot. In estimates heretofore made on the Ohio River $400 per linear foot has been commonly used. This covered office expenses, cost of superintendence, inspection, etc. In this project, to cover the increased height of wickets and cost of mattress, $450 per linear foot has been used as the basis of the dam estimates.

The following table gives the location, length, lift, backwater height, and principal elevations in connection with each of the 10 dams in this project:

Data relating to proposed movable dams.

No. of dam.	General location.	Distance from Eads Bridge.	Length of pool above dam.	Elevation of crest of dam.	Amount of backwater above dam.	Elevation of backwater below dam.
		Miles.	*Miles.*	*Feet.*	*Feet.*	*Feet.*
1	1 mile above Meramec River	18.7	18.7	390.0	1.4	389.0
2	St. Nicholas Rock Gauge	34.3	15.6	388.0	1.0	380.0
3	Above Fort Chartres Landing	48.9	14.6	379.0	1.0	168.8
4	2.2 miles above mouth of Kaskaskia River	61.8	12.9	368.0	.8	358.7
5	Foot of Liberty Island	84.5	22.7	357.0	1.7	345.2
6	Hanging Dog Creek	111.4	26.9	343.0	2.2	331.3
7	3 miles below Cape Girardeau	134.4	23.0	329.5	1.8	319.5
8	Head of Buffalo Island	164.7	20.3	318.0	1.5	307.5
9	Beechridge Gauge	169.8	15.1	306.5	1.0	301.3
10	Above Eliza Point	176.6	6.8	300.5	.8	285.5
	Mouth of Ohio River	182.5	.....	.....	.....	.....

No. of dam.	General location.	Maximum head on dam.	Original stage at dam corresponding to zero at St. Louis.	Elevation of sill of dam.	Width of river at dam, survey 1907.	High water of 1844.	Bars to be dredged.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	1 mile above Meramec River	7.0	381.2	378.0	2,900	418.0	.....
2	St. Nicholas Rock Gauge	8.0	372.2	370.0	[a] 3,500	409.0	1
3	Above Fort Chartres Landing	10.2	363.1	361.0	3,000	401.0	.....
4	2.2 miles above mouth of Kaskaskia River	9.3	353.7	350.0	3,000	394.8	.....
5	Foot of Liberty Island	11.8	341.2	339.0	3,000	382.0	2
6	Hanging Dog Creek	11.7	327.3	325.0	3,000	304.8	.....
7	3 miles below Cape Girardeau	10.0	313.5	311.5	[b] 3,900	353.8	2
8	Head of Buffalo Island	10.5	304.7	300.0	[b] 4,300	335.5	.....
9	Beechridge Gauge	5.2	290.8	288.5	[a] 3,800	329.5	.....
10	Above Eliza Point	15.0	285.5	282.5	[a] 3,600	328.5	.....
	Mouth of Ohio River	.....	280.0	.....	.....	.....	.....

[a] Dam—3,000 feet. [b] Dam—3,500 feet.

UNIT PRICES.

The unit prices which are used in the detailed estimates are similar to those which were used for that portion of the waterway from Chicago to the Mississippi River. They are based upon my own experience and upon that of other engineers and contractors for similar work.

Portland cement concrete has been estimated at $6 per cubic yard; structural steel in the lock gates at 6 cents per pound; cast-iron at 5 cents per pound; round piles in place at 40 cents per linear foot; sheet piles in place and oak timber in sills and posts at $50 per thousand; excavation for the locks at 50 cents per cubic yard; backfilling behind the land walls and in the cofferdams at 25 cents per cubic yard; dredging in the river bed at 15 cents per cubic yard; common labor at $2 per day of eight hours; pump engineers at $3 per day of eight hours.

Summary of cost, slackwater project, St. Louis to Cairo.

Lock No. 1, lift, 7 feet	$573,191
Lock No. 2, lift, 8 feet	583,723
Lock No. 3, lift, 10.2 feet	636,196
Lock No. 4, lift, 9.3 feet	648,740
Lock No. 5, lift, 11.8 feet	669,485
Lock No. 6, lift, 11.7 feet	659,644
Lock No. 7, lift, 10 feet	701,411
Lock No. 8, lift, 10.5 feet	631,685

Lock No. 9, lift, 5.2 feet	$612,731
Lock No. 10, lift, 15 feet	769,225
Total for ten locks	6,486,031
8 dams, at $1,350,000	10,800,000
2 dams, at $1,575,000	3,150,000
Bank protection, 50,000 linear feet, at $35	1,750,000
Levees and hurdles	300,000
Dredging in channel, 170,000 cubic yards, at $0.15	25,500
Dredging lock approaches, 150,000 cubic yards, at $0.15	22,500
Right of way, 10 sites, at $10,000	100,000
Contingencies, 10 per cent	2,263,403
Total	24,897,434

OPERATION AND MAINTENANCE.

The Board of Engineers which reported on a 9-foot project for the Ohio River, under date of December 15, 1906, estimated the cost of operation and maintenance of one lock and dam at $15,000 per annum. This is considered a liberal estimate and has been adopted in the following summary.

The cost of maintaining a 14-foot channel between the locks is a more difficult question. The dams which have been built on the upper Ohio are on a gravel bottom, and the banks are not subject to caving, so they do not afford any data upon this subject. On the lower Ohio, where the character of the bed and banks is more like the Mississippi, none of the dams have as yet been built.

The Kanawha River is similar to the upper Ohio River, and for that reason affords us no data. On the Big Sandy River the quantities of sand which are washed in from the banks are enormous. The river goes almost dry in the summer time, and at other times is subject to devastating floods. No valuable comparisons can be made between that stream and the Mississippi River.

During ordinary stages, say from 6 to 12 feet on the St. Louis gauge, the velocity of the current from St. Louis to Cairo will vary from 3 to 6 feet per second, or from 2 to 4 miles per hour, depending upon the stage and the reach under consideration.

When the dams are raised this velocity will be reduced to about one-half mile per hour in the lower portion of the pool and about 1 mile per hour in the upper portion at extreme low water. With a 6 or 7 foot stage, the velocity will be about 1 mile per hour at the lower end of a pool and about 1½ miles per hour at the upper end. This checking of the current will no doubt result in the deposition of a portion of such material as may be in suspension at the time the water passes into these pools. Judging from the difficulty which was formerly experienced at the St. Louis waterworks in making this mud settle, I do not believe that this is a very serious question. Furthermore, it must be borne in mind that the dams will all be down for about half of the year, and it is my opinion that during this half of the year, when the velocities are greatest, most of these deposits will be scoured out and carried down the river.

Now, as to caving banks I have a proposition to make which I believe is true, and if true it means that this project merits the most careful consideration of this board, viz, with the dams raised caving of the banks will practically cease.

I am drawn to this conclusion from two considerations: First, I do not believe that the banks will cave with such low velocities as have been mentioned above. Second, I understand that most of the caving occurs during a falling stage—say from 20 feet downward. With this system in operation, the dams would be raised at an 18 or 20 foot stage, and the river would not be permitted to pass through this critical period.

In view of the foregoing considerations I have estimated the annual cost of dredging under this project at $1,000 per mile, although the actual cost may be very much less.

In order to make the estimate still more liberal I have included an item of $50,000 per annum for bank protection, so that the places which may show any serious tendency toward caving may be permanently protected.

During the winter, when there is danger from running ice, the dams would be kept down. At times, on account of this practice, there may be less than a 14-foot depth in the channel, but there is so little navigation during this season of the year that this is not considered a serious objection.

Estimate of cost of operation and maintenance.

10 locks and dams, at $15,000	$150,000
Dredging, 182 miles, at $1,000	182,000
Bank protection	50,000
	382,000

PERSONNEL.

From September 22 to November 18, 1908, I was assisted on this work by Junior Engineer Geo. H. Wolbrecht, and from December 1, 1908, to date by Surveyor M. C. Emanuel, both of whom rendered faithful and efficient service.

Respectfully submitted.

J. W. WOERMANN,
Assistant Engineer.

Col. W. H. BIXBY,
Corps of Engineers, U. S. Army,
Senior Member, Board on Examination and Survey of Mississippi River.

Estimate of cost, Lock No. 1, slack-water project.

LIFT 7 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	43,330	$6.00	$259,980
Piles in foundation, linear feet	109,200	.40	43,680
Sheet piles, feet B. M.	324,000	.05	16,200
Structural steel in gates, pounds	1,274,230	.06	76,454
Anchorages and connections			9,174
Valves and valve frames			3,900
Cast-iron hollow quoins, pounds	116,100	.05	5,805
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	12,960	.05	648
Operating machinery			47,000
Houses for superintendent and assistants			8,000
Guide piles			11,200
Excavation, cubic yards	0	.50	0
Back filling, do	54,000	.25	13,500
Cofferdam			68,000
Pumping			9,000
Total			573,191

Estimate of cost, Lock No. 2, slack-water project.

LIFT 8 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	44,300	$6.00	$265,800
Piles in foundation, linear feet	109,200	.40	43,680
Sheet piles, feet B. M.	324,000	.05	16,200
Structural steel in gates, pounds	1,296,782	.06	77,807
Anchorages and connections			9,337
Valves and valve frames			4,000
Cast-iron hollow quoins, pounds	117,820	.05	5,891
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	13,152	.05	658
Operating machinery			48,000
Houses for superintendent and assistants			8,000
Guide piles			11,200
Excavation, cubic yards	12,000	.50	6,000
Back filling, do	50,000	.25	12,500
Cofferdam			65,000
Pumping			9,000
Total			583,723

Estimate of cost, Lock No. 3, slack-water project.

LIFT 10.2 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	48,000	$6.00	$288,360
Piles in foundation.....linear feet..	118,500	.40	47,400
Sheet piles.....feet B. M..	324,000	.05	16,200
Structural steel in gates.....pounds..	1,309,834	.06	82,190
Anchorages and connections.....	.....	.....	9,863
Valves and valve frames.....	.....	.....	4,200
Cast-iron hollow quoins.....pounds..	123,840	.05	6,192
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	13,824	.05	691
Operating machinery.....	.....	.....	50,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	11,200
Excavation.....cubic yards..	0	.50	0
Back filling.....do....	81,000	.25	20,250
Cofferdam.....	.....	.....	80,000
Pumping.....	.....	.....	11,000
Total.....	.....	.....	636,196

Estimate of cost, Lock No. 4, slack-water project.

LIFT 9.3 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	49,070	$6.00	$294,420
Piles in foundation.....linear feet..	121,300	.40	48,520
Sheet piles.....feet B. M..	324,000	.05	16,200
Structural steel in gates.....pounds..	1,397,630	.06	83,858
Anchorages and connections.....	.....	.....	10,063
Valves and valve frames.....	.....	.....	4,100
Cast-iron hollow quoins.....pounds..	125,560	.05	6,278
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	14,018	.05	701
Operating machinery.....	.....	.....	50,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	11,200
Excavation.....cubic yards..	34,000	.50	17,000
Back filling.....do....	43,000	.25	10,750
Cofferdam.....	.....	.....	56,000
Pumping.....	.....	.....	9,000
Total.....	.....	.....	648,740

Estimate of cost, Lock No. 5, slack-water project.

LIFT 11.8 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	51,790	$6.00	$310,740
Piles in foundation, linear feet	133,400	.40	53,360
Sheet piles, feet B. M.	324,000	.05	16,200
Structural steel in gates, pounds	1,401,040	.06	87,698
Anchorages and connections			10,524
Valves and valve frames			4,300
Cast-iron hollow quoin, pounds	131,580	.05	6,579
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	14,688	.05	734
Operating machinery			52,000
Houses for superintendent and assistants			8,000
Guide piles			11,200
Excavation, cubic yards	14,000	.50	7,000
Back filling, do	62,000	.25	15,500
Cofferdam			75,000
Pumping			10,000
Total			669,485

Estimate of cost, Lock No. 6, slack-water project.

LIFT 11.7 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	50,430	$6.00	$302,580
Piles in foundation, linear feet	133,400	.40	53,360
Sheet piles, feet B. M.	324,000	.05	16,200
Structural steel in gates, pounds	1,438,740	.06	86,325
Anchorages and connections			10,359
Valves and valve frames			4,300
Cast-iron hollow quoins, pounds	129,000	.05	6,450
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	14,400	.05	720
Operating machinery			52,000
Houses for superintendent and assistants			8,000
Guide piles			11,200
Excavation, cubic yards	14,000	.50	7,000
Back filling, do	62,000	.25	15,500
Cofferdam			75,000
Pumping			10,000
Total			659,644

Estimate of cost, Lock No. 7, slack-water project.

LIFT 10 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	48,940	$6.00	$293,640
Piles in foundation.....linear feet..	120,000	.40	48,000
Sheet piles.....feet B. M..	324,000	.05	16,200
Structural steel in gates.....pounds..	1,384,548	.06	83,073
Anchorages and connections.....	.....	.....	9,969
Valves and valve frames.....	.....	.....	4,200
Cast-iron hollow quoins.....pounds..	125,560	.05	6,278
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	14,018	.05	701
Operating machinery.....	.....	.....	50,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	11,200
Excavation.....cubic yards..	0	.50	0
Back filling.....do....	150,000	.25	37,500
Cofferdam.....	.....	.....	120,000
Pumping.....	.....	.....	12,000
Total.....	.....	.....	701,411

Estimate of cost, Lock No. 8, slack-water project.

LIFT 10.5 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	46,270	$6.00	$277,620
Piles in foundation.....linear feet..	111,800	.40	44,720
Sheet piles.....feet B. M..	324,000	.05	16,200
Structural steel in gates.....pounds..	1,316,950	.06	79,017
Anchorages and connections.....	.....	.....	9,482
Valves and valve frames.....	.....	.....	4,200
Cast-iron hollow quoins.....pounds..	118,680	.05	5,934
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	13,248	.05	662
Operating machinery.....	.....	.....	50,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	11,200
Excavation.....cubic yards..	3,000	.50	1,500
Back filling.....do....	90,000	.25	22,500
Cofferdam.....	.....	.....	90,000
Pumping.....	.....	.....	10,000
Total.....	.....	.....	631,685

Estimate of cost, Lock No. 9, slack-water project.

LIFT 5.2 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete....cubic yards..	42,180	$6.00	$253,080
Piles in foundation....linear feet..	108,400	.40	43,360
Sheet piles....feet B. M..	324,000	.05	16,200
Structural steel in gates....pounds..	1,251,244	.06	75,075
Anchorages and connections....	.....	.....	9,009
Valves and valve frames....	.....	.....	3,800
Cast-iron hollow quoins....pounds..	114,380	.05	5,719
Oak timber:			
Miter and contact sills....feet B. M..	13,000	.05	650
Miter and quoin posts....do....	12,768	.05	638
Operating machinery....	.....	.....	45,000
Houses for superintendent and assistants....	.....	.....	8,000
Guide piles....	.....	.....	11,200
Excavation....cubic yards..	0	.50	0
Back filling....do....	120,000	.25	30,000
Cofferdam....	.....	.....	100,000
Pumping....	.....	.....	11,000
Total....	.....	.....	612,731

Estimate of cost, Lock No. 10, slack-water project.

LIFT 15 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete....cubic yards..	58,070	$6.00	$352,020
Piles in foundation....linear feet..	142,400	.40	56,960
Sheet piles....feet B. M..	324,000	.05	16,200
Structural steel in gates....pounds..	1,590,120	.06	95,407
Anchorages and connections....	.....	.....	11,449
Valves and valve frames....	.....	.....	4,500
Cast-iron hollow quoins....pounds..	141,040	.05	7,052
Oak timber:			
Miter and contact sills....feet B. M..	13,000	.05	650
Miter and quoin posts....do....	15,744	.05	787
Operating machinery....	.....	.....	55,000
Houses for superintendent and assistants....	.....	.....	8,000
Guide piles....	.....	.....	11,200
Excavation....cubic yards..	3,000	.50	1,500
Back filling....do....	110,000	.25	27,500
Cofferdam....	.....	.....	110,000
Pumping....	.....	.....	11,000
Total....	.....	.....	769,225

APPENDIX No. 7.

THE CANAL PROJECT.

[By Assistant Engineer J. W. Woermann.]

ST. LOUIS, MO., *January 21, 1909.*

COLONEL: I have the honor to submit herewith my report upon a project for obtaining a 14-foot waterway from St. Louis, Mo., to Cairo, Ill., by means of a continuous canal, and also by means of an interrupted canal.

The river and harbor act of March 2, 1907, reads, in part, as follows: "The Secretary of War may appoint a board of five members * * * to examine the Mississippi River below St. Louis and report to Congress * * * upon the practicability of constructing and maintaining a navigable channel fourteen feet deep and of suitable width from St. Louis to the mouth of the river, either by the improvement of said river or by a canal or canals for part of said route."

GENERAL DESCRIPTION OF PROJECT.

In accordance with this provision I was instructed by the board to prepare estimates for a canal or canals from St. Louis to Cairo of similar size to the canal sections of the adopted project between Chicago and St. Louis, viz, a canal trunk with a bottom width of 160 feet and side slopes of one on two, and locks 80 feet wide and 641 feet long between hollow quoins, or 600 feet long in the clear.

When I began work on this project on August 1, 1908, the survey had been completed and most of the charts were well under way. A study of these charts, together with my personal knowledge of the topography, convinced me that a continuous canal from St. Louis to Cairo was impracticable, on account of its probable cost, as it would involve many miles of canal trunk through bluffs, from 75 to 200 feet high. However, to show its impracticability more conclusively, an approximate estimate of such a canal was prepared, which is given at the close of this report.

I decided, therefore, to lay out a canal across the bottom lands only where the conditions were favorable, and elsewhere to use the natural bed of the river. The project as laid out consists of four stretches of open river navigation, connected by three sections of canal, all of which are laid out on the Illinois side of the river. These have been designated the upper section, middle section, and lower section, respectively.

A movable dam of the Chanoine wicket type has been located in the river near the upper end of each section, for the purpose of affording ample depth in the open river section, and also for the purpose of securing an economical bottom grade for the adjacent section of the canal.

Dam No. 1 is located about 1 mile above the Meramec River, or 18.7 miles below the Eads Bridge. Dam No. 2 is located at the foot of Crains Island, or 79.7 miles, by river, below the Eads Bridge. Dam No. 3 is located at the town of Commerce, or 143.9 miles, by river, below the Eads Bridge.

The general location and length of each section of the canal and of each stretch of open river navigation is shown in the following table:

Lengths of component parts of canal project.

	Miles.
Open river from the Eads Bridge to Meramec River	18.1
Canal from Meramec River to Kaskaskia River	39.8
Open river from Kaskaskia River to foot of Crains Island	16.1
Canal from foot of Crains Island to head of Devils Island	45.2
Open river from head of Devils Island to Commerce	18.9
Canal from Commerce to Pond Lilly Crossing	15.5
Open river from outlet of canal to mouth of Ohio River	7.7
Total	161.3

The total distance by river from the Eads Bridge to the mouth of the Ohio River is 182.5 miles, so that the canal project will effect a saving in distance of 21.2 miles.

A guard lock is provided at the upper end of each section of canal. These are designated as No. 1, No. 4, and No. 6, on the accompanying maps, profile, and estimates. Ordinarily there will be little or no lift at these locks, but they are designed for a lift of 4 feet, so that they may be used up to a stage which is 4 feet above the normal pool level. The guard gates are designed for a head of 18 feet at the upper end and 14 feet at the lower end, which may occur when a lock is pumped out for repairs.

Locks No. 2 and No. 3 are located near the lower end of the upper section, with lifts of 15 feet and 22 feet, respectively. Lock No. 5, with a lift of 32 feet, is located at the lower end of the middle section. Lock No. 7, with a lift of 38 feet, is located at the lower end of the lower section. The total fall from the proposed pool at St. Louis to the mouth of the Ohio River is distributed as follows:

	Fall.	Elevation.
	Feet.	*Feet.*
Crest of Dam No. 1, above Meramec River	.....	396
Upper section:		
Lock No. 1, guard lock	0	
Lock No. 2, lift	15	
Lock No. 3, lift	22	
Fall from Lock No. 3 to Dam No. 2	1	
		38
Crest of Dam No. 2 at Crains Island	.....	358
Middle section:		
Lock No. 4, guard lock	0	
Lock No. 5, lift	32	
Fall from Lock No. 5 to Dam No. 3	1	
		33
Crest of Dam No. 3, at Commerce, Mo.	.....	325
Lower section:		
Lock No. 6, guard lock	0	
Lock No. 7, lift	38	
Fall from Lock No. 7 to the Ohio River	6	
		44
Total fall	115	
Elevation of water surface at the junction of the rivers	.....	281

CANAL TRUNK.

The center line of the canal was laid out on the large charts, where the topography seemed most favorable, taking into account the elevation and character of the ground, stream crossings, highways, and other features which affect the cost, maintenance, and utility of a canal. Where the best location could not be determined by inspection, two routes were laid out, and comparative estimates prepared to decide the question. For the purpose of computing the earthwork the lines were transferred to the field sheets, as the ground elevations could be tabulated more accurately from them than from the large charts.

The location has also been transferred from the large charts to the four sets of photolithographic copies, which accompany this report. The dams and other structures relating to the canal are shown in red, while those relating to the slack-water project are shown in blue. The parallel red lines indicate the width of the canal at the water surface, which is 216 feet. The right of way, which is 800 feet wide, on an average, is not shown.

The location and degree of curvature of each curve on the canal is shown in the following table:

Table of curves on canal project.

[L.—left; R.—right.]

UPPER SECTION.

From station (approximate)—	To station (approximate)—	Degree of curve.	No. of chart.
		° ′	
13	16	0 30 L.	3
34+200	36+600	0 30 R.	3
			4
43	47	0 30 L.	4
61	68	0 30 L.	4
86	89	0 30 L.	4
117+700	120+500	0 30 R.	5
129	131+700	0 30 L.	5
146	148	0 30 R.	5
161	163	0 30 L.	6
197	200	0 30 L.	6

Table of curves on canal project—Continued.

[L.=left; R.=right.]

MIDDLE SECTION.

From station (approximate)—	To station (approximate)—	Degree of curve.	No. of chart.
		° ′	
0	3	0 30 R.	8
13	14	0 30 R.	8
39	41	0 30 R.	8 and 9
59+600	61+400	0 30 L.	9
77+600	80+600	0 30 L.	9
91+700	93+600	3 00 R.	10
96+800	99	0 30 R.	10
134+700	144+400	0 18 R.	11
150	168	0 40 L.	11
179+500	184	0 30 R.	11
203+400	206	0 30 R.	12
210	212	0 30 R.	12
221	225	0 30 R.	12
229	234	0 30 R.	12

LOWER SECTION.

2	4	1 00 L.	14
24	30	0 50 R.	15
33+500	38	1 00 L.	15
53+400	56	1 00 R.	15
78+500	81	1 00 R.	17

EMBANKMENTS.

The embankments have been designed with a top width of 16 feet, so that they may be used as highways by the people along the canal, to travel from the many private roads to the proposed highway bridges, which are located only at public roads.

The side slopes are 1 on 2, the same as for the excavated portion of the canal.

A careful study was made of the high-water elevations on file in this office, and the embankment grades established 1.5 feet above the high-water line of 1844. The amount of earth work in the embankments was computed for all stations where the amount of embankment exceeded the amount of excavation.

To prevent wave wash, the inside slopes are riprapped for a width of 9 feet, measured along the slope. This riprap will usually lie on the excavated slopes, but where the ground is low it will fall on the embankments.

BACKWATER.

The subject of backwater slopes above the proposed dams is covered in my report upon the slack-water project, and need not be repeated here.

LOCKS AND DAMS.

The locks and dams are similar in every respect to those provided for the slack-water project, and for details reference may be made to my report upon that project. A detailed estimate for each lock is given in the appendix to this report. The following table gives the location, lift, and principal elevations in connection with each of the seven locks in this project.

Data relating to proposed locks.

No. of lock.	General location.	Distance from upper end of section, in 1,000 foot stations.	Distance from Eads Bridge by canal project.	Elevation of upper miter sill.	Elevation of lower miter sill.	Lift in feet at low water.
			Miles.	*Feet.*	*Feet.*	*Feet.*
1	1 mile above Meramec River	0 to 1	18.1	382	382	0
2	2 miles above Ste. Genevieve	176 to 177	51.5	382	367	15
3	1.3 miles above Kaskaskia River	206 to 207	57.2	367	345	22
4	Foot of Crains Island	1 to 2	74.2	344	344	0
5	8 miles above Cape Girardeau	227 to 228	117.1	344	312	32
6	Opposite Commerce	1 to 2	138.3	311	311	0
7	3 miles above Cairo	78 to 79	153.0	311	273	38
	Mouth of Ohio River		161.1			

No. of lock.	General location.	Top of walls at upper end.	Top of walls at lower end.	Height of walls at upper end above chamber floor.	Height of walls at lower end above chamber floor.	No. of chart.
		Feet.	*Feet.*	*Feet.*	*Feet.*	
1	1 mile above Meramec River	420	402	37	18	3
2	2 miles above Ste. Genevieve	399	399	31	31	6
3	1.3 miles above Kaskaskia River	396	387	50	41	6
4	Foot of Crains Island	386	364	41	19	8
5	8 miles above Cape Girardeau	361	361	48	48	12
6	Opposite Commerce	342	331	30	19	14
7	3 miles above Cairo	331	331	57	57	17
	Mouth of Ohio River					

BRIDGES.

A swing bridge with a draw pier to one side of the canal has been adopted as the most economical type for this project. The short span which swings over dry land is counterweighted. The piers and abutments are of concrete, founded on piles.

It was found that 54 highway bridges and 3 railroad bridges were required for the entire project. The locations are shown on the accompanying maps, each series being numbered consecutively.

CULVERTS AND AQUEDUCTS.

In determining the dimensions of the culverts and aqueducts required under this project, much weight was given to the sizes of existing bridges across the same water courses. Where such bridges did not exist, the determinations were based upon the size of the channels and upon the areas of the watersheds.

Wherever it is practicable the culverts have been taken under the canal, flushing devices being provided where needed. Where the topography is unfavorable to this arrangement, a culvert is provided under one embankment and the water is taken into the canal.

The following table shows the location, size, character, and cost of the 28 culverts and 1 aqueduct required under this project. None are required on the lower section of the canal.

Table of culverts and aqueducts.

UPPER SECTION.

No.	Station.	No. of chart.	Size and character.	Cost.
1	10	3	Two 48-inch pipes under east embankment	$5,000
2	18	3	One 48-inch pipe under east embankment	3,000
3	25	3	Six 12-foot arches with flushing device	136,000
4	50	4	Two 48-inch pipes with flushing device	19,500
5	59	4	.....do	19,500
6	77	4	.....do	19,500
7	95	5	Three 10-foot arches with flushing device	64,800
8	101	5	Two 10-foot arches with flushing device	43,200
9	107	5	Three 12-foot arches with flushing device	75,600
10	123	5	Two 48-inch pipes with flushing device	15,500
11	133	5	Three 48-inch pipes with flushing device	29,200
12	141	5	Two 12-foot arches with flushing device	50,400
13	174	6	One 12-foot arch with flushing device	21,000
				502,200

MIDDLE SECTION.

14	3	8	No culvert, but new outlet	$3,300
15	11	8	One 10-foot arch under east embankment	6,000
16	20	8	Two 12-foot arches under east embankment	12,600
17	28	8	One 12-foot arch under east embankment	7,000
18	38	8	.....do	7,000
19	45	9	Two 8-foot arches under east embankment	9,000
20	54	9	Two 48-inch pipes under west embankment	5,000
21	77	9	Two 12-foot arches with flushing device	50,400
22	101	10	One 12-foot arch under west embankment	7,000
23	111	10	Two 48-inch pipes under west embankment	5,000
24	117	10	.....do	5,000
25	124	10	.....do	5,000
26	130	10	.....do	5,000
27	140	11	.....do	5,000
28	164	11	One 10-foot arch with flushing device	24,000
(a)	146	11	Eighteen 35-foot spans over Big Muddy River	510,000
				666,300

(a) Aqueduct.

UNIT PRICES.

The unit prices used in this project are the same as given in my report on the slackwater project, with the following exception: The price of earth excavation for the locks has been taken at 35 cents per cubic yard instead of 50 cents, as in this project most of the excavation is dry.

We have the following additional items: 25 cents per cubic yard for excavation of canal trunk and ditches; 25 cents per cubic yard for embankment, wherever the embankment is in excess of the excavation; 60 cents per square yard for riprap; and $200 per acre for right of way.

The average price for a highway swing bridge has been taken at $55,000 and for a single track railroad swing bridge at $70,000. These prices are based on the cost of similar bridges over the Chicago Drainage Canal.

Estimate of cost.

UPPER SECTION OF CANAL.

	Quantity.	Price.	Total.
Excavation:			
Canal trunk.....cubic yards..	22,590,703	$0.25	$5,647,676
Ditches.....do....	368,000	.25	92,000
Embankments: Excess over excavation.....do....	347,925	.25	86,981
Riprap.....square yards..	414,000	.60	248,400
Highway bridges.....	21	55,000.00	1,155,000
Railroad bridges.....	1	70,000.00	70,000
Culverts.....	13	Variable.	502,000
Dam No. 1.....	.....	.....	1,350,000
Lock No. 1, guard lock.....	.....	.....	454,962
Lock No. 2, lift 15 feet	.....	.....	566,164
Lock No. 3, lift 22 feet	.....	.....	766,342
Right of way.....acres..	3,857	200.00	771,400
Contingencies, 10 per cent.....	.....	.....	1,171,112
Total.....	.....	.....	12,882,237

MIDDLE SECTION OF CANAL.

Excavation:			
Canal trunk.....cubic yards..	30,142,518	$0.25	$7,535,630
Ditches.....do....	421,333	.25	105,333
Embankments: Excess over excavation.....do....	1,389,629	.25	347,407
Riprap.....square yards..	474,000	.60	284,400
Highway bridges.....	27	55,000.00	1,485,000
Railroad bridges.....	2	70,000.00	140,000
Culverts.....	15	Variable.	150,300
Aqueducts.....	1	.....	510,000
Dam No. 2.....	.....	.....	1,500,000
Lock No. 4, guard lock.....	.....	.....	517,614
Lock No. 5, lift 32 feet	.....	.....	857,254
Right of way.....acres..	4,389	200.00	877,800
Contingencies, 10 per cent.....	.....	.....	1,431,674
Total.....	.....	.....	15,748,412

LOWER SECTION OF CANAL.

Excavation:			
Canal trunk.....cubic yards..	9,936,962	$0.25	$2,484,240
Ditches.....do....	140,444	.25	35,111
Embankments: Excess over excavation.....do....	61,111	.25	15,278
Riprap.....square yards..	158,000	.60	94,800
Highway bridges.....	6	55,000.00	330,000
Dam No. 3.....	.....	.....	1,500,000
Lock No. 6, guard lock.....	.....	.....	484,110
Lock No. 7, lift 38 feet.....	.....	.....	1,014,395
Right of way.....acres..	1,488	200.00	297,600
Contingencies, 10 per cent.....	.....	.....	625,553
Total.....	.....	.....	6,881,087

GRAND SUMMARY.

Upper section, 39.8 miles long	$12,882,237
Middle section, 45.2 miles long	15,748,412
Lower section, 15.3 miles long	6,881,087
Grand total, 100.3 miles long.....	35,511,736

OPERATION AND MAINTENANCE.

The cost of operation and maintenance for one lock is estimated as follows:

One superintendent, at $100 per month.....	$100
Six lock tenders, at $50 per month.....	300
Labor for one month.....	400
Labor for one year.....	4,800
Supplies and repairs.....	3,200
Total for one lock for one year.....	8,000

The cost of operation and maintenance for one lock and an adjacent dam has been taken at $15,000 per annum, the same as in the slackwater project.

The cost of operation and maintenance for each bridge is estimated as follows:

One bridge tender (mechanic) at $100 per month	$100
Two bridge tenders at $50 per month	100
Labor for one month	200
Labor for one year	2,400
Supplies and repairs	1,600
Total for one bridge for one year	4,000

The cost of maintaining a 14-foot channel in the 61 miles of open river which constitute a part of this project has been taken at $1,000 per mile, the same as in my report on the slackwater project.

The cost of maintaining the canal trunk has been taken at $200 per mile. This cost is not uniformly distributed, but is principally for dredging at the points where streams are taken into the canal.

In order to make the estimate more liberal I have included an item of $50,000 per annum for bank protection, the same amount as in the slackwater project, so that the banks may be permanently protected, wherever the caving threatens to do any serious damage.

Estimate of cost of operation and maintenance for canal in three sections.

3 locks and adjacent dams, at $15,000	$45,000
4 locks, without dams, at $8,000	32,000
57 bridges, at $4,000	228,000
Dredging in river, 61 miles, at $1,000	61,000
Maintaining canal trunk, 100 miles, at $200	20,000
Bank protection	50,000
Total	436,000

CONTINUOUS CANAL.

The following estimate for a continuous canal from Madison, Ill. (the terminus of the canal recommended by the Mississippi River Commission in 1905), to the mouth of the Ohio River was prepared by estimating the cost of constructing four sections of canal to replace the four stretches of open river navigation in the preferred project and adding these to the estimates for the three sections of canal above described.

The excavation for each section was computed by taking the average of a number of typical elevations along each section. The estimates of embankment and of highway bridges and culverts are based largely upon the results obtained in my detailed study of the canal in three sections. The number of railroad bridges was determined from the maps on file in this office. No dams will be required in this project, but a very expensive and unusual structure is required at the Kaskaskia River, viz, an aqueduct with a draw span. This is necessary because the Kaskaskia is a navigable river. The only alternative is a lock on each side of the river, so that boats may lock into the Kaskaskia River and out again, and a siphon under the Kaskaskia to carry the water supply for the canal. The costs of the two plans would not differ materially.

The aqueducts over the other large streams do not offer any special difficulties.

Estimate of cost of a canal from Madison, Ill., to the Meramec River, 22.8 miles.

Excavation:	
Canal trunk, 22.8 miles, at $160,000	$3,648,000
Ditches, 22.8 miles, at $2,300	52,000
Embankments: Excess over excavation	77,000
Riprap, 22.8 miles, at $6,200	141,000
Highway bridges, 15, at $55,000	825,000
Railroad bridges:	
One three-track, at $180,000	180,000
Three double track, at $125,000	375,000
Six single-track, at $70,000	420,000

Culverts	$520,000
Right of way	450,000
Contingencies, 10 per cent	668,800
Total	7,356,000

Estimate of cost of a canal from Kaskaskia River to foot of Crains Island, 16 miles.

Excavation:	
Canal trunk—	
1.5 miles, at $2,670,000	$4,005,000
8 miles, at $4,576,000	36,608,000
6.5 miles, at $180,000	1,566,000
Ditches, 16 miles, at $2,300	37,000
Embankments: Excess over excavation, 8.7 miles	40,000
Riprap, 16 miles, at $6,200	99,000
Highway bridges:	
Four (300 feet), at $55,000	220,000
Six (900 feet), at $150,000	900,000
Railroad bridges, 3, $70,000	210,000
Aqueduct over Kaskaskia River, with drawspan	1,800,000
Aqueduct over Marys River	225,000
Culverts	200,000
Right of way:	
9.5 miles, at $60,000	570,000
6.5 miles, at $20,000	130,000
Contingencies, 10 per cent	4,604,000
Total	51,271,000

Estimate of cost of a canal from Devils Island to Commerce, 13.3 miles.

Excavation:	
Canal trunk—	
6.8 miles, at $1,071,000	$7,283,000
6.5 miles, at $70,000	455,000
Ditches, 13.3 miles, at $2,300	31,000
Embankments: Excess over excavation, 6.5 miles, at $50,000	325,000
Riprap, 13.3 miles, at $6,200	82,000
Highway bridges:	
Four (300 feet), at $55,000	220,000
Four (450 feet), at $80,000	320,000
Railroad bridges, 2, $70,000	140,000
Culverts and aqueducts	500,000
Right of way:	
6.8 miles, at $40,000	272,000
6.5 miles, at $20,000	130,000
Contingencies, 10 per cent	976,000
Total	10,734,000

Estimate of cost of a canal from Pond Lily to mouth of Ohio River, 6.5 miles.

Excavation:	
Canal trunk, 6.5 miles, at $70,000	$455,000
Ditches, 6.5 miles, at $2,300	15,000
Embankments: Excess over excavation, 6.5 miles, at $50,000	325,000
Riprap, 6.5 miles, at $6,200	40,000
Highway bridges, 4, at $55,000	220,000
Railroad bridges, 1, at $70,000	70,000
Culverts	200,000
Right of way, 6.5 miles, at $40,000	260,000
Contingencies, 10 per cent	158,000
Total	1,743,000

GRAND SUMMARY.

Estimate of cost of a continuous canal from Madison, Ill., to mouth of Ohio River.

	Miles.	Amount.
Madison, Ill., to Meramec River	22.8	$7,356,000
Meramec River to Kaskaskia River[a]	39.8	11,397,237
Kaskaskia River to foot of Crains Island	16.0	51,271,000
Foot of Crains Island to head of Devils Island[b]	45.2	14,098,412
Head of Devils Island to Commerce	13.3	10,734,000
From Commerce to Pond Lily Crossing[c]	15.3	5,231,087
From Pond Lily Crossing to mouth of Ohio River	6.5	1,743,000
Grand total	158.9	101,830,736

[a] Without Dam No. 1, deduct estimated cost + 10 per cent for contingencies.
[b] Without Dam No. 2, deduct estimated cost + 10 per cent for contingencies.
[c] Without Dam No. 3, deduct estimated cost + 10 per cent for contingencies.

ALTERNATE PROJECT FOR A CONTINUOUS CANAL.

An approximate estimate has also been prepared for a canal which would cross over to the Missouri side of the river above the Kaskaskia River and then back again into Illinois at the foot of Liberty Island. This would avoid the high bluffs which follow the Illinois shore between these points and also eliminate the aqueducts over the Kaskaskia River and Marys River.

This project requires a lock on each side of the river at both places where the Mississippi is crossed, or a net addition of two locks to the continuous canal project on the Illinois side.

The estimated cost of a canal on the Missouri side from the Kaskaskia River to the foot of Liberty Island is as follows:

Cost of canal trunk, 16 miles, at $423,000	$6,768,000
Cost of two additional locks on Missouri side	1,800,000
Additional cost on account of increased lift of two locks on Illinois side	600,000
Total	9,168,000

The estimated cost of the canal on the Illinois side between the same two points is $42,179,000, making a difference of $33,011,000 in favor of the Missouri side. This difference is reduced, however, by the increased cost of the canal trunk from Liberty Island to Devils Island. On account of the loss of grade which results from locking into the river the bottom grade of the canal is lowered 15 feet from Liberty Island to Devils Island and the cost of this section increased by $7,722,000. The higher bottom grade can be secured in this alternate project only by means of a dam in the river, as in the preferred canal project.

Deducting this amount from $33,011,000 gives us $25,289,000 as the net saving in favor of crossing over into Missouri. Deducting this from $101,831,000 gives us $76,542,000 as the estimate of cost for the alternate project.

OPERATION AND MAINTENANCE OF CONTINUOUS CANALS.

The following estimates of cost of operation and maintenance require no additional explanation, except perhaps as to the item, bank protection, $50,000. This has been included in each estimate with the idea that at times the caving of the bank may threaten the canal and require protection for that reason if for no other.

Estimate of cost of operation and maintenance for a continuous canal on the Illinois side of river.

7 locks, at $8,000	$56,000
110 bridges, at $4,000	440,000
Maintaining canal (100 miles), at $200	20,000
Maintaining canal (60 miles), at $500	30,000
Bank protection	50,000
Total	596,000

Estimate of cost of operation and maintenance for alternate project for continuous canal.

9 locks, at $8,000	$72,000
110 bridges, at $4,000	440,000
Maintaining canal (153 miles), at $200	30,600
Maintaining canal (7 miles), at $500	3,500
Dredging at river crossing	10,000
Bank protection	50,000
Total	606,100

Respectfully submitted.

J. W. WOERMANN, *Assistant Engineer.*

Col. W. H. BIXBY,
Corps of Engineers, U. S. Army,
Senior Member Board on Examination and Survey of Mississippi River.

Estimate of cost, Lock No. 1, canal project.

GUARD LOCK.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	33,460	$6.00	$200,760
Piles in foundation, feet	98,600	.40	38,440
Structural steel in gates, pounds	1,068,290	.06	65,297
Anchorages and connections			7,836
Valves and valve frames			2,634
Cast-iron hollow quoins, pounds	99,760	.05	4,988
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	11,136	.05	557
Operating machinery			40,000
Houses for superintendent and assistants			8,000
Guide piles			7,420
Excavation, cubic yards	110,110	.35	38,538
Back filling, do	119,370	.25	29,842
Cofferdam			6,000
Pumping			4,000
Total			454,962

Estimate of cost, Lock No. 2, canal project.

LIFT 15 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete, cubic yards	42,900	$6.00	$297,400
Piles in foundation, feet	112,200	.40	44,880
Structural steel in gates, pounds	1,024,560	.06	61,474
Anchorages and connections			7,380
Valves and valve frames			4,500
Cast-iron hollow quoins, pounds	101,480	.05	5,074
Oak timber:			
Miter and contact sills, feet B. M.	13,000	.05	650
Miter and quoin posts, do	11,328	.05	566
Operating machinery			55,000
Houses for superintendent and assistants			8,000
Guide piles			2,240
Excavation, cubic yards	148,150	.35	51,852
Back filling, do	72,590	.25	18,148
Cofferdam			5,000
Pumping			4,000
Total			566,164

Estimate of cost, Lock No. 3, canal project.

LIFT 22 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	62,320	$6.00	$373,920
Piles in foundation.....feet..	166,400	.40	66,560
Structural steel in gates.....pounds..	1,478,400	.06	88,704
Anchorages and connections.....	.....	.....	10,644
Valves and valve frames.....	.....	.....	5,200
Cast-iron hollow quoins.....pounds..	147,060	.05	7,353
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	16,416	.05	821
Operating machinery.....	.....	.....	62,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	5,320
Excavation.....cubic yards..	244,440	.35	85,554
Back filling.....do....	142,080	.25	35,520
Cofferdam.....	.....	.....	12,000
Pumping.....	.....	.....	6,000
Total.....	.....	.....	766,342

Estimate of cost, Lock No. 4, canal project.

GUARD LOCK.

	Quantity.	Unit price.	Cost.
Portland cement, concrete.....cubic yards..	35,650	$6.00	$213,900
Piles in foundations.....feet..	106,200	.40	42,480
Structural steel in gates.....pounds..	1,141,290	.06	68,477
Anchorages and connections.....	.....	.....	8,217
Valves and valve frames.....	.....	.....	2,034
Cast-iron hollow quoins.....pounds..	103,200	.05	5,160
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	11,520	.05	576
Operating machinery.....	.....	.....	40,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	7,420
Excavation.....cubic yards..	219,150	.35	76,702
Back filling.....do....	125,590	.25	31,398
Cofferdam.....	.....	.....	8,000
Pumping.....	.....	.....	4,000
Total.....	.....	.....	517,614

Estimate of cost, Lock No. 5, canal project.

LIFT 32 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	72,500	$6.00	$435,000
Piles in foundation.....feet..	193,900	.40	77,560
Structural steel in gates.....pounds..	1,458,460	.06	87,507
Anchorages and connections.....	.....	.....	10,500
Valves and valve frames.....	.....	.....	6,900
Cast-iron hollow quoins.....pounds..	132,440	.05	6,622
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	14,784	.05	739
Operating machinery.....	.....	.....	72,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	5,320
Excavation.....cubic yards..	250,110	.35	87,538
Back filling.....do....	163,670	.25	40,918
Cofferdam.....	.....	.....	12,000
Pumping.....	.....	.....	6,000
Total.....	.....	.....	857,254

Estimate of cost, Lock No. 6, canal project.

GUARD LOCK.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	32,060	$6.00	$192,366
Piles in foundation.....feet..	95,400	.40	38,160
Structural steel in gates.....pounds..	1,008,080	.06	60,485
Anchorages and connections.....	.....	.....	7,258
Valves and valve frames.....	.....	.....	2,634
Cast-iron hollow quoins.....pounds..	93,740	.05	4,687
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	10,704	.05	538
Operating machinery.....	.....	.....	40,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	7,420
Excavation.....cubic yards..	241,520	.35	84,532
Back filling.....do....	101,520	.25	25,380
Cofferdam.....	.....	.....	8,000
Pumping.....	.....	.....	4,000
Total.....	.....	.....	484,110

Estimate of cost, Lock No. 7, canal project.

LIFT 38 FEET.

	Quantity.	Unit price.	Cost.
Portland cement concrete.....cubic yards..	97,400	$6.00	$584,400
Piles in foundation.....feet..	276,800	.40	110,720
Structural steel in gates.....pounds..	1,656,550	.06	99,393
Anchorages and connections.....	.....	.....	11,927
Valves and valve frames.....	.....	.....	8,500
Cast-iron hollow quoins.....pounds..	159,640	.05	7,982
Oak timber:			
Miter and contact sills.....feet B. M..	13,000	.05	650
Miter and quoin posts.....do....	16,704	.05	835
Operating machinery.....	.....	.....	78,000
Houses for superintendent and assistants.....	.....	.....	8,000
Guide piles.....	.....	.....	5,320
Excavation.....cubic yards..	355,560	.35	124,446
Back filling.....do....	224,890	.25	56,222
Cofferdam.....	.....	.....	12,000
Pumping.....	.....	.....	6,000
Total.....	.....	.....	1,014,395

APPENDIX No. 8.

REPORT ON THE RESERVOIR POSSIBILITIES OF THE SOURCES OF THE MISSISSIPPI, MINNESOTA, ST. CROIX, CHIPPEWA, WISCONSIN, AND OTHER TRIBUTARIES OF THE UPPER MISSISSIPPI RIVER, WITH REFERENCE TO THE IMPROVEMENT OF NAVIGATION OF THOSE TRIBUTARIES AND OF THE MISSISSIPPI ITSELF.

[Extract from Report of Assistant Engineer C. W. Durham, U. S. Engineer Office, Rock Island, Ill.]

The writer was able to procure all of the reports of the various district engineer officers connected with reservoir exploration and operation and of their assistants from 1869 to date, as also many additional documents and maps, all of which are supplemented by his own knowledge of the improvement of the Mississippi River gained by thirty-seven years' experience in the work, and by other information found in the United States engineer office at Rock Island.

The writer's main endeavor will be to show:

First. The greatest practicable extent to which the reservoir systems may be carried with a view to obtaining the greatest possible discharge during periods of summer and fall low-water in the Mississippi River, and ascertaining the probable quantity of such discharge.

Second. The effect of the proposed reservoirs upon the improvement of navigation of the Mississippi River at and below St. Paul.

No attempt will be made to give the probable cost of building and operating these reservoirs, nor to reconcile the various conflicting interests which may arise from their construction. It is the writer's belief, however, that these reservoir systems carried out to their fullest extent can be made to subserve both the interests of navigation and of water power, besides acting as a potent restraint on floods. Under such circumstances it might be to the advantage of water-power interests to come in and relieve the Government of an equitable part of the cost. It is believed that a very great part of the flowage damages, which have been the most expensive feature of reservoir construction, could be avoided by drawing down the water in the lakes themselves, thereby taking more advantage of their natural capacity than has heretofore been done, which result can in most cases be attained by locating the aprons of the dams at a much lower elevation and then dredging proper channels to the gates and sluices of the dam both above and below. The reservoir capacity could also be further increased by dredging in the basins, which could be very cheaply done with a suction dredge, and possibly a berm or levee could be built at the same time around the lakes, and adjacent lands could be raised, with manifestly excellent results.

Prior to the surveys made by Major Allen, in 1879, 1880, and 1881, which have given us the greater part of our information in regard to reservoir sites, preliminary surveys and examinations had been made by General Warren, in 1869, and Colonel Farquhar, in 1874.

The main object of all these surveys was to ascertain the extent to which the impounded water could be applied to the improvement of the navigation of each stream, and ultimately to that of the main river. But the reservoir system so far as built by the Government is intended primarily for the benefit of the navigation of the Mississippi River, and incidentally to mitigate its floods.

The object of the reservoirs already constructed at the headwaters of the Mississippi River is to collect the surplus water, principally from the precipitation of winter, spring, and early summer, to be systematically released so as to benefit navigation upon the Mississippi River below the reservoir dams. In 1905 the district officer says:

"The expenditure has resulted in benefit during the low-water season to the navigable portions of the Mississippi River from Cass Lake to Lake Pepin and below, and incidentally to the mitigation of the floods in the river at St. Paul."

The examinations and surveys that have been made and the additional claims presented in this report, perhaps on somewhat insufficient grounds, do not represent the total possibilities; in fact it is manifest that far greater storage facilities could be shown to be available.

The district officer further says, in 1907:

"The original project (for the reservoirs at the headwaters of the Mississippi River) calls for the construction of 41 reservoirs. * * * The efficiency of the reservoir system could also be greatly increased at small expense by dredging the channels above the dams and those connecting the various lakes that constitute the reservoirs. The aprons of the dams are now several feet below the level to which the water can be drawn down through the existing contracted channels."

The results as to precipitation, run-off, discharge, and velocity of streams, etc., given in the following tables and pages of this report, were obtained by constant study and effort during the past thirty years, and are believed to be accurate. The results only are given, without any attempt to explain the methods adopted.

There follows a table showing the areas of the drainage basins or watersheds of the various tributaries of the Mississippi River above the mouth of the Missouri. The figures in this table were mostly taken from General Warren's report on bridging the upper Mississippi River, but they were revised by the writer many years ago and some unimportant changes were made.

Drainage basins or watersheds of the upper Mississippi River Valley.

Designation.	Square miles.	Square feet.
Mississippi River above junction with the Minnesota	21,600	602,173,440,000
Minnesota River	12,119	337,858,329,600
Vermilion River	237	6,607,180,800
St. Croix River	7,568	210,983,731,200
Cannon River	1,690	47,114,496,000
Trimbelle (95), Isabelle (73), and Rush (183) rivers	351	9,785,318,400
Chippewa River	9,602	267,688,396,800
Zumbro River	1,604	44,716,953,600
Beef (452) and Whitewater (382) rivers, and Eagle (158) and Rollingstone (136) creeks	1,128	31,446,835,200
Trempealeau River	700	19,514,880,000
Black (2880) and La Crosse (403) rivers	3,343	93,197,491,200
Root River	1,685	46,976,104,000
Bad Axe River (180) and two creeks (209)	389	10,844,697,600
Upper Iowa River	939	26,177,817,600
Yellow River (270) and several creeks (382)	652	18,176,716,800
Wisconsin River	11,850	330,359,040,000
Turkey River	1,589	44,298,777,600
Galena River (185), Grant River (289), Platte River (306), and several creeks (357)	1,137	31,697,740,800
Maquoketa River	1,803	51,937,459,200
Apple River (245), Rush Creek (85), and Plum River (280)	610	17,005,824,000
Wapsipinicon River	2,490	69,417,216,000
Rock River	10,690	298,020,096,000
Iowa River	12,250	341,510,400,000
Edwards River and creeks (638), Henderson River and creeks (1227)	1,865	51,993,216,000
Flint and two other creeks	334	9,311,385,600
Skunk River	4,322	120,490,444,800
Des Moines River	14,955	416,921,472,000
Fox River (479), Bear Creek (418), and Wyaconda Creek (480)	1,377	38,388,556,800
Fabius (1590), North and South rivers (1496)	3,086	86,032,742,400
Salt River	2,741	76,414,694,400
Cuivre River (1180) and seven creeks (482)	1,662	46,333,900,800
Illinois River	27,465	765,180,256,000
Piasa Creek and Wood River	245	6,830,208,000
Total	164,138	4,575,904,819,200

The following table gives the areas of watershed; the mean annual run-off, which is usually taken as one-fourth of the rainfall; the known storage capacity of the reservoirs already constructed and in operation (the first five on the list), and the estimated capacity of several sites, some of which have been surveyed and others suggested; all of which are tributary to the upper Mississippi above the Falls of St. Anthony, excepting Big Stone Lake and Lake Traverse, which are in the Minnesota Basin. The discharges in second-feet for ninety days are also given.

Reservoir sites at headwaters of the Mississippi and Minnesota rivers.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Lake Winnibigoshish	36,325,555,200	43,992,000,000	16,709,755,392	2,149
Leech Lake	26,763,264,000	33,094,300,000	12,311,101,440	1,583
Pokegama Falls	17,424,000,000	5,260,000,000	8,016,040,000	676
Sandy Lake	11,402,265,600	3,157,900,000	5,245,042,176	406
Pine River	15,082,214,400	7,732,900,000	6,937,818,624	892
Vermilion River	12,074,340,800	5,770,828,800	8,449,042,760	742
Mud Lake	4,460,544,000	2,885,414,400	3,122,380,800	371
Gull Lake	7,582,924,800	12,000,000,000	11,898,128,500	1,530
Mille Lacs	12,405,888,000	9,000,000,000	8,684,121,600	1,115
Crow Wing River	94,228,992,000	6,753,000,000	91,392,822,876	868
Long Prairie River	6,412,032,000	3,300,000,000	3,185,977,461	410
Total for Mississippi River	244,162,026,800	132,946,343,200	175,952,131,629	10,742
Big Stone Lake and Lake Traverse	81,293,414,400	33,000,000,000	33,000,000,000	4,243
Grand total	325,455,441,200	165,946,343,200	208,952,131,629	14,985

The combined estimated discharge of all these reservoirs, built and proposed, could doubtless be brought up to the 14,985 cubic feet per second for ninety days as given in the table. It will be noted that the entire watershed of the two main streams is 940,031,769,600 square feet, while that of the selected reservoir sites amounts to but 325,455,441,200 square feet, about 35 per cent; and, further, that of the total calculated run-off of 208,952,131,629 cubic feet, only 165,946,343,200 cubic feet, or about 80 per cent, is available for the purposes mentioned in this report. From the well-known character of the country at the headwaters of these two streams, it is believed that a much greater area of storage ground could be made available than the table indicates.

The following table gives information similar to the former one, but none of the reservoirs have been built. The information was chiefly obtained from surveys made in 1879, 1880, and 1881, and it is believed that further examination would disclose additional favorable sites for reservoirs. In fact, it is noted that while the entire watershed of the St. Croix is 210,983,731,200 square feet, that of the selected reservoir sites only amounts to 109,952,409,600 square feet, or about 52 per cent, and that the run-off is more than double the capacity of the reservoirs.

Reservoir sites at headwaters of the St. Croix River.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Mud Lake	706,656,000	390,377,420	530,059,200	51
Rice Lake	3,749,044,800	2,474,944,500	2,624,751,360	318
Yellow River	4,440,604,800	3,402,712,000	3,112,623,360	437
Veazies	12,154,982,400	1,379,393,850	8,508,487,680	177
Mouth of Totogatic (1)	5,910,220,800	3,082,033,820	4,137,154,560	396
Upper Totogatic	1,983,722,400	1,388,605,680	1,308,605,680	178
Gilmore Lake	7,210,149,600	2,881,095,000	5,051,304,720	370
Mouth of Totogatic (2)	1,644,825,600	1,541,016,900	1,131,377,920	145
Eau Claire lakes	1,979,366,400	961,045,400	1,385,556,480	124
Upper St. Croix	6,105,369,600	4,698,269,800	4,273,758,720	604
Clam Lake	7,903,526,400	4,670,786,500	5,532,468,480	602
Lower St. Croix	28,714,752,000	2,709,500,000	20,100,326,400	349
Ground House	3,233,894,400	1,045,440,000	2,263,726,080	134
Chengwatana	24,142,694,400	3,703,238,000	16,899,886,080	476
Total for the St. Croix River	109,952,409,600	34,334,458,870	76,946,686,720	4,361

There follows similar information in regard to the Cannon River, which has a drainage area of 1,690 square miles and a mean annual discharge of 31,350,000,000 cubic feet, about 1,000 cubic feet per second during the entire year. This stream enters the Mississippi 4 miles above Redwing.

Reservoir sites at headwaters of the Cannon River.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Above Northfield	7,902,210,000	5,000,000,000	5,000,000,000	643
Horseshoe and Mud lakes	3,946,130,000	2,500,000,000	2,500,000,000	322
Total for Cannon River	11,848,340,000	7,500,000,000	7,500,000,000	965

All of the figures in the case of the Cannon River are estimated and are not the result of accurate surveys.

The next table covers the reservoir sites of the Chippewa River as obtained from the surveys of 1879–1881, of which river the total watershed is 267,688,396,800 square feet, and that of the selected reservoir sites, 153,689,100,800 square feet, or about 58 per cent. The run-off is about 5½ times the capacity of the reservoirs, indicating that their capacity could probably be trebled without difficulty.

Reservoir sites at headwaters of the Chippewa River.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Bear Lake	6,816,268,800	1,113,148,856	5,077,951,910	143
Little Chief Lake	1,605,795,840	771,332,009	1,337,627,935	99
Moose Lake	5,974,341,120	2,021,783,402	4,076,626,153	260
Pakwawang Lake	7,170,324,480	6,193,632,598	5,972,880,292	796
Courts Oreilles Lake	3,178,137,600	1,986,336,000	2,647,388,621	256
Paint Creek	109,927,319,040	505,336,720	91,569,456,760	65
Butternut Lake	1,115,136,000	585,446,400	928,903,288	75
Rest Lake	5,900,120,800	1,840,000,000	4,897,100,264	237
Bear Creek	4,307,212,800	5,400,567,152	3,107,280,000	695
Round Lake	1,750,339,200	1,303,036,416	1,382,304,000	168
Squaw Lake	1,087,257,600	731,808,000	864,230,400	94
Park Lake	4,850,847,600	620,782,720	4,026,198,428	80
Total for the Chippewa River	153,089,100,800	23,079,210,273	127,387,953,051	2,968

RESERVOIRS AT HEADWATERS OF THE ZUMBRO RIVER.

This stream has not been accurately surveyed, but the following information has been gleaned from county maps and from reconnoissances:

The drainage area is 1,604 square miles, or 44,716,953,600 square feet, which affords an annual run-off of 37,264,128,000 cubic feet, or 1,184 cubic feet per second. Reservoirs of about the capacity of those on the Cannon River will add about 1,000 second-feet for ninety days to the Mississippi River, into which it enters by two mouths, one 2 miles and the other 6 miles below the mouth of the Chippewa.

RESERVOIRS AT HEADWATERS OF THE BLACK RIVER.

This stream, like the Zumbro, has not been accurately surveyed.

The drainage area is 2,880 square miles, or 81,389,792,000 square feet, which affords an annual run-off of 67,824,826,666 cubic feet, or 2,150 cubic feet per second.

Reservoirs of a capacity sufficient to afford 1,500 second-feet for ninety days can readily be built on suitable sites.

RESERVOIRS AT HEADWATERS OF THE ROOT RIVER.

This stream, which enters the Mississippi about 5 miles below the Black, has not been accurately surveyed. Its drainage area is 1,685 square miles, or 46,975,104,000 square feet, which affords an annual run-off of 39,145,920,000 cubic feet, or 1,240 cubic feet per second.

Reservoirs of a capacity sufficient to afford 1,000 cubic feet per second for ninety days can be built on suitable sites.

RESERVOIRS AT HEADWATERS OF THE UPPER IOWA RIVER.

This stream enters the Mississippi about 9 miles below Genoa. Its drainage area is 939 square miles, or 26,177,817,600 square feet, which affords an annual run-off of about 21,815,000,000 cubic feet, or 692 cubic feet per second. A reservoir affording 500 cubic feet per second for ninety days can be built.

The Wisconsin River was surveyed in 1879–1880 and 1881, and reservoir sites were carefully selected. The entire watershed of this stream is 11,850 square miles, or 330,359,040,000 square feet, and of the proposed reservoirs, 39,322,483,000, or about 12 per cent, and the run-off 31,752,800,640 cubic feet, which is about 1⅞ times the capacity of the reservoirs. It is thought that the reservoir capacity and the ninety-day discharge of 2,499 second-feet could be much increased.

Reservoirs at headwaters of the Wisconsin River.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Pelican	8,391,398,400	5,153,180,527	6,830,590,800	663
Sugar Camp	1,672,704,000	1,350,281,160	1,335,840,000	174
Otter Rapids	12,461,644,800	7,389,727,488	10,027,628,160	950
Tomahawk	2,829,657,800	2,226,113,030	2,201,680,480	283
Squirrel Lake	1,561,190,400	1,338,163,200	1,239,427,200	159
Rice Lakes	11,039,846,400	1,043,516,880	9,130,176,000	134
Vieux Desert	529,689,600	400,000,000	360,096,000	52
Twin Lakes	836,352,000	650,000,000	621,456,000	84
Total for Wisconsin River	39,322,483,400	19,550,985,291	31,752,800,640	2,499

RESERVOIR AT HEADWATERS OF THE TURKEY RIVER.

No accurate surveys of this stream have been made. Information obtained from county and post-office maps show a drainage area of 1,589 square miles, or 44,298,777,600 square feet, which indicate a run-off of 36,900,000,000 cubic feet, or about 1,170 second-feet per annum. A reservoir affording a ninety-day discharge of 1,000 second-feet can be built on this river, which empties into the Mississippi opposite Cassville, Wis.

RESERVOIR AT HEADWATERS OF THE MAQUOKETA RIVER.

This stream enters the Mississippi about 8 miles below Bellevue, Iowa. It has a watershed of 1,863 square miles, or 51,937,459,200 square feet, with a run-off of 43,281,216,000 cubic feet, or 1,372 second-feet per annum. Reservoirs of a capacity of 1,000 second-feet for ninety days can be built on this stream.

RESERVOIRS AT HEADWATERS OF THE WAPSIPINICON RIVER.

This stream comes into the Mississippi 4 miles above Cordova. It has a drainage area of 2,490 square miles, or 69,417,216,000 square feet, which affords a run-off of 57,847,680,000 cubic feet, or 1,834 second-feet per annum. Reservoirs of a discharge capacity of 1,500 second-feet for ninety days can be built on this river.

A survey of the Rock River was made in 1881 and reservoir sites selected, as shown in the following table. This stream, which enters the Mississippi just below the city of Rock Island, has a drainage area of 10,690 square miles, or 298,020,096,000 square feet, while the watersheds of the proposed reservoirs embrace 102,487,830,400 square feet, or about 35 per cent. The capacity of the reservoirs, which will discharge 6,221 second-feet for ninety days, is about four-fifths of the run-off.

Reservoirs at headwaters of the Rock River.

Location.	Drainage area.	Reservoir capacity.	Run-off.	Discharge for ninety days.
	Square feet.	*Cubic feet.*	*Cubic feet.*	*Second-feet.*
Lake Horicon	13,688,294,000	8,000,000,000	8,000,000,000	1,027
Beaver Dam Lake	261,360,000	.....	.....	50
Lake Koshkonong	70,811,136,000	30,000,000,000	40,000,000,000	3,858
Lake Mendota	16,727,040,000	10,000,000,000	10,000,000,000	1,286
Total for Rock River	102,487,830,000	48,000,000,000	58,000,000,000	6,221

RESERVOIRS AT HEADWATERS OF THE IOWA RIVER.

This is one of the large tributaries, although not considered a navigable stream. It enters the Mississippi nearly opposite New Boston, and has a drainage area of 12,250 square miles, or 341,510,000,000 square feet, affording an annual run-off of 284,591,666,667 cubic feet, or about 9,024 cubic feet per second. While no accurate surveys of this stream are available, enough is known of its headwaters to warrant the statement that reservoirs can be built and operated without difficulty, capable of contributing 7,000 second-feet for ninety days.

RESERVOIRS AT HEADWATERS OF THE SKUNK RIVER.

The Skunk River enters the Mississippi about 8 miles below Burlington, and has a watershed of 4,332 square miles, or 120,490,444,800 square feet, indicating an annual run-off of 100,408,704,000 cubic feet, or 3,184 cubic feet per second. This stream will afford, it is believed, sites for reservoirs capable of discharging 2,500 second-feet for ninety days.

RESERVOIRS AT HEADWATERS OF THE DES MOINES RIVER.

Next to the Illinois, this is the largest tributary of the upper Mississippi, which enters the main stream about 3 miles below Keokuk; it has a drainage area of 14,955 square miles, or 416,921,472,000 square feet, affording an annual run-off of 347,434,560,000 cubic feet, or 11,017 second-feet. Nothing very definite is known of the reservoir conditions on this stream, but it is believed a ninety-day discharge of 7,500 second-feet can be secured.

RESERVOIRS AT HEADWATERS OF FABIUS, NORTH, AND SOUTH RIVERS.

These streams coming into the Mississippi, near together, a few miles below Quincy, have a combined drainage area of 3,086 square miles, or 86,032,742,400 square feet, which indicates an annual run-off of 71,693,952,000 cubic feet, or 2,273 second-feet. Small reservoirs on each of these streams will furnish combined about 1,500 second-feet for ninety days.

RESERVOIRS AT HEADWATERS OF SALT RIVER.

This tributary enters the Mississippi just above Louisiana, Mo.; it has a drainage area of 2,741 square miles, or 76,414,694,400 square feet, indicating an annual run-off of 63,678,912,000 cubic feet, or about 2,019 second-feet. A reservoir on this river should contribute 1,500 second-feet for ninety days.

THE ILLINOIS RIVER.

This is the largest tributary of the upper Mississippi River; it has a drainage area of 27,645 square miles, or 765,680,256,000 square feet, which affords a run-off of 638,066,880,000 cubic feet, or about 20,233 second-feet per annum.

This stream does not, apparently, offer any suitable reservoir sites, but the Chicago drainage canal furnishes from Lake Michigan about 10,000 second-feet, which it is understood will be increased to 14,000.

Summary of reservoir increments, upper Mississippi River.

Miles from St. Paul.	Names of tributaries.	Total watershed.	Ninety-day discharge.	
			For each stream.	Combined.
		Square miles.	*Second-feet.*	*Second-feet.*
0	Upper Mississippi and Minnesota	33,719	14,985	14,985
30	St. Croix	7,568	4,361	19,346
45	Cannon	1,690	985	.....
77	Chippewa	9,602	2,968	23,279
84	Zumbro	1,004	1,000	.....
144	Black	2,880	1,500	.....
149	Root	1,685	1,000	.....
172	Upper Iowa	939	500	.....
212	Wisconsin	11,850	2,499	29,778
235	Turkey	1,589	1,000	.....
296	Maquoketa	1,863	1,000	.....
338	Wapsipinicon	2,490	1,500	.....
366	Rock	10,690	6,221	.....
410	Iowa	12,250	7,000	46,499
450	Skunk	4,322	2,500	.....
487	Des Moines	14,955	7,500	.....
525	Fabius, North and South	3,086	1,500	57,999
566	Salt	2,741	1,500	.....
635	Illinois	27,465	10,000	69,499
	Total	.....	69,499	.....

* * * * * * *

C. W. DURHAM,
Principal Assistant U. S. Engineer.

(MAY–JUNE, 1908.)

APPENDIX 9.

REPORT ON EXPERIMENTAL 14-FOOT DREDGING CARRIED ON IN MISSISSIPPI RIVER BELOW THE MOUTH OF THE OHIO RIVER, BY THE MISSISSIPPI RIVER COMMISSION DURING 1908, AND ESTIMATE OF COST OF OBTAINING AND MAINTAINING A NAVIGABLE CHANNEL 14 FEET DEEP, BY DREDGING ALONE IN THAT STRETCH OF THE RIVER.

[By Capt. G. R. Lukesh, Corps of Engineers, recorder of the Board.]

COLONEL: I have the honor to submit the following report on experimental 14-foot dredging carried on in the Mississippi River below the mouth of the Ohio River by the Mississippi River Commission during the year 1908, followed by an estimate of the cost of obtaining and maintaining continuously in that stretch of river by dredging, a 14-foot channel of suitable width.

Dredging of an experimental nature to a depth of 14 feet and width of channel of 250 feet was carried on during 1907 at three localities, Corona (204)[a], Island 35 (193), and Linda (82). Prior to the low-water season of 1908, it was found to be the intention of the Mississippi River Commission to continue the experiments during that season, but to a width of 500 feet, the localities where the work should be done to be selected by the board on examination and survey. At its meeting of June 26, 1908, the board left the selection of localities to the senior member, but recommended that the same localities as had been selected for the previous year be considered.

As in the previous year, the desirability of selecting bars of diverse character with a view to obtaining variety of experience was borne in mind. Two of the points ultimately selected were crossings where 14-foot dredging was done last year—Corona, a crossing furnishing especial difficulties to dredging, and Linda, offering comparatively very few; for the third locality a crossing of intermediate character was sought, and Pecan Point (196) was selected instead of Island 35, a scene of last season's 14-foot dredging, but which had been abandoned by the river in the interval between the two seasons.

The experimental 14-foot dredging operations, as well as those of the regular 9-foot dredging carried on during both these years by the Mississippi River Commission, were under my charge, and my conclusions as to the feasibility of dredging a 14-foot channel below Cairo throughout all stages of river and the cost of the necessary plant and labor are largely based upon studies and observations made by me in that capacity.

Only one dredge of the Mississippi River Commission, the *Beta*, whose suction pipe was specially lengthened for the purpose, is sufficiently well prepared to cope with the depths that 14-foot dredging involves. The depths below water surface to which the dredges can dig are:

	Feet.		Feet.
Beta	26	Iota	20
Gamma	20	Kappa	20
Delta	20	Flad	20
Epsilon	18	Harrod	20
Zeta	18		

The beginning of the season found the *Beta* out of commission. It had been found necessary after the season of 1907 to install new pump runners, and they were ordered at an early date, but the contractor was several months overdue on delivery. The dredges *Harrod* and *Iota*, which had been loaned for work under the first and second districts, returned late in July, and the *Gamma* returned August 30 from work in Arkansas River under United States engineer office, Little Rock, all in more or less need of repair. The *Kappa* was sent to Keokuk for dry docking in July, returning in August; the use of the dry dock could not be obtained at an earlier date. The *Flad* was out of commission the entire season through nonreceipt of materials for rebuilding.

The beginning of the season accordingly found the dredging plant not prepared to undertake the experimental dredging under the best auspices. But, with the exception of the *Flad*, all the dredges were available the greater part of the season, and sufficient dredging was done to make the work of value to the board.

The water stages during the low season of 1907 were somewhat above the average, and the results of the experimental dredging in that year lack the conclusiveness of those of this past season, when very low water of considerable duration prevailed.

Tables are appended showing in considerable detail the dredging operations at the three selected localities, and to amplify the tables there are given below histories of conditions and operations at these points, with maps also appended.

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[a] Number in parentheses indicates distance in miles of locality below Cairo according to the Mississippi River Commission official table of distances.

Corona Crossing (204 miles below Cairo).—During the years 1905, 1906, and 1907 the tendency of the channel in this crossing was to cross the river at an angle of about 45 degrees from Massey's field on the left bank to a point a little below Corona Landing on the right bank.

The season's first survey, that of July 30, 1908, showed a radical change. The channel no longer sought the right bank at so great an angle, but had shifted to the middle of the river, following the shape of the left-hand bar, and reaching the lower pool at a point only just above the Happy Valley light, about 3 miles below Corona Landing. The bar above Corona Landing had extended down, but had left a well-defined, narrow, deep pool between it and the right bank. This survey showed that there was a channel 500 feet wide, with a least depth of 19 feet. The river was then falling at a uniform rate of about 0.3 foot per day.

The channel had a total length of about 2½ miles, with a deflection of about 35 degrees in the middle, both sections being almost straight. However, at a point about 1,500 feet below the turn there were some small lumps on the left bank side, on which there was but 15 feet, and it was thought well to remove them without attempting to improve the main channel. The dredge *Epsilon* did the work on August 7 and 8 in four hours' actual work dredging.

With the fall of the river the current showed a disposition to spread out and direct its main force more or less to a point on the right bank, about 1¼ miles below Corona Landing, just below Harrison's store. The bank began to cave at this point and below, the caving increasing in intensity as the water fell. The natural result was that the channel above described began to fill at its lower end, and the dredge *Harrod*, which had arrived to take the place of the *Epsilon*, was placed in position at a point about 3,000 feet below where the *Epsilon* had operated, to remove this shoaling. The work of the dredge was not effective, as the current constantly extended the upper bar downstream and filled up the dredged channel faster than the dredge could remove the material. The shoulder of the left shore bar was also constantly encroaching on the channel at or near this point.

The *Harrod* was then dropped to a point below the downstream end of the upper bar in an attempt to stay its further progress downstream by making a deep and effective cut across it. A number of minor breakdowns allowed a period of actual dredging here of but ninety hours out of a total of three hundred and eighty-four hours—September 11 to 26—and a channel of only 8 feet depth could be maintained. During this period the river broke through the upper bar very close to the channel of 1905, 1906, and 1907, and the *Harrod* was placed at this point September 27 to keep it open and reduce its very sharp curvature at the lower end.

It was, however, apparent by this time that the final low water channel would have its lower end just below Harrison's store landing. The *Harrod* could not be placed there, however, as there was not yet enough water over the middle bar to allow her to mount the reef to place the head piles. On October 26 she did get into position 1,500 feet below Harrison's store landing and on November 3 had secured a 14-foot channel, 600 feet wide through the middle bar.

The *Beta* replaced the *Harrod* on November 16 and improved the 14-foot channel to a width of 650 feet and over a width of 250 feet secured an actual depth of 17.5 feet. This channel persisted during the remainder of the year, and even improved, without further dredging, the river rising gradually about 4 feet with a subsequent fall of about 3 feet.

The results of the season's work at Corona are by no means as discouraging as they may at first sight appear. This crossing presented probably as adverse conditions as any that may be met anywhere in 14-foot dredging below Cairo; the season's 9-foot dredging developed few other localities of a character approaching in difficulty that of Corona. The results emphasize the necessity of early and frequent surveys at crossings in order that the natural channel making tendencies of the river may be learned in good season before actual dredging is needed. They emphasize, too, the importance of having plant available for immediate action when navigation is threatened. But the principal point which a crossing of this exceptional character brings out is that a local system of channel regulation—revetments and contraction works—by preventing shifting of the channel, offers a valuable auxiliary to dredging, and is even necessary at crossings of the Corona type to guarantee an uninterrupted channel of the required dimensions without undesirably acute changes of direction.

Pecan Point (196 miles below Cairo).—During the low water season of 1907 the principal channel left the upper pool some distance above Pecan Point, crossed to Island 36 and returned again to the right bank, a minor channel following the right bank. This year conditions were reversed, the principal channel following along the right bank.

CORONA CROSSING

204 MILES BELOW CAIRO.

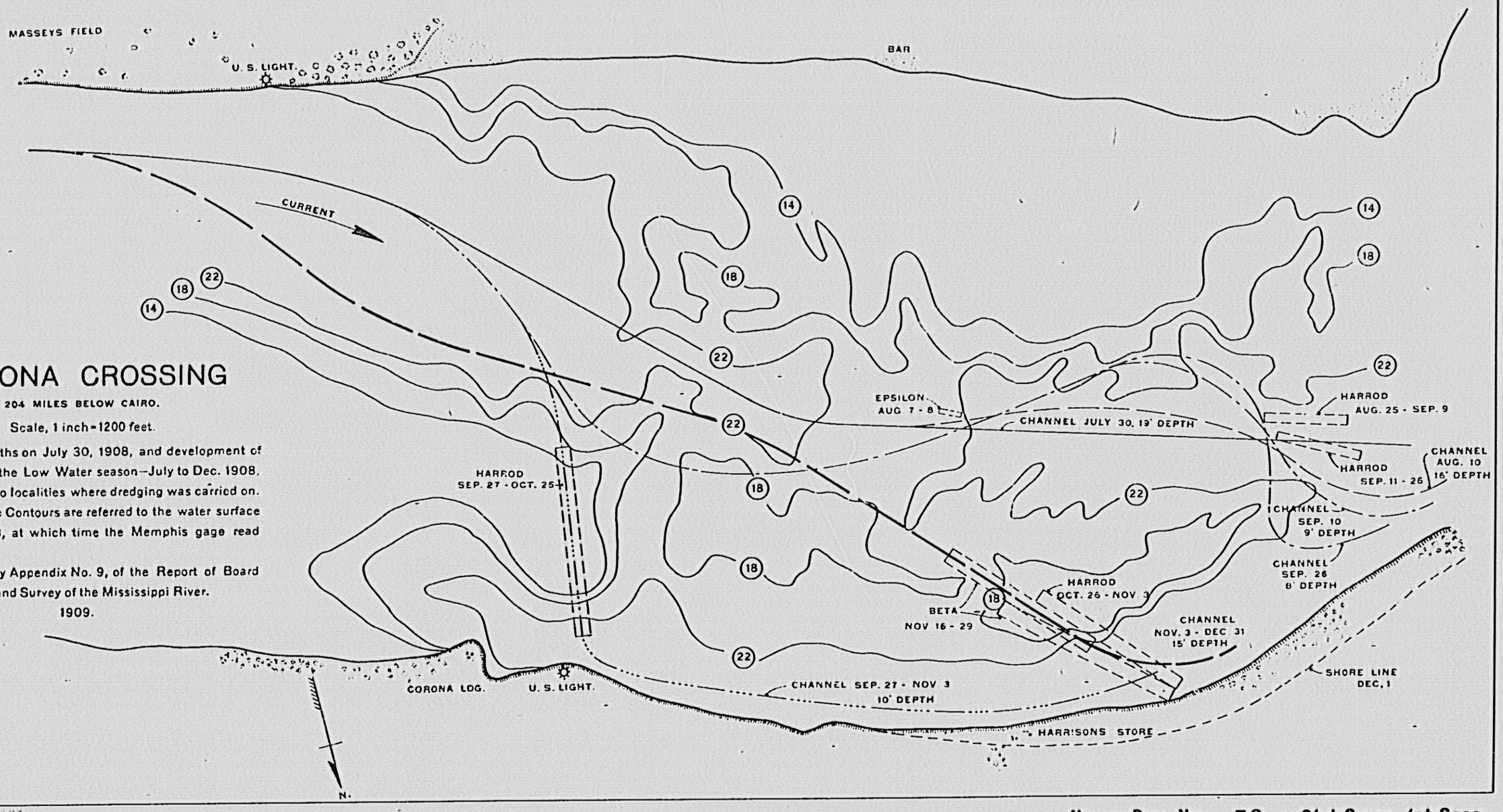
Scale, 1 inch = 1200 feet.

Showing depths on July 30, 1908, and development of channel during the Low Water season—July to Dec. 1908, and, showing also localities where dredging was carried on.

Hydrographic Contours are referred to the water surface of July 30, 1908, at which time the Memphis gage read 17.50 feet.

To accompany Appendix No. 9, of the Report of Board on Examination and Survey of the Mississippi River.

1909.



House Doc. No. 50 ; 61st Cong., 1st Sess.

During 1907 the shoal between the major and minor channels was well defined and lay about 1 mile above Pecan Point Landing. By the low water season of 1908 it had made down almost to that point. Later another bar formed between it and the right bank, dividing the right bank channel into two, the better one nearest the right shore.

During 1907 dredging was required on the crossing from the right bank to Island 35, and here 14-foot experimental work was carried on. This year the channel over that crossing gave way to the better one along the right bank and the experimental dredging took place there across a shoal rather than on a "crossing." The work required was essentially connecting two right bank pools by a cut through a bar. This was done with the dredge *Zeta* during the three periods—October 3–9, October 16–24, and November 24–27.

During the first period the mere placing of the dredge was sufficient to deflect the current toward the right bank and close the narrow gut above but leaving an available channel of at least 9.5 feet, 250 feet wide.

The second period of dredging produced a 14-foot channel nearly 500 feet wide, but as the force of the current was still too widely scattered over the area the channel narrowed to 375 feet and the dredge was again placed in position.

At the end of this last period a 500 foot wide channel of 14-foot least depth was obtained and this channel constantly improved of itself during the rest of the season without further work on it, the river rising in the meantime about 4 feet by December 16 and then falling again about 3 feet by the end of the year.

The conditions at Pecan Point represent about the average conditions met in dredging below Cairo. The results at that point show that a channel of the desired dimensions may be preserved throughout the season across such bars with a reasonable amount of dredging; but they show, also, the necessity of early dredging, with its necessary prior study of channel tendencies, and show, too, that even after a channel of the required dimensions has been obtained the services of a dredge must be available for work from time to time to counteract narrowing or shoaling through deposit of silt or lowering of the water surface.

Linda Crossing (82 miles below Cairo).—The prominent characteristic of this crossing during the low-water season of 1908 was the tendency of the current to spread itself over a wide area. Notwithstanding the excessive width of channel at this point the dredging here was a simple and easy proposition, the channel showing little tendency to change its position. Deterioration showed principally in narrowing and shoaling and the channel submitted readily to improvement by dredging.

On October 17, 1908, the upper pool, with 14 feet least depth, extended to a point 3,000 feet below Daniels's lower light on the left bank; between this upper pool and the lower pool, also of 14 feet least depth, there was a shoal of 2,400 feet length with a least depth of 9 feet. The 10-foot contours of the upper and lower pools overlapped slightly, but did not join, the shoal place in the channel being only about 100 feet in length.

During the early part of the season this crossing was included in only the project for a 9-foot channel, 250 feet wide, and a channel of those dimensions was successfully maintained. Linda was then selected as the third point for 14-foot dredging, and on October 28 dredging to obtain and maintain the channel of 14 feet least depth and 500 feet width was commenced by the dredge *Delta* and completed on November 1, at which time there was a 14-foot channel of 1,100 feet least width and a 14.5-foot channel of a least width of 500 feet, after but seventy-nine hours' actual dredging.

At the end of this period the river was rising and the dredge was temporarily withdrawn. During this rise the dredge channel became partially filled, reducing the 14-foot channel to a width of 200 feet. From November 15 to November 23 the dredge *Delta* again operated and restored the channel to the required width and depth. Up to December 31 this channel was in good shape, but had shifted slightly toward the left bank, but needed no further work upon it.

The operations at Linda serve to show the slight amount of initial dredging and subsequent attention required at crossings where the natural channel remains in practically one position; the conditions at Linda and Corona are quite the opposite in this respect. The small amount of dredging needed to secure and retain the required channel at the former point confirms the conclusion drawn from conditions at Corona—that fixation of the channel would lessen the amount of dredging required during a season, and that artificial means, like contraction and training works, should be resorted to where the natural conditions do not limit the movement of the channel.

It should be added that during 1907 simultaneous gauge readings were taken in the upper and lower pools at Corona. What effect the increased cuts through the bar produced on the pool levels were quite inappreciable, warranting little fear that a 14-foot channel would uncover to any extent new bars in the river or decrease the depth on others.

CONCLUSIONS.

From a study of the results of 14-foot dredging during 1907, with its moderate stages and during 1908, with its extreme low stages, and a study of the 9-foot dredging of the past three seasons during personal observation, and of the records of earlier years, I draw the following conclusions:

1. Given a corresponding increase in dredging plant, the maintenance of a 14-foot channel, 500 feet wide from Cairo to Red River (the stretch where dredging is required), is quite as feasible as that of the 9-foot channel, 250 feet wide, which has been maintained for several years, the difficulties encountered in the former case differing from those in the latter in degree only, and not in kind, and are due to the greater depth and width of channel to be dug, and the greater number of crossings and bars that will require attention.

2. At certain unfavorable localities, where natural widths give the dredge especially deep and long cuts to make and shifting currents diminish the effective work of the dredge through obliteration of dredged cuts, contraction and training works should be made auxiliaries to dredging.

3. A channel of required dimensions once obtained will not necessarily maintain itself even if the stage of river goes no lower. This fact requires that a dredge must always be within convenient reach, all through the season, of every bar or crossing where dredging has been done or may yet be required.

4. Continuous inspection of the entire river should begin as soon as the low-water season approaches, to develop crossings and bars where navigation might later be obstructed or threatened. And quite as necessary a part of the dredging operations are early and frequent surveys of such suspected localities in order that the local conditions and tendencies at such points may be studied from comparative maps. And these surveys should continue throughout the season.

5. There will always, even with ample plant, be occasions when a channel of the required dimensions may fail temporarily, through one or more of various causes—unforeseen river conditions, breakdown of plant, errors of judgment in selecting locations for dredge cuts, etc. But these can be guarded against to such extent that they will cause comparatively slight interruption to traffic. With ample plant of large capacity for the first line and for reserves, with dredge rendezvous sufficient in number and properly located, and with suitable facilities for repairs on the dredges and at the depots, no serious total interruption will occur.

That a depth of 14 feet may occasionally occur over less than 500 feet at crossings it is reasonable to suppose; in fact experience this year has shown such to be the case; but in such cases, proper buoying of the channel will limit interference with navigation to breaking up tows for the passage of the narrow channels—an interference of less importance than that encountered in locking tows through the locks of a canal.

ESTIMATE OF COST.

The cost of a 14-foot channel of suitable width from Cairo to the Gulf, throughout all stages of the river, would be composed of the initial cost of the dredging units and auxiliary plant, and the annual cost of their operation and maintenance, including administration. The number of dredge units required depends upon the capacity and type of the unit selected, the probable number, character, and distribution of the bars to be dredged, the length of river to be covered, the adopted width of channel, and the length of the dredging season. The amount and character of the auxiliary plant is governed partly by the number of dredge units, and partly by the dredging organization adopted, and this latter in turn depends principally upon the length of river to be covered.

Capacity and type of dredges.—In 1895 the Mississippi River Commission began in an experimental way to secure and maintain below Cairo a navigable channel by means of hydraulic dredging, working for a channel 9 feet deep and 250 feet wide. Since that date the plant of the commission has been steadily increased in amount and efficiency. The feasibility of maintaining a channel of the desired dimensions was early established, and in that regard the project has lost its experimental nature. But the plant used has continued in a state of development and it is reasonable to expect that further improvement in the plant will be made. Whether or not such occurs, and if it does, by the adoption of a larger and more powerful dredge unit than the latest Mississippi River Commission dredge, the *B. M. Harrod*, or by gain in efficiency in a dredge of that or smaller capacity, it is on the *Harrod*, the most improved of all the Mississippi River dredges, that an estimate of the number of units that will be required for a 14-foot project can at this time best be based. Should later improvements be made they will operate to reduce the cost of the plant or operation, or both, and an estimate based on the *Harrod* will cover the cost in either case.

PECAN POINT CROSSING

195 MILES BELOW CAIRO.

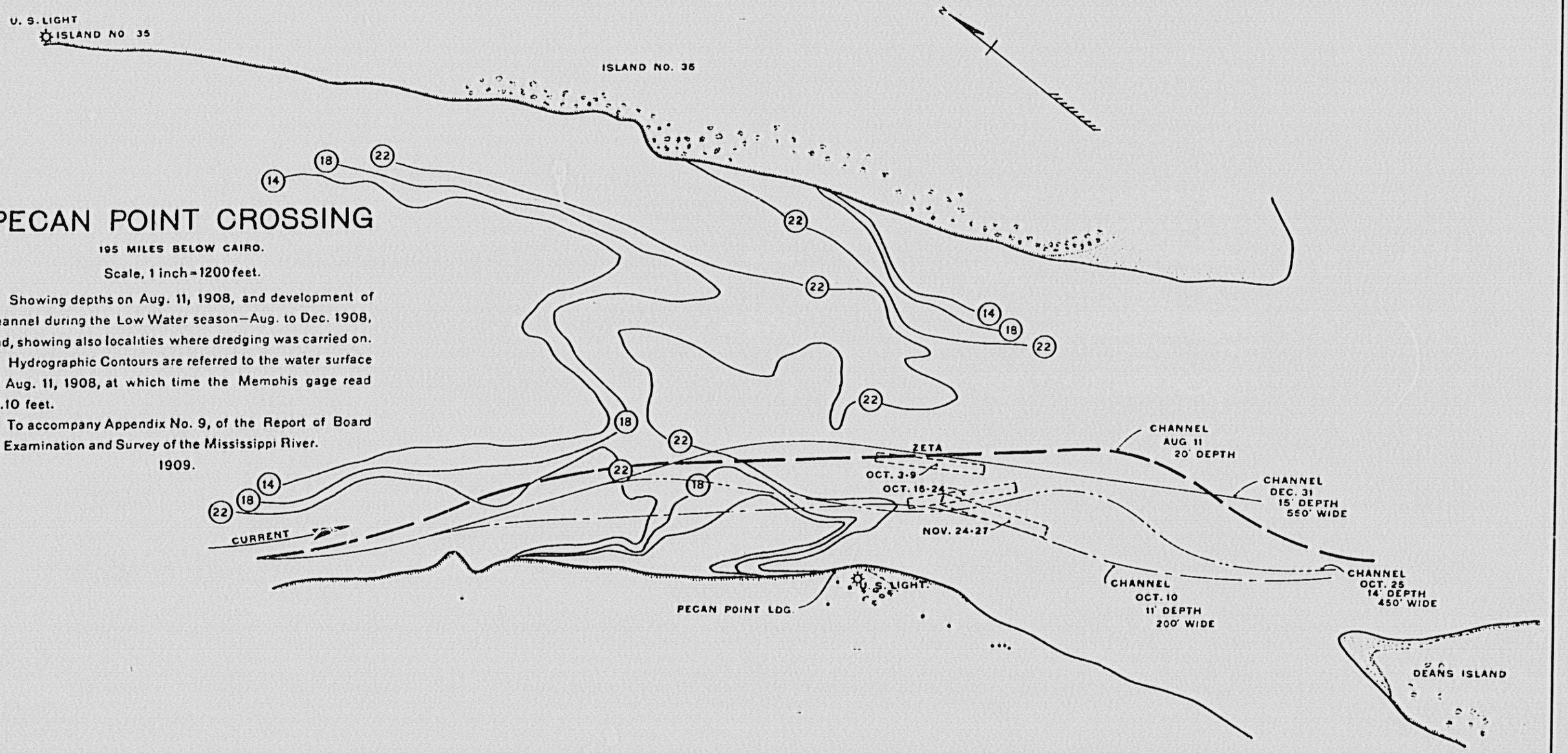
Scale, 1 inch = 1200 feet.

Showing depths on Aug. 11, 1908, and development of channel during the Low Water season—Aug. to Dec. 1908, and, showing also localities where dredging was carried on.

Hydrographic Contours are referred to the water surface of Aug. 11, 1908, at which time the Memphis gage read 15.10 feet.

To accompany Appendix No. 9, of the Report of Board on Examination and Survey of the Mississippi River.

1909.



House Doc. No. 50 ; 61st Cong., 1st Sess.

LINDA CROSSING

82 MILES BELOW CAIRO.

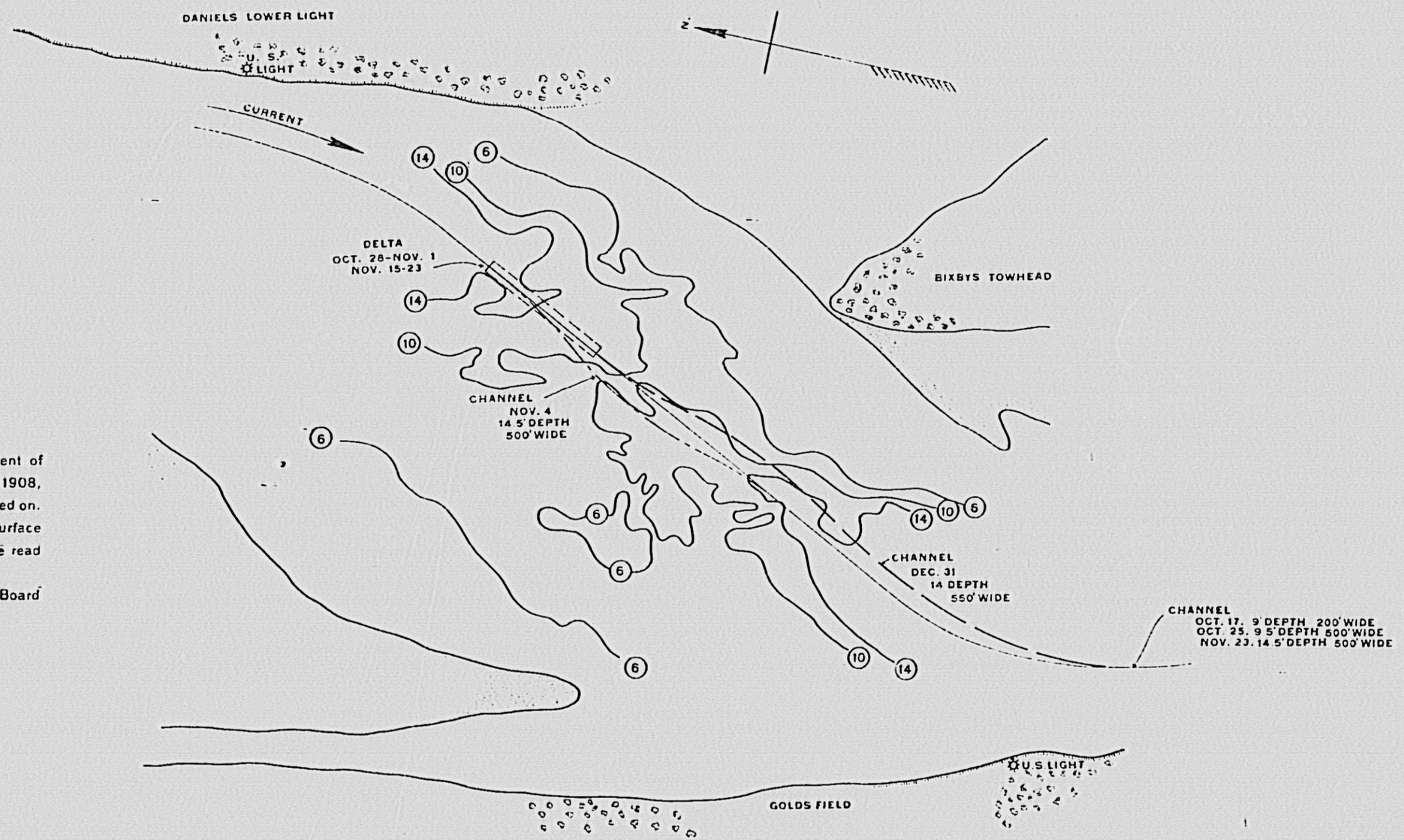
Scale, 1 inch=1200 feet.

Showing depths on Oct. 17, 1908, and development of channel during the Low Water season--Oct. to Dec. 1908, and, showing also localities where dredging was carried on.

Hydrographic Contours are referred to the water surface of Oct. 17, 1908, at which time the New Madrid gage read 3.77 feet.

To accompany Appendix No. 9, of the Report of Board on Examination and Survey of the Mississippi River.

1909.



House Doc. No. 50 ; 61st Cong., 1st Sess.

Length of river to be covered by dredging operations.—(River distances given are from the official table of the Mississippi River Commission, and are mid-stream, not channel distances.) During the low-water seasons of 1907 and 1908 a record was kept of all bars and crossings where channel depths of less than 14 feet developed. During 1907 such bars were found at irregular intervals from Point Pleasant (80 miles below Cairo) to Torras, just below the mouth of Old (Red) River (765 miles below Cairo). During 1908 such bars were found lying between Medleys (mile 29) and Torras. No 9-foot dredging operations have ever been required above Medleys and few, if any, 14-foot bars may be expected to develop in that stretch. Below Torras ample depths for navigation always exist, even at lowest stages. This gives a length of river to be operated over—Cairo to Torras—of about 790 miles, channel distance.

This length of river affects both the number of dredges required and the organization. The former feature will be discussed later. As to organization, it has been the experience of the Mississippi River Commission that when dredging was required only between Cairo and Memphis, some 230 miles, a single superintendent could, traveling during daylight hours only, cover the stretch sufficiently often to enable him properly to supervise the work of the individual dredges and correlate the work of all under his charge. When, however, as in 1908, dredging operations extended over a greater stretch, the operation of a single system was unsatisfactory, and for a 14-foot project, with its greater plant and more numerous bars, the need of additional supervision will be greater. A river length of about 250 miles is believed to constitute a proper district, which would give three for the entire stretch below Cairo.

The entire stretch should be under a single superintendent for general supervision of dredging operation and for proper regulation of the distribution of plant between districts. Each district should be under an assistant superintendent of dredging. One district should be provided with a depot completely equipped with shops and plant, including marine ways or dry dock, suitable for all large repairs, alterations, and renewals required for the entire dredge and auxiliary fleet, with coal-storage plant, warehouses, and general headquarters. Each of the other districts should have a subdepot with shops and equipment for ordinary repairs, etc., that can not be made aboard the dredges themselves; also a coal-storage plant. A depot in each district is necessary also to provide rendezvous for dredges within easy reach of all points in the dredging territory, economy and ease of administration and repair requiring that dredges when not needed in the field be assembled at headquarters and be out of commission as long as river conditions permit.

This organization calls for the following plant and equipment, and it is accordingly included in the estimate: One inspection boat for superintendent of dredging, one general supply boat, three inspection boats (one for each district), three towboats for moving fuel barges and disabled craft, one main depot, two subdepots.

The remainder of the auxiliary plant—survey boats and fuel barges—is dependent in amount on the number of dredges.

Probable number, distribution, and character of bars to be dredged.—During 1908 the river stages during the low-water season were very favorable for ascertaining the number of crossings where dredging operations would be required to maintain a 14-foot channel. The lowest stage reached at Cairo was +4.31 feet, four-tenths foot below the average of the lowest waters since 1871. At Memphis the lowest was +3.50, as compared with +1.90, the average of lowest stages since 1871. The oscillations in stage during the season were considerable, and as many bars were developed as may reasonably be expected during any one year. The appended table shows the location of the bars having at some time or other, during 1907 and 1908, least channel depths of less than 14 feet. The total number in 1908 (88) may be taken as a reasonable maximum to be allowed for in an estimate, but to provide for the very exceptional occasions when more bars may develop in a season, a small reserve supply of dredges should be allowed for.

The bars developed in 1908 extended, as stated, over about 790 miles, channel distance, of river, and they showed the following depth of cut required for a 14-foot channnel:

Cut.	Number of bars.	Cut.	Number of bars.
½ foot	3	4½ feet	9
1 foot	3	5 feet	18
1½ feet	0	5½ feet	9
2 feet	14	6 feet	11
2½ feet	1	6½ feet	1
3 feet	3	7 feet	2
3½ feet	8	7½ feet	1
4 feet	4	8 feet	1

It is well known that bars shift in location from season to season and that they change in importance as obstacles to navigation, a bar offering obstruction to navigation one season often improving through natural causes so as to offer none the following season, sometimes during the same season, and the converse. But, while the location of 14-foot bars in 1908 do not accordingly necessarily represent the exact scenes of future dredging, yet the distribution for that year is a fair basis for an estimate of plant, leaving the actual distribution of the plant in any season to the river conditions then obtaining.

The character of the material requiring removal for a 14-foot channel may be expected to be the same as that heretofore encountered in 9-foot dredging—mainly soft, easily handled material such as mud and sand, with occasional clay, gravel, bowlders, and logs. Dredging at the greater depths will likely encounter a greater proportion of more solidly bedded material through reaching deposits longer undisturbed. This fact, and the difficulty at times experienced even in 9-foot dredging suggests a change from the *Harrod* type in part of the dredges of this project, by the substitution of a mechanical agitator, or cutter-head, for the water-jets to loosen and break up such bar-forming material as successfully resists the present water-jet agitation.

Suitable width of channel.—This estimate is based on a channel width of 500 feet. A greater width, with 14-foot depth prevails naturally along more than 90 per cent of the stretch of river between Cairo and Red River, and throughout the stretch below the latter point. It is only at the "crossings" where the channel will need artificial widening, and these points will probably average in number not over 50, scattered along some 800 miles of channel. Such a channel, with the channel crossings properly buoyed, and this should be made a part of the project, and with a proper system of lights, should suffice for all craft that will use a 14-foot waterway. With proper buoying, a channel of even less width—as may occasionally occur for limited periods at some of the crossings—should meet all reasonable demands.

Length of dredging season.—This element is of importance in two respects. It affects the cost of operation of the dredges and the number of reserve units. The dredging season will extend over an average of five months a year, August to December, inclusive—occasionally the season may begin earlier, in July, and some years it may extend into January. Exceptional stage declines in other months may call for a limited amount of dredging at one or more localities—a minor item in the cost of operation. While the average season will be from August to December, yet the periods of actual dredging will be much smaller, varying from year to year and depending in length on river conditions; however, the dredges must remain in commission fully manned throughout the season to be available for service on short notice. In the estimate allowance is made for a maximum of six months of service for each dredge, and an additional month's service for one-third of the total number.

Since the shortness of the dredging season leaves the dredges in a stage of practically uninterrupted idleness for several months, ample opportunity is afforded for all repairs, etc., required to keep the plant in serviceable condition, without requiring the withdrawal of dredges needed in service. No need exists therefore to provide for any reserve units to be used as substitutes for dredges undergoing usual repairs. A reserve to provide substitutes for dredges disabled in the field is allowed for in the estimate.

Number of dredge units required.—Could the maximum rate of dredging required to maintain a channel of the required dimensions be determined, the necessary number of dredge units would at once be fixed by the capacity of the adopted unit. But the maximum rate can not be determined for two important reasons:

1. No fixed relation exists between the amount of material a dredge actually handles, and the volume of cut produced, due to the variable and indeterminable effects of natural currents on the shifting bottom of the river in assisting and retarding the work of the dredge through scouring and shoaling.

2. Even were there a definite and known relation between amount of material moved and channel results obtained, it is impossible to ascertain the maximum rate of development of the obstructing bars and the consequent necessary rate of removal. Only by discontinuing present dredging operations and allowing bars to form naturally through a considerable and speedy decline of river to very low stage, and by making simultaneous surveys on all bars in the district, could the maximum total rate of development of the bars be determined with a satisfactory degree of accuracy.

In the absence of data affording a reasonable clue to the required maximum rate of dredging and the consequent impossibility of determining the number of dredge units necessary by a consideration of that element and the capacity of the dredge unit, the only safe guide to a reliable determination of the number of dredge units needed is a study of the factors referred to and discussed above, probable maximum number, character and distribution of bars obstructing the 14-foot channel; relative importance of the bars, as obstructions, and of this the depth of cut required is as

good a measure as any; the desired width of channel, and the length of river to be covered; and following this, an assignment of dredges of the adopted type, the *Harrod*, to reaches of river each of which presents a fair task in the way of dredging requirements, as determined by past experience in Mississippi River dredging.

In making such an assignment of dredges the following rules have been followed, which, it is believed, are justified by the results of the experimental 14-foot dredging carried on in 1907 and 1908, and by the past experience of the Mississippi River Commission in the Mississippi River dredging operations.

1. Irrespective of the probable number of bars to be dredged, the river should be guarded by dredges at the rate of one dredge to each 75 miles of river.

2. Each bar forming within a dredge territory reduces the allowable radius of activity of the dredge, in proportion to the importance of the bar as indicated by the depth of cut required, as follows:

A bar requiring a cut of one-half to 2 feet reduces the proper dredge territory by 5 miles; one requiring 2½ to 4 feet cut, by 10 miles; one requiring 4½ to 6 feet cut, by 15 miles; and one requiring more than 6 feet cut, by 20 miles.

3. A reserve of about one dredge to every ten should be provided to assist in emergencies and to act as substitutes for disabled dredges.

Applying these rules to the conditions of 1908, the year on which this estimate is based as affording the most reliable and complete data, we would have:

	Miles.
Total river length to be covered	790
20 bars requiring cut of one-half to 2 feet, equivalent to	100
16 bars requiring cut of 2½ to 4 feet, equivalent to	160
47 bars requiring cut of 4½ to 6 feet, equivalent to	705
5 bars requiring cut of over 6 feet, equivalent to	100

a total of 1,855 miles, calling for 25 dredges and a reserve of 3, a total of 28.

The average task of each of the 25 dredges would be the protection of about 32 miles of river, and the dredging of four-fifths of a bar of less than 2 feet cut, three-fifths of one requiring 2½ to 4 feet cut, 2 bars requiring 4½ to 6 feet cut, and one-fifth of a bar requiring cut of 6 feet or more. In a year of average stages the task per dredge would be about one-half as great, and, as a rule, the development of the bars and the consequent demands for dredging are spread over several weeks.

The above assignment is, of course, wholly for the purpose of determining the amount of adequate plant. The actual distribution and number of dredges in the field in any season would be a matter wholly dependent on the distribution, number, and rate of occurrence of the obstructing bars.

Survey boats.—To provide ample data for study of channel tendencies and conditions frequent surveys become a very necessary part of dredging operations. Not more than 3 dredges should be dependent upon a single survey party, and a total of 10 is considered advisable for the proposed dredging plant, 8 pertaining to the regular plant, 1 to the reserve dredges, and 1 in general reserve for emergencies and to be substituted for disabled plant.

Fuel barges and storage plant.—At least 2 fuel barges per dredge are required for the proper storage, movement, and distribution of coal in the field, and adding a reserve of 4 gives a total required of 60. Using 500-ton barges, 750,000 bushels of coal will be accommodated, about one-third of the probable maximum requirement of a single season and probably two-thirds the average year's requirement. The balance for a maximum year should be kept on hand, stored ashore or afloat. A storage plant for each district is included in the estimate.

The estimate of cost of the entire dredging plant for the stretch below Cairo follows, and is based on a current cost of plant and operation in Mississippi River dredging under the Mississippi River Commission and the St. Louis engineer office. The cost of operation and maintenance of the dredges includes like cost in the cases of the auxiliary plant.

Initial cost.

28 dredges, *Harrod* type, at $250,000	$7,000,000
1 inspection boat, at $50,000	50,000
3 inspection boats (district), at $25,000	75,000
1 supply boat, at $25,000	25,000
3 towboats (district), at $75,000	225,000
10 survey boats, at $15,000	150,000
1 main depot (with complete equipment, including marine ways and coal storage plant)	250,000
2 subdepots (with equipment for ordinary repairs, and coal storage plant), at $150,000	300,000

60 coal barges, 500 ton, at $6,000	$360,000
Instruments, office equipment, etc	50,000
	8,485,000
Contingencies, about 6 per cent	515,000
Total	9,000,000

Annual operation and maintenance cost.

28 dredges in field six months, at $10,000	$1,680,000
9 dredges in field one month, at $10,000	90,000
28 dredges, repairs, three months, at $2,000	168,000
19 dredges, in ordinary, three months, at $500	28,500
9 dredges, in ordinary, two months, at $500	9,000
	1,975,500
Contingencies, about 6 per cent	124,500
Total	2,100,000

The Mississippi River Commission now has a dredging plant, especially suited for 9-foot channel dredging, but which would be of considerable value in 14-foot work. Its present value, in round numbers, may be placed at $1,000,000. There is also to be constructed and already provided for one marine ways capable for docking the largest plant of the commission, and one large inspection boat. In addition, the commission has one dredge depot with fair equipment of shops and tools. Probably about one and one-quarter million dollars' worth of plant would be on hand should a project for a 14-foot channel by dredging be adopted.

To acquire the complete plant needed for a 14-foot channel project, a period of ten years must be allowed, in view of the sparcity of available shipyards. However, with the existing dredges, and through moderate stages of river, especially after new plant begins to be completed, a 14-foot channel could be expected within a much shorter space of time, say five years, interrupted only during extreme low stages, and for but limited periods.

FIRST SUPPLEMENTAL ESTIMATE.

The greatest menaces to navigation are crossings where natural causes and the lack of artificial restraints cause and permit the channel to shift laterally through a considerable range, or permit several minor shallow channels to form in lieu of one principal one. Contraction works at any crossing will benefit navigation and decrease the amount of dredging required, but at crossings of the kind described above contraction and training works are an essential auxiliary to dredging plant to hasten the reopening of a bad bar and to relieve the latter of those tasks that are at times so great that temporary interruptions of navigation may occur in spite of all efforts.

Such crossings have been found in connection with 9-foot channel dredging, and may be expected in greater number in 14-foot dredging operations. Their locations as to the former are quite well known, but how many will be found in 14-foot dredging and where they will be is now a matter of conjecture. Nevertheless allowance should be made for them as a part of the estimate of cost of the waterway. Examinations of the crossings of the low-water season of 1908 indicate some twenty localities where contraction works would have been desirable auxiliaries to a dredging plant, but of these perhaps but ten or twelve would have been necessary to give reasonable assurance of an uninterrupted channel of the requisite dimensions, assuming dredging plant contemplated in the preceding estimate to have been available.

As the stage of water reached in 1908 was very low, this number of localities is as fair a basis for estimate of cost as is now available. Assuming this number, and an average length of river of 1 mile to be treated at each, with, in general, bank revetment along the one bank and contraction works along the other, at an average cost of about $400,000, the total cost would be about $5,000,000, which should be immediately available for use until all localities requiring treatment have developed, and at a rate of not less than $1,000,000 per year. The subsequent cost of maintenance at a rate of 5 per cent ($250,000) annually should be provided for.

SECOND SUPPLEMENTAL ESTIMATE.

Without fixation of the banks of the Mississippi River below Cairo, and the consequent prevention of the constant addition of bar-forming material from caving banks, the greatest enemy of navigable channels in that alluvial stream, the cost of main-

taining a 14-foot channel by dredging alone must needs continue without lessening as long as the project remains in force. But with systematic fixation of the banks, though considerable time may be required for its completion, the necessary dredging will decrease in amount and will ultimately become of minor importance. A complete project for the river below Cairo should, it is believed, include adequate dredging plant to provide, with the aid of contraction works at selected crossings, a channel of the requisite dimensions, and as an adjunct a systematic fixation of the banks wherever needed throughout the stretch, beginning at the worst places. Such a treatment of the banks will unquestionably pay for itself in the reduction of the cost of channel dredging and the security given the levee system, not to mention the benefit conferred on owners of riparian land through their protection from loss through erosion.

The natural channel depths below Red River Landing are ample, and no bank protection below that point is needed in the interests of navigation.

During the low-water season of 1907 measurements were made of the caving on both sides of the river between Cairo and Red River, and the result shows the total length of banks then actively caving to have been 749 miles over a channel length of about 790 miles.

The following table gives the length of bank caving fast, moderately, and slowly at high and low stages:

Rate of caving.	Linear feet.	Total.
Fast at high water and fast at low water	1,108,633	
Fast at high water and moderate at low water	69,128	
Fast at high water and slow at low water	256,546	
Fast at high water and no caving at low water	734,352	
Fast at low water and no caving at high water	94,204	
		2,262,863
Moderate at high water and moderate at low water	52,581	
Moderate at high water and slow at low water	5,270	
Moderate at high water and no caving at low water	200,320	
Moderate at low water and no caving at high water	5,751	
		263,922
Slow at high water and slow at low water	313,921	
Slow at high water and no caving at low water	736,442	
Slow at low water and no caving at high water	117,591	
		1,167,954
Caving at both high water and low water rate not stated	.....	148,836
Caving at high water (rate not stated) and no caving at low water	.....	106,145
Sliding bank reported	.....	4,541
Total	.....	3,954,261

To protect this total length with standard revetment covering the bank from the lowest limit of scour to high-water line, at an average cost of $30 per linear foot, would amount to some $120,000,000. But it will be seen from the above table that but little over 50 per cent of the total is rapidly caving at any stage; and but little over 25 per cent is caving fast at both high and low stages; less than 7 per cent is caving moderately or slowly at all stages, and for about the same amount the rate is not given; about 30 per cent shows none but slow caving and of this the greater part by far shows no caving at some stages.

Allowing for revetment of the banks showing rapid caving at one or more stages, about 57 per cent, and those having moderate caving, about 7 per cent, and making allowance for the part where rate is unknown, about 7 per cent, the total length to be revetted would be about 2,780,000 linear feet, and at $30 per foot the revetment would cost $83,400,000.

The locations of the caving banks are constantly subject to change, as are also their lengths and the rate, and by the time a bank protection system in the interests of navigation could be well under way new caving banks will develop; others now caving will have ceased to cave, and some now caving at so slow a rate as not to be detrimental to navigation will be caving so seriously as to require attention.

An estimate of the cost of a satisfactory protection of the caving banks must, to be comprehensive, include a sum sufficient to revet the length of bank now caving, an annual sum for maintenance of protection works when in place, and an annual sum for such extensions as the future developments may show to be necessary. The nature of the data on which such an estimate must be based does not allow close figures, but the following is submitted in the belief that it is justified by the data at hand:

For protection of banks $90,000,000, to be expended at a rate of not less than $5,000,000 per year. At this rate the project would require eighteen years for comple-

tion, and the annual cost of maintenance at 5 per cent would increase from $250,000 after the first year to $4,500,000 at the end of the period. An additional $500,000 per annum would provide for extensions of the system to include points of incipient caving.

Résumé.

Dredging project (time required, ten years):	
Initial cost	$8,900,000
Annual cost	2,060,000
Contraction works (time required, five years):	
Initial cost	5,000,000
Annual cost	250,000
Bank protection (time required, eighteen years):	
Initial cost	90,000,000
Annual cost	5,000,000

Very respectfully,

G. R. LUKESH,
Captain, Corps of Engineers, U. S. Army,
Recorder of the Board.

Col. W. H. BIXBY,
Corps of Engineers.

Authoritative least depths on bars between the mouths of the Ohio and Red rivers during the low-water seasons of 1907 and 1908.

[Compiled for use by the Board on Examination and Survey of Mississippi River, in determining the number of bars that would, during those seasons, have required dredging for the maintenance of a 14-foot channel.]

[Survey—From map of bar survey of even date. S. T.—From reports of soundings taken during channel inspection by superintendent of dredging. Com'n.—From record of soundings taken during inspection trip of Mississippi River Commission. D.—From reports of district officers.]

Distance below Cairo.	Name of bar or crossing.	1907.			1908.			Nearest gauge.	Authority.		Serial number of bar.	
		Least depth observed.	Date.	Stage of river nearest gauge.	Least depth observed.	Date.	Stage of river nearest gauge.		1907.	1908.	1907.	1908.
Miles.		*Feet.*		*Feet.*	*Feet.*		*Feet.*					
29	Medleys				[a]8.5	Sept. 20	8.4	Columbus, Ky		S. T.		1
34	Head of Island 6				13.5	Oct. 5	6.0	do		S. T.		2
55	Lesters				9.5	do	4.7	New Madrid		S. T.		3
60	Slough Landing				9.0	do	4.7	do		S. T.		4
62	Head of Island 10				9.5	Nov. 26	5.8	do		S. T.		5
63	Foot of Island 10				18.0	Sept. 20	7.1	do		S. T.		
65	La Forge (upper)				9.5	Sept. 29	5.7	do		S. T.		6
66	La Forge (lower)				13.5	do	5.7	do		S. T.		7
70	Morrissons	14.5	Aug. 19	16.5	9.0	Sept. 27	6.0	do	S. T.	S. T.		8
74	Watsons				12.0	Oct. 21	3.8	do		S. T.		9
76	Nolans				9.5	Oct. 24	4.0	do		Com'n.		10
80	Point Pleasant	12.5	Sept. 27	10.9	9.0	Oct. 21	3.8	do	S. T.	S. T.	1	11
82	Linda	12.0	Sept. 6	15.3	8.5	Oct. 24	4.0	do	S. T.	Com'n.	2	12
89	Cherokee	13.5	Sept. 27	10.9	10.0	Oct. 5	4.7	do	S. T.	S. T.	3	13
92	Joe Eckels	10.5	Nov. 25	13.3	8.0	Oct. 8	4.3	do	S. T.	Survey.	4	14
93	Bass				9.5	do	4.3	do		S. T.		15
98	Island 14 or Reelfoot	10.0	Nov. 2	5.8	9.0	Oct. 24	0.0	Cottonwood Point	S. T.	Com'n.	5	16
101	Fritz	11.0	do	5.8	8.5	do	0.0	do	S. T.	Com'n.	6	17
103	Hathaway	13.5	Sept. 29	8.8	8.0	Sept. 27	2.2	do	S. T.	S. T.	7	18
121	Foot of Island 16				15.0	Oct. 8	0.4	do		S. T.		
123	Cottonwood				18.0	Sept. 20	3.8	do		S. T.		
128	Island 20				16.5	Oct. 8	0.4	do		S. T.		
131	Foot of Island 21	13.5	Nov. 2	5.8	10.5	Oct. 24	0.0	do	S. T.	Com'n.	8	19
133	Wrights Point	13.0	Oct. 29	6.7	12.0	do	0.0	do	S. T.	Com'n.	9	20
135	Mouth Obion				15.0	do	0.0	do		Com'n.		
136	Hales Point				12.0	Dec. 21	4.5	do		S. T.		21
139	River Styx				10.5	Oct. 21	−0.4	do		S. T.		22
140	Buckners				10.5	Oct. 24	0.0	do		Com'n.		23
146	Forked Deer	13.0	Nov. 9	6.6	9.0	Oct. 27	2.2	do		S. T.	10	24
150	O'Donnels	10.5	Nov. 2	7.1	10.5	Oct. 21	3.5	Fulton	S. T.	S. T.	11	25

[a] One cast only.

Authoritative least depths on bars between the mouths of the Ohio and Red rivers during the low-water seasons of 1907 and 1908—Continued.

Distance below Cairo.	Name of bar or crossing.	1907.			1908.			Nearest gauge.	Authority.		Serial number of bar.	
		Least depth observed.	Date.	Stage of river nearest gauge.	Least depth observed.	Date.	Stage of river nearest gauge.		1907.	1908.	1907.	1908.
Miles.		*Feet.*		*Feet.*	*Feet.*		*Feet.*					
153	Ashport[a]				9.0	Oct. 21	3.5	Fulton		S. T.		
153	Fletchers T. H. (upper)				8.0	Sept. 27	5.2	do		S. T.		26
153.5	Fletchers T. H. (lower)				8.5	Oct. 25	3.7	do		Com'n.		
158	Gold Dust	12.0	Nov. 2	7.1	8.5	do	3.7	do	S. T.	Com'n.	12	27
162	New Haven	11.0	do	7.1	8.5	do	3.7	do	S. T.	Com'n.	13	28
167	Bullerton	12.0	Oct. 29	7.8	9.5	do	3.7	do	S. T.	Com'n.	14	29
177	Fulton Bluffs				9.0	Sept. 20	6.4	do		S. T.		30
178	Hatchie[b]	11.0	Nov. 8	7.1	10.0	Aug. 25	11.0	do	S. T.	S. T.	15	
178	Down Shore of Island 34				10.0	Sept. 20	6.4	do		S. T.		31
180	Island 34				9.0	Oct. 5	4.5	do		S. T.		32
181	Morgans Point	16.0	Oct. 29	7.8	8.5	Oct. 25	3.7	do	S. T.	Com'n.		33
193	Bend of Island 35[c]	9.5	Sept. 27	9.3	10.5	Dec. 1	5.0	do	Survey.	S. T.	16	
195	Uzzels[c]				12.0	Oct. 25	3.7	do		Com'n.		
196	Pecan Point	10.0	Nov. 8	7.1	10.5	Oct. 5	4.5	do	S. T.	S. T.	17	34
201	Waltz	11.0	Nov. 2	7.1	8.5	Oct. 25	3.7	do	S. T.	Com'n.	18	35
204	Corona 9′ Dredging Project	10.0	Oct. 26	9.1				Memphis	Survey.		19	
204	Corona 14′ Dredging Project	8.5	Oct. 14	11.0	8.0	Sept. 24	6.3	do	Survey.	S. T.		36
209	Old River	9.5	Nov. 8	6.8	9.0	Sept. 15	8.4	do	S. T.	S. T.	20	37
223	Arthur	14.0	Nov. 6	6.6	15.0	Dec. 1	5.3	do	S. T.	S. T.		
228	Paddy Hen	12.0	Sept. 27	9.4				do	S. T.		21	
233	Head President Island	14.0	Nov. 2	6.9	10.0	Oct. 26	3.9	do	S. T.	S. T.		38
235	Nonconnah	10.5	Dec. 17	7.8	15.0	Aug. 21	12.2	do	S. T.	S. T.	22	
236	Below Nonconnah				9.0	Sept. 8	10.0	do		S. T.		39
238	Wyanoke				9.0	Sept. 26	5.9	do		S. T.		40
239	Foot President Island	10.0	Nov. 2	6.9	8.0	Oct. 26	3.9	do	S. T.	Com'n	23	41
241	Armstrong				17.0	Nov. 5	7.6	do		S. T.		
244	Horn Lake	10.5	Nov. 6	6.6	9.0	Aug. 21	12.2	do	S. T.	S. T.	24	42
250	Cow Island				10.5	Sept. 17	[d] 7.8	do		2d D.		
252	Daisy	10.0	Dec. 17	7.8	7.0	Oct. 26	3.9	do	S. T.	Com'n	25	43
255	Harckelrodes	15.0	Oct. 24	8.4	8.5	do	— 1.3	Mhoon Landing	S. T.	Com'n		44
259	Star Landing				9.0	Oct. 10	— 0.7	do		S. T.		45
264	Polks	9.5	Nov. 6	3.6	8.5	Oct. 26	— 1.3	do	S. T.	Com'n	26	46
269	Head McCullough T. H	12.0	do	3.6	8.0	Oct. 10	— 0.7	do	S. T.	S. T.	27	47
271	Foot McCullough T. H. or Peters	11.0	Oct. 24	8.4	11.0	Nov. 24	0.6	do	S. T.	S. T.	28	48
274	Ashley Point				11.5	Nov. 15	2.9	do		S. T.		49
275	Foxburns				10.5	Oct. 26	— 1.3	do		Com'n		50
276	Mhoons Bend				8.0	Oct. 10	— 0.7	do		S. T.		51

[a] Left bank channel; after September 1 the channel was between towhead and right bank.
[b] Left bank channel; after September 1 the channel was along right bank (Island 34).
[c] Abandoned by river between 1907 and 1908.
[d] Authenticity questionable.

280	Bordeaux				12.0	Oct. 26	− 1.3	....do		Com'n		52
287	Hardin Point				13.0	Oct. 10	5.0	Helena		S. T.		53
312	Montezuma	13.5	Sept. 27	12.7	9.0	Oct. 15	4.8	....do	S. T.	S. T.	29	54
318.5	Westover	15.0	Sept. 24	13.8	9.0	Oct. 26	4.3	....do	S. T.	S. T.		55
319	Friars Point				12.0	Oct. 1	6.4	....do		S. T.		56
327	Ledbetter				13.0	Oct. 26	4.3	....do		S. T.		57
332	Head Island 63	15.0	Sept. 27	13.1	8.0	Oct. 1	7.6	Sunflower Landing	S. T.	S. T.		58
333	Foot Island 63				9.0	Oct. 26	5.6	....do		S. T.		59
359	Andersons	13.5	Oct. 24	13.6	8.0	Oct. 1	7.6	....do	S. T.	S. T.	30	60
361	Island 68				9.5	Oct. 26	5.6	....do		S. T.		61
361	T. H. Island 68				10.5	Nov. 24	7.0	....do		S. T.		
367	Parkers				9.5	Oct. 10	6.2	....do		S. T.		62
384	Henrico				9.0	Oct. 27	5.6	....do		Com'n		63
385	Scrub Grass Bend				12.0	Oct. 26	7.7	Mouth White River		S. T.		64
390	Victoria				11.0	...do....	7.7	....do		S. T.		65
408	Indian Point	13.5	Oct. 24	17.5	8.0	Oct. 10	9.4	....do	S. T.	S. T.	31	66
421	Jersey Point				18.0	Oct. 1	7.4	Arkansas City		S. T.		
425	Catfish Towhead	13.5	Nov. 9	9.6	10.5	Oct. 27	3.8	....do	3d D.	Com'n.	32	67
427	Head Cypress Bend				12.0	Oct. 29	11.4	....do		S. T.		68
436	Choctaw Bend				7.5	Oct. 10	5.7	....do		S. T.		69
455	Moss Lake	16.0	Nov. 9	9.6	18.0	Oct. 28	8.5	....do	3d D.	Com'n.		
473–4	Point Chicot to Salona	9.0	Nov. 10	7.6				Greenville	3d D.		33	
476	Salona	10.5	Nov. 22	12.5	6.5	Oct. 1	7.0	....do	Com'n.	S. T.	34	70
484	Refuge				12.0	...do....	7.0	....do		S. T.		71
501	Longwood, Miss	13.5	Nov. 11	7.7	10.0	Oct. 10	5.6	....do	3d D.	S. T.	35	72
505	Worthington Point				15.0	Oct. 1	7.0	....do		S. T.		
506–8	Fannie Bullitts T. H. to Mosswood	10.5	Nov. 11	7.7					3d D.		36	
512	Head Grand Lake T. H				14.0	Oct. 1	4.6	Lake Providence		S. T.		
512.5	Foot Grand Lake T. H				11.0	...do....	4.6	....do		S. T.		73
513	Leota	10.5	Nov. 11	5.8	12.0	Oct. 28	1.8	....do	3d D.	Com'n.	37	74
517	Carolina				15.0	Oct. 1	4.6	....do		S. T.		
520	Head Louisiana Bend				13.0	Oct. 26	1.2	....do		S. T.		75
532	Wilsons Point	12.0	Nov. 11	5.8	10.5	Oct. 29	5.0	....do	3d D.	Com'n.	38	76
538	Longwood, La				9.0	Oct. 10	3.3	....do		S. T.		77
540	Stack Island				12.0	Oct. 29	5.0	....do		Com'n.		78
553	Homestead				*8.0	...do....	5.0	....do		S. T.		79
564	Salem	15.0	Nov. 12	5.9	6.0	...do....	5.0	....do	3d D.	Com'n.		80
573–4	Villa Vista Light to Henderson Light	12.0	...do....	6.7	12.0	Sept. 29	5.6	Vicksburg	3d D.	3d D.	39	81
574	Henderson				9.5	Nov. 24	4.8	....do		S. T.		82
578	Mascot to Omega Light				12.0	Sept. 30	5.5	....do		3d D.		83
613	Diamond Island				12.0	Nov. 24	4.8	....do		S. T.		84
618	Kellogs	14.0	Nov. 9	6.7	15.0	Oct. 29	3.3	....do	4th D.	Com'n.		
624	Buck Ridge				16.5	...do....	3.3	....do		Com'n.		
651	Rodney	13.0	Nov. 26	11.2				St. Joseph	4th D.		40	
697	Waverly Point				15.0	Oct. 30	6.0	Natchez		S. T.		
707	Natchez Island	13.0	Nov. 8	9.2	13.5	...do....	6.0	....do	4th D.	S. T.	41	85
710	Fords	15.0	...do....	9.2	7.0	...do....	6.0	....do	4th D.	Com'n.		86
764	Mouth Old River				9.0	...do....	4.7	Red River Landing		Com'n.		87
765	Torras or mouth of Red River	11.0	Nov. 12	7.8	12.0	Nov. 24	7.6	....do	4th D.	S. T.	42	88

* At night.

Corona crossing.

[204 miles below Cairo.]

Dredge.	Inclusive dates of dredging operations.	Distribution of time in hours.						Total length of single cut.	Width of single cut.	Number of cuts.	Suction lowered to depth.	Average depth of cut.	Material moved.		Stage of river, Memphis gauge.		Results.				Remarks.
		Dredging.	Changing cuts.	Repairs.	Passing boats.	Not working.	Total.						Cubic yards.	Kind.	At beginning of period.	At end of period.	Least depth 500 feet wide.		Least width 14 feet depth.		
																	Before dredging.	After dredging.	Before dredging.	After dredging.	
								Feet.	*Ft.*		*Ft.*	*Ft.*					*Feet.*	*Feet.*	*Feet.*	*Feet.*	
Epsilon.	Aug. 7 to Aug. 8	4:00	2:45	2:10	.....	39:05	48:00	625	20	4	17	1.0	618	Sand and gravel.	15.50	15.30	16.8	16.2	1,700	1,200	At this time water too high for suction of Epsilon. Work was effective, as acceleration of current, due to operation of pump, straightened and improved channel. Dredge operated outside of 500-foot wide channel of best water to improve general conditions.
Harrod.	Aug. 25 to Sept. 9	184:50	8:20	:30	.....	193:40	384:00	24,550	32	30	18	5.0	147,375	...do.....	12.00	9.70	15.1	9.4	800	.....	Not effective. River was trying to cut into lower pool at two points above dredge. Force of current distributed over large area, shoaling channel by deposited sand by lessened velocity. Dredge dropped downstream to try to keep upper bar from extending farther downstream.
Do...	Sept. 11 to Sept. 26	91:25	6:20	183:00	22:55	80:20	384:00	11,350	32	10	18	6.8	96,265	...do.....	9.40	5.90	9.4	8.0	.....	.....	During this period a new channel broke through upper bar opposite Corona Landing. This further lessened velocity of current in vicinity of operations and increased deposit of sand there. Assisting ground-

																				ed boats and passing same, together with a series of minor breakages, limited the period of actual dredging to ninety-one hours. (See Report of Operations, Secretary Mississippi River Commission, September, 1908.)
Do...	Sept. 27 to Oct. 25	231:30	55:25	35:15	4:15	369:35	696:00	30,600	32	40	18	7.7	284,112	...do.....	5.70	3.90	.....	.....	.....	.....	Work done in newly opened cut at Corona Landing. This being the best channel, it was decided to keep it open and to reduce curvature at lower end, though it was then apparent that this would not be the final low-water channel, but that the final channel, at its lower end, would be at a point 1¼ miles below Corona Landing. There was not, at this time, enough water on bar at that point to allow dredge to get into position to sink head piles. This was accomplished October 26. A channel 250 feet wide of 10.5 feet least depth was maintained.
Do...	Oct. 26 to Nov. 3	138:55	9:35	.....	.....	67:30	216:00	12,400	32	13	18	9.1	140,340	...do.....	3.90	5.80	5.5	14.5	.....	600	Effective.
Beta....	Nov. 16 to Nov. 29	207:45	13:45	8:00	.....	106:30	336:00	13,400	38	8	20	8.4	171,782	...do.....	6.50	5.15	14.5	16.5	600	650	No further dredging necessary after November 29. On December 3 there was a channel 250 feet wide with a least depth of 17.5 feet and the 14-foot depth had widened to 700 feet. On December 31 the channel was of project depth and width or better.

Linda crossing.

[82 miles below Cairo.]

Dredge.	Inclusive dates of dredging operations.	Distribution of time in hours.						Total length of single cut.	Width of single cut.	Number of cuts.	Suction lowered to depth.	Average depth of cut.	Material moved.		Stage of river, New Madrid gauge.		Results.				Remarks.
		Dredging.	Changing cuts.	Repairs.	Passing boats.	Not working.	Total.						Cubic yards.	Kind.	At beginning of period.	At end of period.	Least depth 500 feet wide.		Least width 14 foot depth.		
																	Before dredging.	After dredging.	Before dredging.	After dredging.	
								Feet.	*Ft.*		*Ft.*	*Ft.*					*Ft.*	*Ft.*	*Ft.*	*Feet.*	
Delta...	Oct. 28 Nov. 1	79:15	8:05	.....	....	32:40	120:00	11,400	33.5	13	16	3.7	53,915	Coarse sand and gravel.	3.73	6.35	9.0	14.5	....	1,100	Crossing selected for 14-foot dredging on October 24, 1908. Dredge withdrawn at close of period on account of rising river.
Delta...	Nov. 15 Nov. 23	81:45	10:15	31:35	....	92:25	216:00	10,745	33.5	16	17	4.8	66,098	.....do.....	7.00	5.55	12.0	14.5	200	550	During interval between dredging periods the river rose to 9.13 on New Madrid gauge and then fell, [illegible]g to 200 feet, the channel made during the first period. No further dredging was needed after November 23. The dredged channel constantly improved of itself during rest of season.

Pecan Point Crossing.

[195 miles below Cairo.]

Dredge.	Inclusive dates of dredging operations.	Distribution of time in hours.						Total length of single cut.	Width of single cut.	Number of cuts.	Suction lowered to depth.	Average depth of cut.	Material moved.		Stage of river, Memphis gauge.		Results.				Remarks.
		Dredging.	Changing cuts.	Repairs.	Passing boats.	Not working.	Total.						Cubic yards.	Kind.	At beginning of period.	At end of period.	Least depth 500 feet wide.		Least width 14-foot depth.		
																	Before dredging.	After dredging.	Before dredging.	After dredging.	
								Feet.	*Ft.*		*Ft.*	*Ft.*					*Ft.*	*Ft.*	*Ft.*	*Feet.*	
Zeta	Oct. 3 to Oct. 9	79:05	20:05	4:00	8:25	56:25	168:00	9,900	20.0	14	16	5.1	39,286	Sand	5.30	4.30	14.0	8.6	600	.....	Placing of dredge caused channel to shift to right-bank shore. At end of period there was, however, a channel of 9-foot depth, 250 feet wide.
Zeta	Oct. 16 to Oct. 24	74:55	14:30	1:00	....	125:35	216:00	10,850	20.0	22	16	5.9	48,809	.....do.....	4.00	3.80	8.6	13.2	....	450	Placing of dredge caused another shift in channel. The desired width of 14-foot depth was nearly attained, and in a very good line.
Zeta	Nov. 24 to Nov. 27	56:35	14:30	4:50	1:05	19:00	96:00	9,300	20.0	11	16	3.0	21,371	.....do.....	4.90	5.00	10.8	14.3	375	525	No further dredging required after November 27. Survey of December 22 showed improvement of 14-foot depth, and that this channel was widening.

APPENDIX No. 15.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo.

CHAIN OF ROCKS, MO.

1892.

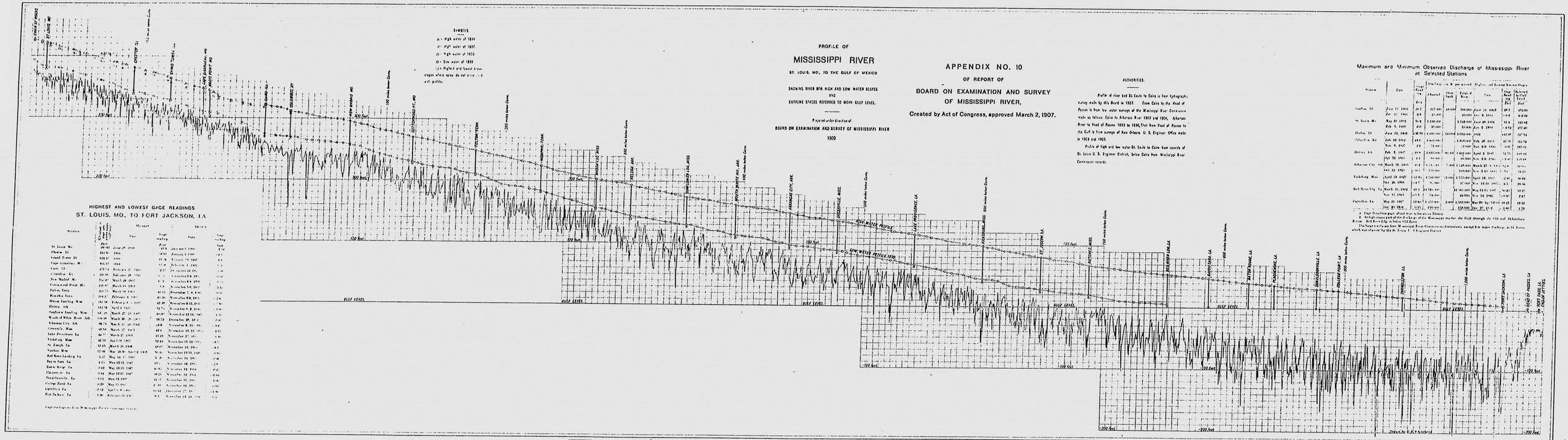
[Gauge 10.42 miles from Eads Bridge. Zero of gauge, 321.18 feet above Memphis datum plane. Gauge read at 2 p. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	89.40	.....	103.40	99.20	90.00	83.70	80.50	79.90	.....
2	.....	.....	.....	90.50	91.80	103.60	99.50	89.80	83.40	80.40	79.80	.....
3	.....	.....	.....	.....	91.80	104.40	.....	89.40	83.00	80.40	79.70	.....
4	.....	.....	.....	91.50	91.40	105.40	101.20	89.00	82.90	80.20	79.60	.....
5	.....	.....	.....	95.20	92.50	106.10	101.90	88.50	82.50	80.10	79.50	.....
6	.....	.....	.....	97.40	94.80	105.85	101.90	88.20	82.20	80.05	79.40	.....
7	.....	.....	.....	98.30	97.20	105.50	101.90	87.80	82.00	80.00	79.30	.....
8	.....	.....	.....	98.50	98.80	105.05	101.90	87.60	81.70	79.90	79.25	.....
9	.....	.....	.....	98.30	99.50	104.60	102.00	87.40	81.60	79.80	79.25	.....
10	.....	.....	.....	.....	100.10	104.10	101.80	87.20	81.60	79.60	79.30	.....
11	.....	.....	.....	95.50	101.40	103.40	101.50	86.90	81.90	79.50	79.25	.....
12	.....	.....	.....	94.00	102.40	102.80	101.20	86.70	82.10	79.40	79.20	.....
13	.....	.....	.....	93.00	103.40	102.50	101.00	86.90	82.40	79.40	.....	.....
14	.....	.....	.....	92.60	104.75	102.00	100.90	86.70	82.10	79.30	.....	.....
15	.....	.....	.....	92.90	.....	101.35	100.70	86.30	81.90	79.30	.....	.....
16	.....	.....	.....	92.90	107.45	100.90	100.20	86.10	81.70	79.30	.....	.....
17	.....	.....	.....	.....	107.70	100.10	99.80	86.00	81.70	79.20	.....	.....
18	.....	.....	.....	93.70	108.00	99.50	99.60	85.80	81.60	79.20	.....	.....
19	.....	.....	.....	95.00	108.10	99.00	99.20	85.70	81.50	79.20	.....	.....
20	.....	.....	.....	96.00	107.75	98.50	98.60	85.50	81.40	79.30	.....	.....
21	.....	.....	.....	97.65	107.10	97.90	97.60	85.20	81.40	79.35	.....	.....
22	.....	.....	.....	97.90	106.70	97.30	97.20	85.00	81.30	79.30	.....	.....
23	.....	.....	.....	97.80	106.50	96.80	96.40	84.70	81.20	79.25	.....	.....
24	.....	.....	.....	97.40	106.40	97.10	95.70	84.50	81.10	79.20	.....	.....
25	.....	.....	.....	96.75	106.10	97.90	95.00	84.30	81.00	79.20	.....	.....
26	.....	.....	.....	95.80	105.60	98.10	94.00	84.20	80.90	79.25	.....	.....
27	.....	.....	.....	95.00	105.00	98.30	93.00	84.00	80.80	79.30	.....	.....
28	.....	.....	.....	94.20	104.30	98.70	92.00	83.80	80.70	79.45	.....	.....
29	.....	.....	.....	93.50	103.60	99.20	91.10	83.70	80.60	79.80	.....	.....
30	.....	.....	.....	92.80	103.05	99.00	90.50	83.70	80.50	.....	.....	.....
31	.....	.....	.....	.....	103.00	.....	90.20	83.70	.....	79.90	.....	.....

1893.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis Datum Plane. Gauge read at 2 p. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	86.90	102.25	98.20	90.00	84.20	80.30	79.20	78.20	78.20
2	.....	.....	.....	86.40	102.95	98.80	90.00	84.60	80.40	79.10	79.00	77.90
3	.....	.....	.....	86.30	103.00	99.30	89.70	84.50	80.30	79.20	79.00	77.90
4	.....	.....	.....	86.20	102.40	99.50	89.50	84.00	80.20	79.20	79.10	.....
5	.....	.....	.....	86.30	101.10	98.70	89.10	83.50	80.10	.....	.....	.....
6	.....	.....	.....	86.70	100.60	97.70	90.60	83.00	80.00	79.60	79.00	.....
7	.....	.....	.....	86.70	.....	96.90	92.50	82.70	79.90	79.70	79.00	75.75
8	.....	.....	.....	86.70	98.20	97.20	92.30	82.40	79.80	79.60	79.00	75.75
9	.....	.....	.....	.....	97.50	97.30	.....	82.10	79.80	79.50	79.00	76.15
10	.....	.....	.....	86.60	97.00	96.80	90.80	81.90	.....	79.60	79.00	.....
11	.....	.....	.....	89.60	96.90	.....	90.00	81.90	79.70	79.70	78.90	76.35
12	.....	.....	.....	91.30	97.40	94.60	89.00	81.90	79.70	79.60	.....	76.30
13	.....	.....	.....	95.00	97.70	93.70	88.20	81.80	79.60	79.60	78.90	76.25
14	.....	.....	.....	94.80	97.40	93.00	87.50	81.60	79.50	79.50	78.90	75.95
15	.....	.....	.....	94.70	97.00	92.60	87.00	81.50	79.40	79.40	78.90	76.20
16	.....	.....	.....	94.90	96.80	92.40	87.60	81.40	79.30	79.30	78.80	76.70
17	.....	.....	.....	94.90	96.60	91.70	88.30	81.40	.....	79.20	78.80	77.40
18	.....	.....	.....	94.00	96.40	.....	87.50	81.50	79.20	79.20	78.80	77.20
19	.....	.....	.....	93.10	95.90	91.00	87.10	81.10	79.20	79.20	78.80	77.10
20	.....	.....	.....	94.10	95.40	90.40	86.10	.....	79.20	79.10	78.75	76.80
21	.....	.....	.....	97.30	95.00	89.90	85.60	82.40	79.10	79.10	78.80	77.10
22	.....	.....	.....	97.60	94.50	89.40	85.00	83.50	79.10	79.10	78.80	77.40
23	.....	.....	.....	.....	94.10	89.40	.....	83.70	79.30	79.10	78.90	77.50
24	.....	.....	.....	96.80	93.90	89.80	.....	83.20	79.30	79.10	78.85	.....
25	.....	.....	.....	96.70	93.60	90.00	.....	82.60	79.30	79.10	78.80	.....
26	.....	.....	.....	97.30	94.20	91.60	.....	82.00	79.30	79.10	78.70	77.90
27	.....	.....	.....	98.00	96.40	92.50	.....	.....	79.20	79.10	78.65	77.95
28	.....	.....	.....	98.70	98.70	92.00	.....	81.30	79.20	79.00	78.60	77.95
29	.....	.....	.....	99.25	99.30	91.60	.....	81.00	79.20	.....	78.40	78.00
30	.....	.....	.....	100.60	99.30	90.50	.....	80.90	79.10	79.00	78.30	78.00
31	.....	.....	.....	.....	98.70	.....	84.40	80.70	.....	78.90	.....	78.00



HIGHEST AND LOWEST GAGE READINGS
ST. LOUIS, MO., TO FORT JACKSON, LA.

Station	Highest			Lowest		
	Distance above mouth of Mississippi River	Date	Gage reading	Date	Gage reading
	Miles		Feet		Feet
St. Louis, Mo.		June 29, 1844	47.8	January 7, 1940	2.4
Chester, Ill.	361.9	1844	49.5	January 3, 1940	4.1
Grand Tower, Ill.	329.3	1844	41.6	February 24, 1940	4.1
Cape Girardeau, Mo.	86.3	1844	47.0	February 1, 1940	5.4
Cairo, Ill.	17.5	February 27, 1883	54.7	February 25, 1940	7.1
Columbus, Ky.	39.0	February 28, 1883	47.3	November 8-9, 1940	9.0
New Madrid, Mo.	75.0	March 29, 1867	47.2	November 8-9, 1940	9.0
Osceola and Point, Ark.	230.7	March 31, 1903	53.8	November 5-8, 1940	13.5
Helena, Ark.	366.5	March 31, 1903	49.5	November 2, 3, 4, 1940	10.5
Memphis, Tenn.	734.2	February 8, 1937	48.8	November 8-9, 1940	7.5
Mhoon Landing, Miss.	863.0	February 6, 1937	42.8	November 8-11, 1940	7.6
Helena, Ark.	366.5	April 4, 1927	53.7	November 8, 9, 1940	10.0
Sunflower Landing, Miss.	881.2	March 27, 29, 1927	49.0	November 10, 11, 1940	8.0
Mouth of White River, Ark.	530.0	March 29, 30, 1927	50.0	December 29, 30, 1940	9.0
Arkansas City, Ark.	580.5	March 27, 28, 1927	48.8	November 8, 10, 11, 1940	8.4
Greenville, Miss.	630.4	March 27, 1927	48.1	November 10, 11, 1940	9.5
Lake Providence, La.	667.7	March 27, 1927	45.9	November 17, 18, 1940	5.0
Vicksburg, Miss.	605.0	April 18, 1865	50.4	November 13, 14, 1940	4.5
St. Joseph, La.	574.5	March 29, 1908	49.0*	November 11, 1940	10.5
Natchez, Miss.	57.0	Mar. 28-30, Apr. 2, 1903	54.6	November 10-13, 1940	10.6
Red River Landing, La.	345.2	May 14, 15, 1927	51.2	November 14, 1940	11.8
Bayou Pare, La.	411.5	May 13-15, 1927	51.1	November 10, 1940	7.9
Baton Rouge, La.	14.0	May 13-15, 1927	46.6	November 14, 1940	10.1
Plaquemine, La.	9.6	May 13-17, 1927	46.2	November 14, 1940	10.4
Donaldsonville, La.	13.2	May 15, 1927	42.2	November 11, 1940	7.6
College Point, La.	10.8	May 15, 1927	41.6	November 11, 1940	6.9
Carrollton, La.	7.2	April 9, 1922	37.2	November 27, 28, 1940	4.8
Fort Jackson, La.	0.0	February 21, 1936	8.3	November 12-14, 1940	0.0

Gage readings are in feet above mean gulf level.

Maximum and Minimum Observed Discharge of Mississippi River at Selected Stations

Station	Date	Gage Height	Discharge in M. per second			Highest and Lowest Known Stages	
		Meters	Channel	Over Bank	Total at Station	Gage Height Meters	Discharge in M. per second
Cairo, Ill.	June 11, 1903	16.7	21,240	14,160	35,400	June 11, 1903	16.7
	Jan. 31, 1940	1.4	2,550		2,550	Dec. 8, 1939	1.4
St. Louis, Mo.	May 27, 1903	14.3	21,240		21,240	June 29, 1844	14.6
	Feb. 5, 1940	0.0	2,550		2,550	June 29, 1844	-0.52
Chester, Ill.	June 16, 1908	14.0	21,240	14,160	35,400	1844	15.2
Columbus, Ky.	Feb. 28, 1903	14.6	21,240		21,240	Feb. 28, 1903	14.6
	Nov. 8, 1940	2.2	2,550		2,550	Nov. 8-9, 1940	2.0
Helena, Ark.	Feb. 3, 1907	16.9	21,240	14,160	35,400	April 3, 1927	16.75
	July 28, 1940	4.1	2,550		2,550	Nov. 8-9, 1940	4.0
Arkansas City, Ark.	March 28, 1903	16.8	21,240	14,160	35,400	March 27 - 29, 1927	16.8
	Oct. 12, 1940	3.9	2,550		2,550	Nov. 8-10, 1940	3.9
Vicksburg, Miss.	April 18, 1927	15.8	21,240	14,160	35,400	April 18, 1927	15.8
	Oct. 26, 1940	4.7	2,550		2,550	Nov. 13-14, 1940	4.5
Red River Landing, La.	March 31, 1892	16.5	21,240	14,160	35,400	May 13-15, 1927	16.2
	Nov. 17, 1940	5.3	2,550		2,550	Nov. 14, 1940	5.3
Plaquemine, La.	May 15, 1927	15.6	21,240	14,160	35,400	May 13 - 17, 1927	15.6
	Dec. 31, 1940	4.15	2,550		2,550	Dec. 27 - 31, 1940	4.15

* After Crevasse, page 18 and was taken above Delacy.
† Highest recorded part of the flow of the Mississippi was for the Gulf through the 1922 and Atchafalaya River. Red River Gulf, is below 1922 flow.
The height of the new Mississippi River Commission observations ceased for wake Anchorage at St. Louis, which was observed by the St. Louis U. S. Engineer District.

House Doc. No. 50 ; 61st Cong., 1st Sess.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1894.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge, 321.18 feet above Memphis datum plane. Gauge read at 2 p. m. After October 1 gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	78.10	76.30	80.70	84.40	85.70	89.80	.....	82.70	79.10	79.35	78.10	78.15
2	78.20	76.30	80.70	84.20	86.80	89.70	88.90	82.80	.....	79.10	78.15	78.20
3	78.30	76.20	80.80	83.90	86.90	.....	88.50	82.50	79.00	78.95	78.25	78.30
4	78.50	.....	81.30	83.70	86.70	89.10	88.10	82.45	79.00	78.80	78.35	78.55
5	78.65	77.10	81.80	83.50	86.60	89.00	88.00	82.30	79.20	78.75	78.40	78.85
6	78.70	77.30	84.00	83.40	.....	89.00	88.30	82.00	79.35	78.70	78.50	78.80
7	.....	77.80	87.00	83.30	88.70	89.30	88.30	81.70	79.35	78.60	78.60	78.75
8	78.50	79.90	89.60	84.40	90.10	89.60	87.60	81.50	79.80	78.55	78.70	78.60
9	78.35	.....	90.90	84.90	91.10	89.60	86.90	81.30	79.85	78.50	78.80	78.20
10	78.15	80.70	91.50	84.90	92.10	.....	86.40	81.00	79.80	78.50	78.80	78.00
11	77.90	81.60	.....	84.50	94.60	89.30	86.10	80.90	79.80	78.60	78.70	77.90
12	77.80	.....	90.30	84.90	94.20	89.20	85.90	80.80	79.80	78.60	78.60	77.75
13	77.50	81.40	.....	85.50	.....	89.20	85.40	80.70	79.70	78.65	78.45	77.65
14	.....	81.00	87.60	85.60	91.80	89.10	85.00	80.50	79.60	78.70	78.45	77.70
15	77.50	80.40	86.90	85.50	91.10	89.10	.....	80.35	79.80	78.60	78.45	77.85
16	77.50	80.10	86.20	85.30	90.80	88.90	84.10	80.20	80.10	78.50	78.40	78.00
17	77.60	79.70	85.60	87.50	90.20	88.90	83.90	80.00	80.70	78.45	78.50	77.90
18	77.70	.....	.....	88.90	89.40	88.90	83.80	80.00	80.90	78.40	78.45	77.85
19	77.80	.....	84.60	90.40	88.50	89.00	83.80	.....	80.70	78.15	78.45	77.85
20	77.90	80.70	84.30	89.90	87.80	89.00	83.80	79.90	80.30	78.10	78.45	77.85
21	.....	81.10	84.30	88.50	87.20	89.00	83.70	79.80	80.20	78.10	78.40	77.90
22	79.00	80.70	84.50	87.40	86.90	89.00	83.60	79.75	80.10	78.10	78.40	77.95
23	79.20	80.70	84.60	86.80	86.70	89.10	83.60	79.70	a 79.80	78.05	78.45	78.00
24	79.60	80.70	84.70	86.40	86.50	.....	83.50	79.60	80.35	78.15	78.45	78.00
25	78.70	80.60	.....	86.10	86.50	89.00	83.10	79.50	80.20	78.30	78.45	78.05
26	77.70	80.50	84.60	85.90	86.40	89.10	83.00	79.45	80.50	78.40	78.40	78.00
27	76.90	80.50	84.40	85.70	86.20	89.20	82.90	79.40	80.40	78.25	78.30	77.70
28	.....	80.60	85.40	85.40	86.20	90.00	82.80	79.30	80.05	78.10	78.20	77.10
29	76.60	.....	85.90	.....	87.90	90.10	.....	79.25	79.90	78.05	78.05	77.50
30	76.50	.....	85.60	85.20	89.40	90.00	83.00	79.25	79.60	78.05	78.05	77.10
31	76.40	.....	84.90	.....	89.70	.....	82.90	79.20	.....	78.10	.....	77.10

a Reading changed one-half foot or more.

1895.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.05	80.75	80.80	81.85	80.45	82.00	85.40	85.90	82.30	78.55	77.70	77.15
2	75.60	80.60	81.15	82.60	80.25	81.90	85.70	85.65	82.45	78.50	77.65	77.20
3	76.20	80.50	81.35	82.65	80.25	81.60	85.80	85.30	82.95	78.60	77.60	76.90
4	75.80	80.40	81.55	82.10	80.40	81.40	86.10	84.90	83.30	78.70	77.60	76.65
5	75.60	80.40	81.20	81.50	80.65	81.30	85.95	84.20	83.40	78.80	77.55	76.25
6	75.70	80.30	81.35	81.15	80.90	81.40	85.35	83.60	83.55	78.80	77.50	75.65
7	75.70	80.25	81.80	81.00	81.60	81.40	88.30	83.25	83.80	78.80	77.55	75.55
8	75.80	80.10	81.95	80.85	81.50	81.30	89.05	83.20	84.10	78.70	77.70	75.40
9	75.65	80.10	81.85	80.70	81.60	81.30	88.85	82.85	83.50	78.60	77.85	75.40
10	75.40	80.30	81.50	81.30	81.20	81.65	88.45	82.90	83.10	78.60	77.90	75.50
11	75.70	80.55	81.40	82.90	80.80	82.60	87.60	82.80	82.75	78.65	77.90	75.65
12	75.20	80.65	81.00	83.10	80.75	82.70	86.40	82.50	82.35	78.75	77.80	75.65
13	74.60	80.65	80.75	83.00	81.00	84.05	84.95	82.10	81.90	78.85	77.75	75.80
14	74.80	80.60	80.70	82.90	81.05	84.85	84.65	81.55	81.50	78.85	77.75	75.95
15	75.10	80.50	80.75	82.55	81.00	84.90	84.95	81.15	81.20	78.85	77.75	76.05
16	75.85	80.45	80.70	82.05	81.00	85.00	84.85	80.80	80.90	78.85	77.75	76.15
17	76.35	80.30	80.60	81.70	81.35	85.10	84.65	80.55	80.60	78.75	77.70	76.20
18	76.70	80.20	80.60	81.55	81.50	85.10	84.50	80.45	80.45	78.65	77.60	76.40
19	76.60	80.10	80.55	81.40	82.40	85.30	84.55	80.35	80.35	78.60	77.55	77.35
20	76.80	80.00	80.30	81.30	82.90	85.10	85.10	80.65	80.25	78.50	77.50	87.10
21	76.90	80.00	80.05	81.20	82.95	84.90	85.15	80.95	80.00	78.35	77.50	94.10
22	76.80	80.15	79.70	81.25	83.40	85.15	85.35	81.20	79.70	78.30	77.50	94.40
23	76.60	80.15	79.70	81.30	82.90	85.50	85.70	81.00	79.30	78.25	77.50	94.20
24	76.50	80.35	79.80	81.15	82.35	85.60	86.10	80.80	79.10	78.15	77.55	94.30
25	76.20	80.75	79.85	80.90	82.00	85.45	86.40	81.10	79.00	78.10	77.60	93.90
26	75.80	82.70	80.80	80.70	81.80	85.05	85.90	81.60	79.00	78.00	77.75	92.50
27	75.30	79.45	81.00	80.60	81.75	84.85	85.40	81.90	78.90	78.00	77.80	90.85
28	75.45	79.55	80.85	80.60	81.70	85.00	85.00	82.05	78.70	77.95	77.60	90.15
29	75.85	.....	81.70	80.65	81.70	85.30	84.50	82.35	78.60	77.90	77.40	89.90
30	76.50	.....	82.05	80.60	81.85	85.35	84.75	82.40	78.60	77.80	77.25	89.10
31	79.00	.....	81.85	.....	81.95	.....	84.90	82.30	.....	77.75	.....	88.25

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1896.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	87.30	79.10	82.10	81.45	86.00	95.80	88.60	86.20	82.95	81.20	79.40	80.20
2	86.20	79.55	82.50	81.05	86.20	95.50	89.05	86.40	81.80	81.00	79.50	80.15
3	85.30	80.35	82.40	80.80	86.30	95.80	89.15	86.60	81.55	80.80	79.90	80.30
4	84.05	80.70	82.20	80.60	86.30	95.95	89.40	86.90	81.30	80.65	80.55	80.55
5	82.90	80.70	81.90	80.40	86.35	96.25	89.80	87.15	81.30	80.55	81.25	80.30
6	82.30	80.80	81.75	80.20	86.30	96.60	89.65	87.20	81.00	80.55	82.15	80.00
7	81.90	81.00	81.50	80.10	86.35	96.30	89.05	87.20	80.80	80.50	82.65	79.70
8	81.30	80.95	81.20	80.00	86.50	95.70	89.00	87.10	80.70	80.40	82.30	79.55
9	80.85	80.85	81.10	80.05	86.65	95.80	89.30	86.65	80.55	80.35	81.85	79.35
10	80.45	80.70	81.00	80.35	86.90	95.65	89.00	86.10	80.40	80.25	81.50	79.20
11	80.10	80.60	80.90	83.95	87.20	95.00	88.25	85.55	80.30	80.20	81.35	79.15
12	79.85	80.40	80.70	85.40	87.30	94.45	87.40	85.10	80.20	80.25	81.20	79.20
13	79.70	80.90	80.55	85.70	87.00	93.40	86.95	85.00	80.15	80.30	81.00	79.40
14	79.65	82.65	80.40	85.35	86.70	91.50	86.50	84.55	80.20	80.30	80.90	79.60
15	79.55	83.40	80.30	85.10	86.30	90.00	85.80	84.00	80.40	80.50	80.80	79.85
16	79.55	82.95	80.15	84.80	86.20	88.95	85.30	83.70	80.50	80.60	80.75	80.10
17	79.50	82.60	79.90	84.55	86.15	88.80	85.20	83.35	80.45	80.55	80.80	80.45
18	79.50	82.35	79.70	84.20	86.25	90.00	85.30	83.15	80.55	80.35	80.85	81.10
19	79.50	82.00	79.55	83.65	88.80	90.40	85.20	83.10	80.80	80.15	80.90	81.45
20	79.40	81.30	79.45	83.20	92.70	90.40	85.75	83.70	81.50	80.10	80.90	81.55
21	79.30	80.60	79.40	83.10	95.50	90.20	87.90	84.30	82.15	80.00	80.90	81.55
22	79.20	80.20	79.40	82.90	96.50	89.75	91.90	84.80	82.90	79.95	80.80	81.50
23	79.15	79.90	79.50	82.65	97.30	89.10	92.90	85.30	83.30	79.85	80.70	81.40
24	79.35	79.70	79.55	82.55	98.20	88.70	92.50	85.00	83.15	79.75	80.60	81.35
25	79.60	79.70	79.65	82.55	98.90	88.50	91.30	84.50	82.80	79.65	80.55	81.30
26	79.50	80.10	80.30	82.65	99.45	88.20	90.05	84.35	82.55	79.60	80.50	81.20
27	79.15	80.60	80.75	83.20	99.00	88.30	89.20	84.10	82.30	79.50	80.45	81.00
28	79.00	81.40	80.90	83.70	99.25	88.75	88.30	83.50	82.10	79.45	80.40	80.80
29	78.95	81.70	81.20	84.30	98.65	89.05	87.60	83.05	81.85	79.40	80.30	80.75
30	78.85	.....	81.80	85.30	97.90	88.50	87.10	82.70	81.55	79.40	80.20	80.70
31	78.90	.....	81.80	.....	96.85	.....	86.55	82.40	.....	79.35	.....	80.70

1897.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	80.70	79.80	85.10	95.60	102.25	86.50	92.50	86.00	81.20	79.55	78.85	78.80
2	80.60	79.55	84.75	98.85	102.45	86.15	92.35	85.80	81.00	79.50	78.90	78.70
3	81.20	79.90	85.10	99.70	102.30	86.30	92.85	85.50	80.85	79.50	78.85	78.45
4	92.10	80.40	85.30	99.50	102.00	86.90	93.45	85.20	80.70	79.45	78.80	78.30
5	95.50	80.70	87.00	99.60	101.25	87.70	93.05	84.95	80.60	79.40	78.80	78.00
6	95.50	81.00	92.20	99.75	100.20	88.05	a 92.05	84.80	80.55	79.40	78.85	77.60
7	95.80	81.30	93.20	99.80	98.85	88.35	91.80	84.60	80.55	79.35	78.90	76.95
8	94.80	81.80	92.90	99.45	97.65	88.45	91.45	84.40	80.55	79.30	79.10	76.50
9	92.35	82.20	92.30	100.00	96.55	88.35	91.75	84.65	80.50	79.25	79.25	76.30
10	89.65	83.20	91.80	100.80	95.75	88.10	91.25	84.75	80.50	79.20	79.30	76.45
11	87.30	83.90	90.90	101.15	94.90	87.85	90.10	84.35	80.45	79.15	79.30	76.50
12	85.30	83.90	90.45	100.80	94.00	87.55	89.50	84.10	80.30	79.10	79.35	76.70
13	84.15	83.85	89.90	100.45	93.00	87.15	88.70	83.90	80.15	79.10	79.30	76.80
14	83.55	85.00	89.70	99.65	92.20	86.80	87.80	83.80	80.05	79.05	79.25	77.20
15	83.10	84.80	89.20	98.90	91.55	86.60	87.20	83.80	79.95	79.00	79.25	77.35
16	82.85	85.45	88.70	98.30	91.00	86.50	86.75	83.75	79.85	78.95	79.35	77.50
17	82.90	85.50	88.60	98.15	90.30	86.60	86.45	83.65	79.80	78.90	79.25	77.75
18	83.20	85.20	88.65	98.20	89.70	86.75	86.55	83.55	79.80	78.90	79.10	77.50
19	84.90	85.05	88.60	98.35	89.20	86.85	86.70	83.45	79.75	78.85	79.00	76.25
20	86.00	84.80	88.90	98.25	88.70	86.70	86.40	83.30	79.70	78.85	78.95	76.00
21	86.40	84.80	89.65	98.50	88.20	86.40	86.05	83.15	79.65	78.80	78.95	75.90
22	86.60	85.65	90.20	98.70	87.70	86.35	85.70	83.05	79.60	78.75	78.95	75.50
23	86.65	87.00	90.95	98.95	87.35	87.10	85.50	82.95	79.60	78.75	79.00	75.60
24	86.30	87.30	91.75	99.05	87.10	87.55	85.40	82.80	79.65	78.70	78.95	75.50
25	85.60	87.35	91.85	98.75	87.00	87.55	85.90	82.60	79.80	78.70	78.95	75.60
26	84.40	87.10	93.20	98.30	87.40	88.95	87.80	82.40	79.85	78.75	78.95	75.80
27	83.35	86.70	94.45	98.35	87.50	89.30	89.40	82.15	79.80	78.80	79.00	76.20
28	82.40	85.80	94.90	99.15	87.45	89.60	89.30	81.90	79.70	78.80	79.00	76.80
29	81.35	.....	94.85	100.30	87.50	91.20	88.10	81.75	79.65	78.80	78.95	77.30
30	80.40	.....	94.70	101.50	87.80	92.60	86.85	81.55	79.60	78.80	78.90	77.50
31	79.90	.....	94.65	.....	87.30	.....	86.25	81.35	.....	78.80	.....	77.80

a Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1898.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	78.05	79.90	82.00	93.60	86.70	90.55	94.10	83.35	80.35	80.45	82.55	80.10
2	77.80	79.70	81.90	92.80	86.80	90.30	94.00	83.35	80.10	80.30	81.85	79.70
3	77.50	79.20	81.80	91.30	88.60	90.90	93.20	84.50	79.90	80.05	81.35	79.45
4	77.50	(a)	81.70	90.10	90.45	91.55	92.05	84.50	79.75	79.90	81.00	79.20
5	77.70	(a)	81.55	89.40	92.00	92.00	91.25	84.10	79.60	79.70	80.80	78.80
6	77.90	(a)	81.45	89.45	92.25	92.20	91.00	83.50	79.55	79.40	80.75	78.80
7	78.25	(a)	81.35	89.70	92.30	91.75	91.05	83.00	79.60	79.25	80.80	78.65
8	78.35	(a)	81.30	89.55	91.85	90.90	92.80	82.60	79.90	79.10	81.10	78.25
9	78.35	79.85	81.20	89.70	91.35	90.45	93.05	82.75	80.60	79.00	81.20	78.00
10	78.60	79.60	81.20	89.80	90.90	90.55	92.60	82.45	81.20	78.90	81.30	77.00
11	79.90	79.70	81.30	89.55	90.25	91.30	91.75	82.05	82.20	79.00	81.60	76.40
12	b80.30	80.30	81.60	88.90	89.40	92.30	91.20	81.80	82.30	79.25	81.65	77.10
13	80.70	81.60	83.90	88.50	88.45	93.35	90.15	82.05	82.15	79.75	81.40	76.90
14	80.90	82.40	87.75	88.40	88.10	93.95	89.20	82.40	81.70	79.35	81.10	76.75
15	80.70	82.55	88.25	88.85	87.80	94.10	88.35	82.25	81.35	79.00	80.85	76.80
16	80.55	82.65	89.20	88.95	88.45	94.60	87.35	82.50	81.35	78.75	80.60	77.25
17	80.30	82.65	89.60	88.45	91.95	96.00	86.40	82.25	82.70	78.55	80.45	77.50
18	80.10	82.85	89.45	87.80	94.00	96.45	85.85	82.25	83.55	78.60	80.40	77.75
19	79.90	83.30	89.10	87.30	94.45	95.90	85.35	82.00	83.95	79.10	80.35	78.10
20	80.00	83.90	88.90	86.90	94.00	94.95	84.95	82.80	83.25	80.05	80.25	78.30
21	80.50	85.15	89.50	86.40	94.05	93.65	84.90	c83.65	82.60	81.60	80.25	78.55
22	80.85	84.95	91.15	85.85	97.45	92.50	84.70	c83.65	82.00	82.90	80.35	79.70
23	81.10	84.20	95.80	85.65	98.50	91.60	84.10	82.95	81.70	83.25	80.40	81.10
24	81.00	83.40	96.00	85.65	98.15	91.00	83.80	82.25	82.25	83.15	81.10	82.10
25	80.80	82.95	95.30	85.70	97.15	90.40	83.75	81.80	82.40	82.80	81.60	82.75
26	81.00	82.60	94.30	86.50	96.15	89.90	83.90	81.65	82.20	82.25	82.60	83.10
27	81.60	82.30	93.30	89.00	95.00	90.40	84.10	81.30	82.20	81.75	82.55	83.10
28	81.55	82.10	93.40	89.00	93.85	92.30	83.70	81.10	81.80	82.00	81.85	82.80
29	81.20	.....	93.10	88.20	93.15	92.45	83.45	80.95	81.20	83.00	81.10	82.55
30	80.80	.....	93.25	87.25	92.55	93.50	83.50	80.90	80.80	83.50	80.50	b82.15
31	80.50	.....	93.55	.....	91.60	.....	83.70	80.65	.....	83.25	.....	81.75

a Ice reading doubtful. b Changed less than one-half foot. c Reading changed one-half foot or more.

1899.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	80.70	75.60	86.80	85.20	96.50	94.00	91.90	85.85	81.60	80.10	79.40	80.30
2	80.00	76.40	86.35	85.00	96.40	94.55	92.05	86.00	81.60	80.00	79.45	80.25
3	79.45	76.80	85.85	84.55	95.90	95.25	92.50	85.90	81.45	79.95	79.70	80.20
4	79.50	77.75	85.50	84.50	94.25	95.25	93.15	85.55	81.30	79.90	79.80	80.20
5	79.60	78.25	85.00	84.75	92.75	95.40	93.65	85.35	81.20	79.80	79.95	80.10
6	79.60	78.35	85.00	85.25	91.75	95.40	93.85	85.35	81.10	79.75	80.15	80.05
7	79.50	78.55	84.80	85.50	91.20	94.85	94.25	85.10	80.95	79.65	80.30	80.00
8	79.85	78.60	84.05	85.55	90.90	94.05	94.30	84.80	80.90	79.55	80.40	79.95
9	79.35	78.90	83.80	85.75	90.85	93.85	94.20	85.25	80.90	79.50	80.55	79.90
10	79.55	81.85	84.00	86.00	90.75	94.00	94.25	86.75	80.95	79.40	80.65	79.90
11	79.45	81.40	84.25	86.10	91.40	94.00	94.65	87.80	81.10	79.40	80.80	79.85
12	79.40	82.20	84.45	87.45	92.10	94.40	94.75	87.60	81.10	79.40	80.85	79.90
13	80.00	82.05	84.50	88.60	92.35	95.50	94.35	87.10	81.10	79.30	80.90	79.85
14	79.65	82.00	84.95	88.30	92.60	95.75	93.70	87.00	81.05	79.25	81.00	79.95
15	79.40	82.10	86.00	87.60	92.25	95.10	93.00	86.60	81.00	79.20	81.05	80.00
16	79.65	82.10	87.90	87.40	91.75	93.85	92.35	85.75	80.90	79.15	80.95	79.80
17	79.75	82.10	88.50	87.35	91.00	93.55	91.90	85.10	80.85	79.25	80.90	79.45
18	79.65	82.00	88.75	87.35	90.55	93.60	91.70	84.60	80.95	79.25	80.95	79.40
19	79.55	81.80	89.45	87.40	89.85	93.55	91.60	84.20	81.15	79.20	80.95	79.60
20	79.50	81.50	90.65	88.05	89.50	93.40	91.40	83.85	81.10	79.20	80.90	80.15
21	79.60	78.90	91.35	89.00	90.35	93.20	90.90	83.60	80.90	79.15	80.80	79.90
22	79.50	78.60	91.30	89.55	91.40	92.80	90.15	83.25	80.75	79.05	80.85	79.55
23	79.50	78.85	90.90	92.35	93.40	92.10	89.45	82.85	80.65	79.00	81.05	79.25
24	79.55	78.90	90.20	94.75	94.60	91.50	88.90	82.50	80.55	79.00	81.05	79.05
25	79.60	78.60	89.40	95.95	95.70	91.10	88.55	82.25	80.50	78.95	81.00	78.75
26	79.55	79.80	88.50	96.60	96.20	90.85	88.00	82.05	80.40	78.90	80.80	78.50
27	79.40	83.95	87.55	96.70	96.00	91.00	87.40	81.95	80.40	79.00	80.65	78.20
28	79.25	86.30	86.75	96.45	95.45	91.50	86.90	81.85	80.30	79.25	80.50	77.90
29	79.00	.....	85.95	96.10	94.55	91.80	86.55	81.70	80.30	79.55	80.45	77.35
30	78.20	.....	85.25	96.35	94.15	92.00	86.20	81.60	80.20	79.75	80.35	76.75
31	76.30	.....	85.10	.....	94.10	.....	85.90	81.50	.....	79.55	.....	75.65

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1900.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	75.50	77.75	81.30	85.60	87.55	85.45	83.90	84.00	83.20	83.60	85.40	83.30
2	76.10	77.30	81.00	86.15	87.40	85.45	84.00	83.60	83.35	84.00	84.80	82.90
3	78.40	76.65	80.65	86.15	87.60	85.40	83.90	83.35	83.35	85.05	84.60	82.55
4	80.10	76.75	80.35	86.10	87.70	85.10	84.00	83.05	83.35	85.70	84.65	82.25
5	80.50	77.00	80.50	86.45	87.50	84.75	84.05	82.70	83.40	85.75	84.85	82.00
6	78.00	77.50	82.30	86.90	87.65	84.45	83.85	82.30	83.50	85.35	85.10	81.85
7	78.10	77.95	87.60	87.60	87.90	84.20	83.70	82.00	83.10	85.15	85.90	81.60
8	78.70	79.35	88.95	88.30	88.25	84.10	83.50	81.65	82.55	85.30	86.20	81.50
9	78.60	81.00	89.15	88.30	88.10	84.00	83.40	81.40	82.25	85.65	86.00	81.35
10	78.95	81.80	90.00	87.90	87.90	83.80	83.50	81.20	82.00	85.50	85.70	81.30
11	79.05	81.40	91.80	87.70	87.70	83.55	83.15	80.90	81.65	84.80	85.40	81.20
12	78.80	81.15	92.35	87.80	87.55	83.40	83.35	80.70	81.50	84.20	85.30	81.10
13	78.85	81.20	93.50	88.25	88.35	83.60	83.35	80.50	81.30	83.80	85.20	80.95
14	78.75	80.75	94.25	89.70	88.30	85.20	83.00	80.30	81.15	83.60	85.00	80.75
15	78.80	80.75	94.50	89.95	87.55	86.00	82.75	80.20	81.10	83.40	84.80	80.60
16	78.65	81.15	94.60	89.25	86.75	85.25	82.80	80.10	81.00	83.30	84.65	80.40
17	78.75	81.10	94.30	88.50	86.15	84.65	83.05	80.10	80.90	83.30	84.65	80.20
18	79.00	80.30	93.60	87.80	86.10	84.10	82.85	80.20	80.80	83.30	84.65	80.05
19	79.90	80.30	92.55	87.25	86.40	83.95	82.60	81.50	80.75	83.40	84.80	79.85
20	81.50	80.55	91.35	87.40	86.40	83.95	82.45	82.00	80.85	83.55	84.75	79.70
21	81.65	81.40	90.20	87.90	86.30	84.20	82.60	82.55	81.00	83.75	84.90	79.55
22	81.10	82.05	89.60	88.05	86.30	85.70	83.25	82.80	81.40	84.05	84.90	79.35
23	80.60	82.45	89.20	88.25	86.35	86.60	84.50	82.75	a 81.65	84.50	84.85	79.35
24	80.45	82.90	88.65	88.50	86.40	86.75	85.10	82.70	81.75	84.80	84.90	79.25
25	80.50	a 82.70	88.10	88.80	86.05	86.65	85.30	82.60	81.80	85.00	84.90	79.25
26	80.50	81.80	87.80	89.10	85.70	86.50	85.40	82.50	81.80	85.05	84.85	79.20
27	80.40	81.35	87.45	89.10	85.40	86.00	85.10	82.50	82.00	85.10	84.65	79.25
28	80.30	80.90	86.95	88.80	85.10	85.40	85.00	82.50	82.30	85.10	84.50	79.25
29	a 80.00	.....	86.55	88.35	85.25	84.75	84.70	82.40	82.90	85.05	84.30	79.10
30	79.50	.....	86.10	88.05	85.80	84.15	84.45	82.45	83.30	85.20	83.85	78.85
31	79.15	.....	85.70	.....	85.70	.....	84.30	83.05	.....	85.50	.....	78.90

a Reading changed one-half foot or more.

1901.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	78.80	79.50	79.60	89.90	87.35	82.80	86.20	82.15	79.60	79.15	79.50	78.75
2	78.60	79.40	79.35	90.00	87.05	82.80	85.70	82.25	79.50	79.10	79.45	78.70
3	78.50	79.30	79.15	90.00	86.80	83.80	85.20	82.25	79.45	79.00	79.40	78.65
4	78.00	79.55	79.30	90.35	86.50	84.60	84.60	82.10	79.35	78.95	79.30	78.60
5	77.75	79.40	79.70	90.45	86.25	84.80	84.20	82.05	79.30	79.00	79.20	78.50
6	77.45	79.30	80.00	90.80	86.05	85.05	83.95	81.85	79.20	79.00	79.10	78.45
7	77.40	79.10	80.20	91.00	85.80	85.30	83.70	81.55	79.15	79.05	79.15	78.40
8	77.50	78.60	80.75	91.30	85.60	85.60	83.60	81.35	79.10	79.10	79.10	78.40
9	77.90	78.40	81.40	91.60	85.40	85.70	83.80	81.20	79.05	79.15	79.10	78.60
10	78.45	77.70	82.60	92.80	85.15	85.45	84.55	81.10	79.00	79.15	79.15	78.50
11	78.85	78.30	85.80	93.15	84.90	85.20	84.60	81.00	78.95	79.10	79.10	78.40
12	79.95	78.40	88.10	93.25	84.75	85.10	84.50	81.00	78.95	79.25	79.20	78.30
13	80.10	78.50	89.00	93.60	84.65	85.15	83.70	80.90	78.90	79.25	79.20	78.40
14	80.30	78.45	89.20	93.50	84.45	85.40	83.50	80.80	78.85	79.15	79.15	78.60
15	80.45	78.50	88.90	93.45	84.25	86.05	83.40	80.80	78.80	79.10	79.15	78.30
16	80.30	78.55	88.60	93.00	84.05	86.35	83.35	80.70	78.80	79.10	79.15	77.65
17	80.30	78.60	88.40	93.60	83.90	86.15	83.35	80.60	78.80	79.25	79.10	77.05
18	80.50	78.75	88.35	94.10	83.80	85.70	83.35	80.60	78.80	79.40	79.10	76.10
19	80.35	79.00	88.20	93.90	83.65	85.30	83.35	80.50	79.00	79.50	79.05	a 74.65
20	80.20	79.10	88.20	93.00	83.40	85.15	83.50	80.45	79.30	79.65	79.00	74.60
21	80.00	78.85	88.10	92.00	83.20	85.15	83.85	80.40	80.10	79.70	79.00	77.30
22	80.05	b 78.60	88.80	91.30	83.00	85.25	83.85	80.30	80.35	79.70	79.00	78.65
23	80.15	b 78.70	89.50	90.85	82.85	85.60	83.40	80.30	80.20	79.65	79.00	79.10
24	80.20	78.90	89.95	90.25	82.80	86.30	83.00	80.25	79.95	79.60	79.05	79.20
25	80.05	79.30	90.35	89.70	82.65	86.70	82.80	80.20	79.75	79.50	79.00	78.45
26	79.90	80.00	90.50	89.20	83.20	86.85	82.60	80.10	79.60	79.45	78.90	77.45
27	79.95	80.05	90.35	88.65	83.60	87.10	82.40	80.00	79.45	79.50	78.85	77.40
28	79.90	79.70	90.00	88.30	83.45	87.30	82.25	79.90	79.35	79.50	78.85	77.40
29	79.85	.....	89.70	88.00	83.20	87.25	82.10	79.80	79.30	79.50	78.80	77.40
30	79.90	.....	89.65	87.70	83.00	86.70	82.05	79.75	79.25	79.50	78.75	77.30
31	79.75	.....	89.70	.....	82.90	.....	82.10	79.65	.....	79.55	.....	77.55

a Reading 1 p. m., 74.00. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1902.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	77.55	76.00	79.40	83.10	81.80	89.50	94.50	93.80	91.50	88.40	84.00	86.90
2	77.55	76.10	79.40	83.80	82.00	89.30	95.20	92.90	90.80	88.20	83.70	86.30
3	77.50	76.50	79.75	83.90	83.55	90.80	95.70	92.10	90.50	88.25	83.40	86.10
4	77.20	76.15	80.80	83.95	83.90	91.30	95.85	91.30	91.00	89.20	83.20	85.90
5	77.70	76.45	80.60	83.75	83.40	91.10	95.40	90.85	91.30	89.70	83.10	85.95
6	78.00	77.00	80.40	84.00	82.75	90.90	94.50	90.50	90.80	90.10	83.40	86.00
7	78.10	77.70	80.50	84.90	82.00	90.40	93.75	90.40	90.10	90.85	83.90	86.20
8	78.30	77.90	81.30	84.75	81.60	89.70	93.25	90.30	89.10	91.80	83.90	86.40
9	78.05	78.50	82.20	84.10	81.55	89.40	93.40	89.90	88.05	92.40	84.40	86.05
10	77.85	79.15	82.60	83.65	82.20	89.80	93.20	89.50	87.30	92.10	85.00	85.50
11	77.90	79.50	82.60	83.35	83.20	90.60	92.60	89.00	86.90	91.30	85.10	84.70
12	77.90	79.60	82.50	83.10	83.70	91.40	92.75	88.40	86.40	90.50	84.75	84.00
13	77.75	79.60	83.20	82.80	84.25	91.25	93.90	88.20	85.85	89.70	84.30	84.00
14	77.20	79.45	84.20	82.60	84.55	91.70	95.20	88.15	85.30	88.90	83.90	84.10
15	77.20	79.80	84.60	82.45	84.50	92.60	96.20	87.60	84.70	88.15	83.70	83.80
16	77.65	79.90	85.80	82.30	84.40	92.50	96.75	86.90	84.25	87.60	83.50	83.30
17	77.80	79.90	86.00	82.10	84.30	93.10	97.10	86.60	83.75	87.40	83.60	82.80
18	77.80	79.70	85.60	82.05	84.20	91.80	97.60	86.50	83.50	87.40	83.90	82.90
19	77.80	79.60	85.00	82.10	84.50	91.55	97.90	86.90	83.20	87.60	84.80	83.20
20	77.90	79.45	84.30	81.95	84.85	91.30	97.85	87.40	82.80	87.90	85.70	83.60
21	77.85	79.50	83.50	81.55	84.60	90.80	97.60	88.40	82.50	88.10	86.20	84.10
22	77.90	79.45	83.00	81.25	84.30	90.40	97.45	89.30	82.25	88.70	86.30	84.80
23	77.80	79.40	82.60	81.00	84.30	90.20	98.00	89.65	82.05	88.95	86.10	85.30
24	77.80	79.15	82.40	82.55	84.65	90.15	98.30	89.75	82.00	88.80	85.90	86.10
25	77.70	79.70	82.05	82.20	85.25	90.00	98.40	89.70	82.80	88.70	85.70	86.80
26	77.70	78.90	81.75	81.90	85.90	90.00	98.50	89.75	84.70	88.40	85.80	86.75
27	77.10	78.35	81.75	81.40	86.75	90.40	98.20	90.05	85.70	87.45	86.00	86.40
28	76.95	78.45	81.80	81.30	88.80	90.90	97.30	90.70	86.30	86.35	86.15	85.80
29	75.60	.....	81.80	81.50	90.20	92.60	96.45	91.40	87.30	85.40	86.60	85.10
30	75.20	.....	81.80	81.75	90.10	92.90	95.40	91.70	88.30	84.80	87.00	84.10
31	76.00	.....	81.90	.....	89.80	.....	94.60	91.70	.....	84.30	.....	83.20

1903.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	82.50	83.70	87.70	91.60	89.80	99.30	91.65	88.30	89.30	88.80	87.30	81.40
2	82.10	83.30	87.85	91.40	89.70	101.30	91.40	87.70	90.80	88.85	87.20	81.20
3	82.20	83.70	88.30	91.30	89.40	102.75	90.70	87.30	91.15	88.90	87.00	81.00
4	82.65	85.20	89.10	91.10	89.20	104.05	89.90	87.60	91.10	89.00	86.85	80.80
5	82.80	88.05	89.65	91.90	88.85	105.60	89.30	86.60	90.80	89.25	86.75	80.60
6	82.80	88.25	89.70	93.00	88.60	106.90	88.70	86.50	90.20	89.40	86.75	80.60
7	83.20	87.30	90.30	93.50	88.50	109.30	88.30	87.40	89.40	89.65	87.10	80.45
8	83.25	86.65	92.60	93.60	88.33	110.10	88.20	88.10	89.00	90.25	87.30	80.30
9	83.00	85.80	95.50	93.25	88.40	110.20	88.30	88.35	89.10	91.60	87.25	80.20
10	82.40	84.90	96.50	93.00	88.50	110.60	88.30	88.40	88.60	92.40	86.95	80.25
11	82.10	84.30	96.80	92.70	88.40	110.45	88.30	88.60	88.70	93.60	86.80	80.00
12	81.40	84.40	96.50	94.10	88.10	110.20	88.05	88.40	89.90	93.40	86.40	79.70
13	80.00	84.80	95.90	95.00	87.85	109.30	87.50	88.50	91.30	93.20	85.95	79.30
14	80.00	84.75	95.60	95.30	87.70	108.20	87.20	88.55	91.80	92.80	85.60	78.50
15	80.00	84.60	95.80	95.50	87.40	106.30	87.50	88.70	91.70	92.40	85.30	78.30
16	80.10	84.40	95.50	95.40	87.50	104.60	88.10	89.05	92.30	91.90	85.05	78.00
17	80.60	83.55	94.70	95.20	88.90	102.80	89.20	88.60	92.35	91.20	84.90	77.70
18	81.30	83.00	95.00	95.90	91.10	101.50	90.20	88.70	91.90	90.80	84.50	77.50
19	81.65	82.20	94.90	95.55	92.10	100.00	90.80	89.00	91.80	90.30	84.20	77.50
20	82.05	82.10	94.70	94.80	92.45	98.70	90.30	89.10	91.85	90.00	83.85	78.10
21	81.95	82.10	95.50	94.60	92.05	98.10	89.90	89.20	91.35	89.20	83.60	78.60
22	81.80	82.20	95.65	94.70	91.70	97.40	89.80	89.15	90.50	88.70	83.40	78.90
23	81.85	82.30	95.20	94.20	91.50	96.60	89.90	88.70	89.75	88.40	83.20	79.10
24	81.80	82.35	95.20	93.50	91.35	96.10	90.10	88.05	89.10	88.20	82.95	79.70
25	81.70	82.60	95.00	92.90	91.80	95.60	90.50	87.60	88.60	88.10	82.70	79.90
26	81.40	82.80	94.50	92.30	93.20	95.20	91.30	87.40	88.30	88.10	82.50	79.70
27	81.75	83.40	94.00	91.70	95.40	94.30	91.45	87.15	88.30	87.90	82.20	79.70
28	83.50	86.70	93.40	91.10	95.65	93.20	90.70	87.20	88.55	87.70	81.90	a 79.60
29	83.90	.....	92.90	90.65	95.55	92.10	90.00	87.50	88.70	87.60	81.70	80.20
30	83.80	.....	92.30	90.20	95.90	91.60	89.60	88.15	88.80	87.50	81.45	80.60
31	83.85	.....	91.90	.....	96.80	.....	88.90	88.70	.....	87.50	.....	80.60

a Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1904.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	80.70	82.00	81.80	95.80	105.20	94.30	94.90	85.50	81.90	84.50	83.40	79.90
2	80.75	81.40	81.70	95.50	104.65	95.50	94.20	85.20	81.05	84.00	83.30	79.80
3	80.40	81.50	81.70	95.10	103.90	95.20	93.70	84.90	81.50	83.85	83.20	79.70
4	79.70	81.35	81.80	94.50	102.85	94.20	93.30	84.65	81.60	83.40	83.10	79.60
5	79.40	81.50	82.00	93.90	101.60	95.60	92.90	84.55	82.10	82.90	83.00	79.50
6	79.55	81.65	82.60	93.40	100.10	98.50	92.40	84.40	81.80	82.60	82.85	79.40
7	79.60	82.10	82.90	92.70	98.80	99.80	91.75	84.00	81.50	82.50	82.70	79.10
8	79.75	82.10	83.10	92.40	97.60	99.90	91.55	83.60	81.30	82.50	82.65	78.90
9	79.55	82.20	83.60	92.20	97.50	99.00	94.00	83.20	81.20	82.20	82.50	78.80
10	79.60	82.75	83.80	93.40	97.35	98.00	96.30	82.90	81.30	82.00	82.50	78.90
11	79.60	83.20	84.20	93.90	96.70	97.10	98.00	82.55	81.40	82.00	82.45	78.90
12	79.50	83.55	84.70	94.50	96.15	96.40	98.90	82.40	81.35	81.85	82.30	78.70
13	79.70	83.55	84.70	94.70	95.25	95.60	99.05	82.10	81.10	81.70	82.25	78.30
14	79.75	83.90	84.80	94.50	94.30	95.30	98.30	82.15	81.15	81.50	82.10	77.50
15	80.00	84.00	84.60	94.40	93.60	95.40	96.40	82.15	81.00	81.35	81.95	77.30
16	80.10	83.70	84.50	94.40	92.85	96.00	94.50	82.30	80.90	81.30	81.85	77.10
17	80.05	83.30	84.60	94.20	92.40	96.10	92.95	82.50	81.00	81.20	81.70	76.80
18	80.35	82.90	85.10	95.50	92.55	95.70	92.30	82.60	81.50	81.20	81.55	76.20
19	80.45	82.50	85.45	95.70	93.10	95.55	92.00	82.40	82.30	81.10	81.40	75.90
20	80.30	82.70	85.60	95.20	93.30	95.60	91.65	83.30	83.15	81.10	81.30	75.90
21	81.00	82.65	85.60	94.80	92.70	95.75	91.20	84.50	84.25	81.20	81.10	75.80
22	83.50	82.10	86.00	94.90	92.00	96.30	90.10	84.25	84.40	81.20	80.90	75.70
23	86.40	81.80	87.40	95.10	91.40	95.90	89.15	84.55	83.80	81.30	80.80	75.75
24	87.50	81.90	88.60	95.80	90.70	94.80	88.70	85.00	83.10	81.50	80.70	76.50
25	87.20	82.10	89.40	100.00	90.35	94.10	88.70	84.80	83.10	81.70	80.50	76.20
26	86.95	82.20	91.10	102.80	90.00	93.10	88.65	85.10	83.60	81.95	80.40	77.00
27	85.90	82.30	91.85	104.20	89.70	92.40	88.20	85.00	84.05	82.15	80.25	77.70
28	84.55	82.20	93.90	105.10	90.10	92.40	87.40	84.30	84.00	82.50	80.10	77.30
29	83.95	81.95	95.10	105.80	90.00	93.25	86.80	83.40	84.05	82.85	80.00	75.65
30	83.30	.....	95.80	105.70	90.50	94.45	86.30	82.70	84.60	83.30	80.00	75.30
31	82.60	.....	95.90	.....	92.30	.....	85.80	82.20	.....	83.40	.....	75.30

1905.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	75.30	84.00	89.30	89.80	89.70	90.40	93.90	91.50	84.30	86.70	85.00	83.70
2	75.85	83.90	89.40	90.40	88.70	90.20	93.80	92.10	84.20	86.00	85.00	83.80
3	77.30	83.40	89.70	90.20	88.10	90.30	93.80	92.50	83.90	85.60	85.10	83.50
4	77.80	84.30	89.60	90.10	87.40	90.70	94.10	92.40	83.70	85.20	85.20	83.30
5	77.40	84.40	90.90	89.90	86.60	91.40	95.30	91.60	83.30	84.90	85.20	83.00
6	77.80	84.35	90.20	89.35	86.00	91.90	95.90	90.80	83.20	84.60	85.70	82.70
7	77.60	84.10	89.50	88.70	85.10	91.60	96.40	89.90	83.30	84.20	86.20	82.30
8	77.00	83.70	89.10	88.10	84.60	91.00	96.20	88.90	83.40	83.80	86.20	81.80
9	77.20	83.80	88.70	87.70	84.10	90.40	95.70	88.50	83.40	83.40	85.90	81.40
10	76.70	83.50	88.35	87.30	83.90	90.10	95.40	88.20	83.30	83.30	85.80	81.00
11	76.00	83.40	88.30	87.00	84.10	89.80	95.30	87.80	83.40	83.10	85.60	80.80
12	76.00	83.40	88.40	86.80	84.60	89.90	95.50	87.20	84.20	82.90	85.70	80.60
13	75.60	82.90	88.20	86.70	84.60	90.90	96.10	86.60	85.10	82.70	85.90	80.50
14	75.15	82.90	87.20	86.60	85.30	91.50	96.70	86.40	84.50	82.50	85.60	80.70
15	74.90	83.05	86.50	86.60	86.80	92.20	97.10	85.90	84.00	82.30	85.00	80.80
16	74.80	83.10	86.00	86.70	88.60	92.30	96.60	85.30	84.00	82.10	84.50	80.70
17	75.35	83.00	85.70	86.80	90.80	92.10	95.40	85.00	86.00	82.00	84.00	80.70
18	76.00	83.10	85.60	86.80	90.90	91.60	93.80	84.70	95.00	84.10	83.70	80.70
19	76.60	83.00	85.60	86.50	91.30	91.20	92.50	84.90	98.60	89.90	83.40	80.90
20	77.20	82.90	85.30	86.20	92.30	91.80	91.50	85.50	100.70	88.40	83.40	80.90
21	77.50	82.80	85.20	86.00	92.00	92.00	90.90	85.60	101.30	87.00	83.60	81.10
22	78.00	82.80	85.60	85.80	91.20	91.80	90.40	85.90	101.10	87.00	83.30	81.00
23	78.25	82.90	86.40	86.00	90.60	91.50	89.80	87.00	100.10	86.80	83.00	81.00
24	78.55	83.30	87.10	86.40	90.30	91.60	90.00	89.30	98.00	86.50	83.00	80.90
25	79.30	83.70	87.40	86.70	89.80	92.20	90.50	89.60	95.10	86.10	82.90	80.80
26	81.30	84.60	87.70	87.10	89.60	92.70	91.20	89.20	93.10	86.80	82.80	80.70
27	83.20	86.90	88.00	87.60	89.50	92.80	91.00	89.00	91.50	87.50	82.70	80.60
28	83.80	87.90	88.40	87.90	89.80	92.80	90.00	88.40	89.70	86.50	82.70	80.60
29	83.70	.....	89.00	88.00	90.00	93.10	89.50	87.20	88.20	86.10	83.00	81.10
30	83.70	.....	89.20	89.00	90.90	93.50	89.40	86.00	87.20	85.80	83.40	81.20
31	84.00	.....	89.05	.....	90.90	.....	90.70	84.90	.....	85.40	.....	81.40

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1906.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	81.5	86.7	93.4	96.3	92.4	87.0	91.1	84.0	84.0	85.2	81.3	83.2
2	81.4	86.9	93.8	95.7	92.4	87.7	91.1	84.0	83.7	85.5	81.7	83.4
3	81.7	86.7	94.2	95.3	92.4	88.1	91.3	84.3	83.6	85.8	81.9	83.7
4	82.7	85.9	93.6	94.8	93.5	88.5	91.2	84.1	83.4	85.8	82.1	83.8
5	86.7	85.3	92.2	95.2	92.2	89.0	90.8	83.9	83.2	85.5	82.2	83.8
6	87.7	84.6	91.4	95.0	92.3	89.0	90.4	83.7	83.2	84.5	82.2	84.2
7	87.3	83.9	90.7	94.7	93.2	89.6	90.2	83.7	83.1	84.0	82.2	84.4
8	86.5	83.2	90.4	94.7	93.7	90.1	89.9	83.8	83.1	83.7	82.4	84.2
9	85.4	83.0	90.4	95.2	93.0	90.7	89.4	83.8	83.1	83.5	82.4	84.0
10	84.2	82.8	90.2	95.4	92.1	91.2	88.9	84.0	83.0	83.2	82.5	83.7
11	83.2	82.4	89.9	95.1	91.3	91.3	88.3	84.3	83.1	82.9	82.7	83.5
12	82.8	82.3	89.6	94.7	90.8	90.8	88.0	84.5	83.3	82.6	82.7	83.3
13	82.5	82.3	89.3	94.8	90.3	90.4	87.6	85.1	83.1	82.5	82.6	83.3
14	82.3	82.5	88.9	96.5	89.8	90.3	87.4	85.7	83.0	82.5	82.6	83.1
15	82.1	82.5	88.6	97.2	89.4	90.2	87.1	86.1	82.9	82.3	82.6	82.8
16	82.2	82.4	88.0	96.6	88.8	89.9	87.0	86.1	82.8	82.2	82.6	82.5
17	81.8	82.5	87.3	96.1	88.2	89.6	86.7	85.7	82.8	82.1	82.7	82.2
18	81.7	82.8	86.8	95.7	87.6	89.4	86.5	85.2	82.8	82.0	82.9	81.9
19	81.8	83.1	86.5	95.5	87.3	89.4	86.1	84.8	83.0	81.9	82.7	81.4
20	81.9	83.4	86.1	95.2	87.0	89.9	85.7	85.1	83.2	81.8	82.7	81.0
21	82.4	83.6	85.4	95.0	86.6	90.8	85.6	85.1	83.1	81.6	83.1	81.2
22	83.7	83.7	84.9	94.5	86.3	91.5	85.6	84.9	83.1	81.5	83.4	81.0
23	84.5	84.7	84.6	94.0	86.1	92.2	85.6	84.5	83.1	81.4	83.4	80.7
24	85.8	86.9	84.7	93.6	86.0	92.5	85.9	84.1	83.7	81.4	83.3	80.2
25	86.0	89.2	84.9	93.6	86.0	92.7	86.7	83.9	84.5	81.2	83.1	79.8
26	85.8	90.9	85.1	93.3	85.8	91.8	86.9	83.9	84.8	81.1	83.1	79.5
27	85.6	92.2	89.5	93.0	85.8	91.0	86.2	85.7	84.9	81.1	83.0	79.2
28	85.5	93.0	93.3	92.8	85.8	91.0	85.9	86.1	84.9	81.0	83.0	79.1
29	85.5	.....	94.9	92.6	86.1	91.3	85.2	85.3	85.2	81.0	83.0	79.2
30	85.8	.....	95.9	92.4	86.0	91.3	84.8	84.8	85.2	80.9	83.0	79.7
31	86.2	.....	96.6	.....	86.5	.....	84.3	84.4	.....	81.0	.....	80.1

1907.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	80.5	88.2	87.5	88.9	90.3	86.8	93.9	96.3	86.0	82.9	81.3	80.6
2	80.9	87.8	87.3	89.2	90.6	87.0	93.3	95.1	86.0	82.9	81.4	80.5
3	81.3	87.1	87.0	89.2	90.7	87.9	92.9	93.7	85.9	83.2	81.2	80.5
4	82.0	86.3	86.7	89.0	90.5	90.3	92.2	92.8	85.8	83.9	81.1	80.4
5	82.9	85.5	86.5	88.9	89.8	91.9	91.4	92.2	85.9	84.4	81.1	80.4
6	83.5	84.7	86.5	88.9	89.6	92.5	90.7	91.6	85.8	84.4	81.0	80.2
7	83.8	83.7	86.5	88.9	89.6	92.5	90.8	91.0	85.6	84.5	81.0	80.2
8	83.9	82.5	86.1	88.7	90.2	91.5	91.1	91.0	85.4	84.6	80.9	80.1
9	83.8	82.0	85.8	88.9	91.0	91.2	91.3	90.8	85.0	84.9	80.9	79.9
10	83.8	82.0	85.6	88.9	91.3	91.2	91.3	90.5	84.5	85.3	81.0	79.9
11	83.7	82.1	85.8	88.9	90.8	91.8	91.3	90.1	84.1	85.4	80.8	79.9
12	83.7	82.3	86.4	89.2	90.1	92.4	91.3	89.5	83.8	85.5	80.8	79.7
13	83.7	83.0	87.9	90.5	89.1	93.8	91.5	89.0	83.6	85.3	80.7	79.7
14	84.0	83.9	90.0	90.6	88.5	94.2	91.9	88.7	83.3	85.0	80.7	79.7
15	84.5	84.9	90.3	90.4	88.5	93.9	92.6	88.4	83.2	84.5	80.6	79.7
16	84.7	84.6	89.7	90.2	90.7	94.8	92.8	88.4	83.0	84.2	80.6	79.8
17	85.8	84.6	89.1	90.2	92.3	93.7	93.4	87.9	82.8	83.8	80.6	79.9
18	88.4	85.0	88.9	90.2	92.5	92.8	95.0	87.9	82.7	83.4	80.6	80.0
19	90.3	85.4	88.7	90.5	92.2	92.2	95.9	88.5	82.3	83.1	80.6	80.0
20	94.0	85.2	88.7	91.1	90.7	91.8	96.2	89.3	82.2	83.0	80.5	79.9
21	96.7	84.9	89.0	91.8	89.7	a91.7	96.6	89.5	82.0	82.7	80.6	79.8
22	97.1	84.9	88.3	91.9	88.9	91.3	97.4	89.3	81.9	82.5	80.6	79.7
23	97.3	85.6	87.6	91.4	87.9	91.3	98.0	89.0	82.1	82.2	80.6	79.7
24	96.6	86.6	87.3	91.6	87.3	92.0	98.5	88.6	82.3	82.1	80.6	79.8
25	95.6	87.3	87.1	91.6	86.7	93.7	98.8	a88.4	82.5	82.0	80.5	79.8
26	94.1	87.6	87.0	91.2	a86.3	94.0	98.7	88.7	82.6	81.9	80.5	79.6
27	92.5	87.6	87.0	90.9	86.2	95.2	98.2	87.8	82.3	81.9	80.5	79.6
28	91.0	87.6	86.8	90.1	86.9	95.2	97.6	86.8	82.9	81.6	80.6	79.6
29	89.9	.....	86.8	89.5	87.0	94.9	97.4	86.4	82.9	81.5	80.6	79.5
30	89.2	.....	87.8	89.5	86.9	94.4	97.2	86.3	82.9	81.4	80.6	79.4
31	88.6	.....	88.2	.....	86.8	.....	97.2	86.1	.....	81.3	.....	79.4

a Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

CHAIN OF ROCKS, MO.—Continued.

1908.

[Gauge 10.42 miles from Eads Bridge. Zero of gauge 321.18 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	79.60	79.00	88.30	86.50	87.80	98.90	101.30	.....	.....	.....	.....	.....
2	79.80	78.00	88.20	86.30	87.40	99.30	101.30	.....	.....	.....	.....	.....
3	79.80	77.80	88.50	86.30	87.00	99.90	101.70	.....	.....	.....	.....	.....
4	79.80	77.60	88.70	86.60	87.00	101.00	102.00	.....	.....	.....	.....	.....
5	79.80	77.80	88.90	86.60	87.40	101.30	102.10	.....	.....	.....	.....	.....
6	79.80	77.80	89.30	86.50	88.20	101.30	102.00	.....	.....	.....	.....	.....
7	79.80	78.10	89.50	86.50	88.90	101.40	101.80	.....	.....	.....	.....	.....
8	79.70	78.60	89.50	86.70	89.60	101.40	100.60	.....	.....	.....	.....	.....
9	79.50	79.20	90.30	87.40	90.30	101.40	99.30	.....	.....	.....	.....	.....
10	79.30	79.20	91.80	88.90	91.00	101.50	98.60	.....	.....	.....	.....	.....
11	79.30	79.30	91.70	90.10	91.60	101.60	98.00	.....	.....	.....	.....	.....
12	79.60	79.70	91.70	90.80	91.40	102.00	97.80	.....	.....	.....	.....	.....
13	79.80	79.70	91.70	90.80	90.80	102.60	97.60	.....	.....	.....	.....	.....
14	79.80	80.40	91.50	90.80	90.60	103.00	97.10	.....	.....	.....	.....	.....
15	79.70	82.30	91.10	90.90	90.60	103.70	96.30	.....	.....	.....	.....	.....
16	79.70	85.50	90.80	90.70	92.60	104.80	95.30	.....	.....	.....	.....	.....
17	79.50	86.90	90.30	90.10	94.20	105.80	94.30	.....	.....	.....	.....	.....
18	79.40	86.90	89.90	89.60	95.60	105.90	93.60	.....	.....	.....	.....	.....
19	79.40	87.10	89.60	88.70	95.30	106.10	93.70	.....	.....	.....	.....	.....
20	79.40	87.80	89.20	88.00	95.10	106.10	93.70	.....	.....	.....	.....	.....
21	79.00	87.80	88.90	87.50	94.50	106.10	94.10	.....	.....	.....	.....	.....
22	79.00	87.30	88.70	87.30	94.20	105.80	94.00	.....	.....	.....	.....	.....
23	79.30	87.10	88.40	87.00	94.00	105.30	93.50	.....	.....	.....	.....	.....
24	79.70	86.70	88.00	87.40	94.00	104.70	92.80	.....	.....	.....	.....	.....
25	79.60	86.30	87.50	87.60	93.60	104.20	92.30	.....	.....	.....	.....	.....
26	79.70	86.50	87.50	87.80	93.80	103.90	91.90	.....	.....	.....	.....	.....
27	79.80	87.90	86.90	88.40	95.00	103.70	91.80	.....	.....	.....	.....	.....
28	79.80	88.30	86.80	88.90	96.20	103.20	91.80	.....	.....	.....	.....	.....
29	79.80	88.50	87.00	88.90	96.70	102.60	91.80	.....	.....	.....	.....	.....
30	79.20	.....	87.00	88.40	97.10	101.80	91.30	.....	.....	.....	.....	.....
31	78.89	.....	86.70	.....	98.50	.....	90.80	.....	.....	.....	.....	.....

BISSELLS POINT, MO.

1880.

[Gauge 3.30 miles from Eads Bridge. Zero gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	85.00	91.00	85.10	79.60	79 20	75.90	71.00
2	.....	.....	.....	.....	.....	85 80	91.50	84 60	79 80	79 60	75.80	71.40
3	.....	.....	.....	.....	.....	86.90	92.10	84.10	79 90	79 70	75.70	71.70
4	.....	.....	.....	.....	.....	86.90	92.90	83.60	81.00	79 80	75.60	71.90
5	.....	.....	.....	.....	.....	86.10	93.10	83 30	82 00	80 00	75 60	72 30
6	.....	.....	.....	.....	.....	86 00	93 80	83 00	81.80	80 10	75 60	72 90
7	.....	.....	.....	.....	.....	86.80	94.30	82.70	81.60	80 00	75 60	72 90
8	.....	.....	.....	.....	.....	86.50	94.40	82 50	81.50	79 80	75.50	72.60
9	.....	.....	.....	.....	.....	86.10	94.40	82 40	82 20	79 60	75 40	72 30
10	.....	.....	.....	.....	.....	86 20	94.50	82.20	82 80	79 30	75 40	72 20
11	.....	.....	.....	.....	.....	87 20	94 60	82 10	83.00	79 00	75.60	72 10
12	.....	.....	.....	.....	.....	88 70	94 70	81.90	82 50	78 80	75 70	72 40
13	.....	.....	.....	.....	.....	88 80	94.70	81 60	81.80	77 90	75.60	72.50
14	.....	.....	.....	.....	.....	88 20	94.50	81.30	81 10	77 60	75 60	72.60
15	.....	.....	.....	.....	.....	87 60	94 20	81.10	80 50	77 40	75 70	73.00
16	.....	.....	.....	.....	.....	87 60	94 10	80 80	80 00	77 10	75 90	73.40
17	.....	.....	.....	.....	.....	87 10	93 70	80 60	79 40	77 00	76 00	73 80
18	.....	.....	.....	.....	.....	86.70	93.10	80.10	79 00	76 70	76 20	74.10
19	.....	.....	.....	.....	.....	86 30	92 30	79 80	78 60	76 40	76 10	74 20
20	.....	.....	.....	.....	.....	86 00	91.80	79 40	78 40	76.20	75 90	74 20
21	.....	.....	.....	.....	.....	86.00	91.00	79 10	78 20	76.20	75.80	74.00
22	.....	.....	.....	.....	.....	86 40	90 20	78 70	77 80	76.30	75 60	73 60
23	.....	.....	.....	.....	.....	87 60	89 70	78.40	77 60	76.40	74 90	73 40
24	.....	.....	.....	.....	.....	88.00	89 40	78.20	77.50	76.60	74.20	73.20
25	.....	.....	.....	.....	.....	88 20	89 00	78 00	77 60	76 70	73 60	73 10
26	.....	.....	.....	.....	.....	88.40	88.60	77 80	77 80	76 70	72.90	73 10
27	.....	.....	.....	.....	.....	89 30	88 30	77 70	78 00	76.50	71.90	73 20
28	.....	.....	.....	.....	.....	90 20	87 70	77 70	78.00	76 40	71 30	72 20
29	.....	.....	.....	.....	.....	90 60	87 00	77.80	78.20	76 30	71.00	71.30
30	.....	.....	.....	.....	.....	90 80	86 20	78.50	78.50	76.20	70.90	73 00
31	.....	.....	.....	.....	.....	90.90	85.70	79.40	.....	76.00	.....	74.50

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1881.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	75.00	75.60	81.00	91.30	100.40	89.50	91.20	84.10	76.50	81.30	92.30	89.20
2	76.00	75.60	82.60	93.00	100.60	89.20	91.40	83.80	76.40	82.30	92.40	88.60
3	76.40	75.50	83.80	95.30	101.30	88.80	92.40	83.50	76.30	84.60	92.50	88.00
4	76.80	75.50	84.00	.....	102.10	88.90	93.00	83.10	76.30	85.60	92.60	87.70
5	76.80	75.30	84.00	.....	102.60	89.60	93.20	82.70	76.30	87.70	92.70	87.30
6	76.70	75.30	83.80	.....	102.90	90.00	93.00	82.40	76.30	87.70	92.80	87.00
7	76.80	75.20	83.60	.....	102.90	90.00	92.50	82.00	76.40	87.80	92.90	86.60
8	76.50	75.80	83.60	.....	102.30	89.70	91.50	81.50	76.40	88.00	92.90	86.10
9	76.40	76.70	83.60	.....	100.99	89.20	90.40	81.00	76.50	88.10	92.90	85.80
10	76.30	78.20	83.30	.....	98.40	89.00	89.20	80.70	76.60	88.20	92.80	85.50
11	76.30	85.70	82.90	.....	97.00	89.10	88.00	80.20	76.90	88.50	92.70	85.10
12	76.40	85.40	82.40	.....	95.80	89.10	87.00	80.00	77.10	88.70	92.50	84.90
13	76.50	85.30	83.50	.....	95.00	89.40	86.40	79.60	77.40	88.90	92.60	84.60
14	76.70	85.30	85.80	.....	94.80	90.10	86.00	79.30	77.60	88.90	92.70	84.50
15	76.30	83.00	87.60	.....	94.60	90.80	86.80	79.00	77.80	88.80	93.10	85.20
16	76.20	82.40	88.20	.....	94.20	90.70	87.60	78.60	78.10	88.50	94.20	86.50
17	76.40	81.60	88.50	.....	93.70	90.60	88.70	78.40	78.40	88.10	94.50	86.80
18	76.40	80.50	88.80	.....	93.50	90.70	89.30	78.20	78.80	88.20	94.60	86.20
19	76.40	79.80	90.00	.....	93.50	91.10	89.70	78.00	79.10	88.80	95.10	85.50
20	76.40	79.10	90.40	.....	93.50	92.20	90.00	77.90	79.20	90.00	97.80	85.00
21	76.40	78.80	90.40	.....	93.50	93.20	90.30	77.80	79.30	91.00	97.80	84.70
22	76.30	78.60	89.80	.....	93.40	93.00	90.50	77.70	79.40	92.00	97.10	84.20
23	76.20	78.40	89.20	.....	93.20	93.00	90.50	77.60	79.50	92.40	96.20	84.20
24	76.10	78.00	88.70	.....	93.00	93.00	90.50	77.60	79.70	92.60	95.50	85.00
25	76.00	78.40	88.60	.....	93.20	93.00	90.30	77.50	79.90	93.10	94.60	86.00
26	75.90	78.70	88.80	.....	93.50	93.00	90.00	77.40	80.10	93.30	93.70	86.50
27	75.80	78.90	89.00	.....	93.40	92.80	89.20	77.30	80.30	93.50	92.50	86.50
28	75.70	79.70	89.10	.....	93.00	92.40	87.80	77.10	80.60	93.40	91.40	86.40
29	75.70	.....	89.10	.....	92.30	92.00	86.20	77.00	80.80	93.10	90.50	86.00
30	75.70	.....	89.20	.....	91.50	91.60	85.20	76.80	81.00	92.80	89.80	85.70
31	75.60	.....	89.90	.....	90.50	.....	84.50	76.60	.....	92.50	.....	85.40

1882.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	85.00	77.90	86.80	85.70	93.30	96.00	97.60	85.70	78.30	75.30	78.60	78.60
2	84.70	78.10	86.30	85.80	93.40	96.40	98.30	85.50	78.10	75.20	78.90	78.40
3	84.50	78.10	86.30	86.00	93.20	96.60	99.30	85.00	78.30	75.10	78.90	78.20
4	83.40	77.90	85.10	86.00	92.70	96.70	100.80	85.00	78.40	75.00	78.80	77.80
5	82.90	77.70	84.70	86.00	92.00	96.40	101.30	85.00	78.20	75.00	78.60	77.50
6	82.60	77.70	84.50	86.00	91.60	96.00	101.40	85.50	78.10	75.00	78.50	77.20
7	82.40	77.80	84.70	85.90	91.40	95.80	101.10	86.10	78.10	75.00	78.20	77.00
8	81.70	77.80	84.70	85.80	91.30	95.60	100.80	85.80	78.10	74.80	78.00	76.80
9	81.30	78.00	84.70	85.70	91.30	95.50	100.40	85.40	78.10	74.70	77.80	75.90
10	81.30	78.20	85.10	86.40	91.40	95.10	99.70	84.90	78.20	74.70	77.60	75.00
11	81.10	78.40	86.10	87.30	92.20	94.60	98.80	84.30	78.40	74.80	77.60	74.00
12	80.90	78.30	87.70	87.60	92.80	94.00	97.80	83.80	78.40	74.90	77.60	72.80
13	80.70	78.30	88.10	88.10	92.80	93.10	96.70	83.50	78.30	75.00	77.70	72.20
14	80.60	78.20	87.80	88.80	92.80	92.50	95.70	83.10	78.10	75.20	77.80	72.00
15	80.80	78.50	87.20	89.80	92.80	92.50	94.80	82.60	78.00	75.40	78.50	71.80
16	81.10	78.60	86.80	91.10	92.70	92.60	94.00	82.30	77.90	75.60	78.70	71.30
17	81.00	78.50	86.40	91.80	92.60	92.70	93.20	82.10	77.70	75.80	78.50	70.90
18	80.50	78.30	86.00	91.60	92.40	93.80	92.90	81.80	77.50	76.00	78.20	70.70
19	80.00	78.20	86.00	91.00	92.20	95.40	92.80	81.50	77.30	76.20	78.10	70.50
20	79.60	79.40	86.10	90.60	92.10	95.30	92.60	81.10	77.00	76.80	78.20	70.70
21	79.30	89.00	86.30	90.00	92.30	95.00	92.50	80.70	76.80	77.60	78.30	71.60
22	78.80	96.50	86.70	89.60	92.40	94.70	92.50	80.30	76.60	77.80	78.40	72.00
23	78.20	96.60	86.80	89.50	91.80	95.70	92.10	80.10	76.60	77.80	78 40	72.50
24	77.70	95.40	86.80	90.60	91.00	96.10	91.10	79.80	76.50	77.80	78.40	73.60
25	77.30	93.70	86.60	92.00	90.20	96.30	90.10	79.60	76.30	77.80	78.40	74.60
26	77.50	91.80	86.60	92.50	89.90	95.90	89.10	79.50	76.00	77.80	78.30	75.00
27	77.60	89.80	86.40	92.60	90.10	95.50	88.30	79.40	75.80	77.80	78.40	76.00
28	77.80	88.10	86.20	92.80	91.10	95.40	87.40	79.20	75.60	77.80	78.40	76.20
29	78.00	.....	86.00	93.00	93.20	96.10	86.70	79.00	75.50	77.80	78.50	76.30
30	77.90	.....	85.80	93.20	95.10	96.80	86.10	78.70	75.40	78.00	78.60	76.30
31	77.60	.....	85.70	.....	95.70	.....	86.00	78.50	.....	78.50	.....	76.30

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1883.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge, 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.50	74.00	94.20	86.00	86.70	94.00	101.50	86.00	79.20	74.70	79.30	78.30
2	76.30	74.00	94.10	85.80	86.80	93.20	100.70	87.00	78.90	74.80	79.30	78.20
3	76.10	74.40	94.00	85.00	86.80	92.60	100.00	89.00	78.70	75.10	79.10	78.10
4	75.70	74.70	93.40	84.70	87.20	92.30	99.00	89.10	78.40	75.30	78.70	78.00
5	75.40	75.00	92.50	84.00	87.40	91.80	97.70	88.20	78.40	75.40	78.20	77.90
6	75.00	75.20	91.70	83.70	87.50	91.20	96.50	87.70	78.20	75.50	78.10	77.70
7	74.20	75.00	91.00	83.40	87.60	91.10	94.80	87.20	78.00	75.90	77.80	77.50
8	74.10	74.90	90.80	83.60	87.70	91.80	93.50	86.70	77.70	76.50	77.80	77.20
9	74.00	74.30	91.00	84.60	87.80	92.80	92.50	86.50	77.40	76.70	79.00	77.00
10	74.10	73.70	90.70	85.30	87.90	93.20	91.50	86.20	77.10	76.70	80.50	76.90
11	74.20	73.70	89.60	85.40	88.00	93.50	91.10	85.80	76.90	76.70	81.70	76.80
12	73.60	73.50	89.00	85.50	88.00	94.00	91.00	85.20	76.70	76.70	82.20	76.90
13	72.30	73.30	88.70	85.50	88.00	94.50	91.00	84.70	76.50	76.70	82.00	77.00
14	72.50	73.10	87.90	85.40	88.00	94.50	91.00	84.00	76.20	77.30	81.70	77.10
15	72.40	75.30	87.70	85.30	88.00	95.80	91.20	83.40	76.00	76.70	81.20	77.00
16	72.60	78.20	87.50	85.10	88.50	97.30	92.00	83.10	75.80	76.30	80.60	77.00
17	72.70	88.00	87.70	84.80	89.40	98.20	92.50	82.70	75.60	76.30	80.20	77.00
18	72.90	92.00	87.30	84.50	90.70	99.40	92.60	82.50	75.50	76.30	79.70	77.00
19	73.50	94.00	86.80	84.50	91.60	100.90	92.20	82.70	75.30	76.70	79.00	76.30
20	73.70	93.20	86.60	84.80	93.00	101.50	91.70	82.70	75.20	76.70	78.40	75.70
21	73.90	92.00	86.70	85.30	94.40	102.40	91.10	82.00	75.10	77.60	78.00	75.20
22	73.80	91.60	86.80	86.40	94.60	102.90	90.50	81.50	75.10	78.80	77.90	74.60
23	73.50	92.00	86.80	87.80	95.00	103.40	90.20	81.20	75.00	78.90	78.50	74.00
24	73.30	92.60	86.80	88.80	95.00	103.80	89.20	81.40	75.00	78.50	79.30	73.60
25	73.30	93.90	86.70	88.70	94.50	104.40	88.00	82.00	75.00	78.10	78.90	73.40
26	73.40	94.60	86.50	88.10	94.00	104.60	87.00	81.80	74.90	78.20	78.70	72.90
27	73.60	94.60	86.20	87.50	93.50	104.30	86.30	81.40	74.90	78.10	78.70	72.70
28	73.50	94.50	86.10	87.10	93.60	103.80	86.50	81.30	74.90	77.80	78.60	72.40
29	73.70	.....	85.70	86.80	93.70	103.20	86.00	80.50	74.80	77.90	78.30	72.20
30	73.90	.....	85.20	86.70	94.60	102.40	85.90	80.00	74.80	78.30	78.30	72.20
31	74.00	.....	85.50	.....	94.50	.....	85.80	79.50	.....	79.10	.....	72.70

1884.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	72.90	80.20	79.90	92.60	89.10	85.60	88.90	84.50	80.30	88.30	85.40	80.30
2	72.90	82.00	79.60	92.80	88.60	85.00	88.50	84.90	80.50	89.00	85.00	79.60
3	72.80	77.00	79.50	93.60	89.40	84.50	87.90	84.20	80.40	90.20	84.10	78.70
4	71.70	78.20	79.30	93.90	90.10	85.40	87.30	83.70	80.30	89.30	83.60	77.90
5	71.20	78.90	79.40	94.10	90.80	85.90	87.60	83.40	80.20	88.20	83.10	77.30
6	71.00	81.00	79.20	94.50	92.00	86.10	86.60	83.30	79.70	87.40	82.60	76.80
7	71.50	83.40	79.00	95.00	93.30	86.30	86.50	82.80	79.00	86.80	82.50	76.50
8	74.90	82.90	78.80	95.20	93.50	86.60	86.80	82.10	78.40	86.60	82.10	76.30
9	77.70	82.10	78.00	95.90	93.20	86.80	87.10	81.50	78.00	86.50	81.60	76.50
10	78.00	81.00	77.70	96.50	92.70	87.50	87.30	81.00	77.80	86.20	81.20	77.50
11	78.60	79.80	77.70	96.50	92.20	88.80	87.00	80.40	77.90	86.60	80.90	78.40
12	79.40	78.70	77.70	96.40	91.70	89.50	86.40	80.00	77.80	87.40	80.70	79.10
13	79.80	78.30	79.20	96.20	91.50	90.00	85.80	79.70	77.70	88.00	80.50	80.00
14	79.80	80.20	78.10	95.70	91.20	89.90	85.60	79.40	77.50	88.20	80.30	80.90
15	80.00	82.10	78.00	94.80	90.40	89.40	85.40	79.20	77.30	88.20	80.20	80.90
16	80.10	81.80	78.00	94.10	89.40	88.70	85.60	79.00	78.00	88.10	80.00	80.50
17	80.40	81.60	78.20	93.40	88.60	88.20	87.00	78.70	77.70	87.80	79.80	80.00
18	80.50	82.10	77.80	92.60	88.00	87.80	88.70	78.40	77.60	87.50	79.70	79.30
19	80.50	82.80	79.40	91.90	87.90	87.60	88.60	78.30	77.80	87.10	79.60	78.30
20	80.20	83.60	82.40	91.20	87.80	87.70	87.50	78.10	77.80	86.80	79.40	77.60
21	80.00	82.60	84.00	91.10	87.90	88.10	86.30	78.10	77.50	86.40	79.30	76.80
22	80.00	82.10	84.40	90.40	87.90	88.90	85.10	78.60	77.40	86.00	79.10	75.60
23	80.00	82.10	85.10	90.20	87.50	88.90	84.00	78.60	77.70	85.90	79.00	73.50
24	79.80	82.10	85.40	90.90	87.00	89.20	83.20	78.20	78.00	85.50	79.00	72.90
25	79.60	81.90	88.20	91.90	86.50	89.10	82.80	77.80	78.40	86.10	80.00	72.20
26	79.80	81.50	87.80	92.30	86.00	89.20	82.70	77.70	79.00	86.50	81.50	72.40
27	80.00	81.10	89.60	92.20	85.80	89.55	82.80	77.70	81.20	86.80	81.60	72.60
28	79.80	80.70	91.50	91.80	85.50	89.70	83.00	77.90	83.00	86.40	81.40	73.00
29	79.70	80.40	93.80	90.80	85.50	89.60	83.80	78.40	85.00	86.00	81.10	73.30
30	79.60	.....	93.80	90.10	85.70	89.40	84.10	79.30	87.00	85.90	80.80	75.10
31	79.50	.....	92.90	.....	85.80	.....	84.10	79.80	.....	85.50	.....	81.10

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1887.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	85.50	82.00	84.70	78.20	75.40	76.70	74.10	.....
2	.....	.....	.....	.....	85.60	81.20	84.90	78.00	75.40	76.60	74.10	.....
3	.....	.....	.....	.....	85.50	80.60	84.90	77.90	75.30	77.00	74.10	.....
4	.....	.....	.....	.....	85.50	80.30	85.10	.....	75.10	76.40	74.00	.....
5	.....	.....	.....	.....	86.30	80.10	85.30	77.60	75.00	76.10	74.10	.....
6	.....	.....	.....	.....	86.70	80.30	85.30	77.40	75.00	76.00	74.00	.....
7	.....	.....	.....	.....	86.90	80.50	85.10	77.30	75.00	75.70	74.00	.....
8	.....	.....	.....	.....	86.40	80.80	84.70	77.00	75.10	75.60	73.90	.....
9	.....	.....	.....	.....	85.90	81.10	84.60	76.90	75.90	75.50	73.80	.....
10	.....	.....	.....	.....	85.40	81.00	84.40	76.70	76.70	75.40	73.80	.....
11	.....	.....	.....	.....	84.90	81.00	84.30	76.70	77.00	75.40	73.80	.....
12	.....	.....	.....	.....	84.60	81.00	83.70	76.70	77.20	75.30	73.80	74.80
13	.....	.....	.....	.....	84.30	83.30	.....	76.40	77.00	75.70	73.80	74.30
14	.....	.....	.....	.....	84.10	84.20	82.60	76.30	76.80	76.60	73.80	73.90
15	.....	.....	.....	.....	84.00	84.70	82.10	76.10	76.80	76.50	73.80	73.70
16	.....	.....	.....	.....	84.40	85.60	81.70	76.10	76.70	76.00	73.80	73.60
17	.....	.....	.....	.....	84.30	86.30	81.30	76.40	77.00	75.50	73.80	73.20
18	.....	.....	.....	.....	84.60	86.40	81.00	76.30	79.40	75.20	73.90	72.90
19	.....	.....	.....	.....	85.20	85.70	80.60	76.10	79.70	75.00	73.90	72.80
20	.....	.....	.....	.....	85.20	84.80	80.20	76.00	79.40	74.80	73.80	72.80
21	.....	.....	.....	83.70	84.50	84.00	80.00	75.90	79.00	74.70	73.80	72.60
22	.....	.....	.....	84.50	84.10	83.60	79.90	75.80	78.50	74.60	73.70	72.20
23	.....	.....	.....	87.70	83.80	84.00	79.80	75.60	78.10	74.60	.....	71.70
24	.....	.....	.....	87.90	83.50	84.00	79.80	75.50	77.70	74.40	.....	70.70
25	.....	.....	.....	87.20	83.10	84.00	79.70	75.60	77.40	74.30	.....	70.30
26	.....	.....	.....	86.30	83.10	83.90	79.80	75.90	77.10	74.30	.....	70.20
27	.....	.....	.....	85.70	83.40	83.80	79.80	75.90	77.00	74.30	.....	70.10
28	.....	.....	.....	85.60	83.10	83.90	79.60	75.80	76.80	74.30	.....	70.80
29	.....	.....	.....	85.50	83.10	84.20	79.20	75.60	76.80	74.20	.....	72.20
30	.....	.....	.....	85.40	83.10	84.40	78.80	75.50	76.80	74.20	.....	73.00
31	.....	.....	.....	.....	82.70	.....	78.50	75.40	.....	74.10	.....	73.80

1888.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.20	82.50	82.30	.....	90.20	97.60	95.80	83.60	80.60	73.90	73.50	.....
2	74.60	80.20	81.80	.....	90.30	97.60	95.40	83.00	.....	73.90	73.50	.....
3	75.40	81.00	81.20	.....	90.60	98.00	94.60	82.20	.....	73.90	73.50	.....
4	76.50	82.30	81.70	.....	90.90	98.30	93.80	81.50	.....	73.80	73.50	.....
5	79.50	82.30	82.90	88.50	91.10	97.80	93.10	81.00	.....	.....	73.70	.....
6	78.60	82.90	83.50	87.80	91.20	96.70	92.50	81.00	78.20	.....	73.60	.....
7	.....	.....	83.40	87.40	91.30	95.80	91.90	81.50	78.00	73.80	73.70	.....
8	.....	80.90	83.10	88.30	91.60	95.20	91.50	83.60	77.70	73.80	74.00	.....
9	.....	80.00	82.60	90.00	91.60	94.70	.....	.....	77.40	73.80	74.70	.....
10	.....	.....	82.60	90.60	92.10	94.00	93.00	.....	77.10	.....	75.40	.....
11	.....	77.80	82.90	90.00	92.90	93.50	93.80	.....	76.80	.....	76.10	.....
12	.....	77.00	83.30	90.00	93.00	92.90	93.70	83.10	76.50	.....	76.30	.....
13	.....	76.50	83.40	90.80	93.40	92.40	93.30	82.60	76.10	.....	76.40	.....
14	77.20	76.30	83.30	91.40	.....	91.90	93.00	85.20	75.90	.....	76.80	.....
15	76.50	76.30	83.20	91.70	.....	91.70	92.70	87.30	75.80	.....	77.00	.....
16	76.10	76.50	83.20	91.40	94.40	92.50	92.20	86.80	75.70	.....	76.70	.....
17	75.70	75.60	.....	91.10	94.60	93.30	91.60	86.10	75.70	.....	76.20	.....
18	75.30	75.50	.....	90.70	95.20	94.30	90.30	86.00	75.40	.....	75.80	.....
19	75.40	75.80	.....	90.40	95.60	94.50	89.20	85.90	75.20	.....	75.50	.....
20	75.60	76.00	.....	90.40	95.40	94.00	88.20	85.20	75.10	73.40	.....	.....
21	76.70	78.40	.....	90.40	.....	93.10	87.60	84.60	75.00	73.40	.....	.....
22	79.70	79.30	.....	90.70	96.40	.....	87.20	.....	.....	73.50	.....	.....
23	81.60	80.50	.....	91.60	96.80	93.90	87.00	.....	.....	73.50	.....	.....
24	82.50	82.60	.....	91.90	96.80	94.00	86.20	.....	.....	73.50	.....	.....
25	82.80	84.20	.....	91.50	96.50	94.70	.....	.....	.....	73.50	.....	.....
26	82.30	84.40	.....	90.70	96.20	94.60	85.20	.....	.....	73.50	.....	.....
27	82.80	84.20	.....	90.00	95.90	94.40	84.70	.....	.....	73.60	.....	.....
28	82.60	84.00	.....	89.80	95.90	94.50	84.60	.....	.....	73.60	.....	.....
29	82.60	83.20	.....	89.80	96.80	95.00	85.80	.....	.....	73.60	.....	.....
30	83.20	.....	.....	90.10	97.50	95.60	84.80	81.80	.....	73.60	.....	.....
31	84.20	.....	.....	.....	97.70	.....	83.00	81.30	.....	73.60	.....	.....

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1889.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	75.00	.....	.....	78.90	93.00	84.10	81.40	74.30	73.50	72.30	73.70
2	.....	74.50	.....	.....	78.40	91.70	83.60	81.00	74.30	.....	73.10	73.80
3	.....	74.40	.....	.....	78.10	89.80	.....	80.50	74.10	.....	75.70	73.80
4	.....	74.30	.....	.....	77.80	87.40	.....	80.20	74.10	.....	77.40	73.70
5	.....	74.30	.....	.....	77.80	85.50	.....	79.50	74.40	.....	76.80	73.40
6	.....	74.70	.....	.....	78.00	84.00	.....	78.90	.....	72.90	75.90	73.20
7	.....	74.70	.....	.....	77.70	82.90	.....	78.30	.....	72.90	75.40	73.00
8	.....	74.30	.....	.....	77.30	82.40	.....	77.90	74.20	72.80	75.00	72.70
9	.....	73.80	.....	.....	77.00	82.90	.....	77.50	74.20	72.70	74.70	72.70
10	.....	73.60	.....	.....	76.80	85.70	.....	77.40	74.20	72.60	.....	72.80
11	75.00	73.50	.....	.....	76.70	87.60	80.40	77.10	74.20	72.50	77.70	72.80
12	74.70	73.50	.....	.....	76.70	.....	80.10	.....	74.30	72.40	79.00	73.10
13	74.50	73.20	.....	.....	76.80	.....	80.20	.....	74.70	72.20	.....	74.10
14	75.00	73.20	.....	.....	76.80	.....	79.80	.....	.....	72.10	.....	74.90
15	75.80	73.20	.....	.....	77.10	.....	79.70	.....	.....	72.20	.....	74.90
16	76.60	73.40	.....	.....	77.50	.....	79.60	.....	.....	72.20	.....	74.70
17	78.00	74.20	.....	.....	77.80	.....	79.50	.....	.....	72.10	.....	74.70
18	79.40	75.60	.....	.....	79.40	.....	79.70	.....	.....	72.10	.....	74.70
19	80.10	75.50	.....	.....	79.90	.....	80.60	.....	.....	72.10	.....	74.50
20	80.50	74.80	.....	.....	82.00	.....	82.00	79.40	.....	72.10	74.70	74.40
21	80.20	.....	.....	.....	86.20	.....	83.70	79.10	76.00	72.00	74.30	74.30
22	79.20	.....	.....	.....	87.70	86.80	83.30	78.80	75.80	72.10	74.00	74.30
23	78.20	.....	.....	.....	87.40	86.60	82.10	78.30	75.10	72.20	73.80	74.20
24	77.40	.....	.....	.....	86.80	86.00	81.60	77.60	74.50	72.60	73.60	74.00
25	76.80	.....	.....	.....	86.60	85.40	81.20	76.90	74.30	72.80	73.50	74.10
26	76.60	.....	.....	.....	86.10	.....	80.90	76.40	74.30	72.70	73.50	74.00
27	76.50	.....	.....	81.60	85.40	85.70	80.50	75.90	74.10	72.60	73.60	73.90
28	76.20	.....	.....	80.50	85.00	85.50	80.20	75.50	73.90	72.50	73.60	73.90
29	75.80	.....	.....	79.70	84.50	84.80	81.30	75.00	73.80	72.30	73.60	73.80
30	75.40	.....	.....	79.30	90.60	84.40	82.00	74.80	73.60	72.20	73.60	73.70
31	75.30	.....	.....	.....	93.00	.....	81.80	74.50	.....	72.20	.....	73.70

1890.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.00	77.10	76.20	82.10	86.80	80.80	89.00	79.10	76.30	76.10	76.60	74.90
2	75.20	77.80	75.70	81.70	86.10	80.30	88.80	78.80	76.30	76.30	76.50	74.50
3	75.30	78.20	75.30	83.00	85.40	80.10	88.70	78.50	76.20	76.30	76.40	74.50
4	75.30	78.20	74.90	85.60	84.80	80.50	88.60	78.20	75.90	76.10	76.10	74.40
5	75.40	78.90	74.30	86.00	84.40	81.40	88.30	77.90	76.00	75.90	76.00	74.30
6	77.50	79.50	73.80	85.30	83.80	81.80	88.10	77.70	76.00	75.80	75.80	74.10
7	79.70	80.00	73.80	84.00	83.40	81.60	87.80	77.50	75.50	75.70	75.50	73.90
8	79.60	79.80	73.60	83.20	83.40	81.60	87.70	77.40	75.50	75.60	75.30	73.70
9	78.50	79.30	73.70	82.60	83.40	82.00	87.60	77.50	75.60	75.50	75.30	73.20
10	77.80	79.00	74.10	81.70	82.00	83.60	87.20	77.50	75.50	75.80	75.10	72.70
11	78.40	79.00	74.90	81.20	81.40	84.60	86.20	77.10	75.50	76.20	75.00	72.60
12	80.00	79.20	76.10	80.80	81.10	85.10	85.40	76.80	75.60	76.20	74.80	72.50
13	83.40	79.30	77.90	80.60	81.20	86.60	84.70	76.70	75.60	75.90	74.70	72.50
14	85.60	79.40	80.90	80.70	81.80	87.80	84.40	76.60	75.50	75.40	74.60	72.00
15	86.00	79.60	82.70	81.10	82.20	87.80	84.50	77.00	75.50	75.10	74.60	71.80
16	85.00	79.90	83.60	81.70	82.10	87.80	84.10	78.00	75.30	75.00	74.70	71.50
17	83.80	79.60	83.30	82.10	81.70	87.80	83.40	77.20	75.20	75.00	74.90	71.40
18	.....	79.20	82.60	82.30	81.80	88.00	82.80	76.50	75.10	75.60	74.90	71.40
19	.....	79.00	.....	82.40	81.80	88.20	82.20	76.40	75.30	76.60	74.90	71.50
20	.....	79.00	.....	83.20	81.40	88.40	81.70	76.40	75.60	77.10	75.10	71.70
21	.....	78.80	.....	84.10	81.20	88.30	81.50	76.30	76.00	77.50	75.60	71.80
22	.....	78.40	.....	84.20	80.90	87.80	81.20	76.10	76.40	77.60	76.70	72.00
23	.....	77.80	.....	83.90	80.50	87.80	81.30	76.60	76.50	77.40	77.30	72.00
24	.....	77.40	.....	83.60	80.60	88.50	81.20	77.20	76.30	77.20	77.20	72.20
25	.....	77.20	.....	83.50	81.50	88.50	81.40	77.00	76.40	76.90	76.80	72.30
26	75.00	77.30	.....	83.90	82.60	88.20	81.70	76.70	76.30	76.80	76.50	72.40
27	75.50	77.50	.....	85.60	81.50	88.00	81.30	76.70	76.10	76.50	76.20	72.30
28	76.00	77.40	.....	87.40	81.20	88.50	80.60	76.50	76.00	76.50	76.00	72.00
29	76.50	.....	.....	87.30	81.10	89.20	80.10	76.20	76.00	76.50	75.60	71.50
30	76.50	.....	83.40	87.20	81.00	89.20	79.80	76.20	75.90	76.50	75.20	71.30
31	76.60	.....	82.60	.....	81.00	.....	79.50	76.40	.....	76.60	.....	71.30

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1891.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	71.80	72.60	79.20	88.00	88.90	83.90	89.60	83.60	78.10	72.60	72.90	72.10
2	72.20	72.80	78.70	88.20	88.70	83.60	91.00	84.10	77.40	72.50	72.80	71.60
3	72.70	73.00	78.20	88.20	88.90	82.60	92.00	83.20	77.00	72.40	72.80	71.20
4	73.10	73.00	77.40	88.00	89.40	83.60	92.50	82.20	76.60	72.30	72.80	71.40
5	73.30	73.20	76.60	87.90	89.20	87.30	92.30	81.70	76.20	72.30	72.80	71.50
6	73.10	73.20	76.20	87.80	88.70	87.70	91.70	81.90	75.90	72.20	72.80	71.50
7	73.30	73.00	76.10	87.50	88.50	87.10	90.40	82.20	75.60	72.00	72.80	71.80
8	73.70	72.40	76.50	87.30	88.20	89.20	89.00	81.80	75.30	72.20	72.80	72.20
9	73.80	72.20	76.60	87.20	87.60	90.90	88.60	81.30	75.10	72.20	72.90	72.10
10	73.50	72.30	76.60	87.20	87.00	91.70	88.90	81.00	74.90	72.30	73.10	71.70
11	73.30	72.30	76.50	87.80	86.50	91.60	89.30	80.80	74.70	72.60	73.10	71.60
12	73.10	72.50	76.50	88.80	86.10	91.70	89.00	80.80	74.50	73.10	73.00	71.70
13	72.90	72.70	76.10	89.00	85.70	90.50	88.40	80.20	74.40	73.50	72.80	71.80
14	72.50	73.20	75.80	88.90	85.30	88.50	87.50	79.40	74.40	73.90	72.80	72.00
15	72.40	73.70	75.70	88.50	84.90	87.80	86.60	79.20	74.30	74.30	72.90	72.30
16	72.10	74.00	75.50	89.10	84.60	88.40	86.10	79.50	74.10	74.40	73.00	72.50
17	71.90	73.90	75.60	90.90	84.00	88.20	86.10	80.90	73.90	74.50	73.20	72.70
18	71.80	73.90	75.60	91.30	83.60	87.90	86.00	81.00	73.80	74.40	73.20	73.00
19	72.00	73.70	75.70	91.40	82.90	87.60	85.20	81.80	73.70	74.30	73.30	73.20
20	72.10	73.70	76.40	91.50	82.40	87.90	84.60	83.40	73.60	74.20	73.10	73.30
21	72.10	73.60	78.20	91.40	81.90	88.40	84.10	86.40	73.50	74.00	73.30	73.40
22	72.30	75.30	80.40	91.40	81.80	89.10	83.50	87.90	73.50	73.80	72.80	73.50
23	72.50	77.40	82.00	91.60	82.40	90.30	83.10	86.50	73.40	73.80	73.30	73.70
24	72.50	78.60	83.90	92.20	82.80	91.70	82.80	85.10	73.30	73.60	73.60	74.00
25	72.60	79.60	85.10	92.40	83.10	91.90	82.90	84.40	73.20	73.60	74.10	74.10
26	72.50	80.20	85.60	92.10	84.20	91.20	83.10	83.80	73.10	73.50	74.00	74.20
27	72.40	80.10	86.00	91.40	84.80	90.00	83.40	82.60	73.00	73.30	73.50	74.20
28	72.50	79.70	86.60	90.80	84.50	88.70	83.30	81.20	72.90	73.30	73.00	74.00
29	72.70	.....	87.20	90.20	84.20	88.20	82.70	80.00	72.80	73.20	72.80	73.80
30	72.60	.....	87.80	89.40	84.50	88.50	82.50	79.10	72.70	73.10	72.60	73.90
31	72.50	.....	87.90	.....	84.50	.....	82.80	78.50	.....	73.00	.....	74.10

1892.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.30	75.40	82.80	86.30	89.80	101.30	96.70	86.20	76.80	73.90	73.10	71.30
2	74.90	76.40	82.40	86.20	89.10	101.70	97.10	85.60	76.70	73.80	72.90	71.10
3	76.80	75.80	82.00	86.70	89.10	102.50	97.70	85.20	76.50	73.90	72.70	71.00
4	76.50	76.40	82.10	88.70	89.00	103.50	98.80	84.60	76.20	73.40	72.60	70.80
5	75.70	76.60	82.30	92.30	89.80	103.80	99.60	84.10	76.00	73.20	72.50	70.70
6	74.90	77.80	82.00	94.50	92.20	103.60	99.60	83.60	75.80	73.20	72.40	70.70
7	74.40	80.00	82.00	95.70	95.00	103.20	99.60	83.20	75.60	73.00	72.30	71.10
8	74.10	81.90	82.80	96.00	96.50	102.80	99.70	82.80	75.40	72.80	72.20	71.20
9	73.50	83.00	84.80	95.80	97.10	102.40	99.80	82.30	75.40	72.80	72.10	72.00
10	72.50	83.40	87.00	93.70	98.00	101.90	99.60	82.00	75.20	72.60	72.10	72.60
11	71.40	83.30	86.80	92.90	99.00	101.50	99.30	81.70	75.10	72.40	72.10	72.70
12	71.40	82.90	86.30	91.40	100.10	100.70	98.90	81.60	75.70	72.40	72.00	72.70
13	75.00	82.00	85.50	90.20	101.30	100.40	98.80	81.80	76.30	72.30	72.00	72.60
14	77.60	81.00	84.60	90.20	103.20	99.90	98.60	81.50	76.00	72.20	72.00	72.40
15	77.70	80.40	84.00	90.40	104.30	99.20	98.60	80.90	75.80	72.20	72.00	72.20
16	77.70	80.70	83.50	90.50	104.90	98.70	98.00	80.60	75.60	72.10	71.90	71.90
17	77.90	80.20	82.80	90.60	105.50	98.00	97.50	80.30	75.40	72.10	72.30	71.50
18	78.40	79.40	82.50	91.20	105.90	97.30	97.30	80.10	75.30	72 00	72.20	71.00
19	78.10	79.60	82.20	92.30	106.10	96.60	96.00	79.80	75.10	72.10	72.20	70.60
20	78.20	83.30	81.60	93.70	105.70	96.10	96.20	79.50	75.00	72.20	72.00	70.20
21	78.50	85.90	81.10	95.30	105.00	95.60	95.20	79.10	75.00	72.20	72.10	69.50
22	78.50	85.40	80.60	95.40	104.50	94.70	94.70	78.80	74.90	72.20	72.10	68.90
23	78.70	84.10	80.80	95.60	104.30	94.30	94.20	78.40	74.80	72.10	72.10	68.60
24	78.80	82.70	81.70	95.00	104.20	94.60	93.50	78.10	74.70	72.10	72.00	68.30
25	79.10	81.60	82.00	94.30	103.90	95.30	92.70	77.80	74.60	72.00	72.00	68.40
26	79.60	81.50	82.50	93.60	103.50	95.60	91.60	77.50	74.40	72.10	71.90	68.20
27	79.60	82.20	82.60	92.70	102.90	95.70	90.40	77.20	74.20	72.20	71.80	71.00
28	79.60	82.70	82.40	91.80	102.00	96.20	89.10	77.00	74.10	72.30	71.80	71.80
29	78.00	83.00	82.60	91.10	101.10	96.50	88.00	76.90	73.90	72.80	71.60	72.40
30	74.90	.....	83.80	90.50	100.70	96.50	87.20	76.80	73.90	73.20	71.40	73.80
31	75.00	.....	85.10	.....	100.70	.....	86.70	76.80	.....	73.20	.....	74.00

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1893.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.00	75.00	79.80	84.70	99.60	95.60	86.30	78.20	72.50	70.60	70.60	69.50
2	75.70	74.60	80.80	84.40	100.20	96.20	86.50	78.70	72.30	70.60	70.40	69.20
3	74.70	74.00	81.10	84.10	100.40	96.70	85.80	78.70	72.10	70.60	70.50	68.60
4	74.40	74.00	81.00	84.00	99.80	96.90	85.40	78.00	72.00	70.60	70.60	68.40
5	74.40	74.10	80.60	83.80	99.10	96.30	85.30	71.80	71.80	70.70	70.60	67.70
6	74.10	74.80	80.50	83.90	97.90	95.30	86.90	77.30	71.70	71.20	70.50	67.60
7	73.70	74.50	80.30	84.50	96.70	94.50	89.40	76.10	71.60	71:30	70.50	67.40
8	74.10	74.70	80.10	84.30	95.70	94.80	89.30	75.60	71.40	71.20	70.50	67.20
9	74.30	75.00	81.60	84.00	94.80	94.90	88.00	75.20	71.40	71.10	70.50	67.30
10	74.30	75.00	85.00	85.40	94.20	94.30	87.30	74.90	71.40	71.00	70.50	67.50
11	74.50	75.10	86.80	88.00	94.20	93.20	86.20	74.60	71.30	71.40	70.50	67.70
12	75.10	75.10	87.50	91.00	94.80	92.00	85.00	74.70	71.20	71.30	70.50	67.70
13	75.40	75.20	87.60	91.80	95.00	91.00	83.90	75.00	71.10	71.20	70.50	67.80
14	75.40	75.90	87.40	91.70	94.70	90.10	83.00	74.60	71.00	71.20	70.40	67.40
15	75.50	77.40	87.00	91.60	94.30	89.70	82.40	74.20	70.90	71.00	70.40	67.70
16	75.40	78.10	86.90	91.70	94.10	89.60	81.80	74.00	70.80	70.80	70.40	68.10
17	75.60	77.80	87.80	91.70	93.90	89.30	81.90	73.80	70.70	70.70	70.40	68.70
18	75.80	77.30	89.20	90.80	93.60	87.80	83.00	73.80	70.70	70.70	70.40	68.70
19	75.80	77.00	89.80	89.80	93.10	87.80	84.20	73.60	70.60	70.70	70.40	68.60
20	75.60	76.90	89.80	90.90	92.60	87.00	84.00	73.60	70.50	70.70	70.40	68.40
21	75.80	77.10	89.30	94.40	92.00	86.30	83.00	75.00	70.50	70.70	70.40	68.70
22	75.80	76.70	88.80	94.70	91.80	85.70	82.30	76.60	70.40	70.70	70.40	69.00
23	75.90	76.90	88.90	94.30	91.20	85.60	81.70	77.10	70.60	70.60	70.40	69.10
24	75.90	76.70	89.00	93.80	90.90	86.20	81.00	76.60	70.60	70.60	70.40	69.40
25	76.00	76.90	87.90	93.80	90.70	86.30	80.20	75.80	70.60	70.60	70.40	69.70
26	75.90	77.60	87.00	94.40	90.80	88.50	79.50	75.00	70.60	70.60	70.40	69.70
27	75.80	78.50	86.30	95.30	93.90	89.60	78.90	74.30	70.60	70.60	70.20	69.70
28	75.80	79.20	86.00	96.00	96.20	88.90	78.40	73.70	70.60	70.50	70.20	69.80
29	75.60	.....	85.60	96.50	96.80	88.40	78.10	73.30	70.60	70.60	70.00	69.70
30	75.60	.....	85.30	98.10	96.80	87.30	77.80	73.00	70.60	70.50	69.80	69.70
31	75.30	.....	85.00	.....	96.20	.....	78.40	72.70	.....	70.50	.....	69.80

1894.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.; after October 1, about noon.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	70.00	68.00	72.90	79.00	80.80	86.10	85.00	76.50	71.20	71.85	70.20	70.52
2	70.20	68.00	72.80	78.70	82.10	85.90	84.90	76.60	71.00	71.50	70.30	70.55
3	70.20	67.80	73.00	78.50	82.40	85.60	84.50	76.20	71.00	71.18	70.45	70.75
4	70.40	68.10	73.60	78.20	82.20	85.40	83.90	76.10	71.00	71.05	70.50	71.00
5	70.60	68.70	74.20	77.70	82.20	85.30	83.80	75.80	71.20	70.95	70.65	71.55
6	70.70	69.00	76.80	77.60	83.10	85.20	84.20	75.40	71.50	70.89	70.75	71.45
7	70.80	69.50	81.70	77.40	84.70	85.60	84.30	75.00	71.50	70.65	70.90	71.45
8	70.70	70.80	85.20	78.10	86.40	85.80	83.40	74.70	72.00	70.60	71.05	71.22
9	70.40	72.40	86.80	79.60	87.60	85.80	82.40	74.40	72.30	70.48	71.25	70.70
10	70.20	73.30	87.70	79.70	88.80	85.60	81.80	74.10	72.20	70.48	71.25	70.40
11	70.00	73.80	87.60	79.20	91.30	85.40	81.40	73.90	72.20	70.55	71.10	70.28
12	69.90	73.40	86.40	79.50	90.80	85.30	81.20	73.70	72.20	70.60	71.10	70.15
13	69.60	72.70	84.80	80.30	89.40	85.30	80.70	73.50	72.20	70.65	70.82	70.00
14	69.30	71.80	83.30	80.40	88.50	85.40	80.00	73.30	72.00	70.65	70.85	70.12
15	69.10	71.50	82.20	80.00	87.80	85.20	79.30	73.00	72.10	70.65	70.85	70.25
16	69.40	71.40	81.30	80.00	87.50	85.20	78.80	72.80	72.40	70.45	70.78	70.40
17	69.70	71.70	80.60	82.60	86.80	85.20	78.50	72.60	73.40	70.40	70.85	70.35
18	69.60	71.80	80.00	84.60	85.80	84.90	78.30	72.50	73.80	70.35	70.85	70.35
19	69.60	72.20	79.40	86.40	84.80	84.90	78.20	72.30	73.60	70.25	70.85	70.28
20	70.10	73.00	79.10	86.10	83.80	85.00	78.20	72.20	73.20	70.20	70.85	70.30
21	70.60	72.60	79.00	84.20	83.20	85.00	78.00	72.20	73.00	70.20	70.82	70.38
22	71.00	72.30	79.10	83.00	82.70	85.10	77.90	72.10	72.90	70.25	70.85	70.38
23	71.40	72.50	79.20	82.30	82.50	85.20	77.90	72.00	72.80	70.15	70.88	70.42
24	72.10	72.50	79.30	81.80	82.30	85.20	77.70	71.80	73.10	70.20	70.90	70.50
25	71.30	72.60	79.30	81.30	82.20	85.20	77.30	71.80	73.00	70.55	70.95	70.52
26	70.30	72.80	79.20	81.20	82.10	85.20	77.10	71.60	73.30	70.60	70.95	70.45
27	69.30	72.80	78.90	80.90	81.90	85.40	76.90	71.60	73.30	70.40	70.78	70 38
28	68.60	72.80	80.10	80.60	81.80	86.30	76.70	71.40	72.90	70.25	70.60	70 40
29	68.20	.....	80.90	80.30	81.80	86.40	77.30	71.40	72.50	70.20	70.45	69.83
30	68.30	.....	80.60	80.30	83.60	85.60	76.90	71.40	72.20	70.20	70.45	69.60
31	68.10	.....	79.80	.....	85.70	.....	76.60	71.20	.....	70.25	.....	69.40

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1895.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	68.00	73.60	73.60	75.78	74.10	76.45	80.98	81.65	77.10	71.50	70.48	69.94
2	67.32	73.20	74.70	76.50	73.90	76.27	81.37	81.60	77.28	71.43	70.44	69.97
3	67.82	73.20	75.00	77.00	73.82	75.92	81.48	81.08	78.00	71.50	70.40	69.82
4	67.63	72.95	75.30	76.25	74.05	75.65	81.88	80.67	78.60	71.69	70.38	69.35
5	67.45	72.95	75.10	75.50	74.32	75.55	81.73	79.95	78.55	71.83	70.29	69.83
6	67.45	72.80	75.00	74.95	74.67	75.72	81.00	79.16	78.80	71.89	70.26	68.38
7	67.45	72.60	75.50	74.75	75.60	75.69	84.05	78.68	79.10	71.85	70.26	67.99
8	67.55	72.40	75.90	74.50	75.50	75.53	85.35	78.65	79.50	71.75	70.42	67.86
9	67.65	72.32	75.80	74.25	75.57	75.50	85.10	78.20	78.82	71.65	70.58	67.85
10	67.40	72.60	75.30	74.72	75.20	75.85	84.55	78.18	78.30	71.65	70.74	67.96
11	67.45	73.00	75.10	77.00	74.60	77.05	83.55	78.04	77.82	71.70	70.72	67.96
12	67.45	73.25	74.75	77.50	74.45	77.35	82.25	77.58	77.30	71.77	70.42	67.85
13	67.60	73.25	74.40	77.45	74.70	78.80	80.58	77.13	77.75	71.90	70.59	68.33
14	70.80	73.25	74.30	77.22	74.92	80.07	80.10	76.34	76.10	71.93	70.59	68.55
15	71.15	73.15	74.45	76.85	75.00	80.08	80.44	75.65	75.63	71.93	70.53	68.64
16	71.75	73.12	74.40	76.15	74.88	80.20	80.35	75.17	75.15	71.99	70.56	68.72
17	72.60	72.95	74.25	75.70	75.30	80.35	80.12	74.72	74.68	71.80	70.50	68.92
18	73.12	72.75	74.20	75.45	75.58	80.40	79.98	74.52	74.42	71.78	70.38	69.02
19	71.35	72.65	74.20	75.28	76.30	80.58	79.97	74.36	74.27	71.63	70.27	69.89
20	70.65	72.52	73.80	75.10	77.38	80.42	80.60	74.68	74.10	71.58	70.28	81.27
21	69.65	72.55	73.65	75.02	77.53	80.15	80.80	75.18	73.72	71.35	70.29	90.65
22	69.12	72.82	73.20	75.10	78.02	80.18	81.02	75.58	73.27	71.22	70.25	91.35
23	68.85	73.10	73.20	75.20	77.58	80.89	81.47	75.45	72.78	71.13	70.25	91.15
24	69.00	73.35	73.30	75.50	76.80	81.20	81.90	75.02	72.33	71.07	70.32	91.39
25	68.52	73.90	73.28	74.80	76.35	80.97	82.31	75.38	72.18	70.98	70.40	90.98
26	68.05	72.35	74.20	74.47	76.08	80.50	81.79	76.12	72.11	70.93	70.64	89.30
27	67.42	72.10	74.70	74.30	76.00	80.22	81.45	76.62	71.91	70.82	70.69	87.60
28	67.60	72.30	74.42	74.35	76.05	80.40	80.78	76.78	71.78	70.75	70.45	86.80
29	71.00	.....	75.70	74.35	76.00	80.78	80.19	77.19	71.58	70.67	70.27	86.43
30	73.35	.....	76.05	74.27	76.10	80.88	80.53	77.33	71.53	70.58	70.10	85.65
31	73.40	.....	75.84	.....	76.30	.....	80.60	77.13	.....	70.52	.....	84.68

1896.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	83.57	72.60	76.69	76.10	81.85	93.21	85.96	82.48	76.38	74.90	71.80	73.10
2	82.38	73.10	77.23	75.55	82.05	92.90	86.45	82.68	75.95	74.48	71.95	73.04
3	81.28	74.40	77.20	75.17	82.21	93.25	86.57	83.02	75.47	74.13	72.42	73.28
4	79.72	75.02	76.90	74.81	82.25	93.45	86.80	83.43	75.07	73.92	73.60	73.60
5	78.31	75.14	76.52	74.54	82.31	93.83	87.27	83.68	74.78	73.79	74.67	73.47
6	77.30	75.21	76.28	74.33	82.22	94.10	87.05	83.77	74.41	73.77	75.95	72.86
7	76.75	75.50	76.00	74.09	82.27	93.80	86.41	83.67	74.09	73.63	76.75	72.33
8	75.90	75.66	75.54	73.88	82.49	93.25	86.30	83.60	73.80	73.45	76.50	72.04
9	75.20	75.40	75.32	74.10	82.66	93.40	[a] 86.60	83.10	73.54	73.30	75.90	71.79
10	74.60	[a] 75.10	75.17	74.38	82.99	93.17	86.35	82.33	73.29	73.25	75.35	71.47
11	74.03	74.83	75.00	78.68	83.33	92.62	85.44	81.57	73.08	73.19	74.99	71.35
12	73.63	74.48	74.76	80.85	83.46	92.02	84.47	81.00	72.90	73.29	74.70	71.40
13	73.44	74.90	74.48	81.42	83.16	90.97	83.83	80.79	72.83	[a] 73.40	74.42	71.73
14	73.30	77.33	74.24	81.12	82.87	89.18	83.19	80.23	72.90	73.33	74.23	72.06
15	73.20	78.80	74.05	80.73	82.44	87.45	82.35	79.49	73.25	73.54	74.07	72.50
16	73.15	78.29	73.90	80.40	82.32	86.24	81.67	79.07	73.51	73.83	74.03	73.02
17	73.07	77.65	73.59	80.05	82.25	86.17	81.47	78.52	73.48	73.75	74.02	73.60
18	73.04	77.35	73.22	79.80	82.36	87.48	81.60	78.19	73.60	73.48	74.23	74.39
19	73.07	76.85	[a] 73.00	79.20	85.02	87.90	81.55	78.03	74.10	73.20	74.20	75.09
20	72.95	75.99	72.91	78.65	89.38	87.99	82.08	78.74	75.08	[b] 73.00	74.22	75.38
21	72.99	74.93	72.82	78.40	92.36	87.77	84.98	79.70	76.12	72.90	74.26	75.40
22	72.60	74.10	72.78	78.23	93.45	87.25	89.40	80.40	77.20	72.70	74.10	75.38
23	72.61	73.60	72.94	77.95	94.20	86.54	90.41	81.02	77.99	72.53	74.00	75.20
24	72.89	73.22	73.15	77.70	95.21	86.05	90.02	80.81	77.83	72.46	73.78	75.10
25	73.28	73.13	73.45	77.70	96.07	85.77	88.76	80.09	77.30	72.32	73.75	75.10
26	73.20	73.63	74.25	77.82	96.57	85.46	87.25	79.80	76.97	72.10	73.65	74.90
27	72.70	74.30	75.16	78.45	96.30	85.58	86.35	79.47	76.55	72.00	73.52	74.63
28	72.48	75.52	75.20	79.20	96.70	86.04	85.24	78.62	76.25	71.90	73.47	74.37
29	72.40	76.09	75.63	79.90	96.00	86.43	84.33	77.94	75.89	71.85	73.26	74.28
30	72.30	.....	76.33	81.05	95.24	85.80	83.70	77.48	75.39	71.87	73.12	74.18
31	72.38	.....	76.54	.....	94.20	.....	83.00	76.91	.....	71.78	.....	74.12

[a] Reading changed less than one-half foot. [b] Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1897.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.15	73.00	80.40	92.70	99.95	82.45	89.50	81.20	74.20	71.20	70.30	70.70
2	74.10	72.70	79.95	95.75	100.35	81.95	89.30	81.00	73.85	71.15	70.40	70.45
3	74.70	73.00	80.25	96.85	100.25	82.10	89.70	80.60	73.55	71.05	70.45	70.15
4	88.10	73.70	80.70	96.70	99.95	82.75	90.50	80.10	73.30	71.05	70.40	69.95
5	92.15	74.30	82.85	96.75	99.15	83.85	90.10	79.80	73.15	71.05	70.40	70.00
6	92.50	74.85	88.50	96.85	98.10	84.30	89.00	79.60	72.95	70.95	70.45	69.20
7	92.90	75.20	89.85	96.70	96.90	84.65	88.70	79.35	72.85	70.90	70.60	68.15
8	92.00	75.85	89.60	96.55	95.50	84.80	88.30	79.15	72.85	70.85	70.90	67.50
9	89.35	76.40	89.05	97.00	94.40	84.70	88.60	79.35	72.85	70.70	71.05	67.20
10	86.20	77.65	88.35	98.00	93.50	84.35	88.10	79.60	72.85	70.65	71.30	67.40
11	83.50	78.70	87.30	98.35	92.65	84.10	86.70	79.00	72.70	70.60	71.30	67.40
12	81.10	78.95	86.85	98.20	91.65	83.65	86.00	78.70	72.50	70.55	71.30	67.75
13	79.60	78.90	86.25	97.95	90.60	83.10	85.00	78.45	72.25	70.50	71.30	67.75
14	78.70	80.20	86.05	97.15	89.70	82.65	83.80	78.25	72.05	70.45	71.30	68.20
15	78.20	80.10	85.40	96.40	88.90	82.30	82.90	78.20	71.90	70.35	71.30	68.50
16	77.80	80.90	84.90	95.80	88.25	82.20	82.30	78.15	71.70	70.35	71.35	68.75
17	77.70	81.00	84.85	95.70	87.45	82.20	81.90	78.00	71.55	70.25	71.35	69.10
18	78.10	80.60	84.95	95.85	86.65	82.40	81.90	77.85	71.45	70.25	71.10	68.90
19	80.10	80.40	84.95	95.95	86.00	82.50	82.20	77.65	71.40	70.20	71.00	67.90
20	81.50	80.10	85.25	95.90	85.35	82.25	81.90	77.45	71.30	70.20	70.90	67.55
21	82.20	80.00	86.10	96.10	84.60	81.90	81.40	77.35	71.25	70.15	70.85	67.45
22	82.35	81.00	86.80	96.40	84.05	81.90	80.90	77.10	71.15	70.10	70.80	67.10
23	82.35	82.70	87.50	96.65	83.55	82.80	80.50	76.95	71.15	70.10	70.80	67.00
24	81.95	83.20	88.30	96.80	83.15	83.40	80.40	76.80	71.25	70.10	70.80	67.00
25	81.30	83.15	88.40	96.50	83.05	83.35	81.00	76.45	71.50	70.10	70.80	67.10
26	79.90	82.90	89.70	96.10	83.60	85.05	83.30	76.10	71.60	70.10	70.85	67.15
27	78.60	82.45	91.10	96.10	83.75	85.35	85.40	75.70	71.50	70.15	70.90	67.45
28	77.50	81.30	91.65	96.90	83.70	85.90	85.50	75.35	71.40	70.20	70.95	67.90
29	76.15	.....	91.65	98.00	83.70	87.80	84.20	75.05	71.30	70.20	70.90	68.60
30	74.30	.....	91.55	99.20	84.10	89.50	82.50	74.80	71.25	70.25	70.85	68.90
31	73.55	.....	91.55	.....	83.50	.....	81.60	74.50	.....	70.25	.....	69.20

1898.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge, 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	69.80	72.35	76.00	90.65	82.90	87.65	91.65	78.05	73.20	73.40	76.50	73.10
2	69.90	72.65	75.85	89.65	82.80	87.35	91.55	77.95	72.85	73.10	75.45	72.50
3	69.30	72.05	75.70	88.15	84.95	88.05	90.70	79.45	72.50	72.65	74.70	72.00
4	68.90	71.50	75.55	86.80	87.30	88.75	89.35	79.70	72.20	72.35	74.20	71.50
5	69.10	71.20	75.40	86.00	89.00	89.30	88.55	79.10	72.00	72.00	73.80	71.20
6	69.40	70.80	75.30	86.05	89.25	89.50	88.15	78.40	71.85	71.60	73.75	70.85
7	69.95	71.15	75.15	86.40	89.25	89.05	88.15	77.60	71.85	71.35	73.75	70.70
8	70.05	71.55	75.05	86.20	88.75	88.05	90.30	76.95	72.25	71.15	74.20	70.15
9	70.20	72.45	75.00	86.20	88.25	87.55	90.55	77.10	73.25	70.90	74.35	69.70
10	70.45	72.45	74.95	86.45	87.70	87.55	90.10	76.80	74.15	70.80	74.50	68.70
11	72.15	72.45	75.10	86.20	86.95	88.50	89.15	76.15	75.60	70.85	74.95	68.00
12	72.85	73.25	75.45	85.45	85.95	89.60	88.55	75.70	75.90	71.15	75.05	68.55
13	73.60	74.85	78.00	85.00	84.90	90.75	87.20	75.85	75.85	72.05	74.75	68.55
14	74.00	76.15	83.05	84.80	84.55	91.50	86.05	76.35	75.25	71.60	74.35	68.50
15	73.80	76.40	84.75	85.30	84.10	91.60	85.00	76.25	74.65	71.05	74.00	68.50
16	73.60	76.60	85.20	85.45	84.80	92.15	83.60	76.55	74.50	70.80	73.65	68.90
17	73.25	76.60	85.65	84.85	88.70	93.65	82.50	76.20	76.35	70.50	73.45	69.05
18	72.95	76.75	85.55	84.10	90.95	94.10	81.70	76.15	77.60	70.50	73.30	69.25
19	72.65	77.35	85.20	83.45	91.70	93.55	81.05	75.80	78.30	71.00	73.25	69.55
20	72.75	78.20	85.00	82.95	91.20	92.55	80.50	76.80	77.50	72.25	73.20	69.95
21	73.35	79.65	85.60	82.40	91.30	91.20	80.35	78.00	76.55	74.50	73.20	70.40
22	73.95	79.65	87.65	81.70	94.70	89.85	80.10	78.15	75.70	76.50	73.35	71.75
23	74.40	78.85	92.50	81.45	95.70	88.90	79.30	77.20	75.10	77.30	73.25	74.20
24	74.30	77.80	92.80	81.40	95.50	88.20	78.80	76.15	75.85	77.30	74.15	75.70
25	74.10	77.15	92.30	81.45	94.70	87.55	78.70	75.50	76.20	76.70	74.90	76.70
26	74.25	76.70	91.40	82.20	93.60	86.90	78.80	75.15	75.95	76.00	76.10	77.35
27	75.00	76.25	90.40	85.55	92.40	87.50	79.10	74.70	75.85	75.25	76.50	77.35
28	75.20	76.00	90.45	85.60	91.25	89.75	78.65	74.30	75.35	75.25	75.65	77.00
29	74.65	.....	90.05	84.60	90.60	89.95	78.15	74.10	74.50	76.65	74.60	76.70
30	74.05	.....	90.20	83.50	89.75	91.10	78.25	74.00	73.85	77.55	73.75	76.20
31	73.60	.....	90.65	.....	88.70	.....	78.60	73.65	.....	77.35	.....	75.75

a Reading changed one-half foot or more.

b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1899.

[Gauge, 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.35	67.50	82.30	80.90	93.90	91.50	89.35	81.70	74.70	72.20	71.25	72.90
2	73.40	68.10	81.70	80.65	93.80	92.10	89.50	81.90	74.85	72.00	71.25	72.80
3	72.60	68.70	81.10	80.10	93.30	92.80	89.95	81.85	74.60	71.90	71.70	72.60
4	72.20	69.50	80.60	80.00	91.60	92.90	90.65	81.30	74.40	71.85	72.00	72.60
5	72.35	70.40	79.95	80.25	89.90	93.00	91.25	80.95	74.20	71.75	72.20	72.60
6	71.85	70.80	79.95	80.90	88.95	93.00	91.50	80.95	74.00	71.60	72.45	72.50
7	72.20	71.45	80.00	81.25	88.30	92.50	91.85	80.65	73.80	71.40	72.70	72.45
8	72.75	72.30	79.20	81.30	87.95	91.65	91.95	80.10	73.60	71.20	72.90	72.35
9	72.00	75.60	78.55	81.50	87.90	91.40	91.85	80.60	73.60	71.10	73.15	72.25
10	71.80	75.65	78.70	81.80	87.90	91.55	91.90	82.55	73.70	71.00	73.35	72.25
11	72.00	75.35	79.00	81.90	88.55	91.55	92.35	84.00	73.95	71.00	73.45	72.20
12	72.00	75.00	79.40	83.45	89.35	92.00	92.40	83.85	74.00	71.00	73.70	72.45
13	72.60	75.20	79.35	84.90	89.70	93.30	92.05	83.25	74.00	70.90	73.75	72.25
14	72.85	75.40	80.00	84.70	90.00	93.55	91.30	82.95	73.90	70.70	73.85	72.25
15	72.35	75.60	81.20	83.80	89.65	92.90	90.55	82.50	73.80	70.65	74.00	72.45
16	72.65	75.65	83.40	83.50	89.05	91.55	89.90	81.50	73.70	70.60	73.90	72.30
17	72.80	75.65	84.30	83.50	88.20	91.20	89.35	80.55	73.55	70.65	73.80	71.65
18	72.75	75.70	84.70	83.50	87.70	91.20	89.05	79.90	73.70	70.80	73.80	71.60
19	72.65	76.40	85.40	83.55	86.90	91.15	88.90	79.40	73.95	70.80	73.85	71.60
20	72.55	74.95	86.80	84.30	86.50	91.00	88.75	78.80	73.95	70.75	73.75	72.70
21	72.65	72.20	87.60	85.50	87.50	90.75	88.20	78.40	73.75	70.65	73.60	72.40
22	72.55	70.90	87.70	86.05	88.60	90.30	87.30	77.85	73.50	70.60	73.60	71.85
23	72.50	70.45	87.30	89.25	90.85	89.55	86.50	77.20	73.25	70.50	74.00	71.30
24	72.50	70.40	86.65	92.00	92.10	88.90	85.80	76.60	73.15	70.40	74.05	70.90
25	72.70	70.55	85.80	93.40	93.30	88.35	85.25	76.10	72.90	70.40	73.90	70.40
26	72.60	72.20	84.75	93.90	93.70	88.15	84.65	75.70	72.80	70.35	73.60	69.90
27	72.50	77.80	83.60	94.00	93.60	88.35	83.90	75.50	72.70	70.35	73.35	69.20
28	72.30	81.40	82.70	93.90	92.90	88.80	83.25	75.35	72.55	70.90	73.20	68.70
29	71.75	.....	81.75	93.50	92.10	89.15	82.75	75.10	72.45	71.35	73.10	68.20
30	70.55	.....	81.00	93.70	91.70	89.40	82.25	74.85	72.35	71.85	73.00	67.90
31	68.75	.....	80.70	.....	91.70	.....	81.80	74.75	.....	71.50	.....	66.60

1900.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	69.60	69.90	74.50	81.50	83.85	81.15	79.10	79.30	77.80	78.40	80.80	78.00
2	69.40	69.20	74.20	82.25	83.70	81.10	79.25	78.70	78.00	78.90	80.00	77.50
3	69.80	68.50	73.70	82.30	83.90	81.10	79.10	78.30	78.10	80.20	79.70	77.00
4	70.20	68.00	73.45	82.25	83.95	80.80	79.20	77.90	78.00	81.10	79.70	76.60
5	71.10	68.30	73.70	82.55	83.75	80.30	79.30	77.40	78.00	81.20	80.00	76.25
6	68.80	68.80	76.00	83.10	84.00	79.90	79.10	76.85	78.25	80.70	80.40	75.90
7	68.80	69.40	83.20	83.80	84.20	79.55	78.95	76.25	77.70	80.30	81.30	75.65
8	69.70	71.30	85.10	84.60	84.55	79.45	78.60	75.75	77.00	80.50	81.50	75.50
9	69.70	73.80	85.50	84.70	84.50	79.30	78.40	75.20	76.50	81.10	a 81.70	a 75.20
10	70.35	75.20	86.30	84.25	84.25	79.00	78.40	74.90	76.00	81.00	81.10	75.00
11	70.65	75.20	88.20	83.90	84.05	78.60	78.10	74.40	75.70	80.10	80.70	74.85
12	70.50	74.65	88.90	84.00	83.85	78.45	78.20	74.00	75.10	79.30	80.60	74.75
13	70.40	74.60	90.15	84.65	84.70	78.60	78.30	73.70	74.80	78.80	80.40	74.40
14	70.40	74.10	91.00	86.30	84.75	80.30	77.90	73.40	74.50	78.50	80.30	74.15
15	70.45	73.90	91.20	86.60	83.90	81.80	77.50	73.10	74.40	78.20	79.90	73.90
16	70.20	73.90	91.40	85.90	82.95	80.90	77.50	72.90	74.25	78.00	79.60	73.65
17	70.25	74.30	91.00	84.90	82.25	80.10	77.90	72.80	74.00	78.00	79.60	73.35
18	70.65	73.50	90.30	84.10	82.15	79.40	77.60	a 72.90	73.85	78.00	79.60	73.00
19	71.75	72.95	89.30	83.45	82.45	79.10	77.30	74.10	73.80	78.10	79.80	72.70
20	74.45	73.20	88.05	83.45	82.45	79.10	77.10	75.90	73.95	78.30	79.80	72.50
21	75.10	74.00	86.85	84.10	82.30	79.35	77.10	76.90	74.20	78.50	79.90	72.25
22	74.40	75.55	86.10	84.40	82.20	81.20	78.00	77.20	74.70	78.90	79.90	72.00
23	73.60	76.40	85.70	84.55	82.20	82.40	79.70	77.20	75.25	79.60	79.90	72.00
24	73.30	77.45	85.10	84.90	82.20	82.70	80.60	77.10	75.45	79.90	80.00	71.65
25	73.30	77.00	84.45	85.25	81.90	82.50	80.80	76.95	75.50	80.10	80.00	71.60
26	73.40	76.00	84.05	85.60	81.50	82.40	81.00	76.80	75.55	80.30	79.90	71.55
27	73.40	75.40	83.80	85.65	81.15	81.80	80.70	76.70	75.80	80.40	79.70	71.55
28	73.20	74.50	83.20	85.25	80.80	81.10	80.50	76.75	76.25	80.40	79.60	71.60
29	72.55	.....	82.70	84.75	80.90	80.40	80.10	76.60	77.30	80.30	79.30	71.40
30	71.80	.....	82.00	84.30	81.50	79.50	79.80	76.60	77.90	80.50	78.80	71.00
31	71.10	.....	81.60	.....	81.50	.....	79.60	77.50	... ...	a 80.80	.....	70.95

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1901.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	70.80	72.35	72.60	86.15	83.70	77.75	82.30	76.30	71.30	71.05	71.85	70.70
2	70.50	72.10	72.10	86.30	83.40	77.70	81.70	76.40	71.20	70.85	71.75	70.65
3	70.20	72.00	71.90	86.30	83.10	78.90	81.00	76.40	71.05	70.75	71.60	70.55
4	69.90	72.20	72.05	86.60	82.80	80.30	80.30	76.20	70.95	70.60	71.50	70.45
5	69.35	72.00	72.65	86.80	82.50	80.50	79.75	76.10	70.80	70.60	71.30	70.35
6	68.95	71.90	73.15	87.30	82.30	80.75	79.30	75.70	70.70	70.75	71.30	70.30
7	68.85	71.55	73.40	87.50	82.00	81.00	78.90	75.30	70.55	70.85	71.15	70.20
8	68.85	70.80	74.20	87.80	81.75	a81.40	78.80	74.80	70.45	70.90	71.15	70.25
9	69.40	70.40	75.10	88.30	81.50	81.55	79.00	74.55	70.45	71.10	71.05	70.45
10	70.20	69.70	77.00	89.60	81.20	81.30	80.10	74.30	70.40	71.15	71.15	70.40
11	70.80	70.10	80.60	89.90	80.90	81.00	80.15	74.10	70.30	71.10	71.15	70.15
12	72.50	70.50	83.80	90.00	80.70	80.80	79.50	74.00	70.30	71.15	71.30	70.05
13	73.10	70.50	85.10	90.30	80.55	80.80	78.90	73.90	70.25	71.35	71.35	70.25
14	73.30	70.60	85.20	90.35	80.20	81.20	78.65	73.80	70.25	71.20	71.25	70.50
15	73.70	70.75	84.80	90.35	79.95	82.00	78.50	73.60	70.20	71.10	71.25	69.95
16	73.55	70.75	84.50	90.05	79.70	82.40	78.40	73.50	70.00	71.05	71.30	69.50
17	73.40	70.90	84.35	90.50	79.50	82.10	78.40	73.25	70.00	71.25	71.20	68.25
18	73.75	71.00	84.35	91.10	79.30	81.60	78.35	73.20	70.15	71.50	71.15	67.65
19	73.60	71.45	84.10	90.90	79.10	81.15	78.35	73.10	70.45	71.75	71.15	66.55
20	73.40	71.75	84.15	89.95	78.80	80.90	78.50	72.90	70.90	71.95	71.15	b67.95
21	73.10	71.40	84.05	88.80	78.50	80.90	79.10	72.80	72.40	72.05	71.10	b68.05
22	73.10	71.15	84.85	88.15	78.20	81.00	79.10	72.70	73.00	72.10	71.10	b68.95
23	73.20	71.30	85.60	87.55	78.00	81.50	78.45	72.60	72.80	72.05	71.10	b70.40
24	73.30	71.65	86.10	86.90	77.80	82.40	78.00	72.50	72.40	71.95	71.15	b71.00
25	73.10	72.00	86.60	86.25	77.50	82.75	77.50	72.40	72.10	71.80	71.05	b71.80
26	73.00	72.65	86.80	85.70	78.30	83.00	77.10	72.25	71.75	71.75	71.05	b73.80
27	72.95	73.10	86.70	85.20	79.00	83.30	76.80	72.10	71.55	71.75	70.85	b74.30
28	72.85	72.90	86.30	84.80	78.70	83.60	76.50	72.00	71.35	71.80	70.80	b74.00
29	72.80	.....	86.00	84.50	78.30	83.50	76.30	71.80	71.25	71.85	70.80	b73.95
30	72.90	.....	85.85	84.10	78.10	82.90	76.10	71.65	71.15	71.85	70.75	b73.70
31	72.70	.....	85.90	.....	77.90	.....	76.10	71.45	.....	71.85	.....	b73.75

a Changed less than one-half foot.
b Doubtful on account of ice, gorged from December 20, 1901, to January 11, 1902.

1902.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a73.50	67.45	72.00	77.70	76.00	85.85	91.70	91.40	88.85	85.00	78.90	82.80
2	a73.05	67.65	72.20	78.90	76.15	85.85	92.40	90.45	88.20	84.65	78.40	82.00
3	a71.80	67.70	71.95	79.00	78.35	87.35	93.00	89.50	87.80	84.70	77.90	81.65
4	b71.75	71.30	74.00	79.00	79.20	87.90	93.20	88.70	88.30	85.70	77.45	81.30
5	a74.15	72.30	74.00	78.90	78.50	87.75	92.80	88.40	88.70	86.40	77.35	81.30
6	a75.70	72.10	73.60	79.10	77.70	87.55	91.85	87.90	88.10	86.90	77.60	81.40
7	a76.30	72.80	73.80	80.30	76.60	87.15	91.15	87.80	87.20	87.75	78.50	81.70
8	a75.60	72.80	74.70	80.20	76.00	86.35	90.60	87.60	86.10	88.80	78.55	82.00
9	a74.60	72.30	76.00	79.40	75.80	86.10	90.85	87.15	84.80	89.45	79.20	81.60
10	a72.45	72.30	76.90	78.40	76.55	86.60	90.55	86.70	83.85	89.15	80.05	80.80
11	a70.15	72.50	76.90	78.40	78.10	87.35	89.90	86.05	83.10	88.30	80.30	79.80
12	69.50	72.50	76.80	78.00	78.90	88.20	90.10	85.50	82.60	87.40	79.75	78.60
13	69.30	72.80	77.70	77.60	79.60	88.15	91.30	85.25	81.85	86.50	79.20	78.50
14	69.00	72.70	79.10	77.25	80.00	88.60	92.70	85.10	81.00	85.50	78.70	78.80
15	68.50	72.50	79.70	77.00	79.90	89.50	93.70	84.40	80.20	84.60	78.25	78.40
16	68.95	72.90	81.10	76.80	79.80	89.45	94.10	83.55	79.50	83.85	77.95	77.60
17	69.30	73.10	81.40	76.50	79.60	89.05	94.60	83.10	78.70	83.60	78.05	76.85
18	69.40	73.00	81.00	76.40	79.60	88.80	94.95	83.00	78.20	83.60	78.45	76.85
19	69.45	72.90	80.40	76.40	79.90	88.50	95.20	83.55	77.70	83.85	79.69	77.20
20	69.55	72.70	79.50	76.30	80.40	88.20	95.15	85.10	77.10	84.20	80.90	78.05
21	69.50	72.80	78.45	75.75	80.30	87.80	94.90	85.50	76.50	84.50	81.70	78.55
22	69.60	72.80	77.65	75.50	79.80	87.25	94.80	86.50	76.00	85.20	81.80	79.60
23	69.55	72.60	77.30	76.00	79.80	87.10	95.25	86.90	75.65	85.50	81.70	80.30
24	69.40	72.40	76.90	77.10	80.20	87.10	95.70	87.00	75.45	85.40	81.30	81.40
25	69.35	72.60	76.40	76.75	80.90	87.00	95.75	87.00	76.60	85.20	81.10	82.50
26	69.10	75.10	76.00	76.30	81.70	87.00	95.85	87.00	79.55	84.80	81.20	82.30
27	68.55	71.60	75.90	75.40	82.70	87.35	95.55	87.30	81.20	83.70	81.40	c82.00
28	67.50	70.90	76.05	75.20	84.85	87.90	94.70	88.10	82.10	82.30	81.60	81.25
29	66.65	.....	76.05	75.45	86.40	89.85	93.90	88.75	83.50	81.00	82.20	80.30
30	66.45	.....	76.10	75.90	86.40	90.00	93.60	89.10	84.75	80.10	82.80	78.80
31	67.30	.....	76.20	.....	86.15	.....	92.10	89.10	.....	79.40	.....	77.40

a Doubtful, account of ice. b Reading changed one-half foot or more. c Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1903.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76.25	78.00	83.40	88.75	87.00	97.10	89.15	84.70	85.45	84.80	82.90	73.55
2	75.75	77.55	83.70	88.50	a 86.70	99.05	a 88.90	83.95	87.30	84.85	82.80	73.35
3	75.85	77.70	84.20	88.20	86.40	100.75	88.00	83.25	87.90	84.90	82.50	73.00
4	76.30	79.60	85.10	88.20	86.10	102.00	87.00	83.80	87.90	85.00	82.25	72.65
5	76.65	83.60	85.80	89.10	85.80	103.60	86.10	82.35	87.50	85.30	82.10	72.20
6	76.95	84.30	85.90	90.25	85.50	104.90	85.40	82.10	86.35	85.60	82.00	72.10
7	77.30	83.10	86.60	90.70	75.40	107.00	85.00	83.20	85.60	85.90	82.50	72.00
8	77.30	82.20	88.80	90.80	85.20	107.40	84.80	84.30	84.95	86.60	82.85	71.80
9	76.90	81.20	92.10	90.40	85.25	108.00	84.80	84.50	85.10	87.90	82.80	71.65
10	76.60	80.00	93.15	90.00	85.35	108.30	84.85	84.60	84.50	89.10	82.40	71.50
11	76.00	79.00	93.15	89.85	85.25	108.20	84.80	84.90	84.55	90.10	82.10	71.15
12	75.00	79.00	a 93.20	91.40	85.00	107.90	84.45	84.65	85.80	89.90	81.70	70.95
13	74.05	79.60	a 92.60	92.30	84.60	107.30	83.75	84.70	87.65	89.50	81.15	70.55
14	73.20	79.60	a 92.30	92.60	84.40	106.30	83.45	84.85	88.30	89.15	80.60	69.40
15	73.00	79.50	92.60	92.80	84.05	104.60	83.65	85.05	88.25	88.80	a 80.00	b 69.20
16	73.00	79.20	92.30	92.75	84.10	102.90	84.50	85.45	88.85	88.30	79.70	b 68.85
17	73.55	78.30	91.60	92.55	86.00	101.30	85.80	84.85	89.05	87.65	79.40	b 68.50
18	73.95	77.50	91.80	93.20	88.40	99.80	87.15	84.95	88.45	86.90	78.90	b 68.35
19	74.70	77.10	91.70	92.90	89.50	98.20	87.90	85.35	88.30	86.35	78.40	b 69.05
20	74.95	76.60	91.50	92.20	89.85	96.90	87.40	85.40	88.35	85.90	77.80	b 69.20
21	75.15	76.30	92.50	92.00	89.45	96.10	86.80	85.55	87.85	85.30	77.50	c 69.55
22	74.95	76.35	92.80	92.15	89.10	95.50	86.65	85.45	86.90	84.80	77.10	70.10
23	75.00	76.45	92.40	91.60	88.80	94.50	86.75	84.95	86.10	84.40	76.80	c 70.45
24	74.80	76.40	92.40	91.00	88.70	94.00	87.00	84.05	85.35	84.10	76.40	71.15
25	74.70	76.55	92.00	90.30	89.10	93.55	87.35	83.35	84.75	84.00	76.00	c 71.85
26	74.20	76.75	91.60	89.60	90.60	93.15	88.40	83.10	84.30	83.85	75.50	a 72.30
27	74.55	77.40	91.20	89.00	93.00	92.00	88.55	82.70	84.30	83.65	75.10	c 71.70
28	76.70	81.70	90.60	88.40	93.30	90.70	87.70	82.75	84.50	83.50	74.60	71.40
29	78.40	.....	89.90	87.90	93.30	89.60	86.95	83.15	84.70	83.35	74.20	71.70
30	78.20	.....	89.45	87.50	93.70	89.00	86.35	84.00	84.70	83.20	73.80	72.00
31	78.20	.....	89.05	.....	94.70	.....	85.55	84.70	.....	83.10	.....	72.50

a Changed less than one-half foot. b Doubtful on account of ice. c Reading changed one-half foot or more.

1904.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	72.80	75.20	75.05	92.70	102.20	91.80	92.60	a 80.40	74.95	78.75	77.40	73.10
2	72.70	74.20	74.80	92.40	101.95	93.20	91.90	a 79.90	74.50	78.50	77.30	73.00
3	72.70	73.90	b 74.80	92.10	101.10	93.00	91.40	79.50	74.30	77.80	77.20	72.80
4	71.95	73.80	75.10	91.50	a100.00	91.80	90.90	79.10	74.30	77.40	b 77.05	72.70
5	71.40	73.75	75.20	90.85	a 99.10	93.40	90.45	78.90	74.90	76.75	b 76.90	72.50
6	71.45	73.90	76.30	90.25	97.80	96.10	89.90	78.60	74.80	b 76.25	76.75	72.40
7	71.40	74.80	76.80	89.60	96.40	97.60	89.00	78.30	74.40	76.10	76.60	72.10
8	71.40	74.95	77.00	89.10	95.30	97.50	88.80	b 77.70	74.10	76.00	76.50	71.80
9	71.10	75.20	77.65	88.85	95.20	96.80	91.80	77.10	73.80	75.75	76.40	71.65
10	a 70.90	75.85	77.90	90.20	95.00	95.70	94.20	76.80	73.90	75.40	76.30	71.65
11	a 71.00	76.50	78.40	90.90	94.40	a 94.90	96.00	76.00	74.10	75.30	76.20	71.60
12	a 70.95	77.20	79.20	91.50	93.70	94.00	96.95	75.50	74.00	75.20	76.10	71.45
13	a 71.00	77.40	79.25	91.75	92.80	93.20	97.00	75.30	73.75	74.90	76.10	71.30
14	a 71.10	77.70	79.40	91.50	91.80	92.90	96.10	75.10	73.75	74.65	76.00	70.45
15	a 71.60	77.95	79.25	91.50	90.90	93.00	94.45	75.20	73.55	74.40	75.80	70.00
16	a 71.65	77.60	79.10	91.40	90.20	93.60	92.30	75.30	73.40	74.30	b 75.60	69.90
17	a 71.60	b 77.20	79.30	91.25	89.70	93.70	90.40	75.60	73.45	74.20	75.40	69.60
18	a 72.00	a 76.70	79.90	92.60	89.80	93.60	89.70	75.50	a 73.75	74.20	75.20	69.10
19	72.25	a 76.10	80.40	92.80	90.35	93.40	89.30	75.50	74.80	74.10	75.10	68.60
20	a 72.30	76.25	80.50	92.30	90.60	93.50	88.90	76.70	a 76.10	74.00	74.90	68.60
21	73.10	76.00	80.50	91.70	90.00	93.70	88.30	78.50	77.90	74.20	74.70	68.50
22	76.80	75.40	80.95	91.80	89.30	94.20	87.00	78.20	78.40	74.20	74.50	68.40
23	80.70	75.00	82.90	92.00	88.70	93.80	85.80	a 78.50	77.80	74.45	74.35	68.30
24	82.80	75.00	84.50	92.70	88.00	92.70	85.20	a 79.10	77.20	74.70	74.15	68.75
25	82.50	75.30	85.50	96.90	87.60	91.00	85.00	a 78.80	76.60	74.95	73.90	69.00
26	82.20	75.50	87.50	99.95	87.30	90.10	84.95	b 79.40	77.30	75.30	73.75	69.25
27	81.20	75.80	88.40	b101.35	87.00	89.80	84.50	79.40	78.00	75.60	73.60	70.20
28	79.65	75.60	90.85	102.10	87.80	89.75	83.30	78.60	78.00	76.20	73.40	70.00
29	78.60	75.35	92.40	102.75	87.70	90.70	82.30	77.30	77.90	76.60	73.25	68.90
30	77.35	.....	93.00	102.60	88.20	92.20	a 81.50	76.25	78.50	76.90	73.25	68.30
31	76.15	.....	92.95	.....	90.00	.....	a 81.00	75.60	.....	77.35	.....	68.10

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1905.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	67.70	79.70	85.70	85.90	85.45	86.85	90.80	a 88.50	79.50	82.80	80.30	78.00
2	68.00	78.50	85.60	86.70	84.80	86.60	90.80	89.20	79.30	81.90	80.00	78.20
3	69.40	77.80	85.60	86.50	84.00	86.70	90.75	89.60	78.80	81.30	80.20	77.90
4	70.50	77.70	85.60	86.30	83.00	87.10	91.30	89.60	78.30	80.70	80.30	77.60
5	70.10	77.90	87.00	86.10	82.40	88.00	92.30	88.80	78.00	80.30	80.90	77.10
6	70.30	78.00	86.50	85.50	81.80	88.50	92.90	87.80	77.90	79.90	80.90	76.60
7	70.30	77.90	85.60	84.80	80.60	88.10	93.40	86.90	77.80	79.20	81.60	76.00
8	70.00	77.60	85.30	84.20	79.90	87.50	93.30	86.00	78.00	78.60	81.60	75.20
9	70.25	77.50	84.80	83.50	79.30	86.90	92.90	85.10	77.90	78.10	81.20	74.40
10	70.00	77.20	84.40	83.10	79.10	86.45	92.80	84.50	77.70	77.80	81.00	73.70
11	69.70	77.00	84.40	82.70	79.20	85.95	92.80	84.20	77.80	77.50	80.90	73.30
12	69.40	76.90	84.35	82.40	79.80	86.30	92.90	83.40	a 78.80	77.10	80.90	72.90
13	69.00	76.45	84.10	82.30	79.80	87.35	93.30	82.70	80.30	76.80	81.20	72.70
14	68.40	76.20	83.00	82.30	80.70	88.00	94.10	82.35	79.60	76.50	80.90	72.90
15	68.10	76.40	82.00	82.30	82.20	88.75	94.40	81.80	78.80	76.20	80.20	73.10
16	b 67.90	76.45	81.40	82.20	84.35	89.00	a 93.95	80.90	78.80	76.00	79.40	73.00
17	b 70.70	76.50	81.00	82.40	86.45	88.80	92.80	80.40	81.00	75.80	79.00	73.00
18	b 73.00	76.50	80.90	82.40	87.15	88.30	91.10	80.20	91.90	77.90	78.10	73.00
19	b 74.30	76.45	80.70	82.20	87.60	87.90	89.70	80.50	95.90	85.90	77.80	73.20
20	b 74.70	76.40	80.50	81.90	88.70	88.40	88.70	81.00	97.90	85.00	77.60	73.30
21	b 75.10	76.50	80.30	81.70	88.50	88.60	88.00	81.40	98.80	83.00	78.00	73.60
22	b 75.40	76.60	a 80.70	81.30	87.70	88.50	a 87.30	81.80	98.60	83.00	77.70	73.60
23	b 76.00	76.70	81.60	81.30	87.00	88.10	a 86.60	83.20	97.60	82.70	77.20	73.50
24	b 76.40	a 76.70	82.60	81.85	86.70	88.20	86.80	85.90	95.20	82.30	76.90	73.40
25	78.30	a 77.00	83.00	82.30	86.30	88.80	87.30	86.30	92.50	81.90	76.80	73.20
26	78.90	77.90	83.50	82.70	86.00	89.40	88.20	85.80	90.70	82.40	76.70	73.10
27	79.30	80.50	83.80	83.30	85.85	89.50	88.00	85.50	89.00	83.70	76.60	72.90
28	80.20	83.70	84.40	83.40	86.20	89.70	86.80	85.00	86.80	82.50	76.50	72.90
29	79.90	.....	85.00	83.80	86.40	89.95	86.00	83.40	84.90	81.80	76.90	73.60
30	79.60	.....	85.30	84.90	87.25	90.30	85.90	81.80	83.60	81.40	77.60	73.80
31	79.80	.....	85.10	.....	87.35	.....	87.45	80.50	.....	80.90	.....	74.20

a Reading changed one-half foot or more. b Doubtful on account of ice.

1906.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	74.3	82.0	90.0	93.2	89.3	82.7	88.0	78.6	78.3	79.9	73.7	76.8
2	74.3	82.4	90.4	92.9	89.3	83.5	88.0	78.4	77.8	80.2	74.5	77.1
3	74.6	81.9	91.0	92.3	89.3	84.1	88.2	78.8	77.5	80.6	74.8	77.5
4	76.0	80.9	90.0	91.9	89.4	84.8	88.1	78.7	77.3	80.8	75.1	77.6
5	81.5	80.2	89.0	92.2	89.2	85.4	87.7	78.1	77.0	80.33	a 75.3	77.7
6	83.6	79.3	88.0	92.0	89.1	85.3	87.4	78.0	76.9	79.1	75.3	78.0
7	83.0	78.7	87.2	91.7	b 90.2	86.0	86.9	77.8	76.8	78.3	75.4	78.5
8	81.9	77.6	86.7	91.8	90.7	86.7	86.4	78.0	76.7	77.8	75.6	78.5
9	80.6	76.9	86.6	92.3	90.0	87.5	86.0	78.0	76.7	77.4	75.7	78.0
10	78.8	76.6	86.5	92.5	89.1	87.8	85.4	78.2	76.7	76.9	75.9	77.6
11	77.2	76.3	86.2	92.2	88.5	85.0	84.6	78.8	76.9	76.6	76.0	77.4
12	76.4	75.9	85.8	91.8	87.9	87.8	84.2	79.0	77.0	76.3	76.0	77.2
13	75.7	75.7	85.4	91.8	87.3	87.2	83.7	79.7	76.9	76.0	76.0	77.0
14	75.5	75.9	84.9	93.7	86.5	87.0	83.4	80.6	76.7	75.8	75.9	76.8
15	75.2	76.1	a 84.5	94.4	85.9	b 86.9	83.0	81.2	76.5	75.6	76.0	76.5
16	75.4	76.0	83.8	93.8	85.2	a 86.5	82.8	81.3	76.4	75.4	76.1	76.2
17	74.9	76.2	83.0	93.2	84.4	86.1	82.4	80.8	76.2	75.3	76.2	75.6
18	74.6	76.5	82.3	93.0	83.7	86.1	82.0	80.0	76.1	75.2	76.3	75.1
19	74.6	77.0	82.0	92.8	83.2	86.2	81.6	79.6	76.6	75.0	76.1	74.5
20	74.9	77.4	81.4	92.4	82.9	86.6	81.1	79.8	76.9	74.7	76.1	73.8
21	75.5	77.7	80.5	92.0	82.3	87.8	80.7	79.9	76.8	74.5	76.7	73.7
22	77.4	78.0	79.7	91.7	82.0	88.7	80.8	79.5	76.7	74.4	77.1	a 73.7
23	78.6	79.1	79.5	91.2	b 81.8	89.3	80.7	79.1	76.7	74.2	77.2	73.3
24	80.7	81.9	79.5	90.8	81.5	89.8	81.2	78.5	77.4	74.2	77.0	72.4
25	81.0	85.0	79.7	90.5	81.4	90.0	82.4	78.0	78.7	73.9	76.9	71.8
26	80.7	87.0	80.0	90.3	81.3	89.0	82.8	77.9	79.1	73.7	76.8	71.3
27	80.5	88.5	85.1	90.1	81.2	88.3	81.8	80.3	79.3	a 73.6	76.8	70.8
28	80.3	89.4	89.8	89.9	81.4	88.0	81.2	81.2	79.4	73.5	76.8	70.5
29	80.2	.....	91.6	89.7	81.5	a 88.3	80.4	80.3	79.8	73.3	76.7	70.6
30	80.6	.....	92.7	89.5	81.3	88.3	79.6	79.4	79.7	73.3	76.7	71.4
31	81.3	.....	93.4	.....	81.7	.....	79.0	79.0	.....	73.3	.....	72.1

a Reading changed less than one-half foot. b Changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BISSELLS POINT, MO.—Continued.

1907.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	72.8	84.4	83.0	85.0	87.1	82.8	91.7	94.2	81.6	76.8	74.4	73.3
2	73.4	83.7	82.8	85.4	87.4	83.1	91.0	92.8	81.5	76.9	74.5	73.2
3	74.1	82.9	82.4	85.5	87.5	84.2	90.6	91.4	81.6	77.3	74.2	73.2
4	75.1	81.9	82.0	85.2	87.3	87.0	89.7	90.5	81.6	78.2	74.2	73.1
5	76.3	80.9	81.7	85.1	86.6	89.0	88.9	89.7	81.5	78.8	74.0	73.0
6	77.4	79.6	81.7	85.1	86.2	89.7	a 88.2	89.1	81.4	79.2	74.0	72.9
7	77.8	78.1	81.6	84.8	86.3	89.4	88.2	88.5	81.1	79.3	73.9	72.8
8	77.9	76.5	81.4	84.8	87.0	88.6	88.5	88.3	80.8	79.4	73.8	72.5
9	77.9	75.8	81.0	85.0	87.9	88.4	88.4	87.9	a 80.4	79.8	73.8	72.4
10	77.9	a 75.6	80.6	85.0	88.4	88.7	88.6	87.7	79.6	80.2	73.8	72.4
11	77.8	75.7	80.8	85.1	87.9	89.0	88.7	87.4	79.0	80.5	73.7	72.3
12	77.7	76.0	81.7	85.6	86.9	89.7	88.7	86.5	78.5	80.6	73.5	72.0
13	77.7	77.0	83.4	86.8	86.0	91.0	88.8	86.0	78.0	a 80.4	73.4	71.9
14	78.1	78.0	86.1	87.0	85.1	91.7	a 89.4	85.7	77.7	79.9	73.3	72.0
15	78.7	79.8	86.5	86.8	85.1	91.4	90.1	85.1	77.2	79.4	73.3	72.0
16	79.1	79.4	85.9	86.7	87.5	92.2	90.3	85.0	77.0	79.0	73.3	72.1
17	80.3	79.2	85.1	86.6	89.4	91.2	91.1	84.7	76.8	78.4	73.2	72.2
18	83.3	79.8	84.9	86.6	89.8	90.2	92.7	84.3	76.5	77.9	73.2	72.5
19	86.2	80.4	84.6	87.1	89.0	89.4	93.4	85.1	76.1	77.5	73.2	72.5
20	89.9	80.1	84.6	87.7	87.8	89.0	93.8	86.1	75.8	77.2	73.2	72.4
21	93.3	79.7	85.1	88.4	86.6	88.9	94.2	86.3	75.5	76.7	73.4	72.2
22	a 93.8	79.6	84.4	88.6	85.6	88.6	94.9	86.1	75.4	76.4	73.4	71.8
23	94.0	80.6	83.7	88.2	84.5	88.8	95.6	85.9	75.5	a 76.1	73.3	72.0
24	b 93.5	81.8	83.0	88.4	83.6	89.3	96.3	85.4	75.9	75.8	73.2	72.1
25	92.5	82.8	82.8	88.6	83.0	91.3	96.6	85.0	76.2	75.5	73.2	72.1
26	90.9	83.4	82.7	88.0	82.3	91.7	96.6	85.6	76.4	75.4	73.1	72.0
27	89.0	83.3	82.7	87.7	82.0	92.8	96.0	84.4	76.5	75.3	73.2	72.0
28	87.8	83.2	82.6	86.8	83.0	92.9	95.4	83.0	76.8	75.0	73.3	71.8
29	86.6	.....	82.7	86.1	83.2	92.5	95.1	82.4	76.9	74.7	73.4	71.7
30	85.8	.....	83.8	86.2	83.0	92.1	95.0	82.0	76.8	74.5	73.4	71.7
31	85.1	.....	84.2	.....	82.9	.....	94.9	81.8	.....	74.4	.....	71.8

a Reading changed one-half foot or more. b Changed less than one-half foot.

1908.

[Gauge 3.30 miles from Eads Bridge. Zero of gauge 320.36 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	71.90	71.10	84.50	82.60	84.40	96.00	99.80	.....	.....	.....	.....	.....
2	72.00	71.00	84.40	82.40	83.80	96.80	99.80	.....	.....	.....	.....	.....
3	72.20	69.30	84.80	82.60	83.40	97.20	100.00	.....	.....	.....	.....	.....
4	72.20	69.30	85.00	82.40	83.40	98.20	100.40	.....	.....	.....	.....	.....
5	72.00	69.30	85.20	82.50	83.70	98.70	100.90	.....	.....	.....	.....	.....
6	72.00	69.80	85.60	82.50	84.70	98.70	100.90	.....	.....	.....	.....	.....
7	72.00	69.70	86.00	82.50	85.70	98.90	100.50	.....	.....	.....	.....	.....
8	71.80	70.30	86.00	82.80	86.50	99.00	99.00	.....	.....	.....	.....	.....
9	71.60	70.80	86.90	83.60	87.10	99.00	97.70	.....	.....	.....	.....	.....
10	71.50	71.00	88.50	85.90	87.90	99.60	96.70	.....	.....	.....	.....	.....
11	71.50	71.10	88.50	87.00	88.80	99.30	96.50	.....	.....	.....	.....	.....
12	71.90	71.90	88.60	87.90	88.50	99.80	95.90	.....	.....	.....	.....	.....
13	72.30	72.00	88.50	87.90	87.80	100.20	95.80	.....	.....	.....	.....	.....
14	72.40	72.60	88.30	87.70	87.30	100.80	95.40	.....	.....	.....	.....	.....
15	72.20	75.30	88.20	88.00	87.70	101.50	94.40	.....	.....	.....	.....	.....
16	72.00	a 79.70	87.50	87.70	88.70	102.90	93.40	.....	.....	.....	.....	.....
17	72.00	82.50	87.00	87.00	91.20	103.70	92.20	.....	.....	.....	.....	.....
18	71.40	82.50	86.60	86.30	92.10	104.40	91.60	.....	.....	.....	.....	.....
19	71.60	82.90	86.20	85.50	92.50	104.60	91.50	.....	.....	.....	.....	.....
20	71.30	83.90	85.80	84.70	92.50	104.60	91.60	.....	.....	.....	.....	.....
21	71.00	83.80	85.50	83.90	92.00	104.10	91.90	.....	.....	.....	.....	.....
22	71.00	83.30	85.20	83.60	91.60	103.90	91.90	.....	.....	.....	.....	.....
23	71.40	82.90	84.90	83.40	91.40	103.50	91.40	.....	.....	.....	.....	.....
24	72.00	82.50	84.40	83.80	91.40	103.20	90.60	.....	.....	.....	.....	.....
25	72.00	81.90	83.90	84.10	91.10	103.00	90.10	.....	.....	.....	.....	.....
26	72.00	82.20	83.70	84.30	91.20	102.50	89.60	.....	.....	.....	.....	.....
27	72.30	83.80	83.10	84.90	92.40	102.10	89.40	.....	.....	.....	.....	.....
28	72.10	84.90	83.10	85.70	93.70	101.40	89.30	.....	.....	.....	.....	.....
29	71.80	84.80	83.00	85.90	94.10	100.80	89.10	.....	.....	.....	.....	.....
30	71.80	.....	83.20	85.00	94.40	100.00	88.60	.....	.....	.....	.....	.....
31	71.10	.....	82.90	.....	95.60	.....	88.10	.....	.....	.....	.....	.....

• Interpolated—no reading.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.

1891.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.50	4.65	3.95
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.35	4.55	3.40
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.25	4.50	3.00
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.15	4.40	2.95
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.10	4.40	3.05
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.40	3.20
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.40	3.45
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.00	4.40	3.70
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.00	4.50	3.80
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.90	4.70	3.60
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	4.75	3.20
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.60	4.70	3.20
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.95	4.60	3.30
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.40	4.50	3.50
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.80	4.50	3.70
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.05	4.70	3.90
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.15	4.70	4.10
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.15	4.75	4.30
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.10	4.80	4.50
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.00	4.85	4.70
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.80	4.60	4.80
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	4.50	4.85
23	.....	.....	.....	.....	.....	.....	.....	.....	5.25	5.50	4.85	4.95
24	.....	.....	.....	.....	.....	.....	.....	.....	5.15	5.45	5.00	5.20
25	.....	.....	.....	.....	.....	.....	.....	.....	5.05	5.30	5.60	5.35
26	.....	.....	.....	.....	.....	.....	.....	.....	4.95	5.25	6.00	5.50
27	.....	.....	.....	.....	.....	.....	.....	.....	4.85	5.15	5.50	5.50
28	.....	.....	.....	.....	.....	.....	.....	.....	4.75	5.00	5.00	5.40
29	.....	.....	.....	.....	.....	.....	.....	.....	4.70	4.90	4.70	5.25
30	.....	.....	.....	.....	.....	.....	.....	.....	4.60	4.80	4.50	5.10
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.70	.....	5.10

1892.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	5.80	13.90	16.70	19.70	29.00	24.70	17.00	9.10	6.45	5.80	4.30
2	5.85	7.40	13.50	17.10	19.00	29.30	24.90	16.60	9.10	6.45	5.70	4.10
3	7.05	7.30	13.20	17.30	18.40	29.70	25.40	16.10	9.00	6.30	5.40	4.00
4	8.15	7.50	12.90	18.80	18.50	30.40	25.80	15.70	8.80	6.10	5.30	3.80
5	7.45	8.20	13.20	21.60	18.60	31.10	26.70	15.30	8.60	5.95	5.25	3.80
6	6.70	8.65	13.15	24.60	20.25	30.90	27.00	14.90	8.45	5.85	5.20	3.75
7	6.30	11.50	13.20	26.60	22.70	30.70	27.00	14.50	8.20	5.70	5.00	3.90
8	5.70	13.30	13.30	26.20	24.30	30.50	27.10	14.20	8.00	5.60	4.90	4.10
9	5.30	15.00	14.25	25.60	25.10	30.10	27.15	13.90	7.80	5.50	4.80	4.80
10	5.00	15.20	17.30	24.60	25.40	29.70	27.05	13.50	7.80	5.30	4.80	5.50
11	3.90	15.00	17.80	23.30	26.00	29.30	26.90	13.30	7.80	5.20	4.80	5.70
12	2.25	14.55	17.50	21.80	27.10	28.60	26.70	13.25	7.90	5.10	4.75	5.60
13	1.90	14.00	16.80	19.60	28.10	28.20	26.30	13.20	8.50	5.00	4.75	5.50
14	2.40	13.00	16.00	19.80	29.50	27.80	26.35	13.35	8.60	4.90	4.70	5.35
15	2.20	12.30	15.20	20.00	31.30	27.30	26.30	12.85	8.30	5.00	4.70	5.10
16	3.00	12.20	14.60	20.00	31.80	26.80	26.00	12.50	8.10	4.90	4.60	4.95
17	2.85	12.20	13.80	20.10	32.30	26.40	25.70	12.30	7.90	4.90	4.60	4.50
18	3.10	11.40	13.30	20.40	32.60	25.80	25.50	12.00	7.80	4.90	4.70	4.20
19	4.20	11.00	13.10	20.90	32.80	25.20	25.20	11.90	7.60	4.80	5.05	3.75
20	4.35	12.70	12.55	22.70	32.60	24.70	24.70	11.50	7.60	4.90	5.10	3.35
21	4.70	17.20	12.25	23.80	32.30	24.30	24.00	11.25	7.50	4.95	5.05	2.70
22	4.90	17.50	11.70	24.80	31.80	23.60	23.30	11.00	7.40	4.95	5.00	2.25
23	4.70	16.20	11.50	24.60	31.50	23.10	23.00	10.50	7.30	4.90	a 4.90	1.80
24	4.90	14.70	12.50	24.10	31.30	22.95	22.50	10.30	7.20	4.80	4.85	1.55
25	5.15	13.40	13.10	23.50	31.20	23.40	21.90	10.10	7.20	4.80	4.80	1.60
26	5.05	12.70	13.30	23.00	30.85	23.80	21.50	9.80	6.95	4.90	4.70	1.40
27	5.50	13.25	13.60	22.10	30.50	23.95	20.40	9.60	6.85	4.90	4.70	0.80
28	5.75	13.70	13.40	21.30	29.90	24.20	19.40	9.30	6.70	4.95	4.70	1.80
29	6.00	13.90	13.20	20.70	29.30	24.50	18.50	9.20	6.60	5.25	4.60	2.50
30	6.90	.....	13.90	20.20	28.70	24.55	17.80	9.15	6.50	5.70	4.50	3.20
31	6.05	.....	15.10	.....	28.60	.....	17.30	9.10	.....	5.80	.....	4.10

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1893.

[Gauge, 22 40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.50	6.80	10.90	15.80	27.60	24.30	17.20	10.80	6.10	4.25	4.00	3.40
2	5.50	6.50	11.45	15.60	28.50	24.10	17.20	10.90	5.95	4.25	4.00	3.20
3	5.50	6.20	12.05	15.20	29.20	24.70	16.90	11.10	5.75	4.25	4.00	2.60
4	6.60	6.00	12.20	15.20	28.90	25.00	16.50	10.85	5.60	4.30	4.00	2.30
5	6.30	5.70	11.70	15.00	28.10	24.80	16.20	10.20	5.45	4.35	4.15	1.90
6	7.00	5.80	11.60	15.00	26.80	24.10	16.50	9.70	5.35	4.45	4.10	1.60
7	7.80	6.00	11.50	15.20	25.80	23.20	18.60	9.20	5.25	4.85	4.10	1.45
8	7.60	6.00	11.40	15.50	24.90	23.10	19.40	8.80	5.10	4.80	4.00	1.35
9	7.80	6.10	12.10	15.20	24.10	23.30	18.70	8.50	5.05	4.75	4.00	1.35
10	7.40	6.45	14.50	15.60	23.50	23.10	17.90	8.10	4.95	4.85	4.00	1.55
11	7.30	6.50	16.90	17.80	23.30	22.40	17.40	7.80	5.05	4.90	4.10	1.65
12	7.25	6.50	17.70	20.70	23.30	21.60	16.50	8.20	5.00	4.90	4.10	1.70
13	7.35	6.45	17.80	21.80	23.70	20.80	15.60	8.10	4.95	4.90	4.00	1.80
14	7.50	6.90	17.60	22.00	23.50	20.10	14.80	8.00	4.80	4.75	4.00	1.50
15	7.45	6.70	17.30	21.80	23.30	19.60	14.20	7.60	4.70	4.65	4.00	1.50
16	7.30	6.05	17.20	21.50	23.10	19.40	13.80	7.40	4.60	4.55	4.00	1.80
17	7.30	9.30	17.50	21.40	22.80	19.30	13.50	7.30	4.50	4.40	4.00	2.20
18	7.45	9.10	18.40	20.90	22.50	19.00	14.00	7.20	4.45	4.35	4.00	2.60
19	7.45	8.80	19.50	20.10	22.20	18.40	15.00	7.00	4.40	4.30	4.00	2.50
20	7.50	8.90	19.70	20.20	21.80	17.70	15.50	6.90	4.40	4.25	4.00	2.30
21	7.40	8.90	19.60	22.90	21.40	17.20	14.80	7.20	4.30	4.30	4.00	2.25
22	7.40	8.80	19.20	23.90	21.00	16.80	14.20	8.90	4.30	4.25	4.00	2.70
23	7.50	8.45	19.10	23.80	20.70	16.40	13.60	9.80	4.30	4.20	4.00	2.80
24	7.50	8.50	19.60	23.20	20.30	15.90	13.20	9.70	4.40	4.20	4.10	3.00
25	7.50	8.50	19.00	23.20	20.30	16.40	12.50	8.90	4.45	4.10	4.10	3.30
26	7.50	9.00	18.10	23.30	20.30	17.40	12.00	8.35	4.45	4.10	4.00	3.40
27	7.40	9.80	17.40	24.30	22.10	19.50	11.50	7.90	4.45	4.10	3.95	3.40
28	7.30	10.40	16.90	24.90	24.10	19.10	11.00	7.20	4.45	4.15	3.90	3.40
29	7.20	.....	16.60	25.80	25.10	18.60	10.70	6.90	4.50	4.10	3.80	3.35
30	7.10	.....	16.20	26.80	25.30	18.10	10.40	6.60	4.50	4.00	3.70	3.30
31	7.00	.....	16.00	.....	25.00	.....	10.80	6.40	.....	4.00	.....	3.40

1894.

[Gauge, 32.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.50	2.00	5.95	11.70	12.70	17.25	16.70	9.30	5.00	5.40	3.95	4.00
2	3.60	2.00	5.90	11.30	13.40	17.20	16.50	9.40	4.90	5.10	4.00	4.30
3	3.70	1.95	5.90	10.90	14.20	16.90	16.20	9.40	4.80	4.80	4.15	4.40
4	3.85	1.95	6.40	10.55	14.50	16.70	15.60	9.15	4.75	4.60	4.20	4.70
5	4.10	2.50	6.95	10.45	14.20	16.55	15.40	9.00	4.95	4.50	4.30	5.30
6	4.20	2.60	8.70	10.10	15.10	16.55	15.60	8.75	5.20	4.45	4.40	5.20
7	4.30	2.60	12.90	10.00	16.50	16.70	15.90	8.40	5.30	4.30	4.45	5.10
8	4.20	3.45	16.40	11.10	17.90	17.00	15.50	8.10	5.40	4.30	4.65	5.00
9	4.00	5.20	18.25	11.40	19.30	17.20	14.70	7.80	5.95	4.20	4.75	4.60
10	3.70	6.20	18.90	11.60	20.00	17.00	14.00	7.60	5.90	4.15	4.85	4.20
11	3.60	7.70	18.60	12.10	20.60	16.90	13.60	7.40	5.80	4.20	4.80	4.00
12	3.40	7.30	17.80	12.20	21.85	16.75	13.40	7.30	5.80	4.30	4.60	3.80
13	3.20	6.30	16.80	12.50	20.50	16.70	13.05	7.10	5.80	4.30	4.55	3.60
14	3.00	5.60	15.50	12.60	19.50	16.80	12.50	6.90	5.60	4.30	4.50	3.50
15	2.70	4.95	14.45	12.60	18.90	16.80	11.90	6.75	5.70	4.30	4.40	3.80
16	2.90	4.50	13.80	12.35	18.45	16.65	11.50	6.50	5.85	4.20	4.50	4.00
17	3.00	4.60	13.00	13.30	17.95	16.60	11.10	6.30	6.40	4.10	4.50	4.00
18	3.20	5.00	12.50	15.60	17.40	16.50	10.90	6.20	7.10	4.00	4.50	3.90
19	3.20	5.35	12.00	17.30	16.55	16.35	10.75	6.10	7.15	4.00	4.50	3.90
20	3.50	6.10	11.60	18.10	15.70	16.40	10.65	6.00	6.80	3.95	4.50	3.90
21	3.90	6.50	11.45	17.00	15.10	16.40	10.55	5.90	6.50	3.95	4.50	3.90
22	4.90	5.70	11.55	15.90	14.60	16.50	10.50	5.80	6.35	4.00	4.50	3.90
23	5.50	5.30	11.65	14.80	14.35	16.55	10.50	5.80	6.30	3.95	4.50	4.00
24	5.80	5.70	11.80	14.10	14.20	16.70	10.35	5.60	6.55	3.95	4.50	4.00
25	5.40	5.65	11.80	13.80	14.00	16.70	10.15	5.50	6.50	4.10	4.55	4.10
26	3.60	5.70	11.75	13.60	13.95	16.70	9.85	5.40	6.50	4.25	4.50	4.00
27	2.60	5.80	11.50	13.20	13.75	16.70	9.75	5.35	6.75	4.15	4.45	4.00
28	2.50	5.85	11.40	13.00	13.70	17.00	9.70	5.30	6.45	4.00	4.30	3.75
29	2.50	.....	12.90	12.60	13.60	17.70	9.30	5.10	6.05	4.00	4.00	3.00
30	2.30	.....	13.00	12.40	13.90	17.30	9.90	5.10	5.70	3.95	4.00	3.00
31	2.00	.....	12.30	.....	16.30	.....	9.55	5.05	.....	3.95	.....	3.00

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1895.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.20	0.80	6.30	8.90	7.10	9.20	13.40	13.80	9.80	4.80	4.10	3.70
2	1.30	0.90	7.90	9.50	6.90	9.10	13.70	14.10	10.00	4.70	4.10	3.80
3	1.40	1.10	8.05	10.10	6.80	8.80	13.80	13.50	10.40	4.80	4.10	3.40
4	1.20	0.90	8.50	9.50	6.90	8.50	14.10	13.10	11.10	4.90	4.00	3.30
5	1 10	0.90	8.30	8.70	7.30	8.30	14.20	12.30	11.20	5.00	4.00	3.20
6	0 90	0.75	8.10	8.30	7.50	8.50	13.60	11.60	11.60	5.10	4.00	2.80
7	1.10	0.70	8.60	7.90	8.30	8.60	15.30	11.10	11.90	5.10	4.00	2.15
8	1.10	0.75	8.90	7.70	8.50	8.50	17.50	10.90	12.20	5.00	4.20	1.80
9	1.20	(a)	8.90	7.40	8.50	8.30	17.20	10.60	11.70	5.00	4.30	1.60
10	0.90	(a)	8.50	7.45	8.25	8.60	16.90	10.50	11.10	4.90	4.40	1.80
11	0.80	(a)	8.15	9.60	7.70	9.60	16.10	11.50	10.70	4.80	4.50	1.80
12	0.90	(a)	8.00	10.40	7.40	10.10	15.00	10.10	10.10	5.00	4.40	1.90
13	−0.30	(a)	7.60	10.30	7.60	10.95	13.30	9.80	9.70	5.10	4.30	2.00
14	−0.50	(a)	7.50	10.20	7.90	12.60	12.50	9.10	9.00	5.30	4.30	2.20
15	−0.20	(a)	7.50	9.80	7.90	12.75	12.60	8.40	8.70	5.30	4.30	2.30
16	0.20	(a)	7.50	9.30	7.95	12.90	12.80	7.90	8.20	5.30	4.30	2.40
17	0.90	(a)	7.30	8.90	8.20	13.00	12.60	7.50	7.70	5.20	4.30	2.40
18	1.55	(a)	7.30	8.50	8.40	13.10	12.40	7.30	7.40	5.20	4.25	2.70
19	2.70	(a)	7.25	8.40	9.00	13.30	12.30	7.20	7.20	5.10	4.20	3.60
20	2.30	(a)	7.10	8.20	10.10	13.30	12.80	7.30	7.10	5.00	4.00	11.70
21	2.35	(a)	6.80	8.10	10.40	12.95	13.30	7.80	6.90	4.90	4.00	22.60
22	2.50	(a)	6.60	8.10	10.70	13.10	13.30	8.10	6.50	4.80	4.00	23.80
23	2.20	(a)	6.40	8.20	10.60	13.40	13.70	8.30	6.10	4.70	4.00	23.70
24	2.20	(a)	6.70	8.10	9.90	13.60	14.00	8.50	(b)	4.60	4.10	24.00
25	1.90	(a)	6.70	7.90	9.40	13.50	14.60	8.10	(b)	4.50	4.10	23.20
26	1.20	5.65	7.00	7.50	9.10	13.20	14.20	8.70	(b)	4.45	4.30	21.50
27	0.40	5.55	7.85	7.30	8.90	12.90	13.80	9.20	(b)	4.40	4.40	20.00
28	0.55	5.40	7.70	7.30	8.80	12.95	13.30	9.40	5.00	4.40	4.30	19.00
29	−0.40	.....	8.20	7.30	8.90	13.20	12.60	9.70	4.90	4.30	4.10	18.70
30	0.50	.....	9.15	7.30	8.90	13.40	13.40	10.00	4.80	4.20	3.95	18.10
31	0.60	.....	9.00	.....	9.00	.....	13.00	9.90	.....	4.10	.....	17.20

a Doubtful and not recorded.

b Mud on gauge.

1896.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	16.20	5.75	9.40	9.20	14.30	24.80	17.00	14.20	9.30	8.35	5.40	6.80
2	15.20	6.10	10.00	8.70	14.70	24.30	17.30	14.40	9.00	8.00	5.50	6.70
3	14.20	7.10	10.20	8.30	14.75	24.60	17.50	14.60	8.60	7.70	5.90	6.75
4	13.10	7.80	9.90	8.00	14.75	24.90	17.50	14.90	8.20	7.40	6.80	7.00
5	11.50	8.20	9.50	7.70	14.80	24.80	18.10	15.10	7.95	7.30	7.70	7.00
6	10.50	8.30	9.30	7.50	14.75	24.90	18.10	15.20	7.70	7.30	8.90	6.60
7	9.90	8.50	9.00	7.30	14.75	24.65	17.60	15.20	7.40	7.10	9.90	6.10
8	9.00	8.70	8.70	7.00	14.75	24.10	17.20	15.10	7.10	7.00	10.00	5.80
9	8.40	8.50	8.40	7.00	14.90	23.90	17.50	14.80	6.95	6.90	9.40	5.50
10	7.70	8.30	8.20	7.30	15.20	23.90	17.50	14.20	6.70	6.80	8.90	5.30
11	7.20	8.00	8.00	10.10	15.40	23.40	16.90	13.60	6.60	6.70	8.60	5.10
12	6.80	7.70	7.85	13.30	15.60	22.90	15.90	13.10	6.40	6.80	8.30	4.90
13	6.60	8.30	7.55	14.20	15.40	22.00	15.20	12.80	6.30	6.90	8.10	5.10
14	6.40	10.30	7.35	14.00	15.00	20.70	14.80	12.50	6.30	6.90	7.80	5.40
15	6.30	12.10	7.25	13.50	14.75	19.00	14.20	11.90	6.50	7.00	7.60	a 5.90
16	6.30	11.50	7.00	13.20	14.40	17.75	13.50	11.60	6.80	7.30	7.50	6.30
17	6.20	11.00	6.80	13.00	14.50	17.20	13.30	11.10	6.80	7.30	7.60	6.80
18	6 10	10.60	6.50	12.60	14.40	18.20	13.30	10.70	6.90	7.10	7.60	7.40
19	6.10	10.10	6.20	12.10	16.30	18.60	13.40	10.50	7.30	6.80	7.70	8.10
20	6.10	9.40	6.20	11.40	20.80	18.80	13.80	10.70	7.90	6.70	7.80	8.50
21	6.00	8.30	6.00	11.20	23.80	18.60	a 15.40	11.60	8.90	6.50	7.70	8.70
22	5.80	7.50	6.20	10.90	25.20	18.35	19.90	12.20	9.90	6.40	7.60	8.60
23	5.80	7.00	6.40	10.60	25.80	17.90	21.50	12.90	10.70	6.20	7.40	8.50
24	6.10	6.60	7.00	10.40	26.80	17.10	21.10	13.00	10.80	6.10	7.30	8.30
25	6.50	6.40	7.90	10.35	27.20	17.00	a 20.10	12.40	10.30	6.00	7.20	8.20
26	6.50	6.80	8.90	10.45	27.70	16.70	a 18.80	12.10	10.00	5.90	b 7.15	b 8.10
27	6.10	7.20	9.50	10.90	27.30	16.70	17.70	11.80	9.75	5.70	7.10	7.90
28	5.80	8.30	8.80	11.60	27.60	17.00	a 16.80	11.30	9.40	5.60	7.10	7.60
29	5.70	9.00	8.90	12.10	27.40	17.60	a 16.00	10.60	9.10	5.50	7.10	7.50
30	5.60	.....	9.20	13.20	26.70	17.20	15.30	10.20	8.80	5.40	6.90	b 7.40
31	5.60	.....	9.60	.....	25.50	.....	14.80	9.80	.....	5.40	.....	7.30

a Reading changed one-half foot or more.

b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1897.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.30	Ice.	13.00	23.30	27.30	14.10	20.00	13.30	7.70	5.10	4.30	4.50
2	7.30	Ice.	12.60	a 25.40	27.70	13.60	19.40	13.00	7.40	5.00	4.30	4.30
3	7.60	Ice.	12.50	26.90	27.60	13.80	19.70	12.80	7.30	5.00	4.40	4.00
4	18.30	Ice.	13.30	26.80	27.40	14.00	20.20	12.40	7.00	4.90	4.30	3.80
5	23.60	Ice.	16.00	26.70	26.80	14.80	20.20	12.10	6.80	4.90	4.30	3.70
6	24.20	7.90	20.80	26.20	26.10	15.20	19.30	12.00	6.70	4.90	4.40	2.80
7	24.50	8.20	22.60	26.20	25.20	15.60	19.00	11.80	6.70	4.80	4.50	.....
8	23.90	8.60	22.80	26.10	24.20	15.70	18.60	11.70	6.60	4.70	4.60	.....
9	21.00	9.10	22.10	26.60	23.20	15.70	18.80	11.60	6.60	4.70	4.90	.....
10	18.40	10.20	a 21.60	27.10	22.40	15.40	18.60	12.00	6.50	4.60	5.10	.....
11	15.90	11.10	19.80	27.60	21.60	15.20	17.60	11.60	6.50	4.60	5.20	.....
12	13.90	11.50	19.30	27.40	20.80	14.90	16.80	11.30	6.30	4.50	5.20	.....
13	12.50	11.40	18.90	26.90	20.00	14.50	16.30	11.10	6.10	4.50	5.20	.....
14	11.40	12.50	18.30	26.20	19.30	14.30	15.30	10.90	6.00	4.40	5.10	2.30
15	10.90	12.60	17.70	25.40	18.60	13.90	14.60	10.90	5.80	4.40	5.10	2.50
16	10.50	13.20	17.00	24.80	18.20	13.80	14.10	10.80	5.60	4.30	5.30	2.80
17	10.40	13.50	16.70	24.50	17.50	13.80	13.70	10.70	5.50	4.20	5.20	3.00
18	10.40	13.20	16.90	24.50	16.90	14.00	a 13.70	10.60	5.40	4.20	5.00	2.80
19	11.90	12.80	17.20	24.40	16.50	14.10	a 13.90	10.40	5.30	4.20	4.80	2.20
20	13.50	12.60	17.60	24.40	16.00	13.90	13.80	10.30	5.20	4.10	4.70	1.30
21	14.20	12.50	18.40	24.60	15.50	13.80	13.50	10.10	5.10	4.10	4.60	1.30
22	14.30	13.60	18.90	24.70	15.00	13.90	13.10	10.00	5.10	4.00	4.60	0.90
23	14.40	14.90	19.10	24.90	14.60	14.70	12.80	9.90	5.10	4.00	4.50	0.90
24	14.20	15.60	19.50	25.10	14.30	15.40	12.50	9.70	5.20	4.00	4.30	0.70
25	13.80	b 15.60	19.70	24.90	14.20	15.50	13.00	9.50	5.30	4.00	4.20	0.80
26	12.40	15.20	20.30	24.60	14.40	16.30	14.30	9.30	5.40	4.00	4.40	0.90
27	11.40	14.80	21.70	24.30	14.80	17.10	16.30	8.90	5.40	4.10	4.60	1.30
28	10.10	13.90	22.20	24.90	14.80	a 17.10	16.70	8.60	5.30	4.10	4.60	1.90
29	8.70	.....	22.40	25.50	14.70	18.20	15.80	8.40	5.20	4.20	4.50	2.40
30	Ice.	.....	b 22.00	26.60	15.00	19.90	14.50	8.20	5.10	4.20	4.50	2.70
31	Ice.	.....	21.80	.....	14.90	.....	13.60	8.00	.....	4.20	.....	3.10

a Reading changed one-half foot or more. b Changed less than one-half foot.

1898.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	6.60	8.80	21.80	14.40	18.40	21.50	11.80	7.00	6.90	9.60	6.20
2	3.20	5.90	8.70	20.60	14.30	18.10	21.50	11.30	6.60	6.70	8.80	5.70
3	2.50	5.10	8.60	19.40	15.50	18.40	21.00	12.00	6.30	6.20	8.00	a 5.30
4	2.80	(b)	8.40	18.10	17.50	19.00	20.00	12.90	6.00	6.00	7.50	a 5.00
5	3.10	(b)	8.20	17.60	a 19.30	19.50	19.20	12.50	5.90	5.80	7.20	a 4.70
6	3.30	(b)	8.10	17.50	a 19.90	19.80	18.80	11.70	5.70	5.40	7.00	4.10
7	3.70	(b)	8.00	17.90	20.00	19.60	18.80	10.80	5.60	5.10	6.80	3.90
8	4.00	4.90	7.90	17.80	19.80	18.80	20.50	10.30	5.80	4.90	7.20	3.70
9	4.20	5.50	7.90	17.40	19.30	18.20	a 20.90	10.30	6.50	4.70	7.40	3.20
10	4.30	5.90	7.80	17.50	18.60	18.10	21.00	10.60	7.30	4.60	7.50	2.50
11	5.60	5.80	7.80	17.30	18.00	18.70	20.60	10.30	8.50	4.60	7.80	2.00
12	6.70	6.20	8.10	16.70	17.30	19.70	19.90	9.60	9.00	4.60	8.10	1.80
13	7.30	7.50	9.80	16.30	16.30	20.70	18.50	9.30	9.00	5.50	7.90	1.90
14	7.90	9.00	14.40	16.20	16.10	21.30	17.50	9.70	8.60	5.40	7.60	2.10
15	c 7.60	9.40	16.70	16.20	15.90	21.60	16.70	9.60	8.10	4.90	7.20	2.00
16	7.20	9.60	16.90	16.60	15.60	21.80	15.70	9.80	7.70	4.60	6.90	2.40
17	7.10	9.50	17.00	16.20	18.10	23.30	14.70	9.60	8.80	4.30	6.60	2.50
18	6.80	9.70	16.90	15.50	20.80	23.70	14.00	9.50	10.20	4.30	6.50	2.60
19	6.50	10.10	16.70	15.00	21.50	23.30	13.60	9.30	11.00	4.40	6.40	2.90
20	6.40	10.70	16.50	14.50	21.30	22.60	13.00	9.60	10.60	5.40	6.30	3.20
21	7.20	11.90	17.50	14.00	21.40	21.50	12.70	10.60	9.90	7.10	6.30	3.50
22	8.00	12.50	18.60	13.30	24.10	20.30	12.70	11.10	9.00	9.00	6.30	4.20
23	8.40	11.70	22.80	13.30	25.30	19.50	12.10	10.40	8.50	10.20	6.30	6.20
24	8.30	10.80	23.90	13.30	25.30	18.90	11.70	9.60	8.50	10.30	6.80	8.20
25	8.20	10.10	23.60	13.30	24.30	18.20	11.40	9.00	9.20	9.80	7.70	9.30
26	8.20	9.70	23.00	13.40	23.40	17.90	11.40	8.60	9.10	9.30	8.80	10.00
27	8.30	9.20	22.10	16.20	22.50	a 18.50	11.70	8.30	8.90	8.50	9.40	10.10
28	8.50	9.00	21.90	16.70	21.30	20.60	11.50	7.90	8.70	8.30	8.80	9.80
29	8.30	.....	21.50	16.00	20.80	21.30	11.00	a 7.70	8.00	9.20	7.80	9.40
30	7.70	.....	21.90	15.20	20.30	21.60	11.30	7.60	7.40	10.10	7.00	9.10
31	7.30	.....	22.10	.....	19.50	.....	12.10	7.40	.....	10.30	.....	8.80

a Reading changed one-half foot or more. b Reading doubtful. c Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1899.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.50	1.70	15.00	12.90	23.70	21.50	19.60	13.40	8.00	5.80	4.90	6.00
2	6.50	1.90	14.30	12.80	23.70	21.60	19.50	13.60	8.10	5.60	4.80	5.80
3	5.70	2.50	13.30	12.20	23.50	22.50	19.70	13.60	7.90	5.50	5.00	5.70
4	5.40	2.90	12.90	12.00	22.40	22.60	20.40	13.30	7.70	5.40	5.30	5.70
5	5.40	3.80	12.20	12.10	20.80	22.70	21.00	12.90	7.50	5.30	5.40	5 60
6	4.90	6.60	12.10	13.00	19.70	22.70	21.20	13.00	7.40	a 5.20	a 5.60	5.60
7	5.00	8.40	12.20	13.50	19.20	22.50	21.50	12.80	7.20	5.10	5.80	5.50
8	5.50	8.10	11.80	13.40	18.70	21.80	21.70	12.30	7.10	5.00	6.00	5.40
9	5.30	7.50	11.10	13.30	18.60	21.40	21.60	12.20	7.00	4.90	6.20	5.40
10	4.90	7.50	11.10	13.50	18.60	21.40	21.50	13.70	7.00	4.70	6.40	5.40
11	5.00	7.40	11.20	13.70	19.30	21.40	21.90	15.20	7.20	4.70	6.60	5.30
12	5.00	7.10	11.50	14.40	19.90	21.50	22.10	15.40	a 7.30	4.70	6.80	5.30
13	5.20	7.30	11.50	16.00	20.40	22.60	21.80	14.80	7.30	4.60	6.80	5.30
14	5.90	7.50	12.00	16.10	20.60	23.20	21.20	14.60	7.20	4.60	6.90	5.30
15	5.40	7.60	12.60	15.30	20.40	22.90	20.60	a 14.30	a 7.10	4.50	7.00	5.50
16	5.70	7.70	14.70	15.00	19.90	21.80	20.00	13.70	7.00	4.40	7.00	5.40
17	5.90	7.80	15.70	14.70	19.20	21.10	19.50	12.80	6.90	4.50	6.90	4.90
18	5.90	7.70	16.30	14.70	18.70	21.10	19.30	12.20	7.00	4.50	6.90	4.70
19	5.80	7.40	16.70	14.80	17.90	21.10	19.10	11.80	7.10	4.50	6 90	4.70
20	5.50	7.60	17.90	15.20	17.50	21.00	19.00	11.30	7.20	4.50	6.90	5.50
21	5.60	7.50	18.70	16.30	18.10	20.80	18.60	11.00	7.10	4.40	6.80	5.60
22	5.50	5.70	18.80	16.90	18.80	20.50	18.00	10.60	6.80	4.30	6.70	5.10
23	5.40	5.20	18.40	19.40	20.60	19.90	17.40	10.10	6.70	4.20	7.00	4.70
24	5.40	4.50	17.80	22.30	22.00	19.30	16.70	9.60	6.50	4.20	7.20	4.20
25	5.40	4.80	17.10	23.50	22.80	18.80	16.30	9.20	6.40	4.10	7.20	4.00
26	5.40	7.00	16.20	24.30	23.40	18.50	15.80	8.90	6.30	4.10	7.00	3.60
27	5.40	10.10	15.20	24.40	23.30	18.60	15.20	8.60	6.20	4.10	6.60	3.10
28	5.30	14.00	14.40	23.90	22.90	18.90	14.70	8.50	6.10	4.40	6.40	2.50
29	4.80	.....	13.60	23.50	22.20	19.20	14.30	8.30	6.00	4.70	6.20	2.10
30	4.00	.....	13.00	23.60	21.70	19.50	13.90	8.10	5.90	5.20	6.10	1.30
31	2.70	.....	12.60	.....	21.60	.....	13.60	8.00	.....	5.10	.....	0.90

a Changed less than one-half foot.

1900.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	−0.10	3.60	7.30	12.60	15.20	12.80	11.30	11.30	9.85	10.15	12.60	10.15
2	−0.10	3.30	7.30	13.20	14.85	12.60	11.35	10.70	9.95	10.65	12.00	9.50
3	1.50	2.70	7.00	13.40	15.00	12.65	11.25	10.35	10.00	11.55	11.50	9.00
4	2.30	2.20	6.50	a 13.40	15.10	12.35	11.20	10.00	10.00	12.65	11.50	8.60
5	3.70	2.00	6.90	a 13.55	14.95	11.95	11.30	9.60	10.00	13.00	11.70	8.30
6	4.00	2.50	9.40	14.00	15.10	11.55	11.20	9.05	10.10	12.65	12.00	8.00
7	3.50	2.60	15.30	a 14.60	15.30	11.35	10.95	8.60	9.90	12.25	a 12.80	7.70
8	3.30	3.60	17.80	a 15.40	15.60	11.10	10.80	8.10	9.25	12.30	13.30	7.50
9	3.30	6.10	18.00	15.60	15.80	11.05	10.45	7.70	8.70	12.65	13.30	7.30
10	3.70	8.00	18.40	15.30	15.60	10.85	10.50	7.35	8.30	12.80	12.90	7.20
11	4.00	8.20	19.50	15.00	15.30	10.60	10.30	7.00	7.80	12.10	12.55	7.00
12	4.00	7.50	20.00	15.10	15.00	10.30	10.30	6.65	7.50	11.30	12.30	6.90
13	3.70	7.30	21.00	15.80	15.50	10.50	10.45	6.30	7.20	10.65	12.30	6.70
14	3.70	7.00	21.70	17.00	15.95	11.30	10.20	6.00	6.95	10.30	12.05	6.40
15	3.70	6.60	21.90	17.60	15.25	13.85	9.80	5.80	6.80	10.00	11.70	6.20
16	3.60	6.50	22.00	17.00	14.30	13.40	9.60	5.65	6.70	9.95	11.50	6.00
17	3.60	6.80	21.60	16.20	13.75	12.20	10.00	5.50	6.50	9.80	11.45	5.75
18	3.80	6.80	21.20	15.30	13.45	11.50	9.90	5.55	6.30	9.80	11.40	5.50
19	4.50	6.00	20.30	14.70	13.70	11.10	9.60	6.20	6.20	9.80	11.80	5.20
20	6.80	6.00	19.20	14.70	13.70	11.00	9.40	7.70	6.35	10.05	11.70	5.00
21	8.00	6.40	18.10	15.00	13.65	11.10	9.30	8.70	6.50	10.20	11.75	4.70
22	7.50	8.10	17.30	15.40	13.65	12.35	9.90	9.15	6.90	10.60	11.90	4.50
23	6.80	a 8.90	16.90	15.60	13.65	13.75	11.15	9.25	7.35	11.15	11.85	4.35
24	6.30	9.90	16.40	16.00	13.70	14.30	12.20	9.20	7.60	11 60	11.90	4.35
25	6.20	9.50	15.70	16.30	13.45	14.30	12.80	9.10	7.70	11 85	12.00	4.25
26	6.20	8.70	15.30	16.80	12.95	14.30	13.30	9.05	7.75	12.10	12.10	4.20
27	6.00	8.10	15.00	16.90	12.65	14.00	13.10	9.00	7.85	12.10	11.90	4.25
28	6.00	7.60	14.50	16.60	12.25	13.35	12.60	9.00	8.20	12.10	11.60	4.20
29	5.30	.....	14.00	16.10	12.20	12.35	12.20	8.90	9.00	12.10	11.30	4.10
30	4.50	.....	13.40	15.70	12.85	11.70	11.80	8.80	9.60	12.25	10.85	3.80
31	3.80	.....	13.00	.....	13.00	.....	11.55	9.40	.....	12.40	.....	3.60

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo– Cont'd.

WATERS POINT, MO.—Continued.

1901.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.60	4.85	4.95	17.60	14.90	9.10	13.50	8.25	4.45	4.00	4.60	3.60
2	3.60	4.60	4.70	17.80	14.60	9.05	13.00	8.40	4.35	3.90	4.50	3.55
3	3.30	4.40	4.30	17.85	14.20	9.00	12.30	8.45	4.20	3.75	4.40	3.45
4	3.00	4.65	4.40	18.00	13.90	11.20	11.70	8.35	4.10	3.60	4.30	3.40
5	2.70	4.60	4.75	18.20	13.60	11.20	11.20	8.25	4.00	3.65	4.20	3.30
6	2.30	4.50	5.30	18.60	13.40	11.90	10.80	8.05	3.90	3.70	4.00	3.20
7	2.15	4.45	5.55	18.80	13.05	12.10	10.50	7.60	3.80	3.75	4.00	3.20
8	2.10	3.90	6.10	19.00	12.70	12.40	10.20	7.30	3.75	3.80	3.95	3.20
9	2.30	3.25	6.90	19.45	12.50	12.70	10.30	7.05	3.65	3.95	3.90	3.35
10	2.90	2.70	8.50	20.50	12.30	12.45	11.10	6.90	3.70	4.00	3.90	3.30
11	3.35	2.70	12.10	21.00	[a] 12.00	12.25	11.50	6.70	3.55	3.95	3.90	3.15
12	4.60	3.30	15.95	21.10	11.75	12.10	11.10	6.60	3.60	4.00	4.10	3.05
13	5.40	3.30	16.90	21.30	11.60	12.05	10.50	6.50	3.55	4.10	4.10	3.20
14	5.50	3.35	17.00	21.40	11.40	12.20	10.20	6.40	3.50	4.10	4.05	3.60
15	5.95	3.30	16.60	21.50	11.20	12.90	10.00	6.30	3.45	3.90	4.00	3.15
16	5.85	3.40	16.20	21.10	10.90	13.50	10.00	6.20	3.40	3.95	4.00	3.00
17	5.70	3.50	16.00	21.30	10.70	13.30	10.00	6.05	3.30	4.05	4.00	2.25
18	5.85	3.65	15.90	22.00	10.50	12.90	9.95	5.95	3.35	4.20	3.95	1.35
19	5.90	3.90	15.70	22.20	10.30	12.40	9.95	5.90	3.50	4.45	3.90	1.45
20	5.60	4.20	15.65	21.50	10.10	12.15	10.00	5.75	3.80	4.60	3.90	[b] 1.55
21	5.40	4.00	15.50	20.30	9.80	12.10	10.40	5.60	4.60	4.80	3.90	[b] 2.60
22	5.30	3.75	16.10	19.40	9.50	12.10	10.65	5.50	5.50	4.80	3.90	[b] 2.70
23	5.45	3.75	17.00	18.80	9.30	12.45	10.20	5.50	5.55	4.75	3.90	[b] 3.50
24	5.50	3.80	17.50	18.20	9.30	13.20	9.70	5.40	5.20	4.70	3.90	[b] 4.10
25	5.50	4.10	17.95	17.50	9.00	13.80	9.40	5.30	4.90	4.60	3.85	[b] 4.40
26	5.25	4.70	18.20	17.00	9.30	14.00	9.00	5.20	4.65	4.50	3.85	[b] 5.00
27	5.20	5.20	18.10	16.50	10.05	14.20	8.80	5.05	4.45	4.50	3.75	[b] 5.30
28	5.20	5.25	17.70	16.05	10.00	14.50	8.60	4.95	4.30	4.50	3.70	[b] 4.65
29	5.10	.....	17.50	15.60	9.70	14.60	8.40	4.80	4.20	4.55	3.70	[b] 4.45
30	5.10	.....	17.30	15.25	[a] 9.50	14.10	8.20	4.70	4.10	4.60	3.60	[b] 3.70
31	5.10	.....	17.35	.....	9.30	.....	8.20	4.55	.....	4.60	.....	[b] 3.40

[a] Interpolated—no reading. [b] Doubtful on account of ice.

1902.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 3.50	[a] 2.25	4.20	10.10	8.25	16.90	21.50	20.90	18.70	15.10	10.35	13.60
2	[a] 3.40	[a] 3.75	5.30	10.70	8.00	16.60	22.40	20.10	18.00	14.90	9.90	13.20
3	[a] 3.40	[a] 4.50	4.90	10.80	9.70	17.70	22.80	19.30	17.60	14.90	9.55	12.85
4	[a] 2.70	[a] 4.05	6.30	10.80	10.90	18.55	22.80	18.50	17.80	15.70	9.15	12.40
5	[a] 2.20	[a] 4.40	6.50	10.60	10.45	18.40	22.40	18.10	18.30	16.40	9.05	12.60
6	[a] 2.25	[a] 4.10	6.00	10.70	9.80	18.15	21.60	17.75	18.00	16.80	9.15	12.70
7	[a] 2.85	[a] 4.55	5.90	11.80	8.90	17.80	20.80	17.50	17.30	17.50	9.80	12.75
8	[a] 3.40	[a] 4.70	6.55	12.00	8.10	17.15	20.30	17.15	16.30	18.45	10.00	13.05
9	[a] 3.55	[a] 4.60	7.70	11.30	7.70	16.70	20.30	17.10	15.30	19.10	10.35	12.90
10	[a] 3.50	[a] 4.30	8.60	10.60	7.90	17.00	20.20	16.70	14.50	19.10	10.95	12.25
11	3.35	[a] 4.40	8.70	10.15	9.25	17.60	19.70	16.20	13.95	18.30	11.40	11.45
12	2.60	[a] 4.40	8.60	9.90	10.15	18.45	19.60	15.70	13.50	17.50	11.20	10.50
13	2.40	[a] 4.50	9.10	9.40	10.70	18.45	20.40	15.40	12.95	16.70	10.70	10.65
14	2.05	[a] 4.45	10.55	9.10	11.30	18.70	21.60	15.35	12.25	15.85	10.10	11.15
15	1.70	[a] 4.35	11.30	8.85	11.30	19.60	22.60	14.95	11.65	15.10	9.85	11.20
16	1.90	[a] 4.40	12.30	8.60	11.10	19.65	23.10	14.35	11.05	14.40	9.55	10.60
17	2.10	[a] 4.55	13.00	8.35	11.00	19.30	23.50	13.80	10.50	14.10	9.50	9.60
18	2.30	[a] 4.50	12.65	8.20	11.00	19.00	23.80	13.75	10.10	14.10	9.70	9.45
19	2.30	[a] 4.50	12.10	8.25	11.10	18.70	24.20	14.05	9.95	14.20	10.50	9.45
20	2.30	[a] 4.30	11.40	8.20	11.70	18.50	24.25	14.35	9.35	14.50	11.70	9.90
21	2.30	[a] 4.25	10.35	7.70	11.60	18.10	24.10	15.55	8.80	14.65	12.45	10.40
22	2.35	[a] 4.35	9.50	7.20	11.20	17.60	23.85	16.35	8.35	15.20	12.75	11.30
23	2.35	[a] 4.25	9.00	7.50	11.00	17.40	24.25	16.70	8.05	15.60	12.60	11.90
24	2.30	[a] 4.10	8.60	8.60	11.30	17.50	24.60	16.80	7.85	15.60	12.35	12.55
25	2.30	[a] 3.80	8.20	8.65	12.30	17.20	24.80	16.80	7.95	15.40	12.15	13.50
26	2.15	4.00	7.90	8.20	12.95	17.20	24.80	16.85	10.40	15.15	12.15	13.85
27	1.75	4.40	7.90	7.50	13.70	17.50	24.65	17.10	11.80	14.40	12.35	13.50
28	1.95	3.80	8.30	7.10	15.40	18.00	24.00	17.95	12.70	13.20	12.70	13.10
29	1.30	.....	8.70	7.55	17.40	19.80	23.30	18.70	13.60	12.10	12.90	12.35
30	.90	.....	9.30	8.10	17.50	20.30	22.40	19.20	14.60	11.40	13.50	11.20
31	1.50	.....	9.50	.....	17.20	.....	21.50	19.00	.....	10.80	.....	9.85

[a] Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1903.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept	Oct.	Nov.	Dec.
1	8.60	10.10	15.00	18.65	16.90	24.80	18.80	15.60	16.00	15.60	14.10	6.10
2	8.15	9.65	15.20	18.40	16.50	26.75	18.70	15.05	17.40	15.60	13.95	5.95
3	8.10	9.45	15.30	18.10	16.30	28.00	18.10	14.50	18.10	15.70	13.80	5.60
4	8.30	10.60	15.90	18.00	16.10	29.00	17.40	14.85	18.10	15.80	13.60	5.30
5	8.60	14.30	16.95	18.65	15.80	30.00	16.80	14.60	17.85	16.05	13.40	5.00
6	8.95	15.45	17.20	19.60	15.50	30.90	16.25	13.60	17.25	16.30	13.35	4.60
7	9.40	14.60	17.80	20.10	15.30	32.20	15.80	14.20	16.60	16.50	13.60	4.80
8	9.05	13.70	19.40	20.30	15.20	32.80	15.60	15.15	16.00	16.95	14.00	4.65
9	8.80	12.80	22.50	20.05	15.20	32.98	15.60	15.50	16.30	18.10	a 14.10	4.40
10	8.65	11.90	23.50	19.50	15.30	33.50	15.65	15.45	15.70	19.05	13.70	4.25
11	b 8.00	11.00	23.80	19.40	15.20	33.60	15.65	15.70	15.60	19.90	13.30	4.00
12	b 7.70	10.80	23.35	20.35	15.00	33.50	15.50	15.60	16.40	19.70	13.10	3.80
13	6.80	11.20	22.75	21.50	14.80	33.20	15.00	15.50	18.10	19.40	12.70	3.65
14	5.95	11.50	22.35	21.90	14.55	32.50	14.60	15.70	18.70	19.10	12.25	2.70
15	5.80	11.35	22.50	22.10	14.35	31.50	14.65	15.70	18.60	18.80	11.80	c 2.30
16	5.70	11.30	22.30	22.00	14.30	30.20	15.45	16.30	18.95	18.35	11.50	c 2.00
17	6.00	10.60	21.50	21.80	15.40	28.90	16.30	15.80	19.40	17.80	11.25	c 1.40
18	6.50	9.70	21.70	22.20	17.50	27.60	17.35	15.70	18.80	17.30	10.90	c 1.40
19	7.30	9.20	21.65	22.10	18.70	26.25	17.90	16.10	18.70	16.80	10.40	1.80
20	7.90	8.95	21.35	21.50	19.20	25.00	17.70	16.15	18.70	16.40	9.95	2.00
21	8.00	8.45	22.20	21.10	19.00	24.30	17.10	16.30	18.35	16.00	9.55	2.20
22	7.75	8.50	22.60	21.30	18.60	23.75	17.00	16.30	17.55	15.60	9.25	2.70
23	7.70	8.55	22.30	20.95	18.40	23.00	17.05	15.90	16.80	15.25	8.90	3.00
24	7.55	8.65	21.90	20.30	18.25	22.50	17.20	15.25	16.20	15.05	8.65	3.50
25	7.50	8.80	21.70	19.20	18.40	22.15	17.45	14.70	15.60	15.00	8.30	4.15
26	7.10	8.90	21.30	19.20	19.60	21.85	18.25	14.40	15.25	14.80	7.90	4.50
27	6.85	9.40	20.90	18.65	21.60	21.25	18.55	14.10	15.20	14.60	7.45	4.30
28	8.10	12.50	20.30	18.10	22.20	20.25	17.90	14.10	15.30	14.50	7.10	4.00
29	10.30	.....	19.85	17.65	22.10	19.30	17.30	14.30	15.50	14.40	6.70	4.20
30	10.35	.....	19.30	17.25	22.30	18.75	16.90	14.90	15.50	14.30	6.40	4.55
31	10.10	.....	18.95	.....	23.00	.....	16.30	15.60	.....	14.20	.....	4.80

a Changed less than one-half foot.
b Reading changed one-half foot or more.
c Doubtful on account of ice.

1904.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.30	7.80	7.45	22.80	30.10	21.00	21.80	12.40	8.10	11.35	9.80	5.20
2	5.25	6.80	7.20	22.40	29.70	22.00	21.10	12.20	7.75	11.00	9.70	5.00
3	5.00	6.40	7.10	22.20	29.15	a 22.10	20.50	11.70	7.45	10.80	9.60	4.90
4	4.60	6.30	7.40	21.60	28.50	21.50	20.05	11.40	7.40	10.30	9.45	4.80
5	4.05	6.25	7.40	21.00	27.40	22.00	20.00	11.40	7.90	9.70	9.20	4.70
6	4.05	6.45	8.20	20.50	26.20	24.30	19.60	11.20	7.95	9.00	9.10	4.60
7	4.10	7.00	8.80	19.90	25.10	25.50	19.00	10.75	7.60	8.90	9.00	4.35
8	4.10	7.30	8.95	19.30	24.05	25.70	18.65	10.25	7.10	8.80	8.85	4.10
9	3.90	7.60	9.50	19.10	23.70	25.10	20.40	9.65	6.95	8.50	8.70	3.95
10	3.75	8.10	9.80	20.10	23.70	24.25	22.80	9.20	7.00	8.20	8.65	3.95
11	3.85	8.60	10.10	20.80	23.20	23.50	24.10	8.90	7.20	8.10	8.60	3.95
12	3.75	9.10	10.90	21.20	22.70	22.90	24.80	8.50	7.10	7.95	8.50	3.70
13	3.80	9.40	11.10	21.40	22.00	22.20	25.00	8.25	6.90	7.70	8.35	3.60
14	3.80	9.60	11.20	21.25	21.20	21.85	24.40	8.15	6.90	7.45	8.20	3.00
15	4.30	9.90	11.10	21.10	20.50	21.80	23.30	8.25	6.80	7.20	8.05	2.50
16	4.30	9.70	11.00	21.10	19.90	22.35	21.70	8.25	6.70	7.10	7.90	2.20
17	4.35	9.15	11.10	20.90	19.50	22.50	20.05	8.60	6.70	7.00	7.75	2.00
18	4.60	8.40	11.55	21.70	19.50	22.30	19.45	8.50	6.80	6.90	7.50	a .50
19	4.90	8.10	12.00	22.20	19.90	22.45	19.25	8.50	8.00	6.90	7.35	a 1.10
20	4.90	8.30	12.20	22.00	20.20	22.30	18.90	9.60	9.60	6.85	7.15	a .90
21	5.50	8.10	12.35	21.50	19.70	22.55	18.50	10.90	10.90	6.80	6.95	a 1.00
22	8.70	7.80	12.45	21.80	19.10	22.05	17.60	11.10	11.40	6.90	6.70	a .90
23	12.10	7.40	13.95	22.05	18.50	22.60	16.65	11.15	10.80	7.00	6.50	a .80
24	14.50	7.40	15.30	22.50	18.00	21.70	16.00	11.80	9.90	7.20	6.30	a 1.15
25	14.20	7.60	16.35	25.35	17.60	21.00	15.90	11.70	9.60	7.45	6.10	a 1.40
26	13.60	7.75	18.95	28.20	17.10	20.10	a 15.90	11.90	10.00	7.75	5.90	a 1.60
27	12.80	8.05	19.60	29.50	16.90	19.55	15.55	12.10	10.80	8.10	5.70	2.20
28	11.70	8.00	21.90	30.20	17.20	19.50	14.70	11.30	11.00	8.45	5.50	2.70
29	10.70	7.70	23.30	30.50	17.20	20.20	14.00	10.30	10.75	8.85	5.40	1.60
30	9.75	.....	23.50	30.40	17.50	21.35	13.40	9.30	11.10	9.40	5.30	1.25
31	8.75	.....	22.80	.....	19.00	.....	12.90	8.60	.....	9.75	.....	1.30

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1905.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.50	9.10	16.80	16.90	17.00	17.90	21.00	18.80	11.30	13.75	11.80	9.50
2	.70	8.80	17.05	17.70	16.40	17.60	21.00	19.40	11.15	13.05	11.50	9.75
3	1.60	8.25	17.10	17.55	15.60	17.60	21.00	19.75	10.60	12.30	11.70	9.55
4	2.70	7.95	16.80	17.35	14.85	17.90	21.20	20.06	10.20	11.90	11.70	9.40
5	2.50	8.35	17.90	17.20	14.40	18.50	22.30	19.20	9.90	11.55	11.80	8.95
6	2.50	8.50	17.60	16.70	13.60	19.10	22.85	18.30	9.65	11.20	12.30	8.45
7	2.70	8.50	16.90	16.10	12.60	18.95	23.30	17.50	9.70	10.60	13.05	7.90
8	2.20	8.45	16.80	15.50	12.20	18.30	23.20	16.70	9.80	10.10	13.20	7.30
9	2.00	8.25	16.80	15.00	11.40	17.75	22.80	15.95	9.80	10.10	12.80	6.70
10	2.05	8.20	16.50	14.50	11.20	17.30	22.50	15.40	9.60	9.35	12.40	6.00
11	1.45	7.90	16.45	14.20	11.10	17.00	22.40	15.15	9.60	9.10	12.20	5.50
12	1.35	a7.90	16.10	14.00	12.00	17.05	22.60	14.60	10.30	8.80	12.20	5.20
13	1.25	a8.50	15.60	13.90	11.70	17.90	23.10	14.00	11.70	8.50	12.45	5.00
14	.75	a8.50	14.80	13.80	12.30	18.70	23.65	13.60	11.50	8.25	12.30	5.10
15	a.70	a8.70	13.80	13.70	13.70	19.30	24.05	13.20	10.60	8.00	11.70	5.20
16	a3.60	a8.70	13.20	13.75	15.70	19.60	23.75	12.35	10.30	7.75	10.95	5.20
17	a3.60	a8.80	12.90	13.90	17.50	19.40	22.80	12.00	12.90	7.50	10.20	5.20
18	a5.00	a8.70	12.55	13.95	18 30	19.00	21.30	11.70	21.70	8.70	9.80	5.20
19	a6.40	a8.60	12.40	13.60	15.65	18.50	20.00	11.90	25.30	15.60	9.40	5.30
20	a8.10	a8.40	12.25	b13.40	19.60	18.90	19.10	12.30	27.45	16.00	9.40	5.35
21	a7.90	a8.30	12.00	13.20	19.50	19.30	18.50	12.80	28.30	14.10	9.95	5.50
22	a8.25	8.40	12.20	13.00	18.80	19.15	17.90	13.00	28.20	13.90	b9.70	5.60
23	a8.40	8.55	13.10	13.00	18.20	18.90	17.60	14.10	27.40	13.60	9.20	5.60
24	a8.45	8.80	14.00	13.40	17.90	18.90	17.60	16.50	25.30	13.30	8.70	5.60
25	a8.60	9.50	14.30	13.80	17.45	19.30	17.90	17.50	22.90	13.10	8.60	5.40
26	7.45	11.10	14.70	14.20	17.20	19.85	18.45	16.90	20.80	13.45	8.50	5.20
27	7.45	12.80	14.95	14.80	17.10	20.10	18.60	16.50	19.30	15.20	8.40	5.00
28	8.40	15.85	15.30	15.50	17.25	20.10	17.50	16.10	17.40	14.40	8.25	5.00
29	8.90	.....	16.00	15.75	17.40	20.30	16.80	14.90	15.75	13.30	8.40	5.50
30	8.85	.....	16.40	16.60	c17.70	20.70	16.45	13.40	14.60	12.70	9.00	5.80
31	8.90	.....	16.50	.....	18.30	.....	17.70	12.20	.....	12.25	.....	6.10

a Doubtful on account of ice. b Changed less than one-half foot. c Reading changed one-half foot or more.

1906.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.30	13.30	20.60	23.70	18.90	12.95	17.65	9.90	9.80	11.50	5.65	8.70
2	6.30	13.70	21.10	23.35	18.70	13.50	17.60	9.70	9.25	12.00	6.30	8.90
3	6.50	13.30	21.30	22.70	18.70	14.30	17.75	9.95	9.00	12.25	6.65	9.30
4	7.60	12.50	20.70	22.00	18.80	14.70	17.80	9.95	8.90	12.10	6.95	9.40
5	12.20	11.70	a19.70	22.00	18.60	15.40	17.50	9.50	8.60	11.80	7.10	9.50
6	14.80	10.90	18.80	22.00	18.50	15.40	17.10	9.40	8.50	10.80	7.10	9.80
7	14.35	10.20	17.95	21.70	19.20	15.80	16.80	9.20	8.40	9.95	7.20	10.20
8	13.40	9.25	17.50	21.50	19.70	16.50	16.50	9.90	8.35	9.40	7.30	10.30
9	12.15	8.45	17.35	21.90	19.30	17.20	16.10	9.75	8.35	9.00	7.45	10.00
10	10.60	8.10	17.30	22.20	18.50	17.70	15.50	9.80	8.30	8.65	7.60	9.60
11	9.20	7.70	17.00	22.00	17.80	17.80	15.00	10.30	8.40	8.30	7.70	9.25
12	8.30	7.45	16.60	21.60	17.10	17.60	14.50	10.35	8.50	8.00	7.75	9.10
13	7.70	7.35	16.30	21.50	16.70	17.05	14.10	10.90	8.45	7.70	7.70	8.90
14	7.35	7.60	15.80	22.70	16.20	16.85	13.95	11.55	8.35	7.55	7.70	8.60
15	7.10	7.75	15.40	23.80	15.65	16.75	13.50	12.10	8.20	7.30	7.75	8.40
16	7.10	7.85	14.90	23.50	15.10	16.50	13.30	12.20	8.10	7.20	7.80	8.15
17	6.80	7.90	14.10	22.90	14.40	16.10	13.20	11.90	8.10	7.10	7.90	7.80
18	6.40	8.05	13.60	22.55	13.90	15.95	12.80	11.30	7.95	7.00	8.10	7.30
19	6.40	8.40	13.10	22.30	13.40	16.00	12.30	10.75	8.15	6.80	8.10	6.70
20	6.50	8.80	12.40	21.80	13.10	16.40	12.00	10.80	8.45	6.60	8.05	6.05
21	7.00	9.10	11.80	21.50	12.70	17.25	11.70	11.00	8.40	6.45	8.70	5.85
22	9.40	9.30	11.20	21.10	12.40	18.00	11.60	10.75	8.30	6.30	9.70	5.90
23	10.65	10.05	10.90	20.70	12.50	18.65	11.60	10.40	8.30	6.10	9.95	5.40
24	12.60	12.60	11.00	20.30	12.10	19.05	11.90	9.90	8.65	6.00	9.60	4.70
25	13.20	15.70	11.30	20.00	12.00	19.40	12.80	9.40	9.80	5.90	9.10	4.20
26	12.40	17.70	11.60	19.80	11.90	18.75	13.40	9.50	10.30	5.60	8.90	3.70
27	12.20	19.30	15.60	19.60	11.85	18.20	12.80	11.00	10.50	5.50	8.70	3.40
28	11.95	20.00	20.50	19.40	11.90	17.50	12.10	12.20	10.80	5.40	8.70	3.10
29	11.90	.....	22.40	19.20	12.10	17.70	11.60	11.90	11.10	5.40	8.70	3.10
30	12.10	.....	23.20	19.00	11.90	17.80	10.80	10.90	11.20	5.35	8.55	3.60
31	12.60	.....	23.90	.....	12.10	.....	10.20	10.30	.....	5.35	.....	4.40

a Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

WATERS POINT, MO.—Continued.

1907.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.0	15.4	14.0	15.3	16.8	13.55	21.0	23.0	12.1	8.35	6.4	5.65
2	5.7	14.9	13.8	15.8	17.35	14.2	20.4	21.9	12.0	8.4	6.4	5.6
3	6.4	14.3	13.4	15.9	17.4	15.0	20.05	20.6	12.0	8.6	6.4	5.6
4	7.25	13.35	13.0	15.7	17.2	17.0	19.3	19.6	12.0	9.3	6.2	5.5
5	8.45	12.35	12.8	15.5	16.7	19.25	18.5	18.9	11.9	9.9	6.1	5.4
6	9.4	11.2	12.6	15.6	16.3	19.55	17.75	18.3	11.8	10.2	6.1	5.3
7	9.8	9.9	12.6	15.35	16.2	19.4	17.6	17.9	11.6	10.3	6.0	5.2
8	9.8	8.5	12.4	15.2	17.0	18.8	17.9	17.6	11.45	10.4	5.9	5.0
9	9.7	7.65	12.0	15.3	18.1	18.4	18.1	17.5	11.0	10.8	6.0	4.9
10	9.6	7.0	11.7	15.5	18.5	18.4	18.1	17.2	10.5	11.1	5.95	4.85
11	9.6	7.0	11.7	15.5	18.3	18.8	18.1	16.9	10.0	11.4	5.9	4.85
12	9.45	7.2	12.4	15.8	17.1	19.2	18.0	16.2	9.6	11.5	5.8	4.7
13	9.5	8.4	14.05	16.9	16.2	20.4	18.2	15.7	9.25	11.5	5.6	4.5
14	9.7	9.0	16.7	17.15	15.3	21.1	18.6	15.4	9.0	11.1	5.5	4.5
15	10.35	10.4	17.5	17.1	15.3	20.8	19.4	15.0	8.8	10.6	5.5	4.6
16	11.1	10.55	17.1	17.0	17.0	21.45	19.5	14.9	8.5	10.2	5.5	4.65
17	12.4	10.3	16.1	16.9	19.1	20.8	20.3	14.6	8.3	9.8	5.5	4.8
18	14.6	10.5	a 15.6	16.9	19.6	19.9	21.5	14.2	8.0	9.35	5.45	4.95
19	17.5	11.2	15.4	17.35	19.0	19.15	22.4	14.7	7.9	9.0	5.45	5.05
20	20.4	11.1	15.3	17.7	17.8	18.65	22.6	15.55	7.5	8.7	5.4	5.0
21	23.5	10.7	15.7	18.4	16.8	18.5	23.0	16.0	7.3	8.4	5.7	4.8
22	23.9	10.5	15.2	18.5	15.8	18.3	23.4	15.9	7.1	8.1	5.6	4.5
23	24.0	11.2	14.4	18.2	14.7	18.3	24.1	15.8	7.2	7.9	5.6	4.5
24	23.8	12.3	13.9	18.3	13.9	18.7	24.65	15.65	7.5	7.6	5.6	4.7
25	22.8	13.4	13.5	18.6	13.3	20.2	25.0	15.5	7.75	7.4	5.5	4.7
26	21.5	14.05	13.4	18.05	12.7	21.0	24.95	15.9	7.9	7.3	5.5	4.6
27	19.9	14.15	13.2	17.7	12.2	22.0	24.55	15.0	8.1	7.2	5.5	4.7
28	18.5	14.1	13.2	17.0	13.0	22.2	24.0	13.5	8.15	7.0	5.6	4.65
29	17.3	.....	13.2	16.2	13.4	21.9	23.75	12.9	8.30	6.8	5.6	4.5
30	16.5	.....	14.0	16.15	13.3	21.5	23.5	12.5	8.35	6.6	5.7	4.3
31	15.9	.....	14.5	.....	13.55	.....	23.6	12.2	.....	6.45	.....	4.4

a Reading changed one-half foot or more.

1908.

[Gauge, 22.40 miles from Eads Bridge. Zero of gauge, 377.54 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	4.55	3.30	15.40	13.25	15.40	25.40	27.20	.....	.....	.....	.....	.....
2	4.70	2.85	15.25	13.10	14.80	25.80	27.05	.....	.....	.....	.....	.....
3	4.80	2.00	15.50	13.15	14.30	26.25	27.20	.....	.....	.....	.....	.....
4	4.80	a 1.90	15.80	13.10	14.10	27.10	27.50	.....	.....	.....	.....	.....
5	4.70	2.30	16.00	13.10	15.10	27.50	27.65	.....	.....	.....	.....	.....
6	4.60	2.80	16.30	13.00	16.20	27.50	27.65	.....	.....	.....	.....	.....
7	4.60	2.65	16.80	13.00	17.40	27.50	27.50	.....	.....	.....	.....	.....
8	4.50	3.10	16.70	13.20	18.00	27.60	26.70	.....	.....	.....	.....	.....
9	4.30	3.40	17.70	14.30	18.50	27.50	25.60	.....	.....	.....	.....	.....
10	4.20	3.80	19.30	16.50	18.75	27.55	24.80	.....	.....	.....	.....	.....
11	4.15	4.00	19.50	18.10	19.20	27.55	24.10	.....	.....	.....	.....	.....
12	4.60	4.55	19.40	19.00	19.25	27.80	23.90	.....	.....	.....	.....	.....
13	5.50	4.80	19.30	19.30	18.50	28.20	23.70	.....	.....	.....	.....	.....
14	6.10	5.10	19.00	18.90	17.90	28.70	23.50	.....	.....	.....	.....	.....
15	5.60	7.65	18.60	18.90	18.10	29.10	22.80	.....	.....	.....	.....	.....
16	5.15	11.70	18.10	18.20	19.75	29.80	21.90	.....	.....	.....	.....	.....
17	4.75	14.40	17.50	17.70	21.55	30.55	21.00	.....	.....	.....	.....	.....
18	4.50	14.50	17.05	16.90	22.20	31.05	20.50	.....	.....	.....	.....	.....
19	4.50	14.70	16.70	16.10	22.80	31.20	20.30	.....	.....	.....	.....	.....
20	4.30	15.20	16.30	15.15	22.80	31.20	20.40	.....	.....	.....	.....	.....
21	3.95	15.55	16.00	14.50	22.10	31.10	20.70	.....	.....	.....	.....	.....
22	3.90	14.90	15.60	14.00	21.80	30.95	20.70	.....	.....	.....	.....	.....
23	4.10	14.30	15.20	13.90	21.70	30.70	20.25	.....	.....	.....	.....	.....
24	4.70	13.90	14.80	14.00	21.50	30.40	19.70	.....	.....	.....	.....	.....
25	4.65	13.45	14.35	15.10	21.00	30.00	19.20	.....	.....	.....	.....	.....
26	4.60	13.50	14.00	15.40	20.90	29.70	18.80	.....	.....	.....	.....	.....
27	5.00	14.50	13.70	15.80	21.80	29.35	18.65	.....	.....	.....	.....	.....
28	4.80	15.70	13.50	16.40	23.00	28.90	18.65	.....	.....	.....	.....	.....
29	4.50	15.70	13.50	16.70	23.60	28.30	18.55	.....	.....	.....	.....	.....
30	4.10	.....	13.70	16.00	23.80	27.70	18.15	.....	.....	.....	.....	.....
31	3.70	.....	13.70	.....	24.80	.....	17.75	.....	.....	.....	.....	.....

a Reading on temporary gauge.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.

1891.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.45	4.50	3.90
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	4.45	3.50
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	4.40	3.25
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.15	4.35	2.95
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.10	4.30	3.05
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.10	4.30	3.15
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.25	3.25
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.30	3.50
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.35	3.70
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	4.40	3.55
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.25	4.50	3.25
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.60	4.50	3.20
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.80	4.40	3.20
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.05	4.35	(a)
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.35	4.35	3.50
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	4.35	3.65
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.65	4.40	3.85
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.70	4.50	3.95
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	4.50	4.20
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.55	4.65	4.20
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.45	4.50	4.40
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.30	4.40	4.50
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.20	4.70	4.50
24	.....	.....	.....	.....	.....	.....	.....	.....	5.00	5.20	4.85	4.75
25	.....	.....	.....	.....	.....	.....	.....	.....	4.90	5.05	5.05	4.85
26	.....	.....	.....	.....	.....	.....	.....	.....	4.80	5.00	5.45	4.95
27	.....	.....	.....	.....	.....	.....	.....	.....	4.75	4.90	5.05	5.00
28	.....	.....	.....	.....	.....	.....	.....	.....	4.60	4.80	4.80	(a)
29	.....	.....	.....	.....	.....	.....	.....	.....	4.55	4.75	4.45	4.80
30	.....	.....	.....	.....	.....	.....	.....	.....	4.50	4.75	4.35	4.75
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.65	.....	4.70

a High wind.

1892.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.80	6.80	12.30	14.40	18.30	28.20	23.55	16.20	9.20	7.00	6.55	5.30
2	5.05	6.30	12.00	15.15	17.50	28.50	23.70	15.80	9.20	7.00	6.55	5.20
3	5.75	6.50	11.60	15.35	17.00	28.90	24.10	15.40	9.10	6.85	6.30	5.10
4	6.75	6.40	11.20	18.10	16.90	29.50	24.70	15.00	8.90	6.60	6.25	5.00
5	6.80	7.00	11.50	19.35	16.90	30.15	25.50	14.30	8.70	6.60	6.20	4.95
6	5.90	7.30	11.60	21.85	18.00	30.20	25.90	.....	8.60	6.55	6.00	4.95
7	Ice.	9.45	11.40	23.40	20.25	30.00	26.00	13.90	8.50	6.50	5.90	4.95
8	5.00	10.95	11.50	23.75	22.50	29.70	26.05	13.40	8.35	6.40	5.80	5.10
9	4.75	12.70	12.30	23.75	23.50	29.55	26.25	13.20	8.15	6.35	5.70	5.50
10	4.30	13.20	14.80	22.90	24.00	29.20	26.10	13.00	8.10	6.20	5.60	6.30
11	3.80	13.20	15.90	21.80	24.70	28.70	25.90	12.80	8.00	6.00	5.60	6.50
12	3.50	12.75	14.65	20.30	25.75	28.20	25.70	12.80	8.10	.....	5.65	6.50
13	Ice.	12.30	15.20	.....	26.70	27.40	25.50	12.80	8.50	5.90	5.70	6.40
14	Ice.	11.45	14.40	18.30	28.50	27.10	25.35	12.85	8.70	5.85	5.70	6.30
15	Ice.	10.70	13.50	18.20	29.70	26.60	25.40	12.40	8.50	5.85	5.60	6.00
16	3.20	10.45	13.00	18.45	30.20	26.10	25.35	12.00	8.30	5.85	5.60	5.90
17	3.25	10.55	12.35	18.45	30.50	25.50	24.75	11.90	8.20	5.70	5.70	5.50
18	3.55	10.00	11.75	18.70	30.90	24.95	24.40	11.75	8.10	5.65	5.80	5.25
19	4.50	9.50	11.50	19.30	31.20	24.45	24.15	11.50	8.00	5.65	.....	5.10
20	5.20	9.60	11.20	21.00	31.50	23.70	23.75	11.20	7.85	5.70	5.80	5.00
21	5.40	14.40	10.80	22.10	31.30	23.35	23.05	11.00	7.80	5.80	5.90	4.95
22	5.50	15.40	10.40	23.20	30.90	22.65	23.30	10.85	7.75	5.85	5.95	4.85
23	5.50	14.40	10.25	23.35	30.70	22.05	22 00	10.50	7.70	5.70	5.95	4.85
24	5.40	13.00	10.90	22.90	30.45	21.85	21.85	10.20	7.60	5.70	5.90	4.65
25	5.45	12.00	11.45	22.45	30.35	22.10	20 75	10.00	7.50	5.65	5.85	2.95
26	6.00	11.20	11.60	21.70	30.20	22.50	20.05	9.90	7.40	5.60	5.75	2.95
27	7.60	11.40	11.90	21.00	29.90	22.65	19.30	9.60	7.30	5.60	5.70	(a)
28	7.55	11.80	11.90	20.20	29 40	22.90	18.40	9.40	7.20	5.70	5.65	(a)
29	7.35	12.25	11.70	19.50	28.80	23.30	17.55	9.30	7.10	6.00	5.50	(a)
30	8.40	.....	12.05	18,80	28.00	23.45	16.90	9.20	7.05	6.45	5.40	2.95
31	7.45	.....	13.10	.....	28.10	.....	16.50	9.05	.....	6.55	.....	3.35

a Below gauge.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1893.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	4.50	10.80	14.40	26.55	23.50	15.85	9.50	5.20	3.60	3.40	(a)
2	4.25	4.40	11.50	14.30	27.40	23.35	15.60	9.55	4.95	3.65	3.40	(a)
3	4.10	4.20	Wind.	14.20	28.25	23.70	15.40	9.85	4.75	3.65	3.50	(a)
4	4.00	4.00	12.00	13.90	28.20	24.00	15.00	9.50	4.65	3.70	3.60	(a)
5	3.80	3.90	12.30	13.90	27.65	24.00	15.00	9.05	4.45	3.75	3.60	(a)
6	3.70	3.80	11.30	13.30	26.55	23.35	15.10	8.50	4.35	3.80	3.60	(a)
7	3.25	3.85	11.50	13.70	25.55	22.40	16.80	8.05	4.20	4.05	3.60	(a)
8	3.30	3.90	11.60	14.00	24.50	22.10	17.60	8.00	4.10	4.20	3.60	(a)
9	3.05	4.00	12.00	13.90	23.60	22.30	17.20	7.35	4.20	4.00	3.60	(a)
10	3.30	4.50	13.60	14.45	23.00	22.10	16.60	7.00	4.20	3.95	3.60	(a)
11	3.40	4.50	16.10	15.00	22.45	21.40	16.00	7.00	4.25	4.10	3.60	(a)
12	3.60	4.65	17.20	18.80	22.45	20.40	15.30	6.90	4.15	4.30	3.55	(a)
13	3.80	4.85	17.25	20.30	22.75	19.80	15.00	6.80	4.10	4.35	3.55	(a)
14	4.00	4.95	17.20	20.40	22.65	18.90	14.10	6.65	4.05	4.20	3.55	(a)
15	4.10	5.00	16.40	20.45	22.50	18.35	13.90	6.30	4.00	4.00	3.50	(a)
16	4.10	8.80	Wind.	20.20	22.10	18.00	12.20	6.10	3.90	3.80	3.55	(a)
17	4.10	10.00	16.70	20.10	21.90	18.00	12.20	6.10	3.70	3.65	3.35	(a)
18	4.50	10.50	17.50	19.75	21.70	17.60	13.00	6.00	3.50	3.55	3.35	(a)
19	4.70	9.70	18.70	18.90	21.35	17.00	13.70	5.80	3.35	3.50	3.30	(a)
20	4.90	10.50	18.65	18.80	20.95	16.70	14.00	5.75	3.25	3.60	3.25	(a)
21	4.50	10.00	18.40	20.90	20.50	16.40	13.60	6.05	3.20	3.55	3.25	(a)
22	4.45	9.90	17.95	22.50	20.00	15.90	12.75	7.10	3.25	3.55	3.30	(a)
23	4.40	10.10	17.80	22.60	19.65	15.00	12.20	8.40	3.30	3.50	3.35	(a)
24	4.50	9.10	18.20	22.20	19.35	15.40	11.55	8.00	3.35	3.50	3.40	(a)
25	4.70	8.90	17.70	21.90	19.20	15.55	11.20	7.60	3.40	3.55	3.35	(a)
26	4.70	9.90	16.85	22.20	19.10	15.95	10.70	7.20	3.50	3.55	3.30	(a)
27	4.70	Wind.	16.00	22.90	20.80	17.70	10.20	6.30	3.50	3.55	3.25	(a)
28	4.70	10.10	15.60	23.65	22.70	17.65	9.70	6.20	3.55	3.60	3.15	(a)
29	4.65	.....	15.30	24.55	24.00	17.30	9.55	5.70	3.60	3.55	3.05	(a)
30	4.70	.....	15.00	25.90	24.55	16.75	9.10	5.50	3.60	3.50	2.80	(a)
31	4.70	.....	14.60	.....	Wind.	.....	9.40	5.25	.....	3.40	.....	(a)

a Below gauge.

1894.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	(a)	5.35	10.90	11.70	16.55	16.15	8.55	3.90	4.45	2.75	2.90
2	2.80	(a)	5.40	10.35	12.20	16.55	15.75	8.60	3.80	4.10	2.75	2.95
3	3.05	(a)	5.40	10.00	13.35	16.40	15.60	8.60	3.75	3.80	2.85	3.05
4	3.15	(a)	5.80	9.80	13.65	16.15	15.00	8.30	3.65	3.55	2.90	3.20
5	3.25	(a)	6.20	9.50	13.55	16.00	14.75	8.20	3.90	3.30	2.95	3.75
6	3.55	(a)	7.60	9.00	14.00	16.95	14.75	7.90	4.05	3.25	3.10	3.95
7	3.65	(a)	11.30	9.05	15.20	16.00	15.15	7.40	4.30	3.15	3.20	3.85
8	3.85	(a)	15.00	9.20	16.70	16.40	15.00	7.20	4.70	3.05	3.40	3.65
9	3.50	4.30	16.90	10.50	18.00	16.55	14.20	6.90	4.90	2.95	3.50	3.35
10	3.25	5.50	17.70	11.50	18.85	16.50	13.40	6.70	4.90	2.85	3.55	3.00
11	3.05	6.80	17.50	11.20	19.35	16.45	12.90	6.50	4.85	2.95	3.45	2.85
12	2.70	6.00	17.00	11.05	20.90	16.30	12.65	6.35	4.90	2.95	3.40	2.50
13	(a)	5.10	16.95	11.40	19.85	16.10	12.40	6.10	4.85	3.05	3.35	2.45
14	(a)	5.00	14.70	11.90	18.85	16.15	11.90	5.90	4.70	3.10	3.30	2.50
15	(a)	5.00	13.45	11.75	18.20	16.20	11.40	5.70	4.70	3.10	3.25	2.60
16	(a)	3.80	12.80	11.45	17.65	16.15	10.80	5.50	4.90	2.95	3.25	2.80
17	(a)	4.00	12.15	12.05	17.30	16.05	10.35	5.20	5.30	2.85	3.25	2.70
18	(a)	4.40	11.40	14.20	16.90	16.00	10.15	5.15	6.00	2.80	3.20	2.65
19	(a)	5.20	11.00	16.00	15.95	15.70	10.00	5.10	6.30	2.75	3.25	2.60
20	2.70	6.00	10.60	17.00	15.10	15.75	9.90	5.00	5.90	2.70	3.20	2.60
21	3.20	5.90	10.45	16.20	14.55	15.75	9.90	4.95	5.50	(a)	3.25	2.65
22	4.10	4.75	10.45	15.00	14.00	15.85	9.75	4.80	5.40	(a)	3.25	2.70
23	4.50	4.55	10.50	14.20	13.65	15.90	9.75	4.75	5.30	(a)	3.20	2.75
24	4.00	4.65	10.70	13.25	13.50	16.00	9.75	4.65	5.50	(a)	3.20	2.75
25	3.15	5.00	10.80	12.80	13.40	16.05	9.40	4.55	5.50	(a)	3.25	2.75
26	2.70	5.30	10.70	12.50	13.30	15.95	9.10	4.40	5.45	2.70	3.20	2.60
27	(a)	5.50	10.50	12.20	13.50	16.00	8.90	4.30	5.70	2.75	3.20	2.60
28	(a)	5.30	10.40	12.00	13.00	16.30	8.90	4.20	5.55	2.70	3.10	2.60
29	(a)	.....	11.05	11.75	12.95	17.05	8.80	4.10	5.20	.....	2.90	1.80
30	(a)	.....	12.00	11.40	13.10	16.90	9.10	4.05	4.85	.....	2.90	1.60
31	(a)	.....	11.50	.....	15.40	.....	8.80	4.00	.....	2.75	.....	1.80

a Below gauge.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1895.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.50	(a)	5.50	7.55	5.80	7.70	12.00	11.80	8.40	(b)	(b)	2.00
2	(a)	(a)	6.20	8.00	(c)	7.60	12.15	12.70	8.55	(b)	(b)	2.00
3	(a)	(a)	6.50	8.60	(c)	7.50	12.35	11.15	8.85	(b)	(b)	1.95
4	(a)	(a)	6.95	8.25	(c)	7.35	12.65	11.70	9.70	(b)	(b)	1.60
5	(a)	(a)	6.90	7.35	5.80	6.80	12.90	11.30	9.80	(b)	(b)	1.40
6	(a)	2.50	6.70	7.00	6.05	6.90	12.50	11.40	10.10	(b)	(b)	(a)
7	(a)	5.10	7.00	6.60	6.60	7.00	12.05	9.85	10.40	(b)	(b)	(a)
8	(a)	5.10	7.40	6.25	7.10	6.90	16.35	9.60	10.75	(b)	(b)	(a)
9	(a)	3.95	7.40	6.00	7.00	6.75	16.00	9.30	10.50	(b)	(b)	(a)
10	(a)	3.95	7.20	5.95	6.15	6.80	15.70	9.15	9.85	(b)	(b)	(a)
11	(a)	3.95	6.90	7.45	.....	7.50	14.00	9.10	9.40	(b)	2.70	(a)
12	(a)	4.05	6.70	8.80	.....	8.45	13.70	8.90	8.80	(b)	2.70	0.10
13	0.60	4.05	6.60	8.90	6.15	9.00	12.45	8.55	8.40	(b)	2.50	0.20
14	1.00	3.95	6.40	8.60	6.30	10.75	11.50	7.85	7.60	(b)	2.50	0.40
15	2.20	5.00	6.20	8.40	6.40	11.15	11.35	7.15	7.20	(b)	2.45	0.45
16	2.60	5.00	6.20	8.05	6.45	11.35	11.45	6.70	6.90	(b)	2.40	0.60
17	2.80	4.80	6.00	7.50	6.50	11.35	11.45	6.25	6.50	(b)	2.40	0.80
18	3.35	4.80	5.95	7.30	6.80	11.35	11.35	6.00	6.10	(b)	2.40	1.00
19	2.80	4.65	5.90	7.00	7.20	11.50	11.30	.....	5.90	(b)	2.30	2.00
20	2.20	4.35	5.70	6.75	8.20	11.65	11.05	.....	5.80	(b)	2.30	6.10
21	1.60	3.95	(d)	6.65	8.75	11.40	11.45	6.30	(b)	(b)	2.20	20.10
22	1.35	4.15	(d)	6.65	9.00	11.40	11.85	6.60	(b)	(b)	2.20	22.00
23	1.15	4.45	(d)	6.80	9.20	11.75	11.85	6.85	(b)	(b)	2.15	22.00
24	1.10	4.80	(d)	6.60	8.50	12.00	12.25	6.70	(b)	(b)	2.25	22.30
25	0.80	3.95	(d)	6.50	7.90	12.10	13.05	6.90	(b)	(b)	2.30	21.90
26	0.60	4.05	(d)	6.15	7.50	11.75	13.00	7.05	(b)	(b)	2.35	20.40
27	(a)	4.45	6.30	6.00	7.40	11.40	12.70	7.40	(b)	(b)	2.55	18.18
28	(a)	4.05	6.50	5.95	7.30	11.35	12.30	7.85	(b)	(b)	2.45	17.40
29	(a)	.....	6.40	5.90	7.25	11.55	12.05	8.15	(b)	(b)	2.35	17.20
30	(a)	.....	7.50	5.90	7.30	11.85	12.00	8.45	(b)	(b)	2.10	16.80
31	(a)	.....	7.55	.....	7.50	.....	11.70	8.50	(b)	(b)	.....	15.80

[a] Below gauge. [b] Gauge broken. [c] Section out of place. [d] Gauge out of place.

1896.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.80	[a] 4.20	7.70	7.70	12.40	23.50	15.80	13.00	7.90	6.60	3.40	[a] 4.65
2	13.85	4.60	8.25	7.20	12.90	22.70	16.00	13.05	7.45	6.15	3.45	4.55
3	12.60	5.30	8.55	6.90	12.95	23.05	16.35	13.15	7.00	5.80	3.70	4.50
4	[b] 11.50	6.25	8.35	6.50	12.95	23.20	16.40	13.45	6.70	5.60	4.40	4.70
5	10.40	6.65	8.00	6.20	13.00	23.20	16.80	13.70	6.40	5.40	5.50	4.90
6	[b] 9.40	6.75	7.75	6.00	13.00	23.35	16.85	[a] 13.80	6.10	5.30	6.40	4.65
7	[a] 8.60	6.95	7.40	5.75	13.05	23.10	16.50	13.80	5.80	5.25	7.45	4.05
8	8.00	7.20	7.10	5.60	15.10	22.70	16.00	13.75	5.50	5.10	7.85	3.70
9	7.30	7.05	6.80	5.50	13.25	22.45	16.25	13.35	5.30	5.00	[b] 7.40	3.45
10	6.65	6.80	6.60	6.00	13.45	22.40	16.30	13.00	5.10	4.90	[b] 6.90	3.20
11	6.00	6.50	6.45	8.00	13.85	21.90	15.75	12.30	4.90	4.80	[b] 6.40	3.00
12	5.40	6.25	[a] 6.20	11.20	14.00	21.55	14.80	11.75	4.75	4.80	6.15	3.00
13	5.20	[a] 6.80	5.90	11.80	14.00	20.80	14.00	11.50	4.60	4.85	5.90	3.10
14	5.10	8.00	5.80	12.00	13.80	[b] 19.55	13.50	[a] 11.15	4.60	4.90	5.70	3.40
15	5.00	10.20	5.60	[a] 11.70	13.20	17.90	13.05	10.50	4.75	4.90	5.55	3.60
16	5.00	10.10	5.50	11.40	13.00	16.65	[a] 12.50	10.30	5.00	5.15	5.40	4.00
17	4.90	9.40	5.20	11.15	12.90	16.00	12.25	10.00	5.20	5.15	5.40	4.50
18	4.85	8.90	5.10	10.90	[b] 12.90	16.70	12.25	9.40	5.25	5.10	5.50	5.00
19	4.85	8.50	4.80	10.45	14.80	17.40	[a] 12.30	9.25	5.65	4.80	5.55	5.70
20	4.80	7.80	4.60	9.80	18.40	17.55	13.25	9.35	6.00	4.70	5.55	6.15
21	4.65	6.90	4.60	[b] 9.70	21.35	17.45	14.05	10.20	6.95	4.50	5.55	6.35
22	4.55	6.00	4.80	[b] 9.60	22.90	17.20	18.00	10.75	7.90	4.35	5.50	6.30
23	4.50	5.50	5.40	9.35	[b] 23.60	[b] 17.10	20.05	11.40	8.90	4.25	5.40	6.20
24	4.75	5.20	5.80	9.10	24.40	16.00	20.05	11.65	9.15	4.05	5.25	6.05
25	5.05	5.00	6.20	8.80	25.00	15.90	19.10	11.15	8.80	3.95	5.10	[b] 5.90
26	5.25	5.10	7.10	8.90	25.70	15.60	17.60	10.70	8.35	3.85	5.05	[a] 5.70
27	4.90	5.55	[b] 7.70	9.20	25.50	15.65	16.50	10.45	8.15	3.70	5.00	5.60
28	4.50	6.60	7.40	[b] 9.70	26.00	15.85	[b] 15.70	9.95	7.80	3.60	4.95	5.40
29	4.30	7.35	7.30	[b] 10.40	26.00	16.30	14.50	9.30	7.50	3.55	4.75	5.20
30	4.20	.....	7.55	11.30	25.20	[b] 16.20	14.00	8.80	7.00	3.45	4.70	[a] 5.10
31	4.10	.....	8.00	.....	24.25	.....	13.45	8.35	.....	3.40	.....	5.05

[a] Reading changed less than one-half foot. [b] Changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1897.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.10	Ice.	11.40	22.85	26.70	13.30	18.95	11.80	5.80	3.10	2.00	2.10
2	5.10	Ice.	11.00	24.60	27.20	12.65	18.15	a 11.60	5.60	3.00	2.25	2.00
3	5.50	Ice.	11.00	26.15	27.15	12.80	18.35	11.40	5.30	3.00	2.20	1.70
4	15.00	Ice.	a 11.50	26.45	27.00	12.90	18.80	11.15	5.20	2.90	2.10	1.50
5	21.40	Ice.	14.50	26.15	26.60	13.70	18.95	10.75	4.80	2.90	2.00	1.20
6	22.40	5.90	19.10	25.80	25.95	14.10	18.05	10.50	4.65	2.80	2.05	(b)
7	22.80	6.25	21.05	25.90	25.00	14.60	17.50	10.30	4.60	2.75	2.15	(b)
8	22.50	6.65	21.35	25.80	23.80	14.70	17.15	10.10	4.55	2.70	2.30	(b)
9	20.00	7.10	21.00	26.30	22.65	14.75	17.20	9.90	4.55	2.70	2.60	(b)
10	17.40	8.20	20.35	26.80	a 21.90	14.50	17.10	10.40	4.50	2.70	2.70	(b)
11	14.80	9.15	19.20	27.35	21.20	14.20	16.30	10.10	4.50	2.65	2.70	(b)
12	12.75	9.85	18.55	27.15	20.25	13.90	15.45	a 9.80	4.35	2.65	2.80	(b)
13	10.95	9.75	18.20	26.65	19.35	13.50	14.90	9.50	4.15	2.55	2.80	(b)
14	10.05	10.35	17.50	26.00	18.75	13.00	14.00	9.25	4.00	2.50	2.75	(b)
15	9.30	10.90	16.90	25.30	18.10	12.80	13.30	9.10	3.80	2.40	2.75	(b)
16	8.95	11.40	16.20	c 24.50	17.60	12.70	12.85	9.05	3.60	2.35	2.80	(b)
17	8.65	11.70	16.00	24.20	17.00	12.65	12.30	8.90	3.50	2.25	2.90	(b)
18	8.85	11.40	16.10	24.10	16.40	12.65	12.20	8.80	3.40	2.15	2.75	(b)
19	9.90	11.10	16.65	24.30	15.80	12.75	12.35	8.70	3.30	2.10	2.65	(b)
20	11.60	10.70	16.65	24.20	15.30	12.75	12.45	8.50	3.25	2.05	2.50	(b)
21	12.45	10.60	17.30	24.20	14.80	12.55	12.10	8.30	3.20	2.05	2.30	(b)
22	12.65	11.50	18.00	24.30	14.30	13.25	11.60	8.20	3.10	2.00	2.25	(b)
23	12.85	12.80	18.30	24.50	13.85	13.40	11.30	8.00	3.10	2.00	2.25	(b)
24	c 12.55	13.50	18.60	24.70	a 13.60	14.40	11.10	7.90	3.05	2.00	2.25	(b)
25	11.90	14.00	18.80	a 24.50	13.55	14.35	11.25	7.60	3.20	2.05	2.25	(b)
26	11.20	13.80	19.50	a 24.30	13.55	14.90	d 12.60	7.40	3.35	2.05	2.25	(b)
27	10.00	13.20	20.90	23.95	13.90	15.85	d 14.60	7.10	3.40	2.00	2.25	(b)
28	Ice.	12.40	21.55	24.25	14.00	15.85	15.00	6.70	3.35	2.00	2.25	(b)
29	Ice.	.....	21.70	25.00	14.00	16.60	14.30	6.50	3.30	1.95	2.20	(b)
30	Ice.	.....	21.45	26.10	14.10	18.25	13.00	6.35	3.20	1.95	2.15	(b)
31	Ice.	.....	21.25	.....	14.00	.....	12.30	6.10	.....	1.95	.....	(b)

a Changed less than one-half foot.
b Below gauge.
c Reading changed one-half foot or more.
d Interpolated—no reading.

1898.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	Ice.	6.70	20.70	13.00	17.20	20.35	10.30	5.40	5.40	.....	4.50
2	(a)	Ice.	6.50	19.55	12.80	16.80	20.35	9.70	5.00	5.05	.....	4.05
3	(a)	Ice.	6.45	18.40	13.40	16.90	19.95	10.50	4.70	4.80	7.00	b 3.75
4	0.40	Ice.	6.30	17.00	15.50	17.55	19.20	11.20	c 4.40	4.40	6.15	b 3.25
5	.50	Ice.	6.15	16.60	17.50	18.00	b 18.20	11.10	c 4.20	4.10	5.70	3.00
6	c.80	Ice.	6.00	16.30	18.40	18.30	17.60	10.25	4.05	3.80	5.40	2.60
7	1.30	Ice.	5.95	16.60	18.45	18.30	17.55	9.50	4.00	3.55	5.10	2.40
8	1.60	2.70	5.85	16.55	18.30	17.55	18.30	8.80	4.00	3.45	5.30	2.20
9	1.80	2.90	5.80	16.10	17.70	16.80	19.70	8.65	4.55	3.25	5.70	1.90
10	2.05	3.60	5.70	d 16.10	17.20	16.70	19.90	8.85	5.50	3.00	c 5.80	1.30
11	2.70	3.65	5.70	16.05	16.65	17.05	19.50	8.70	6.50	3.05	c 6.20	.....
12	3.90	3.90	6.05	15.20	15.80	18.05	19.00	7.95	7.25	c 3.05	6.60	.....
13	4.60	4.70	7.50	b 14.90	14.95	19.00	.....	7.85	7.25	3.70	6.40	.....
14	5.20	c 6.40	11.25	c 14.90	14.60	19.70	.....	7.90	7.00	3.85	6.20	.....
15	5.30	7.00	14.30	14.90	14.20	20.10	.....	7.90	6.50	3.45	5.80	.....
16	5.00	7.05	14.80	15.15	14.00	20.30	.....	8.00	6.00	2.95	5.50	.....
17	4.60	7.15	14.95	14.90	15.50	21.55	.....	7.90	6.60	2.70	5.20	.....
18	4.30	7.20	15.00	14.55	18.85	22.35	.....	7.75	8.15	2.45	4.90	.....
19	4.05	7.55	14.60	14.30	19.70	22 20	.....	b 7.70	9.00	2.55	4.80	1.10
20	4.35	8.15	14.60	c 13.80	19.75	21.50	.....	7.65	8.80	b 3.00	4.70	1.50
21	4.55	9.20	15.10	13.20	19.75	20.60	.....	8.80	8.45	b 4.00	4.40	1.80
22	5.40	10.10	16.65	12.80	b 21.70	19.35	.....	9.30	7.25	6.70	4.40	2.20
23	5.95	9.60	20.40	12.60	23.30	18.05	.....	c 9.00	6.80	7.90	4.65	3.80
24	6.00	8.75	21.80	12.00	b 23.70	b 17.60	.....	8.20	6.80	8.20	4.90	5.10
25	5.80	8.10	21.80	11.75	c 23.20	b 17.20	.....	7.30	b 7.40	8.00	5.70	6.80
26	5.75	7.65	21.50	12.15	22.20	17.00	.....	7.00	7.40	7.10	6.50	7.60
27	5.65	7.15	21.21	14.00	21.30	17.30	.....	6.70	7.20	6.50	7.40	8.00
28	6.10	6.90	20.75	15.20	20.30	18.70	9.90	6.30	7.00	6.20	7.00	7.80
29	5.95	.....	20.45	14.60	19.30	19.90	9.30	6.00	6.40	6.90	6.15	7.50
30	5.55	.....	20.70	13.65	18.90	20.40	9.60	5.90	5.60	b 7.90	5.15	7.15
31	4.90	.....	20.95	.....	18.20	.....	10.50	5.70	.....	8.25	.....	6.60

a Below gauge.
b Reading changed one-half foot or more.
c Changed less than one-half foot.
d Interpolated—no reading.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1899.

[Gauge, 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.80	.....	13.00	11.80	22.45	20.30	18.20	12.30	6.55	4.30	a 3.50	4.30
2	4.80	.....	12.90	11.80	22.40	20.45	18.20	12.40	6.60	4.05	a 3.40	4.20
3	4.00	.....	11.90	11.35	a 22.20	21.15	18.40	12.40	6.45	4.00	3.50	4.10
4	3.50	.....	11.50	10.80	21.45	21.35	19.00	12.10	6.25	3.95	3.70	4.10
5	3.40	.....	10.85	11.00	b 19.85	21.35	19.60	11.75	a 6.10	3.85	3.90	4.00
6	.....	.....	10.50	11.70	18.80	21.45	19.85	a 11.70	5.95	3.75	4.05	4.00
7	.....	.....	b 10.50	12.30	18.20	21.20	b 19.95	a 11.60	5.75	3.60	4.25	3.90
8	.....	.....	b 10.25	12.35	a 17.75	20.70	20.35	11.30	5.55	3.50	4.50	3.85
9	.....	.....	9.50	12.20	17.50	20.25	20.25	11.15	5.55	3.40	4.60	3.80
10	.....	.....	9.35	12.25	17.50	20.25	20.20	12.05	5.55	3.30	4.70	3.70
11	.....	.....	9.60	12.40	18.05	20.25	20.50	13.60	5.60	3.25	4.80	3.70
12	.....	.....	9.85	12.75	18.70	20.30	20.75	b 14.10	5.75	3.20	5.10	3.65
13	.....	.....	9.90	14.50	19.30	21.10	20.55	13.45	5.80	3.10	5.20	3.65
14	.....	.....	10.40	14.80	19.50	22.00	20.00	13.30	5.70	3.05	5.30	3.70
15	.....	.....	b 11.10	14.25	19.35	21.80	19.35	13.15	5.60	3.00	5.40	3.75
16	.....	.....	13.10	13.70	18.85	20.80	18.65	12.40	5.50	2.90	5.40	3.80
17	.....	.....	14.30	13.50	18.15	20.00	18.30	11.60	5.45	3.00	5.30	3.55
18	.....	.....	15.00	13.40	a 17.65	19.95	17.95	11.00	5.55	3.00	5.30	3.20
19	.....	.....	15.45	13.40	17.00	19.95	17.85	10.50	5.65	3.05	5.30	3.30
20	.....	.....	16.70	13.60	16.40	19.90	17.65	10.00	a 5.70	3.05	5.25	3.65
21	.....	.....	17.75	14.75	16.80	19.70	17.35	9.65	a 5.60	3.05	5.20	4.05
22	.....	.....	18.00	15.50	17.50	19.30	16.80	9.30	5.40	3.00	5.20	3.70
23	.....	.....	17.70	17.90	19.10	18.85	16.20	8.80	5.30	2.90	5.30	2.80
24	.....	.....	17.15	20.60	20.60	18.20	a 15.60	8.20	5.00	2.85	5.50	2.50
25	.....	.....	16.45	22.10	21.50	17.70	15.10	7.85	4.85	2.80	5.55	2.40
26	.....	3.90	a 15.70	22.90	22.25	17.30	14.60	7.50	4.70	2.70	5.30	2.25
27	.....	6.50	b 14.60	23.10	22.25	17.35	14.10	7.25	4.65	2.70	5.05	.....
28	.....	11.40	13.60	22.75	21.80	17.55	13.55	7.10	4.50	2.90	b 4.70	.....
29	.....	.....	12.85	22.45	21.15	18.00	13.15	6.90	4.35	3.20	4.60	.....
30	.....	.....	12.10	22.35	20.55	18.20	12.70	6.65	4.35	3.60	4.55	.....
31	.....	.....	11.60	.....	20.35	.....	a 12.45	6.55	.....	3.70	.....	.....

a Reading changed less than one-half foot. b Changed one-half foot or more.

1900.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	Ice.	Ice.	a 11.75	13.90	11.50	10.20	10.05	8.60	8.65	11.25	9.10
2	.....	Ice.	Ice.	12.20	13.45	11.40	10.00	9.65	8.65	9.20	10.70	8.50
3	.....	Ice.	Ice.	12.40	13.35	11.45	10.05	9.25	8.80	9.75	10.30	8.00
4	.....	Ice.	Ice.	12.40	13.55	11.30	9.95	8.90	8.80	11.00	10.20	7.50
5	.....	Ice.	Ice.	12.45	13.50	10.90	10.00	8.50	8.80	11.40	10.35	7.15
6	.....	.....	7.10	12.75	13.40	10.50	9.95	8.05	8.90	11.25	10.50	6.80
7	1.50	Ice.	11.70	13.30	13.75	10.15	9.65	7.55	8.85	10.80	11.35	6.50
8	1.75	2.00	15.60	14.00	14.00	9.95	9.50	7.10	8.20	a 10.80	b 11.85	6.30
9	2.05	3.60	16.10	14.35	14.25	9.90	9.30	6.70	7.65	11.15	11.90	6.10
10	2.15	5.65	16.40	14.20	14.05	9.60	9.30	6.30	7.35	11.35	11.60	6.05
11	2.40	6.45	17.30	13.90	13.90	9.50	9.15	6.00	6.85	11.00	11.25	5.90
12	2.55	6.00	18.20	13.80	13.60	9.20	9.05	5.70	6.60	10.15	11.00	5.75
13	.....	5.50	a 19.35	14.40	13.80	9.20	9.05	5.30	6.25	9.60	a 10.85	5.55
14	.....	5.45	a 20.25	15.30	14.40	9.55	9.00	5.10	6.00	9.20	10.75	5.35
15	.....	5.00	20.55	16.20	13.90	12.30	8.60	4.90	5.80	8.95	10.60	5.10
16	.....	Ice.	20.55	15.90	13.20	12.20	8.50	4.75	5.60	8.80	10.35	4.90
17	2.10	Ice.	20.45	15.00	a 12.30	11.10	8.60	4.60	5.55	8.70	10.20	4.70
18	2.30	Ice.	20.05	14.10	12.10	10.50	8.65	4.60	5.40	8.65	10.15	4.50
19	2.80	Ice.	19.25	13.50	12.20	9.95	8.50	4.90	5.30	8.70	10.50	4.20
20	4.25	Ice.	18.05	13.35	12.35	9.85	8.20	6.20	5.30	8.80	10.50	4.00
21	6.10	Ice.	17.15	13.60	12.35	9.80	8.10	7.25	5.45	9.00	10.50	3.70
22	6.00	5.65	16.40	14.00	12.35	10.60	8.45	7.90	5.75	9.35	10.55	3.50
23	5.60	6.50	15.90	14.10	12.25	12.05	9.50	8.00	6.20	9.75	10.65	3.30
24	b 4.90	7.70	15.45	14.50	b 12.30	12.85	a 10.70	7.90	6.45	10.20	10.70	3.25
25	4.60	7.10	14.85	14.80	12.15	13.00	11.50	7.80	6.60	10.45	10.70	3.10
26	4.50	6.80	14.35	15.15	11.85	12.95	11.90	8.00	6.60	10.65	10.80	3.05
27	4.40	Ice.	14.00	15.25	11.45	12.80	11.75	7.80	6.70	10.75	10.70	3.20
28	4.25	Ice.	13.60	b 15.10	11.05	12.30	11.35	7.80	6.90	10.85	b 10.40	3.26
29	4.00	.....	13.00	14.70	10.95	11.35	10.95	7.70	7.40	10.75	10.10	3.10
30	Ice.	.....	12.55	14.35	11.40	10.65	10.55	7.60	8.20	10.90	9.65	b 2.90
31	Ice.	.....	12.10	.....	11.80	.....	10.30	8.00	.....	11.00	.....	2.75

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1904.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m. Commenced reading April 1, 1904.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	21.90	29.80	19.70	20.90	12.70	7.60	10.30	a 8.80	(b)
2	.....	.....	.....	21.50	29.40	21.00	c 20.50	12.30	7.10	10.20	c 8.75	(b)
3	.....	.....	.....	21.30	29.00	21.30	19.70	12.00	6.80	10.00	c 8.60	(b)
4	.....	.....	.....	20.80	28.20	21.00	19.40	11.50	7.00	9.70	a 8.50	(b)
5	.....	.....	.....	20.20	27.30	c 20.90	19.00	11.00	7.20	9.00	a 8.30	(b)
6	.....	.....	.....	19.70	26.10	c 22.80	c 18.80	10.50	7.30	a 8.50	8.20	(b)
7	.....	.....	.....	19.10	25.10	24.50	c 18.20	9.90	6.90	8.20	8.10	5.47
8	.....	.....	.....	18.50	23.80	24.80	17.80	9.50	6.60	8.00	8.00	5.37
9	.....	.....	.....	18.20	23.30	24.40	18.70	9.00	6.40	7.80	7.80	5.27
10	.....	.....	.....	18.00	23.20	23.70	21.10	8.50	6.30	7.60	7.70	5.17
11	.....	.....	.....	21.10	22.80	22.80	22.90	8.20	6.40	7.30	7.60	5.27
12	.....	.....	.....	20.30	22.20	22.10	23.70	7.90	6.30	7.00	7.50	5.17
13	.....	.....	.....	20.70	21.50	21.50	24.00	7.70	6.20	6.90	7.40	4.87
14	.....	.....	.....	20.60	20.70	21.00	23.60	7.50	a 6.20	6.70	7.30	4.47
15	.....	.....	.....	20.40	19.90	21.30	22.80	7.60	6.20	6.60	7.20	4.07
16	.....	.....	.....	20.50	19.40	21.50	c 21.40	7.70	a 6.10	6.40	7.10	3.67
17	.....	.....	.....	20.30	19.00	a 21.60	c 19.80	7.80	c 6.10	6.20	6.90	3.37
18	.....	.....	.....	20.80	18.70	a 21.50	c 17.90	7.90	c 6.15	6.10	6.70	2.87
19	.....	.....	.....	21.60	19.00	a 21.75	c 17.60	7.80	c 7.20	6.00	6.60	2.27
20	.....	.....	.....	21.50	19.40	21.50	c 17.30	8.50	8.50	5.90	6.40	2.17
21	.....	.....	.....	21.10	19.10	21.70	a 17.10	9.50	9.60	5.90	6.20	2.27
22	.....	.....	.....	21.10	18.50	21.90	a 16.50	10.20	10.30	6.10	6.00	2.07
23	.....	.....	.....	21.40	18.10	21.50	15.80	c 10.10	10.00	6.20	5.80	1.97
24	.....	.....	.....	21.80	17.50	21.00	a 15.10	10.80	9.10	6.30	5.60	2.27
25	.....	.....	.....	23.90	16.90	19.40	14.90	10.80	8.80	6.50	5.50	2.67
26	.....	.....	.....	27.00	16.20	19.00	14.90	a 10.60	c 9.00	6.80	(b)	2.97
27	.....	.....	.....	28.50	16.10	18.90	14.50	11.20	9.70	7.10	(b)	3.37
28	.....	.....	.....	29.40	16.20	18.70	14.00	10.40	9.90	7.40	(b)	4.07
29	.....	.....	.....	29.80	16.40	19.10	13.60	9.50	9.70	7.90	(b)	2.77
30	.....	.....	.....	29.90	16.70	20.30	13.20	8.70	9.90	8.20	(b)	2.27
31	.....	.....	.....	.....	17.70	.....	12.90	8.30	.....	8.70	(b)	2.27

a Reading changed less than one-half foot. b No gauge. c Reading changed one-half foot or more.

1905.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 1.4	a 8.4	16.3	15.6	15.8	17.0	19.8	17.4	10.9	13.3	11.1	a 8.6
2	1.4	a 8.0	16.4	16.4	15.3	16.5	19.9	18.1	10.5	12.5	10.7	9.0
3	2.3	7.3	16.6	16.6	14.6	16.6	19.9	18.5	10.0	12.0	10.8	a 8.8
4	3.2	7.1	16.2	16.3	14.0	16.8	20.0	18.8	9.6	11.4	10.8	a 8.7
5	3.5	7.0	17.0	16.2	13.4	17.4	20.9	18.2	9.0	11.0	11.0	8.1
6	3.4	7.1	a 17.4	a 15.8	13.0	18.0	21.5	17.6	8.8	10.6	a 11.7	7.6
7	b 3.6	7.2	16.8	15.1	12.0	17.9	22.0	a 16.8	8.7	10.1	12.0	7.2
8	3.4	7.6	16.4	14.5	11.4	17.4	22.0	15.7	9.0	9.8	a 12.4	6.7
9	2.7	7.3	16.0	14.1	10.7	16.8	21.7	15.0	9.0	9.1	11.9	6.3
10	2.5	b 7.3	15.7	13.6	10.3	16.4	21.6	14.2	8.8	8.6	11.6	5.7
11	2.5	6.8	15.4	13.2	10.2	16.0	21.3	14.2	8.9	8.2	11.4	c 5.0
12	2.1	6.7	15.0	13.1	10.6	16.0	21.4	13.7	9.1	8.0	11.2	c 4.7
13	d 1.9	6.7	14.5	13.0	10.8	16.7	21.7	13.0	10.4	7.8	b 11.5	c 4.5
14	d 3.6	6.3	13.8	12.8	11.2	17.5	22.4	12.6	10.2	7.7	b 11.3	c 4.4
15	d 5.0	5.9	12.9	12.6	12.3	18.2	22.9	12.3	9.8	7.4	10.8	b 4.4
16	d 4.0	5.7	12.3	12.6	14.1	18.3	22.8	11.4	9.4	7.3	10.2	4.4
17	3.7	5.5	11.7	12.8	16.0	18.4	22.0	11.1	11.0	7.2	9.7	4.3
18	5.1	5.5	11.5	12.8	17.0	18.1	20.7	b 10.7	19.2	7.4	9.2	4.3
19	a 6.3	5.4	11.3	12.6	17.4	17.5	19.4	10.8	a 23.0	13.6	9.1	4.3
20	8.0	5.4	11.2	12.3	17.7	17.8	18.5	11.2	25.2	15.3	9.0	4.4
21	8.6	5.6	11.1	12.1	18.5	18.2	18.2	11.7	26.8	13.6	8.9	4.5
22	8.7	5.8	11.3	11.9	a 17.8	18.1	17.2	12.0	27.1	b 13.2	9.2	4.7
23	8.8	a 6.4	b 11.6	11.8	17.4	17.9	16.7	12.7	26.4	b 12.9	8.9	4.6
24	8.7	7.1	b 12.6	12.1	16.9	17.7	16.6	14.8	25.0	12.7	8.7	4.6
25	8.4	7.9	b 13.2	12.6	16.5	18.1	16.8	a 16.3	23.0	b 12.6	8.6	4.5
26	8.8	8.3	b 13.5	13.0	16.1	18.7	17.4	a 15.9	20.6	12.7	8.1	4.4
27	9.5	9.8	13.7	13.5	16.0	18.9	17.0	b 15.5	a 18.8	14.3	7.9	4.1
28	8.9	a 14.8	14.0	14.1	16.1	19.0	16.4	15.0	17.1	13.7	7.7	4.1
29	8.4	.....	14.5	14.4	16.3	19.1	15.8	14.1	15.3	12.7	7.5	4.3
30	7.9	.....	14.8	15.1	17.0	19.4	15.2	12.8	14.2	12.0	8.0	4.7
31	8.2	.....	15.4	.....	17.2	.....	16.5	11.4	.....	11.6	.....	5.0

Changed by comparative hydrograph:
a Reading changed one-half foot or more.
b Changed less than one-half foot.
c Interpolated—no reading.
d Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1906.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.3	11.8	19.1	22.7	17.8	12.0	16.8	9.3	9.1	10.6	4.5	7.5
2	5.3	a 12.1	19.7	22.6	17.7	12.5	16.8	9.0	8.6	10.8	4.9	7.7
3	5.4	a 12.0	20.0	21.9	17.6	13.3	16.8	9.0	b 8.4	11.1	5.5	7.9
4	6.4	11.0	19.6	21.2	17.6	13.7	17.0	8.9	a 8.2	11.1	5.6	8.2
5	9.8	10.0	18.7	21.0	17.5	14.3	16.7	8.8	8.7	10.8	5.9	8.3
6	13.3	9.4	17.7	20.8	17.4	14.5	16.3	8.7	7.6	10.0	6.0	8.5
7	13.3	b 9.0	b 16.7	20.7	17.8	14.7	16.0	8.6	7.4	9.0	6.0	9.0
8	c 12.3	8.5	b 16.4	20.5	18.6	15.4	15.7	9.0	7.4	8.5	6.1	9.2
9	c 11.3	7.8	a 16.2	20.9	18.3	16.3	15.2	9.1	7.3	8.1	6.3	9.0
10	c 9.8	7.3	16.2	20.9	17.7	16.6	14.8	8.9	7.3	7.7	6.4	8.5
11	b 8.5	7.0	16.0	a 20.8	17.0	16.9	14.2	9.6	7.3	7.4	6.5	8.1
12	7.4	6.7	15.6	20.6	16.4	16.7	13.7	9.7	7.6	7.1	6.6	8.0
13	6.9	6.5	15.2	20.4	15.8	16.2	13.3	9.9	7.6	6.8	6.6	7.8
14	6.3	6.7	14.9	21.4	15.2	15.9	13.2	10.4	7.3	6.6	6.6	7.7
15	6.0	6.7	14.4	22.5	14.8	15.9	12.8	11.0	7.2	6.3	6.6	7.3
16	5.9	6.8	14.0	22.5	14.2	15.6	12.5	11.1	7.1	6.2	6.7	7.2
17	5.8	6.8	13.3	21.9	13.7	15.3	12.4	11.1	7.0	6.0	6.8	7.0
18	5.5	7.0	12.9	21.5	13.1	15.0	12.1	10.5	6.9	5.8	6.9	a 6.6
19	5.3	7.3	12.4	21.3	12.7	15.1	11.7	10.1	7.0	5.7	6.9	a 6.1
20	5.3	7.8	11.8	20.9	12.3	15.3	11.1	10.0	7.3	5.6	7.0	a 5.5
21	5.8	8.1	11.4	20.5	12.1	16.0	10.9	10.1	7.4	5.5	7.8	b 5.2
22	8.5	8.3	11.0	20.2	b 11.7	17.0	10 8	10.0	7.4	5.3	8.7	b 5.2
23	9.4	8.8	10.3	19.7	11.5	17.6	10.9	9.6	7.5	5.2	8.8	b 4.9
24	11.0	10.5	10.4	19.3	11.3	18.1	11.1	9.3	7.9	5.1	8.7	b 4.4
25	12.0	13.7	10.7	19.0	11.2	18.7	11.7	9.1	8.5	5.0	8.2	b 4.0
26	11.6	15.8	11.2	18.8	11.1	18.0	12.4	9.1	9.1	4.8	7.8	b 3.6
27	11.2	17.6	13.5	18.6	11.1	17.0	12.3	9.6	9.3	4.7	7.6	b 3.2
28	10.9	18.4	18.5	18.4	11.1	16.6	11.4	11.3	9.5	4.6	7.6	b 2.9
29	10.8	.....	20.5	18.1	11.1	16.8	10.8	11.1	10.0	4.5	7.5	b 2.9
30	10.9	.....	22.0	17.9	11.2	17.0	10.0	10.4	10.3	4.5	7.5	b 3.3
31	11.4	.....	22.8	.....	11.2	.....	9.6	9.7	.....	4.5	.....	b 3.9

a Reading changed less than one-half foot. b Reading changed one-half foot or more.
c Interpolated—no reading.

1907.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge, 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 4.3	14.4	13.2	14.5	16.0	13.2	20.1	22.0	11.6	7.5	5.3	4.4
2	a 4.9	13.8	13.0	b 15.1	16.6	13.6	19.5	21.0	11.4	7.4	5.2	4.4
3	b 5.8	13.4	12.8	b 15.3	16.8	14.1	19.2	19.6	11.2	7.5	5.1	4.4
4	b 6.4	(c)	12.3	15.2	16.7	15.6	18.5	18.8	11.2	8.3	5.0	4.3
5	7.1	(c)	12.1	15.0	16.2	17.8	17.6	18.1	11.2	8.7	5.0	4.1
6	8.2	(c)	12.0	15.1	15.8	18.7	17.0	17.4	11.1	9.1	5.0	4.0
7	8.5	(c)	11.9	14.9	15.6	18.7	16.7	17.0	11.1	9.4	5.0	3.9
8	8.8	(c)	11.8	14.8	16.2	18.3	17.0	16.8	10.9	9.4	4.9	3.8
9	8.8	(c)	11.3	14.7	17.1	17.5	17.0	16.7	10.5	9.6	4.9	3.6
10	8.5	(c)	11.0	14.9	17.7	17.6	17.1	16.5	10.0	10.1	4.9	3.5
11	8.5	(c)	10.9	15.0	17.6	17.8	17.2	16.1	9.5	10.4	4.8	3.4
12	8.4	(c)	11.4	15.1	16.9	18.3	17.1	15.7	9.1	10.5	4.7	3.4
13	8.4	7.5	13.3	15.9	15.8	19.3	17.1	15.1	8.7	10.5	4.4	3.3
14	8.5	8.1	15.6	16.6	14.9	20.1	17.6	14.8	8.3	10.2	4.4	3.2
15	9.3	9.0	16.7	16.5	14.7	19.9	18.4	14.4	8.1	9.6	4.4	3.2
16	10.0	9.9	16.6	16.4	15.6	20.4	18.6	14.3	7.9	9.1	4.4	3.2
17	11.1	9.5	15.5	16.3	18.0	20.1	18.8	14.1	7.8	b 8.6	4.4	3.4
18	12.1	9.5	15.1	16.2	18.7	19.2	20.3	13.7	7.6	8.2	4.4	3.5
19	15.6	10.1	14.8	16.4	18.6	18.6	21.0	14.3	7.2	7.9	4.4	3.6
20	18.6	10.3	14.7	16.9	17.2	17.8	21.4	a 15.0	6.9	7.7	4.4	3.6
21	21.6	10.0	15.0	17.4	16.4	17.7	21.7	15.3	6.6	7.2	4.4	3.5
22	22.4	9.8	14.8	17.7	15.4	17.4	22.1	15.2	6.5	7.0	4.3	3.4
23	22.7	10.2	14.0	17.7	14.4	17.3	22.7	15.6	6.5	6.8	4.3	3.2
24	22.6	11.3	13.4	17.5	13.6	17.6	23.2	15.0	6.7	6.5	4.3	3.3
25	a 21.8	12.4	13.1	17.9	13.0	18.8	23.6	14.8	6.9	6.2	4.3	3.2
26	20.8	13.1	12.9	17.4	b 12.5	19.9	23.7	15.1	7.1	6.1	4.3	3.2
27	19.0	13.3	12.8	17.0	b 12.1	20.4	23.4	a 14.6	7.3	6.0	4.3	3.2
28	17.5	13.2	12.7	16.5	b 12.5	21.1	22.9	13.1	7.4	5.9	4.3	3.2
29	16.6	.....	12.6	15.8	12.9	20.8	22.8	12.4	7.5	5.7	4.3	3.0
30	15.4	.....	13.3	15.4	12.8	20.5	22.4	12.1	7.6	5.5	4.4	2.8
31	14.9	.....	13.8	.....	13.0	.....	22.4	11.8	.....	5.4	.....	3.0

a Reading changed one-half foot or more. b Reading changed less than one-half foot.
c No readings, account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BRICKEYS MILL, MO.—Continued.

1903.

[Gauge 45.60 miles from Eads Bridge. Zero of gauge 364.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

[Gauge discontinued from February 1 to June 4 and from June 27 to end of year.]

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	3.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	3.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	3.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	3.30	.....	.....	.....	.....	25.8	.....	.....	.....	.....	.....	.....
6	3.20	.....	.....	.....	.....	25.9	.....	.....	.....	.....	.....	.....
7	3.10	.....	.....	.....	.....	25.9	.....	.....	.....	.....	.....	.....
8	2.90	.....	.....	.....	.....	26.0	.....	.....	.....	.....	.....	.....
9	2.90	.....	.....	.....	.....	25.9	.....	.....	.....	.....	.....	.....
10	2.80	.....	.....	.....	.....	26.0	.....	.....	.....	.....	.....	.....
11	2.80	.....	.....	.....	.....	26.0	.....	.....	.....	.....	.....	.....
12	3.10	.....	.....	.....	.....	26.3	.....	.....	.....	.....	.....	.....
13	3.80	.....	.....	.....	.....	26.8	.....	.....	.....	.....	.....	.....
14	4.50	.....	.....	.....	.....	27.0	.....	.....	.....	.....	.....	.....
15	4.00	.....	.....	.....	.....	27.3	.....	.....	.....	.....	.....	.....
16	3.80	.....	.....	.....	.....	28.3	.....	.....	.....	.....	.....	.....
17	3.40	.....	.....	.....	.....	29.1	.....	.....	.....	.....	.....	.....
18	3.10	.....	.....	.....	.....	29.6	.....	.....	.....	.....	.....	.....
19	3.00	.....	.....	.....	.....	30.0	.....	.....	.....	.....	.....	.....
20	2.90	.....	.....	.....	.....	30.2	.....	.....	.....	.....	.....	.....
21	2.50	.....	.....	.....	.....	30.0	.....	.....	.....	.....	.....	.....
22	2.40	.....	.....	.....	.....	30.0	.....	.....	.....	.....	.....	.....
23	2.40	.....	.....	.....	.....	29.7	.....	.....	.....	.....	.....	.....
24	2.70	.....	.....	.....	.....	29.6	.....	.....	.....	.....	.....	.....
25	2.90	.....	.....	.....	.....	29.2	.....	.....	.....	.....	.....	.....
26	3.10	.....	.....	.....	.....	28.9	.....	.....	.....	.....	.....	.....
27	3.40	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	3.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	3.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	3.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	2.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

LITTLE ROCK, MO.

1894.

[Gauge 56.45 miles from Eads Bridge. Zero of gauge 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	143.25	148.00	148.30	152.15	152.00	145.55	141.85	142.25	140.80	140.85
2	.....	.....	143.25	147.50	148.75	152.30	151.65	145.55	141.75	142.00	140.80	140.90
3	.....	.....	143.25	147.08	149.65	152.00	151.45	145.60	141.70	141.75	140.90	140.95
4	.....	.....	143.35	146.95	150.00	151.90	151.05	145.35	141.70	141.60	141.00	141.00
5	.....	.....	143.85	146.65	150.10	151.75	150.75	145.25	141.85	141.50	141.05	141.30
6	.....	.....	144.90	146.40	150.45	151.70	150.80	145.05	141.90	141.40	141.10	141.70
7	.....	.....	147.70	146.25	151.40	151.75	151.00	144.80	142.10	141.30	141.15	141.60
8	.....	.....	151.20	146.20	152.65	152.00	150.95	144.50	142.10	141.25	141.25	141.40
9	.....	.....	153.00	147.30	153.85	152.20	150.30	144.20	142.45	141.15	141.35	141.10
10	.....	.....	153.90	148.30	154.65	152.15	149.60	144.05	142.55	141.05	141.45	140.85
11	.....	.....	154.05	148.10	155.05	152.00	149.20	143.85	142.50	141.10	141.40	140.65
12	.....	.....	153.45	147.95	156.50	151.90	149.00	143.70	142.50	141.15	141.35	140.50
13	.....	.....	152.45	148.20	155.70	151.85	148.75	143.60	142.50	141.15	141.25	140.40
14	.....	.....	151.35	148.70	154.70	151.90	148.40	143.45	142.40	141.20	141.15	140.30
15	.....	.....	150.40	a148.50	154.10	151.90	147.85	143.30	142.35	141.25	141.15	140.35
16	.....	.....	149.70	148.30	153.60	151.80	147.40	143.10	142.45	141.15	141.10	140.45
17	.....	.....	149.20	148.50	153.20	151.85	147.10	142.90	142.75	141.10	141.05	140.60
18	.....	.....	148.60	150.60	152.80	151.75	146.85	142.80	143.40	141.00	141.05	140.50
19	.....	.....	148.22	152.30	152.00	151.60	146.70	142.75	143.65	140.95	141.05	140.45
20	.....	.....	147.85	153.15	151.20	151.55	146.60	142.65	143.45	140.90	141.10	140.45
21	.....	.....	147.60	152.50	150.60	151.60	146.60	142.60	143.15	140.85	141.05	140.45
22	.....	.....	147.63	151.45	150.00	151.65	146.50	142.50	143.00	140.90	141.00	140.50
23	.....	.....	147.70	150.50	149.90	151.70	146.45	142.45	142.90	140.80	141.00	140.50
24	.....	.....	147.80	149.80	149.70	151.80	146.40	142.35	143.00	140.80	141.20	140.50
25	.....	.....	147.85	149.40	149.60	151.80	146.30	142.30	143.05	140.90	141.05	140.55
26	.....	.....	147.82	149.15	149.50	151.70	146.00	142.20	142.95	141.10	141.00	140.60
27	.....	.....	147.68	148.90	149.40	151.75	145.85	142.10	143.20	141.05	141.05	Wind.
28	.....	.....	147.50	148.70	149.30	151.95	145.75	142.05	143.00	140.95	141.00	140.50
29	.....	.....	148.50	148.45	149.25	152.65	145.75	141.95	142.80	140.80	141.00	140.00
30	.....	.....	148.80	148.25	149.25	152.55	146.00	141.90	142.55	140.75	140.95	139.60
31	.....	.....	148.48	.....	150.95	.....	145.80	141.90	.....	140.75	.....	139.60

a Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1895.

[Gauge 56.45 miles from Eads Bridge. Zero of gauge 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	139.65	138.45	142.00	144.80	143.15	144.75	148.50	148.60	145.55	141.30	140.45	140.00
2	138.90	138.60	143.50	144.85	143.00	144.80	148.70	149.30	145.60	141.25	140.40	.....
3	138.50	138.60	143.90	145.55	142.90	144.55	148.85	148.85	145.85	141.25	140.40	.....
4	138.60	138.95	144.20	145.45	142.90	144.30	149.00	148.45	146.40	141.30	140.35	139.70
5	138.50	140.55	144.35	144.80	143.10	144.10	149.30	148.00	146.70	141.45	140.35	139.60
6	138.30	141.60	144.10	144.25	143.30	144.10	148.95	147.30	146.90	141.55	140.25	139.30
7	138.45	141.80	144.30	143.90	143.80	144.20	148.90	146.75	147.15	141.60	140.25	138.80
8	138.40	Frozen.	144.70	143.70	144.20	144.15	152.20	146.55	147.45	141.50	140.30	138.60
9	138.50	Frozen.	144.70	143.50	144.15	144.10	152.20	146.40	147.35	141.40	140.40	138.30
10	138.30	Frozen.	144.55	143.35	144.15	144.10	152.00	146.15	146.75	141.35	140.55	138.30
11	138.20	Frozen.	144.25	144.40	143.75	144.70	151.35	146.15	146.35	141.35	140.60	138.40
12	138.15	Frozen.	144.00	145.70	143.35	145.40	150.40	146.00	145.95	141.40	140.60	138.45
13	138.00	Frozen.	143.85	145.80	143.40	145.70	149.10	145.60	145.50	141.50	140.50	138.50
14	(a)	142.25	143.70	145.75	143.50	147.30	148.15	145.20	145.10	141.55	140.50	138.60
15	(a)	142.25	143.45	145.50	143.75	147.85	148.00	144.70	144.70	141.60	140.45	138.75
16	137.70	142.20	143.45	145.10	143.80	148.00	148.20	144.25	144.35	141.60	140.40	138.80
17	137.90	142.10	143.45	144.75	143.80	148.10	148.05	143.85	144.00	141.55	140.45	138.85
18	138.40	142.00	143.40	144.50	144.10	148.25	147.95	143.40	143.70	141.50	140.40	138.95
19	139.50	141.90	143.40	144.25	144.35	148.30	147.80	143.25	143.30	141.45	Windy.	139.50
20	139.65	141.80	143.30	144.10	145.10	148.50	147.95	143.20	143.20	141.35	140.25	142.60
21	139.40	141.70	143.15	143.90	145.70	148.30	148.40	143.55	143.00	141.25	140.25	154.80
22	139.40	141.60	142.90	143.90	145.90	148.15	148.50	144.00	142.80	141.10	140.20	157.50
23	139.10	141.90	142.80	144.00	146.10	148.30	148.85	144.30	142.40	141.00	140.20	157.90
24	139.10	142.00	142.90	144.00	145.55	148.65	149.10	144.20	142.00	140.95	140.25	158.20
25	139.10	141.70	142.90	143.80	145.10	148.75	149.50	144.05	141.80	140.90	140.30	158.00
26	138.75	140.55	142.95	143.65	144.80	148.50	149.50	144.40	141.80	140.80	140.40	156.60
27	138.20	142.05	143.70	143.40	144.60	148.15	148.90	144.90	141.60	140.75	140.50	155.10
28	137.85	141.80	143.80	143.25	144.50	148.05	148.80	145.15	141.50	140.70	140.45	154.00
29	137.75	.....	143.75	143.25	144.50	148.20	148.15	145.35	141.30	140.65	140.30	153.50
30	138.25	.....	144.65	143.25	144.50	148.40	148.20	145.70	141.20	140.60	140.20	152.90
31	.....	.....	144.80	.....	144.60	.....	148.35	145.65	.....	140.50	.....	152.20

a About 1 foot below gauge.

1896.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	151.30	141.80	144.90	144.85	149.00	159.80	152.25	150.00	145.70	144.60	141.60	142.70
2	150.30	142.10	145.40	144.40	149.40	158.95	152.50	149.90	145.25	144.20	141.65	142.70
3	149.50	142.75	145.80	144.15	149.50	158.90	152.70	150.00	144.80	143.90	141.90	142.60
4	148.60	143.60	145.55	143.85	149.50	159.20	152.75	150.20	144.50	a143.70	142.20	142.75
5	147.40	143.90	145.20	143.60	149.55	159.20	153.10	150.45	144.25	143.45	143.30	142.90
6	146.40	144.10	145.00	143.40	149.50	159.30	153.20	150.60	144.00	143.30	144.20	142.65
7	145.80	144.20	144.80	143.20	149.50	159.20	152.90	150.60	143.75	143.20	145.20	142.20
8	145.20	144.40	144.60	143.00	149.60	158.80	152.50	150.55	143.55	143.10	145.60	141.80
9	144.50	144.30	144.30	142.95	149.70	158.40	152.60	150.40	143.35	143.00	145.30	141.60
10	144.10	144.10	144.10	143.10	149.90	158.35	152.70	149.90	143.15	142.90	144.90	141.40
11	143.60	143.85	144.00	144.00	150.15	158.10	152.30	149.40	143.00	142.85	144.45	141.25
12	143.10	143.60	143.80	147.60	150.40	157.60	151.50	148.90	142.80	142.85	144.20	141.15
13	142.90	144.00	143.60	148.70	150.30	150.90	150.90	148.70	142.70	142.90	144.00	141.10
14	142.70	145.20	143.40	148.80	150.00	155.80	150.50	148.45	142.70	142.95	143.80	141.40
15	142.60	146.85	143.20	148.50	149.70	154.20	149.80	148.00	142.80	142.95	143.60	141.60
16	142.50	147.20	143.10	148.20	149.55	153.00	149.50	147.65	143.00	143.15	143.50	141.90
17	142.50	146.50	142.95	148.00	149.50	152.25	149.20	147.40	143.20	143.30	143.50	142.30
18	142.40	146.10	142.75	147.70	149.45	152.70	149.10	146.90	b143.30	143.20	143.50	142.70
19	142.40	145.90	142.60	147.40	150.40	153.50	149.20	146.70	143.60	142.90	143.60	143.50
20	142.35	145.30	142.40	146.85	154.20	153.60	150.05	146.75	143.80	142.75	143.60	144.00
21	142.25	144.60	142.30	146.55	157.30	153.60	150.80	147.50	144.60	142.40	143.60	144.10
22	142.10	143.90	142.40	146.40	158.80	153.40	154.20	148.00	145.50	142.30	143.60	144.15
23	142.10	143.25	142.90	146.20	159.65	153.20	156.20	148.50	146.30	142.15	b143.45	b144.10
24	142.40	142.90	143.05	146.00	160.60	152.50	156.40	148.70	146.60	142.20	143.30	b144.00
25	142.60	142.70	143.50	145.90	161.30	152.30	155.70	148.35	146.40	142.15	143.20	143.90
26	142.75	142.75	144.30	145.90	161.80	152.00	154.30	148.00	146.00	142.00	143.10	b143.75
27	142.50	143.10	144.80	146.10	161.80	151.90	153.30	147.80	145.85	141.90	143.20	b143.60
28	142.10	143.60	144.60	146.65	162.10	152.20	152.40	147.40	145.50	141.80	143.20	143.40
29	142.00	144.50	144.40	147.20	162.10	152.60	151.60	146.90	145.30	141.70	143.00	143.30
30	141.90	.....	144.60	148.00	161.50	152.65	150.90	146.40	144.90	141.70	142.85	143.15
31	141.80	.....	145.00	.....	160.70	.....	150.40	146.00	.....	141.65	.....	143.10

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1897.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	143.10	142.70	149.20	158.90	162.60	160.90	155.80	149.30	144.30	141.60	140.55	140.80
2	143.15	142.30	148.70	160.70	163.10	160.30	155.30	a149.00	144.10	141.50	140.70	140.70
3	143.30	142.00	148.60	162.30	163.25	160.40	155.30	148.80	143.85	141.45	140.70	140.50
4	150.10	142.60	149.00	162.90	163.25	160.50	155.70	148.80	143.55	141.40	140.70	140.20
5	157.45	143.00	151.50	162.75	162.85	151.15	155.95	148.50	143.45	141.35	140.65	139.85
6	158.80	143.90	155.40	162.55	162.30	151.50	155.20	148.30	143.20	141.30	140.65	139.75
7	159.40	144.20	157.60	162.45	161.40	151.90	154.70	148.20	143.05	141.25	140.70	139.40
8	159.30	144.50	158.20	162.45	160.40	152.00	154.40	148.00	143.00	141.20	140.85	139.00
9	157.30	145.00	157.90	162.90	159.40	152.00	154.40	147.90	143.00	141.15	141.10	(b)
10	154.70	145.40	157.60	163.30	158.50	151.80	154.40	148.20	143.00	141.10	141.30	(b)
11	152.30	146.70	156.40	163.85	157.80	151.60	153.60	148.10	142.95	141.00	141.35	(c)
12	150.40	147.20	155.90	163.80	a157.10	151.30	152.70	147.70	142.80	140.90	141.40	(c)
13	148.80	147.40	155.30	163.30	156.40	151.00	152.35	147.50	142.65	140.90	141.40	(c)
14	147.80	147.50	154.70	162.80	155.70	150.70	151.55	147.30	142.45	140.85	141.40	(c)
15	147.15	148.50	154.10	162.00	155.10	150.40	150.90	147.30	142.25	140.75	141.40	(c)
16	146.80	148.70	153.40	161.30	154.60	150.20	150.50	147.20	142.15	140.70	141.40	(c)
17	146.50	149.15	153.10	160.80	154.10	150.20	150.10	147.10	142.00	140.65	141.50	(c)
18	146.60	149.00	153.35	160.60	a153.55	150.20	149.90	147.00	141.85	140.60	141.40	(c)
19	147.30	148.70	154.00	160.65	153.00	150.40	149.90	146.90	141.80	140.55	141.15	(c)
20	148.80	148.40	153.80	160.50	152.60	150.40	150.00	146.80	141.75	140.50	141.00	(c)
21	149.70	148.60	154.30	160.50	152.20	150.20	149.70	146.60	141.65	140.50	140.95	(c)
22	150.00	149.00	154.90	160.50	151.70	150.00	149.35	146.50	141.60	140.50	140.90	(c)
23	150.30	150.10	155.10	160.65	151.35	150.80	148.90	146.40	141.60	140.45	140.85	(c)
24	a150.20	151.10	155.40	160.80	151.00	151.70	148.65	146.25	141.55	140.45	140.90	(c)
25	149.90	151.30	155.60	160.80	150.90	151.80	148.70	146.10	141.70	140.40	140.80	(c)
26	149.10	151.00	156.05	160.60	151.00	152.15	149.70	145.80	141.85	140.40	140.90	(c)
27	147.85	150.70	157.30	160.10	151.35	153.10	151.90	145.50	141.90	140.45	140.90	(c)
28	146.60	150.00	158.05	160.30	151.45	152.80	152.40	145.30	141.80	140.50	140.90	d137.50
29	145.65	.....	158.10	161.00	151.40	153.70	152.00	145.00	141.70	140.50	140.90	d138.20
30	.....	.....	157.90	161.80	151.40	155.30	150.90	144.80	141.65	140.50	140.60	d138.90
31	.....	.....	157.70	.....	a151.50	.....	150.10	144.60	.....	140.50	.....	d139.20

a Changed less than one-half foot. b Below zero. c Gauge destroyed. d Temporary gauge.

1898.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	139.40	143.10	144.90	157.90	150.60	154.00	150.40	148.20	143.70	143.80	146.00	142.70
2	139.70	142.60	144.80	156.90	150.30	153.60	150.40	147.70	143.30	143.30	145.30	142.20
3	139.80	141.90	144.70	155.75	150.80	153.60	150.25	148.30	143.00	143.00	144.60	141.75
4	139.30	141.20	144.50	154.50	152.70	154.20	155.50	149.00	142.80	142.70	144.00	141.30
5	139.15	140.90	144.35	a154.00	154.60	154.65	154.70	148.95	142.50	142.40	143.60	141.00
6	139.40	140.65	144.20	153.60	155.50	154.90	154.20	148.20	142.40	142.10	143.30	140.50
7	139.85	140.50	144.05	153.60	155.70	154.90	154.30	147.50	142.30	141.80	143.20	140.35
8	140.25	140.90	143.95	153.60	155.35	154.25	155.30	146.90	142.35	141.60	143.45	140.15
9	140.45	141.60	143.85	153.20	155.00	153.60	150.10	146.75	142.80	141.50	143.80	139.60
10	140.80	142.00	143.80	153.20	154.35	153.40	150.25	146.95	143.05	141.30	143.90	139.20
11	141.10	142.20	143.70	153.10	153.75	153.65	155.90	146.80	144.50	141.20	144.10	139.00
12	142.40	142.20	144.00	152.60	153.00	154.45	155.55	146.10	145.40	141.30	144.40	138.80
13	143.20	142.90	145.50	152.10	152.20	155.30	154.30	145.80	145.50	141.80	144.30	139.10
14	143.80	144.40	148.60	152.00	151.80	156.00	153.30	146.00	145.30	142.10	144.00	139.00
15	143.95	145.20	151.90	152.00	151.60	156.35	152.55	146.10	144.80	141.70	143.70	138.90
16	143.80	145.50	152.60	152.30	151.30	156.50	151.80	146.10	144.40	141.20	143.35	139.00
17	143.50	145.50	152.70	152.10	152.70	157.55	150.90	146.10	144.80	141.00	143.10	139.40
18	143.20	145.55	152.80	151.60	155.50	158.45	150.20	145.90	146.20	140.70	142.90	139.70
19	142.90	145.90	152.40	151.10	156.50	158.30	149.70	145.80	147.00	140.85	142.80	139.80
20	143.20	146.40	152.20	150.60	156.60	157.70	149.30	145.80	147.00	141.60	142.70	140.00
21	143.30	147.40	152.60	150.15	156.45	156.80	148.90	146.65	146.40	143.00	142.50	140.10
22	144.00	148.20	154.00	149.70	158.30	155.70	148.90	147.30	145.80	144.80	142.50	140.30
23	144.60	147.80	157.10	149.50	159.80	154.80	148.50	147.00	145.10	146.00	142.70	141.80
24	144.65	147.00	159.00	149.30	160.20	154.20	148.00	146.25	144.90	146.40	142.85	143.60
25	144.40	146.30	159.10	149.30	159.60	153.60	147.60	145.55	145.50	146.20	143.75	145.00
26	144.40	145.90	158.70	149.00	158.05	153.45	147.70	145.20	145.55	145.70	144.40	145.70
27	144.45	145.50	158.50	151.20	157.80	153.75	147.90	144.90	145.40	145.10	145.40	146.00
28	144.75	145.15	158.20	152.50	156.90	155.00	147.80	144.50	145.20	144.60	145.20	145.90
29	144.60	.....	157.80	152.00	156.00	156.00	147.45	144.30	144.70	145.20	144.40	145.55
30	144.10	.....	157.90	151.20	155.70	156.40	147.45	144.15	144.10	146.10	143.50	145.30
31	143.10	.....	158.10	.....	154.95	.....	148.10	144.00	.....	146.50	.....	144.90

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1899.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	144.00	137.00	150.40	148.90	158.65	156.80	155.10	149.95	144.80	142.60	141.80	142.70
2	143.00	136.00	a150.60	149.10	158.70	156.90	155.10	150.00	144.80	142.50	141.70	142.65
3	142.20	136.00	a149.80	148.60	158.50	157.60	155.30	150.05	144.80	142.40	141.75	142.55
4	141.80	139.50	149.10	148.20	157.80	157.70	155.70	149.80	144.60	142.30	142.00	142.50
5	141.70	142.60	148.50	148.20	156.35	157.75	156.25	149.50	144.45	142.20	142.15	142.40
6	141.45	144.00	148.20	148.80	155.30	157.80	156.60	149.50	144.30	142.10	142.30	142.40
7	141.10	145.00	148.20	149.50	154.70	b157.70	156.70	149.40	144.10	142.00	142.60	142.30
8	141.50	145.20	148.00	149.50	154.25	157.25	156.90	149.00	144.00	141.80	142.80	142.20
9	141.70	144.60	147.30	149.30	154.00	156.85	156.95	148.75	143.90	141.70	142.90	142.10
10	141.10	145.00	147.10	149.40	154.10	156.85	156.80	149.60	143.90	141.60	143.10	142.10
11	141.10	145.00	147.30	149.50	154.60	156.85	157.10	150.90	144.00	141.60	143.25	142.10
12	141.30	144.90	147.50	149.80	155.20	156.90	157.30	151.40	144.20	141.60	143.40	142.05
13	141.30	144.70	147.60	151.30	155.70	157.60	157.20	150.90	144.20	141.45	143.45	142.10
14	142.10	144.90	147.80	151.80	155.90	158.40	156.70	150.70	144.10	141.40	143.50	142.10
15	141.90	145.10	148.40	151.20	155.90	158.35	156.10	150.60	144.00	141.25	143.65	142.20
16	141.80	145.30	150.00	150.60	155.50	157.50	155.60	150.05	143.90	141.15	143.70	142.20
17	142.00	145.50	151.30	150.50	154.85	156.80	155.20	149.40	143.85	141.25	143.60	141.90
18	142.10	145.55	151.90	150.45	154.40	156.60	154.90	148.80	143.80	141.25	143.50	141.50
19	142.00	145.10	152.30	150.45	153.75	156.60	154.75	148.30	143.90	141.45	143.55	141.50
20	141.85	145.50	153.30	150.60	153.30	156.60	154.70	148.00	144.10	141.35	143.55	141.90
21	141.80	144.90	154.20	151.50	153.65	156.40	154.40	147.60	144.00	141.30	143.50	142.40
22	141.80	143.40	154.50	152.20	154.20	156.10	153.90	147.30	143.80	141.20	143.50	142.10
23	141.75	141.80	154.25	153.90	155.70	155.70	153.35	146.85	143.60	141.10	143.65	141.65
24	141.70	140.70	153.70	156.80	156.90	155.20	b152.90	146.40	143.40	141.00	143.80	141.15
25	141.80	141.90	153.00	158.10	157.80	154.75	152.50	146.00	143.25	141.00	143.80	140.90
26	141.80	143.15	152.30	158.95	158.50	154.45	152.05	145.70	143.10	140.95	143.80	140.20
27	141.75	144.30	151.50	159.30	158.50	154.40	151.60	145.45	143.00	140.95	143.50	139.80
28	141.60	148.80	150.80	159.05	158.25	154.50	151.00	145.30	142.90	141.20	143.15	139.30
29	141.30	.....	150.00	158.70	157.70	154.90	150.60	145.15	142.80	141.50	143.00	138.90
30	140.60	.....	149.35	158.60	157.20	155.10	b150.30	145.00	142.70	141.95	142.85	138.25
31	139.90	.....	148.90	.....	156.95	.....	150.10	144.80	.....	142.10	.....	137.80

a Reading changed one-half foot or more. b Changed less than one-half foot.

1900.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	136.70	139.70	143.80	149.40	151.20	149.10	147.80	147.15	145.90	146.00	148.35	146.50
2	136.20	138.90	143.80	149.80	150.70	148.80	147.50	147.10	146.10	146.45	148.00	145.90
3	136.80	138.40	143.75	150.00	150.70	148.80	147.50	146.70	146.20	147.00	147.50	145.50
4	137.20	138.10	143.50	150.00	150.90	148.75	147.50	146.40	146.20	148.10	147.35	145.05
5	137.90	138.10	143.80	150.00	150.90	148.40	147.50	146.10	146.20	148.50	147.50	144.70
6	140.50	138.20	145.40	150.30	150.70	148.10	147.50	145.70	146.25	148.40	147.65	144.40
7	139.90	138.70	149.30	150.75	151.00	147.80	147.30	145.30	146.25	148.00	148.20	144.10
8	139.50	139.70	152.70	151.35	151.40	147.80	147.20	144.90	145.75	147.95	148.80	143.90
9	139.90	141.90	153.10	151.80	151.60	147.50	146.90	144.50	145.20	148.20	148.95	143.80
10	140.30	143.80	153.40	151.65	151.40	147.40	146.80	144.20	144.90	148.45	148.70	143.60
11	140.60	144.80	154.10	151.45	151.20	147.30	146.70	143.90	144.50	148.10	148.40	143.50
12	140.80	144.40	154.90	151.25	151.00	146.90	146.55	143.60	144.25	a147.30	148.15	143.35
13	140.60	144.00	155.70	151.85	151.00	146.85	146.70	143.30	143.90	b146.80	148.00	143.25
14	140.50	143.90	156.60	152.40	151.70	147.30	146.60	143.00	143.70	146.40	147.90	143.00
15	140.50	143.40	157.00	153.30	151.30	149.60	146.35	142.80	143.55	146.20	147.70	142.75
16	140.50	143.20	157.05	153.00	150.60	149.70	146.00	142.65	143.40	146.05	147.50	142.55
17	140.35	142.90	157.05	152.35	149.90	148.80	146.20	142.50	143.30	145.95	147.35	142.30
18	140.50	142.90	156.65	151.60	149.50	148.10	146.30	142.45	143.10	145.95	147.35	142.10
19	140.90	142.40	156.00	151.00	149.60	147.60	146.05	142.70	142.90	145.95	147.65	141.85
20	142.40	142.40	155.10	150.65	149.80	147.40	145.80	143.00	143.00	146.10	147.60	141.60
21	144.30	142.60	154.10	151.00	149.70	147.30	145.75	144.90	143.10	146.30	147.60	141.40
22	144.35	a143.90	153.40	151.30	149.60	148.00	145.95	145.45	143.40	146.60	147.75	141.20
23	143.70	144.80	153.00	151.45	149.60	149.40	146.80	145.60	143.80	146.90	147.80	141.00
24	143.10	145.90	152.60	151.80	149.60	150.20	148.00	145.60	144.05	147.30	147.85	140.95
25	142.90	145.60	152.20	152.00	149.60	150.40	148.80	145.50	144.15	147.60	147.95	140.85
26	142.90	145.40	151.75	152.40	149.30	150.30	149.05	145.60	144.15	147.80	147.90	140.75
27	142.90	144.80	151.45	152.55	148.90	150.10	149.10	145.30	144.25	147.90	147.85	140.75
28	142.80	144.50	151.10	152.40	148.60	149.70	148.65	145.10	144.40	148.00	147.65	140.80
29	142.30	.....	150.60	152.00	148.40	148.80	148.30	145.35	144.90	147.90	147.40	140.75
30	141.40	.....	150.20	151.70	148.80	148.30	147.90	145.20	145.50	148.00	147.10	140.55
31	140.50	.....	149.80	.....	149.30	.....	147.65	145.40	.....	148.10	.....	140.35

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1901.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	140.30	141.35	141.45	152.55	150.30	145.30	149.00	144.15	140.55	140.20	140.75	139.70
2	139.95	141.10	141.25	152.80	150.00	145.20	148.60	144.30	140.45	140.10	140.65	139.65
3	139.80	141.00	140.90	152.85	149.80	145.30	148.10	144.40	140.35	139.95	140.55	139.60
4	139.50	141.00	140.80	152.90	149.50	146.50	147.60	144.30	140.20	139.85	140.45	139.55
5	139.20	141.10	140.95	153.10	149.20	147.20	147.10	144.20	140.10	139.80	140.35	139.45
6	138.95	140.95	141.50	153.25	149.00	147.35	146.70	144.10	140.00	139.85	140.15	139.40
7	138.70	141.10	141.80	153.55	148.75	147.50	146.40	143.75	139.90	139.90	140.00	139.30
8	138.55	140.65	142.10	153.75	148.50	147.75	146.25	143.40	139.85	139.95	140.00	a139.30
9	138.70	139.90	142.85	154.05	148.30	148.05	146.10	143.15	139.75	140.05	140.00	139.40
10	139.20	139.40	144.30	154.80	148.10	147.95	146.50	142.95	139.70	140.10	140.00	139.40
11	139.70	139.10	146.70	155.50	147.90	147.75	147.15	142.80	139.70	140.15	140.05	139.30
12	140.45	139.45	150.40	155.75	147.70	147.60	146.95	142.65	139.80	140.20	140.15	139.20
13	141.60	139.70	151.60	155.95	147.50	147.50	146.45	142.55	139.65	140.25	140.20	139.30
14	141.90	139.75	152.10	156.10	147.40	147.60	146.10	142.50	139.50	140.30	140.20	a139.90
15	142.20	139.80	151.80	156.10	147.20	148.00	145.95	142.35	139.50	140.15	140.10	139.60
16	142.30	139.85	151.50	155.95	146.95	148.55	145.85	142.30	139.50	140.10	140.10	139.10
17	142.30	139.90	151.30	155.85	146.70	148.70	145.80	142.15	139.40	140.15	140.10	138.50
18	142.20	140.05	151.10	156.60	146.60	148.40	145.80	142.00	139.40	140.30	140.10	138.10
19	142.30	140.20	151.00	156.90	146.50	148.00	145.80	141.95	139.50	140.50	140.00	136.40
20	142.15	140.50	150.80	156.50	146.30	147.80	145.80	141.85	139.75	140.70	140.00	135.40
21	142.00	140.60	150.75	155.50	146.00	147.65	146.00	141.70	140.30	140.85	139.95	136.10
22	141.75	140.30	150.95	154.60	145.80	147.75	146.35	141.65	141.30	140.90	140.00	137.00
23	141.85	140.15	151.80	153.90	145.60	147.85	146.20	141.60	141.70	140.90	140.00	137.10
24	141.95	140.05	152.30	153.20	145.55	148.35	145.70	141.50	141.50	140.85	140.00	137.60
25	141.95	140.30	152.70	152.70	145.35	148.90	145.40	141.40	141.20	140.75	140.00	136.60
26	141.80	140.70	153.05	152.15	145.25	149.20	145.00	141.30	140.90	140.65	139.95	136.90
27	141.65	141.40	153.05	151.70	145.95	149.40	144.80	141.20	140.70	140.65	139.85	136.90
28	141.60	141.60	152.85	151.30	146.10	149.60	144.60	141.10	140.50	140.65	139.80	138.20
29	141.55	.....	152.60	150.90	145.80	149.80	144.40	140.95	140.40	140.65	139.70	137.50
30	141.55	.....	152.50	150.60	145.60	149.50	144.20	140.85	140.30	140.65	139.70	137.60
31	141.55	.....	152.40	.....	145.40	.....	144.15	140.75	.....	140.70	.....	137.60

a Changed less than one-half foot.

1902.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	137.70	136.50	140.05	145.70	144.00	151.95	155.70	156.10	153.90	150.30	146.40	149.00
2	137.80	136.50	141.20	146.40	143.85	151.05	156.85	155.30	153.40	150.30	146.05	148.70
3	137.90	136.40	141.35	146.70	144.00	152.10	157.30	154.55	152.90	150.20	145.70	148.50
4	138.00	136.30	141.70	146.70	146.20	153.20	157.60	153.75	152.90	150.70	145.35	148.20
5	137.50	138.90	142.70	146.60	146.35	153.30	157.35	153.20	153.40	151.40	145.15	148.10
6	137.30	140.40	142.40	146.50	145.75	153.10	156.75	152.85	153.35	151.70	145.10	148.30
7	137.50	140.30	142.10	147.10	145.10	152.80	156.00	152.60	152.70	152.40	145.50	148.30
8	138.00	140.70	142.40	147.60	144.25	152.30	155.60	152.50	152.10	153.20	145.90	148.45
9	138.50	140.30	143.30	147.20	143.80	151.70	155.20	152.30	151.00	154.10	146.00	148.45
10	138.80	140.15	144.30	146.50	143.70	151.70	155.30	152.00	150.20	154.20	146.60	148.00
11	139.00	139.95	144.70	146.10	144.55	152.20	154.95	151.55	149.60	153.70	147.10	147.40
12	138.95	140.20	144.55	145.80	145.50	153.00	154.60	151.10	149.10	152.90	147.10	146.70
13	138.65	140.10	144.75	145.40	146.05	153.30	154.95	150.75	148.65	152.20	146.60	146.70
14	138.40	140.10	145.70	145.10	146.60	153.30	156.00	150.65	148.05	151.40	146.25	146.90
15	137.90	139.90	146.70	144.85	146.75	154.00	156.90	150.45	147.50	b150.70	145.90	147.10
16	137.80	140.00	147.45	144.65	146.70	154.40	157.60	149.90	147.00	150.10	145.75	146.85
17	138.10	140.35	148.30	144.45	146.60	154.10	158.10	149.35	146.45	149.65	145.50	145.95
18	138.40	140.40	148.20	144.20	146.50	153.85	158.50	149.20	a146.20	149.50	145.60	145.50
19	138.50	140.40	147.80	144.15	146.50	153.55	158.80	149.45	145.70	149.60	146.10	145.50
20	138.50	140.20	147.20	144.15	147.00	153.35	158.95	149.60	145.40	149.80	147.00	145.85
21	138.50	140.20	146.45	143.90	147.10	153.10	158.85	150.30	144.90	149.95	147.80	146.30
22	138.60	140.30	145.70	143.40	146.85	152.55	158.60	151.30	144.45	150.35	148.30	146.60
23	138.65	140.35	145.20	143.30	146.55	152.30	158.70	151.70	144.20	150.80	148.20	147.50
24	138.60	140.25	144.80	144.05	146.65	152.30	159.10	151.95	143.95	150.90	148.00	148.00
25	138.55	139.90	144.45	144.60	147.50	152.25	159.35	151.95	143.95	150.80	147.90	148.30
26	138.45	140.30	144.10	144.20	148.15	152.10	159.40	151.95	145.60	150.65	147.80	b149.10
27	138.00	140.30	144.10	143.70	148.65	152.30	159.40	152.30	147.10	150.15	147.90	149.20
28	137.60	140.20	144.40	143.40	149.70	152.60	159.00	152.70	148.00	149.15	148.10	148.60
29	136.90	.....	145.00	143.35	151.80	154.05	158.30	153.45	148.65	148.15	148.30	148.00
30	136.70	.....	145.50	144.00	152.50	155.00	157.50	154.05	149.70	147.40	148.70	147.20
31	136.20	.....	146.50	.....	152.30	.....	156.70	154.10	.....	146.80	.....	146.00

a Changed less than one-half foot. b Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1903.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	145.00	145.80	149.75	153.95	152.80	159.10	155.20	152.20	152.00	152.00	150.70	143.40
2	144.25	145.60	150.45	153.60	152.50	161.00	155.15	151.50	153.00	152.00	150.55	143.20
3	144.10	145.30	150.60	153.40	152.30	162.30	154.80	151.00	154.10	152.10	150.40	142.90
4	144.15	146.00	150.95	153.25	152.10	163.50	154.20	151.10	154.20	152.15	150.20	142.60
5	144.50	148.40	152.20	153.40	151.80	164.60	153.55	150.75	154.15	152.30	150.00	142.30
6	144.75	150.60	152.50	154.30	151.55	165.70	153.05	150.20	153.65	152.50	149.90	142.00
7	144.80	150.40	152.90	155.00	151.40	166.70	152.55	150.30	153.00	152.90	150.00	141.90
8	144.85	149.35	154.20	155.45	151.20	167.70	152.30	151.20	152.50	153.20	150.40	141.80
9	144.75	148.70	156.80	155.35	151.15	168.05	152.30	151.70	152.30	154.10	150.55	141.70
10	144.60	147.90	158.40	154.90	151.25	168.60	152.30	151.75	152.10	155.10	150.35	141.45
11	144.10	147.05	158.80	154.65	151.25	169.15	152.30	151.90	151.70	156.00	150.00	141.30
12	143.30	146.60	158.80	155.00	151.10	169.30	152.30	152.00	152.20	156.20	149.80	141.05
13	142.60	146.80	158.25	156.00	150.90	169.30	151.70	151.70	153.70	155.90	149.50	140.75
14	141.60	147.20	157.80	156.80	150.70	169.00	151.35	152.00	154.70	155.60	149.00	140.20
15	141.30	147.20	157.75	157.15	150.50	168.30	151.30	151.90	154.90	155.35	148.60	a139.40
16	141.20	147.10	157.80	157.30	150.35	167.20	151.70	152.40	155.00	154.90	148.30	a139.50
17	141.40	146.60	157.15	157.20	150.80	166.20	152.40	152.20	155.70	154.50	148.10	a140.10
18	141.90	145.70	156.90	157.35	152.55	164.90	153.30	151.95	155.30	153.90	147.70	a141.10
19	142.40	145.00	157.00	157.35	153.90	163.40	153.90	152.20	155.00	153.40	147.40	a141.90
20	143.00	144.50	156.70	157.15	154.60	162.00	154.00	152.35	155.00	152.90	147.00	a140.50
21	143.30	144.10	157.15	156.60	154.60	160.90	153.50	152.45	154.85	152.50	146.60	a140.05
22	143.10	144.00	157.80	156.70	154.30	160.20	153.30	152.50	154.20	152.10	146.40	139.95
23	143.00	144.10	157.70	156.60	154.00	159.50	153.30	152.20	153.40	151.80	146.10	140.15
24	142.95	144.25	157.30	156.10	153.80	158.90	153.35	151.70	152.60	151.50	145.75	140.50
25	142.85	144.45	157.15	155.60	153.85	158.60	153.50	151.10	152.10	151.40	145.45	141.05
26	142.75	144.65	156.80	155.00	154.60	158.25	154.00	150.80	151.70	151.30	145.10	141.30
27	142.75	145.20	156.40	154.50	156.30	157.80	154.60	150.60	151.50	151.20	144.80	141.15
28	143.40	146.80	155.80	154.00	157.25	156.90	154.30	150.40	151.60	151.00	144.40	141.05
29	145.50	.....	155.35	153.60	157.40	156.00	153.60	150.55	151.75	150.90	144.00	141.10
30	146.10	.....	154.70	153.30	157.50	155.40	153.30	150.90	151.85	150.80	143.65	141.40
31	145.90	.....	154.30	.....	157.90	.....	152.60	151.60	.....	150.75	.....	141.60

a Doubtful on account of ice.

1904.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	142.05	145.00	144.40	159.70	166.80	156.75	158.10	149.80	145.70	148.40	146.80	142.55
2	142.40	144.20	144.10	159.35	166.50	158.10	157.80	149.50	145.30	148.30	146.70	142.40
3	142.10	143.40	143.90	159.10	166.10	158.70	157.10	149.10	145.00	147.90	146.60	142.25
4	141.80	143.25	144.10	158.65	165.40	158.50	156.70	148.80	144.80	147.70	146.50	142.20
5	141.20	143.15	144.20	158.00	164.70	158.10	156.50	148.70	145.20	147.10	146.30	142.05
6	140.90	143.30	144.60	157.50	163.50	160.00	156.30	148.50	145.40	146.60	146.20	141.95
7	140.90	143.70	145.40	156.85	162.40	161.40	155.70	148.20	145.10	146.20	146.00	141.80
8	141.00	144.20	145.65	156.20	161.15	161.90	155.20	147.80	144.80	146.10	145.90	141.45
9	141.00	144.40	145.90	155.70	160.50	161.70	156.30	147.20	144.45	145.85	145.80	141.35
10	140.90	144.80	146.40	156.20	160.30	160.90	158.40	146.80	144.35	145.50	145.70	141.40
11	140.90	145.20	146.60	157.20	159.95	160.15	160.00	146.50	144.50	145.40	145.60	141.30
12	140.90	145.80	147.30	157.50	159.35	159.40	160.90	146.10	144.55	145.20	145.50	141.20
13	140.80	146.10	147.70	157.80	158.80	158.80	161.30	145.85	144.40	145.00	145.40	141.10
14	140.90	146.25	147.80	157.80	157.90	158.30	161.00	145.65	144.40	144.80	145.30	140.70
15	141.00	146.60	147.75	157.50	157.15	158.15	160.00	146.00	144.25	144.60	145.15	140.10
16	141.35	146.70	147.60	157.50	156.60	158.50	158.70	145.75	144.15	144.40	145.00	139.70
17	141.45	146.20	147.60	157.30	156.10	158.70	157.00	145.95	144.10	144.30	144.85	139.50
18	141.45	145.60	147.90	157.70	155.90	158.70	156.00	146.00	144.15	144.30	144.70	139.10
19	141.80	145.20	148.40	158.50	156.20	159.00	155.60	146.10	145.20	144.20	144.50	138.70
20	141.90	145.00	148.70	158.60	156.60	158.70	155.40	146.60	146.85	144.10	144.30	138.30
21	142.10	145.10	148.85	158.10	156.40	158.80	155.20	147.70	147.65	144.10	144.10	138.40
22	144.30	144.90	149.00	158.00	155.80	158.90	154.50	148.50	148.60	144.15	143.95	138.25
23	147.40	144.50	149.75	158.40	155.30	159.00	153.60	148.30	148.20	144.25	143.70	138.20
24	150.50	144.30	151.30	158.70	154.75	158.40	153.00	148.80	147.30	144.40	143.55	138.35
25	151.00	144.40	152.55	160.80	154.30	157.80	152.70	149.00	147.10	144.60	143.30	138.80
26	150.30	144.45	150.50	163.40	154.00	156.85	152.65	148.80	147.00	144.90	143.20	138.80
27	149.80	144.80	150.20	165.30	153.70	156.10	152.50	149.30	147.70	145.20	143.00	139.50
28	148.90	144.90	157.80	166.30	153.70	156.00	151.90	148.85	148.10	145.40	142.85	140.20
29	147.80	144.65	159.60	166.80	153.90	156.40	151.20	147.90	147.90	145.70	142.70	139.60
30	147.00	.....	160.30	166.90	153.95	157.40	150.70	147.00	148.00	146.20	142.60	138.10
31	145.90	.....	159.90	.....	154.90	.....	150.20	146.25	.....	146.65	.....	137.80

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo--Cont'd.

LITTLE ROCK, MO.—Continued.

1905.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	138.00	145.70	153.90	152.60	153.20	153.90	156.80	154.80	148.50	151.20	149.20	146.70
2	137.90	145.70	154.05	153.50	152.70	153.55	157.00	155.45	147.95	150.60	148.80	147.20
3	138.40	144.90	154.05	153.70	152.20	153.45	157.15	155.90	147.95	149.90	148.90	147.20
4	139.70	144.30	153.75	153.40	151.50	153.70	157.15	156.30	147.40	149.40	148.90	147.00
5	140.15	144.30	154.45	153.35	151.10	154.15	158.00	155.70	147.10	149.00	149.00	146.70
6	139.95	144.50	154.60	153.00	150.70	154.80	158.70	155.00	146.85	148.70	149.55	146.20
7	140.20	144.60	154.00	152.40	149.70	154.90	159.10	154.20	146.80	148.20	149.95	145.80
8	139.90	144.50	153.70	151.90	149.10	154.50	159.30	153.50	146.85	147.70	150.35	145.25
9	139.40	144.35	153.50	151.40	148.50	153.90	159.00	152.70	146.85	147.20	150.10	144.70
10	139.50	144.35	153.15	151.10	148.10	153.40	158.90	152.20	146.80	146.90	149.75	144.10
11	139.15	144.10	152.90	150.80	147.90	153.20	158.70	151.90	146.75	146.65	149.55	143.50
12	138.50	144.00	152.60	150.55	148.50	152.90	158.65	151.50	146.95	146.45	149.40	143.20
13	a138.60	143.70	152.20	150.35	148.50	153.50	159.10	150.90	148.05	146.20	149.50	143.05
14	a143.10	143.20	151.50	150.25	149.70	154.30	159.60	150.50	148.55	145.90	149.60	143.00
15	a142.70	143.00	150.70	150.25	149.70	154.90	160.00	150.25	147.85	145.70	149.10	143.10
16	a142.00	143.20	149.90	150.25	151.60	155.30	160.00	149.60	147.40	145.50	148.50	143.10
17	a141.40	143.20	149.50	150.40	153.10	155.30	159.30	149.10	149.40	145.30	147.80	143.05
18	141.70	143.30	149.25	150.40	154.10	155.00	158.00	148.60	155.50	145.40	147.30	143.00
19	143.10	143.30	149.10	150.30	154.45	154.50	156.80	148.70	160.10	150.60	147.00	143.05
20	144.50	143.30	148.95	150.00	155.20	154.55	155.70	149.00	162.10	153.30	147.00	143.10
21	145.40	143.30	148.70	149.80	155.60	155.00	155.90	149.50	163.40	151.65	147.20	143.20
22	145.75	143.40	148.70	149.60	155.00	155.05	154.80	149.70	163.80	151.10	147.50	143.35
23	146.00	143.90	149.30	149.50	154.30	154.85	154.20	150.50	163.50	150.95	147.00	143.30
24	146.20	144.20	150.10	149.70	153.90	154.70	154.00	152.10	162.10	150.75	146.40	143.30
25	145.90	144.70	150.70	150.20	153.55	154.95	154.10	153.90	160.20	150.65	146.20	143.20
26	145.10	145.50	150.95	150.60	153.25	155.50	154.70	153.60	158.10	150.65	146.10	143.00
27	144.40	146.20	151.20	151.00	153.05	155.80	155.00	153.20	156.40	152.10	145.95	142.85
28	144.80	151.80	151.50	151.70	153.15	155.90	154.30	152.80	154.80	151.90	145.75	142.75
29	145.60	.....	152.00	152.10	153.30	156.10	153.40	152.00	153.10	150.90	145.75	143.00
30	145.70	.....	152.50	152.50	153.85	156.35	153.00	150.70	152.00	150.20	146.25	143.45
31	145.60	.....	152.55	.....	154.15	.....	153.60	149.50	.....	149.70	.....	143.70

a Doubtful on account of ice.

1906.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	143.95	150.55	156.70	159.70	154.90	149.75	153.85	147.50	147.35	148.50	143.30	145.90
2	144.00	150.90	157.20	159.40	154.80	150.20	153.70	147.30	146.90	148.80	143.70	146.00
3	144.10	150.80	157.50	159.00	154.70	150.85	153.80	147.30	146.60	149.20	144.10	146.30
4	145.10	150.30	157.20	158.40	154.75	151.15	153.95	147.45	146.50	149.10	144.30	146.50
5	148.00	149.50	156.30	158.20	154.75	151.75	153.70	147.20	146.20	148.90	144.50	146.55
6	151.40	148.80	155.40	158.25	154.55	151.90	153.35	146.90	146.05	148.30	144.55	146.75
7	151.65	148.20	154.60	158.10	154.80	152.10	153.10	146.80	146.00	147.40	144.60	147.10
8	150.90	147.40	154.10	157.90	155.60	152.55	152.75	147.30	145.90	146.90	144.70	147.50
9	149.90	146.50	153.80	158.05	155.45	153.35	152.50	147.35	145.90	146.50	144.80	147.20
10	148.70	145.90	153.80	158.20	154.80	153.70	152.10	147.20	145.90	146.20	144.90	146.95
11	147.30	145.60	153.60	158.10	154.15	153.90	151.60	147.00	145.90	145.90	145.00	146.60
12	146.10	145.20	153.35	157.80	154.15	153.85	151.20	147.00	146.05	145.60	145.10	146.40
13	145.50	145.00	153.05	157.50	153.15	153.40	150.90	148.00	146.00	145.40	145.10	146.20
14	145.10	145.30	152.70	158.10	152.60	153.10	150.80	148.45	145.90	145.15	145.10	145.90
15	144.70	145.45	152.40	169.30	152.30	153.00	150.50	148.95	145.80	145.00	145.05	145.90
16	144.60	145.50	152.00	159.40	151.90	152.65	150.30	149.25	145.70	144.90	145.10	145.70
17	144.50	145.60	151.40	158.90	151.40	152.50	150.20	149.10	145.65	144.80	145.30	145.40
18	144.15	145.70	150.90	158.45	150.90	152.25	149.90	148.70	145.60	144.70	145.40	145.05
19	144.00	145.90	150.60	158.25	150.55	152.30	149.60	148.20	145.60	144.55	145.40	144.60
20	144.15	146.20	150.10	157.90	150.30	153.45	149.25	148.00	145.85	144.40	145.40	144.00
21	144.50	146.60	149.60	157.55	150.00	153.05	149.00	148.15	145.90	144.20	146.30	143.70
22	147.20	146.80	149.20	157.25	149.70	153.80	148.80	148.10	145.80	144.10	147.10	143.60
23	148.00	147.25	148.80	156.80	149.50	154.40	148.80	147.80	145.80	144.00	147.20	143.35
24	149.40	148.80	148.80	156.50	149.35	154.90	148.85	147.45	145.90	143.90	147.15	142.90
25	150.50	151.70	149.00	156.10	149.20	155.30	149.50	147.00	146.70	143.80	146.65	142.50
26	150.10	153.50	149.30	155.80	149.15	155.00	150.20	146.90	147.50	143.65	146.30	142.10
27	149.80	155.25	151.10	155.65	149.10	154.10	150.10	147.60	147.65	143.50	146.10	141.70
28	149.65	156.00	155.50	155.45	149.05	153.60	149.40	149.00	147.85	143.40	146.00	141.45
29	149.45	.....	157.60	155.20	149.20	153.75	149.05	149.15	148.25	143.35	145.95	141.40
30	149.60	.....	158.70	155.05	149.15	153.90	148.35	148.40	148.55	143.30	145.90	141.60
31	150.00	.....	159.70	.....	149.10	.....	147.85	147.80	.....	143.25	.....	142.30

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

LITTLE ROCK, MO.—Continued.

1907.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	142.7	152.05	150.55	151.3	152.6	150.4	156.6	158.7	149.5	145.9	144.1	143.1
2	143.3	151.55	150.45	151.9	153.35	150.7	156.1	157.9	149.4	145.9	144.2	143.15
3	144.2	151.0	150.2	152.05	153.45	151.1	155.75	156.8	149.3	146.0	144.1	143.05
4	144.8	150.4	149.9	152.0	153.45	152.25	155.2	155.8	149.25	146.6	143.9	143.0
5	145.5	149.5	149.6	151.8	153.1	154.25	154.5	155.1	149.25	147.1	143.8	142.9
6	146.5	148.7	149.5	151.8	152.65	155.1	153.9	154.6	149.15	147.4	143.8	142.8
7	146.95	147.7	149.45	151.7	152.5	155.1	153.6	154.2	149.05	147.6	143.75	142.7
8	147.1	146.4	149.35	151.5	152.8	154.75	153.75	154.0	148.9	147.6	143.65	142.6
9	147.1	145.6	149.0	151.45	153.9	154.3	153.9	153.9	148.6	147.75	143.6	142.45
10	147.0	145.2	148.7	151.6	154.35	154.3	154.0	153.75	148.2	148.1	143.65	142.4
11	147.0	145.1	148.6	151.7	154.45	154.5	154.0	153.5	147.8	148.4	143.6	142.35
12	146.9	145.2	149.0	151.8	153.7	154.7	153.9	153.1	147.4	148.5	143.5	142.25
13	146.8	145.65	151.0	152.4	152.7	155.7	153.9	152.5	147.1	148.5	143.35	142.1
14	146.9	146.2	152.5	153.2	152.05	156.5	154.2	152.35	146.8	148.3	143.3	142.05
15	147.5	147.2	153.7	153.3	151.85	156.5	154.7	152.0	146.6	147.9	143.2	142.05
16	148.2	147.8	153.7	153.1	152.4	156.8	155.0	151.8	146.4	147.5	143.2	142.1
17	149.0	147.55	152.75	152.85	154.4	156.8	155.4	151.65	146.2	147.1	143.2	142.2
18	150.5	147.55	152.35	152.8	155.2	155.9	156.4	151.3	145.95	146.8	143.2	142.3
19	152.9	148.0	152.1	153.0	155.05	155.25	157.3	151.4	145.7	146.45	143.15	142.4
20	155.3	148.2	151.9	153.4	154.15	154.7	157.7	152.05	145.5	146.20	143.1	142.4
21	158.5	147.95	152.1	153.9	153.25	154.45	158.05	152.5	145.3	145.9	143.15	142.3
22	159.5	147.65	152.05	154.3	152.4	154.2	158.5	152.5	145.1	145.65	143.25	142.1
23	159.85	148.0	151.3	154.3	151.55	154.15	159.0	153.0	145.05	145.5	143.2	142.0
24	159.85	148.75	150.8	154.15	150.85	154.2	159.6	152.5	145.2	145.2	143.15	142.2
25	159.4	149.75	150.45	154.45	150.4	155.1	160.0	152.3	145.4	145.0	143.1	142.1
26	158.0	150.45	150.2	154.15	149.85	156.2	160.2	152.4	145.55	144.9	143.1	142.1
27	156.55	150.7	150.1	153.8	149.35	156.8	160.0	152.3	145.7	144.85	143.05	142.05
28	155.1	150.65	150.0	153.35	149.6	157.45	159.6	150.95	145.8	144.7	143.15	142.15
29	153.9	.....	149.9	152.55	150.1	157.3	159.4	150.25	145.9	144.5	143.2	142.0
30	153.0	.....	150.3	152.35	150.1	157.0	159.0	149.85	145.95	144.3	143.2	141.8
31	152.4	.....	150.8	.....	150.15	.....	159.0	149.6	.....	144.15	.....	141.85

1908.

[Gauge, 56.45 miles from Eads Bridge. Zero of gauge, 220.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	141.90	140.70	151.90	150.10	151.95	160.50	163.10	.....	.....	.....	.....	.....
2	142.00	140.50	151.70	149.80	151.40	160.90	162.80	.....	.....	.....	.....	.....
3	142.10	139.90	151.80	149.80	151.00	161.30	162.80	.....	.....	.....	.....	.....
4	142.10	139.70	152.20	149.80	150.70	161.95	163.05	.....	.....	.....	.....	.....
5	142.05	140.05	152.40	149.80	151.90	162.50	163.20	.....	.....	.....	.....	.....
6	141.95	140.30	152.55	149.70	152.30	162.55	163.20	.....	.....	.....	.....	.....
7	141.90	140.20	153.00	149.70	153.90	162.55	163.20	.....	.....	.....	.....	.....
8	141.85	140.35	153.15	150.10	154.30	162.65	162.75	.....	.....	.....	.....	.....
9	141.75	140.70	153.80	150.80	154.70	162.65	161.85	.....	.....	.....	.....	.....
10	141.60	141.00	154.90	152.10	155.10	162.65	160.95	.....	.....	.....	.....	.....
11	141.60	141.20	155.50	154.00	155.50	162.70	160.30	.....	.....	.....	.....	.....
12	142.10	141.50	155.45	154.70	155.90	162.80	159.90	.....	.....	.....	.....	.....
13	142.40	141.90	155.40	155.20	155.50	163.20	159.70	.....	.....	.....	.....	.....
14	143.10	142.20	155.10	154.90	155.00	163.50	159.50	.....	.....	.....	.....	.....
15	143.10	144.20	154.90	154.80	154.75	163.95	159.00	.....	.....	.....	.....	.....
16	142.60	147.00	154.55	154.50	155.45	164.55	158.30	.....	.....	.....	.....	.....
17	142.20	150.30	154.10	154.00	157.10	165.30	157.50	.....	.....	.....	.....	.....
18	142.00	150.80	153.70	153.40	157.90	165.80	156.80	.....	.....	.....	.....	.....
19	141.80	151.00	153.30	152.70	158.40	166.10	156.60	.....	.....	.....	.....	.....
20	141.75	151.20	153.00	151.80	158.50	166.30	156.65	.....	.....	.....	.....	.....
21	141.60	151.70	152.60	151.20	158.10	166.30	156.80	.....	.....	.....	.....	.....
22	141.35	151.40	152.30	150.70	157.50	166.25	156.90	.....	.....	.....	.....	.....
23	141.40	150.90	151.90	150.50	157.50	166.10	156.65	.....	.....	.....	.....	.....
24	141.70	150.60	151.50	150.70	157.35	166.00	156.15	.....	.....	.....	.....	.....
25	142.00	150.30	151.10	151.60	156.95	165.60	155.65	.....	.....	.....	.....	.....
26	141.90	150.20	150.70	151.70	156.70	165.40	155.35	.....	.....	.....	.....	.....
27	142.05	150.80	150.45	152.30	157.20	165.10	155.05	.....	.....	.....	.....	.....
28	142.05	151.80	150.25	152.50	158.20	164.65	155.00	.....	.....	.....	.....	.....
29	141.90	152.20	150.20	152.95	158.90	164.20	155.00	.....	.....	.....	.....	.....
30	141.60	.....	150.20	152.65	159.20	163.60	154.70	.....	.....	.....	.....	.....
31	141.30	.....	150.40	.....	159.70	.....	154.35	.....	.....	.....	.....	.....

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.

1896.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.90
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.80
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.60
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.55
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.70
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.60
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.20
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.70
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.45
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.20
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.95
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.90
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.90
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.10
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.35
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.95
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.40
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.05
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.60
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.90
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.05
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.95
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.85
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.00	7.70
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.65
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.50
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.25
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.05	7.05
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.05	6.95
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.85

1897.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.85	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.85	5.00
2	6.75	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.85	4.85
3	6.95	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.90	4.75
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.80	4.40
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.75	4.00
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.70	3.55
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.80	3.10
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.90	2.50
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.40	a1.80
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.40	a1.50
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.55	a1.90
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	a2.00
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	a2.10
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.55	2.50
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.50	2.70
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	3.00
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	3.40
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60	3.50
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.40	3.10
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.30	a2.40
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.10	a1.70
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.05	a1.60
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a1.35
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a1.15
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a.80
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a.70
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a1.20
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a1.95
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	a2.40
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	3.00
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.15

a Temporary gauge doubtful.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.—Continued.

1898.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.25	8.20	9.60	25.50	16.00	20.40	22.15	12.90	8.15	8.60	a 10.70	7.60
2	3.40	7.75	9.35	24.70	15.20	19.65	22.25	12.50	7.80	8.20	10.10	6.90
3	a 3.60	6.90	9.15	23.50	15.70	19.50	22.10	12.90	7.50	7.80	9.25	6.40
4	3.80	6.25	9.00	22.00	17.50	19.90	21.40	13.70	7.30	7.35	8.60	5.90
5	3.40	5.80	8.75	21.40	19.90	20.40	20.50	13.80	6.95	7.15	8.10	5.40
6	3.50	5.60	8.60	20.50	21.20	20.80	19.70	13.20	6.90	7.00	7.80	5.20
7	3.75	5.25	8.40	20.30	21.70	20.90	19.40	12.50	6.80	6.80	7.65	5.00
8	4.20	5.30	8.30	20.10	21.50	20.40	20.50	12.20	6.75	6.50	7.70	4.70
9	4.70	5.50	8.15	19.70	21.00	19.50	22.10	12.30	7.00	6.20	8.05	4.40
10	5.25	6.10	8.10	19.40	20.50	19.00	21.90	11.75	7.65	5.90	8.20	4.10
11	5.60	6.50	8.10	19.20	19.90	18.90	21.60	11.55	8.40	5.85	8.30	3.30
12	6.65	7.10	8.75	18.80	19.20	19.60	b 21.20	10.90	9.40	5.80	8.70	2.60
13	7.80	7.30	11.40	18.20	18.30	20.60	20.10	10.40	9.90	6.00	8.90	2.60
14	8.40	8.40	12.80	17.70	17.40	21.60	18.90	10.30	9.70	6.50	8.80	2.20
15	9.10	9.80	16.35	17.70	17.30	22.10	17.90	10.50	9.30	6.40	8.55	1.90
16	8.80	10.15	17.80	17.90	16.60	22.35	17.00	10.40	8.85	6.00	8.25	2.00
17	8.40	10.35	18.20	17.85	17.20	23.20	16.00	10.50	8.70	5.70	8.00	3.30
18	8.20	10.40	18.35	17.40	20.20	24.40	15.10	10.30	9.90	5.40	7.70	4.40
19	7.80	10.50	18.20	16.75	21.90	24.60	14.40	10.20	11.00	5.45	7.40	4.00
20	8.30	11.10	18.10	16.00	22.60	24.00	13.90	10.00	11.45	5.80	7.30	4.90
21	8.50	11.60	18.60	15.50	22.60	23.30	13.40	10.55	11.00	6.80	7.10	4.25
22	8.60	12.70	19.80	15.00	23.80	22.10	13.20	11.40	10.40	8.50	7.10	4.50
23	9.70	12.80	22.70	14.50	25.65	20.90	12.95	11.50	9.70	10.05	7.10	5.60
24	9.80	12.20	25.65	14.30	26.50	20.00	12.40	11.00	9.30	10.80	7.20	7.50
25	9.50	11.40	26.00	14.20	26.20	19.40	12.00	10.15	9.50	11.00	7.80	9.10
26	9.25	10.85	25.70	14.40	25.40	18.90	11.90	9.70	9.90	10.50	8.60	10.20
27	9.30	10.40	25.70	15.50	24.60	19.50	12.20	9.30	9.80	9.90	9.70	10.70
28	9.50	9.95	26.00	17.50	23.60	20.00	12.20	9.00	9.70	9.20	10.00	10.80
29	9.70	.....	25.30	17.60	22.45	21.50	12.20	8.70	9.30	9.30	9.40	10.50
30	9.25	.....	25.20	16.85	22.00	22.00	11.80	8.50	a 8.90	10.20	8.40	10.10
31	8.80	.....	25.50	.....	21.25	.....	12.25	8.40	.....	10.90	.....	9.70

a Changed less than one-half foot. b Reading changed one-half foot or more.

1899.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.00	5.00	15.50	14.30	25.00	22.80	20.30	14.70	9.10	7.10	6.50	7.30
2	7.90	5.60	16.35	14.40	25.00	22.70	20.30	14.50	9.15	7.00	6.20	7.20
3	7.00	6.00	15.70	14.20	25.00	23.10	20.40	14.50	9.15	6.90	6.20	7.10
4	6.30	6.50	15.00	13.70	24.50	a 23.50	20.80	14.40	9.00	6.80	6.40	6.90
5	6.10	6.60	14.50	13.60	23.30	23.70	21.40	14.10	8.80	6.70	6.70	6.85
6	6.10	7.00	14.00	14.00	22.00	23.80	21.80	13.90	8.70	6.60	6.80	6.80
7	5.80	7.30	13.80	14.60	21.10	23.85	22.05	13.90	8.50	6.50	7.00	6.70
8	5.85	7.35	13.60	14.85	20.60	23.50	22.30	13.50	8.35	6.40	7.20	6.60
9	6.25	7.40	13.00	14.65	20.10	22.90	22.40	13.20	8.30	6.25	7.40	6.55
10	6.10	7.30	12.50	14.65	20.10	22.70	22.40	13.60	8.25	6.10	7.55	6.50
11	5.80	7.60	12.50	14.70	20.70	22.60	22.40	14.90	8.30	6.00	7.70	6.50
12	5.80	7.70	12.70	14.80	21.20	22.60	22.80	15.80	8.40	5.95	7.85	6.50
13	5.80	7.60	12.80	15.90	21.80	23.00	22.90	15.80	8.50	5.90	8.00	6.50
14	6.90	7.60	12.80	17.10	22.00	24.10	22.50	15.50	8.50	5.90	8.10	6.50
15	7.50	7.80	13.20	16.80	22.00	24.30	22.00	15.30	8.40	5.80	8.20	6.50
16	7.10	8.00	14.30	16.15	21.80	23.80	21.40	15.00	8.30	5.75	8.20	6.50
17	7.10	8.30	16.10	15.80	21.20	22.60	20.90	14.20	8.20	5.80	8.15	6.50
18	7.25	8.50	17.00	15.70	20.50	22.30	20.40	13.50	8.20	5.80	8.10	6.10
19	7.25	8.60	17.60	15.70	19.90	22.30	20.10	13.00	8.20	5.85	8.10	6.00
20	7.10	9.00	18.30	15.75	19.50	22.20	20.00	12.50	8.40	5.90	8.10	6.10
21	6.95	6.90	19.40	16.35	19.10	22.05	19.70	12.10	8.40	5.80	8.10	6.70
22	6.95	6.30	20.00	17.30	19.70	21.80	19.30	11.80	a 8.20	5.75	7.90	6.70
23	6.90	5.50	20.00	18.30	20.70	21.40	18.70	11.40	8.00	5.65	8.10	6.50
24	6.80	4.65	19.50	21.30	22.30	20.75	18.00	10.90	7.90	5.60	8.25	6.10
25	6.80	3.90	18.90	23.50	23.40	20.10	17.60	10.55	7.70	5.50	8.40	5.50
26	6.80	7.90	18.20	24.70	24.20	19.70	17.10	10.20	7.60	5.50	8.40	5.00
27	6.60	9.00	17.40	25.30	24.70	19.50	16.50	9.90	7.50	5.50	8.10	4.50
28	6.60	12.40	16.60	25.40	24.50	19.60	16.00	9.80	a 7.40	5.70	7.70	4.00
29	6.30	.....	15.80	25.00	24.00	19.80	15.50	9.60	a 7.30	5.85	7.50	3.50
30	5.80	.....	15.20	24.80	23.40	20.10	15.30	9.40	7.20	6.30	7.40	3.00
31	5.00	.....	14.50	.....	22.90	.....	14.80	9.20	.....	6.60	.....	2.60

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.—Continued.

1900.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.80	4.50	8.70	14.20	16.40	a 14.30	13.20	12.35	10.30	10.40	13.10	11.75
2	1.50	3.80	8.30	14.10	15.90	13.80	12.80	12.00	10.60	10.90	13.10	11.10
3	2.10	.....	8.20	14.50	15.60	13.70	12.70	11.60	b 10.70	11.30	12.50	10.45
4	2.60	6.00	8.20	14.60	15.70	13.70	12.60	11.20	10.80	12.30	12.20	9.55
5	3.00	3.80	8.40	14.60	15.80	13.50	12.60	10.85	10.80	13.20	12.20	9.50
6	3.50	3.40	9.70	14.80	15.70	13.30	12.60	10.45	10.80	13.30	12.40	9.10
7	5.00	3.00	12.80	15.20	16.00	12.95	12.50	10.00	10.90	13.00	12.75	8.80
8	5.35	3.60	17.40	15.80	16.40	12.60	12.20	9.50	10.65	12.70	13.50	8.50
9	4.50	5.50	18.70	16.40	16.70	12.45	11.80	9.00	10.00	12.90	14.00	8.30
10	4.70	7.50	19.10	16.50	16.70	12.40	11.50	8.60	9.60	13.20	13.80	8.05
11	4.90	9.00	19.70	16.40	16.50	12.30	11.40	8.30	9.05	13.20	13.50	7.95
12	5.10	9.30	20.90	16.00	16.30	11.90	11.20	8.00	8.70	12.50	13.20	7.80
13	5.10	8.90	21.60	16.20	16.00	11.75	11.20	7.60	8.40	11.80	13.00	7.60
14	4.90	8.70	22.50	16.90	16.60	11.90	11.20	7.30	8.10	11.30	12.80	7.40
15	4.90	8.50	23.00	18.00	16.60	13.60	11.00	7.00	7.85	11.00	12.70	7.15
16	4.90	8.00	23.20	18.30	15.80	14.00	10.70	6.80	7.70	10.80	12.40	6.80
17	4.75	7.80	23.30	17.80	15.10	14.30	10.70	6.70	7.50	10.60	12.20	6.70
18	4.80	7.60	23.00	16.80	14.50	13.50	10.90	6.55	7.40	10.55	12.20	6.50
19	5.00	7.45	22.40	16.00	14.45	12.80	10.80	6.55	7.30	10.55	12.40	6.20
20	6.00	7.25	21.40	15.50	14.50	12.50	10.50	7.45	7.20	10.65	12.50	5.90
21	8.00	7.25	20.30	15.00	14.50	12.40	10.50	8.70	7.30	10.80	12.50	5.70
22	8.80	7.80	19.40	16.00	b 14.40	12.70	10.50	9.60	7.40	11.15	12.60	5.50
23	8.40	9.30	18.70	16.30	14.40	13.90	11.10	9.90	7.90	11.40	12.80	5.30
24	7.70	10.10	18.30	16.70	14.40	15.00	12.20	10.10	8.30	11.85	13.10	5.20
25	7.40	10.80	17.80	16.90	14.40	15.70	13.30	10.00	8.40	12.20	12.90	5.10
26	7.20	10.50	17.20	17.30	14.00	15.60	14.00	10.05	8.50	12.50	12.90	5.00
27	7.20	9.90	16.80	17.60	13.70	15.40	14.00	9.95	8.70	12.70	12.90	4.95
28	7.10	9.20	16.40	17.60	13.50	15.00	13.80	9.90	8.80	12.75	12.80	5.00
29	6.90	.....	15.80	17.20	13.10	14.50	13.40	9.90	9.10	12.75	12.55	5.00
30	6.30	.....	15.20	16.80	13.30	13.70	13.00	9.75	9.80	12.80	12.30	4.85
31	5.50	.....	14.70	.....	13.80	.....	12.60	9.75	.....	12.90	.....	4.60

a Reading changed one-half foot or more. b Changed less than one-half foot.

1901.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.40	5.70	6.00	18.60	16.50	10.60	14.80	9.20	5.70	5.30	5.80	4.60
2	4.30	5.50	5.70	18.80	16.10	10.50	14.35	9.30	5.50	5.10	5.70	4.55
3	4.00	5.40	5.50	19.00	15.75	10.50	13.80	9.40	5.40	5.00	5.60	4.50
4	3.85	a 5.30	5.20	19.00	15.50	11.25	13.20	9.50	5.30	4.85	5.50	4.45
5	3.50	5.50	5.10	19.20	15.10	12.50	12.70	9.40	5.20	4.75	5.50	4.35
6	3.30	5.40	5.60	19.50	14.90	12.85	12.20	9.20	a 5.10	4.70	5.40	4.25
7	3.00	5.30	6.10	19.70	14.60	13.05	11.80	9.00	5.00	4.80	5.10	4.20
8	2.80	5.30	6.40	19.90	14.30	13.30	11.50	8.65	4.85	4.85	5.05	4.15
9	2.80	4.80	7.00	20.20	14.00	13.60	11.40	8.30	4.80	4.90	5.05	4.15
10	3.20	a 4.20	8.40	20.75	13.90	13.70	11.50	8.05	4.70	5.00	5.00	4.30
11	3.70	3.50	10.90	21.70	13.60	13.50	12.00	7.90	4.70	5.10	5.00	4.25
12	4.20	3.50	14.50	22.10	13.30	13.25	12.40	7.75	4.70	5.30	5.10	4.10
13	5.50	3.90	17.20	22.30	13.15	13.10	11.90	7.60	4.70	5.30	5.25	4.10
14	6.20	4.00	18.00	22.60	13.00	13.10	11.50	7.50	4.60	5.30	5.25	4.70
15	6.50	4.00	18.00	22.50	12.80	13.40	11.20	7.40	4.50	5.30	5.10	4.70
16	6.90	4.10	17.80	22.50	12.50	14.00	11.10	7.30	4.45	5.20	5.05	4.10
17	6.70	4.20	17.50	22.30	12.30	14.40	11.00	7.20	4.40	5.15	5.05	3.90
18	a 6.60	4.30	17.30	23.00	12.10	14.20	10.95	7.10	4.30	5.20	5.05	3.10
19	6.80	4.40	17.20	23.50	11.90	13.80	10.95	7.00	4.40	5.50	5.00	6.40
20	6.70	4.60	17.00	23.30	11.80	13.30	10.95	6.90	4.50	5.60	4.95	4.50
21	6.55	4.90	16.90	22.50	11.50	13.15	11.10	6.80	4.90	5.80	4.90	4.00
22	6.30	4.80	16.90	21.60	11.20	13.10	11.40	6.70	5.80	5.90	4.90	4.00
23	6.20	a 4.50	17.00	20.80	11.00	13.10	11.50	6.70	6.00	5.90	4.90	4.00
24	6.30	4.30	18.40	20.20	10.90	13.60	11.10	6.60	6.60	5.90	4.90	5.10
25	6.25	a 4.45	18.90	19.50	10.70	14.30	10.70	6.50	6.30	5.80	4.90	6.10
26	6.25	4.80	19.30	18.80	10.50	14.70	10.50	6.40	6.00	5.70	4.90	6.40
27	6.05	5.50	19.40	18.20	10.90	14.00	10.00	6.20	5.70	5.65	4.85	3.50
28	6.00	6.10	19.25	17.70	11.40	15.20	9.80	6.10	5.50	5.65	4.75	3.20
29	5.90	.....	19.00	17.30	11.30	15.40	9.60	6.00	5.40	5.65	4.70	3.60
30	5.80	.....	18.85	16.85	11.00	15.40	9.40	5.90	5.40	5.65	4.65	3.40
31	5.80	.....	18.50	.....	10.80	.....	9.20	5.85	.....	5.70	.....	3.20

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo--Cont'd.

RED ROCK, MO.—Continued.

1902.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	a 0.90	5.70	11.40	9.50	18.00	21.70	23.00	20.20	15.70	11.80	14.20
2	3.30	a .40	6.20	12.00	9.30	17.60	22.95	22.10	19.75	15.80	11.40	14.30
3	3.25	a .40	6.90	12.45	9.40	17.60	24.70	21.35	19.10	15.65	11.10	14.15
4	a 3.25	a .30	6.90	12.60	11.00	18.80	24.60	20.50	18.80	16.00	10.80	13.80
5	2.40	a .60	8.00	12.50	11.80	19.40	24.10	19.80	19.10	16.60	10.55	13.50
6	2.20	a .00	7.90	12.35	11.30	19.20	23.70	19.40	19.50	17.15	10.40	13.60
7	2.20	a .50	7.60	12.40	10.90	19.00	22.90	19.00	19.00	17.70	10.55	13.70
8	2.60	a .80	7.60	13.00	10.10	18.60	22.50	18.80	18.20	18.50	11.10	13.80
9	3.10	a 1.70	8.20	13.00	9.40	17.90	21.90	18.60	17.15	19.50	11.25	13.90
10	3.40	a 1.50	9.30	12.40	8.90	17.60	21.80	18.20	16.10	20.10	11.70	13.60
11	3.60	1.50	10.10	11.80	9.20	17.90	21.70	17.80	15.40	19.80	12.30	13.10
12	3.50	1.30	10.15	11.30	10.35	18.70	21.20	17.20	14.80	19.00	12.50	12.20
13	3.40	1.90	10.00	11.10	11.20	19.40	21.20	16.80	14.30	18.10	12.30	11.90
14	3.10	1.90	10.70	10.70	11.70	19.40	21.90	16.50	13.80	17.35	11.30	12.30
15	2.60	2.10	11.90	10.40	12.10	19.85	23.10	16.40	13.15	16.40	11.40	12.50
16	2.30	2.00	12.65	10.10	12.10	20.50	24.05	16.00	12.60	15.70	11.10	12.60
17	2.50	2.00	13.65	9.90	12.00	20.55	24.60	15.40	12.00	15.15	10.90	12.00
18	2.90	2.60	13.90	9.70	11.90	20.30	25.00	15.10	12.00	14.90	10.85	11.30
19	3.10	2.60	13.60	9.50	11.90	19.90	25.40	15.20	11.40	14.90	11.10	11.10
20	3.10	2.60	13.60	9.55	12.20	19.70	25.70	15.35	10.90	15.00	11.90	11.30
21	3.20	2.60	12.30	9.40	12.50	19.50	25.55	15.70	10.60	15.30	12.90	11.90
22	3.20	2.80	11.50	8.90	12.50	19.00	25.40	16.90	10.10	15.50	13.70	12.30
23	3.20	2.80	10.80	8.55	12.10	18.50	25.40	17.00	9.75	16.00	13.60	12.95
24	3.20	2.80	9.90	8.80	12.00	18.30	25.60	17.85	9.50	16.30	13.50	13.40
25	3.10	2.80	9.70	9.85	12.80	18.30	26.00	17.90	9.50	16.25	13.40	14.00
26	3.10	2.90	9.50	9.80	13.65	18.20	26.15	17.95	10.15	16.10	13.20	14.50
27	3.00	3.15	9.60	9.20	14.00	18.20	26.15	18.30	12.00	15.80	13.20	14.50
28	2.60	6.40	9.90	8.80	14.75	18.50	26.00	18.70	13.10	15.00	13.40	14.20
29	1.70	.....	11.50	8.90	16.50	19.60	25.40	19.20	13.80	13.85	13.60	13.65
30	1.00	.....	11.75	8.90	18.10	21.20	24.50	19.90	14.80	12.90	13.80	13.05
31	a .10	.....	11.50	.....	18.20	.....	23.60	20.30	.....	12.20	.....	12.20

a Doubtful on account of ice.

1903.

[Gauge 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.20	11.80	14.75	20.50	19.00	25.30	21.00	17.70	17.20	17.15	15.70	8.30
2	10.30	11.70	16.20	20.20	18.60	27.40	21.00	17.00	17.80	17.20	15.60	8.10
3	10.00	11.30	16.40	19.80	18.20	29.30	20.70	16.50	19.30	17.20	15.40	7.90
4	10.00	11.50	16.70	19.50	18.00	30.70	20.00	16.20	19.80	17.20	15.30	7.55
5	10.10	13.00	17.80	19.50	17.60	31.90	19.20	16.40	19.70	17.40	15.10	7.30
6	10.40	15.80	18.50	20.50	17.20	33.20	18.50	15.70	19.40	17.60	15.00	7.00
7	10.70	16.50	19.00	21.50	17.00	34.40	18.00	15.30	18.70	18.00	14.90	6.80
8	10.50	15.70	20.50	22.20	16.85	35.60	17.50	16.10	18.00	18.30	15.20	6.70
9	10.60	14.95	23.00	22.30	16.70	36.40	17.40	16.90	17.70	18.80	15.50	6.60
10	10.30	14.15	25.20	21.90	16.70	36.90	17.50	17.00	17.60	20.00	15.50	6.40
11	9.80	13.40	26.20	21.40	16.80	37.00	17.50	17.10	17.20	21.20	15.30	6.10
12	9.20	12.80	26.50	21.40	16.70	38.30	17.40	17.30	17.30	21.70	15.00	5.80
13	8.40	12.65	26.00	22.80	16.50	38.60	17.10	17.10	18.50	21.55	14.60	5.60
14	a 8.00	13.00	25.40	23.60	16.35	38.60	16.60	17.40	19.90	21.20	14.20	b 5.40
15	a 7.60	13.45	25.20	24.00	16.10	38.20	16.50	17.25	20.40	20.90	13.75	b 3.90
16	a 7.10	c 13.70	25.30	24.30	15.80	37.30	16.80	17.60	20.40	20.50	13.40	b 3.20
17	a 7.10	13.20	25.10	24.30	16.00	36.00	c 17.30	17.70	21.00	19.85	13.00	b 2.95
18	a 7.20	12.40	24.50	24.20	17.40	34.30	18.50	17.30	21.10	19.20	d 12.80	b 2.40
19	a 7.80	11.60	24.40	24.00	19.30	32.50	19.30	17.50	20.50	18.70	12.50	b 2.50
20	a 8.30	11.80	24.40	24.40	20.50	30.40	19.70	17.70	20.50	18.30	12.20	b 3.70
21	8.65	10.50	24.40	23.80	20.80	28.70	19.30	17.80	20.40	17.80	11.80	b 4.00
22	8.80	10.20	25.00	23.50	20.50	27.50	18.80	17.90	19.80	17.40	d 11.50	b 4.55
23	8.60	10.30	25.30	23.50	20.10	26.70	18.70	17.80	19.00	17.00	11.30	b 4.90
24	8.60	10.30	24.90	23.10	19.80	25.80	18.90	17.30	18.20	16.70	11.00	5.30
25	8.40	10.40	24.60	22.60	19.75	25.10	19.00	16.65	17.60	16.50	10.80	5.65
26	8.40	10.60	24.30	21.95	20.25	24.70	19.30	16.30	17.10	16.40	10.50	6.20
27	8.10	11.10	23.70	21.40	21.90	24.30	20.20	16.10	16.75	16.20	10.10	6.30
28	8.50	12.20	23.20	20.50	23.50	23.40	20.10	15.80	16.70	16.10	9.70	6.10
29	10.40	.....	22.60	19.90	24.00	22.30	19.60	15.80	16.90	16.00	8.90	6.10
30	11.70	.....	21.80	19.50	24.00	21.60	18.90	16.00	17.00	15.90	8.60	6.30
31	11.80	.....	21.30	.....	24.30	.....	18.40	16.70	.....	15.80	.....	6.60

a Interpolated—no reading.
b Doubtful on account of ice.
c Reading changed one-half foot or more.
d Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.—Continued.

1904.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 7.00	11.20	10.40	27.60	35.20	21.30	23.20	14.90	10.95	13.10	11.55	7.75
2	7.40	10.50	10.00	27.30	34.80	23.00	23.30	14.60	10.45	13.35	11.50	7.60
3	7.20	9.50	9.60	27.00	34.40	25.00	22 60	14.05	10.05	13.00	11.45	7.50
4	7.00	9.20	9.10	26.50	33 80	25.00	22.10	13.75	9.90	12.80	11.35	7.40
5	6.60	10.40	9.30	25.80	32.90	23.70	21.80	13.55	9.90	12.30	11.20	7.30
6	6.10	9.30	9.50	25.10	31.70	25.70	21.60	13 35	10.05	11.70	11.10	7.20
7	6.00	9.50	10.30	24.40	30.30	27.50	21.10	13.00	10.05	11.20	11.00	7.05
8	6.10	10.20	10.70	23.00	28.90	28.40	20.50	12.70	9.80	11.00	10.85	6.80
9	6.15	10.40	10.90	22.30	27.70	28.50	21.20	12 20	9.50	10.75	10.70	6.60
10	5.90	10.60	11.40	22.20	27.20	27.80	23.00	11.65	9.50	10.45	10.70	6.50
11	5.80	11.10	11.80	23.10	26.90	26.90	25.40	11.50	9.60	10.20	10.55	6.50
12	5.80	11.55	12.20	23.40	26.20	26.10	26.80	11.10	9.70	10.05	10.50	6.50
13	5.80	11.90	12.90	23.75	25.50	25.30	27.35	10.75	9.60	10.00	10.40	6.30
14	5.75	12.10	13.10	23.70	24.00	a 24.60	27.30	10.55	9.55	9.80	10.30	6.10
15	5.75	12.40	13.00	23.60	23.10	a 24.20	26.60	11.20	9.50	9.70	10.20	5.50
16	6.20	12.60	12.90	23.40	22.30	b 24.30	25.35	10 65	9.35	9.60	10.00	5.00
17	6.30	12.30	12.80	23.30	21.70	a 24.80	23.10	10.85	9.25	9.50	9.90	5.00
18	6.30	11.60	13.00	23.30	21.30	24.90	21.85	11.10	9.20	9.40	9.75	4.60
19	6.60	11.10	13.40	24.20	21.40	25.50	21.30	11.15	10.35	9.30	9.60	4.00
20	6.90	10.70	13.80	25.40	21.80	25.00	21.15	11.30	11.70	9.30	9.40	3.60
21	7.00	10.80	13.90	25.10	21.70	24.80	20.80	12.30	12.50	9.30	9.30	3.50
22	8.20	10.80	14.00	24.00	21.20	25.00	20.30	13.20	13.20	9.20	9.10	3.40
23	11.90	10.80	14.30	24.20	20.70	25.10	19.20	13.20	12.20	9.30	8.90	3.30
24	15.10	10.45	15.70	25.40	20.20	24.70	18.60	13.55	11.50	9.40	8.70	3.30
25	16.50	10.40	17.30	27.50	19.50	23.50	18.30	13.95	12.20	9.50	8.60	3.60
26	16.20	10.50	22.90	30.30	19.20	22.60	18.20	13.75	11.80	9.70	8.40	3.90
27	15.70	10.60	22.40	c 32.40	18.80	21.70	18.00	13.95	12.20	9.95	8.20	4.40
28	15.20	10.85	23.10	c 33.80	18.60	21.40	17.30	13.85	12.80	10.20	8.10	4.80
29	14.20	10.70	26.50	c 34.70	18.90	21.40	16.50	13.10	12.90	10.50	7.90	4.80
30	13.30	.....	27.60	35.20	18.90	22.20	15.90	12.20	12.80	10.90	7.80	3.20
31	12.20	.....	27.90	.....	19.60	.....	15.30	11.50	.....	11.30	.....	3.00

a Reading changed one-half foot or more. b Changed less than one-half foot. c Interpolated—no reading.

1905.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.00	8.30	17.80	18.00	18.60	19.30	22.30	19.70	13.90	16.50	14.30	11.50
2	3.00	8.50	19.10	18.60	18.70	19.00	22.50	20.50	13.20	15.70	13.90	12.20
3	3.10	8.80	19.40	19.10	18.10	18.80	22.70	21.10	13.10	15.00	13.70	12.30
4	4.20	8.20	19.40	18.90	17.40	18.90	22.80	21.60	12.60	14.50	a 13.70	12.10
5	5.00	7.70	19.40	18.70	16.90	19.30	23.20	21.30	12.20	14.00	13.80	11.90
6	5.00	8.00	20.10	18.40	16.80	20.00	24.00	20.50	11.90	13.70	14.20	11.50
7	5.00	8.10	19.60	18.00	15.90	20.30	b 24.30	19.70	11.80	13.30	14.70	11.10
8	5.00	8.20	19.40	17.30	14.90	20.10	b 24.60	18.90	11.80	12.80	15.10	10.60
9	4.80	8.05	19.20	16.80	14.30	19.60	b 24.40	18.10	11.80	12.40	15.20	10.00
10	4.60	7.80	18.80	16.30	13.70	19.00	b 24.40	17.50	11.75	12.00	14.90	9.30
11	c 5.50	7.65	18.50	15.90	13.40	18.60	b 24.20	17.10	11.70	11.70	14.60	8.70
12	4.30	7.30	18.30	15.70	13.50	18.30	b 24.00	16.80	11.75	11.50	14.40	8.30
13	3.60	8.20	17.80	15.50	13.80	18.60	b 24.30	16.20	12.50	11.30	14.30	8.10
14	3.60	8.10	17.20	15.40	13.90	19.40	b 24.90	15.70	13.40	11.00	14.30	8.00
15	4.00	8.00	16.40	15.30	14.60	20.20	b 25.50	15.50	13.10	10.80	14.10	8.10
16	3.40	7.90	15.40	15.10	15.90	20.70	b 25.70	14.90	12.50	10.60	13.50	8.15
17	2.70	7.90	14.80	15.30	17.90	20.80	b 25.00	14.40	14.20	10.30	12.90	8.10
18	2.00	7.80	14.50	15.40	19.30	20.60	b 24.10	14.00	17.50	10.30	12.40	8.10
19	2.60	7.80	14.30	15.30	19.90	20.20	23.10	13.80	b 24.10	12.80	12.00	8.05
20	4.40	7.70	14.00	15.10	20.30	19.80	21.80	13.90	b 26.90	18.00	12.00	8.15
21	5.70	7.60	13.80	14.90	21.10	20.40	23.10	14.35	b 28.90	17.30	12.10	8.40
22	c 7.70	7.75	13.60	14.70	20.70	20.70	22.00	14.60	b 29.60	16.20	12.40	8.40
23	c 7.70	8.50	14.00	14.50	19.90	20.50	20.50	15.00	b 29.70	16.00	12.20	8.40
24	c 7.45	9.00	14.80	14.60	19.40	20.20	20.00	16.20	b 28.60	15.90	11.60	8.40
25	c 7.45	10.00	15.50	15.00	19.00	20.35	19.80	18.30	b 26.60	15.70	11.20	8.40
26	c 8.00	10.40	15.90	15.60	18.60	20.80	20.10	18.60	24.00	15.90	11.00	8.25
27	c 7.50	11.20	16.20	16.20	18.40	21.30	20.60	18.10	22.40	16.50	10.90	8.10
28	6.70	15.40	16.50	16.90	18.30	21.40	20.20	17.80	20.60	17.10	10.80	7.95
29	7.50	.....	17.00	17.60	18.50	21.50	19.30	17.20	18.90	16.30	10.70	8.10
30	8.00	.....	17.60	18.00	18.80	21.75	18.60	16.20	17.50	15.50	10.90	8.70
31	8.40	.....	17.90	.....	19.40	.....	18.60	14.90	.....	14.90	.....	9.00

a Changed less than one-half foot. b Reading changed one-half foot or more. c Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.—Continued.

1906.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.30	15.40	21.50	26.90	20.90	14.70	19.40	12.60	a 12.40	13.55	8.20	11.20
2	9.50	15.80	22.40	26.60	20.80	15.20	19.20	12.30	12.00	13.60	8.50	11.10
3	9.80	15.90	23.00	26.30	20.70	15.90	19.30	12.20	11.60	13.95	8.95	11.20
4	10.70	15.50	23.00	25.80	20.70	16.30	19.40	12.40	11.50	14.05	9.25	11.40
5	11.70	14.60	22.10	25.40	20.70	16.90	19.30	12.30	11.30	13.90	9.40	11.50
6	15.30	13.80	21.20	25.50	20.50	17.20	19.00	12.00	11.00	13.50	9.50	11.80
7	16.60	13.20	20.40	25.30	20.60	17.30	18.70	11.90	10.90	12.70	9.50	12.10
8	16.20	12.50	19.80	25.00	21.40	17.90	18.40	12.60	10.80	12.10	9.60	12.40
9	15.20	11.60	19.50	25.30	21.60	18.80	18.00	12.60	10.80	11.70	9.75	12.40
10	14.10	11.00	19.40	25.40	21.00	19.10	17.70	12.30	10.80	11.30	9.80	12.20
11	13.00	10.60	19.20	25.30	20.20	19.40	17.10	12.45	10.80	11.00	9.90	11.90
12	11.70	10.20	18.90	25.00	19.60	19.40	16.70	12.70	10.80	10.70	10.00	11.60
13	10.85	10.00	18.60	24.60	19.00	19.10	16.30	12.80	11.00	10.40	10.05	11.40
14	10.30	10.00	18.30	25.10	18.50	18.70	16.20	13.20	10.80	10.20	10.05	11.20
15	9.90	10.50	17.90	26.20	18.10	18.50	15.80	13.80	10.75	10.10	10.05	11.50
16	9.70	10.50	17.30	26.70	17.70	18.40	15.50	14.20	10.65	9.90	10.10	11.20
17	9.70	10.50	16.80	26.30	17.00	18.10	15.35	14.20	10.50	9.75	10.20	10.80
18	9.50	10.50	16.10	25.70	16.50	17.90	15.00	13.85	10.50	9.65	10.40	10.50
19	9.25	10.60	15.80	25.40	16.00	17.80	14.85	13.40	10.45	9.50	10.40	10.10
20	9.40	10.80	15.10	25.10	15.70	17.90	14.60	13.00	10.60	9.25	10.50	9.50
21	9.70	11.10	14.50	23.90	15.40	18.30	14.10	13.00	10.80	9.15	11.80	9.05
22	13.40	11.50	14.30	23.50	15.10	19.00	13.90	13.20	10.75	9.10	13.30	8.90
23	13.80	11.70	13.90	23.10	14.80	19.70	13.80	12.90	10.70	9.00	12.90	8.60
24	14.30	12.70	13.80	22.70	14.70	20.30	13.80	12.60	10.70	8.90	12.60	8.30
25	15.40	15.40	13.80	22.30	14.50	20.70	14.20	12.20	11.20	8.80	12.20	7.55
26	15.60	17.60	14.40	22.00	14.40	20.70	15.00	11.85	12.10	8.60	11.90	7.00
27	15.20	19.60	16.30	21.80	14.30	19.90	15.35	12.10	12.60	8.50	11.60	6.65
28	15.10	20.70	19.70	21.40	14.20	19.20	a 14.70	13.50	12.80	8.30	11.40	6.30
29	14.90	.....	22.50	21.30	14.20	19.20	14.20	14.20	13.20	8.20	11.40	6.10
30	14.85	.....	24.10	21.00	14.30	19.40	13.60	13.70	13.60	8.20	11.30	6.40
31	15.00	.....	a 25.50	.....	14.20	.....	13.00	12.90	.....	8.20	.....	7.70

a Reading changed one-half foot or more.

1907.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge, 335.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.0	18.5	16.1	16.8	18.3	16.6	23.5	a 25.8	15.2	11.4	9.6	8.8
2	8.3	18.1	16.0	17.4	19.0	16.8	23.0	a 25.2	15.0	11.35	9.7	8.8
3	10.5	17.5	15.8	17.75	19.4	17.2	22.4	23.9	14.9	11.5	9.6	8.7
4	11.4	16.8	15.5	17.75	19.4	a 17.9	22.0	22.7	14.8	11.8	9.5	8.6
5	11.6	15.7	15.2	17.5	19.2	19.9	21.2	21.8	14.8	12.4	9.4	8.5
6	11.8	15.0	15.0	17.4	18.9	21.4	20.5	b 21.1	14.7	12.7	9.4	8.4
7	12.4	14.0	14.9	17.4	18.6	21.7	19.9	20.6	14.6	13.0	9.3	8.3
8	12.7	12.9	14.8	17.2	18.6	21.6	19.9	20.3	14.5	13.1	9.25	8.2
9	12.9	11.7	14.6	17.1	19.55	21.0	20.1	20.1	14.3	13.15	9.25	8.1
10	12.7	11.1	14.2	17.1	20.3	20.9	20.2	20.0	13.8	13.45	9.2	8.0
11	12.65	10.7	14.0	17.3	20.6	21.1	20.2	19.8	13.4	13.7	9.1	8.1
12	12.55	10.5	14.2	17.3	20.1	21.3	20.2	19.3	13.0	13.8	9.05	7.9
13	12.3	10.8	16.0	17.7	19.2	22.3	20.2	18.8	12.6	13.9	8.95	7.8
14	12.4	11.3	17.9	18.6	18.2	23.1	20.3	18.5	12.3	13.75	8.8	7.8
15	12.9	12.1	19.2	19.0	18.2	23.45	20.9	18.2	12.1	13.4	8.75	7.8
16	13.6	13.0	19.6	18.8	18.2	23.5	21.3	17.8	11.9	13.0	8.75	7.8
17	14.1	13.0	18.9	18.6	20.0	24.0	21.6	17.8	11.7	12.6	8.7	7.85
18	15.3	12.8	18.4	18.6	21.4	23.2	22.4	17.4	11.5	12.3	8.7	8.0
19	18.3	13.1	18.2	18.6	21.7	22.5	23.6	17.2	11.2	12.0	8.7	8.05
20	20.4	13.5	17.9	19.0	20.9	21.7	24.3	17.7	11.0	11.7	8.7	8.1
21	23.7	13.35	18.0	19.5	19.9	21.2	a 24.8	18.4	10.8	11.4	8.85	8.1
22	a 25.8	13.0	18.2	20.0	19.2	20.9	a 25.3	18.5	10.6	11.2	8.9	7.9
23	a 26.4	13.1	17.6	20.2	a 17.9	20.6	a 25.8	19.0	10.4	11.0	8.85	8.0
24	a 26.6	13.7	16.9	20.1	17.1	20.5	a 26.4	19.1	10.6	10.75	8.8	8.4
25	a 26.3	14.7	16.4	20.3	16.5	21.2	a 27.0	18.7	10.8	10.55	8.75	8.4
26	a 25.1	15.6	16.1	20.2	15.9	22.6	a 27.3	18.5	11.0	10.4	8.7	8.3
27	a 23.8	16.1	15.9	19.8	15.3	23.2	a 27.2	18.6	11.1	10.3	8.65	8.3
28	22.4	16.1	15.8	19.3	15.2	24.0	a 26.8	17.4	11.2	10.2	8.75	8.35
29	21.0	.....	15.7	18.7	15.7	a 24.2	a 26.5	16.3	11.3	10.0	8.8	8.4
30	19.9	.....	15.8	18.2	15.9	23.9	a 26.1	15.5	11.4	9.8	8.8	8.4
31	19.1	.....	16.4	.....	15.8	.....	a 26.0	15.4	.....	9.7	.....	8.1

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

RED ROCK, MO.—Continued.

1908.

[Gauge, 89.20 miles from Eads Bridge. Zero of gauge 335.84 feet above Memphis datum plane. Gauge read at 8. a. m.]

[Gauge discontinued after Jan. 31, 1908.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	8.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	8.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	8.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	8.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	7.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
7	7.85	.....	.....	.....	.....	30.30	.....	.....	.....	.....	.....	.....
8	7.85	.....	.....	.....	.....	30.35	.....	.....	.....	.....	.....	.....
9	7.75	.....	.....	.....	.....	30.45	.....	.....	.....	.....	.....	.....
10	7.60	.....	.....	.....	.....	30.45	.....	.....	.....	.....	.....	.....
11	7.55	.....	.....	.....	.....	30.50	.....	.....	.....	.....	.....	.....
12	8.00	.....	.....	.....	.....	30.60	.....	.....	.....	.....	.....	.....
13	9.00	.....	.....	.....	.....	30.90	.....	.....	.....	.....	.....	.....
14	9.30	.....	.....	.....	.....	31.30	.....	.....	.....	.....	.....	.....
15	9.50	.....	.....	.....	.....	31.90	.....	.....	.....	.....	.....	.....
16	9.00	.....	.....	.....	.....	32.40	.....	.....	.....	.....	.....	.....
17	8.75	.....	.....	.....	.....	33.20	.....	.....	.....	.....	.....	.....
18	8.40	.....	.....	.....	.....	33.90	.....	.....	.....	.....	.....	.....
19	8.05	.....	.....	.....	.....	34.40	.....	.....	.....	.....	.....	.....
20	7.75	.....	.....	.....	.....	34.80	.....	.....	.....	.....	.....	.....
21	7.60	.....	.....	.....	.....	35.00	.....	.....	.....	.....	.....	.....
22	7.40	.....	.....	.....	.....	35.00	.....	.....	.....	.....	.....	.....
23	7.20	.....	.....	.....	.....	34.90	.....	.....	.....	.....	.....	.....
24	7.50	.....	.....	.....	.....	34.70	.....	.....	.....	.....	.....	.....
25	7.70	.....	.....	.....	.....	34.40	.....	.....	.....	.....	.....	.....
26	7.80	.....	.....	.....	.....	34.10	.....	.....	.....	.....	.....	.....
27	7.80	.....	.....	.....	.....	33.75	.....	.....	.....	.....	.....	.....
28	7.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	7.70	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	7.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	7.20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

GRAND TOWER, ILL.

1896.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 4 p. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	17.0	5.6	8.3	9.0	12.2	25.1	.....	.....	.....	.....	.....	.....
2	15.7	5.4	8.7	8.6	13.0	24.4	.....	.....	.....	.....	.....	.....
3	13.9	6.6	9.2	8.1	13.2	24.0	.....	.....	.....	.....	.....	.....
4	12.6	7.1	9.2	7.8	13.6	24.4	.....	.....	.....	.....	.....	.....
5	11.2	7.8	9.0	7.4	a 13.2	24.4	.....	.....	.....	.....	.....	.....
6	9.9	8.1	8.7	7.1	13.2	24.3	.....	.....	.....	.....	.....	.....
7	9.5	8.2	8.5	6.7	13.2	24.2	.....	.....	.....	.....	.....	.....
8	8.9	8.2	8.2	6.6	13.2	23.8	.....	.....	.....	.....	.....	.....
9	8.4	8.2	7.9	6.5	13.4	23.4	.....	.....	.....	.....	.....	.....
10	7.7	8.1	7.6	6.5	13.5	23.0	.....	.....	.....	.....	.....	.....
11	7.2	8.0	7.4	7.0	13.8	22.8	.....	.....	.....	.....	.....	.....
12	6.7	7.9	7.3	10.4	13.9	22.4	.....	.....	.....	.....	.....	.....
13	6.4	7.8	7.1	11.2	13.8	21.8	.....	.....	.....	.....	.....	.....
14	6.2	9.1	6.9	12.7	13.8	20.6	.....	.....	.....	.....	.....	.....
15	5.4	10.7	6.8	a 12.5	13.5	19.2	.....	.....	.....	.....	.....	.....
16	5.4	11.7	6.6	12.1	13.3	18.0	.....	.....	.....	.....	.....	.....
17	5.4	11.1	6.5	11.8	13.3	16.9	.....	.....	.....	.....	.....	.....
18	5.5	10.8	6.2	11.4	13.2	16.8	.....	.....	.....	.....	.....	.....
19	5.3	10.2	6.2	11.1	13.8	17.8	.....	.....	.....	.....	.....	.....
20	5.3	9.7	5.8	10.7	17.7	18.0	.....	.....	.....	.....	.....	.....
21	5.6	9.0	5.6	10.2	21.0	18.0	.....	.....	.....	.....	.....	.....
22	5.8	8.3	6.0	10.0	23.1	17.8	.....	.....	.....	.....	.....	.....
23	6.0	7.2	7.2	9.8	24.0	17.7	.....	.....	.....	.....	.....	.....
24	6.4	6.6	7.6	9.6	24.8	17.2	.....	.....	.....	.....	.....	.....
25	a 6.0	6.2	7.6	9.4	25.6	16.6	.....	.....	.....	.....	.....	.....
26	5.7	6.1	8.1	a 9.4	26.2	16.4	.....	.....	.....	.....	.....	.....
27	5.5	6.4	8.7	9.6	26.8	16.2	.....	.....	.....	.....	.....	.....
28	5.5	6.9	8.9	9.8	b 27.2	16.6	.....	.....	.....	.....	.....	.....
29	5.5	7.9	8.3	10.6	b 27.4	17.0	.....	.....	.....	.....	.....	.....
30	5.5	.....	8.6	11.4	b 26.9	17.2	.....	.....	.....	.....	.....	.....
31	5.5	.....	8.8	.....	26.0	.....	.....	.....	.....	.....	.....	.....

a Reading changed one-half foot or more. b Interpolated—no reading

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAND TOWER, ILL.—Continued.

1896.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 320.04 feet above Memphis datum plane. Gauge read at 6 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	16.90	14.10	9.60	8.60	5.40	6.80
2	.....	.....	.....	.....	.....	.....	a 16.80	13.70	9.20	8.10	5.40	6.70
3	.....	.....	.....	.....	.....	.....	16.80	13.50	8.90	7.80	5.40	6.60
4	.....	.....	.....	.....	.....	.....	17.00	13.70	8.50	7.50	5.70	6.60
5	.....	.....	.....	.....	.....	.....	17.10	13.90	8.20	7.20	6.50	6.60
6	.....	.....	.....	.....	.....	.....	17.30	14.20	8.00	a 7.00	7.10	6.60
7	.....	.....	.....	.....	.....	.....	17.40	14.30	7.80	6.90	8.20	6.30
8	.....	.....	.....	.....	.....	.....	16.90	14.30	7.50	a 6.80	9.00	6.00
9	.....	.....	.....	.....	.....	.....	16.60	14.00	7.20	6.60	9.20	5.70
10	.....	.....	.....	.....	.....	.....	16.70	13.70	7.10	6.50	8.90	5.50
11	.....	.....	.....	.....	.....	.....	16.80	13.50	6.90	6.60	8.50	5.30
12	.....	.....	.....	.....	.....	.....	16.20	13.00	6.80	6.60	8.10	5.20
13	.....	.....	.....	.....	.....	.....	15.40	12.60	6.60	6.60	7.90	5.20
14	.....	.....	.....	.....	.....	.....	15.00	12.30	6.50	6.60	7.70	5.30
15	.....	.....	.....	.....	.....	.....	14.60	12.10	6.40	6.60	7.50	5.40
16	.....	.....	.....	.....	.....	.....	13.80	11.60	6.70	6.70	7.30	5.50
17	.....	.....	.....	.....	.....	.....	13.20	11.40	6.80	6.90	7.20	5.80
18	.....	.....	.....	.....	.....	.....	12.90	10.90	6.90	7.00	7.20	6.10
19	.....	.....	.....	.....	.....	.....	.....	10.60	7.00	6.80	a 7.20	6.80
20	.....	.....	.....	.....	.....	.....	.....	10.30	7.40	6.60	7.20	7.30
21	.....	.....	.....	.....	.....	.....	.....	10.60	8.10	6.40	7.20	7.70
22	.....	.....	.....	.....	.....	.....	16.70	11.30	8.70	6.30	7.20	7.80
23	.....	.....	.....	.....	.....	.....	19.70	11.90	9.60	6.20	7.10	7.80
24	.....	.....	.....	.....	.....	.....	20.70	12.40	10.30	6.10	7.00	7.70
25	.....	.....	.....	.....	.....	.....	19.70	12.40	10.40	5.90	6.90	7.60
26	.....	.....	.....	.....	.....	.....	.....	11.90	10.00	5.80	6.80	7.60
27	.....	.....	.....	.....	.....	.....	18.60	11.60	9.70	5.60	6.90	7.40
28	.....	.....	.....	.....	.....	.....	17.60	11.40	9.50	5.60	7.00	7.20
29	.....	.....	.....	.....	.....	.....	16.60	10.90	9.20	5.60	7.00	7.00
30	.....	.....	.....	.....	.....	.....	15.60	10.40	8.90	5.50	6.80	6.90
31	.....	.....	.....	.....	.....	.....	14.90	10.00	.....	5.40	.....	6.80

a Changed less than one-half foot.

1897.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.70	7.30	a 14.20	23.40	27.00	15.50	20.10	13.90	8.40	5.90	5.10	5.40
2	6.70	6.80	13.40	25.10	27.60	14.90	20.00	13.50	8.20	5.90	5.20	5.30
3	6.90	6.50	13.50	26.50	27.90	14.40	19.70	13.20	7.90	5.90	5.20	5.20
4	9.10	6.50	13.40	27.60	28.00	14.70	19.90	13.00	7.70	5.80	5.20	5.00
5	19.60	6.80	15.20	27.70	27.70	15.00	20.30	12.70	7.50	5.80	5.20	4.80
6	22.50	7.50	18.60	27.60	27.30	15.60	20.10	12.50	7.40	5.70	5.10	4.30
7	24.10	8.10	22.00	27.40	26.50	16.00	19.30	12.30	7.30	5.70	5.20	4.00
8	24.30	8.30	23.30	27.50	25.60	16.20	19.00	12.10	7.20	5.60	5.30	3.60
9	22.90	8.70	23.40	28.00	24.60	16.30	18.80	11.90	7.20	5.50	5.70	3.20
10	20.50	9.20	23.30	28.10	23.70	16.20	18.90	12.10	7.20	5.50	5.60	2.90
11	18.10	10.10	22.60	28.50	22.80	16.00	18.60	12.20	7.10	5.40	5.80	3.00
12	15.70	11.00	22.00	28.70	22.50	15.80	17.60	11.80	7.00	5.40	5.80	3.00
13	13.60	11.40	21.30	28.70	21.50	15.50	17.00	11.60	6.90	5.40	5.80	3.00
14	12.50	11.30	21.00	28.10	20.70	15.20	16.30	11.40	6.70	5.30	5.80	3.30
15	11.50	12.20	b 20.40	27.60	20.00	14.80	15.60	11.30	6.60	5.20	5.80	3.50
16	10.90	12.30	19.60	26.90	19.30	14.40	14.90	11.20	6.50	5.20	5.80	3.70
17	10.60	12.80	19.10	26.30	18.80	14.30	14.50	11.20	6.50	5.20	5.80	3.80
18	10.50	13.00	19.50	25.90	18.20	14.30	14.10	11.10	6.20	5.10	5.90	4.10
19	10.60	12.70	20.50	25.80	17.60	14.50	14.00	11.00	6.10	5.10	5.70	4.00
20	11.80	12.40	20.00	25.50	17.10	a 14.70	14.30	10.80	6.00	5.10	5.50	3.60
21	13.40	12.10	19.70	25.20	16.60	14.40	14.20	10.70	6.00	5.10	5.40	2.90
22	13.80	12.60	20.50	25.40	16.10	14.70	13.90	10.60	6.00	5.10	5.30	2.80
23	14.20	13.50	20.70	25.60	15.80	15.40	13.20	10.40	5.90	5.00	5.30	2.80
24	14.30	14.60	20.80	25.70	15.50	15.50	12.90	10.20	5.90	5.00	5.30	2.60
25	a 14.00	15.50	21.00	25.70	15.20	16.60	12.80	10.10	5.90	4.90	5.30	2.20
26	13.40	15.60	21.10	25.70	15.10	16.20	13.40	9.90	6.10	4.90	5.40	2.30
27	12.50	15.30	21.90	25.10	15.40	17.00	15.00	9.60	6.20	4.90	5.40	2.30
28	11.20	14.90	22.90	25.00	15.60	17.30	b 16.30	9.30	6.20	5.00	5.40	2.60
29	10.30	.....	23.30	25.50	15.60	17.50	16.50	9.10	6.10	5.00	5.40	3.20
30	9.40	.....	23.20	26.20	15.60	18.90	15.80	8.80	6.00	5.00	5.40	3.80
31	8.20	.....	22.80	.....	15.80	.....	14.70	8.60	.....	5.00	.....	4.20

a Changed less than one-half foot. b Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAND TOWER, ILL.—Continued.

1898.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.9	8.3	9.3	24.4	15.5	19.6	a 21.1	12.4	7.9	8.2	10.2	7.4
2	4.0	7.9	9.1	23.8	15.0	18.9	21.2	12.2	7.6	8.0	9.8	6.8
3	4.0	7.4	8.9	22.7	15.1	18.7	21.1	12.3	7.3	7.5	9.0	6.1
4	4.1	6.7	8.7	21.5	16.4	19.0	20.5	13.1	7.0	7.1	8.4	5.9
5	3.8	5.8	8.5	20.8	18.8	19.5	19.8	13.5	6.9	6.9	7.9	5.6
6	3.9	5.8	8.4	19.9	20.0	19.8	19.0	12.9	6.8	6.8	7.5	5.3
7	4.1	5.5	8.2	19.5	20.7	20.0	18.7	12.2	6.7	6.6	7.3	5.0
8	4.4	5.4	8.1	19.5	20.5	19.6	19.3	12.1	6.6	6.3	7.3	4.9
9	4.9	5.5	8.0	19.1	20.0	18.8	21.1	12.2	6.7	6.1	7.7	4.8
10	5.2	5.8	7.9	a 18.9	19.7	18.3	21.0	11.5	7.2	5.9	7.8	4.6
11	5.7	6.5	7.9	18.7	19.0	18.2	20.8	11.3	7.9	5.8	7.9	4.0
12	6.5	6.5	8.5	18.0	a 18.4	18.7	20.4	10.8	8.9	5.7	8.3	3.4
13	7.5	6.7	b 11.0	17.5	17.7	19.7	19.6	10.3	9.5	5.8	8.5	3.3
14	8.2	8.0	12.2	17.0	16.9	20.6	18.5	10.0	9.3	6.3	8.5	2.9
15	8.9	9.4	15.9	16.9	16.8	21.1	17.5	10.2	9.0	6.3	8.2	3.0
16	8.8	9.8	17.6	17.0	16.2	21.3	16.6	10.1	8.6	6.0	8.0	2.7
17	8.4	10.0	17.9	17.0	16.5	22.0	15.7	10.2	8.4	5.7	7.7	3.2
18	8.2	10.1	18.0	16.5	18.9	23.0	14.8	10.0	9.3	5.4	7.4	4.2
19	7.8	10.2	18.0	16.0	20.8	23.3	14.0	9.8	10.4	5.3	7.1	4.5
20	8.2	10.7	18.0	15.3	21.4	22.9	13.6	9.7	11.0	5.6	7.0	5.6
21	8.6	11.3	18.4	14.8	21.7	22.2	12.9	10.0	10.6	6.4	6.8	4.7
22	8.6	12.2	19.3	14.4	22.4	21.1	12.7	10.8	10.1	7.9	6.8	4.9
23	9.7	12.5	21.8	13.9	24.2	20.0	12.5	11.1	9.4	9.5	6.8	5.5
24	9.8	12.0	24.7	13.7	25.0	19.2	12.0	10.6	8.9	10.3	6.9	7.1
25	9.6	11.2	25.0	13.4	24.9	18.1	11.6	9.9	9.0	10.5	7.4	8.6
26	9.4	10.6	24.9	13.6	24.1	18.2	11.5	9.3	9.5	10.2	8.0	9.6
27	9.4	10.2	24.9	14.6	23.4	18.9	11.6	9.0	9.4	9.6	9.0	10.2
28	9.5	9.7	25.1	16.5	22.6	19.0	11.7	8.7	9.3	9.0	9.5	10.3
29	9.7	.....	24.6	16.9	21.5	20.5	11.8	8.4	9.0	8.8	9.0	10.1
30	9.4	.....	24.4	16.3	21.1	21.0	11.5	8.3	8.5	9.6	8.2	9.7
31	9.0	.....	24.5	.....	20.3	.....	11.8	8.1	.....	10.3	.....	9.3

a Changed less than one-half foot. b Reading changed one-half foot or more.

1899.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.0	3.6	14.7	13.7	23.4	21.3	19.2	14.1	9.1	7.2	6.6	7.3
2	8.2	3.1	a 15.7	13.8	23.4	21.3	b 19.2	14.0	9.1	7.1	6.3	7.1
3	7.2	3.1	15.3	13.6	23.3	21.6	19.2	14.0	9.1	6.9	6.3	7.0
4	6.5	3.3	14.6	13.2	23.0	22.0	19.5	13.9	9.0	6.8	6.4	6.9
5	6.5	3.7	14.3	13.1	21.8	22.2	20.1	13.6	8.9	6.8	6.7	6.8
6	6.2	4.1	13.9	13.4	20.7	22.3	20.6	13.4	8.8	6.7	6.9	6.8
7	5.8	5.0	13.5	13.9	b 19.8	22.3	20.8	13.4	8.5	6.6	7.0	6.8
8	6.4	4.9	13.4	14.2	19.3	22.1	21.0	13.1	8.4	6.5	7.2	6.7
9	6.4	4.6	13.0	14.0	18.8	21.5	21.2	12.8	8.3	6.3	7.3	6.6
10	6.4	4.3	12.4	13.8	18.7	21.3	21.1	13.0	8.3	6.2	7.5	6.6
11	6.1	5.0	12.2	13.9	19.3	21.3	21.1	14.1	8.3	6.2	7.6	6.6
12	6.2	6.0	12.4	14.0	19.8	21.2	21.5	15.0	8.4	6.2	7.8	6.6
13	6.2	6.2	12.5	14.8	b 20.4	21.5	21.6	15.2	8.5	6.1	7.9	6.5
14	7.2	6.5	12.5	16.0	20.6	22.4	21.4	15.0	8.5	6.0	8.0	6.5
15	7.9	6.3	12.9	15.9	20.7	22.8	20.9	14.7	8.4	6.0	8.0	6.5
16	7.5	6.2	13.6	15.3	20.5	22.4	20.3	14.4	b 8.3	5.9	8.1	6.6
17	7.3	6.1	15.3	14.9	20.0	21.5	19.8	13.8	8.2	5.9	8.1	6.6
18	7.5	6.2	16.2	14.7	19.4	21.0	19.3	13.1	8.2	5.9	8.0	6.2
19	7.0	6.3	16.9	14.6	18.9	21.0	19.1	12.6	8.2	6.0	8.0	6.1
20	7.5	5.3	17.5	14.7	18.1	20.9	19.0	12.2	8.3	6.0	8.0	6.2
21	7.3	7.0	18.6	15.3	17.9	20.8	18.8	11.9	8.4	6.0	8.0	6.6
22	7.3	6.9	19.3	16.1	18.4	20.6	18.4	11.6	8.2	5.9	7.9	6.8
23	7.2	6.2	19.2	17.1	19.2	20.2	17.8	11.3	8.0	5.8	8.0	6.6
24	7.1	5.4	18.7	20.0	20.7	19.8	17.3	10.8	7.9	5.8	8.1	6.4
25	6.9	4.7	18.3	22.1	21.7	19.1	16.9	10.5	7.8	5.7	8.2	5.9
26	7.0	7.3	17.6	23.2	22.6	18.7	16.5	10.1	7.6	5.7	8.3	5.5
27	6.8	9.2	16.8	23.5	23.0	18.5	15.9	9.9	7.5	5.7	8.0	5.0
28	6.7	11.8	16.1	23.7	22.9	18.6	15.4	9.7	7.4	5.8	7.7	4.8
29	6.4	.....	15.4	23.5	22.4	18.8	14.9	9.5	7.3	5.9	7.5	4.4
30	6.2	.....	b 14.7	23.3	21.9	19.0	14.8	9.4	7.2	6.3	7.3	4.0
31	5.8	.....	14.0	.....	21.4	.....	14.2	9.2	.....	6.6	.....	3.6

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo--Cont'd.

GRAND TOWER, ILL.—Continued.

1900.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.4	5.1	9.0	13.8	15.9	14.1	13.1	12.1	10.0	10.2	12.7	11.5
2	2.7	4.5	8.4	13.6	15.4	13.5	12.6	11.8	10.4	10.7	12.7	a 10.9
3	2.0	3.1	8.4	13.9	15.1	13.4	12.5	11.4	10.6	11.1	12.3	10.3
4	2.0	3.5	8.3	14.0	15.2	13.5	12.5	11.0	10.6	11.8	11.9	9.8
5	2.6	3.6	8.4	14.0	15.3	13.4	12.4	10.8	10.6	12.8	11.8	9.4
6	3.4	3.3	9.5	14.2	15.1	13.1	12.4	10.3	10.6	13.0	12.0	9.1
7	4.4	3.4	12.0	14.5	15.4	12.8	12.3	9.9	10.7	12.8	12.3	8.9
8	6.1	4.0	16.2	15.0	15.8	12.5	12.1	9.5	10.6	12.6	12.8	a 8.6
9	5.0	5.5	17.9	15.6	16.1	12.3	11.7	9.1	10.0	12.5	13.4	8.4
10	5.0	7.2	18.2	15.7	16.1	12.3	11.3	8.8	9.5	12.8	13.4	8.2
11	5.2	9.0	18.7	15.7	16.0	12.1	11.3	8.5	9.1	12.9	13.1	8.0
12	5.3	9.5	19.7	15.4	15.8	11.9	11.1	8.2	8.9	12.3	12.8	8.0
13	5.4	9.1	20.5	15.5	15.5	11.6	11.1	7.9	8.5	11.7	12.6	7.8
14	5.2	8.9	21.4	16.0	15.9	11.8	11.0	7.6	8.2	11.1	12.4	7.6
15	5.2	8.8	21.7	17.0	16.1	12.8	10.9	7.4	8.0	10.8	12.3	7.4
16	5.2	8.3	21.9	17.4	15.5	14.6	10.6	7.2	7.8	10.6	12.0	7.2
17	5.1	8.1	22.0	16.9	14.8	14.2	10.5	7.0	7.7	10.4	11.9	7.0
18	5.1	7.8	21.7	16.2	14.2	13.5	10.8	7.0	7.5	10.4	11.8	6.8
19	5.2	7.4	21.1	15.4	14.1	12.8	10.7	6.9	7.4	10.4	12.0	6.6
20	5.8	7.1	20.3	15.0	14.0	12.5	10.4	7.4	7.4	10.4	12.0	6.4
21	7.6	7.0	19.3	15.0	14.0	12.4	10.5	8.6	7.4	10.5	12.1	6.2
22	8.7	7.5	18.4	15.3	14.0	12.6	10.4	9.5	7.6	10.8	12.1	6.0
23	8.5	8.9	17.8	15.6	14.0	13.6	10.8	9.9	8.0	11.1	12.3	6.0
24	7.9	10.0	17.4	15.9	14.0	14.8	11.8	10.0	8.3	11.5	12.7	5.7
25	7.5	10.9	17.0	16.2	14.0	15.5	12.8	10.0	8.5	11.8	12.6	5.7
26	7.3	10.5	16.5	16.5	13.8	15.4	13.6	10.0	8.5	12.1	12.5	5.6
27	7.3	9.9	16.2	16.9	13.5	15.2	13.6	9.9	8.9	12.3	12.5	5.5
28	7.2	9.4	15.7	16.9	13.2	14.9	13.5	9.8	8.8	12.4	12.4	5.6
29	7.1	.....	15.3	16.5	12.9	14.3	13.1	9.8	9.0	13.4	12.3	5.6
30	6.7	.....	14.7	16.2	12.9	13.6	12.7	9.7	9.7	12.4	12.0	5.5
31	5.9	.....	14.3	.....	13.4	.....	12.3	9.6	.....	12.4	.....	5.3

a Changed less than one-half foot.

1901.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.10	0.30	6.40	17.50	15.70	10.60	14.50	9.20	6.00	5.50	5.90	5.00
2	5.10	0.00	6.20	17.80	15.40	10.40	14.00	9.20	5.90	5.40	5.90	5.00
3	4.90	5.90	5.90	17.90	15.00	10.40	13.60	9.30	5.80	5.30	5.80	5.00
4	4.60	5.80	5.70	17.90	14.80	10.90	13.00	9.40	5.70	5.20	5.70	4.90
5	4.40	6.00	5.60	a 18.00	14.40	12.00	12.50	9.30	5.60	5.10	5.60	4.80
6	4.40	5.90	5.80	18.30	a 14.20	12.50	12.10	9.20	5.40	5.10	5.60	4.80
7	4.20	5.80	6.30	18.50	14.00	12.70	11.60	9.00	5.30	5.10	5.50	4.70
8	4.00	5.90	6.60	18.70	13.70	12.80	11.40	8.70	5.30	5.20	5.40	4.70
9	4.00	5.60	7.00	18.80	13.50	13.20	11.20	8.40	5.10	5.20	5.30	4.70
10	4.10	5.10	b 8.50	19.30	13.30	13.30	11.30	8.20	5.10	5.30	5.30	4.70
11	4.50	4.40	10.40	20.20	13.10	13.10	11.90	8.00	5.10	5.40	5.30	4.70
12	4.90	4.30	13.40	20.60	12.90	12.90	12.20	7.80	5.10	5.50	5.30	4.60
13	5.60	4.60	16.10	20.80	12.70	12.80	11.80	7.70	5.10	5.50	5.40	4.60
14	6.50	a 4.70	16.90	21.20	12.60	12.80	11.30	7.70	4.90	5.50	5.50	5.00
15	6.80	a 4.70	17.10	21.10	12.40	12.90	11.10	7.60	4.90	5.50	5.40	c 5.30
16	7.10	4.80	16.80	21.00	12.20	13.50	10.90	7.50	4.90	5.40	5.40	c 4.90
17	7.10	4.90	16.60	20.90	12.00	13.90	10.80	7.40	4.80	5.40	5.40	c 4.60
18	7.00	4.90	16.50	21.30	11.80	13.80	10.80	7.30	4.80	5.50	5.40	c 4.90
19	7.00	5.00	16.40	21.80	11.70	13.50	10.80	7.20	4.80	5.60	5.40	c 3.60
20	7.00	5.20	16.30	21.80	11.50	13.10	10.80	7.10	4.90	5.80	5.30	c 3.00
21	6.90	5.40	16.10	21.10	11.30	12.90	10.80	7.00	5.20	5.90	5.30	c 2.40
22	6.70	5.40	16.00	20.30	11.00	12.80	11.20	6.90	5.90	6.10	5.30	c 2.40
23	6.60	5.20	16.30	19.50	10.90	12.80	11.40	6.90	6.70	6.10	5.30	c 2.40
24	6.60	5.10	17.20	19.00	10.70	13.00	11.00	6.80	6.80	6.10	5.30	c 2.50
25	6.60	a 5.10	17.60	18.40	10.60	13.70	10.60	6.70	6.50	a 6.00	5.30	c 3.10
26	6.60	5.30	18.00	17.80	10.40	14.20	10.20	6.60	6.30	5.90	5.30	c 3.50
27	6.50	5.80	18.20	17.20	10.60	14.40	10.00	6.50	6.00	5.90	5.20	c 5.00
28	6.40	6.20	18.10	16.70	11.10	14.60	9.70	6.40	5.80	5.80	5.20	c 4.20
29	6.30	.....	17.90	16.40	11.10	14.80	9.50	6.30	5.70	5.80	5.10	c 4.50
30	6.30	.....	17.80	16.00	10.90	14.90	9.40	6.20	5.60	5.80	5.10	c 4.20
31	6.30	.....	17.60	.....	10.70	.....	9.20	6.10	.....	5.90	.....	c 4.10

a Changed less than one-half foot. b Reading changed one-half foot or more.
c Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAND TOWER, ILL.—Continued.

1902.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 4.20	a 2.30	6.70	11.30	9.20	16.90	20.00	21.60	19.20	15.40	12.20	14.30
2	a 4.20	a 2.60	6.40	11.60	9.20	16.70	21.10	21.00	18.80	15.70	11.90	14.40
3	a 4.30	a 2.60	7.10	12.10	9.20	16.60	21.80	20.50	18.50	15.50	11.50	14.50
4	a 4.40	a 2.30	7.20	12.50	10.40	17.50	22.00	19.50	18.00	15.80	11.20	14.00
5	a 4.00	a 1.70	7.90	12.30	11.40	18.10	22.20	18.00	18.30	16.40	11.00	13.70
6	a 3.80	a 1.80	8.20	12.10	11.20	18.00	22.00	18.50	18.70	16.90	10.80	13.70
7	a 3.70	a 2.30	8.00	12.00	10.60	17.90	21.40	18.10	18.40	17.30	10.90	13.70
8	a 3.90	a 2.60	7.70	12.60	9.90	17.50	21.00	18.00	17.70	18.00	11.30	13.70
9	a 4.00	a 2.80	8.10	12.70	9.20	17.00	20.50	17.80	16.80	18.70	11.50	14.00
10	4.00	a 2.90	9.00	12.00	8.80	16.70	20.40	17.40	16.00	19.20	11.80	13.80
11	4.20	a 3.10	9.90	11.50	9.00	16.80	20.30	17.00	15.20	19.00	12.40	13.20
12	4.30	a 3.10	10.00	11.20	9.80	17.40	19.90	16.70	14.70	18.50	12.60	12.60
13	4.30	a 3.30	9.90	10.80	10.70	18.10	19.80	16.20	14.30	17.80	12.50	12.20
14	4.10	a 3.30	10.30	10.50	11.20	18.20	20.40	16.00	13.80	17.10	12.00	12.50
15	3.70	a 4.20	11.40	10.10	11.70	18.40	21.40	15.70	13.30	16.40	11.70	12.90
16	3.40	a 4.10	12.20	9.90	11.70	19.10	22.20	15.60	12.80	15.80	11.50	13.10
17	3.50	a 4.10	13.00	9.70	11.70	19.20	22.80	14.80	12.30	15.30	11.30	12.60
18	3.70	a 4.20	13.50	9.40	11.60	19.00	23.20	14.50	12.30	15.00	11.20	11.70
19	3.90	a 4.30	13.30	9.30	11.50	18.70	23.50	14.70	11.80	15.00	11.30	11.50
20	3.90	a 4.20	12.80	9.30	11.50	18.50	23.80	14.90	11.30	15.10	12.00	11.60
21	(b)	a 4.30	12.20	9.20	12.00	18.20	23.70	15.20	11.00	15.30	12.90	12.10
22	(b)	a 4.20	11.30	8.90	12.10	17.80	23.50	16.20	10.60	15.50	13.50	12.40
23	(b)	a 4.20	10.60	8.50	11.80	17.50	23.50	16.90	10.30	15.90	13.70	13.00
24	(b)	a 4.00	10.10	8.60	11.60	17.30	23.70	17.20	10.00	16.30	13.70	13.60
25	(b)	a 4.00	9.80	9.30	12.00	17.30	24.00	17.20	9.90	16.20	13.50	14.10
26	(b)	a 3.70	9.50	9.60	13.00	17.30	24.20	17.30	10.30	16.00	13.50	14.70
27	(b)	a 3.70	9.40	9.10	13.40	17.10	24.30	17.50	12.00	15.80	13.40	14.80
28	(b)	a 7.00	9.50	8.70	14.00	17.40	24.00	18.00	13.00	15.00	13.40	14.50
29	(b)	.....	11.30	8.80	15.60	18.20	23.60	18.40	13.70	14.20	13.70	13.90
30	(b)	.....	11.10	8.70	17.10	19.60	23.00	19.00	14.50	13.30	14.00	13.20
31	(b)	.....	11.40	.....	17.40	.....	22.30	19.39	.....	12.80	.....	12.30

a Doubtful on account of ice. b Observer reports gauge records destroyed by fire.

1903.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.20	11.90	14.40	19.40	18.40	23.30	20.40	17.80	17.00	17.10	15.80	9.20
2	10.50	11.80	16.00	19.00	18.00	24.90	20.40	17.30	17.60	17.20	15.70	9.00
3	10.10	11.40	16.40	18.90	17.80	26.40	20.20	16.70	18.90	17.10	15.50	8.90
4	10.00	11.60	16.70	18.60	17.50	27.60	19.70	16.30	19.40	17.20	15.40	8.60
5	10.20	12.80	17.40	18.50	17.20	28.50	19.20	16.50	19.50	17.40	15.20	8.40
6	10.50	15.50	18.20	18.90	16.90	29.50	18.70	16.10	19.20	17.50	15.00	8.10
7	10.70	16.30	18.50	19.90	16.70	30.40	18.00	15.50	18.60	17.70	15.00	8.00
8	10.40	15.50	19.60	20.50	16.50	31.30	17.70	16.00	18.00	18.20	15.20	7.90
9	10.60	15.10	21.40	20.60	16.40	31.90	17.60	16.90	17.70	18.50	15.50	7.90
10	10.40	14.40	23.30	20.20	16.40	32.20	17.60	17.10	17.60	19.50	15.60	7.70
11	10.10	13.60	24.20	19.90	16.50	32.70	17.60	17.20	17.20	20.40	15.30	7.40
12	9.60	13.00	24.60	19.90	16.40	33.20	17.60	17.30	17.20	21.00	15.10	7.20
13	8.90	12.80	24.10	20.90	16.20	33.70	a 17.30	17.20	18.30	21.00	14.80	7.10
14	8.60	13.00	23.80	21.70	16.10	33.80	16.90	17.40	19.40	20.70	14.50	b 6.90
15	7.90	13.40	23.40	22.00	16.00	33.70	16.80	17.30	19.90	20.40	14.00	b 5.90
16	7.60	13.90	23.40	22.30	15.80	33.20	17.00	17.60	20.00	20.00	13.70	b 5.20
17	7.60	13.30	23.40	22.30	15.70	32.30	17.40	17.70	20.40	19.70	13.40	b 5.00
18	7.70	12.80	22.70	22.30	16.80	31.40	18.10	17.40	20.60	19.10	13.20	b 4.70
19	8.30	11.70	22.80	22.50	18.00	29.90	19.00	17.40	20.20	18.60	12.80	b 4.70
20	8.80	11.00	22.80	22.50	19.50	28.60	19.30	17.70	20.00	18.20	12.50	b 5.40
21	9.10	10.60	22.60	22.00	19.80	27.00	19.10	17.70	20.00	17.80	12.10	b 5.70
22	9.30	10.30	23.00	21.80	19.60	25.90	18.70	17.70	19.60	17.40	11.80	b 6.00
23	9.00	10.40	23.30	21.80	19.30	25.30	18.60	17.80	18.90	17.00	11.60	b 6.30
24	8.90	10.40	23.10	21.60	19.00	24.50	18.60	17.50	18.30	16.70	11.30	6.50
25	8.80	10.60	22.70	21.00	19.00	24.10	18.80	16.90	17.60	16.50	11.10	6.90
26	8.70	10.70	22.40	20.50	19.30	23.70	19.10	16.40	17.10	16.40	10.80	7.30
27	8.50	11.00	22.00	20.00	20.40	23.40	19.70	a 16.30	16.80	16.30	10.50	7.60
28	8.80	12.10	21.40	19.70	21.90	22.60	19.80	16.00	16.70	16.20	10.10	7.20
29	10.10	.....	20.80	19.10	22.30	21.70	19.30	15.90	16.80	16.00	9.80	7.20
30	11.70	.....	20.10	18.80	22.40	20.90	18.80	16.00	17.00	16.00	9.50	7.30
31	11.90	.....	19.60	.....	22.60	.....	18.30	16.60	.....	15.80	.....	7.50

a Changed less than one-half foot. b Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAND TOWER, ILL.—Continued.

1904.

[Gauge, 13.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.8	11.1	10.3	25.9	31.5	20.8	22.9	15.3	11.6	13.9	12.1	8.2
2	8.3	10.3	10.0	25.7	31.4	22.4	23.0	15.1	11.2	14.1	12.2	8.2
3	8.2	9.4	9.8	25.3	31.1	23.7	22.4	14.6	10.8	13.8	12.1	8.1
4	8.0	9.0	9.6	25.0	30.8	23.8	22.0	14.3	10.5	13.5	12.0	7.9
5	7.7	a 8.9	9.8	24.4	30.3	23.3	21.7	14.1	10.5	13.1	11.8	7.8
6	7.2	9.2	10.0	23.9	29.4	24.1	21.6	14.0	10.9	12.5	11.7	7.7
7	7.1	9.7	10.7	23.2	28.3	25.4	21.1	13.8	10.9	12.0	11.6	7.7
8	7.1	9.9	11.2	22.7	27.0	26.5	20.6	13.4	10.6	11.8	11.4	7.5
9	7.2	10.3	11.4	22.0	26.1	26.6	21.1	13.0	10.2	11.5	11.3	b 7.1
10	7.0	10.4	11.8	21.7	25.5	26.2	22.6	12.5	10.0	11.3	11.2	7.0
11	6.9	10.8	12.3	22.2	25.2	25.5	24.3	12.3	10.1	11.1	11.1	7.0
12	6.9	11.2	12.5	22.7	24.7	24.7	25.5	11.9	10.2	b 10.9	11.0	7.0
13	6.9	11.6	13.1	22.9	24.1	24.1	26.0	11.7	10.1	10.7	10.9	7.0
14	6.7	11.8	13.4	23.0	23.4	23.6	26.1	11.5	10.0	b 10.5	10.8	6.9
15	6.8	11.9	13.3	22.8	22.6	23.2	25.5	12.0	10.0	10.3	10.7	6.5
16	7.1	12.2	13.2	22.6	21.9	23.3	24.6	11.6	9.9	10.1	10.6	6.2
17	7.3	12.0	13.0	22.5	21.3	23.6	23.3	11.5	9.8	10.0	10.4	6.0
18	7.3	11.6	13.2	22.5	21.0	23.7	21.9	11.7	9.7	b 9.9	10.3	5.8
19	7.4	11.0	13.6	23.2	21.0	24.3	21.3	11.8	10.9	9.8	10.1	5.5
20	7.8	10.6	14.0	23.5	21.3	23.9	21.2	11.8	12.5	9.8	9.9	5.1
21	7.8	10.7	14.4	23.4	21.4	23.7	20.9	12.9	13.3	9.8	9.8	5.0
22	8.6	10.9	14.6	23.1	20.9	23.8	20.4	13.9	13.9	9.8	9.6	5.0
23	11.3	10.8	14.8	23.2	20.4	24.0	19.6	13.9	14.1	9.8	9.4	4.8
24	14.5	10.4	16.0	23.6	20.0	23.7	18.9	14.1	13.5	9.8	9.2	4.8
25	16.1	10.3	17.5	25.2	19.4	23.1	18.5	14.5	13.0	10.0	9.0	5.0
26	16.0	10.4	22.8	27.4	19.0	22.4	18.4	14.4	12.6	10.2	8.9	5.1
27	15.2	10.5	22.6	29.1	18.7	21.5	18.2	14.5	12.9	10.5	8.7	5.2
28	14.7	10.8	22.5	30.3	b 18.6	21.2	17.7	14.5	13.5	10.7	8.6	5.4
29	13.8	10.6	24.9	31.1	18.7	21.4	16.9	13.9	13.6	11.0	8.4	5.9
30	12.9	.....	26.0	31.4	18.8	21.9	16.2	12.9	13.5	11.4	8.3	5.0
31	12.1	.....	26.2	.....	19.8	.....	15.7	12.1	.....	11.8	.....	4.6

a Reading changed one-half foot or more. b Changed less than one-half foot.

1908.

[Gauge, 103.30 miles from Eads Bridge. Zero of gauge, 329.04 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.90	7.90	18.80	16.60	18.50	26.00	29.40	.....	.....	.....	.....	.....
2	8.90	7.40	18.60	16.20	18.00	26.50	29.00	.....	.....	.....	.....	.....
3	8.80	6.90	18.50	16.00	17.50	27.00	28.70	.....	.....	.....	.....	.....
4	8.80	a 6.50	18.60	16.00	17.20	27.40	28.90	.....	.....	.....	.....	.....
5	8.70	a 7.00	19.00	16.00	17.80	27.90	29.00	.....	.....	.....	.....	.....
6	8.60	8.00	19.00	16.00	18.70	28.20	29.10	.....	.....	.....	.....	.....
7	8.50	7.90	19.20	15.90	20.60	28.20	29.10	.....	.....	.....	.....	.....
8	8.50	7.50	19.40	17.10	21.00	28.20	29.00	.....	.....	.....	.....	.....
9	8.50	7.80	20.00	17.60	21.20	28.30	28.30	.....	.....	.....	.....	.....
10	8.30	8.10	21.00	18.00	21.70	28.30	27.40	.....	.....	.....	.....	.....
11	8.20	8.40	21.80	19.90	22.10	28.20	26.60	.....	.....	.....	.....	.....
12	9.40	8.50	21.90	20.80	22.60	28.30	26.10	.....	.....	.....	.....	.....
13	9.70	9.00	21.90	21.30	22.70	28.50	25.80	.....	.....	.....	.....	.....
14	9.90	9.40	21.70	21.40	22.40	28.80	25.60	.....	.....	.....	.....	.....
15	10.10	11.80	21.60	21.20	21.90	29.20	25.30	.....	.....	.....	.....	.....
16	9.90	13.10	21.20	20.90	21.90	29.60	24.60	.....	.....	.....	.....	.....
17	9.50	15.80	20.60	20.50	23.00	a 30.10	24.00	.....	.....	.....	.....	.....
18	9.10	17.40	20.20	19.80	24.00	a 30.80	23.20	.....	.....	.....	.....	.....
19	8.80	18.50	19.80	19.10	24.50	a 31.20	22.70	.....	.....	.....	.....	.....
20	8.70	18.30	19.30	18.10	24.60	a 31.60	22.60	.....	.....	.....	.....	.....
21	8.40	18.70	18.90	17.50	24.40	a 31.80	22.80	.....	.....	.....	.....	.....
22	8.10	18.80	18.60	16.90	23.90	a 31.90	23.00	.....	.....	.....	.....	.....
23	8.10	18.30	18.20	16.40	23.70	a 31.90	22.90	.....	.....	.....	.....	.....
24	8.10	17.90	17.80	17.00	23.60	a 31.80	22.50	.....	.....	.....	.....	.....
25	8.40	17.50	17.40	17.80	23.40	a 31.70	22.00	.....	.....	.....	.....	.....
26	8.50	17.50	16.90	18.10	23.00	a 31.40	21.70	.....	.....	.....	.....	.....
27	8.40	17.40	16.50	18.80	23.00	a 31.30	21.50	.....	.....	.....	.....	.....
28	8.60	18.10	16.20	18.70	23.90	a 31.00	21.30	.....	.....	.....	.....	.....
29	8.50	18.90	16.20	18.90	24.70	a 30.70	21.30	.....	.....	.....	.....	.....
30	8.20	.....	16.20	19.20	25.10	a 30.00	21.10	.....	.....	.....	.....	.....
31	8.00	.....	16.50	.....	25.40	.....	20.80	.....	.....	.....	.....	.....

a Reading on temporary gauge.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.

1896.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.45
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.40
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.30
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.20
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.25
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.25
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.30	6.95
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.20	6.60
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.45	6.25
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[a]9.30	5.95
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[a]9.20	5.85
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.50	5.70
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.30	5.70
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.10	5.80
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.95	5.95
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.85	6.20
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.80	6.40
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.70	6.80
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.70	7.25
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.75	7.80
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.75	8.20
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.70	8.30
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.70	8.30
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.60	8.25
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.55	8.20
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.40	8.10
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.50	8.00
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.60	7.90
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.50	7.65
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.50	7.50
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.40

[a] Changed less than one-half foot.

1897.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.40	8.15	14.50	24.00	26.60	15.60	19.85	14.30	9.40	6.95	6.15	6.35
2	7.40	7.60	13.90	25.70	27.20	14.90	20.20	14.00	9.10	6.90	6.20	6.25
3	7.45	7.30	14.10	26.80	27.40	14.60	19.40	13.80	9.00	6.85	6.20	6.25
4	9.20	7.10	13.95	28.00	27.65	14.80	19.80	13.45	8.70	6.80	6.20	6.00
5	18.70	7.50	15.40	28.10	27.45	14.90	20.10	13.20	8.55	6.80	6.20	5.80
6	22.85	8.15	18.80	27.90	27.00	15.55	20.15	12.90	8.50	6.75	6.15	5.40
7	23.85	8.70	22.40	27.70	26.30	16.00	19.50	12.80	8.20	6.70	6.20	5.00
8	24.35	9.00	23.80	27.70	25.50	16.30	19.05	12.60	8.10	6.60	6.25	4.70
9	23.10	9.40	24.20	28.20	24.50	16.40	18.80	12.40	8.10	6.55	6.60	4.20
10	20.70	9.80	24.10	28.35	23.60	16.30	18.90	12.50	8.00	6.55	6.65	3.90
11	[a]18.40	10.55	23.20	28.70	22.50	16.10	18.70	12.65	8.00	6.50	6.65	3.90
12	16.10	11.30	22.60	28.80	22.20	15.85	17.90	12.45	8.00	6.45	6.70	4.00
13	14.20	11.85	22.20	28.90	21.35	15.60	17.30	12.15	7.90	6.50	6.80	4.05
14	12.90	11.80	21.80	28.50	20.60	15.20	16.60	11.95	7.80	6.40	6.80	4.30
15	11.90	12.45	21.20	27.90	19.95	14.90	15.80	11.80	7.75	6.30	6.75	4.55
16	11.30	12.75	20.50	27.30	19.40	14.70	15.30	11.80	7.50	6.25	6.80	4.80
17	11.10	13.30	19.90	26.60	18.85	14.50	14.90	11.70	7.60	6.20	6.80	5.00
18	11.00	13.40	20.25	26.10	18.30	14.50	14.40	11.60	7.40	6.20	6.85	5.30
19	11.10	13.30	21.10	26.00	17.70	14.60	14.40	11.50	7.30	6.15	6.70	5.00
20	12.20	12.85	20.90	25.80	17.25	14.85	14.50	14.40	7.10	6.10	6.60	4.70
21	13.55	12.70	20.50	25.60	16.85	14.60	14.60	11.30	7.10	6.10	6.50	4.15
22	14.20	13.05	21.10	25.55	16.40	14.50	14.30	11.20	7.00	6.10	6.40	3.95
23	14.45	14.00	21.45	25.60	15.95	15.55	13.80	11.10	7.00	6.00	6.30	3.85
24	14.60	15.30	21.60	25.70	15.65	15.40	13.50	10.85	6.95	6.00	6.35	3.55
25	14.30	15.95	21.85	25.75	15.30	10.75	13.35	10.70	6.95	6.00	6.35	3.20
26	13.70	16.00	21.90	25.70	15.15	10.40	13.75	10.30	6.95	6.00	6.45	3.10
27	12.90	15.55	22.00	25.20	15.40	16.80	14.80	10.15	7.15	6.00	6.40	3.10
28	11.80	15.20	23.65	25.00	15.50	17.40	16.45	10.00	7.15	6.00	6.35	3.40
29	10.80	.....	24.00	25.30	15.70	17.40	16.85	10.00	7.10	6.05	6.30	3.90
30	10.10	.....	23.90	25.90	15.65	18.65	16.20	9.75	7.00	6.05	6.35	4.70
31	9.20	.....	23.60	.....	15.80	.....	15.20	9.60	.....	6.05	.....	4.90

[a] Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1898.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.81 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.30	9.90	10.50	25.20	16.50	20.50	21.50	13.30	8.65	9.00	11.20	8.50
2	a 5.40	9.40	10.30	24.70	16.05	19.50	21.60	13.20	8.20	9.00	10.70	7.80
3	5.40	9.05	10.10	23.50	15.90	19.00	21.65	13.20	8.00	8.50	10.05	7.30
4	5.50	8.55	9.90	22.40	16.80	19.40	21.10	14.00	7.60	8 10	9.35	7.00
5	5.20	7.70	9.70	21.85	18.90	a 19.85	20.60	14.50	7.50	7.80	8.90	6.50
6	5.10	7.30	9.55	21.00	20.50	a 20.15	19.00	14.00	7.30	7.65	8.50	6.20
7	5.20	7.00	9.40	20.60	21.30	20.30	18.20	13.30	7.10	7.45	8.15	5.80
8	5.55	6.70	9.30	20.55	21.10	20.10	18.50	13.15	7.10	7.10	8.10	5.75
9	5.90	6.70	9.10	20.20	20.70	b 19.10	21.40	13.45	7.20	6.80	8.55	5.40
10	6.30	7.00	9.10	19.80	20.10	18.50	21.30	12.50	7.70	a 6.60	8.70	5.30
11	6.80	7.50	9.05	19.60	19.60	18.00	21.00	12.40	8.30	6.50	8.80	4.80
12	7.40	8.10	9.85	19.20	19.00	18.60	20.10	12.00	9.30	6.25	9.10	3.80
13	8.55	8.15	12.30	18.50	18.30	21.15	19.15	11.30	10.10	6.30	9.40	3.50
14	9.15	8.90	13.30	18.00	17.80	20.90	18.20	11.00	10.10	6.90	9.40	3.40
15	9.85	10.20	16.20	17.50	17.40	21.50	17.45	11.05	9.90	7.10	9.20	3.20
16	9.95	10.60	18.00	17.40	16.90	21.80	16.60	11.00	9.50	6.80	9.00	3.20
17	9.55	11.00	18.40	17.40	16.80	22.45	16.10	10.95	9.10	6.30	8.70	3.70
18	9.35	11.10	18.60	17.25	18.70	23.35	15.60	10.60	9.80	6.00	8.45	4.05
19	9.05	11.15	18.60	16.90	20.90	23.75	14.90	10.40	10.95	5.80	8.10	4.80
20	9.55	11.60	18.70	16.25	21.70	23.25	14.45	a 10.30	11.70	6.00	7.90	6.20
21	10.00	12.20	19.10	15.70	22.00	22.80	13.90	10.70	11.55	6.85	7.80	5.50
22	9.90	13.10	19.80	15.35	22.45	21.80	13.60	11.50	10.90	8.10	a 7.60	5.60
23	10.80	13.55	21.90	15.00	24.30	20.80	13.50	11.90	10.40	9.90	7.55	6.35
24	11.05	13.00	24.80	14.70	25.30	19.75	13.00	11.50	9.75	11.00	7.80	7.90
25	11.00	12.40	25.40	14.50	25.40	19.15	12.55	10.70	9.75	11.35	8.10	9.45
26	10.80	11.70	25.30	14.70	24.60	18.35	12.35	10.20	10.20	11.10	8.80	10.50
27	10.90	11.25	25.25	15.20	23.90	18.60	12.40	9.85	10.20	10.30	9.80	11.10
28	10.90	10.80	25.70	17.10	23.10	18.60	12.55	9.55	10.10	9.90	10.30	11.30
29	11.10	.....	25.10	17.70	22.00	20.60	12.85	9.10	9.65	9.65	10.10	11.00
30	10.90	.....	24.95	17.40	21.70	21.30	12.60	9.00	9.40	10.40	9.30	10.60
31	10.40	.....	25.10	.....	21.00	.....	12.70	8.85	.....	11.05	.....	10.20

a Changed less than one-half foot. b Reading changed one-half foot or more.

1899.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.10	4.20	15.60	15.10	23.90	22.15	19.75	14.50	8.80	6.80	6.10	7.20
2	9.10	2.60	16.50	15.05	23.85	21.90	19.75	14.35	8.80	6.60	5.90	7.00
3	8.10	2.35	16.30	14.90	23.80	22.15	19.75	14.40	8.80	6.50	5.80	6.80
4	7.60	2.90	15.70	14.55	23.40	22.05	20.05	14.35	8.70	6.40	5.90	6.75
5	7.70	3.30	15.35	14.45	22.60	22.80	20.65	14.05	8.50	6.20	6.20	6.65
6	7.60	3.70	15.00	14.70	a 21.40	22.95	21.15	13.80	b 8.30	6.10	6.35	6.60
7	7.20	4.20	14.65	15.20	a 20.50	22.95	a 21.35	13.75	8.10	6.15	6.55	6.60
8	7.20	5.10	14.50	15.50	a 19.90	22.75	21.65	13.50	7.95	6.00	6.75	6.50
9	7.50	7.10	14.00	15.35	b 19.30	22.25	21.85	13.10	7.90	5.30	6.90	6.45
10	7.40	7.30	13.40	15.10	a 19.20	22.00	21.75	13.15	7.80	5.70	7.10	6.40
11	7.10	6.85	13.30	15.10	b 19.80	22.00	21.75	14.25	7.75	5.70	7.30	6.40
12	7.10	7.00	13.40	15.10	20.30	21.85	22.05	15.55	7.90	5.60	7.40	6.40
13	7.20	7.60	13.50	15.70	21.00	22.05	22.20	15.70	8.05	5.60	7.60	6.40
14	8.60	7.40	13.55	17.00	21.30	23.05	22.05	15.50	8.05	5.50	7.70	6.35
15	9.10	7.50	13.90	17.05	21.35	23.45	21.55	15.20	8.00	5.40	7.80	6.40
16	8.70	7.50	14.65	16.40	21.20	23.15	21.00	14.90	7.90	5.30	7.90	6.50
17	8.60	7.50	16.25	15.90	20.90	22.15	20.45	14.20	7.80	5.40	7.90	6.50
18	8.80	7.55	17.40	15.70	20.60	21.65	19.95	13.50	7.75	5.40	7.80	6.20
19	8.90	7.50	b 18.30	15.60	19.90	21.55	19.70	13.00	7.75	5.40	7.80	6.00
20	8.95	10.15	19.00	15.60	19.00	21.55	19.55	12.45	7.90	5.45	7.75	5.95
21	8.70	9.00	20.00	16.05	18.60	21.45	19.45	12.05	8.00	5.40	7.80	6.50
22	8.50	8.20	20.50	16.90	a 19.15	21.25	19.05	11.65	7.90	5.35	7.75	6.75
23	8.25	7.45	20.40	18.00	20.00	20.90	18.45	11.30	7.70	5.30	7.80	6.60
24	8.10	6.50	a 19.75	20.40	21.20	20.35	17.85	10.85	7.50	5.20	7.90	6.30
25	7.90	5.65	a 19.25	23.00	22.50	19.85	17.40	10.35	7.45	5.20	8.00	5.90
26	7.80	7.30	b 18.70	24.00	23.20	19.35	16.95	10.05	7.20	5.10	8.10	5.40
27	7.70	10.50	18.00	24.45	23.70	19.10	16.45	9.70	7.10	5.10	8.00	4.80
28	7.55	12.00	17.45	24.50	23.65	19.10	16.00	9.45	7.05	5.20	7.75	4.50
29	7.30	.....	16.70	24.20	23.20	19.35	15.45	9.30	6.90	5.35	7.40	4.00
30	7.00	.....	16.05	23.80	22.60	19.55	15.30	9.10	6.80	5.60	7.25	3.80
31	6.40	.....	15.45	.....	22.30	.....	14.70	8.90	.....	6.05	.....	3.40

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1900.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.30	4.90	9.30	14.20	16.45	14.70	13.80	a 12.70	10.75	10.90	a 13.50	.....
2	4.10	4.10	8.95	14.00	16.00	a 14.30	13.25	12.45	11.00	11.45	13.65	.....
3	4.00	3.10	8.80	14.15	15.75	13.95	13.15	12.05	11.25	11.90	13.20	.....
4	4.00	2.30	b 8.60	14.40	15.60	14.05	13.10	11.65	11.30	12.55	12.75	.....
5	4.60	3.30	8.70	14.35	15.75	13.95	13.05	11.35	11.35	13.65	b 12.65	.....
6	5.75	2.80	9.80	14.45	15.70	13.70	13.05	11.00	11.40	13.85	12.80	.....
7	5.70	2.90	12.25	14.85	15.80	13.35	12.90	a 10.70	11.45	13.80	a 13.00	.....
8	6.85	3.80	16.70	15.35	16.25	13.00	12.65	10.35	11.30	13.60	a 13.50	.....
9	7.10	5.45	19.00	16.05	a 16.55	12.80	12.25	9.95	10.80	13.40	14.25	.....
10	6.75	7.30	19.50	16.20	16.65	12.75	11.85	9.45	10.40	13.65	14.25	9.15
11	5.45	9.10	20.00	16.30	16.60	12.65	11.80	9.10	9.80	13.70	14.00	9.00
12	5.20	9.85	20.70	16.00	16.40	12.35	11.70	8.80	9.60	13.00	13.75	8.85
13	b 5.25	9.50	21.40	16.00	16.15	12.05	11.55	8.40	9.35	12.45	a 13.50	8.75
14	4.95	9.30	22.30	16.50	16.40	12.10	11.60	8.05	9.00	a 12.00	13.25	8.55
15	5.00	9.00	22.70	17.50	16.65	12.90	11.50	7.85	8.75	11.70	13.20	8.25
16	5.00	8.60	23.10	17.90	16.05	15.10	11.10	7.70	8.65	a 11.40	13.00	8.00
17	4.90	8.30	23.10	17.65	15.25	15.00	11.00	a 7.55	8.60	11.20	a 12.85	7.90
18	4.90	8.05	22.70	16.90	14.65	14.25	11.25	7.50	b 8.25	11.20	12.70	7.80
19	5.05	7.70	22.10	16.15	14.50	13.55	11.15	7.55	b 8.20	11.20	12.75	7.55
20	5.60	7.55	21.00	15.50	14.45	13.25	10.95	8.00	8.20	11.20	.....	7.30
21	7.40	7.20	b 20.00	15.50	a 14.50	13.20	a 11.05	8.80	8.15	11.25	.....	7.00
22	8.80	7.70	a 19.00	15.85	14.40	13.35	10.90	10.05	a 8.30	11.70	.....	6.90
23	8.75	9.00	18.40	16.10	14.50	14.25	11.25	10.45	8.60	12.10	.....	6.75
24	8.05	10.20	18.00	16.45	14.45	15.35	12.20	10.75	9.00	12.30	.....	6.50
25	7.60	11.00	17.60	16.75	14.50	16.25	13.45	10.75	9.20	12.75	.....	6.40
26	7.40	10.70	16.90	17.00	14.25	16.20	14.30	10.80	9.40	13.00	13.45	6.30
27	7.30	10.30	16.40	17.40	14.05	16.05	14.40	10.80	9.80	13.25	13.40	6.30
28	a 7.20	+0.70	16.15	17.50	13.90	15.75	14.25	10.50	9.65	13.35	a 13.20	6.25
29	7.10	.....	15.70	17.20	13.65	15.25	13.80	10.50	a 9.90	13.35	13.10	6.20
30	6.50	.....	15.10	16.85	13.35	14.45	13.55	10.45	a 10.50	13.35	12.80	6.20
31	5.70	.....	14.65	.....	13.80	.....	13.05	10.35	.....	13.40	.....	6.00

a Changed less than one-half foot. b Reading changed one-half foot or more.

1901.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.80	7.15	7.35	18.65	16.80	11.15	15.25	9.80	6.60	6.10	6.60	5.65
2	5.60	6.90	7.15	19.10	16.50	11.00	14.75	9.85	6.40	6.00	6.60	5.60
3	5.40	6.85	7.00	19.20	16.15	10.90	14.25	10.00	6.30	5.90	6.55	5.55
4	5.30	6.80	6.80	19.25	15.85	11.30	13.80	10.05	6.20	5.80	6.45	5.50
5	5.05	6.80	6.50	19.40	15.50	12.60	13.30	10.00	6.05	5.70	6.30	5.40
6	4.70	6.80	6.80	19.65	15.20	13.15	12.80	9.85	6.00	5.70	6.20	5.35
7	4.50	6.70	7.20	19.80	a 15.00	13.30	12.40	9.75	5.95	5.70	6.00	5.30
8	4.20	6.75	7.50	20.05	14.70	13.50	12.05	9.40	5.80	5.75	6.00	5.25
9	4.15	6.55	8.00	20.75	14.45	13.85	11.85	9.10	5.70	5.85	6.00	5.25
10	4.50	5.60	9.70	20.70	14.20	14.00	11.85	8.80	5.65	5.90	5.95	5.30
11	4.90	5.00	11.55	21.35	13.95	13.85	12.40	8.60	5.65	6.00	5.90	5.35
12	5.35	5.00	14.25	22.05	13.75	13.65	12.80	8.45	5.55	6.10	5.90	5.25
13	6.30	5.30	17.20	22.35	13.55	13.45	12.50	a 8.30	5.65	6.10	6.10	5.15
14	7.30	5.50	a 18.10	d 22.70	13.35	13.40	12.05	8.15	5.55	6.05	6.10	5.50
15	7.70	5.50	a 18.25	22.55	a 13.20	13.55	11.75	8.00	5.50	6.05	6.00	b 5.90
16	8.00	5.60	c 18.00	22.45	13.05	14.10	11.60	7.95	5.45	6.00	6.00	b 5.50
17	a 8.00	5.65	17.70	22.45	12.80	14.55	11.50	7.80	5.35	6.00	6.00	b 5.25
18	a 7.90	5.75	17.55	22.05	12.60	14.50	11.45	7.65	5.30	5.90	6.00	b 5.10
19	7.90	5.85	17.40	23.25	12.40	14.20	11.40	7.60	5.35	6.10	5.95	d 4.00
20	7.85	6.00	17.30	23.35	12.25	13.75	11.40	7.60	5.40	6.30	5.90	b 3.60
21	7.80	c 6.30	17.00	22.55	12.10	13.55	11.45	7.45	5.65	6.50	5.90	b 3.50
22	7.70	c 6.30	16.80	21.65	11.85	13.50	11.75	7.40	6.40	6.65	5.90	b 3.30
23	7.60	5.80	17.25	20.85	11.65	13.50	11.95	7.50	c 7.30	6.80	5.90	c 3.50
24	7.55	5.80	18.45	20.15	11.40	13.70	11.65	7.35	7.40	6.75	5.90	b 3.30
25	7.50	5.85	18.90	19.65	11.25	14.30	11.25	7.20	7.20	6.70	5.90	b 3.55
26	7.50	6.00	19.30	19.05	11.10	14.80	10.80	7.10	6.90	6.60	5.90	b 3.60
27	7.40	6.50	19.50	18.40	11.50	15.10	10.70	7.00	6.65	6.55	5.80	b 5.05
28	7.35	7.10	19.45	d 17.85	11.70	15.30	10.50	6.85	6.45	6.50	5.80	b 3.85
29	7.25	.....	19.20	17.50	11.75	15.50	10.20	6.85	6.30	6.50	5.70	b 4.20
30	7.25	.....	19.10	17.10	11.50	15.65	10.10	6.80	6.15	6.50	5.70	b 3.70
31	7.20	.....	18.90	.....	11.30	.....	9.90	6.75	.....	6.55	.....	b 3.60

a Changed less than one-half foot.
b Doubtful on account of ice.
c Reading changed one-half foot or more.
d Interpolated—no reading.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1902.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 3.65	a 1.85	7.30	12.20	10.15	18.00	21.10	22.30	b 19.80	15.40	12.60	15.00
2	a 3.90	a 2.00	7.25	12.40	10.20	17.60	21.65	21.70	19.50	16.35	12.20	15.10
3	a 4.00	a 2.10	7.90	12.90	10.15	17.45	22.30	21.10	18.95	16.25	11.80	15.20
4	a 4.00	a 2.10	7.95	13.15	11.00	18.70	b 22.80	b 20.30	18.55	16.40	11.50	14.80
5	a 4.25	a 1.70	8.55	13.10	12.10	19.40	22.80	19.45	18.80	17.00	11.20	14.40
6	a 3.90	a 4.50	c 9.00	13.00	12.15	19.40	22.55	19.20	19.10	17.50	11.00	14.40,
7	a 3.70	a 3.50	8.50	12.90	11.65	19.20	b 22.10	b 18.95	18.90	18.00	11.10	14.40
8	a 3.80	a 4.00	8.55	13.40	10.90	18.90	21.70	b 18.75	18.20	18.70	11.50	14.50
9	a 4.20	a 5.00	8.80	13.50	10.20	18.00	21.30	18.60	17.50	19.50	11.70	14.65
10	a 4.45	a 5.80	9.70	13.00	9.70	17.50	b 21.15	18.20	16.60	20.10	12.00	14.50
11	4.75	a 7.90	10.70	12.45	9.85	17.85	21.05	17.80	15.90	b 20.00	12.05	14.00
12	4.85	a 8.00	10.80	12.70	10.05	18.35	20.70	17.20	15.60	b 19.50	12.90	13.70
13	4.70	a 6.95	10.75	12.00	11.40	d 19.30	20.60	16.80	15.00	b 18.60	12.85	12.80
14	4.40	a 6.70	11.50	11.30	11.90	19.45	21.10	16.60	14.40	17.80	12.45	13.10
15	4.30	a 9.10	12.00	11.00	12.45	19.70	22.00	16.45	13.85	17.40	12.10	13.70
16	4.00	a 9.00	12.95	10.80	12.60	20.30	b 22.80	16.25	13.30	16.50	11.80	13.60
17	3.95	a 8.70	13.80	10.95	12.55	c 20.40	23.40	15.60	12.80	15.90	11.55	13.50
18	4.10	a 8.25	14.40	10.35	12.45	c 20.20	23.90	15.35	12.50	15.60	11.55	12.50
19	4.30	a 8.35	14.20	10.10	12.35	19.95	24.25	15.50	12.25	15.55	11.60	12.20
20	4.40	a 8.10	13.75	10.10	12.45	19.70	24.60	15.65	11.75	15.60	12.20	12.20
21	4.55	a 7.80	13.10	10.05	12.85	d 19.50	b 24.50	15.80	11.30	15.85	d 13.05	12.80
22	4.45	a 7.80	12.25	10.30	12.95	19.15	24.40	16.80	11.00	16.00	13.80	13.20
23	4.45	a 7.40	11.50	9.85	12.70	18.75	24.20	17.60	10.50	16.45	14.30	13.70
24	4.45	a 7.75	11.00	9.30	12.45	b 18.55	24.35	b 18.00	10.20	16.75	14.20	14.35
25	4.40	a 7.30	10.65	10.10	12.60	18.50	b 24.65	18.05	10.10	16.75	14.10	14.95
26	4.40	a 6.10	10.30	10.30	13.75	18.40	24.80	18.05	10.40	16.65	13.95	15.50
27	4.00	b 6.20	10.30	10.10	14.30	18.25	24.85	18.35	12.00	d 16.50	13.95	15.60
28	a 3.90	7.60	10.40	9.65	14.80	b 18.50	24.75	b 18.85	13.40	c 15.80	14.00	15.60
29	a 3.70	.....	12.00	9.65	16.30	19.30	24.35	19.40	14.20	c 15.00	14.25	14.80
30	a 3.20	.....	11.95	9.60	18.30	20.60	23.65	19.80	15.05	13.80	14.50	14.50
31	a 2.40	.....	12.20	.....	18.55	.....	22.95	19.95	.....	13.15	.....	13.30

a Doubtful on account of ice.
b Interpolated—no reading.
c Reading changed one-half foot or more.
d Changed less than one-half foot.

1903.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.00	12.60	15.10	a 19.45	a 18.40	24.25	a 20.20	17.50	17.20	17.30	16.20	9.40
2	b 11.30	12.60	16.90	a 19.10	a 18.00	24.90	20.20	17.00	17.60	17.35	16.10	9.25
3	b 11.85	12.15	17.30	a 18.90	17.60	26.70	20.00	16.50	18.80	17.35	15.95	9.00
4	b 10.70	12.35	17.50	a 18.70	17.40	27.90	19.50	16.10	19.40	17.40	15.80	8.80
5	b 10.80	13.45	a 18.15	a 18.40	17.15	28.90	18.90	16.20	19.50	17.60	15.60	8.50
6	a 11.10	15.95	a 18.80	a 18.80	16.80	29.90	a 18.30	15.75	19.30	17.80	15.50	8.15
7	a 11.30	17.05	a 19.05	a 19.00	16.55	30.70	17.60	15.35	18.75	17.90	15.40	8.05
8	a 11.20	16.30	a 21.00	a 20.25	16.40	31.05	a 17.30	15.75	18.15	18.45	15.60	7.95
9	a 11.30	16.00	a 21.90	a 20.40	16.30	32.30	a 17.20	16.60	17.80	18.75	15.90	7.80
10	a 11.10	15.30	a 24.30	a 20.20	16.30	32.70	17.15	16.90	17.75	a 19.35	15.95	7.65
11	a 10.75	14.60	a 25.00	a 19.80	16.40	33.10	17.15	17.00	17.40	a 20.30	15.75	7.35
12	a 10.30	14.05	25.50	a 19.80	16.30	33.50	17.15	17.10	17.30	a 21.00	15.50	7.20
13	a 9.50	13.70	25.30	a 20.60	16.10	33.80	16.90	17.15	17.85	a 21.10	15.25	7.00
14	a 8.90	b 13.95	24.80	a 21.65	16.05	33.90	16.50	17.20	19.55	a 20.75	15.00	6.70
15	a 8.40	14.50	24.50	a 22.10	15.90	33.80	16.45	17.15	20.15	a 20.45	14.50	6.90
16	a 8.00	14.95	24.50	22.45	15.70	33.40	16.55	17.35	20.25	a 20.20	14.15	4.80
17	a 7.90	14.50	24.40	22.60	15.70	32.70	16.90	17.60	20.55	a 19.80	13.90	4.50
18	a 8.05	13.95	23.80	22.60	16.60	31.70	17.05	17.30	20.85	a 19.30	13.60	4.25
19	a 8.55	13.00	23.60	22.90	18.10	30.30	18.55	17.30	20.40	a 18.80	13.20	4.00
20	a 9.20	12.30	23.60	a 23.00	18.60	28.70	19.05	17.50	20.25	a 18.40	12.85	4.40
21	9.50	12.15	23.50	22.60	18.80	27.05	a 18.90	17.55	c 20.25	a 18.10	12.50	4.85
22	9.60	11.70	23.75	22.30	18.50	25.95	a 18.55	17.75	a 19.90	17.70	12.10	5.10
23	9.55	11.80	24.00	22.25	18.30	25.10	a 18.35	17.75	a 19.20	17.20	11.90	5.50
24	9.45	11.70	23.80	a 22.05	18.00	24.30	a 18.40	17.50	a 18.50	17.10	11.60	5.75
25	9.30	11.70	23.40	a 21.50	17.90	23.85	a 18.50	16.90	17.75	16.90	11.30	6.05
26	9.25	11.80	a 23.00	a 21.00	18.20	23.40	a 18.80	16.45	17.35	16.80	11.00	6.40
27	9.10	12.10	a 22.50	a 20.50	19.30	23.10	a 19.30	16.30	17.00	16.65	10.70	6.55
28	9.30	13.15	a 21.80	a 20.10	20.50	22.45	a 19.50	16.00	16.90	16.55	10.35	6.40
29	9.60	.....	a 21.10	19.20	21.05	21.50	a 19.10	16.00	17.00	16.40	10.00	6.40
30	10.60	.....	a 20.40	a 18.90	21.30	a 20.70	a 18.60	16.10	17.15	16.30	9.60	6.50
31	12.60	.....	a 19.80	.....	21.50	.....	a 18.10	16.70	.....	16.20	.....	6.75

a Interpolated—no reading. b Reading changed one-half foot or more. c Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1904.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.55	a 11.80	10.90	26.60	31.75	21.15	22.80	16.70	12.10	14.30	12.60	9.30
2	7.90	a 11.00	10.60	26.40	31.70	c 22.50	23.15	15.45	11.55	14.35	12.70	9.15
3	8.05	a 10.00	10.40	b 26.00	31.50	b 24.00	22.40	15.00	11.30	14.30	12.05	9.00
4	7.90	9.40	10.20	25.80	b 31.10	b 24.20	22.10	14.65	11.00	14.00	12.55	8.90
5	7.65	8.00	10.30	25.25	29.70	c 23.80	21.90	14.50	11.05	13.70	12.45	8.80
6	7.30	9.40	10.60	24.70	29.00	24.20	21.70	14.30	11.30	13.10	12.30	8.70
7	7.10	10.40	11.15	24.00	c 28.30	25.50	21.30	13.80	11.35	12.55	12.15	8.60
8	7.10	10.35	11.70	23.45	27.35	26.50	b 20.95	13.35	11.10	12.30	12.00	8.40
9	7.20	10.60	12.00	22.80	26.30	26.80	b 21.40	13.10	10.75	c 12.05	11.90	8.25
10	7.10	b 10.80	12.30	22.30	25.55	26.35	b 22.95	12.90	10.60	b 11.85	11.85	8.15
11	7.00	11.10	c 12.70	22.80	25.30	25.60	24.30	12.60	10.60	11.70	11.70	8.00
12	7.00	11.55	13.05	23.40	24.75	24.90	25.50	12.30	10.70	11.50	11.70	8.00
13	7.00	11.95	13.70	23.45	24.20	24.30	26.00	12.00	10.70	11.30	11.60	7.95
14	6.90	12.20	14.00	23.40	23.45	23.65	26.20	11.80	10.50	11.15	11.50	7.80
15	7.00	12.20	13.95	23.30	22.60	23.30	b 25.80	12.10	10.50	10.95	11.40	c 7.50
16	7.20	12.40	13.80	22.90	21.90	23.25	24.90	12.00	10.50	10.75	11.30	7.00
17	7.40	12.30	13.70	22.30	21.40	23.60	23.40	11.90	10.40	10.70	11.15	6.90
18	7.50	12.00	13.80	22.70	21.20	23.70	22.10	12.00	10.30	10.60	11.00	6.65
19	7.60	11.40	14.10	23.30	21.00	24.20	21.55	12.05	11.60	10.50	10.90	6.30
20	7.90	a 11.20	14.60	23.85	21.20	24.00	21.40	12.10	13.00	10.50	10.75	6.00
21	8.10	11.50	15.00	23.60	21.00	23.80	21.10	12.00	13.75	10.45	10.65	6.00
22	8.80	11.45	15.20	23.25	20.45	23.85	20.66	14.60	14.20	10.35	10.50	5.90
23	11.30	11.30	15.40	23.30	20.20	23.95	19.95	14.30	14.60	10.45	10.30	5.80
24	14.70	11.10	10.50	23.80	20.00	23.80	19.20	14.40	14.00	10.50	10.10	c 5.80
25	16.30	11.05	18.45	25.20	19.60	23.20	18.75	14.90	13.50	10.70	c 10.00	5.90
26	16.50	11.05	23.45	27.60	19.20	22.40	18.70	14.70	13.10	10.80	9.85	6.10
27	15.80	11.10	23.20	29.20	18.90	21.90	18.50	14.75	13.30	11.00	9.70	6.20
28	15.30	11.30	23.45	30.15	18.70	21.30	c 18.10	14.80	13.90	11.25	9.55	6.50
29	14.40	11.30	25.30	31.00	18.80	21.25	17.25	14.20	14.10	11.60	9.45	7.00
30	b 13.40	.....	26.60	31.50	18.90	b 21.90	16.60	13.30	14.00	11.90	9.35	b 6.10
31	12.60	.....	26.70	.....	19.45	.....	b 15.90	12.55	.....	12.30	.....	b 5.50

a Interpolated—no reading. b Reading changed one-half foot or more. c Changed less than one-half foot.

1905.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 5.40	7.00	17.80	18.65	19.30	19.90	22.00	19.90	14.95	17.15	15.30	12.40
2	a 5.40	7.00	19.20	19.00	b 19.60	19.60	22.35	20.60	14.30	16.50	14.90	13.30
3	a 5.40	7.10	19.60	19.60	19.00	19.45	22.50	21.15	14.20	15.90	14.70	13.80
4	5.80	7.10	19.50	19.60	18.35	19.45	22.65	21.45	13.80	15.30	14.70	13.60
5	6.80	6.55	19.50	19.35	17.80	19.70	22.85	21.40	13.50	14.90	14.65	13.40
6	6.80	6.50	20.20	19.20	17.70	20.25	b 23.45	a 20.70	13.20	14.70	15.00	13.10
7	6.85	6.80	20.00	18.70	17.35	a 20.70	b 24.00	a 19.90	13.05	14.50	15.50	12.70
8	7.00	6.80	19.90	18.10	16.20	20.50	24.30	a 19.40	13.00	14.10	15.95	12.20
9	6.80	6.70	19.80	17.70	15.50	20.10	24.20	b 18.90	13.00	13.60	16.00	11.70
10	6.50	6.60	19.45	17.20	15.20	19.60	24.10	18.00	13.05	13.10	15.80	11.10
11	6.10	6.60	19.20	16.90	15.00	19.20	24.00	17.60	13.05	13.00	15.60	10.50
12	6.80	6.35	19.10	16.70	14.80	18.95	23.90	17.30	12.90	12.85	15.25	10.25
13	5.20	7.25	a 18.60	16.50	15.10	19.00	24.05	16.80	13.35	12.70	15.20	10.00
14	4.80	8.80	18.15	16.30	15.00	19.65	24.40	16.35	14.30	12.45	15.20	9.70
15	5.10	10.00	17.45	16.30	15.40	20.35	24.95	16.10	14.30	12.25	15.10	9.70
16	4.60	10.50	16.60	16.30	16.50	20.85	25.10	15.60	13.70	12.00	14.70	9.70
17	4.30	10.90	15.90	16.30	18.20	20.95	a 24.80	15.10	14.90	11.85	14.10	9.70
18	b 3.90	10.10	15.40	16.30	19.70	20.90	24.10	14.80	17.40	11.70	13.55	9.70
19	4.00	9.80	15.20	16.30	20.40	20.60	22.95	14.60	23.40	13.20	13.20	9.70
20	4.70	9.50	15.00	16.15	20.70	20.30	21.80	14.65	26.00	17.95	13.10	9.70
21	5.70	9.10	14.80	16.05	21.30	20.60	22.20	14.90	27.70	17.85	13.20	9.80
22	5.90	9.05	14.60	15.70	21.20	20.80	a 22.60	15.40	28.40	17.00	13.40	9.90
23	6.90	8.70	14.70	15.40	20.60	20.80	21.00	15.75	a 28.70	16.75	13.45	9.95
24	7.40	8.00	15.30	15.50	20.00	20.55	20.50	a 16.60	a 28.10	16.60	13.00	9.95
25	7.35	8.25	16.00	15.80	19.70	20.50	20.30	a 18.60	a 27.20	16.60	12.60	10.00
26	7.00	8.75	16.60	16.40	19.50	20.80	20.50	a 19.25	a 25.15	16.80	12.40	9.90
27	6.80	9.00	16.85	16.95	19.10	21.25	20.90	b 18.85	a 23.25	17.00	12.30	9.75
28	6.30	14.60	17.20	17.50	19.15	21.40	20.40	18.35	a 21.45	17.85	12.20	9.75
29	6.30	.....	17.40	17.80	19.10	21.50	20.00	17.95	19.50	17.30	12.10	9.75
30	6.80	.....	18.00	18.80	19.30	21.65	a 19.30	17.00	18.05	16.55	12.10	a 10.05
31	7.00	.....	18.55	.....	19.85	.....	19.15	15.90	.....	15.95	.....	b 10.70

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1906.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.70	16.50	21.40	25.90	20.90	15.50	20.30	14.00	13.80	15.10	10.20	12.90
2	10.90	16.70	22.00	25.75	20.85	16.00	20.20	13.70	13.40	15.10	10.30	12.70
3	11.80	16.70	22.65	25.40	20.80	16.60	20.30	13.50	13.10	15.20	10.45	12.70
4	12.45	16.50	22.60	a 25.00	20.75	17.10	20.20	13.55	12.90	15.25	10.70	12.80
5	12.90	15.70	21.95	24.65	20.75	b 17.60	a 20.10	13.50	12.80	15.10	10.90	12.85
6	16.00	14.95	21.10	24.50	20.70	18.10	19.90	13.40	12.60	15.00	11.00	13.00
7	17.60	14.30	20.30	24.50	20.60	18.10	19.55	13.20	12.45	14.25	11.10	13.25
8	17.00	13.80	20.10	24.35	21.20	b 18.60	19.30	13.70	12.40	13.55	11.10	13.50
9	16.60	13.00	19.70	24.40	21.60	19.50	b 19.00	14.00	12.30	13.40	11.20	13.70
10	15.70	12.30	19.50	24.40	21.20	19.90	18.60	13.75	12.30	12.75	11.30	13.55
11	14.50	11.95	19.50	24.30	20.60	20.20	18.00	13.70	12.30	12.55	11.30	13.20
12	13.50	11.70	19.10	24.15	20.20	20.30	17.60	14.00	12.30	12.40	11.40	12.90
13	12.60	11.50	18.85	23.85	19.60	20.10	17.20	14.00	12.50	11.95	11.50	12.80
14	12.00	11.40	18.70	23.90	19.25	19.80	17.10	14.30	12.35	11.80	11.50	12.50
15	11.60	11.70	18.10	24.65	18.80	19.50	16.80	14.75	12.20	11.60	11.40	13.20
16	11.30	11.80	17.80	b 25.40	18.30	19.45	16.50	15.15	12.20	11.50	11.40	12.90
17	11.20	11.90	17.20	b 25.25	17.80	19.20	16.40	15.20	12.10	11.40	11.70	12.60
18	11.00	11.90	16.80	b 24.65	17.30	18.85	16.20	15.00	12.00	11.30	11.90	12.30
19	10.80	12.00	16.40	24.10	16.80	18.80	15.90	14.60	12.00	11.10	11.90	12.00
20	10.60	12.15	16.00	23.90	16.50	18.80	15.60	14.25	12.05	11.10	12.10	11.60
21	11.00	12.40	15.50	23.50	16.25	19.10	15.30	14.10	12.20	10.90	14.00	11.00
22	14.20	12.80	15.10	23.15	16.00	19.80	15.10	14.35	12.20	10.75	15.30	10.90
23	a 15.30	13.00	14.85	22.70	15.70	20.40	14.90	14.20	12.15	10.65	14.50	10.50
24	a 15.50	13.50	14.65	22.20	15.40	21.00	14.80	13.90	12.10	10.50	b 14.40	10.10
25	16.50	15.30	14.80	22.10	15.30	21.40	15.10	13.50	12.40	10.50	14.10	a 9.70
26	16.90	17.80	15.10	21.80	15.15	21.50	15.60	13.20	13.25	10.40	13.80	b 9.30
27	16.60	19.80	17.30	21.50	a 15.10	20.90	16.30	13.20	13.70	10.30	13.50	b 8.80
28	16.50	20.80	19.60	21.30	a 15.10	20.25	15.90	14.10	13.90	10.05	13.40	8.50
29	16.30	.....	22.50	21.20	15.20	20.00	15.35	15.10	14.50	10.00	13.20	8.20
30	16.10	.....	b 24.10	20.95	15.30	b 20.25	14.90	b 14.70	14.90	10.00	13.10	9.00
31	16.20	.....	25.20	.....	15.30	.....	14.40	a 14.10	.....	10.10	.....	9.80

a Changed less than one-half foot. b Reading changed one-half foot or more.

1907.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.05	19.5	16.8	17.2	19.0	17.3	23.4	25.2	16.0	12.3	10.6	9.55
2	10.2	a 18.8	16.8	17.8	19.5	17.4	22.9	24.6	15.9	12.3	10.7	9.5
3	12.6	18.1	16.65	17.9	20.0	17.7	22.5	b 23.9	15.7	12.4	10.6	9.45
4	13.9	17.55	16.4	18.2	20.0	18.3	22.1	22.8	15.6	12.7	10.6	9.4
5	13.4	16.7	16.15	18.1	19.9	b 19.5	21.5	22.0	15.5	13.1	10.5	9.4
6	13.85	15.8	15.9	18.0	19.7	21.65	20.9	21.3	15.4	13.6	10.35	9.2
7	14.5	14.9	15.85	18.0	19.5	22.1	20.4	21.0	15.3	14.0	10.35	9.1
8	14.85	13.7	15.7	17.7	19.3	22.0	20.2	20.6	15.25	14.3	10.25	9.0
9	15.0	12.8	15.5	17.7	20.0	21.6	20.4	20.5	15.1	14.1	10.1	9.1
10	14.9	12.1	15.2	17.7	20.8	21.4	20.5	20.4	14.8	14.3	a 10.05	9.0
11	14.8	11.7	15.0	17.85	21.1	21.9	20.5	20.25	14.4	14.6	10.0	9.0
12	14.65	11.55	15.05	17.85	20.8	21.8	20.5	20.0	14.1	14.8	9.9	8.8
13	14.5	b 11.5	16.1	18.5	19.9	22.5	20.45	19.5	13.7	14.85	9.8	8.7
14	14.4	b 12.1	b 18.9	19.1	19.1	23.3	20.5	19.0	13.4	14.8	9.7	8.7
15	14.6	b 12.5	a 20.2	19.5	18.9	23.8	21.0	18.7	13.1	14.5	9.6	8.8
16	15.0	13.6	20.4	19.5	18.85	23.8	21.4	18.6	13.0	14.1	9.6	8.8
17	15.5	13.7	19.5	19.3	20.0	24.1	21.7	18.3	12.8	13.7	9.55	8.8
18	16.6	13.7	19.4	19.25	21.65	23.6	22.3	18.1	12.55	13.35	9.6	8.9
19	18.8	13.8	19.2	19.25	21.9	22.9	23.2	17.8	12.3	13.0	9.5	9.0
20	21.3	14.2	19.1	19.5	21.6	22.1	24.05	18.2	12.0	12.7	9.7	9.05
21	23.7	14.2	19.1	20.0	20.6	21.65	24.3	18.9	11.9	12.45	9.95	9.0
22	25.6	13.9	19.2	20.5	19.6	21.2	24.55	19.2	11.7	12.2	9.8	8.8
23	26.2	13.8	18.8	20.8	18.7	20.9	25.05	19.6	11.5	12.0	9.8	9.0
24	26.4	14.4	18.0	20.7	17.8	20.85	25.55	20.2	11.5	11.7	9.8	9.4
25	26.3	15.2	17.5	20.7	17.1	21.3	26.0	19.5	11.7	11.5	9.75	9.55
26	25.4	16.4	17.1	20.8	16.6	22.3	26.2	19.2	11.85	11.35	9.7	9.5
27	24.4	16.7	16.8	20.4	16.0	23.1	26.3	19.5	12.0	11.3	9.6	9.4
28	23.0	16.8	16.7	20.0	15.8	23.8	26.0	18.5	12.15	11.1	9.6	9.4
29	21.9	.....	b 16.6	a 19.6	16.1	24.1	25.7	17.4	12.2	11.0	9.6	9.5
30	20.8	.....	16.5	b 19.0	16.5	23.9	25.5	16.75	12.3	10.8	9.6	9.45
31	20.1	.....	16.8	.....	16.5	.....	25.2	16.35	.....	10.7	.....	9.1

a Changed less than one-half foot. b Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

MOCCASIN SPRINGS, MO.—Continued.

1908.

[Gauge, 116.80 miles from Eads Bridge. Zero of gauge, 320.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

[Gauge discontinued after January 31, 1908.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	9.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	9.05	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
4	9.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
5	8.90	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
6	8.80	.....	.....	.....	.....	28.30	.....	.....	.....	.....	.....	.....
7	8.70	.....	.....	.....	.....	28.30	.....	.....	.....	.....	.....	.....
8	8.65	.....	.....	.....	.....	28.20	.....	.....	.....	.....	.....	.....
9	8.50	.....	.....	.....	.....	28.35	.....	.....	.....	.....	.....	.....
10	8.45	.....	.....	.....	.....	28.25	.....	.....	.....	.....	.....	.....
11	8.50	.....	.....	.....	.....	28.30	.....	.....	.....	.....	.....	.....
12	9.90	.....	.....	.....	.....	28.30	.....	.....	.....	.....	.....	.....
13	10.10	.....	.....	.....	.....	28.60	.....	.....	.....	.....	.....	.....
14	10.60	.....	.....	.....	.....	29.00	.....	.....	.....	.....	.....	.....
15	10.90	.....	.....	.....	.....	29.15	.....	.....	.....	.....	.....	.....
16	10.20	.....	.....	.....	.....	29.90	.....	.....	.....	.....	.....	.....
17	10.00	.....	.....	.....	.....	30.30	.....	.....	.....	.....	.....	.....
18	9.55	.....	.....	.....	.....	30.80	.....	.....	.....	.....	.....	.....
19	9.10	.....	.....	.....	.....	31.25	.....	.....	.....	.....	.....	.....
20	9.00	.....	.....	.....	.....	31.60	.....	.....	.....	.....	.....	.....
21	8.70	.....	.....	.....	.....	31.80	.....	.....	.....	.....	.....	.....
22	8.35	.....	.....	.....	.....	31.90	.....	.....	.....	.....	.....	.....
23	8.30	.....	.....	.....	.....	31.90	.....	.....	.....	.....	.....	.....
24	8.20	.....	.....	.....	.....	31.75	.....	.....	.....	.....	.....	.....
25	8.60	.....	.....	.....	.....	31.60	.....	.....	.....	.....	.....	.....
26	8.60	.....	.....	.....	.....	31.35	.....	.....	.....	.....	.....	.....
27	8.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
28	8.65	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	8.50	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	8.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	8.15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

GRAYS POINT, MO.

1896.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.0	7.4	9.0	11.0	13.7	26.8	18.7	16.2	11.4	10.4	7.2	8.70
2	17.2	7.4	10.3	11.0	14.6	26.2	18.4	15.9	11.1	10.0	7.10	[a] 8.70
3	16.2	8.2	10.8	10.7	15.1	25.7	18.6	15.8	10.6	9.6	7.10	[a] 8.60
4	15.2	9.0	11.2	10.4	15.2	25.7	18.7	15.8	10.3	9.3	7.60	8.50
5	14.2	9.6	11.2	10.2	15.2	25.7	18.8	16.1	10.1	9.0	7.95	8.55
6	13.0	10.2	11.0	10.0	15.2	25.6	18.8	16.3	9.7	8.9	8.70	8.50
7	12.1	10.4	10.6	10.0	15.2	25.4	18.8	16.4	9.6	8.7	9.50	8.35
8	11.4	10.5	10.4	10.0	15.2	25.4	18.6	16.2	9.2	8.6	10.60	8.00
9	10.8	10.6	10.1	10.1	15.2	24.8	18.4	16.2	8.9	8.5	11.15	7.60
10	10.2	10.5	9.8	10.2	15.4	24.5	18.4	15.9	8.8	8.4	11.00	7.30
11	9.8	10.2	9.5	10.4	15.6	24.3	18.5	15.3	8.6	8.4	10.65	7.10
12	9.1	9.8	9.4	11.2	15.8	23.9	18.0	14.8	8.5	8.4	10.10	6.90
13	8.6	9.6	9.2	14.1	16.0	23.5	17.4	14.3	8.3	8.4	9.90	6.85
14	8.4	10.4	9.0	15.2	16.0	22.7	16.8	14.1	8.2	8.4	9.70	6.80
15	8.2	11.8	8.8	15.2	15.4	21.6	16.0	13.8	8.1	8.4	9.40	6.90
16	8.0	13.4	8.6	14.7	15.3	20.2	15.2	13.4	8.2	8.4	9.30	[a] 7.25
17	8.0	13.7	8.5	14.2	15.4	19.1	14.9	13.2	8.4	8.5	9.20	7.60
18	7.9	13.2	8.3	13.8	15.2	18.5	14.5	12.8	8.5	8.7	9.10	7.90
19	7.8	12.7	8.1	13.5	15.3	18.8	14.5	12.4	8.6	8.6	9.00	8.40
20	7.8	12.2	8.0	13.1	17.4	19.4	14.6	12.1	8.8	8.5	9.05	9.00
21	7.8	11.6	7.8	12.6	20.8	19.6	16.3	12.2	9.6	8.4	9.10	9.50
22	7.6	10.7	7.8	12.2	[b] 23.3	19.5	17.9	12.9	10.2	8.1	9.10	9.70
23	7.8	9.5	8.0	12.0	24.8	19.5	19.4	13.6	11.1	8.0	9.05	9.85
24	8.4	9.0	9.7	11.7	25.5	19.0	22.2	13.9	11.9	7.9	9.00	9.75
25	8.5	8.4	9.9	11.5	26.2	18.5	22.2	14.0	12.2	7.8	8.85	9.60
26	8.5	8.1	10.0	11.3	[b] 26.8	18.3	21.7	13.8	12.0	7.7	8.75	9.50
27	8.6	8.0	10.5	11.4	27.4	18.2	20.6	13.5	11.6	7.6	8.75	9.40
28	8.4	8.3	11.2	11.6	27.5	18.2	19.7	13.2	11.3	7.4	8.70	9.25
29	8.0	9.0	11.1	12.2	27.9	18.4	18.9	12.9	11.1	7.3	8.75	9.05
30	7.7	.....	11.0	12.9	27.7	16.8	17.8	12.3	10.7	7.3	8.70	8.90
31	7.6	.....	11.0	.....	27.4	.....	17.4	11.9	.....	7.2	.....	8.80

[a] Reading changed less than one-half foot.
[b] Doubtful. Readings on the following dates are deduced from readings on Grays Point, Engineer gauge June 21-27, inclusive; July 12-Aug. 1, inclusive; Aug. 8-Nov. 1, inclusive.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1897.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.75	10.95	17.25	27.80	28.60	16.85	21.45	15.60	9.90	7.10	6.05	6.50
2	8.75	10.25	16.80	29.10	29.20	16.25	21.75	15.10	9.60	7.00	6.15	6.40
3	8.80	9.60	17.25	30.50	29.50	15.75	a 21.50	14.90	9.30	6.95	6.20	6.30
4	10.00	9.40	17.80	31.10	29.60	15.70	21.50	14.60	9.10	6.90	6.25	6.20
5	19.50	9.70	18.90	31.10	29.35	15.90	21.60	14.40	8.90	6.90	6.20	5.95
6	24.00	9.90	21.90	a 30.90	29.10	16.55	21.80	14.20	8.70	6.80	6.15	5.60
7	25.10	10.25	b 24.30	30.80	28.50	16.85	21.60	14.00	8.55	6.80	6.15	5.00
8	25.50	10.35	26.70	30.90	27.65	17.45	20.80	13.80	8.40	6.75	6.30	4.60
9	24.30	10.65	27.35	31.20	a 26.90	17.70	20.40	13.55	8.40	6.65	6.40	4.10
10	22.20	a 11.00	27.30	a 31.30	26.10	17.55	20.50	13.55	8.40	6.60	6.80	3.70
11	19.90	11.90	26.20	31.60	24.90	17.35	b 20.40	13.70	8.40	6.55	6.80	3.50
12	17.80	12.75	a 25.60	31.80	24.40	17.15	19.40	13.55	8.30	6.50	6.90	3.60
13	b 16.10	13.70	25.40	31.90	23.50	16.80	18.70	13.25	8.20	6.45	6.95	3.70
14	14.75	13.80	25.20	31.55	22.60	16.45	b 18.50	12.90	8.00	6.40	7.00	3.90
15	13.80	a 14.10	25.10	31.30	21.70	16.25	17.80	12.75	7.85	6.35	7.00	4.30
16	13.10	a 14.50	24.70	30.60	21.10	15.90	16.70	12.65	7.70	6.30	6.85	4.30
17	12.80	14.90	24.50	29.90	a 20.60	15.85	16.10	12.55	7.70	6.20	6.95	4.80
18	12.65	15.30	24.90	29.40	20.10	15.80	15.70	12.50	7.50	6.10	7.00	5.10
19	12.65	15.10	25.60	29.20	19.50	a 15.90	15.70	12.40	7.30	6.10	7.00	5.00
20	13.55	14.90	a 25.50	28.80	19.10	b 16.30	15.60	12.20	7.20	6.05	6.80	4.80
21	15.00	14.40	25.40	28.60	a 18.60	b 16.30	15.80	12.05	7.15	6.05	6.70	4.20
22	15.70	14.30	25.70	28.50	18.10	a 16.10	15.70	11.90	7.10	6.00	6.55	3.70
23	16.05	15.40	26.10	28.45	17.55	16.85	15.10	11.85	7.10	5.95	6.40	3.60
24	.....	16.55	26.40	28.40	17.05	16.70	14.80	11.65	7.00	5.90	6.45	3.40
25	.....	17.35	26.60	28.30	16.70	b 18.20	14.40	11.60	7.00	5.90	6.50	3.10
26	.....	17.90	26.60	28.25	16.35	17.90	14.70	11.45	7.10	5.90	6.60	2.95
27	.....	17.80	26.80	b 27.60	16.55	18.10	b 15.70	11.15	7.30	5.90	6.50	2.90
28	.....	17.55	b 27.80	b 27.45	16.85	18.90	17.55	10.95	7.30	5.90	6.50	3.05
29	13.25	.....	a 28.00	a 27.50	a 17.00	b 18.95	18.20	10.60	7.25	6.00	6.40	3.40
30	12.65	.....	27.90	27.90	16.85	b 19.80	17.70	10.30	7.15	6.00	6.50	4.30
31	11.85	.....	27.70	.....	16.85	.....	16.55	10.10	.....	6.00	.....	4.50

a Changed less than one-half foot. b Reading changed one-half foot or more.

1898.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.90	14.80	11.30	28.20	17.70	21.80	23.05	14.50	10.10	10.80	12.70	10.20
2	5.20	14.75	10.90	28.00	17.15	21.15	23.10	14.65	9.75	10.60	12.45	9.40
3	5.15	14.30	10.75	27.10	16.95	20.65	23.10	14.35	9.40	10.00	11.80	8.90
4	5.30	14.10	10.50	26.20	17.65	20.80	22.60	15.10	9.10	9.60	11.05	8.20
5	5.20	12.50	10.40	25.60	20.00	21.30	21.80	15.75	8.90	9.30	10.40	8.10
6	5.00	11.30	10.20	25.00	21.70	21.70	21.10	15.50	8.70	9.00	10.00	7.70
7	5.00	10.10	10.10	24.60	22.70	21.80	20.60	14.80	8.50	8.90	9.70	7.40
8	5.45	8.75	10.00	24.55	22.50	21.70	20.90	14.60	8.40	8.60	9.70	7.10
9	5.95	7.75	9.90	24.20	22.15	20.95	22.70	14.80	8.45	8.30	9.80	6.85
10	6.35	7.50	9.80	23.70	21.70	20.30	23.00	14.00	8.80	8.00	10.00	6.60
11	6.95	7.95	9.80	23.30	21.10	20.00	22.80	13.85	9.50	7.90	10.20	6.20
12	7.50	8.50	10.35	22.70	20.60	20.35	22.50	13.50	10.30	7.75	10.40	5.65
13	8.60	8.80	12.50	21.80	19.80	21.30	21.60	12.90	11.30	7.70	10.75	4.95
14	9.70	9.30	13.70	20.90	18.90	22.20	20.70	12.40	11.60	8.10	10.85	4.50
15	10.10	10.20	16.45	20.30	18.60	22.95	19.80	12.50	11.50	8.50	10.70	4.20
16	10.50	11.30	18.60	19.85	18.25	23.20	18.95	12.50	11.05	8.20	10.50	4.35
17	10.30	11.50	19.00	19.55	18.00	23.80	18.00	12.40	10.50	7.80	10.25	4.50
18	10.10	11.70	19.50	19.00	19.70	24.90	17.10	12.30	10.85	7.50	10.00	4.90
19	10.05	11.70	19.65	18.40	22.10	25.30	16.30	12.10	12.10	7.30	9.70	6.20
20	10.50	11.90	19.85	17.60	23.20	25.20	15.70	11.90	13.00	7.30	9.40	7.00
21	11.50	12.50	20.30	16.90	23.60	24.35	15.20	11.90	13.10	8.00	9.30	7.10
22	11.70	13.30	21.00	16.50	24.00	23.35	14.85	12.70	12.60	9.20	9.30	7.00
23	12.60	14.05	23.00	16.10	25.70	a 22.35	14.80	13.30	12.00	11.00	9.20	7.50
24	13.60	13.95	26.30	15.70	26.90	21.40	14.40	13.10	11.30	12.30	9.20	8.70
25	14.10	13.20	27.30	15.55	27.00	20.70	13.90	13.40	11.05	12.80	9.40	10.40
26	14.40	12.55	27.30	15.50	26.50	20.20	13.60	11.70	11.55	12.60	10.00	11.70
27	14.80	12.05	27.50	16.10	25.75	20.75	13.65	11.30	11.70	12.30	10.80	12.45
28	15.00	11.70	28.10	17.80	25.00	20.75	13.80	10.95	11.50	11.60	11.70	12.70
29	15.20	.....	27.70	18.80	23.80	21.95	14.40	10.55	11.40	11.20	11.75	12.65
30	15.40	.....	27.60	18.40	23.30	22.80	14.00	10.30	10.90	11.50	11.00	12.20
31	15.10	.....	27.95	.....	22.60	.....	14.00	10.15	.....	12.40	.....	11.90

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1899.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	11.75	7.20	16.60	19.50	25.55	23.70	21.45	16.10	10.20	8.10	7.50	8.50
2	10.85	6.40	18.20	19.50	25.65	23.60	21.50	15.95	10.20	8.00	7.30	8.40
3	9.90	6.40	18.50	19.50	25.60	23.80	21.50	16.00	10.25	7.90	7.20	8.20
4	9.15	6.40	18.00	19.20	25.30	24.30	21.70	a 15.90	10.20	7.80	7.25	8.00
5	9.40	7.50	17.80	19.15	24.40	24.40	22.40	15.70	10.00	7.70	7.50	8.00
6	9.00	8.90	17.50	19.25	23.20	24.40	22.85	15.50	9.80	7.60	7.70	8.00
7	8.70	8.90	17.40	19.50	22.50	24.50	23.10	a 15.45	9.60	7.50	7.90	8.00
8	8.65	9.40	a 17.30	19.75	21.90	24.50	23.35	15.10	9.45	7.40	8.10	7.90
9	8.80	9.50	17.30	19.50	21.30	24.00	23.50	14.75	9.35	7.30	8.30	7.75
10	9.05	9.50	16.95	19.30	21.20	23.60	23.50	14.70	9.20	7.10	8.50	7.75
11	8.80	9.40	16.90	19.00	21.70	23.60	23.40	15.50	a 9.20	7.05	8.60	7.80
12	8.70	9.60	17.00	18.60	22.00	23.60	23.60	17.00	9.35	7.05	8.80	7.80
13	9.00	9.80	17.20	18.60	22.70	23.70	23.90	17.40	9.40	7.00	8.95	7.70
14	10.30	9.90	17.50	19.40	23.00	24.50	23.70	17.20	9.40	6.95	9.10	7.70
15	11.50	10.00	17.80	19.40	23.20	25.10	23.20	16.80	9.40	6.80	9.15	7.70
16	11.50	10.10	18.30	18.80	23.10	24.80	22.70	16.60	9.40	6.70	9.20	7.75
17	11.35	10.20	19.30	18.10	22.70	24.00	22.10	16.00	9.30	6.80	9.20	7.85
18	11.50	10.35	20.30	17.70	22.00	23.40	21.70	15.20	9.20	6.75	9.20	7.65
19	11.70	10.40	20.80	17.55	21.60	23.30	21.35	14.60	9.15	6.75	9.10	7.30
20	11.70	10.30	21.40	17.45	20.90	23.30	21.20	14.10	a 9.30	6.85	9.10	7.30
21	11.50	11.25	22.30	17.60	20.40	23.20	21.10	13.70	9.40	6.80	9.15	7.60
22	11.20	10.50	23.10	18.40	20.60	23.00	20.80	13.30	9.35	6.80	9.10	8.00
23	10.85	9.70	23.30	19.20	21.30	22.70	20.20	12.95	9.15	6.70	9.00	8.00
24	10.30	8.90	23.00	21.60	22.80	22.20	19.65	12.50	8.90	6.60	9.20	7.70
25	10.20	8.00	22.50	24.00	24.00	21.60	19.20	12.00	8.80	6.55	9.30	7.30
26	10.00	9.00	22.00	25.25	24.80	21.20	18.75	11.60	8.60	6.50	9.40	6.90
27	9.60	11.70	21.50	25.80	25.30	20.90	18.25	11.30	8.50	6.45	9.40	6.30
28	9.40	13.00	21.00	26.00	25.25	20.80	17.70	10.95	8.40	6.60	9.10	5.80
29	9.10	.....	20.60	25.70	24.90	20.90	17.20	10.75	8.25	6.70	8.70	5.30
30	8.75	.....	20.20	25.55	24.30	21.25	17.00	10.55	8.20	6.90	8.65	5.05
31	8.20	.....	19.60	.....	23.90	.....	16.40	10.30	.....	7.30	.....	4.00

a Changed less than one-half foot.

1900.

[Gauge, 136.82, miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.20	6.50	10.90	16.10	18.10	16.10	15.55	14.00	11.55	11.70	14.50	13.70
2	2.20	5.80	10.30	15.70	17.60	15.70	15.00	13.80	12.05	12.20	14.05	13.20
3	1.50	5.10	10.00	15.90	a 17.30	15.40	14.70	13.40	12.30	12.05	14.35	12.60
4	1.50	3.80	10.00	16.05	17.20	15.50	14.65	13.00	12.35	13.30	13.90	12.20
5	1.50	4.80	10.00	16.00	17.30	15.45	14.40	12.60	12.35	14.30	13.70	11.75
6	2.70	4.00	10.70	16.10	17.20	15.20	14.45	12.30	12.35	14.85	13.80	11.40
7	3.50	3.90	12.80	16.45	17.20	14.90	14.35	11.85	12.45	14.80	14.00	10.90
8	0.40	4.90	17.30	16.85	17.70	14.60	14.10	11.40	12.40	14.35	a 14.50	10.55
9	0.60	6.00	19.95	17.60	18.00	14.35	13.65	10.90	12.00	14.25	15.10	a 10.10
10	7.00	7.80	20.40	17.80	18.20	14.20	13.30	10.50	11.45	14.50	15.35	10.10
11	8.00	9.80	21.00	17.90	18.10	14.10	13.10	10.10	11.00	14.80	15.20	9.90
12	7.30	10.90	22.10	17.65	18.00	13.85	13.10	9.80	10.55	14.45	14.85	9.80
13	6.70	10.80	23.05	17.60	17.70	13.50	12.80	9.40	10.20	13.80	14.60	9.65
14	6.30	10.50	23.90	18.00	17.80	13.50	12.90	9.15	9.90	13.15	14.35	9.40
15	6.30	10.30	24.60	18.80	18.15	14.10	12.80	8.85	9.65	12.75	14.25	9.20
16	6.20	10.10	24.90	19.70	17.75	16.30	12.50	8.55	9.30	12.50	14.00	9.00
17	6.20	10.00	24.90	19.40	17.00	16.55	12.30	8.40	9.20	12.30	13.85	8.80
18	6.00	9.90	24.70	18.70	16.30	15.90	12.50	8.25	9.10	12.20	13.75	8.60
19	6.00	9.65	24.10	17.90	16.05	15.20	12.50	8.20	9.00	12.15	13.85	8.35
20	6.50	9.90	23.10	17.30	16.00	14.80	12.30	8.50	8.90	12.20	14.05	8.05
21	7.80	9.90	22.00	17.10	16.05	14.70	12.30	9.60	8.90	12.30	14.00	7.85
22	9.60	9.90	21.00	17.35	15.95	14.70	12.15	10.70	9.00	12.50	14.00	7.60
23	10.00	11.00	20.20	17.70	16.00	15.50	12.35	11.40	9.30	12.75	14.20	7.55
24	9.50	11.40	19.70	18.00	16.00	16.60	13.20	11.60	9.70	13.10	14.70	7.30
25	8.80	12.40	19.30	18.40	16.00	17.60	14.50	11.60	10.10	13.55	14.50	7.20
26	8.65	12.50	18.80	18.70	15.85	17.75	15.40	11.65	10.20	13.85	14.50	7.05
27	8.60	12.00	18.30	19.00	15.50	17.55	15.60	11.70	10.50	14.10	14.45	7.00
28	8.50	11.50	18.05	19.15	15.25	17.50	15.60	11.50	10.45	14.30	14.30	7.00
29	8.40	.....	17.60	18.90	14.95	16.90	15.20	11.50	10.60	14.50	14.20	7.10
30	7.90	.....	17.00	18.40	14.75	16.10	14.85	11.45	11.05	14.25	a 14.00	7.05
31	7.30	.....	16.50	.....	15.20	.....	14.40	11.30	.....	14.30	.....	6.80

a Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1901.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.60	7.95	8.00	19.60	19.55	12.60	16.80	10.90	7.40	6.90	7.40	6.45
2	6.40	7.80	7.95	19.95	19.30	12.50	16.30	10.90	7.25	6.80	7.40	6.40
3	6.25	7.70	7.70	20.20	19.00	12.40	15.80	11.10	7.10	6.70	7.40	6.30
4	6.00	7.60	7.40	20.30	18.65	12.60	15.35	11.10	7.00	6.50	7.30	6.25
5	5.80	7.50	7.10	20.45	18.20	13.80	14.80	11.10	6.85	6.40	7.20	6.20
6	5.50	7.60	7.20	20.60	17.80	14.65	14.25	11.00	6.70	6.30	7.00	6.10
7	5.20	7.45	7.80	21.00	17.40	14.85	13.80	10.80	6.60	6.40	6.90	6.05
8	4.95	7.50	8.10	21.20	16.90	15.00	13.30	10.50	6.50	6.45	6.80	6.00
9	4.80	7.40	8.55	21.50	16.40	15.30	13.20	10.20	6.40	6.50	6.75	6.00
10	5.00	6.85	10.10	21.90	15.95	15.50	13.20	9.90	6.35	6.55	6.70	6.10
11	5.40	6.10	11.80	22.70	15.50	15.45	13.60	9.60	6.30	6.70	6.60	6.10
12	5.90	5.60	14.00	23.30	15.20	15.20	14.00	9.40	6.40	6.80	6.70	6.05
13	6.70	5.80	17.40	23.60	14.95	15.00	13.90	9.30	6.30	6.90	6.80	6.10
14	7.80	6.10	18.70	23.95	14.80	14.90	13.40	9.20	6.20	6.90	6.85	a 6.40
15	8.30	6.20	19.10	23.90	14.60	14.90	13.00	9.00	6.10	6.90	6.85	6.70
16	8.60	6.25	19.00	23.80	14.40	15.50	12.90	9.00	5.95	6.80	6.80	b 6.60
17	8.80	6.30	18.85	23.65	14.10	16.00	12.80	8.95	5.95	6.70	6.80	b 6.00
18	8.70	6.35	18.70	23.80	13.85	16.05	12.70	8.90	5.85	c 6.80	6.80	b 5.50
19	8.65	6.40	18.60	24.40	13.70	15.70	12.70	8.70	5.90	6.95	6.75	b 4.00
20	8.80	6.50	18.50	24.60	13.50	15.30	12.70	8.60	6.00	7.10	6.70	b 4.50
21	8.70	6.80	18.35	24.20	13.40	15.00	12.70	8.50	6.25	7.30	6.70	b 3.80
22	8.50	7.00	18.10	23.30	13.15	14.90	12.95	8.40	6.80	7.50	6.70	b 3.90
23	8.30	6.65	18.40	22.60	12.90	14.90	13.20	8.45	7.80	7.55	6.70	b 4.30
24	8.25	6.65	19.10	22.10	12.70	15.00	13.00	8.30	8.25	7.60	6.70	b 4.70
25	8.30	6.45	19.65	21.60	12.50	15.60	12.60	8.15	8.10	7.55	6.60	b 4.90
26	8.30	6.60	20.10	21.00	12.30	16.30	12.30	8.05	7.85	7.45	6.65	b 4.90
27	8.20	6.95	20.35	20.50	12.60	16.50	11.95	7.90	7.50	7.40	6.60	b 6.20
28	8.00	7.60	20.25	22.20	13.00	16.70	11.60	7.80	7.30	7.30	6.55	b 5.50
29	8.00	.....	20.00	19.95	13.25	17.00	11.40	7.70	7.10	7.30	6.50	b 5.50
30	7.90	.....	19.90	19.70	13.10	17.10	11.30	7.60	6.95	7.30	6.45	b 5.40
31	7.95	.....	19.80	.....	12.85	.....	11.00	7.50	.....	7.35	.....	b 5.20

a Interpolated—no reading. b Doubtful on account of ice. c Changed less than one-half foot.

1902.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 4.90	a 2.90	8.35	13.50	11.30	19.10	22.00	23.40	21.00	16.70	13.60	15.70
2	a 4.80	a 3.50	8.00	13.80	11.40	18.80	22.90	22.70	20.60	17.30	13.20	16.00
3	a 4.50	a 4.95	8.70	14.40	11.30	18.50	23.60	22.00	20.20	17.20	12.80	16.10
4	a 4.40	a 5.50	9.00	14.80	11.90	19.10	24.10	21.40	19.80	17.30	12.50	15.55
5	a 4.50	a 5.50	9.20	15.00	13.20	20.00	24.20	20.60	19.90	17.80	12.20	15.30
6	a 4.40	a 5.50	10.20	15.10	13.40	20.10	24.00	20.20	20.20	18.50	11.90	15.20
7	a 4.60	a 6.50	10.20	15.00	13.00	19.80	23.50	19.80	20.20	18.80	11.90	15.20
8	a 5.00	a 7.00	10.20	15.30	12.40	19.70	23.00	19.60	19.60	19.40	12.30	15.30
9	a 5.25	a 6.90	10.70	15.60	11.60	19.20	22.60	19.50	18.80	20.35	12.65	15.40
10	5.45	a 7.00	11.70	15.20	11.00	18.80	22.30	19.20	17.80	20.95	12.90	15.50
11	5.50	a 6.30	12.90	14.45	10.90	18.80	22.30	18.90	17.00	21.00	13.50	15.00
12	5.50	a 6.40	13.50	13.75	11.50	19.20	22.60	18.40	16.40	20.50	13.90	14.40
13	5.45	a 6.40	13.70	13.20	12.55	19.90	21.80	18.00	15.90	19.50	13.90	13.70
14	5.35	a 6.30	14.00	12.70	13.00	20.20	22.00	17.60	15.40	19.00	13.60	13.80
15	5.10	a 5.30	14.00	12.40	13.60	20.20	23.00	17.50	14.80	18.30	13.10	14.50
16	4.70	a 5.90	15.70	12.00	13.80	20.90	23.80	17.30	14.20	17.60	12.80	14.85
17	4.45	a 6.50	16.30	11.75	13.80	21.20	24.40	16.70	13.70	17.00	12.50	14.50
18	4.75	a 6.60	17.00	11.40	13.70	21.00	24.80	16.30	13.30	16.60	12.40	13.70
19	5.00	a 6.80	16.70	11.25	13.60	20.70	25.00	16.20	13.10	16.50	12.40	13.40
20	5.15	a 7.00	16.20	11.30	13.60	20.50	25.40	16.40	12.50	16.50	12.90	13.60
21	5.10	a 6.70	15.50	11.30	13.90	20.30	25.40	16.65	12.10	16.80	13.90	14.00
22	5.20	a 6.80	14.60	11.00	14.20	20.00	25.20	17.50	11.60	16.95	14.70	14.50
23	5.20	a 6.90	13.60	10.50	14.00	19.50	25.10	18.40	11.20	17.40	15.20	15.00
24	5.30	a 7.10	12.90	10.30	13.70	19.20	25.25	18.80	10.90	17.75	15.20	15.80
25	5.30	a 7.10	12.40	10.50	13.90	19.20	25.50	18.95	10.60	17.85	15.00	16.20
26	5.20	a 7.30	12.00	11.00	14.80	19.20	25.80	18.95	10.70	17.80	14.80	16.90
27	a 5.00	a 6.80	11.70	11.50	15.30	19.20	25.80	19.10	12.50	17.55	14.80	17.20
28	a 4.50	a 7.50	11.60	11.00	15.70	19.30	25.80	19.60	13.90	17.00	14.80	17.10
29	a 4.30	.....	13.00	10.90	17.00	19.80	25.40	19.90	14.85	16.10	15.10	16.30
30	a 3.60	.....	13.30	10.70	18.80	21.30	24.80	20.50	15.70	15.00	15.30	15.50
31	a 3.10	.....	13.30	.....	19.30	.....	24.00	20.90	.....	14.30	.....	14.60

a Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1903.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	13.30	13.40	17.60	22.00	20.60	24.70	21.80	18.95	18.00	18.20	16.90	9.50
2	12.40	13.35	19.00	21.55	20.20	26.00	21.60	18.40	18.40	18.30	16.80	9.30
3	11.75	13.10	19.40	21.30	19.70	27.70	21.55	17.80	19.50	18.30	16.60	9.10
4	11.50	13.10	19.55	20.95	19.30	28.70	21.10	17.20	20.50	18.30	16.45	8.85
5	11.50	13.70	20.20	20.70	18.80	29.80	20.50	17.30	20.65	18.50	16.25	8.60
6	11.80	16.30	21.10	21.10	18.55	31.00	19.80	17.05	20.50	18.60	16.10	8.30
7	12.00	18.15	21.90	21.75	18.20	31.85	19.20	16.50	19.95	18.90	16.00	8.10
8	12.10	18.00	23.10	22.40	18.00	32.75	18.70	16.60	19.30	19.40	16.10	7.95
9	12.10	17.50	24.60	22.70	17.90	33.40	18.55	17.60	18.80	19.70	16.50	7.90
10	11.90	17.00	26.90	22.55	17.90	33.85	18.40	18.00	18.70	20.30	16.60	7.70
11	11.50	16.50	27.80	22.05	17.90	34.30	18.50	18.10	18.45	21.40	16.30	7.45
12	11.10	16.10	28.30	22.00	17.90	34.70	18.50	18.20	18.20	22.30	16.10	7.30
13	10.20	16.00	28.30	22.70	17.80	35.05	18.30	18.30	18.75	22.40	15.90	7.10
14	9.40	16.25	27.95	23.90	17.60	35.40	17.90	18.30	20.20	22.00	15.50	6.85
15	8.70	16.70	27.80	24.40	17.45	35.40	17.60	18.35	21.10	21.70	15.10	6.30
16	8.20	17.50	27.80	24.90	17.20	35.10	17.70	18.40	21.30	21.40	14.70	5.50
17	8.00	17.60	27.90	25.25	17.10	34.50	18.00	18.70	21.50	21.00	14.30	4.90
18	8.20	17.30	27.30	25.30	17.00	33.70	18.80	18.50	21.85	20.50	14.00	4.40
19	8.60	16.80	27.10	25.70	19.00	32.50	19.80	18.35	21.50	20.00	13.70	4.30
20	9.20	16.40	27.10	25.95	20.90	31.00	20.40	18.60	21.30	19.50	13.30	4.70
21	9.90	17.70	27.00	25.50	21.50	29.40	20.30	18.75	21.30	19.10	12.90	5.30
22	10.10	17.70	27.00	25.25	21.40	28.10	19.90	18.80	21.00	18.70	12.50	5.60
23	10.10	19.00	27.20	25.20	21.10	27.20	19.60	18.90	20.30	18.30	12.30	6.00
24	10.00	16.80	27.00	25.00	20.80	26.40	19.70	18.60	19.60	18.00	12.00	6.25
25	9.90	16.30	26.45	24.50	20.70	25.70	19.70	18.00	19.00	17.70	11.70	6.60
26	9.85	16.35	26.00	24.00	20.80	25.25	20.00	17.50	18.30	17.40	11.30	7.00
27	9.70	16.40	25.40	23.35	22.50	25.00	20.50	17.30	18.00	17.20	11.00	7.60
28	9.80	16.70	24.60	22.80	23.20	24.30	21.00	17.00	17.80	17.20	10.60	7.40
29	10.50	.....	23.70	22.00	24.00	23.30	20.50	16.80	17.80	17.15	10.25	7.25
30	12.00	.....	23.00	21.40	24.00	22.40	20.00	16.90	18.00	17.00	9.80	7.30
31	13.30	.....	22.40	.....	24.00	.....	19.50	17.35	.....	[a] 16.90	.....	7.55

[a] Changed less than one-half foot.

1904.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.75	12.50	11.60	28.90	33.00	21.80	23.95	15.90	12.10	14.30	12.40	8.55
2	8.10	11.60	11.25	28.95	33.05	23.50	24.45	15.60	11.50	14.00	12.55	8.45
3	8.40	10.70	10.90	28.75	33.00	25.10	23.90	15.20	11.10	14.40	12.55	8.30
4	8.25	10.05	10.70	28.65	32.80	25.40	23.20	14.80	10.70	14.10	12.40	8.20
5	7.95	9.40	10.70	28.30	32.40	25.10	23.00	14.50	[a] 10.70	13.70	12.40	8.10
6	7.45	9.05	10.90	27.90	31.60	25.50	22.85	14.30	10.85	13.20	12.20	8.00
7	7.10	10.30	11.50	27.20	30.70	27.00	22.40	14.10	11.10	12.60	12.05	7.90
8	7.15	10.80	12.20	26.60	29.60	28.10	21.90	13.80	10.85	12.40	11.90	7.70
9	7.20	11.00	12.50	25.90	28.50	28.30	22.00	13.40	10.50	12.20	[a] 11.80	7.50
10	7.20	11.20	12.80	25.30	27.70	28.10	23.30	12.90	10.20	11.95	11.70	7.30
11	7.05	11.50	13.30	25.60	27.35	27.35	25.40	12.65	10.15	[a] 11.70	11.60	7.25
12	7.00	12.00	13.65	26.00	26.80	26.65	26.80	12.20	10.20	[a] 11.50	11.50	7.20
13	7.00	12.40	14.20	26.10	26.60	27.40	11.80	10.30	11.20	11.45	7.10
14	7.00	12.65	14.70	26.10	25.50	25.30	27.60	11.60	10.30	11.00	11.30	6.95
15	7.00	12.80	14.80	25.90	24.50	24.80	27.20	11.70	10.20	10.80	11.20	6.60
16	7.10	13.00	14.90	25.50	23.70	24.70	26.20	11.80	10.05	10.50	11.05	6.00
17	7.40	13.05	14.80	25.20	23.10	25.00	25.00	11.50	10.00	10.30	10.90	5.70
18	7.45	12.60	14.80	24.90	22.70	25.25	23.50	11.60	9.95	10.20	10.70	5.50
19	7.55	12.10	15.00	25.30	22.50	25.50	22.60	11.90	10.20	10.10	10.50	5.10
20	7.95	11.70	15.30	25.50	22.70	25.50	22.40	11.90	12.70	10.00	10.35	4.70
21	8.10	11.70	15.70	25.30	23.00	25.20	22.00	12.50	13.70	10.00	10.20	4.50
22	8.00	12.10	16.10	24.80	22.65	25.20	21.60	13.70	14.10	10.00	10.00	4.40
23	10.00	11.95	16.10	24.80	22.10	25.40	20.80	14.30	14.70	10.00	9.85	4.30
24	13.90	11.70	16.95	25.10	21.60	25.20	20.00	14.40	14.20	10.05	9.60	4.20
25	16.55	11.50	19.00	26.50	21.00	24.60	19.50	14.00	13.60	10.20	9.40	4.30
26	17.10	11.50	23.40	28.30	20.50	[a] 23.80	19.20	14.85	13.20	10.35	9.25	4.05
27	16.35	11.70	24.40	30.10	20.30	23.00	19.10	14.85	13.20	10.60	9.05	4.80
28	15.80	11.80	24.60	31.30	[b] 20.10	22.50	18.65	15.00	13.80	10.90	8.90	5.20
29	15.10	11.80	26.60	32.10	[b] 20.10	22.50	17.75	14.55	14.10	11.30	8.80	5.75
30	14.25	.....	28.10	32.70	20.30	23.00	17.00	13.60	14.10	11.60	8.60	4.90
31	13.30	.....	28.85	.....	20.50	.....	16.40	12.70	.....	12.00	.....	4.10

[a] Changed less than one-half foot. [b] Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1905.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	7.80	18.20	19.60	19.80	20.70	23.00	20.30	15.30	18.00	15.60	11.90
2	4.00	8.30	20.00	19.90	20.10	20.40	23.40	21.10	14.40	17.10	15.00	12.80
3	3.90	10.30	20.50	20.50	19.80	20.10	23.60	21.70	13.90	16.30	14.70	13.50
4	4.40	12.00	20.40	20.70	19.20	20.05	23.65	22.00	13.60	15.70	14.65	13.40
5	5.30	12.60	20.40	20.45	18.60	20.30	23.70	22.10	13.20	15.25	14.65	13.20
6	5.80	[a] 12.50	21.10	20.25	18.60	20.70	24.50	21.60	12.90	14.80	[b] 14.90	12.90
7	5.75	[a] 13.00	21.10	19.75	18.30	21.30	25.00	20.80	12.70	14.40	15.40	12.50
8	6.05	[a] 13.60	21.00	19.10	17.15	21.20	25.40	20.00	12.65	14.00	15.90	12.60
9	5.90	[a] 13.75	20.75	18.60	16.40	20.80	25.40	19.35	12.60	13.60	16.10	11.50
10	5.50	12.90	20.40	18.00	15.90	20.30	25.15	18.70	12.60	13.00	16.00	10.80
11	5.50	12.60	20.10	17.75	15.40	19.90	25.00	18.10	12.50	12.70	15.80	10.10
12	5.45	12.40	20.10	17.40	15.20	19.60	24.80	17.80	12.50	12.40	15.45	9.45
13	4.30	10.50	19.85	17.10	15.40	19.40	24.95	17.40	12.80	12.20	15.25	9.00
14	3.40	10.50	19.60	16.95	15.45	20.10	25.50	16.80	13.90	11.90	[c] 15.30	8.80
15	3.50	10.60	19.00	16.80	15.70	20.80	25.90	16.50	14.20	11.65	[c] 15.20	8.70
16	3.50	10.50	18.25	16.60	16.60	21.40	26.20	16.10	13.60	11.30	[c] 14.70	8.75
17	3.25	10.40	17.60	16 75	18.30	21.70	25.90	15.50	14.20	11.10	14.00	8.80
18	2.60	10.70	17.20	16.80	20.20	21.70	25.30	15.10	16.70	10.90	13.50	8.75
19	[c] 2.70	10.60	16.80	16.80	21.20	21.40	24.10	14.70	23.30	[c] 12.20	13.10	8.65
20	3.10	10.45	16.50	16.70	21.60	20.95	23.00	14.70	26.20	17.30	12.85	8.70
21	4.30	10.40	16.10	16.50	22.40	21.10	22.90	15.00	27.00	18.70	12.90	8.80
22	4.80	10.40	15.70	16.25	22.70	21.50	24.00	15.40	28.80	17.50	13.20	8.95
23	5.40	10.50	15.60	16.00	22.10	21.50	22.30	15.70	29.10	17.00	13.40	9.10
24	6.20	[a] 12.80	16.10	16.00	21.50	21.30	21.40	16.40	28.75	16.90	12.80	9.10
25	6.20	[a] 12.20	16.80	16.30	21.00	21.20	21.10	18.50	27.60	16.80	12.30	9.15
26	6.60	[a] 13.00	17.30	16.70	20.80	21.55	21.20	19.60	25.75	16.90	12.00	9.20
27	7.10	9.50	17.65	17.40	20.40	22.00	21.60	19.30	23.90	17.10	11.70	9.10
28	6.60	12.10	17.80	17.90	20.10	22.30	21.60	19.00	22.20	18.10	11.80	9.00
29	6.20	.....	18.30	18.80	20.10	22.30	20.90	18.50	20.50	17.80	11.65	9.00
30	6.80	.....	19.00	19.30	20.20	22.50	20.00	17.70	19.00	16.90	11.60	9.30
31	7.60	.....	19.40	.....	20.60	.....	19.60	16.50	.....	16.20	.....	9.90

[a] Doubtful on account of ice. [b] Interpolated—no reading. [c] Reading changed one-half foot or more.

1906.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.20	17.30	22.10	27.50	21.80	15.50	20.80	13.90	13.80	15.20	8.60	13.50
2	10.45	17.50	22.90	27.70	21.60	16.10	20.75	13.50	13.30	15.10	8.70	13.10
3	11.40	17.60	23.50	27.60	21.55	16.70	20.70	13.30	12.80	15.20	9.20	12.85
4	12.20	17.50	23.80	27.40	21.50	17.45	20.80	13.20	12.50	15.30	9.70	12.90
5	12.50	16.70	23.40	27.10	21.50	18.00	20.80	13.45	12.35	15.60	10.00	12.95
6	15.20	15.90	22.70	27.10	21.45	18.50	20.50	13.20	12.10	15.30	10.20	13.00
7	17.80	14.90	22.00	27.10	21.50	18.60	20.20	12.90	11.90	14.60	10.30	13.30
8	18.00	14.20	21.50	26.90	21.80	18.95	19.90	13.10	11.70	13.70	10.30	13.60
9	17.50	13.40	21.00	27.00	22.40	19.70	19.50	13.00	11.70	13.10	10.40	13.90
10	16.40	12.50	20.90	27.00	22.10	20.30	19.20	13.60	11.70	12.60	10.50	13.80
11	15.30	12.00	20.70	27.00	21.50	20.60	18.80	13.40	11.70	12.20	10.60	13.50
12	14.00	11.60	20.40	26.80	20.80	20.70	18.30	13.80	11.70	11.80	10.70	13.10
13	12.90	11.30	20.10	26.50	20.20	20.70	17.90	13.90	12.00	11.50	10.90	12.85
14	12.20	11.20	19.90	26.40	19.80	20.30	17.60	14.10	11.80	11.20	10.90	12.65
15	11.70	11.60	19.60	26.85	19.40	20.00	17.30	14.70	11.70	11.00	10.90	13.30
16	11.20	11.80	19.10	27.45	18.90	19.90	17.00	15.20	11.60	10.80	10.90	13.30
17	10.90	11.80	18.60	27.30	18.50	19.70	16.70	15.50	11.50	10.50	11.10	12.85
18	10.75	11.80	17.90	26.70	17.90	19.40	16.55	15.20	11.40	10.50	11.50	12.40
19	10.30	11.80	17.50	26.10	17.40	19.20	16.30	14.80	11.30	10.35	11.50	12.20
20	10.30	12.00	17.20	25.70	16.90	19.20	15.90	14.30	11.40	10.20	11.70	11.80
21	10.50	12.30	16.60	25.20	16.60	19.50	15.60	14.10	11.60	10.00	13.70	11.30
22	13.40	12.65	16.10	24.80	16.30	20.10	15.30	14.30	11.70	9.80	15.70	10.80
23	15.70	12.90	15.90	24.30	16.00	20.90	15.00	14.20	11.60	9.60	15.30	10.50
24	15.75	13.50	15.70	23.80	15.80	21.60	15.00	13.90	11.50	9.50	15.00	10.20
25	16.70	15.30	15.80	23.40	15.50	22.10	15.20	13.50	11.70	9.40	14.90	9.80
26	17.60	18.00	16.30	23.00	15.40	22.25	15.90	13.00	12.70	9.20	14.60	9.20
27	17.50	20.10	18.10	22.70	15.30	21.70	16.50	12.80	13.40	9.00	14.35	8.50
28	17.40	21.40	20.20	22.40	15.20	20.90	16.40	13.60	13.80	8.80	14.20	7.80
29	17.20	.....	23.50	22.20	15.20	20.60	15.70	15.10	14.40	8.80	14.00	7.10
30	17.00	.....	25.40	22.00	15.30	20.60	15.20	15.25	14.70	8.80	13.80	7.60
31	17.00	.....	26.70	.....	15.40	.....	14.50	14.50	.....	8.70	.....	8.70

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

GRAYS POINT, MO.—Continued.

1907.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.2	23.6	18.0	19.7	20.1	18.0	24.6	26.5	16.3	12.1	10.2	9.3
2	9.8	23.0	18.0	19.9	20.5	18.7	24.2	25.9	16.1	12.1	10.3	9.2
3	12.4	22.3	17.9	20.15	21.2	18.8	23.6	25.0	16.0	12.1	10.3	9.2
4	14.7	21.6	17.8	20.0	21.4	19.3	23.2	23.9	15.8	12.45	10.25	9.1
5	14.0	20.7	17.6	19.7	21.3	20.8	22.6	23.0	15.8	12.8	10.1	9.1
6	15.4	19.8	17.5	19.3	21.1	22.7	21.8	22.3	15.8	13.4	10.0	8.95
7	16.3	18.6	17.4	19.2	20.85	23.5	21.2	21.8	15.65	13.8	9.95	8.8
8	17.0	17.1	17.3	19.0	20.7	23.4	21.0	21.5	15.5	14.2	9.9	8.7
9	17.4	15.4	17.2	18.8	21.25	23.0	21.1	21.2	15.4	14.1	9.7	8.6
10	17.5	13.8	16.9	18.8	22.3	22.8	21.3	21.0	15.0	14.25	9.65	8.5
11	17.4	12.7	16.6	18.9	22.7	22.9	21.3	20.9	14.6	14.6	9.6	8.5
12	17.2	12.3	16.5	19.0	22.6	23.1	21.35	20.6	14.1	14.8	9.5	8.45
13	16.9	12.1	17.2	19.2	21.7	23.7	21.3	20.0	13.7	14.95	9.4	8.3
14	16.6	12.5	20.0	19.9	20.8	24.6	21.3	19.6	13.3	14.95	9.3	8.3
15	16.5	13.1	21.4	20.5	20.5	25.1	21.7	19.4	13.0	14.7	9.2	8.35
16	17.0	14.1	22.2	20.6	20.4	25.2	22.2	19.0	12.8	14.3	9.1	8.4
17	17.5	14.6	22.1	20.4	21.3	25.5	22.4	18.8	12.6	13.8	9.1	8.5
18	18.3	14.4	21.8	20.3	23.0	25.3	23.0	18.7	12.3	13.4	9.1	8.6
19	20.3	14.5	21.7	20.4	23.7	24.4	24.0	18.3	12.1	13.0	9.1	8.7
20	22.8	14.9	21.7	20.5	23.3	23.7	24.9	18.6	11.8	12.7	9.1	8.8
21	25.6	15.1	21.8	21.0	22.3	23.2	25.2	19.2	11.5	12.4	9.05	8.8
22	27.8	14.7	22.1	21.5	21.2	22.8	25.5	19.6	11.3	12.2	9.45	8.7
23	28.7	14.6	21.9	21.9	20.2	22.4	25.9	19.6	11.1	11.9	9.45	8.8
24	29.2	15.2	21.4	21.9	19.3	22.2	26.5	20.7	11.1	11.6	9.45	9.2
25	29.3	16.0	20.9	21.7	18.4	22.6	27.0	20.0	11.25	11.4	9.4	9.4
26	28.9	17.0	20.6	22.0	17.9	23.4	27.3	19.7	11.5	11.2	9.35	9.4
27	28.0	17.8	20.3	21.7	17.2	24.2	27.3	19.7	11.7	11.0	9.25	9.4
28	27.1	18.0	20.1	21.4	16.7	24.8	27.2	19.3	11.8	10.85	9.2	9.3
29	26.0	.....	19.9	20.9	17.0	25.1	27.0	18.1	11.9	10.7	9.2	9.4
30	25.0	.....	19.6	20.3	17.4	24.95	26.7	17.2	12.1	10.5	9.3	9.3
31	24.2	.....	19.5	.....	17.4	.....	26.4	16.7	.....	10.3	.....	9.1

1908.

[Gauge, 136.82 miles from Eads Bridge. Zero of gauge, 308.15 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.00	7.70	21.90	19.30	20.70	27.30	31.00	.....	.....	.....	.....	.....
2	9.00	7.40	21.50	18.90	20.20	27.90	30.45	.....	.....	.....	.....	.....
3	9.00	6.60	21.10	18.60	19.60	28.30	30.10	.....	.....	.....	.....	.....
4	8.90	5.80	21.00	18.40	19.20	28.65	30.20	.....	.....	.....	.....	.....
5	8.80	6.20	21.00	18.50	19.50	29.10	30.30	.....	.....	.....	.....	.....
6	8.70	7.60	21.20	18.40	20.60	29.50	30.40	.....	.....	.....	.....	.....
7	8.60	7.85	21.20	18.40	22.10	29.50	30.40	.....	.....	.....	.....	.....
8	8.60	7.60	21.50	19.30	23.00	29.50	30.30	.....	.....	.....	.....	.....
9	8.50	7.80	22.00	20.10	23.25	29.65	29.80	.....	.....	.....	.....	.....
10	8.40	8.35	22.00	20.60	23.80	29.70	29.00	.....	.....	.....	.....	.....
11	8.30	8.80	24.00	22.40	24.30	29.70	28.10	.....	.....	.....	.....	.....
12	9.40	9.30	24.30	23.60	25.00	29.80	27.45	.....	.....	.....	.....	.....
13	10.30	9.60	24.30	24.20	25.40	29.90	27.00	.....	.....	.....	.....	.....
14	10.40	10.40	24.30	24.50	25.10	30.30	26.85	.....	.....	.....	.....	.....
15	10.60	12.60	24.30	24.30	24.80	30.60	26.60	.....	.....	.....	.....	.....
16	10.50	14.20	24.10	24.00	24.60	31.00	26.00	.....	.....	.....	.....	.....
17	10.20	16.60	23.80	23.50	25.40	31.40	25.30	.....	.....	.....	.....	.....
18	9.70	19.20	23.40	22.90	26.50	31.90	24.50	.....	.....	.....	.....	.....
19	9.30	20.50	23.00	22.10	27.10	32.25	23.80	.....	.....	.....	.....	.....
20	9.00	20.80	22.60	21.30	27.30	32.70	23.60	.....	.....	.....	.....	.....
21	8.70	21.20	22.20	20.30	27.10	32.85	23.80	.....	.....	.....	.....	.....
22	8.30	21.60	21.70	19.50	26.50	33.00	23.85	.....	.....	.....	.....	.....
23	7.90	21.50	21.20	18.90	26.30	33.00	23.95	.....	.....	.....	.....	.....
24	7.90	21.30	20.70	18.80	25.90	33.00	23.60	.....	.....	.....	.....	.....
25	8.20	21.00	20.10	20.00	25.60	32.90	23.00	.....	.....	.....	.....	.....
26	8.40	21.00	19.60	20.00	25.10	32.70	22.60	.....	.....	.....	.....	.....
27	8.45	20.80	19.10	20.50	24.80	32.50	22.30	.....	.....	.....	.....	.....
28	8.45	21.10	18.80	20.60	25.30	32.20	22.10	.....	.....	.....	.....	.....
29	8.30	21.80	18.70	20.70	26.10	31.90	22.10	.....	.....	.....	.....	.....
30	8.10	.....	18.70	21.20	26.60	31.50	22.00	.....	.....	.....	.....	.....
31	7.90	.....	19.00	.....	26.80	.....	21.60	.....	.....	.....	.....	.....

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.

1896.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.60	4.90	6.20
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.30	4.90	6.20
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.00	4.90	6.10
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.70	5.10	6.00
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.50	5.55	5.95
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.40	6.10	6.00
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.30	6.80	5.85
8	.....	.....	.....	.....	.....	.....	.....	.....	6.75	6.20	7.70	5.50
9	.....	.....	.....	.....	.....	.....	.....	.....	6.60	6.15	8.10	5.20
10	.....	.....	.....	.....	.....	.....	.....	.....	6.40	6.05	8.00	5.00
11	.....	.....	.....	.....	.....	.....	.....	.....	6.20	5.95	7.70	4.80
12	.....	.....	.....	.....	.....	.....	.....	.....	6.10	6.00	7.30	4.65
13	.....	.....	.....	.....	.....	.....	.....	.....	6.00	5.95	7.10	4.60
14	.....	.....	.....	.....	.....	.....	.....	.....	5.90	5.95	6.90	4.60
15	.....	.....	.....	.....	.....	.....	.....	.....	5.85	6.00	6.70	4.80
16	.....	.....	.....	.....	.....	.....	.....	.....	5.90	6.00	6.60	4.95
17	.....	.....	.....	.....	.....	.....	.....	.....	6.05	6.10	6.50	5.20
18	.....	.....	.....	.....	.....	.....	.....	.....	6.20	6.20	6.50	5.50
19	.....	.....	.....	.....	.....	.....	.....	.....	6.20	6.20	6.40	5.80
20	.....	.....	.....	.....	.....	.....	.....	.....	6.45	6.00	6.50	6.40
21	.....	.....	.....	.....	.....	.....	.....	.....	6.95	5.85	6.50	6.70
22	.....	.....	.....	.....	.....	.....	.....	.....	7.50	5.75	6.40	6.90
23	.....	.....	.....	.....	.....	.....	.....	.....	8.10	5.70	6.40	7.00
24	.....	.....	.....	.....	.....	.....	.....	.....	8.75	5.60	6.30	6.90
25	.....	.....	.....	.....	.....	.....	.....	.....	9.05	5.45	6.20	6.80
26	.....	.....	.....	.....	.....	.....	.....	.....	8.90	5.40	6.10	6.75
27	.....	.....	.....	.....	.....	.....	.....	.....	8.55	5.25	6.10	6.70
28	.....	.....	.....	.....	.....	.....	.....	.....	8.30	5.15	6.20	6.55
29	.....	.....	.....	.....	.....	.....	.....	.....	8.10	5.10	6.20	6.40
30	.....	.....	.....	.....	.....	.....	.....	.....	7.90	5.00	6.20	6.20
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.00	.....	6.10

1897.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.05	7.65	14.35	24.35	23.20	a 13.15	17.20	12.35	7.55	5.20	4.35	4.55
2	6.00	(b)	14.40	25.20	23.70	12.70	17.45	11.95	7.40	5.10	4.40	4.50
3	6.05	6.60	15.00	25.80	a 24.00	12.35	17.05	11.75	7.15	5.10	4.40	4.45
4	7.00	6.60	15.50	26.00	24.10	12.40	17.20	11.50	6.95	5.05	4.40	4.30
5	14.50	6.85	16.30	26.05	24.05	12.55	17.50	11.15	6.75	5.00	4.40	4.10
6	18.80	7.25	18.60	26.50	23.80	13.00	17.60	11.00	6.60	4.95	4.35	3.80
7	19.70	7.40	21.40	26.25	23.30	13.40	17.00	10.80	6.50	4.90	4.35	3.40
8	20.00	7.50	22.80	26.25	22.60	13.70	16.60	10.65	6.40	4.90	4.40	3.05
9	19.20	7.55	23.50	26.40	21.80	13.80	16.30	10.40	6.35	4.85	4.60	2.60
10	17.30	7.90	23.60	26.50	21.00	13.85	16.40	10.40	6.30	4.75	4.85	2.25
11	15.35	8.40	23.20	26.80	20.25	13.65	16.35	10.60	6.30	4.75	4.85	2.15
12	13.55	9.25	22.60	26.95	19.85	13.45	15.60	10.50	6.25	4.70	4.90	2.20
13	11.90	10.00	22.40	27.05	19.05	13.25	15.00	10.25	6.20	4.60	4.95	2.30
14	10.80	10.15	22.10	26.85	18.30	13.00	14.50	10.05	6.05	4.60	5.00	2.45
15	10.00	10.60	22.00	26.50	17.60	12.70	13.55	9.90	5.85	4.55	5.00	2.70
16	9.40	11.05	21.80	26.05	17.00	12.45	13.35	9.85	5.80	4.50	5.00	2.90
17	9.20	11.35	21.70	25.55	16.65	12.30	12.85	9.80	5.80	4.40	5.00	3.20
18	9.05	11.60	22.10	25.10	16.20	12.30	12.45	9.70	5.60	4.35	5.05	3.50
19	9.00	11.40	22.60	24.75	15.80	12.40	12.30	9.65	5.45	4.35	5.00	3.35
20	9.75	11.10	22.70	24.45	15.40	12.70	12.30	9.60	5.35	4.30	4.85	3.15
21	10.95	10.80	22.55	24.10	15.00	12.50	12.50	9.45	5.30	4.30	4.75	2.70
22	11.60	c 10.50	22.90	23.90	14.60	12.45	12.25	9.30	5.25	4.25	4.70	2.30
23	11.95	11.70	23.20	23.80	14.15	13.30	11.90	9.20	5.20	4.30	4.60	2.15
24	11.95	12.70	23.25	23.70	13.75	13.30	11.60	9.00	5.15	4.20	4.55	2.00
25	11.95	13.70	23.60	23.60	13.35	14.30	11.40	8.90	5.15	4.20	4.55	1.80
26	12.00	14.15	23.65	23.55	13.10	14.10	11.65	8.75	5.25	4.15	4.65	1.70
27	11.30	14.25	23.90	22.80	13.20	14.30	12.55	8.55	5.35	4.15	4.65	1.60
28	(b)	14.30	24.50	22.35	13.40	15.00	14.00	8.35	5.40	4.20	4.60	1.70
29	10.00	.....	24.70	22.40	13.40	14.95	c 14.50	8.10	5.35	4.20	4.60	1.90
30	9.20	.....	24.60	22.70	13.30	15.90	c 14.10	7.90	5.25	4.20	4.60	2.80
31	8.40	.....	24.30	.....	13.30	.....	13.20	7.70	.....	4.25	.....	3.00

a Changed less than one-half foot. b Shore ice. c Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1898.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.10	13.50	8.55	24.35	13.75	17.55	18.70	11.40	7.80	8.45	10.05	7.85
2	3.20	13.35	8.40	24.25	13.30	16.95	18.80	11.55	7.55	8.30	9.85	7.20
3	3.30	13.05	8.20	23.65	13.20	16.50	18.80	11.35	7.30	7.80	9.20	6.75
4	3.50	12.90	8.05	23.00	13.75	16.60	18.45	12.05	7.05	7.45	8.60	6.40
5	3.45	11.30	7.90	22.60	15.75	17.00	17.70	12.50	6.85	7.15	8.10	5.90
6	3.30	9.90	7.70	22.10	17.20	17.30	17.05	12.30	6.70	7.00	7.75	5.60
7	3.40	8.60	7.55	21.75	18.75	17.45	16.65	11.75	6.55	6.85	7.45	5.40
8	3.70	7.05	7.45	21.65	18.05	17.35	16.80	11.55	6.50	6.60	7.40	5.30
9	4.05	5.80	7.35	21.70	17.75	16.70	18.40	11.70	6.50	6.30	7.55	5.00
10	4.45	5.40	7.30	20.85	17.40	16.10	18.70	11.15	6.80	6.00	7.70	4.65
11	4.95	5.80	7.35	20.40	16.95	15.85	18.55	10.95	7.45	5.95	7.90	4.30
12	5.40	6.20	7.70	19.85	16.50	16.20	18.25	10.75	8.15	5.85	8.05	3.75
13	6.45	6.50	9.80	18.90	15.85	16.90	17.75	10.20	8.95	5.75	8.30	3.30
14	7.10	6.85	10.70	17.90	15.05	17.80	16.75	9.85	9.10	6.10	8.45	2.85
15	7.70	7.80	12.95	17.00	14.70	18.45	15.90	9.85	9.00	6.40	8.35	2.65
16	8.10	8.60	14.85	16.35	14.40	18.70	15.15	9.85	8.65	6.20	8.15	2.75
17	7.95	8.80	15.35	15.75	14.15	19.15	14.35	9.80	8.25	5.90	7.90	2.90
18	7.90	8.95	15.65	15.20	15.50	20.10	13.55	9.70	8.50	5.60	7.65	3.30
19	7.90	8.95	15.90	14.50	17.75	20.60	12.95	9.60	9.50	5.45	7.40	4.20
20	8.40	9.20	16.20	13.75	18.60	20.30	12.40	9.40	10.30	5.50	7.20	5.00
21	9.35	9.70	16.60	13.15	19.00	19.75	12.00	9.40	10.30	6.00	7.10	5.10
22	9.75	10.30	17.35	12.75	19.30	18.95	11.75	10.20	9.90	7.10	7.05	5.00
23	10.70	10.90	19.00	12.35	20.90	18.05	11.65	10.50	9.50	8.50	7.00	5.40
24	11.70	10.75	22.10	12.00	21.95	17.20	11.35	10.40	8.85	9.05	7.00	6.50
25	12.35	10.20	23.15	11.85	[a] 22.20	16.60	10.95	9.85	8.65	10.20	7.15	7.80
26	12.70	9.70	23.20	11.85	21.70	16.15	10.75	9.20	9.00	10.10	7.75	9.05
27	13.15	9.25	23.40	12.30	21.10	16.60	10.75	8.85	9.15	9.70	8.45	9.75
28	13.45	8.90	24.00	13.70	20.45	16.60	10.85	8.60	9.00	9.10	9.20	9.95
29	13.65	.....	23.70	14.70	19.45	17.60	11.45	8.30	8.85	8.70	9.20	9.85
30	13.85	.....	23.70	14.40	18.85	18.45	11.10	8.10	8.55	9.00	8.55	9.60
31	13.75	.....	24.05	.....	18.35	.....	11.05	7.90	.....	9.70	.....	9.40

[a] Changed less than one-half foot.

1899.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.20	5.30	13.60	17.30	21.10	19.35	17.35	12.75	7.80	5.85	5.35	6.05
2	8.30	5.30	15.10	17.30	21.15	19.20	17.35	12.65	7.75	5.80	5.20	5.95
3	7.50	5.40	15.40	17.30	21.00	19.30	17.35	12.65	7.80	5.70	5.05	5.90
4	6.90	5.30	15.15	17.05	20.70	19.80	17.55	12.55	7.70	5.60	5.10	5.75
5	7.20	6.60	15.00	17.05	19.85	19.05	18.10	12.40	7.50	5.50	5.30	5.65
6	6.70	7.30	14.85	17.10	18.80	20.00	18.55	12.15	7.40	[a] 5.45	5.45	5.60
7	6.55	7.25	14.85	17.30	18.20	20.05	18.75	12.10	7.20	5.35	5.60	5.55
8	6.50	7.60	14.80	17.40	17.60	20.00	19.05	11.70	7.10	5.25	5.80	5.50
9	6.50	7.40	14.80	17.25	17.00	19.50	19.20	11.30	7.00	5.10	5.95	5.45
10	6.80	7.70	14.55	16.90	17.00	19.25	19.15	11.20	6.90	5.05	6.10	5.40
11	6.60	7.70	14.50	16.50	17.40	19.15	19.15	12.20	6.90	5.00	6.25	5.40
12	6.55	7.90	14.70	15.95	18.75	19.15	19.40	13.40	7.00	4.95	6.35	5.40
13	6.90	8.00	15.00	15.65	18.40	19.30	19.60	13.90	7.05	4.90	6.50	5.30
14	8.10	8.10	15.30	16.30	18.70	20.10	19.40	13.70	7.05	4.85	6.60	5.30
15	9.25	8.20	15.50	16.30	18.90	20.60	19.00	13.40	7.05	4.75	6.70	5.35
16	9.40	8.30	16.00	15.50	18.85	20.30	18.50	13.20	7.00	4.65	6.75	5.35
17	9.30	8.35	16.85	14.80	18.55	19.60	18.05	12.70	6.90	4.80	6.75	5.30
18	9.45	8.40	17.70	14.35	18.05	19.05	17.65	12.05	6.90	4.70	6.70	5.25
19	9.65	8.40	18.10	14.05	17.45	18.95	17.30	11.55	6.80	4.70	6.70	5.00
20	9.65	8.25	18.60	13.90	16.80	18.95	17.20	11.05	6.90	4.80	6.65	4.95
21	9.45	8.50	19.30	14.05	16.35	18.95	17.10	10.70	7.00	4.80	6.70	5.20
22	9.15	7.70	20.00	14.70	16.60	18.75	16.80	10.30	6.95	4.70	6.65	5.60
23	8.80	6.80	20.25	15.45	17.20	18.50	16.30	10.05	6.80	4.60	6.65	5.55
24	8.50	6.15	20.00	17.50	18.45	18.10	15.80	9.60	6.65	4.55	6.75	5.30
25	8.05	5.35	19.55	19.70	19.55	17.55	15.40	9.25	6.50	4.50	6.85	4.95
26	7.85	6.30	19.05	20.70	20.25	17.10	15.00	9.00	6.35	4.45	6.90	4.50
27	7.55	9.10	18.65	21.20	20.65	16.80	14.55	8.65	6.25	4.45	6.85	4.05
28	7.20	10.10	18.35	21.45	20.65	16.75	14.10	8.40	6.05	4.55	6.70	3.70
29	6.90	.....	18.00	21.30	20.40	16.90	13.70	8.25	[a] 6.00	4.60	6.35	3.25
30	6.60	.....	17.75	21.00	19.90	17.15	13.55	8.15	5.95	4.80	6.30	3.00
31	5.95	.....	17.35	.....	19.40	.....	13.00	7.95	.....	5.05	.....	1.85

[a] Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1900.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 p. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.25	4.20	8.20	12.50	14.35	12.30	12.00	10.65	8.40	8.50	11.00	10.60
2	0.25	3.55	7.70	12.10	13.80	12.05	11.55	10.30	8.80	9.00	11.20	10.05
3	−0.50	2.95	7.30	12.20	13.40	11.75	11.25	9.95	9.00	9.40	10.95	9.50
4	−0.50	1.90	7.30	12.35	13.30	11.90	11.15	9.65	9.10	9.90	10.60	9.00
5	−0.30	2.65	7.30	12.35	13.40	11.80	11.00	9.20	9.10	11.00	10.45	8.70
6	0.50	2.10	7.95	12.35	13.30	11.60	10.95	9.00	9.10	11.40	10.45	8.35
7	1.40	2.00	9.90	12.65	13.30	11.45	10.85	8.65	9.25	11.30	10.60	7.95
8	3.10	2.70	14.40	13.00	13.75	11.00	10.65	8.20	9.20	11.00	11.05	7.55
9	3.40	3.70	16.45	13.65	14.10	10.80	10.30	7.85	8.75	10.90	11.60	7.35
10	3.85	5.35	16.90	13.95	14.20	10.70	9.90	7.50	8.35	11.10	11.80	7.05
11	4.80	7.05	17.40	13.95	14.10	10.70	9.75	7.20	7.85	11.30	11.60	6.85
12	4.55	8.25	18.40	13.80	13.95	10.50	9.75	6.80	7.60	11.05	11.25	6.75
13	4.30	8.30	19.10	13.70	13.75	10.20	9.55	6.60	7.30	10.55	11.10	6.65
14	4.10	7.95	19.90	14.20	13.80	10.10	9.55	6.30	7.00	9.85	11.00	6.50
15	4.00	7.80	20.60	14.90	14.15	10.60	9.45	6.00	6.70	9.50	10.80	6.30
16	4.00	7.50	20.80	15.50	13.80	12.50	9.15	5.80	6.55	9.30	10.70	6.05
17	4.00	7.50	20.80	15.30	[a] 13.00	12.80	9.00	5.70	6.40	9.05	10.50	5.90
18	3.95	7.50	20.50	14.70	12.30	12.25	9.25	5.60	6.30	8.95	10.40	5.70
19	3.95	7.00	19.05	14.00	12.15	11.60	9.20	5.50	6.15	8.90	10.50	5.55
20	4.30	7.60	19.10	13.45	12.25	11.20	9.00	5.80	6.10	8.90	10.60	5.20
21	5.45	7.70	17.90	13.25	12.25	11.10	9.05	6.80	6.10	9.00	10.65	5.05
22	7.05	7.90	16.85	13.45	12.25	11.10	8.90	7.70	6.20	9.20	10.65	4.85
23	7.45	8.90	16.10	13.90	12.20	11.80	9.00	8.25	6.40	9.50	10.75	4.80
24	6.95	8.75	15.70	14.20	12.20	12.70	9.75	8.40	6.75	9.80	11.15	4.60
25	6.45	9.70	15.30	14.50	12.20	13.70	10.95	8.45	7.05	10.20	11.15	4.50
26	6.20	9.80	14.90	14.80	12.10	13.90	11.75	8.45	7.20	10.60	11.05	4.40
27	6.10	9.20	14.50	15.15	11.80	13.70	11.90	8.50	7.50	10.75	11.05	4.30
28	6.10	8.70	14.30	15.25	11.60	13.75	11.95	8.35	7.50	10.80	11.05	4.40
29	6.00	.....	13.85	15.00	11.35	13.20	11.65	8.35	7.75	10.85	10.90	4.40
30	5.50	.....	13.40	14.65	11.20	12.50	11.35	8.30	8.00	10.85	10.75	4.35
31	5.00	.....	12.90	.....	11.50	.....	10.90	8.20	.....	10.85	.....	4.20

[a] Changed less than one-half foot.

1901.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.00	5.05	5.05	15.60	16.00	8.95	12.70	7.55	4.60	4.10	4.45	3.65
2	3.90	4.95	5.05	15.80	15.80	8.70	12.30	7.55	4.45	4.00	4.45	3.65
3	3.75	4.85	4.75	16.00	15.50	8.60	11.90	7.65	4.30	3.90	4.45	3.60
4	3.60	4.80	4.60	16.20	15.15	8.75	11.45	7.70	4.25	3.80	4.40	3.50
5	3.40	4.75	4.35	16.35	[a] 14.70	9.90	10.90	7.70	4.15	3.70	4.30	3.50
6	3.10	4.80	4.45	16.60	14.35	10.40	10.45	7.60	4.05	3.65	4.20	3.45
7	2.90	4.65	4.80	16.90	13.80	10.75	10.00	7.50	3.90	3.70	4.05	3.40
8	2.60	4.75	5.20	17.05	13.15	10.95	9.70	7.20	3.80	3.70	3.95	3.30
9	2.55	4.70	5.60	17.30	12.45	11.15	9.50	6.90	3.75	3.85	3.95	3.30
10	2.70	4.20	6.90	17.70	11.80	11.30	9.45	6.65	3.70	3.85	3.90	3.30
11	3.00	3.60	8.55	18.45	11.30	11.30	9.75	6.45	3.65	3.90	3.85	3.40
12	3.45	3.20	10.90	19.05	10.85	11.10	10.10	6.30	3.70	4.05	3.95	3.35
13	4.05	3.25	14.00	19.35	10.60	10.90	10.10	6.20	3.65	4.10	4.00	3.30
14	4.95	3.50	15.30	19.65	10.45	10.85	9.65	6.10	3.60	4.10	4.05	3.40
15	5.45	3.50	15.65	19.60	10.30	10.85	9.35	6.00	3.55	4.10	4.00	[b] 3.70
16	5.70	3.60	15.50	19.50	10.10	11.30	9.20	5.90	3.50	4.00	4.00	[b] 3.80
17	5.80	3.65	15.25	19.25	9.90	11.80	9.10	5.90	3.40	3.95	4.00	[b] 3.50
18	5.80	3.75	15.00	19.25	9.70	11.90	9.05	5.80	3.35	3.95	4.00	[b] 3.30
19	5.75	3.80	14.90	19.90	9.60	11.60	9.00	5.55	3.30	4.10	3.95	[b] 1.90
20	5.80	3.90	14.75	20.00	9.50	11.25	9.00	5.55	3.35	4.30	3.95	[b] 2.40
21	5.80	4.10	14.50	19.40	9.35	11.00	9.05	5.50	3.60	4.45	3.90	[b] 2.40
22	5.60	4.20	14.40	18.75	9.15	10.85	9.30	5.40	3.95	4.60	3.90	[b] 2.20
23	5.45	3.90	14.60	18.00	9.00	10.90	9.50	5.40	4.85	4.65	3.85	[b] 2.25
24	5.40	3.80	15.35	17.60	8.80	11.00	9.40	5.30	5.30	4.70	3.85	[b] 2.60
25	5.40	3.80	15.75	17.25	8.70	11.50	9.00	5.20	5.20	4.65	3.85	[b] 2.80
26	5.40	4.00	16.10	16.90	8.50	12.00	8.65	5.10	4.95	4.55	3.85	[b] 3.10
27	5.30	4.25	16.35	16.50	8.55	12.35	8.35	5.05	4.70	4.50	3.85	[b] 3.40
28	5.20	4.75	16.25	16.30	9.05	12.50	8.10	4.90	4.50	4.45	3.80	[b] 3.40
29	5.15	.....	16.00	16.20	9.25	12.80	7.90	4.80	4.30	4.45	3.70	[b] 3.45
30	5.10	.....	15.85	16.10	9.20	12.85	7.80	4.70	4.20	4.45	3.70	[b] 3.60
31	5.05	.....	15.70	.....	9.00	.....	7.65	4.70	.....	4.45	.....	[b] 3.30

[a] Changed less than one-half foot.

[b] Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1902.

Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 2.90	a 1.40	5.45	10.35	7.80	15.10	17.60	18.55	16.35	12.70	10.00	11.65
2	a 2.70	a 2.10	5.00	10.60	7.80	14.85	18.15	18.00	16.15	13.10	9.55	11.90
3	a 2.25	a 3.00	5.65	11.10	7.80	14.65	19.00	17.30	15.70	13.10	9.30	12.05
4	a 2.20	a 3.40	5.90	11.65	8.35	15.25	19.45	16.70	15.30	13.20	9.00	11.60
5	a 2.30	a 3.40	6.20	12.00	9.60	15.95	19.60	16.00	15.35	13.05	8.65	11.30
6	a 2.50	a 3.70	7.20	12.10	9.90	16.05	19.50	15.50	15.65	14.20	8.45	11.15
7	a 2.80	a 4.40	7.40	12.10	9.40	15.85	19.00	15.25	15.70	14.55	8.40	11.25
8	a 3.00	a 4.85	7.60	12.35	9.00	15.60	18.55	15.05	15.10	15.15	8.70	11.35
9	a 3.10	a 4.95	8.20	12.55	8.10	15.10	18.15	14.95	a 14.40	15.85	9.10	11.45
10	3.10	a 4.80	9.50	12.00	7.50	14.65	17.90	14.70	13.60	16.10	9.30	11.45
11	3.10	a 4.00	10.50	11.40	7.50	14.60	17.75	14.40	13.00	16.50	9.80	11.00
12	3.10	a 3.50	11.20	10.60	8.00	15.00	17.45	14.00	12.40	16.15	10.10	10.70
13	a 2.90	a 3.45	11.50	9.80	8.90	15.70	17.20	13.55	11.90	15.55	10.20	10.10
14	a 2.80	a 3.20	12.00	9.50	9.50	15.95	17.45	13.30	11.20	14.80	9.90	10.20
15	a 2.65	a 2.50	12.60	8.90	10.00	16.05	18.35	13.20	10.90	14.05	9.50	10.05
16	a 2.30	a 3.10	13.30	8.60	10.10	16.05	19.10	13.05	10.35	13.50	9.30	10.05
17	a 2.00	a 3.40	13.75	8.30	10.10	16.85	19.65	12.45	10.00	13.00	9.05	10.75
18	2.25	a 3.45	14.05	8.10	10.05	16.65	19.95	12.05	9.70	12.60	8.85	10.45
19	2.50	a 3.70	13.90	7.90	10.00	16.40	20.25	12.00	9.55	12.50	8.90	10.25
20	2.60	a 3.85	c 13.45	7.80	10.00	16.20	20.50	12.20	9.00	12.50	9.25	10.50
21	2.60	a 3.75	12.55	7.80	10.30	16.00	20.50	12.45	8.60	12.75	9.95	10.80
22	2.70	a 3.75	11.75	7.60	10.50	15.70	20.40	13.00	8.25	12.90	11.00	11.20
23	2.70	a 4.00	10.75	7.30	10.40	15.30	20.25	14.00	7.80	13.25	11.25	11.70
24	2.70	a 4.20	9.85	7.00	10.10	15.00	20.30	14.30	7.55	13.60	11.25	12.30
25	2.70	a 4.20	9.35	7.50	10.35	14.95	20.60	14.50	7.35	13.70	11.15	12.85
26	2.65	a 4.10	8.75	8.10	11.10	14.95	20.80	14.50	7.40	13.65	11.05	13.40
27	a 2.40	a 4.10	8.45	7.85	11.65	14.90	20.80	14.65	8.85	13.50	11.00	13.70
28	a 2.10	4.20	8.30	7.55	12.00	15.00	20.75	15.00	10.10	13.00	10.90	13.50
29	a 1.95	.....	8.50	7.50	13.00	15.60	20.45	15.35	11.00	12.10	11.10	12.90
30	a 1.40	.....	9.80	7.30	14.95	16.80	19.85	15.85	11.75	11.30	11.35	12.00
31	1.10	.....	10.00	.....	15.35	.....	19.20	16.30	.....	10.50	.....	11.10

a Doubtful on account of ice. b Reading changed one-half foot or more. c Interpolated—no reading.

1903.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.00	9.90	15.05	17.75	16.55	19.70	17.55	15.15	14.30	14.45	13.25	6.85
2	9.10	9.90	15.95	17.40	15.85	20.85	17.35	14.65	14.65	14.55	13.15	6.70
3	8.30	9.70	16.25	17.15	15.15	22.30	17.15	14.15	15.65	14.55	13.05	6.50
4	8.10	9.65	16.45	16.65	14.85	23.25	16.95	13.75	16.55	14.55	12.90	6.30
5	8.10	a 10.00	17.00	16.45	14.45	24.25	16.45	13.75	16.65	14.65	12.75	6.05
6	8.40	12.35	17.80	16.55	14.20	25.30	15.95	13.55	16.45	14.85	12.65	5.80
7	8.70	14.30	18.55	17.15	13.90	26.25	15.45	13.05	15.95	14.90	12.60	5.55
8	9.00	14.45	19.65	17.75	13.70	27.15	15.15	13.15	15.45	15.50	12.60	5.50
9	9.00	14.05	21.15	18.05	13.60	27.65	14.85	14.00	15.05	15.65	12.80	5.40
10	9.60	13.75	23.15	17.85	13.60	28.30	14.85	14.35	14.95	16.40	13.00	5.30
11	8.75	13.45	24.30	17.65	13.65	28.65	14.85	14.45	14.70	17.35	12.85	5.15
12	a 3.25	13.35	24.80	17.50	13.65	28.95	14.85	14.55	14.50	18.05	12.65	4.90
13	7.35	13.20	24.85	18.15	13.55	29.15	14.65	14.55	14.95	18.15	12.40	4.80
14	6.40	13.55	24.70	19.30	13.45	29.35	14.30	14.55	16.25	17.85	12.05	4.70
15	5.70	14.05	24.50	20.00	13.35	29.40	14.15	14.60	17.15	17.55	11.60	4.30
16	5.40	14.75	24.45	20.55	13.15	29.05	14.15	14.70	17.30	17.30	11.45	3.25
17	5.40	15.15	24.55	20.95	12.95	28.55	14.40	14.95	17.50	17.00	11.15	3.00
18	5.45	14.95	24.10	21.10	13.65	27.80	14.65	14.80	17.80	16.50	10.90	2.75
19	5.85	14.75	23.80	21.45	15.25	26.80	15.85	14.65	17.45	16.05	10.50	2.45
20	6.25	14.60	23.70	21.70	16.35	25.45	16.35	14.85	17.25	15.65	10.10	2.80
21	6.70	16.25	23.55	21.55	16.85	24.05	16.25	14.95	17.20	15.25	9.80	3.25
22	7.10	16.30	23.50	21.25	16.75	22.90	15.90	15.05	17.00	14.90	9.40	3.50
23	7.00	17.85	23.50	21.25	16.55	22.05	15.75	15.05	16.40	14.50	9.20	3.80
24	6.90	15.05	23.30	21.05	16.25	21.30	15.75	14.80	15.75	14.20	8.95	4.10
25	6.80	14.65	22.65	20.65	16.20	20.65	15.85	b 14.35	15.05	14.00	8.70	4.30
26	6.70	14.60	22.15	20.05	16.30	20.35	16.05	13.90	14.65	13.90	8.40	4.70
27	6.70	14.60	21.45	19.45	17.15	20.05	16.45	13.75	14.35	13.70	8.10	5.20
28	6.65	14.60	20.55	18.75	18.45	19.35	16.85	13.45	14.15	13.60	7.80	5.05
29	7.35	.....	19.65	18.15	19.15	18.65	16.50	13.30	14.15	13.50	7.45	4.95
30	9.20	.....	18.90	17.25	19.15	17.95	16.05	13.40	14.30	13.40	7.10	4.90
31	9.85	.....	18.25	.....	19.25	.....	15.70	13.75	.....	13.35	.....	5.10

a Reading changed one-half foot or more. b Changed less than one-half foot.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1904.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.30	9.50	8.50	25.10	27.15	17.05	10.40	12.60	9.15	11.00	9.35	5.85
2	5.60	8.70	8.20	25.15	27.30	18.60	10.70	12.35	8.70	11.25	9.40	5.80
3	5.85	8.00	8.00	24.90	27.25	19.90	10.30	12.00	8.40	11.20	9.45	5.75
4	5.85	7.30	7.60	24.95	27.10	20.20	18.80	11.60	8.10	10.90	9.45	5.60
5	5.60	6.60	7.70	24.65	26.85	20.05	18.60	11.40	8.00	10.60	9.35	5.45
6	5.05	6.85	7.90	24.20	26.30	20.30	18.40	11.25	8.15	10.15	9.15	5.40
7	4.75	6.45	8.35	23.70	25.50	21.70	18.10	11.10	8.30	9.55	9.05	5.30
8	4.80	7.00	8.90	23.00	24.40	22.70	17.60	10.80	8.15	9.20	8.90	5.15
9	4.80	8.00	9.50	22.25	23.50	23.05	17.70	10.45	7.80	9.10	8.80	4.95
10	4.80	8.15	9.70	21.90	22.60	22.80	18.80	10.10	7.60	8.90	8.70	4.80
11	4.75	8.50	10.00	21.75	22.20	22.30	20.65	9.60	7.50	8.70	8.55	4.75
12	4.65	9.00	10.30	22.00	21.70	21.60	21.85	9.40	7.65	8.50	8.50	4.70
13	4.65	9.25	10.50	22.10	21.00	21.30	22.40	9.00	7.65	8.20	8.40	4.65
14	4.60	9.50	11.05	22.10	20.40	20.45	22.60	8.80	7.70	8.15	8.30	4.50
15	4.60	9.70	11.65	21.80	19.60	20.00	22.30	9.00	7.55	7.95	8.20	4.20
16	4.70	9.80	11.75	21.30	19.00	19.90	21.70	9.00	7.45	7.70	8.10	3.75
17	[a] 4.90	9.90	11.65	20.90	18.20	20.15	20.50	8.70	7.30	7.50	7.95	3.55
18	[a] 4.95	9.60	11.65	20.45	17.80	20.25	19.20	8.80	7.25	7.45	7.80	3.50
19	5.00	9.15	11.80	20.30	17.70	20.60	18.50	9.00	7.50	7.35	7.65	3.10
20	5.30	8.70	12.00	20.70	17.85	20.60	18.20	9.05	9.05	7.30	7.50	2.75
21	5.55	8.60	12.45	20.50	18.05	20.30	17.90	9.60	10.55	7.25	7.40	2.55
22	6.00	8.60	12.60	19.90	17.70	20.35	17.45	10.60	10.80	7.20	7.20	2.45
23	[b] 7.55	8.80	12.65	19.90	17.40	20.40	16.90	11.25	11.45	7.20	7.00	2.40
24	10.50	8.65	13.25	20.25	17.00	20.35	16.10	11.25	11.05	7.30	6.90	2.30
25	13.10	8.40	15.10	21.35	16.50	19.90	15.60	11.65	10.45	7.45	6.70	2.50
26	13.55	8.40	19.10	22.90	16.20	19.30	15.45	11.55	10.15	7.60	6.50	2.65
27	13.00	8.50	19.70	24.55	15.90	18.50	15.30	11.55	10.10	7.85	6.35	2.75
28	12.35	8.65	19.85	25.55	15.70	18.10	15.00	11.65	10.55	8.05	6.20	3.20
29	11.85	8.75	22.70	26.25	15.70	18.00	14.25	11.20	10.80	8.30	6.10	3.50
30	11.15	.....	24.30	26.85	15.85	18.50	13.65	10.45	10.85	8.70	5.95	2.90
31	10.20	.....	24.95	.....	16.05	.....	13.10	9.70	.....	9.00	.....	2.10

[a] Changed less than one-half foot. [b] Reading changed one-half foot or more.

1905.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.10	6.20	14.40	15.65	15.50	16.40	18.50	16.00	11.55	13.55	11.50	8.35
2	2.10	6.50	10.20	15.95	15.85	16.15	18.95	16.65	10.70	12.90	11.15	9.20
3	1.50	8.85	16.65	16.45	15.45	15.80	19.05	17.10	10.40	12.30	10.80	9.85
4	1.80	10.80	16.60	16.65	15.00	15.70	19.15	17.50	10.10	11.65	10.75	9.80
5	2.60	11.45	16.40	16.35	14.35	15.90	19.25	17.60	9.70	11.20	10.80	9.60
6	2.90	11.45	17.00	16.05	14.40	16.40	19.95	17.00	9.40	10.90	11.00	9.35
7	2.90	11.10	16.95	15.70	14.05	16.90	20.45	16.40	9.30	10.60	11.45	9.05
8	3.10	11.15	16.80	15.05	13.20	16.90	20.70	15.70	9.20	10.10	11.90	8.60
9	2.90	11.15	16.60	14.40	12.50	16.45	20.65	15.05	9.20	9.75	12.20	8.10
10	2.75	10.95	16.30	13.95	12.00	16.00	20.45	14.45	9.15	9.30	12.05	7.45
11	2.70	10.65	16.05	13.70	11.60	15.55	20.30	14.00	9.10	9.05	11.80	6.95
12	2.60	10.60	16.10	13.35	11.40	15.30	20.10	13.70	9.05	8.75	11.50	6.30
13	2.00	9.10	16.05	13.10	11.50	15.20	20.30	13.40	9.30	8.50	11.30	5.90
14	1.10	9.00	15.80	12.95	11.50	15.70	20.60	12.85	10.15	8.30	11.30	5.60
15	1.10	9.00	15.40	12.80	11.75	16.45	21.00	12.60	10.50	8.10	11.25	5.50
16	1.25	8.80	14.75	12.70	12.60	16.95	21.30	12.20	10.05	7.90	11.00	5.55
17	1.00	8.70	14.20	12.70	14.20	17.25	21.20	11.70	10.50	7.70	10.30	5.55
18	.50	8.85	13.80	12.80	16.00	17.35	20.50	11.30	12.60	7.60	9.80	5.50
19	.35	8.75	13.45	12.80	17.00	17.00	19.45	11.00	18.60	8.30	9.45	5.45
20	.80	8.60	13.10	12.65	17.50	16.60	18.35	11.00	21.35	13.15	9.20	5.50
21	1.90	8.50	12.70	12.50	18.30	16.80	18.35	11.20	22.70	14.35	9.30	5.60
22	2.40	8.45	12.20	12.30	18.55	17.10	19.35	11.50	23.40	13.25	9.50	5.70
23	2.80	8.50	12.05	12.10	18.10	17.15	17.50	11.80	23.60	12.90	9.65	5.80
24	3.45	[a] 9.45	12.40	12.05	17.45	16.90	16.95	12.45	23.30	12.75	9.25	5.85
25	3.60	[a] 10.35	12.90	12.40	17.05	16.85	16.60	14.50	22.30	12.70	8.75	5.90
26	4.00	[a] 11.70	13.25	12.70	16.80	17.20	16.70	15.25	[b] 20.70	12.90	8.45	5.90
27	5.00	7.60	13.60	13.30	16.40	17.65	17.05	15.05	19.00	12.95	8.35	5.80
28	4.70	9.25	13.90	13.80	16.05	18.05	17.10	14.75	17.50	13.85	8.25	5.75
29	4.20	.....	14.40	14.70	15.95	17.95	16.50	14.30	16.00	13.60	8.10	5.75
30	4.80	.....	14.95	15.05	16.00	18.10	15.60	13.50	14.80	12.80	8.05	6.00
31	5.80	.....	15.45	.....	16.30	.....	15.30	12.55	.....	12.05	.....	6.55

[a] Doubtful on account of ice. [b] Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1906.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.80	13.50	17.70	23.30	16.90	11.50	16.35	10.30	10.10	11.40	5.60	10.20
2	7.05	13.70	18.35	23.50	16.70	12.00	16.30	9.90	9.65	11.25	5.70	9.65
3	7.85	13.80	18.90	23.50	16.60	12.55	16.25	9.70	9.25	11.50	6.05	9.40
4	8.65	13.60	19.00	23.35	16.50	13.15	16.30	9.70	9.00	11.75	6.50	9.30
5	9.00	12.80	18.60	23.10	16.55	13.60	16.30	9.80	8.75	11.65	6.80	9.30
6	11.35	11.90	17.90	23.05	16.50	14.10	16.10	9.60	8.55	11.50	7.00	9.40
7	13.90	11.30	17.30	23.10	16.50	14.30	15.80	9.35	8.40	11.00	7.00	9.60
8	14.10	10.50	16.85	22.90	16.80	14.55	15.50	9.50	8.30	10.10	7.10	9.80
9	13.50	9.55	16.60	22.95	17.35	15.20	15.30	10.20	8.25	9.40	7.20	10.10
10	12.70	8.80	16.40	22.90	17.20	15.75	15.00	9.90	8.20	9.20	7.30	10.10
11	11.65	8.25	16.25	22.85	16.60	16.05	14.50	9.80	8.20	8.75	7.40	9.75
12	10.50	7.90	15.90	22.65	16.05	16.30	14.10	10.10	8.25	8.40	7.40	9.40
13	9.45	7.50	15.70	22.30	15.55	16.15	13.70	10.20	8.50	8.10	7.50	9.20
14	8.65	7.50	15.30	22.15	15.20	15.90	13.50	10.40	8.35	7.80	7.55	9.00
15	8.00	7.85	15.00	22.40	14.80	15.60	13.25	11.00	8.20	7.60	7.55	9.60
16	7.70	8.00	14.60	22.90	14.45	15.50	12.90	11.40	8.10	7.40	7.50	9.60
17	7.40	8.00	14.10	22.75	14.10	15.30	12.70	11.60	8.05	7.25	7.70	9.20
18	7.25	8.00	13.50	22.10	13.60	15.05	12.50	11.30	8.00	7.15	8.05	8.90
19	6.85	8.05	13.10	21.40	13.15	14.90	12.30	11.00	7.90	7.05	8.05	8.70
20	6.75	8.20	12.85	20.90	12.70	14.90	12.00	10.60	7.90	6.95	8.30	8.40
21	7.00	8.50	12.30	20.50	12.50	15.10	11.70	10.40	8.10	6.75	10.05	8.15
22	9.70	8.80	12.00	19.85	12.20	15.05	11.30	10.60	8.20	6.60	11.85	7.80
23	11.95	9.05	11.90	19.40	11.90	16.45	11.25	10.50	8.20	6.50	11.45	7.60
24	12.00	9.60	11.70	18.90	11.80	17.05	11.20	10.20	8.10	6.35	11.40	7.40
25	13.00	11.25	11.85	18.45	11.55	17.55	11.30	9.80	8.30	6.25	11.40	7.10
26	13.90	13.75	12.30	18.00	11.45	17.65	11.90	9.45	9.10	6.10	11.30	6.60
27	14.00	15.75	13.75	17.70	11.35	17.25	12.55	9.30	9.80	6.00	11.15	5.90
28	13.85	17.05	15.80	17.45	11.25	16.50	12.45	9.90	10.10	5.80	11.00	[a] 5.10
29	13.60	.....	19.00	17.20	11.25	16.15	11.80	11.20	10.55	5.70	10.80	4.40
30	13.30	.....	20.90	17.00	11.30	16.25	11.40	11.40	11.05	5.70	10.55	4.60
31	13.35	.....	22.25	.....	11.35	.....	10.80	10.75	.....	5.60	.....	5.50

[a] Changed less than one-half foot.

1907.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.05	20.8	13.7	16.4	15.4	13.4	19.8	21.45	12.4	8.5	6.85	5.9
2	6.8	20.2	13.7	16.3	15.9	14.0	19.4	21.1	12.1	8.5	7.0	5.9
3	8.85	19.5	13.75	16.2	16.45	[a] 14.1	18.9	20.3	12.05	8.5	7.0	5.85
4	11.85	18.8	13.75	15.75	16.75	14.6	18.5	19.3	11.85	8.8	6.9	5.8
5	12.0	17.95	13.75	15.4	16.6	15.9	18.0	18.6	11.85	9.2	6.8	5.7
6	12.05	17.0	13.6	14.85	16.4	17.75	17.35	17.8	11.8	9.6	6.75	5.55
7	13.5	15.8	13.6	14.7	16.3	18.5	16.65	17.4	11.65	10.0	6.6	5.45
8	14.3	14.2	13.6	14.4	16.2	18.6	16.4	17.0	11.55	10.5	6.5	5.4
9	14.7	12.45	13.45	14.25	16.75	18.3	16.55	16.8	11.45	10.3	6.4	5.25
10	14.9	10.6	13.3	14.2	17.7	18.1	16.7	16.6	11.1	10.4	6.3	5.2
11	14.7	9.3	13.0	14.3	18.2	18.25	16.75	16.4	10.75	10.7	6.3	5.2
12	14.55	8.6	12.85	14.35	18.0	18.5	16.75	16.2	10.4	10.9	6.3	5.15
13	14.3	8.3	13.4	14.7	17.2	19.05	16.7	15.8	10.0	11.0	6.1	5.05
14	13.9	8.6	15.85	15.3	16.5	19.9	16.75	15.35	9.7	11.0	6.0	5.0
15	13.75	9.0	17.1	15.9	16.35	20.45	17.0	15.1	9.4	10.7	5.9	5.1
16	14.0	9.8	18.0	16.0	16.15	20.55	17.5	14.7	9.2	10.4	5.8	5.1
17	14.35	10.3	18.2	15.8	16.0	20.9	17.8	14.5	8.85	10.0	5.8	5.1
18	15.1	10.1	18.1	15.7	18.5	20.7	18.25	14.4	8.65	9.7	5.85	5.25
19	16.8	10.2	18.1	15.7	19.1	20.0	19.3	14.2	8.5	9.3	5.8	5.4
20	19.4	10.6	18.3	15.75	18.8	19.4	20.05	14.3	8.4	9.0	5.95	5.45
21	21.7	10.8	18.5	16.15	17.8	18.8	20.35	14.85	8.2	8.8	6.3	5.45
22	23.9	10.55	18.8	16.65	16.7	18.5	20.7	15.25	8.0	8.5	6.15	5.35
23	24.85	10.4	18.85	17.0	15.6	18.05	21.2	15.3	7.8	8.3	6.15	5.4
24	25.3	10.9	18.45	17.05	14.65	17.8	21.6	16.3	7.75	8.1	6.15	5.85
25	25.5	11.6	18.1	16.9	13.9	18.1	22.0	15.6	7.85	7.9	6.1	6.0
26	25.25	12.55	17.85	17.15	13.3	18.7	22.35	15.4	8.05	7.75	6.05	6.0
27	24.55	13.3	17.6	16.9	12.7	19.5	22.45	15.4	8.2	7.55	5.9	6.0
28	23.75	13.6	17.35	16.5	12.3	20.0	22.25	15.1	8.35	7.45	5.9	6.0
29	22.8	.....	17.05	16.1	12.5	20.3	22.1	13.9	8.45	7.3	5.9	6.1
30	22.05	.....	16.7	15.65	12.9	20.1	21.8	13.1	8.5	7.1	5.95	6.05
31	21.4	.....	16.5	.....	12.9	.....	21.5	12.65	.....	6.95	.....	5.8

[a] Reading changed one-half foot or more.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

COMMERCE, MO.—Continued.

1908.

[Gauge, 143.67 miles from Eads Bridge. Zero of gauge, 308.84 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	[a] 5.70	4.50	18.50	15.85	16.55	22.55	25.40					
2	5.70	4.20	18.10	15.40	16.05	23.00	25.00					
3	5.65	3.60	17.75	15.00	15.60	23.40	24.70					
4	5.65	2.80	17.40	14.70	15.20	23.65	24.70					
5	5.60	2.95	17.35	14.75	15.35	24.00	24.80					
6	5.50	4.35	17.40	14.70	16.40	24.30	24.90					
7	5.40	4.70	17.45	14.70	17.80	24.40	24.95					
8	5.40	4.45	17.60	15.70	18.80	24.40	24.90					
9	5.35	4.60	18.15	16.50	19.20	24.50	24.55					
10	5.25	5.15	18.90	17.20	19.75	24.50	23.90					
11	5.15	5.60	20.00	18.85	20.20	24.55	23.10					
12	6.10	6.00	20.45	20.00	20.90	24.60	22.50					
13	6.95	6.45	20.55	20.60	21.20	24.75	22.10					
14	6.95	7.85	20.60	20.90	21.20	25.00	21.90					
15	7.15	[a] 9.50	20.65	20.70	20.90	25.30	21.70					
16	7.10	11.00	20.60	20.35	20.80	25.60	21.20					
17	6.75	13.10	20.35	19.80	21.50	26.00	20.50					
18	6.30	15.70	20.00	19.25	22.50	26.40	19.90					
19	5.95	16.90	19.80	18.35	23.10	26.70	19.30					
20	5.65	17.40	19.40	17.60	23.20	27.00	19.10					
21	5.40	17.90	18.90	16.70	23.10	27.15	19.15					
22	5.10	18.30	18.45	16.00	22.60	27.20	19.25					
23	4.85	18.30	17.90	15.20	22.20	27.25	19.35					
24	4.70	18.20	17.35	15.00	21.75	27.20	19.05					
25	4.90	18.05	16.70	16.00	21.40	27.10	18.60					
26	5.10	18.00	16.10	15.90	20.80	27.00	18.20					
27	5.10	17.85	15.65	16.40	20.45	26.75	18.00					
28	5.10	18.00	15.35	16.40	20.80	26.50	17.80					
29	5.10	18.50	15.30	16.50	21.45	26.20	17.70					
30	4.90	.....	15.40	16.90	21.90	25.90	17.55					
31	4.55	.....	15.55	.....	22.15	.....	17.30					

[a] From Jan. 1 to Feb. 15, inclusive, on temporary gauge.

BEECHRIDGE, ILL.

1901.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

[Gauge established Oct. 15, 1901.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.40	3.40
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.40	3.40
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.40	3.35
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.40	3.25
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	3.15
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.10	3.10
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.00	3.05
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.85	3.10
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.80	3.15
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.75	3.15
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.70	3.25
12	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.80	3.52
13	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.85	3.25
14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.95	[a] 3.35
15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.85	4.50
16	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.95	3.85	5.00
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.80	3.80	6.10
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.75	3.80	7.40
19	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.80	3.80	8.60
20	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.05	3.75	[b]
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	3.75	[b]
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.45	3.75	[b]
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.60	3.70	[b]
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.70	3.70	[b]
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.55	3.70	[b]
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.50	3.65	[b]
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.40	3.65	[b]
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.35	3.55	[b]
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	3.45	[b]
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.30	3.45	[b]
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.35	.....	[b]

[a] Interpolated—no reading. [b] No gauge.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BEECHRIDGE, ILL.—Continued.

1902.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	Ice.	.....	8.70	.....	.....	.....	.....	.....	.....	.....	.....	.....
2	9.30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.70	.....
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.30	.....
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.00	.....
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.70	.....
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.55	.....
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.75	.....
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.15	.....
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.40	.....
11	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	9.90	.....
12	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
14	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
15	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	10.00	.....
16	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	9.70	.....
17	Ice.	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	9.50	.....
18	Ice.	Ice.	.....	.....	.....	.....	.....	.....	10.00	.....	9.25	.....
19	Ice.	Ice.	.....	.....	.....	.....	.....	.....	9.60	.....	9.20	.....
20	2.95	Ice.	.....	.....	.....	.....	.....	.....	9.00	.....	9.45	.....
21	2.95	Ice.	.....	.....	.....	.....	.....	.....	8.60	.....	.....	.....
22	2.95	Ice.	.....	.....	.....	.....	.....	.....	8.20	.....	.....	.....
23	3.00	Ice.	.....	.....	.....	.....	.....	.....	7.70	.....	.....	.....
24	3.10	Ice.	.....	.....	.....	.....	.....	.....	7.30	.....	.....	.....
25	3.20	Ice.	.....	.....	.....	.....	.....	.....	7.10	.....	.....	.....
26	3.30	Ice.	.....	.....	.....	.....	.....	.....	7.10	.....	.....	.....
27	3.45	Ice.	.....	.....	.....	.....	.....	.....	8.20	.....	.....	.....
28	3.75	Ice.	.....	.....	.....	.....	.....	.....	10.00	.....	.....	.....
29	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
30	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
31	Ice.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

1903.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.25
2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.00
3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.70
4	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.50
5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.20
6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.90
7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.60
8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.40
9	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.30
10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.15
11	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.90
12	.....	.....	38.60	.....	.....	.....	.....	.....	.....	.....	.....	4.75
13	.....	.....	39.00	.....	.....	37.25	.....	.....	.....	.....	.....	4.65
14	.....	.....	39.15	.....	.....	37.35	.....	.....	.....	.....	.....	4.00
15	.....	.....	39.15	.....	.....	37.30	.....	.....	.....	.....	.....	3.20
16	.....	.....	39.20	.....	.....	37.00	.....	.....	.....	.....	.....	2.35
17	.....	.....	39.25	.....	.....	36.30	.....	.....	.....	.....	.....	1.80
18	.....	.....	39.05	.....	.....	35.40	.....	.....	.....	.....	.....	1.70
19	.....	.....	38.80	.....	.....	34.00	.....	.....	.....	.....	.....	1.60
20	.....	.....	38.60	.....	.....	.....	.....	.....	.....	.....	.....	1.75
21	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2.55
22	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3.00
23	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.70	3.50
24	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.50	4.05
25	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9.25	4.15
26	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.90	4.70
27	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.65	5.00
28	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8.30	5.35
29	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.95	5.25
30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.65	5.30
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5.50

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BEECHRIDGE, ILL.—Continued.

1904.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.60	(a)	(a)	37.40	34.25	(a)	(a)	(a)	9.75	11.80	9.90	6.05
2	6.00	(a)	(a)	37.80	34.65	(a)	(a)	(a)	9.20	12.10	10.15	5.95
3	5.50	(a)	(a)	38.00	34.80	(a)	(a)	(a)	8.75	12.15	10.20	5.80
4	5.25	(a)	(a)	38.25	34.90	(a)	(a)	(a)	8.35	11.80	10.15	5.70
5	5.95	(a)	(a)	38.20	34.95	24.45	(a)	(a)	8.10	11.55	10.00	5.55
6	5.40	(a)	(a)	37.90	34.65	24.85	(a)	(a)	8.15	11.05	9.90	5.40
7	5.00	(a)	(a)	37.50	34.00	26.30	(a)	(a)	8.55	10.40	9.70	5.30
8	4.70	(a)	(a)	b 37.00	33.10	27.55	(a)	(a)	8.50	10.00	9.55	5.10
9	4.85	(a)	(a)	c 35.90	31.80	28.25	(a)	(a)	8.15	9.70	9.45	4.90
10	5.00	(a)	(a)	35.40	30.60	28.20	(a)	(a)	7.80	9.40	9.30	4.70
11	4.90	(a)	(a)	35.10	29.50	27.85	(a)	(a)	7.70	8.05	9.20	4.55
12	4.80	(a)	(a)	34.80	28.60	27.20	24.60	(a)	7.80	8.80	9.10	4.55
13	4.70	(a)	(a)	34.65	27.60	26.40	25.60	9.50	7.80	8.60	9.00	4.55
14	4.65	(a)	(a)	34.20	26.40	25.40	26.20	9.25	7.90	8.40	8.95	4.35
15	4.60	(a)	(a)	33.50	25.20	(a)	26.20	9.20	7.70	8.20	8.90	4.10
16	4.65	(a)	24.50	32.50	(a)	(a)	25.60	9.60	7.60	7.95	8.70	b 3.70
17	4.05	(a)	24.60	31.40	(a)	(a)	24.60	9.15	7.40	7.75	8.55	b 3.33
18	4.15	(a)	24.55	29.85	(a)	(a)	(a)	9.25	7.30	7.65	8.40	2.85
19	4.20	(a)	24.35	28.65	(a)	(a)	(a)	9.50	7.40	7.55	8.25	2.60
20	5.50	(a)	24.00	27.70	(a)	(a)	(a)	9.60	7.90	7.50	8.05	1.90
21	5.90	(a)	23.30	26.90	(a)	(a)	(a)	9.80	11.00	7.40	7.90	1.65
22	6.40	(a)	22.50	25.80	(a)	(a)	(a)	(a)	11.50	7.40	7.65	1.50
23	8.00	(a)	21.90	25.20	(a)	(a)	(a)	(a)	12.10	7.35	7.40	1.50
24	(a)	(a)	21.95	25.20	(a)	(a)	(a)	(a)	12.00	7.40	7.25	1.45
25	(a)	(a)	23.70	26.30	(a)	(a)	(a)	(a)	11.35	7.55	7.05	1.40
26	(a)	(a)	27.50	27.60	(a)	(a)	(a)	(a)	11.00	7.75	6.90	1.80
27	(a)	(a)	30.50	29.60	(a)	(a)	(a)	(a)	10.70	8.00	6.65	2.15
28	(a)	(a)	31.90	31.30	(a)	(a)	(a)	(a)	11.20	8.30	6.40	b 2.80
29	(a)	(a)	33.70	32.50	(a)	(a)	(a)	(a)	11.60	8.60	6.30	3.40
30	(a)	.....	35.50	33.65	(a)	(a)	(a)	(a)	11.65	8.95	6.15	3.90
31	(a)	.....	36.70	.....	(a)	.....	(a)	(a)	.....	9.40	.....	3.35

a No gauge. b Interpolated—no reading. c Reading changed one-half foot or more.

1905.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.40	12.95	19.20	24.50	a 19.10	21.50	23.70	19.00	14.90	16.80	15.90	10.60
2	3.60	(b)	22.70	24.60	c 19.60	20.80	24.30	19.90	13.80	15.80	15.10	11.60
3	3.60	(b)	23.70	25.00	19.80	20.00	24.60	20.50	12.90	14.90	14.50	13.50
4	3.50	(b)	23.70	24.80	19.80	19.70	24.70	20.80	12.70	14.80	14.10	14.80
5	3.75	(b)	23.10	24.40	19.70	20.60	24.90	21.00	12.20	13.60	13.90	15.70
6	4.15	(b)	23.60	23.50	a 20.00	20.50	25.40	20.40	11.70	13.10	13.90	16.70
7	4.30	(b)	23.70	22.50	20.60	20.70	25.70	19.70	11.50	12.60	14.30	17.40
8	4.35	(b)	23.20	21.20	20.90	20.00	25.80	18.80	11.40	12.20	14.60	17.80
9	d 4.40	(b)	23.00	19.70	19.50	19.40	25.50	18.10	11.30	11.70	14.90	17.90
10	4.10	(b)	22.60	18.90	18.70	18.80	25.20	a 17.70	11.30	11.30	14.80	18.10
11	d 3.70	(b)	23.00	18.00	17.70	18.40	24.80	16.80	11.20	10.90	14.50	18.00
12	3.40	(b)	24.20	17.20	16.60	18.10	24.70	16.40	11.10	10.60	14.20	17.80
13	3.55	(b)	25.10	16.60	16.30	18.40	24.60	16.10	11.10	10.30	14.00	16.80
14	3.60	(b)	26.00	c 16.40	15.80	19.10	24.90	15.60	11.90	10.20	13.80	15.80
15	2.80	(b)	26.50	16.20	15.80	19.80	25.40	15.20	12.80	9.80	13.80	14.80
16	3.70	(b)	26.90	16.20	17.40	20.10	25.60	14.80	12.50	9.60	13.50	13.80
17	3.80	(b)	26.90	16.30	19.80	20.20	25.70	14.40	12.30	9.40	12.90	12.80
18	3.90	(b)	26.90	16.30	a 22.00	20.20	25.60	14.00	14.90	9.20	12.20	12.10
19	3.90	(b)	26.80	16.30	24.80	20.10	24.70	13.70	20.50	10.10	11.70	11.50
20	3.90	(b)	25.80	16.30	25.90	19.40	23.50	13.60	24.20	14.00	11.30	11.00
21	4.00	(b)	24.50	16.30	27.20	19.80	22.50	13.90	25.90	17.20	11.30	10.50
22	e 10.20	(b)	23.40	16.00	28.00	20.20	23.90	14.20	27.30	16.30	11.50	11.70
23	e 11.00	(b)	21.80	a 15.70	28.30	20.50	22.30	14.60	27.70	15.80	11.80	a 12.10
24	e 11.50	(b)	19.80	15.30	28.00	20.30	21.50	15.10	27.80	15.80	11.60	13.10
25	e 12.00	14.00	19.50	15.30	27.80	20.40	20.80	16.70	27.00	15.80	11.00	13.80
26	e 12.80	14.80	19.60	15.70	27.50	20.70	20.70	18.60	25.70	16.10	10.50	14.80
27	e 13.00	15.50	20.40	16.20	26.90	21.50	20.90	18.80	23.70	16.10	10.40	15.30
28	e 13.50	14.80	21.80	16.80	25.80	22.50	21.20	18.50	21.80	17.00	10.20	15.50
29	e 13.00	.....	22.90	17.70	24.80	22.50	20.50	18.10	20.00	17.40	10.10	15.30
30	e 12.15	.....	23.40	18.60	23.50	23.10	19.50	17.40	18.20	17.00	10.30	15.20
31	e 12.50	.....	24.00	.....	22.30	.....	19.00	16.20	.....	16.50	.....	14.90

a Reading changed one-half foot or more.
b No readings, account of ice.
c Change less than one-half foot.
d Interpolated—no reading.
e Doubtful on account of ice.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BEECHRIDGE, ILL.—Continued.

1906.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14.60	24.20	22.60	33.60	22.40	14.00	19.40	13.60	14.10	14.30	7.60	22.40
2	14.20	24.10	23.30	34.70	21.90	14.40	19.40	12.90	12.70	15.00	7.60	20.60
3	14.20	23.70	24.40	35.20	21.60	15.00	19.30	12.30	12.30	15.60	7.80	18.85
4	14.90	23.00	25.80	35.50	21.30	15.70	19.30	12.10	11.80	16.20	8.20	17.00
5	15.30	21.75	25.60	35.60	21.30	16.20	19.35	12.10	11.40	16.60	8.40	15.80
6	16.40	20.20	24.50	35.90	21.30	16.80	19.20	11.90	11.20	17.00	8.60	14.30
7	19.70	18.30	24.60	36.10	21.30	17.20	18.90	11.50	10.90	17.10	8.70	14.10
8	21.40	16.90	25.30	36.20	21.50	17.40	18.50	11.50	10.80	16.80	8.70	13.70
9	21.90	(a)	25.20	36.20	22.20	18.00	18.20	12.30	10.60	16.80	8.80	13.45
10	21.80	(a)	25.20	36.20	22.30	19.00	17.80	12.10	10.60	16.20	8.95	13.45
11	21.20	(a)	b 24.60	36.10	21.60	19.40	17.30	11.75	10.55	15.60	9.10	13.30
12	20.00	(a)	b 23.80	35.90	20.90	19.60	16.70	11.90	10.50	14.80	9.20	13.15
13	19.30	(a)	23.10	35.50	20.20	19.60	16.20	12.00	10.70	14.00	9.30	13.00
14	18.30	(a)	b 22.30	34.90	19.70	19.30	15.90	12.10	10.90	13.00	9.50	12.90
15	17.50	(a)	21.40	34.60	19.30	18.90	15.60	12.20	10.80	12.10	9.50	13.70
16	16.50	(a)	b 20.90	34.40	18.90	18.80	15.40	b 12.70	10.70	11.20	9.40	b 15.10
17	15.60	(a)	20.30	33.90	18.40	18.55	15.10	13.30	10.45	10.50	9.50	15.90
18	14.90	(a)	b 20.00	33.00	b 17.80	18.30	14.90	13.90	10.30	9.90	10.00	17.30
19	14.30	(a)	b 19.60	32.00	b 17.10	18.10	14.70	13.60	10.10	9.50	11.20	18.80
20	14.40	(a)	b 19.60	31.00	16.40	18.10	14.50	13.30	9.80	9.20	13.40	20.10
21	15.50	10.90	19.10	30.20	15.90	18.30	14.40	13.10	9.80	8.90	16.50	21.00
22	17.60	11.00	20.50	29.40	15.40	18.80	14.20	13.50	9.60	8.70	20.20	21.20
23	21.00	11.30	21.20	b 28.50	15.00	19.60	14.10	13.70	9.90	8.45	21.70	21.60
24	21.90	11.70	21.90	27.80	14.60	20.30	14.10	13.50	9.80	8.25	22.45	21.80
25	23.00	13.10	22.60	27.00	14.30	21.00	14.20	13.30	9.90	8.20	23.40	21.90
26	24.60	16.00	23.00	26.10	14.10	21.10	14.70	12.60	10.90	8.00	24.10	21.60
27	25.50	18.70	23.80	25.10	14.00	20.80	15.40	12.20	12.00	7.60	24.50	20.85
28	25.20	20.50	25.20	24.45	13.80	19.90	15.80	12.40	12.70	7.60	24.60	19.40
29	24.80	.....	27.70	23.45	13.70	19.30	15.50	13.70	13.00	7.60	24.30	17.70
30	24.40	.....	30.00	22.90	13.80	19.20	15.10	14.40	13.70	7.80	23.70	16.20
31	24.30	.....	31.90	.....	13.90	.....	14.40	c 14.40	.....	7.80	.....	15.70

a No readings, account of ice. b Reading changed one-half foot or more. c Changed less than one-half foot.

1907.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	a 16.00	36.95	20.50	31.20	21.30	17.30	24.00	26.50	15.60	10.90	8.60	9.80
2	17.10	36.30	21.40	30.20	22.00	18.30	24.20	26.00	15.40	10.90	8.75	10.20
3	22.15	35.50	22.70	28.90	23.10	18.50	23.50	25.30	15.30	10.90	8.75	10.35
4	25.00	34.70	23.90	27.10	23.80	19.60	22.60	24.00	15.00	11.10	8.50	10.20
5	27.15	33.80	24.80	25.00	23.90	21.10	22.30	23.15	a 14.90	11.60	8.40	9.70
6	a 28.25	32.70	25.50	23.00	23.80	23.20	21.60	22.40	a 14.75	12.10	8.30	9.30
7	29.40	(b)	25.90	22.10	24.30	24.60	20.80	21.70	c 14.60	12.55	8.30	8.75
8	30.00	(b)	26.20	21.60	25.20	25.20	20.30	21.20	14.50	13.20	8.30	8.25
9	30.50	(b)	26.40	21.00	26.00	25.30	20.20	20.80	14.20	13.00	8.30	7.95
10	30.70	(b)	26.50	20.60	27.10	25.70	20.30	20.50	14.00	13.00	8.20	7.50
11	30.60	(b)	26.20	20.60	27.90	26.00	20.20	20.00	13.40	13.40	8.30	7.40
12	30.40	(b)	25.60	20.80	28.00	26.40	20.40	19.80	13.00	13.60	8.35	7.20
13	29.95	(b)	25.20	21.00	27.70	26.80	20.20	19.35	12.50	13.85	8.40	7.10
14	29.60	17.10	26.40	21.60	27.20	27.75	20.20	18.70	12.10	13.85	8.50	7.10
15	29.20	16.40	27.85	22.50	26.90	28.50	20.50	18.40	c 11.80	13.60	8.60	7.10
16	29.10	16.15	29.30	22.60	27.10	a 29.00	21.10	18.00	d 11.50	13.20	8.60	7.30
17	29.20	16.20	30.55	22.40	27.40	29.45	21.60	17.70	11.30	12.85	8.80	7.50
18	29.70	15.20	31.50	22.10	28.30	29.50	22.10	17.50	11.10	12.55	9.10	7.80
19	30.40	15.45	32.20	a 21.80	28.70	29.00	23.20	17.20	11.00	12.00	9.60	8.10
20	32.20	15.50	32.80	21.45	28.20	28.40	24.20	17.30	10.70	11.80	10.00	8.80
21	34.00	15.60	33.30	21.45	a 26.90	27.95	25.10	17.90	10.50	11.40	10.10	9.50
22	35.90	15.20	33.90	21.70	25.10	27.60	25.50	18.50	10.30	a 10.90	a 9.75	10.10
23	37.40	15.10	a 34.30	22.00	23.20	27.40	25.90	18.50	10.00	10.60	9.45	10.60
24	38.40	15.20	34.35	22.10	21.40	26.60	26.50	18.40	10.00	10.30	9.35	11.55
25	39.30	16.70	34.30	22.00	19.90	25.90	26.90	18.40	9.90	a 10.10	9.25	12.00
26	39.50	18.20	34.10	22.20	18.50	25.60	27.40	18.80	10.10	9.85	9.10	12.50
27	39.40	19.30	33.90	22.10	17.60	25.70	27.60	18.50	10.20	9.50	8.95	13.10
28	39.10	20.00	33.60	21.95	16.80	25.60	27.70	18.70	10.50	9.40	9.00	13.50
29	c 38.50	.....	33.10	21.60	16.50	25.70	27.70	17.50	10.80	9.10	9.15	13.75
30	37.95	.....	32.70	21.30	16.90	25.40	27.30	16.60	10.95	8.90	9.20	13.80
31	37.50	.....	31.90	.....	16.95	.....	26.90	15.90	.....	8.60	.....	13.50

a Reading changed one-half foot or more.
b Ice gorge on gauge.
c Changed less than one-half foot.
d One foot has been added to readings from September 16 to September 24, inclusive, and from September 26 to 30, inclusive.
e Interpolated—no reading.

Tabulated gauge readings at selected stations between Chain of Rocks and Cairo—Cont'd.

BEECHRIDGE, ILL.—Continued.

1908.

[Gauge, 169.45 miles from Eads Bridge. Zero of gauge, 289.73 feet above Memphis datum plane. Gauge read at 8 a. m.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	13.70	7.90	32.70	29.95	25.90	29.80	31.10	.....	.....	.....	.....	.....
2	14.50	7.40	32.10	29.50	25.70	30.20	30.80	.....	.....	.....	.....	.....
3	15.10	6.80	31.30	28.70	25.40	30.40	30.10	.....	.....	.....	.....	.....
4	15.80	6.50	30.50	28.30	24.80	30.50	30.10	.....	.....	.....	.....	.....
5	16.40	7.50	29.80	28.10	24.85	30.50	30.10	.....	.....	.....	.....	.....
6	16.80	9.50	29.50	28.30	25.30	30.95	30.10	.....	.....	.....	.....	.....
7	17.00	11.40	29.30	28.50	26.50	31.00	30.20	.....	.....	.....	.....	.....
8	17.20	12.10	29.50	29.30	28.40	31.00	30.10	.....	.....	.....	.....	.....
9	17.10	15.00	30.00	30.40	29.40	31.00	29.80	.....	.....	.....	.....	.....
10	16.95	16.60	30.55	31.50	30.40	31.10	29.20	.....	.....	.....	.....	.....
11	16.20	17.20	31.05	32.60	31.20	31.10	28.20	.....	.....	.....	.....	.....
12	16.00	17.80	32.35	33.65	32.00	31.20	27.40	.....	.....	.....	.....	.....
13	16.00	19.70	32.80	34.20	32.70	31.30	27.00	.....	.....	.....	.....	.....
14	15.40	21.20	33.30	34.30	33.10	31.50	26.50	.....	.....	.....	.....	.....
15	14.90	22.80	33.70	34.00	33.20	31.60	26.30	.....	.....	.....	.....	.....
16	14.40	24.50	34.20	33.50	33.30	31.90	25.80	.....	.....	.....	.....	.....
17	14.00	25.80	34.20	32.95	33.60	32.40	25.00	.....	.....	.....	.....	.....
18	13.85	28.10	34.20	32.30	34.30	32.50	24.30	.....	.....	.....	.....	.....
19	14.00	29.50	34.20	31.50	34.70	32.80	23.30	.....	.....	.....	.....	.....
20	14.45	30.80	33.95	30.80	34.90	33.10	22.80	.....	.....	.....	.....	.....
21	15.10	31.70	33.60	29.95	34.70	33.10	22.80	.....	.....	.....	.....	.....
22	15.25	32.40	33.00	29.30	34.00	33.10	22.90	.....	.....	.....	.....	.....
23	14.80	32.90	32.35	28.30	33.40	33.00	22.90	.....	.....	.....	.....	.....
24	14.00	33.10	31.50	27.10	32.30	32.90	22.60	.....	.....	.....	.....	.....
25	13.40	33.30	30.60	26.70	31.30	32.60	22.00	.....	.....	.....	.....	.....
26	12.40	33.30	30.00	26.00	30.10	32.50	21.50	.....	.....	.....	.....	.....
27	11.50	33.30	29.50	25.50	29.10	32.30	21.20	.....	.....	.....	.....	.....
28	10.70	33.00	29.50	25.60	28.70	32.00	20.90	.....	.....	.....	.....	.....
29	10.00	33.00	29.50	25.45	29.00	31.80	20.80	.....	.....	.....	.....	.....
30	9.20	.....	29.60	25.80	29.40	31.50	20.60	.....	.....	.....	.....	.....
31	8.50	.....	29.80	.....	29.60	.....	20.40	.....	.....	.....	.....	.....

NOTE.—Changes of readings referred to in notes at bottom of tables were made by means of comparative hydrographs.

APPENDIX No. 18.

DISCHARGE RESULTS MISSISSIPPI AND MISSOURI RIVERS GRAFTON, ILL., AND ST. CHARLES, MO., TO RED RIVER LANDING, LA., 1851 TO 1908.

[Grouped by stations. Discharges chronologically, stations geographically. Prepared under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. A., recorder of board on examination and survey of the Mississippi River.]

List of stations.

St. Charles, Mo.
Grafton, Ill.
St. Louis, Mo.
Kaskaskia Chute.
Barnets.
Chester, Ill.
Holschen.
Thebes, Ill.
Buffalo Island.
Near Cairo, Ill.
Columbus, Ky.
New Madrid, Mo.
Point Pleasant, Mo.
Ashport.
Bullerton.
Fulton, Tenn.
Memphis, Tenn.
Hampton Landing.
Helena, Ark.
Old Town Bend.
Chicot, Ark.
Arkansas City, Ark.
Greenville, Miss.
Louisiana Bend.
Wilson Point, La.
Hays Landing, Miss.
Vicksburg, Miss.
Warrenton, Miss.
Waterproof Cut-off.
Natchez, Miss.
Red River Landing, La.

Results of discharge observations, Missouri River.

[Mouth 196 miles above Cairo.]

ST. CHARLES, MO.

[Section about 600 feet above the bridge. Observations under Maj. C. R. Suter. Tabulation, Report Chief of Engineers, 1887, p. 3083. All gauge readings are referred to the St. Louis City Directrix, which is 433.97 feet above the Cairo datum plane. St. Charles 25 miles above mouth.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1878.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 12	7.5	10,900	8.1	.....	1,346	3.27	35,660	Double floats.
1879.								
Feb. 6	8.2	11,075	8.0	.....	1,386	3.61	40,000	Do.
8	7.8	10,295	7.8	.....	1,357	3.53	36,370	Do.
13	8.7	11,390	8.2	.....	1,396	4.04	46,090	Do.
19	6.5	8,580	6.4	.....	1,335	3.00	25,700	Do.
20	6.3	8,610	6.5	.....	1,316	2.79	24,060	Do.
24	7.0	9,425	7.0	.....	1,341	3.08	29,050	Do.
25	7.3	10,180	7.6	.....	1,347	3.16	32,240	Do.
Mar. 1[a]	6.8	9,355	7.4	.....	1,271	3.11	29,100	Do.
5	6.4	8,895	7.0	.....	1,261	2.87	25,520	Do.
7	6.5	9,135	7.2	.....	1,267	2.99	27,280	Do.
8	6.7	9,235	7.2	.....	1,274	3.07	28,340	Do.
12	8.3	11,620	8.8	.....	1,316	3.46	40,220	Do.
13	8.2	11,460	8.7	.....	1,313	3.38	38,780	Do.
15	9.3	12,540	9.1	.....	1,384	3.77	47,230	Do.
17	9.7	13,840	9.8	.....	1,413	3.78	52,320	Do.
18	9.7	13,645	9.7	.....	1,413	3.88	52,950	Do.
19	10.0	14,510	10.2	.....	1,428	4.20	60,900	Do.
20	10.1	14,495	10.0	.....	1,448	4.02	58,240	Do.
21	10.1	14,120	9.7	.....	1,452	3.94	55,580	Do.
24	9.1	13,015	9.4	.....	1,385	3.60	46,810	Do.
25	8.9	12,655	9.2	.....	1,368	3.54	44,780	Do.
27	8.4	11,905	9.0	.....	1,310	3.36	39,950	Do.
31	7.9	11,350	8.7	.....	1,303	3.10	35,220	Do.
Apr. 4	12.0	16,470	10.4	.....	1,584	4.54	74,740	Do.
5	11.8	17,550	11.2	.....	1,570	4.25	74,680	Do.
11	17.9	27,940	14.7	.....	1,900	6.81	190,270	Do.
12	18.3	29,280	15.4	.....	1,900	7.00	204,820	Do.
15	18.4	27,820	14.8	.....	1,870	6.43	178,870	Do.
18	15.9	20,235	15.9	.....	1,046	5.05	132,510	Do.
19	15.1	24,735	15.0	.....	1,048	4.78	118,150	Do.
22	13.5	20,715	13.5	.....	1,531	4.24	87,920	Do.
23	13.1	19,580	12.8	.....	1,526	4.31	84,360	Do.
25	12.5	18,015	12.5	.....	1,487	4.03	75,000	Do.
26	12.4	18,225	12.3	.....	1,486	4.12	75,140	Do.
29	12.0	18,194	12.4	.....	1,472	3.93	71,550	Do.
30	11.9	17,740	12.1	.....	1,470	3.97	70,490	Do.
May 1	11.9	17,030	11.6	.....	1,467	3.89	66,170	Do.
2	11.8	17,280	12.1	.....	1,459	3.83	66,220	Do.
5	11.6	16,205	11.5	.....	1,412	3.79	61,700	Do.
6	11.6	16,145	11.4	.....	1,412	3.85	62,220	Do.
7	11.8	16,285	11.1	.....	1,470	3.84	62,580	Do.
8	12.5	18,795	12.6	.....	1,495	4.13	77,570	Do.
9	12.7	19,325	12.9	.....	1,494	4.12	79,600	Do.
13	12.9	18,854	12.3	.....	1,528	4.51	85,110	Do.
14	12.8	19,100	12.5	.....	1,527	4.58	87,000	Do.
15	12.8	18,990	12.4	.....	1,528	4.20	79,770	Do.
16	13.0	19,610	12.5	.....	1,531	4.36	85,580	Do.
17	12.9	19,065	13.1	.....	1,528	4.35	80,810	Do.
19	12.7	19,255	12.9	.....	1,495	4.30	84,000	Do.
20	12.6	16,975	11.4	.....	1,491	4.28	72,650	Do.
21	12.6	16,585	11.1	.....	1,492	4.36	72,060	Do.
22	12.8	17,124	11.4	.....	1,496	4.38	75,010	Do.
23	12.9	17,530	11.5	.....	1,525	4.49	78,820	Do.
26	12.6	16,300	10.9	.....	1,495	4.55	74,220	Do.
27	12.6	16,550	10.6	.....	1,491	4.40	72,790	Do.
28	12.8	17,545	11.7	.....	1,498	4.39	76,960	Do.
30	13.3	17,610	11.5	.....	1,533	4.48	78,870	Do.
31	13.5	17,925	11.7	.....	1,535	4.65	83,420	Do.
June 2	13.5	18,358	12.0	.....	1,536	4.60	84,380	Do.
4	15.2	21,106	12.8	.....	1,652	5.27	111,250	Do.
5	15.2	20,806	12.6	.....	1,652	5.22	108,570	Do.
6	15.5	21,644	13.1	.....	1,657	5.42	117,320	Do.
7	16.0	22,216	13.3	.....	1,665	5.40	121,990	Do.
9	16.5	23,215	13.9	.....	1,672	5.51	127,950	Do.

[a] New section about 800 feet above the bridge.

Results of discharge observations, Missouri River—Continued.

ST. CHARLES, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
June 10	16.3	22,516	13.5	.....	1,637	5.56	125,110	Double floats.
12	16.3	23,128	13.8	.....	1,670	5.35	123,660	Do.
13	16.8	23,750	14.1	.....	1,681	5.39	128,110	Do.
14	16.6	24,136	14.4	.....	1,679	5.52	133,250	Do.
16	17.0	25,553	14.6	.....	1,753	5.57	142,410	Do.
17	17.4	25,124	14.4	.....	1,743	5.44	136,750	Do.
18	17.9	26,198	14.8	.....	1,765	5.87	153,770	Do.
23[a]	19.8	30,290	16.9	.....	1,957	6.32	191,520	Do.
24	20.6	31,714	16.0	.....	1,982	6.67	211,450	Do.
25	19.6	29,752	15.2	.....	1,960	6.04	179,640	Do.
26	20.0	30,893	15.9	.....	1,948	6.29	194,360	Do.
30	23.4	35,460	17.4	.....	2,041	7.90	280,270	Do.
July 1	23.2	39,248	19.2	.....	2,045	7.26	284,890	Do.
3	23.6	41,060	20.1	.....	2,043	7.08	290,800	Do.
5	22.7	38,385	18.9	.....	2,034	6.70	257,170	Do.
7	21.8	36,366	18.2	.....	1,998	6.81	247,550	Do.
8	21.7	35,840	18.2	.....	1,971	6.09	218,260	Do.
9	21.4	35,030	18.2	.....	1,960	6.20	222,000	Do.
10	21.0	36,010	18.3	.....	1,969	6.12	220,400	Do.
11	20.8	35,600	18.2	.....	1,955	5.96	212,180	Do.
12	20.2	33,900	17.6	.....	1,926	5.54	187,960	Do.
14	18.9	30,790	16.2	.....	1,899	5.10	157,160	Do.
15	18.7	30,810	16.3	.....	1,892	5.18	159,630	Do.
16	18.3	29,970	16.0	.....	1,879	5.09	152,440	Do.
18	17.3	26,980	15.2	.....	1,770	4.87	131,300	Do.
19	17.1	26,220	14.8	.....	1,770	4.90	128,400	Do.
21[b]	16.8	25,260	14.2	.....	1,785	5.06	127,850	Do.
22	16.6	25,980	14.6	.....	1,779	4.85	126,020	Do.
24	16.9	26,220	14.7	.....	1,784	4.87	127,810	Do.
25	17.4	27,330	15.3	.....	1,788	4.80	131,250	Do.
26	18.0	28,370	15.8	.....	1,793	5.03	142,660	Do.
28	17.4	26,170	14.6	.....	1,789	5.09	133,300	Do.
29	16.7	25,130	14.1	.....	1,782	4.83	121,490	Do.
30	16.6	24,700	13.9	.....	1,783	4.64	114,960	Do.
31	16.2	23,670	13.3	.....	1,775	4.80	113,720	Do.
Aug. 1	16.1	23,130	13.1	.....	1,768	4.77	110,330	Do.
2	15.9	23,470	13.3	.....	1,769	4.59	107,760	Do.
4	16.2	23,610	13.3	.....	1,772	4.63	109,330	Do.
5	16.1	24,360	13.8	.....	1,771	4.61	112,230	Do.
6	16.4	25,430	14.3	.....	1,777	4.88	124,210	Do.
7	16.6	25,980	14.6	.....	1,778	5.02	130,310	Do.
8	16.1	23,720	13.4	.....	1,772	4.93	116,920	Do.
9	15.5	23,560	13.4	.....	1,754	4.60	108,370	Do.
11	14.7	20,970	12.4	.....	1,696	4.59	96,350	Do.
12	14.2	20,420	12.2	.....	1,667	4.71	96,240	Do.
14	13.7	19,610	12.6	.....	1,551	4.33	84,830	Do.
16	13.0	18,740	12.3	.....	1,525	4.15	77,740	Do.
18	12.4	17,050	11.5	.....	1,486	3.96	67,430	Do.
19	12.1	17,410	11.8	.....	1,476	3.95	68,780	Do.
20	11.9	17,520	11.9	.....	1,473	3.85	67,430	Do.
21	11.7	17,330	11.8	.....	1,467	3.82	68,780	Do.
22	11.5	16,740	11.5	.....	1,460	3.67	67,430	Do.
23	11.3	17,030	11.7	.....	1,456	3.69	62,920	Do.
26	10.7	15,410	10.7	.....	1,437	3.53	54,450	Do.
27	10.5	16,150	11.3	.....	1,428	3.48	56,240	Do.
28	10.3	16,000	11.2	.....	1,425	3.44	55,070	Do.
29	10.2	15,780	11.1	.....	1,422	3.37	53,240	Do.
30	10.1	15,560	11.0	.....	1,421	3.32	51,590	Do.
Sept. 2	9.6	14,670	11.0	.....	1,339	3.11	45,600	Do.
3	9.4	14,360	10.8	.....	1,335	3.19	45,850	Do.
4	9.3	13,950	10.5	.....	1,333	3.14	43,780	Do.
5	9.1	13,240	10.0	.....	1,319	3.18	42,150	Do.
6	9.0	13,750	10.5	.....	1,315	3.08	42,410	Do.
8	8.8	12,670	9.7	.....	1,306	3.10	39,220	Do.
9	8.6	12,670	9.8	.....	1,300	3.11	39,360	Do.
10	8.5	12,700	9.8	.....	1,299	3.17	40,540	Do.
11	8.7	12,950	10.0	.....	1,302	3.21	41,520	Do.
12	9.2	12,880	9.7	.....	1,325	3.58	46,070	Do.
13	9.0	13,400	10.2	.....	1,316	3.16	42,690	Do.
15	8.8	13,320	10.2	.....	1,307	3.22	42,960	Do.
16	8.8	13,300	10.2	.....	1,309	3.19	42,430	Do.
17	9.0	13,370	10.2	.....	1,314	3.36	44,890	Do.

[a] New section about 1,025 feet above the bridge.
[b] Section about 800 feet above the bridge.

Results of discharge observations, Missouri River—Continued.

ST. CHARLES, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Sept. 18	8.9	12,530	9.6	.....	1,312	3.18	39,890	Double floats.
19	8.6	12,420	9.6	.....	1,299	3.19	39,670	Do.
20	8.3	11,770	9.2	.....	1,281	3.07	36,090	Do.
22	7.7	11,160	8.8	.....	1,271	2.99	33,370	Do.
23	7.7	10,760	8.5	.....	1,271	3.13	33,680	Do.
24	7.6	10,600	8.3	.....	1,271	3.05	32,340	Do.
25	7.5	10,410	8.3	.....	1,248	3.13	32,620	Do.
26	7.4	10,280	8.3	.....	1,244	3.23	33,200	Do.
27	7.3	9,910	8.0	.....	1,242	3.09	30,590	Do.
29	7.1	9,260	7.5	.....	1,239	3.03	28,050	Do.
30	7.1	9,570	7.7	.....	1,238	3.16	30,250	Do.
Oct. 2	6.9	9,390	7.6	.....	1,230	3.06	28,690	Do.
3	7.1	9,940	8.1	.....	1,232	2.92	29,010	Do.
4	7.3	10,300	8.3	.....	1,243	2.92	30,030	Do.
6	7.0	10,350	8.4	.....	1,234	2.89	29,920	Do.
7	7.1	10,670	8.6	.....	1,236	2.77	29,600	Do.
8	7.1	10,730	8.7	.....	1,235	2.84	30,450	Do.
9	7.0	10,330	8.4	.....	1,229	2.77	28,580	Do.
10	6.9	10,020	8.2	.....	1,225	2.78	27,820	Do.
11	6.8	9,910	8.1	.....	1,225	2.86	28,330	Do.
13	7.1	10,240	9.3	.....	1,234	2.93	29,960	Do.
14	7.2	10,460	9.4	.....	1,252	2.98	31,160	Do.
15	7.2	10,560	8.5	.....	1,240	3.09	32,600	Do.
16	7.1	10,340	8.4	.....	1,230	2.95	30,490	Do.
17	7.0	10,370	8.4	.....	1,232	2.87	29,800	Do.
18	6.9	9,960	8.1	.....	1,227	2.81	27,950	Do.
20	6.9	9,850	8.0	.....	1,223	2.97	29,240	Do.
21	6.9	10,500	8.5	.....	1,231	2.99	31,350	Do.
22	7.1	10,300	8.3	.....	1,239	3.06	31,490	Do.
23	7.3	10,790	8.7	.....	1,242	3.10	33,400	Do.
24	7.5	10,610	8.5	.....	1,247	3.16	33,540	Do.
25	7.4	11,120	8.9	.....	1,248	3.07	34,190	Do.
27	7.0	9,920	8.1	.....	1,229	3.04	30,110	Do.
28	6.8	9,500	7.8	.....	1,223	2.84	27,010	Do.
Nov. 9, 1895	a 1.0	9,930	.....	.....	.....	2.44	24,180	

a Hermann, Mo., gauge.

[Discharge section is about 800 feet below the Wabash Railroad bridge. Overbank discharge measured on the right bank on June 22 and 23; all other overbank discharges are derived from these. Zero of local gauge is 460.68 feet above the Cairo datum plane. The rod floats were run mainly at nine-tenths depth and observed velocities corrected for their actual immersion.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
June 17	29.70	2.98	+0.45	50,085	57,489	32.0	32.8	49.0	1,755
18	29.97	3.25	+ .27	58,311	59,271	33.2	33.7	50.0	1,755
19 a. m	30.25	3.53	+ .30	57,142	57,581	32.6	32.8	48.0	1,755
19 p. m	30.32	3.60	.....	57,491	57,810	32.8	33.0	48.0	1,755
20	30.45	3.73	+ .20	.....	.....	.....	.....	.....	.....
21	30.50	3.78	+ .10	58,442	58,442	33.3	33.3	50.0	1,755
22	30.05	3.33	— .35	57,802	58,592	32.9	33.4	49.0	1,755
23 a. m	29.45	2.73	— .68	57,784	59,020	32.9	34.0	50.0	1,755
23 p. m	29.35	2.63	.....	58,123	60,141	33.1	34.2	50.0	1,755
24	29.10	2.38	— .32	58,284	60,741	33.2	34.6	50.0	1,755

Results of discharge observations, Missouri River—Continued.

ST. CHARLES, MO.—Continued.

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
June 17	.....	8.59	481,939	2,744	484,683	Meter...	7	22	VIII. Light.
18	+1,782	9.15	532,313	2,926	535,239	...do.....	11	21	X. Light.
19 a. m	−1,690	8.56	489,319	3,117	492,436	...do.....	11	22	XII. Light.
19 p. m	+ 229	9.44	512,917	3,162	516,079	...do.....	10	20	Do.
20	.....	8.73	506,039	3,250	509,289	(a)	9	....	I. Brisk.
21	+ 632	8.84	516,449	3,285	519,734	Meter...	12	21	
22	+ 150	8.52	492,250	2,980	495,230	...do.....	12	21	XI. Light.
23 a. m	+1,034	8.12	469,450	2,218	471,668	...do.....	9	22	Do.
23 p. m	+ 515	8.26	479,971	2,170	482,141	...do.....	11	21	XII. Strong.
24	+ 600	8.07	470,481	2,043	472,524	...do.....	11	22	III. Light.

—a Rod floats.

[The zero of the gauge is the St. Louis City Directrix, which is 433.95 feet above Cairo datum. The datum line for computing datum areas of October, 1908, was taken at 9.78 feet on the gauge. On account of the change in the width of the river, the datum line for the observations of January, 1909, was taken at 9.38 feet on the gauge. Price meter No. 22 was used in October, 1908. Price meters Nos. 25 and 244 and Haskell meter No. 106, wheel No. 3X, were used in January, 1909. The discharge section is about 800 feet below the Wabash Railroad bridge at St. Charles, Mo. Observations of 1908 made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission. Observations of 1909 and reductions made under direction of First Lieut. C. H. Knight, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908-9.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 10	9.78	.....	−0.12	18,871	18,871	11.56	11.56	28.0	1,632
10	9.78	.....	.....	18,436	18,436	11.30	11.30	28.0	1,632
11	9.69	.....	− .09	17,694	17,841	10.84	10.93	24.0	1,632
12	9.60	.....	− .09	17,585	17,879	10.78	10.96	25.5	1,632
12	9.60	.....	.....	18,095	18,389	11.09	11.27	23.0	1,632
13	9.55	.....	− .05	17,659	18,034	10.82	11.05	24.0	1,632
14	9.53	.....	− .02	17,420	17,837	10.68	10.93	26.0	1,632
15	9.51	.....	+ .01	17,859	18,251	10.91	11.18	25.0	1,632
1909.									
Jan. 4	9.38	.....	.....	13,925	13,925	9.13	9.13	18.0	1,525
4	9.38	.....	.....	14,110	14,110	9.25	9.25	18.0	1,525
4	9.36	.....	.....	14,392	14,423	9.44	9.46	18.5	1,525
5	9.36	.....	− .02	14,498	14,528	9.51	9.53	18.5	1,525
5	9.36	.....	.....	14,340	14,370	9.40	9.42	18.5	1,525
5	9.36	.....	.....	13,750	13,780	9.02	9.04	18.0	1,525

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908-9.	*Sq ft.*	*Feet.*	*Cu. ft.*				
Oct. 10	.....	1.699	32,058	Meter.....	9	33	Calm.
10	−435	2.018	37,208	Double floats.....	9	48	Do.
11	−595	1.836	32,494	Meter.....	10	55	V. Brisk.
12	+ 38	1.685	29,627	.....do.....	10	38	VII. Very light.
12	+510	1.607	29,072	.....do.....	10	59	
13	−355	1.648	29,098	.....do.....	10	41	XI. Brisk.
14	−197	1.718	29,956	.....do.....	10	43	Do.
15	+414	1.758	31,392	.....do.....	10	10	XI. Light.
1909.							
Jan. 4	.....	2.03	28,216	.....do.....	12	26	Do.
4	+185	1.91	27,181	.....do.....	12	26	Do.
4	+313	2.19	31,582	.....do.....	13	14	XII. Brisk.
5	+105	2.30	33,326	.....do.....	12	13	III. Brisk.
5	−158	2.35	33,694	Double floats.....	11	13	Do.
5	−590	2.07	28,471	Meter.....	12	13	IV. Brisk.

Results of discharge observations, Mississippi River.

GRAFTON, ILL.

[The discharges tabulated were measured on the Mississippi River below the mouth of the Illinois River (except on four days which are specially noted). The regular discharge section was about 3 miles below the mouth of the Illinois River; the location of section used from Jan. 6 to Feb 3 is not given exactly, but was apparently between the mouth of the Illinois and the regular section. The mean area of two cross sections was used for float discharges, hence the maximum sounding is omitted except when meter was used. The gauge readings given were observed by the discharge party and when the river was frozen are corrected for thickness of ice. The zero of the gauge was 412.55 feet above the Cairo datum plane. Discharge of Mississippi River Jan. 28, above the mouth of the Illinois River was 26,514 cubic feet per second.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1880.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Nov. 13	15.0	30,275	.....	.....	.....	1.31	46,652	Rod floats.
1881.								
Jan. 6	14.6	22,387	8.0	14.5	2,781	1.39	31,066	Meter.
7	14.5	21,950	7.9	14.9	2,779	1.27	27,935	Do.
8	14.5	21,787	7.8	14.8	2,779	1.22	26,644	Do.
11	14.1	20,952	7.5	14.3	2,776	1.10	24,868	Do.
15	13.8	20,037	7.2	14.1	2,774	1.25	25,062	Do.
17	13.9	20,375	7.3	14.1	2,775	1.33	27,046	Do.
19	13.9	20,200	7.3	14.5	2,775	1.36	27,412	Do.
20	13.9	20,312	7.3	14.2	2,775	1.36	27,520	Do.
21	13.9	20,000	7.2	14.2	2,775	1.33	26,649	Do.
25	13.9	20,062	7.2	14.1	2,775	1.34	26,882	Do.
26	13.8	20,025	7.2	14.0	2,774	1.34	26,895	Do.
Feb. 2	14.1	20,662	7.4	14.3	2,776	1.35	27,985	Do.
3	14.1	20,562	7.4	14.2	2,776	1.35	27,805	Do.
28	18.6	41,387	17.4	.....	2,380	2.34	96,917	Double floats.
Mar. 1	19.6	42,375	17.8	.....	2,380	2.30	97,637	Do.
2	20.4	43,732	18.4	.....	2,380	2.64	115,588	Do.
5	19.7	43,905	18.4	.....	2,380	2.38	104,460	Do.
7	20.1	43,337	18.2	.....	2,380	2.58	111,951	Do.
8	20.1	42,632	17.9	.....	2,380	2.88	122,736	Do.
9	20.0	42,992	18.1	.....	2,380	2.71	116,105	Do.
10	20.1	42,855	18.0	.....	2,380	2.82	121,017	Do.
12	21.3	43,912	18.4	.....	2,385	3.22	141,612	Do.
14	23.0	47,702	20.0	.....	2,390	3.36	160,311	Do.
15	23.3	49,005	20.5	.....	2,390	3.33	163,203	Do.
16	23.7	49,237	20.6	.....	2,392	3.54	174,129	Do.
17	24.0	50,250	21.0	.....	2,392	3.44	172,892	Do.
18	24.0	50,910	21.3	.....	2,392	3.34	170,223	Do.
21	24.1	51,572	21.6	.....	2,392	3.36	173,147	Do.
22	23.7	49,200	20.6	.....	2,391	3.41	167,701	Do.
23	23.4	48,870	20.4	.....	2,390	3.36	164,426	Do.
24	23.3	47,865	20.0	.....	2,390	3.32	158,811	Do.
25	23.4	47,207	19.7	.....	2,390	3.25	153,466	Do.
28	24.1	50,787	21.2	.....	2,391	3.51	178,253	Do.
30	25.4	54,587	22.8	.....	2,395	3.97	216,556	Do.
Apr. 2	26.9	56,069	23.7	.....	2,395	3.88	220,037	Do.
4	27.3	57,506	24.0	.....	2,395	4.06	233,625	Do.
5	27.5	60,281	25.2	.....	2,395	3.96	238,670	Do.
6	27.5	61,212	25.5	.....	2,397	4.02	246,033	Do.
8	28.4	62,850	26.2	.....	2,398	3.99	251,018	Do.
9	28.7	61,900	25.8	.....	2,399	4.33	267,855	Do.
11	29.2	61,087	26.7	.....	2,403	4.00	256,044	Do.
12	29.5	65,825	27.4	.....	2,405	4.38	288,156	Do.
14	29.8	67,812	28.1	.....	2,410	4.04	273,925	Do.
16	30.0	63,050	26.1	.....	2,416	4.25	268,204	Do.
18	29.9	63,237	26.2	.....	2,416	4.38	276,926	Do.
19	29.8	63,031	26.1	.....	2,416	4.21	265,640	Do.
20	29.7	64,462	26.7	.....	2,416	4.30	277,015	Do.
21	29.9	63,525	26.3	.....	2,416	4.42	280,605	Do.
22	30.3	63,657	26.3	.....	2,416	4.30	273,631	Do.
23	30.8	63,800	26.4	.....	2,416	4.41	281,349	Do.
25	32.2	67,545	28.0	.....	2,416	4.59	310,309	Do.
27	33.2	73,620	30.5	.....	2,416	4.58	337,486	Do.
28	33.5	73,815	30.6	.....	2,416	4.41	325,638	Do.
29	33.7	73,920	30.6	.....	2,416	4.47	330,482	Do.
May 3	34.0	73,435	30.4	.....	2,416	4.24	311,132	Do.
4	34.1	73,725	30.5	.....	2,416	4.00	295,285	Do.
5	34.2	74,010	30.6	.....	2,416	3.91	291,364	Do.
6	34.2	73,695	30.5	.....	2,416	3.86	284,405	Do.
7	33.8	72,832	30.1	.....	2,416	3.76	274,013	Do.
9	31.9	68,192	28.2	.....	2,416	4.21	287,378	Do.
10	30.9	66,697	27.6	.....	2,416	4.32	287,888	Do.
11	30.0	64,485	26.7	.....	2,416	4.15	267,87?	Do.
12	29.2	61,730	25.4	.....	2,431	4.12	254,273	Do.

Results of discharge observations, Mississippi River—Continued.

GRAFTON, ILL.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1881.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
May 13	28.8	61,495	25.3	.....	2,431	3.89	239,356	Double floats.
14	28.7	60,650	25.0	.....	2,428	3.93	238,118	Do.
16	28.4	60,090	24.7	.....	2,431	3.91	234,768	Do.
17	28.4	61,775	25.4	.....	2,428	4.05	249,969	Do.
18	28.6	.....	.....	.....	.....	.....	[a] 250,228	Do.
19	28.8	61,765	25.4	.....	2,428	4.01	249,491	Do.
20	28.9	60,860	25.0	.....	2,431	4.12	250,547	Do.
21	28.9	61,120	25.1	.....	2,434	4.13	252,620	Do.
23	28.7	60,865	25.1	.....	2,427	4.22	257,167	Do.
24	28.6	61,495	25.3	.....	2,427	4.08	251,115	Do.
25	28.4	60,780	25.0	.....	2,427	3.94	239,597	Do.
26	28.0	60,115	24.8	.....	2,425	3.90	234,255	Do.
27	27.6	59,440	24.5	.....	2,422	3.72	221,050	Do.
28	27.0	57,215	23.6	.....	2,423	3.59	205,585	Do.
30	25.6	54,350	22.5	.....	2,419	3.48	189,243	Do.
31	25.1	53,700	22.2	.....	2,419	3.26	175,112	Do.
June 1	24.6	52,580	21.7	.....	2,419	3.27	171,899	Do.
2	24.2	51,590	21.3	.....	2,416	3.26	168,420	Do.
3	23.9	50,735	21.0	.....	2,416	3.10	157,373	Do.
4	23.6	49,940	20.7	.....	2,416	3.05	152,521	Do.
6	23.2	48,610	20.1	.....	2,413	2.85	138,322	Do.
7	22.8	.....	.....	.....	.....	.....	[b] 138,816	Do.
8	22.7	47,037	19.8	.....	2,419	2.85	136,527	Do.
9	22.7	47,043	19.8	.....	2,419	2.86	136,948	Do.
10	23.0	48,156	19.9	.....	2,416	2.98	143,746	Do.
11	23.3	49,250	20.4	.....	2,416	3.00	147,938	Do.
13	24.0	50,900	21.0	.....	2,421	3.10	159,048	Do.
14	24.4	51,956	21.4	.....	2,422	3.18	165,480	Do.
15	24.6	52,043	21.5	.....	2,422	3.18	165,738	Do.
16	24.9	52,540	21.7	.....	2,422	3.39	178,064	Do.
17	25.3	52,635	21.7	.....	2,425	3.54	186,419	Do.
18	25.6	53,947	22.2	.....	2,427	3.58	193,282	Do.
22	26.8	55,515	22.9	.....	2,427	3.88	215,690	Do.
23	27.1	56,855	23.4	.....	2,431	3.75	213,300	Do.
24	27.4	58,555	24.1	.....	2,431	3.82	223,383	Do.
25	27.5	57,215	23.5	.....	2,431	3.84	219,647	Do.
27	27.0	57,850	23.8	.....	2,427	3.69	213,597	Do.
28	26.5	54,787	22.6	.....	2,427	3.56	195,012	Do.
29	26.0	54,200	22.4	.....	2,425	3.49	189,329	Do.
30	25.9	53,175	21.9	.....	2,425	3.54	188,271	Do.
July 1	26.0	54,200	22.3	.....	2,427	3.61	195,582	Do.
2	26.3	54,381	22.4	.....	2,427	3.69	200,626	Do.
4	26.8	54,756	22.6	.....	2,427	3.64	199,199	Do.
5	26.6	54,900	22.6	.....	2,427	3.58	196,512	Do.
6	26.0	53,125	21.9	.....	2,427	3.46	183,771	Rod floats.
7	25.4	51,700	21.3	.....	2,425	3.20	165,301	Do.
8	24.5	49,537	20.5	.....	2,422	3.02	149,850	Do.
9	23.5	46,312	19.1	.....	2,419	3.05	141,254	Do.
11	21.9	43,806	18.1	.....	2,416	2.68	117,175	Do.
12	21.4	41,631	17.3	.....	2,411	2.67	111,310	Do.
13	21.5	41,332	17.2	.....	2,410	2.69	111,081	Do.
14	22.7	44,787	18.5	.....	2,419	2.91	130,343	Do.
15	23.4	45,806	18.9	.....	2,419	3.10	141,826	Do.
16	24.3	48,137	19.9	.....	2,421	3.19	153,676	Double floats.
18	25.6	51,006	21.0	.....	2,431	3.44	175,284	Do.
19	26.1	52,187	21.5	.....	2,431	3.60	187,963	Rod floats.
20	26.5	52,012	21.8	.....	2,428	3.80	200,905	Do.
21	27.0	54,610	22.5	.....	2,427	3.81	208,061	Do.
22	27.4	55,035	22.7	.....	2,427	4.16	229,284	Do.
23	27.5	57,005	23.5	.....	2,427	3.97	226,416	Do.
25	27.0	57,030	23.5	.....	2,427	3.84	219,202	Do.
26	26.1	54,580	22.5	.....	2,422	3.76	205,291	Double floats.
27	24.6	51,230	21.2	.....	2,422	3.18	162,735	Rod floats.
28	23.1	48,768	20.2	.....	2,413	2.86	139,300	Do.
29	22.1	45,862	19.0	.....	2,410	2.70	123,751	Do.
30	21.5	44,218	18.4	.....	2,407	2.59	114,635	Do.
Aug. 1	20.9	43,018	17.9	.....	2,407	2.52	108,240	Do.
2	20.6	.....	.....	.....	.....	.....	[c] 106,636	Do.

[a] This is the sum of discharges of the Mississippi (216,955) and Illinois (33,273) rivers; both measured above the mouth of the Illinois. This also includes discharge of as chute at the Mississippi section.

[b] Sections above mouth of Illinois River, as on May 18; Mississippi River discharge 124,163, Illinois River discharge 14,683.

[c] Sections above mouth of Illinois River as on May 18; Mississippi River discharge 100,966 feet. Illinois River discharge, 5,670 feet.

Results of discharge observations, Mississippi River—Continued.

GRAFTON, ILL.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1881.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Aug. 3	20.3	41,425	17.2	.....	2,407	2.41	99,963	Rod floats.
4	20.1	40,725	16.9	.....	2,404	2.34	95,477	Do.
5	19.7	39,825	16.6	.....	2,404	2.34	92,978	Do.
6	19.3	38,968	16.2	.....	2,404	2.20	85,577	Do.
8	18.4	36,287	15.2	.....	2,395	1.97	71,546	Do.
9	18.0	36,062	15.1	.....	2,392	1.97	70,904	Do.
10	17.7	34,831	14.6	.....	2,392	1.86	64,910	Do.
11	17.4	33,637	14.1	.....	2,392	1.78	59,718	Do.
15	16.4	31,043	13.0	.....	2,392	1.60	49,790	Do.
16	16.3	31,075	13.0	.....	2,392	1.60	49,732	Do.
17	16.2	30,656	12.8	.....	2,391	1.62	49,719	Do.
19	16.0	31,368	13.1	.....	2,391	1.69	53,142	Do.
20	16.0	31,637	13.2	.....	2,391	1.65	52,168	Do.
22	16.0	31,281	13.1	.....	2,391	1.65	51,500	Do.
23	16.1	31,475	13.2	.....	2,391	1.62	51,052	Do.
24	16.1	31,462	13.2	.....	2,391	1.61	50,673	Do.
25	16.0	31,856	13.3	.....	2,390	1.64	52,186	Do.
26	15.9	31,281	13.1	.....	2,390	1.60	50,009	Do.
27	15.9	30,931	12.9	.....	2,390	1.58	48,958	Do.
29	15.8	30,388	12.7	.....	2,390	1.49	45,423	Do.
30	15.7	30,212	12.6	.....	2,390	1.56	47,201	Do.
31	15.6	30,243	12.7	.....	2,390	1.51	45,809	Do.
Sept. 1	15.6	30,062	12.6	.....	2,390	1.54	46,447	Do.
2	15.5	29,850	12.5	.....	2,390	1.53	45,616	Do.
3	15.6	30,075	12.6	.....	2,390	1.54	46,192	Do.
5	15.6	30,300	12.7	.....	2,390	1.56	47,281	Do.
6	15.7	31,080	13.0	.....	2,390	1.58	48,942	Do.
7	15.8	31,012	13.0	.....	2,390	1.61	49,975	Do.
8	16.0	31,400	13.1	.....	2,390	1.66	51,966	Do.
9	16.2	32,175	13.5	.....	2,390	1.68	53,958	Do.
10	16.4	32,300	13.5	.....	2,390	1.75	56,538	Do.
12	17.1	34,200	14.3	.....	2,391	1.91	65,180	Do.
13	17.3	34,526	14.4	.....	2,392	1.93	66,608	Do.
14	17.5	34,931	14.6	.....	2,392	1.99	69,337	Do.
15	17.7	35,062	14.7	.....	2,392	2.02	70,658	Do.
16	17.8	34,956	14.6	.....	2,393	2.04	71,299	Do.
17	18.0	35,906	15.0	.....	2,393	2.14	76,804	Do.
19	18.3	36,200	15.1	.....	2,396	2.15	77,717	Do.
20	18.6	37,087	15.5	.....	2,397	2.20	81,711	Do.
21	18.7	37,087	15.7	.....	2,397	2.24	84,247	Do.
22	18.9	37,900	15.8	.....	2,398	2.23	84,628	Do.
23	19.1	38,400	16.0	.....	2,399	2.35	90,344	Do.
24	19.3	38,775	16.2	.....	2,400	2.34	90,683	Do.
26	19.9	39,768	16.6	.....	2,402	2.47	98,058	Do.
27	20.3	41,681	17.3	.....	2,404	2.52	105,171	Do.
28	20.6	41,406	17.2	.....	2,403	2.62	108,425	Do.
29	20.8	41,987	17.5	.....	2,405	2.62	109,778	Do.
Oct. 1	22.2	47,456	19.7	.....	2,410	2.96	140,479	Do.
4	25.3	56,125	23.2	.....	2,418	3.49	195,896	Do.

Results of discharge observations, Mississippi River—Continued.

ISLAND 521 (GRAFTON).

[237 miles above Cairo.]

[Discharge section above mouth of Illinois River. Velocities measured with Haskell & Price current meters. Observations and reduction made under direction of Capt. Wm. B. Ladue, Corps of Engineers, Secretary Mississippi River Commission. Report Chief of Engineers 1904, supplement, p. 75.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1903.		*100*								
Nov. 23:	*Feet.*	*sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Right bank...	7.6	160.00	9.9	14.6	1,617	1.75	28,000	.....	.....	Meter.
Left bank.....	7.6	166.00	11.3	17.8	1,470	2.08	35,000	.....	.....	Do.
Total.....	.....	326.00	10.6	.....	3,087	1.92	63,000	.....	.....	Do.
Nov. 24:										
Right bank...	7.4	155.00	9.6	14.2	1,617	1.70	26,000	.....	.....	Do.
Left bank.....	7.4	160.00	10.8	16.5	1,470	2.04	33,000	.....	.....	Do.
Total.....	.....	315.00	10.2	.....	3,087	1.87	59,000	.....	.....	Do.

GRAFTON, ILL.

[234 miles above Cairo.]

[The zero of the Grafton Weather Bureau gauge, whose readings are tabulated, is 424.09 feet above the Cairo datum plane. Observations and reduction made under direction of Capt. Wm. B. Ladue, Corps of Engineers, Secretary Mississippi River Commission. Velocities measured with Haskell & Price meters. Reports Chief of Engineers 1903, supplement, p. 111, and 1904, p. 75.]

1903.	*Feet.*	*100 sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
June 10.....	28.5	1,121	33	46.1	3,400	2.80	314,000	48,000	[a]362,000	Meter.
11, a. m.....	28.7	1,139	33.5	46.1	3,400	2.79	317,000	48,000	[a]366,000	Do.
11, p. m.....	.....	1,119	32.9	45.2	3,400	2.77	311,000	48,000	[a]359,000	Do.
Nov. 19.....	8.5	461	14.2	27.7	3,250	2.11	97,000	.....	.....	Do.
21.....	8.0	452	13.9	26.2	3,250	2.06	93,000	.....	.....	Do.

[a] Overbank discharge measured on both banks.

GRAFTON, ILL.

[Weather Bureau gauge at Grafton, Ill.; the zero is 424.09 feet above the Cairo datum. The datum line for computing datum areas was taken at 3.9 feet on this gauge. During the October observations Price meter No. 34 was used. In a. m. of January 4 Price meter No. 243 was used; in the subsequent observations Price meter No. 243 and Haskell meter No. 105, wheel No. 1, were run simultaneously and the means of measurements are tabulated. Observations of 1908 made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Observations of 1909 and reductions made under direction of First Lieut. C. H. Knight, Corps of Engineers, U. S. Army, secretary Mississippi River Commission.]

ILLINOIS RIVER 1 MILE ABOVE MOUTH.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 14.....	3.8	.....	−0.10	9,162	.....	12.12	.....	.....	756
17.....	3.7	.....	.00	9,011	.....	11.92	.....	.....	756

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Oct. 14.....	.....	1.023	9,375	Double floats.....	6	32	I. Strong.
17.....	.....	.813	7,327	.....do.....	8	22	Calm.

Results of discharge observations, Mississippi River—Continued.

GRAFTON, ILL.—Continued.

MISSISSIPPI RIVER ABOVE MOUTH OF ILLINOIS RIVER.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.									
Oct. 13:	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Main river	3.9	.....	0.00	9,770	9,770	6.5	6.5	24.0	1,500
Chute No. 1	3.9	.....	.....	2,021	2,021	7.1	7.1	.....	285
Chute No. 2	3.9	.....	.....	580	580	1.67	1.67	2.5	350
Total	.....	.....	.....	12,371	12,371	5.8	5.8	.....	2,135
Oct. 14:									
Main river	3.8	.....	− .10	9,351	9,501	6.2	6.3	25.0	1,500
Chute No. 1	3.8	.....	− .10	2,021	2,049	7.1	7.2	9.8	285
Chute No. 2	3.8	.....	− .10	550	585	1.6	1.7	2.5	350
Total	.....	.....	.....	11,922	12,135	5.6	5.7	.....	2,135
Oct. 17:									
Main river	3.7	.....	0.00	9,643	9,943	6.4	6.6	24.0	1,500
Chute No. 1	3.7	.....	.....	1,971	2,028	6.9	7.1	9.8	285
Chute No. 2	3.7	.....	.....	585	655	1.6	1.8	2.5	350
Total	.....	.....	.....	12,199	12,626	5.7	5.9	.....	2,135

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.							
Oct. 13:	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Main river	.....	3.107	30,360	Meter	11	62	
Chute No. 1	.....	1.497	3,025	.....do	3	14	
Chute No. 2	.....	1.621	940	.....do	3	18	
Total	.....	2.77	34,325				
Oct. 14:							
Main river	−269	3.152	29,473	Meter	10	58	
Chute No. 1	+ 28	1.695	3,426	.....do	3	14	I. Strong.
Chute No. 2	+ 5	1.833	1,008	.....do	3	11	
Total	−236	2.84	33,907				
Oct. 17:							
Main river	+442	2,961	28,543	Meter	10	33	XI. Light.
Chute No. 1	− 21	2.562	5,049	.....do	3	12	
Chute No. 2	+ 70	2.00	1,170	.....do	3	8	
Total	+491	2.85	34,762				

Results of discharge observations, Mississippi River—Continued.

GRAFTON, ILL.—Continued.

MISSISSIPPI RIVER BELOW MOUTH OF ILLINOIS RIVER.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 10	3.90	.....	−0.10	26,302	26,302	9.51	9.51	17.5	2,766
12	3.83	.....	.00	27,068	27,262	9.79	9.86	17.5	2,766
12	3.83	.....	.00	27,068	27,262	9.79	9.86	17.5	2,766
16	3.75	.....	− .10	26,360	26,775	9.53	9.68	17.5	2,766
1909.									
Jan. 4	3.5	.....	.....	27,077	28,183	9.79	10.19	18.1	2,766
4	3.48	.....	.....	.....	.....	.....	.....	.....	.....
5	3.43	.....	− .07	.....	.....	.....	.....	.....	.....
5	3.40	.....	.....	26,403	27,786	9.54	10.04	18.6	2,766

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Oct. 10	.....	1.517	39,892	Meter	16	61	
12	+ 960	1.507	40,795	.....do	18	65	VI. Light.
12	.....	1.514	40,986	Double floats	12	65	Do.
16	− 487	1.638	43,186	Meter	13	33	X. Strong.
1909.							
Jan. 4	+1,408	1.522	41,214	Meter	14	50	VI. Light.
4	.....	1.526	41,327	.....do	16	....	
5	.....	1.467	38,736	.....do	12	....	
5	− 397	1.575	41,584	Double floats	11	42	I. Brisk.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.

[NOTES.—The gauge readings herein tabulated are all referred to the same zero, that of the United States Engineer gauge at foot of Market street, St. Louis. All readings after 1873 were taken on this gauge; the gauge zero is the low water of 1863 and is 400.23 feet above the Cairo datum plane. For readings of the gauge at discharge section of 1880–81, see Report of Chief of Engineers, 1883, page 2257. The standard gauge is about 4 miles below the discharge section of 1880–81. Locations of discharge sections and authorities are as follows: The Mississippi River Commission is authority except otherwise noted. Results of measurements to 1873, inclusive, are from Report of Chief of Engineers, 1873, page 472. Discharge of 1866 was measured by City Engineer Homer at St. Louis; the exact location not stated. Discharges of 1872 and 1873 were measured under direction of Col. J. H. Simpson; in 1872 opposite Carondelet (the southern part of St. Louis), and in 1873 below the Jefferson Barracks; the barracks are about 2 miles below the southern limits of the city of St. Louis. The discharge section of 1880–81 was about one-eighth mile above the reservoirs of the city water works in the northern part of St. Louis. The results of these observations were published in Report of Chief of Engineers, 1883, page 2257. At the higher stages of the river the discharge section included a slough on the Illinois side of the river; this slough was either full of dead water or dry at stages below about 19.5 feet on the gauge herein tabulated. At the higher stages when the slough is discharging, its width, area, and discharge are included in the quantities tabulated, and the mean velocity is derived therefrom in the usual way by dividing total discharge by total area. The discharge section of May 20, 1892, was at the Merchants Bridge, about one-half mile below the section of 1880–81. The discharge section of the following day, May 21, 1892, was at the Pittsburg dike, about 4½ miles below the Merchants Bridge. The discharges of 1892 are only approximate; results in Report of Chief of Engineers, 1893, page 3082. The northern limit of the city of St. Louis is about 5 miles below the mouth of the Missouri River; the city limits include about 19 miles of river front.]

[191 miles above Cairo.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1866.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Aug. 4	12.7	.....	.....	.....	.....	.....	211,000	
Oct. 24	19.7	.....	.....	.....	.....	.....	384,000	
1872.								
May	20.4	.....	.....	.....	.....	.....	[a]315,000	
1873.								
May 16–17	21.8	73,700	.....	.....	.....	5.00	369,000	
1880.[b]								
Oct. 14	10.0	31,800	23.3	.....	1,364	3.35	107,000	Rod and double floats.
18	9.0	30,000	22.3	.....	1,346	3.17	95,000	Do.
19	8.8	30,500	23.0	.....	1,328	3.12	95,000	Do.
Nov. 2	8.2	30,500	22.6	.....	1,349	3.07	94,000	Double floats.
3	8.2	31,400	23.1	.....	1,361	3.04	95,000	Do.
5	8.2	31,800	23.1	.....	1,374	2.99	95,000	Do.
8	8.0	29,800	21.9	.....	1,360	2.99	89,000	Do.
10	8.2	31,000	22.7	.....	1,364	3.11	96,000	Do.
11	8.2	31,700	23.1	.....	1,373	3.21	102,000	Do.
12	8.2	29,400	22.7	.....	1,297	3.31	98,000	Do.
13	8.2	30,300	24.1	.....	1,260	3.17	96,000	Do.
Dec. 14	5.4	29,900	.....	.....	1,920	1.71	51,000	
1881.								
Jan. 12	8.6	22,300	14.8	.....	1,506	2.39	52,000	Meter.
14	8.4	21,700	14.4	.....	1,506	2.25	49,000	Do.
15	8.6	21,400	14.2	.....	1,506	2.20	47,000	Do.
17	8.6	21,300	14.1	.....	1,506	2.21	47,000	Do.
18	8.6	22,000	14.6	33.0	1,506	2.20	48,000	Do.
19	8.6	22,300	14.8	34.0	1,506	2.18	49,000	Do.
20	8.6	22,100	14.6	34.0	1,506	2.33	51,000	Do.
21	8.6	21,600	14.3	29.0	1,506	2.37	51,000	Do.
22	8.5	20,900	13.9	29.0	1,506	2.35	49,000	Do.
24	8.4	19,700	13.1	29.5	1,506	2.30	45,000	Do.
25	8.2	20,600	13.7	29.5	1,506	2.32	48,000	Do.
26	8.1	20,500	13.6	29.5	1,506	2.25	46,000	Do.
27	8.0	20,600	13.7	29.5	1,506	2.20	45,000	Do.
28	8.0	20,600	13.7	29.5	1,506	2.23	46,000	Do.
29	8.0	21,000	14.0	29.0	1,506	2.24	47,000	Do.
31	7.9	20,100	13.4	29.0	1,506	2.42	49,000	Do.
Feb. 1	8.0	20,000	13.3	29.0	1,506	2.45	49,000	Do.
2	7.8	20,200	13.4	30.0	1,506	2.47	50,000	Do.
3	7.8	20,000	13.3	30.0	1,506	2.40	48,000	Do.
4	7.6	19,700	13.1	30.0	1,506	2.38	47,000	Do.
5	7.6	19,800	13.2	29.5	1,506	2.42	47,000	Do.
21	10.8	29,700	.....	.....	.....	3.74	109,000	Ice cakes.
22	10.6	29,600	.....	.....	.....	4.01	117,000	Do

[a] Approximate. [b] The section of 1880 was at St. Louis, Mo.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1881.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 25	10.9	30,500	18.1	.....	1,649	4.27	128,000	Rod floats.
26	10.4	30,100	19.2	.....	1,555	4.03	120,000	Do.
Mar. 1	14.8	29,100	.....	.....	.....	4.73	138,000	Ice cakes.
2	16.0	29,100	.....	.....	.....	4.26	124,000	Do.
8	15.8	49,000	.....	.....	.....	4.02	197,000	Do.
9	15.4	49,000	.....	.....	.....	3.94	193,000	Do.
10	14.9	49,000	.....	.....	.....	4.12	202,000	Do.
12	15.4	50,100	23.0	.....	2,175	4.89	245,000	Rod floats.
14	19.4	52,100	23.4	.....	2,228	6.05	315,000	Do.
16	20.1	60,000	.....	.....	3,135	5.73	349,000	Do.
17	20.6	62,600	.....	.....	3,145	6.19	387,000	Do.
21	21.6	61,800	.....	.....	3,234	5.99	370,000	Do.
22	21.1	62,100	.....	.....	3,218	6.12	380,000	Do.
23	20.6	65,700	.....	.....	3,235	5.72	376,000	Do.
24	20.4	63,500	.....	.....	3,234	5.79	368,000	Do.
25	20.6	63,000	.....	.....	3,233	5.63	360,000	Do.
26	21.0	66,100	.....	.....	3,245	5.84	386,000	Do.
28	20.9	61,000	.....	.....	3,244	5.90	363,000	Do.
Apr. 13	27.0	84,100	.....	.....	3,106	5.82	480,000	Do.
14	27.4	92,400	.....	.....	3,269	6.69	624,000	Do.
15	27.6	86,100	.....	.....	3,200	6.47	557,000	Do.
16	27.8	93,100	.....	.....	3,270	6.70	623,000	Do.
18	27.4	92,500	.....	.....	3,286	6.41	593,000	Do.
19	26.0	90,400	.....	.....	3,208	5.70	516,000	Do.
20	26.3	84,700	.....	.....	3,277	6.14	519,000	Do.
21	26.2	79,600	.....	.....	3,258	6.24	496,000	Do.
22	26.6	88,400	.....	.....	3,273	5.95	526,000	Do.
23	27.4	92,000	.....	.....	3,290	6.24	574,000	Do.
25	29.2	97,600	.....	.....	3,286	6.14	599,000	Do.
26	29.8	98,900	.....	.....	3,315	6.56	648,000	Do.
27	30.2	104,900	.....	.....	3,296	6.78	711,000	Do.
28	30.6	105,000	.....	.....	3,298	6.32	669,000	Do.
29	30.8	104,900	.....	.....	3,296	6.38	669,000	Do.
30	31.1	105,700	.....	.....	3,275	6.37	673,000	Do.
May 4	33.2	120,000	.....	.....	3,345	7.41	890,000	Do.
6	33.6	122,500	.....	.....	3,347	6.29	770,000	Do.
9	30.0	98,300	.....	.....	3,331	6.01	591,000	Do.
10	28.4	89,500	.....	.....	3,306	5.35	479,000	Do.
11	27.2	86,500	.....	.....	3,305	5.56	481,000	Do.
12	26.5	82,700	.....	.....	3,297	5.36	443,000	Do.
16	25.3	76,500	.....	.....	3,295	5.10	390,000	Do.
17	25.0	78,500	.....	.....	3,291	5.13	403,000	Do.
18	25.0	78,300	.....	.....	3,262	5.09	399,000	Do.
19	25.0	78,900	.....	.....	3,250	5.10	402,000	Do.
20	25.0	81,300	.....	.....	3,272	5.16	419,000	Do.
21	24.9	81,700	.....	.....	3,272	5.14	420,000	Do.
24	24.6	78,600	.....	.....	3,272	5.18	407,000	Do.
25	25.0	78,500	.....	.....	3,294	5.10	400,000	Do.
26	25.0	79,000	.....	.....	3,251	5.31	419,000	Do.
27	24.6	77,700	.....	.....	3,272	5.03	391,000	Do.
28	23.8	74,100	.....	.....	3,269	5.08	376,000	Do.
30	22.2	67,000	.....	.....	3,179	4.82	328,000	Do.
31	21.6	65,600	.....	.....	3,153	4.74	311,000	Do.
June 1	21.2	64,400	.....	.....	3,150	4.88	314,000	Do.
2	20.7	65,800	.....	.....	3,067	4.60	303,000	Do.
4	21.3	65,700	.....	.....	3,148	4.82	317,000	Do.
6	21.8	67,400	.....	.....	3,184	4.88	329,000	Do.
7	21.6	62,600	.....	.....	3,182	5.04	316,000	Do.
8	21.0	64,300	.....	.....	3,167	5.06	325,000	Do.
9	20.9	63,500	.....	.....	3,176	4.91	312,000	Do.
10	20.9	62,000	.....	.....	3,145	4.80	300,000	Do.
13	21.8	66,500	.....	.....	3,197	4.81	320,000	Do.
14	22.5	69,400	.....	.....	3,227	5.08	353,000	Do.
15	22.4	67,800	.....	.....	3,209	4.79	324,000	Do.
16	22.3	69,000	.....	.....	3,205	5.16	361,000	Do.
17	22.5	66,900	.....	.....	3,200	5.21	349,000	Do.
18	22.8	69,000	.....	.....	3,221	4.81	336,000	Do.
20	24.6	76,700	.....	.....	3,204	5.34	410,000	Do.
22	24.5	79,000	.....	.....	3,272	5.50	438,000	Do.
23	24.5	76,700	.....	.....	3,271	5.35	410,000	Do.
24	24.4	73,000	.....	.....	3,272	5.24	388,000	Do.
25	24.6	77,500	.....	.....	3,272	5.24	411,000	Do.
28	23.7	74,100	.....	.....	3,244	5.50	407,000	Do.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1881.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
June 29	23.4	72,900	.....	.....	3,225	5.15	375,000	Rod floats.
July 1	23.0	71,200	.....	.....	3,228	5.70	406,000	Do.
2	24.0	73,200	.....	.....	3,271	5.46	399,000	Do.
5	24.7	76,800	.....	.....	3,272	5.59	430,000	Do.
6	24.2	72,900	.....	.....	3,260	5.55	404,000	Do.
7	23.4	70,400	.....	.....	3,230	5.23	368,000	Do.
11	19.0	52,700	.....	.....	2,127	4.89	277,000	Do.
12	18.2	49,000	.....	.....	2,121	4.11	215,000	Do.
14	18.8	53,000	.....	.....	2,106	4.43	250,000	Do.
16	20.5	57,600	.....	.....	2,143	5.01	305,000	Do.
18	21.6	58,500	.....	.....	2,172	4.58	291,000	Do.
19	21.8	59,700	.....	.....	2,105	4.79	311,000	Do.
20	22.1	60,700	.....	.....	3,150	4.77	314,000	Do.
23	22.4	69,000	.....	.....	3,171	5.06	349,000	Do.
26	21.2	64,300	.....	.....	3,097	4.88	314,000	Do.
28	18.8	51,700	.....	.....	2,146	4.74	258,000	Do.
30	16.6	47,900	.....	.....	2,026	4.38	214,000	Do.
Aug. 2	15.5	45,400	.....	.....	2,020	4.10	188,000	Do.
4	14.8	43,300	.....	.....	1,819	4.40	191,000	Do.
5	14.4	43,900	24.2	.....	1,811	4.08	179,000	Do.
6	14.0	43,200	24.1	.....	1,790	4.29	185,000	Do.
8	13.2	40,700	23.2	.....	1,755	3.58	146,000	Do.
9	12.8	40,400	23.2	.....	1,741	3.40	137,000	Do.
10	12.4	40,000	23.1	.....	1,731	3.21	129,000	Do.
11	12.1	39,700	23.2	.....	1,714	3.41	135,000	Do.
12	11.8	39,500	23.1	.....	1,712	3.54	140,000	Do.
13	11.5	37,700	22.1	.....	1,705	3.29	124,000	Do.
15	10.8	36,400	21.6	.....	1,683	3.22	117,000	Do.
16	10.6	34,500	20.8	.....	1,659	3.31	114,000	Do.
17	10.4	34,000	21.0	.....	1,665	3.16	110,000	Do.
18	10.4	35,100	21.1	.....	1,665	3.12	110,000	Do.
19	10.3	34,500	20.8	.....	1,662	2.97	103,000	Do.
20	10.2	35,000	21.3	.....	1,644	3.08	108,000	Do.
22	10.0	35,200	21.6	.....	1,635	3.01	106,000	Do.
23	9.9	34,300	21.0	.....	1,635	3.17	109,000	Do.
24	9.9	32,500	19.9	.....	1,635	2.92	95,000	Do.
25	9.8	32,500	19.8	.....	1,641	2.92	95,000	Do.
26	9.6	30,600	18.8	.....	1,633	2.88	88,000	Do.
27	9.5	31,700	19.5	.....	1,624	2.94	93,000	Do.
29	9.2	29,900	18.5	.....	1,614	2.86	86,000	Do.
30	9.0	30,700	19.1	.....	1,609	2.82	86,000	Do.
31	8.9	30,200	18.8	.....	1,605	2.81	85,000	Do.
Sept. 1	8.8	30,600	19.0	.....	1,605	2.94	90,000	Do.
2	8.8	30,400	18.9	.....	1,605	2.89	88,000	Do.
3	8.6	29,700	18.5	.....	1,608	3.17	94,000	Do.
5	8.8	29,500	18.4	.....	1,600	3.17	93,000	Do.
6	8.8	29,200	18.2	.....	1,600	3.05	89,000	Do.
7	8.8	30,300	18.9	.....	1,602	3.01	91,000	Do.
9	9.1	30,300	18.9	.....	1,602	3.04	92,000	Do.
10	9.3	30,300	18.9	.....	1,602	3.75	114,000	Do.
12	9.8	30,200	18.8	.....	1,629	3.41	104,000	Do.
						3.65	110,000	Meter.
14	10.2	31,600	19.5	32.0	1,620	4.01	127,000	Do.
15	10.4	32,100	19.4	30.5	1,650	3.76	121,000	Rod floats.
						3.56	114,000	Meter.
16	10.8	31,800	19.0	.....	1,669	3.67	117,000	Rod floats.
17	11.1	31,800	18.9	.....	1,683	3.86	123,000	Do.
19	11.4	32,300	19.0	.....	1,698	3.81	123,000	Do.
20	11.5	34,000	20.1	.....	1,695	4.08	130,000	Do.
22	11.8	34,000	20 1	20.5	1,695	4.33	147,000	Do.
						4.92	167,000	Meter.
Oct. 11	20.8	52,500	.....	45.0	3,013	5.54	291,000	Do.
12	21.0	52,800	.....	46.0	3,013	5.81	307,000	Do.
14	20.8	52,700	.....	44.5	3,013	5.07	267,000	Do.
27	25.1	79,900	.....	55.5	3,305	6.82	545,000	Do.
28	24.8	79,900	.....	55.5	3,280	5.80	463,000	Do.
31	24.1	74,700	.....	.....	3,188	5.82	440,000	Do.
Nov. 1	24.0	72,100	.....	55.0	3,188	6.35	458,000	Do.
4	24.4	72,600	.....	55.5	3,229	7.62	553,000	Do.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1892.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
May 20	35.7	104,000	54.7	78.6	1,901	9.62	[a] 1,043,000	Meter.
21	35.2	94,400	53.6	85.6	1,762	12.15	1,146,000	Double floats.
1895. [b]								
Oct. 25	3.0	22,000	.....	.....	1,855	2.20	48,000	
1896. [c]								
Dec. 16	5.5	27,700	.....	.....	2,069	2.41	67,000	Rod floats.
17	6.0	29,800	.....	.....	2,062	2.40	72,000	Do.
VICTOR STREET.								
1897.								
Sept. 20	4.0	32,000	13.8	.....	2,311	2.12	68,000	Rod floats.
LESPERANCE STREET.								
1897.								
Sept. 30	3.9	28,000	15.5	.....	1,847	1.98	57,000	Rod floats.
ARSENAL ISLAND.								
1897.								
Dec. 9	−0.1	16,700	13.7	.....	1,218	1.45	24,000	Rod floats.
ENGINEER DEPOT.								
1898.								
Dec. 23	6.3	33,300	13.1	.....	2,546	2.88	96,000	Rod floats.
1899.								
Jan. 12	4.1	26,100	10.5	.....	2,493	2.76	72,000	Do.
MERCHANTS BRIDGE.								
1899.								
Aug. 9	13.3	46,400	19.7	.....	2,356	3.83	178,000	Rod floats.
NEAR RIVER DES PERES.								
1899.								
Oct. 7	4.0	31,200	20.8	.....	1,497	1.96	61,000	Rod floats.

[a] 43,000 cubic feet of this was discharged along line of railroad on left bank and mainly estimated; its area and width are not included in this table.

[b] The section of 1895 was 18 miles below the city. Report Chief of Engineers, 1896, p. 1751.

[c] Observations and reduction made under direction of Maj. T. H. Handbury, Corps of Engineers, Report Chief of Engineers, 1897, p. 2041. Section was near Sydney street.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

FOOT OF ARSENAL STREET.

[Gauge readings are those of the U. S. Engineer gauge at Market street, St. Louis, whose zero is 400.22 feet above the Cairo datum plane.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1900.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 5	0.0	14,300	7.4	.....	1,925	2.41	35,000	Rod floats.
Mar. 10	18.7	65,000	25.8	.....	2,537	4.50	295,000	Do.
14	23.2	77,000	28.8	.....	2,673	5.30	408,000	Do.
23	17.0	60,400	23.9	.....	2,525	4.17	252,000	Do.
28	15.0	54,900	21.0	.....	2,510	3.70	208,000	Do.
Apr. 3	14.3	52,000	20.8	.....	2,496	3.66	190,000	Do.
5	14.5	53,800	21.5	.....	2,504	3.68	198,000	Do.
7	15.7	57,200	22.8	.....	2,509	3.82	218,000	Do.
12	16.0	56,500	22.4	.....	2,522	3.90	220,000	Do.
14	18.2	62,800	24.8	.....	2,532	4.32	271,000	Do.
17	16.7	57,600	22.8	.....	2,531	3.99	230,000	Do.
19	15.3	53,600	21.4	.....	2,507	3.82	205,000	Do.
21	15.0	53,300	21.1	.....	2,524	3.88	207,000	Do.
24	16.8	56,400	22.3	.....	2,533	3.81	215,000	Do.
26	17.4	57,700	22.7	.....	2,536	4.10	237,000	Do.
28	17.0	56,000	22.4	.....	2,534	3.85	218,000	Do.
May 2	15.4	53,100	21.2	.....	2,509	3.80	202,000	Do.
4	15.7	53,000	21.0	.....	2,522	3.91	207,000	Do.
10	15.9	54,700	21.6	.....	2,529	3.81	208,000	Do.
12	15.6	52,900	20.8	.....	2,538	3.75	198,000	Do.
14	16.4	55,300	21.7	.....	2,552	3.83	212,000	Do.
16	14.7	50,200	20.0	.....	2,510	3.65	183,000	Do.
18	14.0	48,200	19.5	.....	2,474	3.61	174,000	Do.
21	14.2	48,200	19.2	.....	2,511	3.74	180,000	Do.
23	14.1	48,200	19.2	.....	2,515	3.80	183,000	Do.
25	13.0	46,700	18.7	.....	2,506	3.64	170,000	Do.
28	13.7	44,300	17.8	.....	2,491	3.46	153,000	Do.
June 1	13.1	45,200	18.1	.....	2,504	3.60	163,000	Do.
4	12.8	44,800	17.9	.....	2,496	3.52	158,000	Do.
6	11.9	42,200	17.0	.....	2,483	3.38	143,000	Do.
11	10.8	40,000	16.2	.....	2,476	3.30	132,000	Do.
13	11.0	40,100	16.2	.....	2,478	3.35	134,000	Do.
15	13.8	47,300	18.8	.....	2,510	3.76	177,000	Do.
18	11.5	40,700	16.3	.....	2,480	3.47	141,000	Do.
20	11.2	40,300	16.2	.....	2,480	3.41	138,000	Do.
22	13.3	45,500	18.1	.....	2,514	3.79	172,000	Do.
25	14.6	48,000	19.0	.....	2,522	3.89	187,000	Do.
28	13.1	44,000	17.8	.....	2,511	3.66	163,000	Do.
July 2	11.4	39,800	16.0	.....	2,486	3.43	137,000	Do.
6	11.3	39,900	16.1	.....	2,486	3.38	135,000	Do.
9	10.7	38,100	15.5	.....	2,473	3.33	127,000	Do.
11	10.2	37,400	15.2	.....	2,465	3.33	125,000	Do.
13	10.5	38,200	15.5	.....	2,474	3.31	126,000	Do.
16	9.8	36,900	15.0	.....	2,463	3.22	119,000	Do.
18	9.5	37,600	15.2	.....	2,465	3.22	121,000	Do.
20	9.2	35,700	14.5	.....	2,454	3.08	110,000	Do.
23	11.0	42,000	16.8	.....	2,494	3.59	151,000	Do.
25	12.0	44,300	17.7	.....	2,512	3.63	162,000	Do.
30	12.0	42,500	17.1	.....	2,493	3.40	145,000	Do.
Aug. 1	11.3	41,000	16.4	.....	2,495	3.36	138,000	Do.
3	10.5	39,200	15.9	.....	2,468	3.17	124,000	Do.
7	8.4	34,500	14.1	.....	2,442	2.95	102,000	Do.
10	7.1	31,900	13.1	.....	2,433	2.81	90,000	Do.
21	8.9	36,500	14.9	.....	2,459	3.07	112,000	Do.
24	9.2	36,900	15.0	.....	2,467	3.00	111,000	Do.
28	8.9	36,700	14.9	.....	2,462	3.05	112,000	Do.
31	9.6	38,300	15.9	.....	2,471	3.06	117,000	Do.
Sept. 4	10.1	40,000	16.1	.....	2,483	3.08	123,000	Do.
7	9.9	38,500	15.5	.....	2,478	3.07	118,000	Do.
12	7.3	32,100	13.1	.....	2,444	2.94	94,000	Do.
14	6.7	30,500	12.6	.....	2,424	2.79	85,000	Do.
18	6.0	29,000	12.0	.....	2,416	2.82	82,000	Do.
21	6.3	29,700	12.3	.....	2,423	2.77	82,000	Do.
25	7.6	32,400	13.2	.....	2,455	2.90	94,000	Do.
28	8.4	34,200	13.9	.....	2,452	2.97	101,000	Do.
Oct. 2	11.1	40,800	16.4	.....	2,494	3.24	132,000	Do.

[a] Observations and reduction made under direction of Capt. Edw. Burr, Corps of Engineers. Report Chief of Engineers, 1901, pp. 2207-2211.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

FOOT OF ARSENAL STREET—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1900.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 5	13.3	46,700	18.5	.....	2,522	3.45	161,000	Rod floats.
9	13.2	46,500	18.5	.....	2,521	3.54	165,000	Do.
12	11.4	41,800	16.8	.....	2,490	3.27	137,000	Do.
16	10.2	39,300	15.9	.....	2,475	3.14	124,000	Do.
19	10.1	39,500	15.9	.....	2,478	3.11	123,000	Do.
23	11.7	42,300	16.9	.....	2,508	3.37	143,000	Do.
26	12.5	44,000	17.5	.....	2,518	3.48	153,000	Do.
30	12.6	44,400	17.6	.....	2,520	3.48	155,000	Do.
Nov. 7	13.5	46,900	18.5	.....	2,530	3.49	164,000	Do.
13	12.6	45,000	17.9	.....	2,520	3.45	155,000	Do.
20	11.9	43,300	17.3	.....	2,508	3.46	150,000	Do.
27	11.8	43,000	17.2	.....	2,505	3.39	146,000	Do.
27	.....	44,200	.....	.....	.....	.....	.....	Meter.
27	.....	44,200	.....	.....	.....	3.46	153,000	Do.
28	11.6	42,300	16.9	.....	2,500	3.36	142,000	Rod floats.
28	.....	44,500	.....	.....	.....	3.25	144,000	Meter.
28	.....	44,500	.....	.....	.....	3.19	142,000	Do.
Dec. 1	10.0	38,600	15.7	.....	2,454	3.13	121,000	Rod floats.
1	.....	39,600	.....	.....	.....	3.20	126,000	Meter.
1	.....	39,600	.....	.....	.....	3.12	124,000	Do.
4	8.6	34,900	14.4	.....	2,428	2.96	103,000	Rod floats.
4	.....	36,300	.....	.....	.....	3.03	110,000	Meter.
4	.....	36,300	.....	.....	.....	3.02	109,000	Do.
4	8.5	34,900	14.4	.....	2,428	2.97	104,000	Rod floats.
4	.....	36,200	.....	.....	.....	3.09	112,000	Meter.
4	.....	36,200	.....	.....	.....	3.04	110,000	Do.
8	7.4	32,100	13.3	.....	2,423	2.79	90,000	Rod floats.
8	.....	33,600	.....	.....	.....	2.98	100,000	Meter.
8	.....	33,600	.....	.....	.....	3.04	102,000	Do.
8	7.4	32,000	13.2	.....	2,423	2.90	93,000	Rod floats.
8	.....	32,800	.....	.....	.....	3.02	99,000	Meter.
8	.....	32,800	.....	.....	.....	2.99	98,000	Do.
11	6.9	31,100	12.9	.....	2,412	2.84	88,000	Rod floats.
11	.....	31,400	.....	.....	.....	2.94	92,000	Meter.
11	.....	31,400	.....	.....	.....	2.94	92,000	Do.
14	6.2	29,000	12.2	.....	2,388	2.82	82,000	Rod floats.
14	.....	29,500	.....	.....	.....	2.88	85,000	Meter.
14	.....	29,500	.....	.....	.....	2.83	84,000	Do.
14	6.2	28,900	12.1	.....	2,388	2.78	80,000	Rod floats.
14	.....	29,500	.....	.....	.....	2.77	82,000	Meter.
14	.....	29,500	.....	.....	.....	2.79	82,000	Do.
19	4.8	25,800	10.8	.....	2,379	2.58	66,000	Rod floats.
19	.....	27,500	.....	.....	.....	2.61	72,000	Meter.
19	.....	27,500	.....	.....	.....	2.60	72,000	Do.
21	4.3	25,200	10.6	.....	2,375	2.48	62,000	Rod floats.
21	.....	26,700	.....	.....	.....	2.62	70,000	Meter.
21	.....	26,700	.....	.....	.....	2.58	69,000	Do.
27	3.8	23,900	10.0	.....	2,379	2.52	60,000	Rod floats.
27	.....	24,800	.....	.....	.....	2.50	62,000	Meter.
27	.....	24,800	.....	.....	.....	2.50	62,000	Do.
1901.								
Jan. 7	0.6	18,000	7.8	.....	2,323	2.21	40,000	Rod floats.
7	.....	18,600	.....	.....	.....	2.24	42,000	Meter.
7	.....	18,600	.....	.....	.....	2.17	40,000	Do.
10	2.3	20,600	8.8	.....	2,354	2.41	50,000	Rod floats.
10	.....	22,000	.....	.....	.....	2.43	54,000	Meter.
10	.....	22,000	.....	.....	.....	2.38	52,000	Do.
12	4.5	26,400	11.1	.....	2,392	2.66	70,000	Rod floats.
12	.....	27,800	.....	.....	.....	2.61	73,000	Meter.
12	.....	27,800	.....	.....	.....	2.57	72,000	Do.
28	4.8	27,100	11.3	.....	2,407	2.58	70,000	Rod floats.
28	.....	29,100	.....	.....	.....	2.50	73,000	Meter.
28	.....	29,100	.....	.....	.....	2.49	73,000	Do.
Feb. 16	2.6	22,200	9.6	.....	2,330	2.37	53,000	Rod floats.
16	.....	23,300	.....	.....	.....	2.39	56,000	Meter.
16	.....	23,300	.....	.....	.....	2.63	60,000	Do.
Mar. 2	4.1	25,000	10.8	.....	2,392	2.55	66,000	Rod floats.
2	.....	27,400	.....	.....	.....	2.43	66,000	Meter.
2	.....	27,400	.....	.....	.....	2.40	66,000	Do.
Nov. 8 *	3.4	23,800	10.4	.....	2,284	2.42	57,000	Rod floats.

* Observations and reduction from November 8, 1901, to June 30, 1903, made under direction of Maj. Thos. L. Casey, Corps of Engineers. Results furnished in manuscript by Major Casey, February 16, 1905.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

FOOT OF ARSENAL STREET—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1902.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Jan. 16	1.3	20,500	8.9	.....	2,319	2.15	44,000	Rod floats.
July 18,19	26.4	78,700	29.4	41.0	2,677	5.44	[a]428,000	Meter.
18,19	26.4	78,600	30.3	.....	2,600	5.43	427,000	Rod floats.
1903.	...	...	...	.....	...	...	...	
Apr. 24	22.3	67,800	25.9	.....	2,617	4.65	312,000	Do.
27	20.3	64,000	25.2	.....	2,563	4.18	270,000	Do.
29	19.4	61,200	24.2	.....	2,535	4.00	245,000	Do.
May 4	17.8	59,000	23.4	.....	2,518	3.87	228,000	Do.
19	21.0	70,100	27.3	.....	2,574	4.53	317,000	Do.
20	21.2	68,400	26.5	.....	2,582	4.41	302,000	Do.
22	20.5	67,800	26.4	.....	2,563	4.33	293,000	Do.
25	20.6	66,500	25.9	.....	2,565	4.32	287,000	Do.
26	22.3	70,500	26.8	.....	2,627	4.47	315,000	Do.
28	24.6	76,100	28.0	.....	2,720	4.81	366,000	Do.
June 3	31.3	104,500	27.1	.....	3,854	5.85	611,000	Do.
29	21.4	64,000	25.0	.....	2,556	4.54	291,000	Do.
30	20.9	62,400	24.4	.....	2,558	4.55	284,000	Do.
July 2	20.7	65,000	25.4	.....	2,559	4.43	288,000	Do.
6	17.5	55,700	21.9	.....	2,540	4.11	229,000	Do.
8	17.0	54,800	21.6	.....	2,536	3.93	215,000	Do.
11	16.9	55,200	21.8	.....	2,536	3.91	216,000	Do.
13	16.0	52,900	21.3	.....	2,485	3.83	202,000	Do.
15	16.0	51,500	20.7	.....	2,484	3.80	201,000	Do.
17	18.3	60,200	23.9	.....	2,522	4.10	246,000	Do.
20	19.4	62,200	24.6	.....	2,529	4.21	262,000	Do.
22	18.9	60,900	24.1	.....	2,526	4.02	245,000	Do.
24	19.2	61,000	24.1	.....	2,529	4.19	256,000	Do.
27	20.6	66,100	25.9	.....	2,549	4.28	283,000	Do.
31	17.7	56,600	22.7	.....	2,499	3.89	220,000	Do.
Aug. 3	15.8	52,500	21.1	.....	2,486	3.70	194,000	Do.
5	14.9	48,300	19.5	.....	2,484	3.62	175,000	Do.
13	17.2	55,300	22.0	.....	2,509	4.02	222,000	Do.
18	17.4	57,600	23.0	.....	2,506	4.09	235,000	Do.
19	17.8	60,400	24.1	.....	2,510	4.12	249,000	Do.
25	15.9	53,500	25.5	.....	2,487	3.75	201,000	Do.
27	15.1	52,500	21.1	.....	2,486	3.70	194,000	Do.
Sept. 1	18.5	61,900	24.6	.....	2,517	4.07	252,000	Do.
4	20.3	68,000	26.7	.....	2,552	4.44	302,000	Do.
9	17.8	60,700	24.2	.....	2,506	3.90	237,000	Do.
11	17.3	60,400	24.1	.....	2,503	3.81	230,000	Do.
14	21.0	72,400	28.2	.....	2,569	4.27	309,000	Do.
15	20.9	71,500	27.8	.....	2,569	4.33	309,000	Do.
18	21.0	69,700	26.9	.....	2,565	4.45	307,000	Do.
Oct. 13	21.8	73,500	28.5	.....	2,575	4.31	317,000	Do.
14	21.5	71,000	27.6	.....	2,573	4.31	306,000	Do.
20	18.3	64,100	25.4	.....	2,519	3.70	237,000	Do.
26	16.3	59,100	23.7	.....	2,494	3.56	210,000	Do.
Nov. 2	15.2	57,600	23.1	.....	2,490	3.32	191,000	Do.
3	15.0	55,700	22.4	.....	2,489	3.41	190,000	Do.
9	15.2	57,300	23.0	.....	2,492	3.44	197,000	Do.
12	14.1	55,800	22.4	.....	2,487	3.20	178,000	Do.
20	10.3	44,200	18.0	.....	2,449	2.98	132,000	Do.
23	9.4	41,100	16.8	.....	2,443	2.85	117,000	Do.
28	6.9	35,600	14.7	.....	2,429	2.69	96,000	Do.
Dec. 4	5.1	30,000	12.4	.....	2,411	2.31	69,000	Do.
23	2.3	22,100	9.2	.....	2,401	2.33	51,000	Do.
23	2.7	22,600	9.4	.....	2,401	2.43	55,000	Do.
1904.[b]								
Mar. 9	10.0	42,800	12.4	.....	2,459	3.23	138,000	Do.
29	24.7	81,100	30.5	.....	2,663	4.90	398,000	Do.
31	25.2	85,400	32.1	.....	2,663	4.98	425,000	Do.
Apr. 2	24.5	82,200	30.9	.....	2,658	5.08	418,000	Do.
5	22.9	77,300	29.6	.....	2,603	4.56	352,000	Do.
12	23.6	78,600	30.0	.....	2,625	4.86	382,000	Do.
15	23.5	79,000	30.1	.....	2,626	4.95	390,000	Do.

[a] This result from observations and reduction made under direction of Secretary of Mississippi River Commission, Report Chief of Engineers, 1903, supplement, page 111.

[b] Observations and reduction made under direction of Maj. Thos. L. Casey, Corps of Engineers. Report Chief of Engineers, 1904, pages 2136-2137.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

FOOT OF ARSENAL STREET—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1904.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
May 16	21.8	68,000	26.8	.....	2,573	4.80	330,000	Rod floats.
18	21.5	67,100	26.4	.....	2,544	4.87	327,000	Do.
27	18.5	60,200	23.7	.....	2,540	4.40	265,000	Do.
June 1	23.7	71,400	27.7	.....	2,581	5.28	377,000	Do.
14	24.5	74,300	28.6	.....	2,603	5.18	385,000	Do.
21	25.1	75,600	28.8	.....	2,625	5.15	390,000	Do.
23	25.0	75,800	28.9	.....	2,626	5.10	386,000	Do.
29	22.7	72,000	27.9	.....	2,578	4.84	348,000	Do.

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo. Elevation of gauge zero 400.22 feet above the Cairo datum plane.]

Date.	Gauges.			Cross section of discharge.					
	Standard gauge.	Local.	Change in 24 hours.	Area.		Depth.			
				Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1909.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Jan. 5	3.00	2.80	0.0	27,983	27,983	15.3	15.3	18.5	1,822
6	2.70	2.70	−.3	27,499	27,081	15.1	15.2	18.5	1,821

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1909.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Jan. 5	.....	2.27	63,400	Rod floats.....	11	....	X to XII, light.
6	−302	2.26	62,200	.....do.....	10	....	X to XI, brisk.

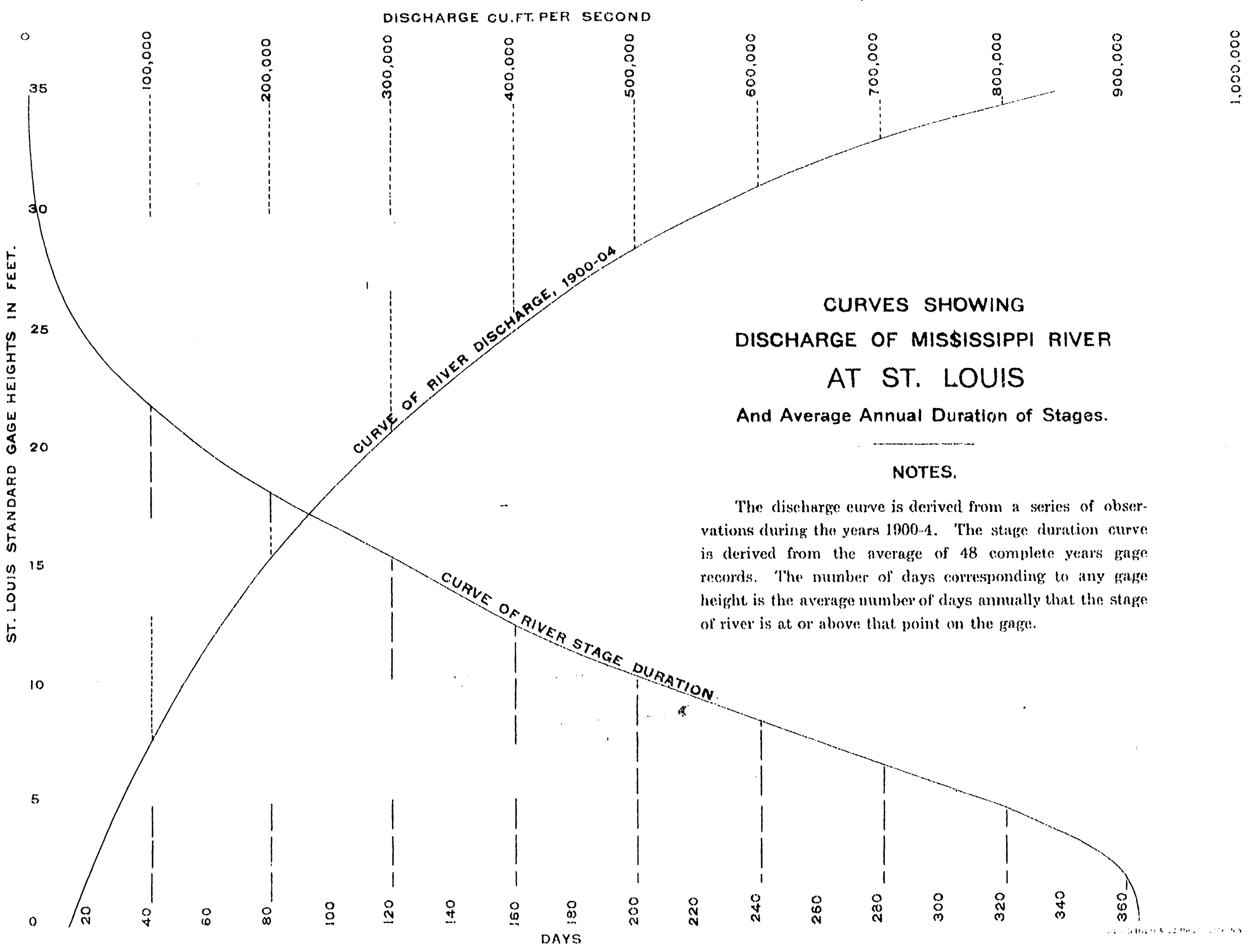
Observations and reduction under direction of Col. W. H. Bixby, Corps of Engineers, U. S. Army.

Results of discharge observations, Mississippi River—Continued.

ST. LOUIS, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1904.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
July 1	24.2	75,500	29.0	.....	2,607	5.19	392,000	Rod floats.
6	21.6	68,300	26.6	.....	2,569	4.51	308,000	Do.
8	21.1	64,800	25.3	.....	2,557	4.55	295,000	Do.
18	21.4	67,300	26.3	.....	2,563	4.61	310,000	Do.
21	20.3	61,100	24.0	.....	2,547	4.43	271,000	Do.
22	19.0	61,900	24.4	.....	2,514	4.26	264,000	Do.
25	17.2	56,400	22.4	.....	2,520	4.11	232,000	Do.
27	16.5	54,900	22.0	.....	2,501	4.00	220,000	Do.
29	14.6	50,600	20.3	.....	2,493	3.83	193,000	Do.
Aug. 1	12.9	45,800	18.4	.....	2,482	3.63	168,000	Do.
4	11.8	44,000	17.8	.....	2,474	3.36	148,000	Do.
5	11.6	43,600	17.6	.....	2,473	3.39	148,000	Do.
9	10.0	39,100	15.9	.....	2,456	3.11	121,000	Do.
10	9.6	37,500	15.3	.....	2,454	3.07	115,000	Do.
12	8.4	36,900	15.0	.....	2,453	2.97	109,000	Do.
16	8.2	37,700	15.4	.....	2,455	2.94	111,000	Do.
17	8.4	38,600	15.7	.....	2,456	2.98	115,000	Do.
22	11.2	44,200	17.9	.....	2,472	3.35	148,000	Do.
24	12.4	47,300	19.1	.....	2,480	3.44	163,000	Do.
26	12.5	48,300	19.4	.....	2,487	3.55	171,000	Do.
29	10.0	40,800	16.6	.....	2,466	3.18	130,000	Do.
31	8.2	37,100	15.1	.....	2,456	2.96	110,000	Do.
Sept. 1	7.7	36,100	14.7	.....	2,453	2.93	106,000	Do.
6	7.7	36,100	14.7	.....	2,454	2.96	107,000	Do.
7	7.2	32,800	13.4	.....	2,454	2.88	94,000	Do.
10	6.8	33,800	13.9	.....	2,442	2.83	96,000	Do.
12	6.8	31,700	13.0	.....	2,442	2.83	90,000	Do.
20	9.6	39,600	16.1	.....	2,466	3.26	129,000	Do.
21	11.1	43,500	17.6	.....	2,475	3.47	151,000	Do.
24	9.6	41,000	16.6	.....	2,468	3.10	127,000	Do.
28	10.9	45,800	18.5	.....	2,475	3.25	149,000	Do.
29	11.0	44,900	18.2	.....	2,475	3.25	146,000	Do.
Oct. 3	10.6	44,100	17.8	.....	2,476	3.22	142,000	Do.
7	8.8	38,200	15.5	.....	2,461	3.06	117,000	Do.
11	7.8	36,600	14.9	.....	2,453	2.95	108,000	Do.
12	7.6	37,000	15.0	.....	2,460	2.97	110,000	Do.
17	6.7	34,200	14.0	.....	2,445	2.75	94,000	Do.
18	6.7	34,700	14.2	.....	2,445	2.74	95,000	Do.
24	7.1	34,900	14.2	.....	2,451	2.84	99,000	Do.
26	7.7	36,900	15.0	.....	2,459	2.90	107,000	Do.
Nov. 1	9.8	41,800	16.9	.....	2,478	3.16	132,000	Do.
2	9.7	42,300	17.1	.....	2,478	3.12	132,000	Do.
7	8.9	40,600	16.4	.....	2,467	2.93	119,000	Do.
22	6.4	33,200	13.6	.....	2,433	2.74	91,000	Do.
23	6.2	33,900	14.0	.....	2,428	2.68	91,000	Do.
26	5.6	31,600	13.0	.....	2,421	2.70	85,000	Do.
28	5.3	31,100	12.8	.....	2,420	2.57	80,000	Do.
30	5.1	30,100	12.4	.....	2,421	2.65	80,000	Do.
Dec. 5	4.3	20,300	12.1	.....	2,416	2.58	76,000	Do.
6	4.3	30,000	12.4	.....	2,415	2.44	73,000	Do.
8	3.8	28,200	11.7	.....	2,415	2.45	69,000	Do.
9–10	3.6	28,100	11.6	.....	2,416	2.46	69,000	Do.
20	0.5	21,200	8.9	.....	2,375	2.02	43,000	Do.
21	0.4	21,000	8.8	.....	2,372	2.03	42,000	Do.
22	0.2	20,300	8.6	.....	2,372	1.93	39,000	Do.
1905.								
Jan. 3	1.5	23,300	9.7	.....	2,399	2.31	54,000	Do.

[a] Observations and reduction made under direction of Maj. Thos. L. Casey, Corps of Engineers. Tabulation in manuscript received from Major Casey, April 20, 1905.



CURVES SHOWING
DISCHARGE OF MISSISSIPPI RIVER
AT ST. LOUIS

And Average Annual Duration of Stages.

NOTES.

The discharge curve is derived from a series of observations during the years 1900-4. The stage duration curve is derived from the average of 48 complete years gage records. The number of days corresponding to any gage height is the average number of days annually that the stage of river is at or above that point on the gage.

House Doc. No. 50 ; 61st Cong., 1st Sess.

Results of discharge observations, Mississippi River—Continued.

FERRY IN KASKASKIA CHUTE.

[125 miles above Cairo.]

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo., whose zero is 400.22 feet above the Cairo datum plane.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1897.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Nov. 21	3.5	22,200	15.8	.....	1,398	2.53	56,000	Rod floats.
21	3.5	21,000	15.1	.....	1,398	2.55	54,000	Do.

NEAR BARNETTS.

[120 miles above Cairo.]

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo., whose zero is 400.22 feet above the Cairo datum plane.]

1897.[a]								
Nov. 20	3.6	20,900	15	.....	1,398	2.61	54,000	Rod floats.

CHESTER, ILL.

[115.5 miles above Cairo.]

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo., whose zero is 400.22 feet above the Cairo datum plane.]

1898.[a]								
Dec. 7	2.9	33,200	17.5	.....	1,900	1.82	61,000	Rod floats.
1899.[a]								
Dec. 7	4.8	35,000	17.3	.....	2,020	2.15	75,000	Do.
1903.[b]								
June 8 9	37.6	107,700	39.9	.....	2,700	7.70	829,000	Do.
10	38.0	114,600	42.5	.....	2,700	7.70	885,000	Do.
11	38.0	116,000	43.0	.....	2,700	7.76	900,000	Do.
13	37.4	115,600	42.8	.....	2,700	7.37	900,000	Do.
18	30.9	100,400	37.2	.....	2,697	6.26	628,000	Do.
1904.[b]								
April 20	33.6	103,000	38.1	.....	2,704	7.47	769,000	Do.
30, a. m	33.5	103,000	38.1	.....	2,700	7.52	774,000	Do.
30, p. m	33.4	102,000	37.7	.....	2,700	7.53	768,000	Do.
May 2, a. m	32.8	101,800	37.6	.....	2,705	7.00	713,000	Do.
2, p. m	32.7	101,700	37.6	.....	2,705	6.98	710,000	Do.
3, a. m	32.3	103,300	38.2	.....	2,704	6.68	690,000	Do.
3, p. m	32.2	99,700	36.9	.....	2,704	6.63	661,000	Do.
4	31.4	100,200	37.1	.....	2,703	6.58	659,000	Do.
5	30.2	99,500	36.9	.....	2,700	6.05	602,000	Do.
6	28.9	93,600	34.7	.....	2,697	5.85	547,000	Do.
7	27.6	91,100	33.8	.....	2,693	5.80	529,000	Do.
9	26.5	84,200	31.3	.....	2,686	5.44	458,000	Do.
July 12	28.4	91,900	34.0	.....	2,701	5.61	515,000	Do.
13, a. m	28.3	94,400	34.9	.....	2,701	5.44	513,000	Do.
13, p. m	28.2	94,200	34.9	.....	2,702	5.63	530,000	Do.
14	27.2	93,800	34.7	.....	2,701	5.38	504,000	Do.
15	25.8	91,500	33.9	.....	2,702	5.19	475,000	Do.

HOLSCHEN LANDING.

[94 miles above Cairo.]

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo., whose zero is 400.22 feet above the Cairo datum plane.]

1899.								
Oct. 21	3.4	29,000	18.6	.....	1,594	1.98	58,000	Rod floats.

[a] Observations and reduction of 1897–1899 were made under direction of Capt. Edward Burr, Corps of Engineers. Report Chief of Engineers, 1901, p. 2207.

[b] Observations and reduction of 1903-4 made under direction of Maj. Thos. L. Casey, Corps of Engineers. Results, 1903, furnished in manuscript February 16, 1905. Tabulation, 1904, in report Chief of Engineers, 1904, p. 2137.

Results of discharge observations, Mississippi River—Continued.

THEBES, ILL.

[44.5 miles above Cairo.]

[The discharge section is about center of street immediately below Chicago and Eastern Illinois Railroad depot. It is about 9 miles below Cape Girardeau, Mo. The overbank discharge was measured on right bank along railroad, parallel to river, about 2¼ miles below Cape Girardeau. Velocities measured with Haskell meter and double floats. M. R. C. gauge at Cape Girardeau, whose zero is 324.97 feet above the Cairo datum plane. Observations and reduction made under direction of Capt. Wm. B. Ladue, Corps of Engineers, secretary of Mississippi River Commission. Tabulation in Report Chief of Engineers, 1903, supplement, p. 112, and 1905, p. 115.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1903.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
June 6	31.83	98,000	37.9	49.8	2,586	7.05	691,000	.....	.....	Meter.
8	33.73	102,600	39.7	52.4	2,586	7.31	750,000	[a] 1,000	751,000	Do.
9	34.43	104,800	40.5	52.9	2,586	7.94	831,000	[a] 4,000	835,000	Do.
10, a. m.	34.93	[b] 105,200	40.7	.....	.....	8.17	860,000	[a] 7,000	867,000	Double floats.
10, p. m.	35.23	[b] 105,200	40.7	.....	.....	8.40	884,000	[a] 7,000	891,000	Meter.
11	35.43	105,700	40.9	52.4	2,586	8.49	898,000	[a] 9,000	907,000	Do.
12, a. m.	35.83	[b] 105,700	40.9	.....	.....	8.18	865,000	[a] 11,000	876,000	Double floats.
12, p. m.	35.98	[b] 105,700	40.9	.....	.....	8.56	905,000	[a] 11,000	916,000	Meter.
13	36.13	105,700	40.9	52.8	2,586	8.60	909,000	[a] 12,000	921,000	Do.
14	36.33	[c] 105,600	40.8	.....	.....	9.47	1,000,000	[a] 14,000	1,014,000	Do.
15	36.43	105,600	40.8	52.7	2,586	9.42	995,000	14,000	1,009,000	Do.
1904.										
Apr. 29	33.0	99,500	38.3	52.2	2,600	7.24	721,000	.....	.....	Do.
30	33.8	101,600	39.1	51.5	2,600	7.62	774,000	.....	.....	Do.
May 1	34.1	104,700	40.3	52.5	2,600	7.69	805,000	.....	.....	Do.
2	34.0	104,900	40.3	52.9	2,600	7.36	772,000	.....	.....	Do.
3	33.9	105,300	40.7	54.1	2,600	7.43	786,000	.....	.....	Do.
4	33.4	103,300	39.7	53.4	2,600	7.29	753,000	.....	.....	Do.
5	32.9	101,500	39.0	55.2	2,600	6.78	688,000	.....	.....	Do.
6	32.0	100,400	38.6	51.8	2,600	6.36	638,000	.....	.....	Do.

[a] All overbank discharges were deduced from observations made on June 15.
[b] Interpolated.
[c] Used area of June 15.

[The discharge section is at street immediately above Chicago and Eastern Illinois Railroad depot. It is about 9 miles below Cape Girardeau, Mo. Velocities measured with Price meters Nos. 22 and 43 and double floats. M. R. C. gauge at Cape Girardeau, Mo., whose zero is 324.97 feet above the Cairo datum plane. Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, secretary of Mississippi River Commission. Zero of local gauge at discharge section is 335.88 feet above the Cairo datum plane.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
June 6, a. m.	30.10	13.55	.....	93,100	101,572	37.7	41.1	55.0	2,470
6, p. m.	.....	13.55	.....	.....	.....	.....	.....	.....	.....
7	30.20	13.61	+0.06	92,130	100,454	37.3	40.7	53.0	2,470
8, a. m.	30.20	13.61	.00	89,980	98,304	36.4	39.8	51.0	2,470
8, p. m.	.....	13.61	.....	.....	.....	.....	.....	.....	.....
9, a. m.	30.30	13.69	+ .08	92,342	100,469	37.4	40.7	52.0	2,470
9, p. m.	.....	13.69	.....	.....	.....	.....	.....	.....	.....
10	30.20	13.70	+ .01	87,955	96,057	35.6	38.9	48.0	2,470
11	30.30	13.74	+ .04	88,385	96,388	35.8	39.0	50.0	2,470
12	30.30	13.81	+ .07	88,085	95,895	35.7	38.8	48.0	2,470
13	30.60	14.00	+ .19	87,202	94,053	35.3	38.3	48.0	2,470
14	30.90	14.35	+ .35	87,975	94,471	35.6	38.2	49.5	2,470
15, a. m.	31.30	14.60	+ .25	89,905	95,784	36.4	38.8	48.0	2,470
15, p. m.	.....	14.65	.....	.....	.....	.....	.....	.....	.....
16	31.80	15.00	+ .40	91,438	96,328	37.0	39.0	48.0	2,470
17	32.30	15.50	+ .50	92,730	96,356	37.5	39.0	49.0	2,470
18	32.90	15.95	+ .45	93,370	95,914	37.8	38.8	51.0	2,470
19	33.40	16.30	+ .35	95,210	96,890	38.5	39.2	49.0	2,470
20, a. m.	33.80	16.65	+ .35	94,045	95,711	38.4	38.7	49.0	2,470
20, p. m.	.....	16.67	.....	.....	.....	.....	.....	.....	.....
21	34.10	16.83	+ .18	94,572	95,943	38.7	38.8	48.5	2,470
22	34.10	16.94	+ .11	93,442	95,541	38.6	38.7	49.0	2,470
23	34.10	16.98	+ .04	90,292	90,292	39.0	39.0	49.0	2,470
24	33.90	16.92	− .06	.....	.....	.....	.....	.....	.....

Results of discharge observations, Mississippi River—Continued.

THEBES, ILL.—Continued.

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1903.	*Sq. feet.*	*Feet.*	*Cu. feet.*				
June 6, a. m.	.....	6.74	627,269	Double floats.....	13	28	VI. Light.
6, p. m.	.....	6.38	593,554	.....do.....	10	....	V. Brisk.
7	−1,118	7.32	674,739	Meter.....	15	36	Do.
8, a. m.	−2,150	7.37	662,773	.....do.....	14	36	VI. Strong.
8, p. m.	.....	7.77	699,333	.....do.....	15	....	VII. Strong.
9, a. m.	+2,165	7.59	700,466	.....do.....	13	36	IX. Light.
9, p. m.	.....	7.69	710,106	.....do.....	15	....	Calm.
10	−4,412	7.74	680,402	.....do.....	13	31	V. Light.
11	+ 331	7.67	678,194	.....do.....	14	34	Calm.
12	− 493	7.59	665,812	.....do.....	13	43	VI. Brisk.
13	−1,242	7.89	688,818	.....do.....	15	43	VI. Strong.
14	− 182	7.67	674,801	.....do.....	14	30	XI. Light.
15, a. m.	+1,313	7.49	673,390	Double floats.....	13	36	X. Brisk.
15, p. m.	.....	7.85	705,490	Meter and double floats.	13	....	
16	+ 544	7.46	652,478	Double floats.....	12	38	III. Light.
17	+ 58	7.75	718,454	.....do.....	13	34	IV. Light.
18	− 472	8.10	757,039	.....do.....	11	42	VI. Strong.
19	+ 076	8.55	813,982	Meter.....	11	38	VI. Light.
20, a. m.	−1,179	8.93	847,791	Meter and double floats.	12	40	VII. Light.
20, p. m.	.....	8.48	805,141	Double floats.....	11	....	Do.
21	+ 232	8.33	706,394	.....do.....	12	41	VI. Light.
22	− 402	8.69	829,527	.....do.....	14	44	
23	+ 751	8.36	805,437	.....do.....	13	40	VII. Light.
24	.....	.....	.....	.....	....	....	

BUFFALO ISLAND.

[30 miles above Cairo.]

[U. S. Engineer gauge at foot of Market street, St. Louis, Mo., whose zero is 400.22 feet above the Cairo datum plane. Observations and reduction made under direction of Capt. Edw. Burr, Corps of Engineers. Report Chief of Engineers, 1901, page 2207.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1899.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 12	3.6	25,200	19.0	.....	1,332	2.41	61,000	Rod floats.
13	3.5	25,600	19.4	.....	1,329	2.41	62,000	Do.

Results of discharge observations, Mississippi and Ohio rivers.

CAIRO, ILL.

[Col. H. L. Abbot is authority for discharge of 1858, which is given for below the mouth of the Ohio River, see Report Chief of Engineers, 1869, p. 339. The stage is here assumed to be maximum for that year. The 1891 discharges are printed in Report Chief of Engineers, 1892, p. 3127; the measurements were made above the mouth of the Ohio River, and their sum represents the discharge of the Mississippi River below the mouth of the Ohio. All the gauge readings were taken at Cairo and are referred to the present United States engineer gauge there, whose zero is 290.84 feet above the Cairo datum plane, survey Mississippi River.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1858.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
H. W.	40.6	.....	.....	.....	.....	.....	1,420,000	
1891.								
Nov. 11 a	2.9	58,400	27.5	36.8	2,122	0.72	42,000	Double floats.
11 b	2.9	8,500	10.6	14.3	800	5.15	44,000	Do.
11 c	2.9	6,700	7.6	14.8	950	4.28	29,000	Do.
							114,000	

a Ohio River. b Mississippi River, Cairo or left chute. c Mississippi River, Missouri or right chute.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.

[The discharges of 1891 to 1893 were all measured at the same place, except that the Missouri end of section was moved upstream about 60 feet in 1893. This location is about 300 feet above the railroad freight depot in Columbus, and about 2,200 feet below the section of 1881-82. The 1891 series is printed in Report of Chief of Engineers, 1892, page 3127; the 1892 series in Report of Chief of Engineers, 1893, page 3682. The 1893 series will appear in Report of Chief of Engineers for 1894. The gauge readings given are all as observed on the Belmont gauge by the discharge parties. The zero of this gauge to 1890 was 287.14 feet above the Cairo datum plane. In November, 1892, the low-water section was found to be at this elevation, but the upper sections were 286.88 feet above the Cairo datum and the low-water section was changed to agree with the upper ones; the gauge has been maintained at the same elevation since 1892. By precise level connection with P. B. M. 10 in May, 1894, the gauge zero was found to be 286.85 feet above the Cairo datum plane. From 1857 to 1882, inclusive, the gauges of the discharge parties were at different elevations, and to reduce them to the present M. R. C. gauge at Belmont, whose zero is 286.85 feet above the Cairo datum plane, corrections were applied to original readings of gauges as follows: H. and A.'s gauge, 1857-58, 2 feet have been added; Major Suter's gauge, 1879, 5.05 feet have been subtracted; M. R. C. gauge, 1881-82, 57.7 feet have been subtracted. No correction has been applied to 1891-92 series.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1857.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 11	22.1					5.74	692,000	Double floats.
12	25.1					6.44	810,000	Do.
14	29.6					7.05	905,000	Do.
15	31.0					7.58	1,001,000	Do.
16	32.0					7.99	1,138,000	Do.
1858.[a]								
Jan. 12	26.0					5.24	676,000	Do.
13	24.6					5.20	656,000	Do.
14	23.5					4.90	606,000	Do.
16	22.6					4.70	583,000	Do.
18	23.2					5.01	617,000	Do.
19	23.9					5.13	640,000	Do.
20	24.3					5.25	660,000	Do.
23	23.0					4.91	603,000	Do.
26	20.7					4.47	538,000	Do.
27	20.0					4.44	515,000	Do.
29	19.3					4.42	507,000	Do.
30	19.7					4.60	531,000	Do.
Feb. 3	19.3					4.42	507,000	Do.
5	19.0					4.23	482,000	Do.
6	18.6					4.10	474,000	Do.
8	18.4					4.25	479,000	Do.
11	17.8					4.14	461,000	Do.
18	18.0					4.12	461,000	Do.
20	18.3					4.05	455,000	Do.
23	16.9					3.92	429,000	Do.
24	16.3					3.70	401,000	Do.
25	15.9					3.72	399,000	Do.
26	15.6					3.72	390,000	Do.
Mar. 4	19.6					4.56	525,000	Do.
5	20.8					4.83	569,000	Do.
9	20.3					4.57	534,000	Do.
10	20.0					4.56	529,000	Do.
11	20.0					4.64	539,000	Do.
13	20.8					4.68	552,000	Do.
16	21.7					4.87	584,000	Do.
18	22.3					5.01	607,000	Do.
22	31.1					6.90	981,000	Do.
23	32.9					7.34	1,059,000	Do.
24	34.2					7.46	1,098,000	Do.
25	35.2					7.40	1,106,000	Do.
26	36.0					7.47	1,130,000	Do.
29	36.7					7.24	1,105,000	Do.
Apr. 1	35.3					7.08	1,059,000	Do.
2	34.0					6.89	990,000	Do.
3	32.2					6.63	947,000	Do.
5	28.0					5.82	778,000	Do.
6	25.8					5.51	710,000	Do.
7	23.9					5.00	623,000	Do.

[a] Velocity and discharge of 1857-58 taken from "Report on the Mississippi River, by Capt. A. A. Humphrey and Lieut. H. L. Abbot, 1861," p. 594, edition of 1876. The H. and A. report does not give dimensions of the discharge section, but the Delta (H. and A.) Survey drawings give 2 cross sections of the Mississippi River, at Columbus, Ky., of Dec. 10 and 11, 1857, which probably are the discharge float ranges—they are called the upper and lower sections. The upper section is 2,120 feet wide, maximum sounding 78.2 feet; the lower section is 2,180 feet wide, maximum sounding 77.5 feet. Gauge readings are all referred to the present Mississippi River Commission gauge at Belmont, across the river from Columbus; the zero of this gauge is 286.85 feet above the Cairo datum plane.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1858.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Apr. 9	21.3					4.77	568,000	Double floats.
14	25.2					5.35	682,000	Do.
15	27.5					6.04	800,000	Do.
20	33.2					7.11	1,031,000	Do.
21	34.8					7.31	1,086,000	Do.
22	36.4					7.37	1,120,000	Do.
24	38.7					8.02	1,261,000	Do.
27	39.3					7.80	1,237,000	Do.
30	38.1					7.15	1,113,000	Do.
May 1	36.9					6.85	1,050,000	Do.
4	31.5					5.69	803,000	Do.
5	30.0					5.69	787,000	Do.
6	28.8					5.76	779,000	Do.
7	28.3					5.79	777,000	Do.
8	28.4					5.85	787,000	Do.
11	31.4					6.31	889,000	Do.
12	33.0					6.61	955,000	Do.
13	33.6					6.65	970,000	Do.
14	34.2					6.83	1,005,000	Do.
17	35.0					6.80	1,011,000	Do.
18	35.0					6.77	1,008,000	Do.
19	34.9					6.76	1,005,000	Do.
21	34.7					6.66	982,000	Do.
25	36.2					7.11	1,078,000	Do.
26	37.4					7.22	1,114,000	Do.
27	37.9					7.29	1,133,000	Do.
29	38.3					7.29	1,140,000	Do.
June 1	38.4					7.31	1,143,000	Do.
2	38.4					7.35	1,151,000	Do.
3	38.6					7.40	1,161,000	Do.
7	39.9					7.55	1,206,000	Do.
8	40.1					7.63	1,222,000	Do.
9	40.4					7.69	1,241,000	Do.
12	41.1					7.88	1,281,000	Do.
14	41.8					8.04	1,318,000	Do.
15	42.1					8.10	1,349,000	Do.
16	42.3					8.40	1,388,000	Do.
17	42.5					8.47	1,403,000	Do.
18	42.7					8.45	1,403,000	Do.
19	42.7					8.43	1,400,000	Do.
22	42.9					8.31	1,383,000	Do.
25	42.2					7.80	1,286,000	Do.
26	41.8					7.67	1,259,000	Do.
28	40.0					7.23	1,157,000	Do.
29	38.7					6.94	1,090,000	Do.
30	37.0					6.50	997,000	Do.
July 1	35.3					5.62	841,000	Do.
2	32.8					5.14	740,000	Do.
3	30.8					4.81	671,000	Do.
5	28.0					4.63	619,000	Do.
6	26.8					4.60	602,000	Do.
7	25.7					4.42	568,000	Do.
8	24.0					4.21	533,000	Do.
9	24.2					3.99	580,000	Do.
12	22.6					3.92	477,000	Do.
13	22.4					3.83	464,000	Do.
14	22.4					3.84	466,000	Do.
15	22.2					3.81	460,000	Do.
16	21.0					3.60	443,000	Do.
17	21.6					3.55	425,000	Do.
19	21.0					3.70	445,000	Do.
20	22.7					4.04	493,000	Do.
21	24.3					4.15	521,000	Do.
22	25.7					4.64	596,000	Do.
24	26.8					4.88	639,000	Do.
26	27.0					4.99	665,000	Do.
27	28.2					4.97	665,000	Do.
28	28.2					4.98	664,000	Do.
29	27.9					4.96	662,000	Do.
30	27.4					4.64	614,000	Do.
31	26.3					4.53	589,000	Do.
Aug. 2	24.4					4.22	532,000	Do.
3	23.8					4.13	514,000	Do.
4	23.2					4.00	493,000	Do.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1858.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Aug. 5	22.7					3.93	480,000	Double floats.
6	22.5					3.94	479,000	Do.
7	22.3					3.97	480,000	Do.
9	22.9					4.05	496,000	Do.
10	23.1					4.05	496,000	Do.
11	22.9					4.14	495,000	Do.
12	22.7					3.93	480,000	Do.
13	22.2					3.87	468,000	Do.
14	21.8					3.90	468,000	Do.
16	20.9					3.66	432,000	Do.
17	20.6					3.75	411,000	Do.
18	20.3					3.35	391,000	Do.
19	19.9					3.33	385,000	Do.
20	19.5					3.33	383,000	Do.
21	18.9					3.28	369,000	Do.
23	17.9					3.26	364,000	Do.
24	17.3					3.08	340,000	Do.
25	16.7					3.05	333,000	Do.
26	15.9					2.80	300,000	Do.
27	15.7					2.75	294,000	Do.
30	15.0					2.55	268,000	Do.
Sept. 2	14.7					2.67	280,000	Do.
4	13.9					2.49	257,000	Do.
6	12.9					2.33	235,000	Do.
7	12.4					2.29	228,000	Do.
8	11.9					2.24	221,000	Do.
9	11.5					2.24	210,000	Do.
10	11.2					2.28	222,000	Do.
11	11.0					2.18	212,000	Do.
13	11.1					2.17	211,000	Do.
14	12.4					2.48	247,000	Do.
15	13.4					2.51	256,000	Do.
16	13.5					2.60	266,000	Do.
17	13.5					2.50	256,000	Do.
18	13.2					2.50	254,000	Do.
20	12.7					2.48	240,000	Do.
21	12.3					2.39	238,000	Do.
22	11.9					2.36	233,000	Do.
23	11.4					2.28	223,000	Do.
24	10.8					2.22	214,000	Do.
27	9.3					1.98	185,000	Do.
29	8.8					1.96	181,000	Do.
30	8.5					1.90	174,000	Do.
Oct. 1	8.3					1.94	177,000	Do.
2	8.1					1.78	162,000	Do.
4	7.7					1.77	159,000	Do.
6	7.3					1.67	149,000	Do.
8	6.8					1.66	146,000	Do.
9	6.7					1.66	146,000	Do.
11	6.2					1.62	141,000	Do.
12	6.0					1.67	144,000	Do.
13	5.9					1.56	134,000	Do.
14	5.8					1.59	137,000	Do.
15	5.6					1.55	133,000	Do.
16	5.5					1.51	129,000	Do.
18	5.3					1.56	130,000	Do.
19	5.2					1.58	134,000	Do.
20	5.1					1.60	136,000	Do.
21	5.1					1.54	131,000	Do.
22	5.2					1.58	134,000	Do.
23	5.2					1.56	132,000	Do.
25	5.4					1.55	132,000	Do.
26	5.6					1.58	135,000	Do.
28	5.7					1.64	140,000	Do.
29	5.9					1.62	140,000	Do.
30	5.9					1.67	144,000	Do.
Nov. 3	10.0					2.49	230,000	Do.
4	11.3					2.92	285,000	Do.
5	13.8					3.45	354,000	Do.
8	18.0					3.05	442,000	Do.
9	17.9					3.80	434,000	Do.
10	17.6					3.79	420,000	Do.
11	17.4					3.78	417,000	Do.
12	17.0					3.65	400,000	Do.
16	15.0					3.40	358,000	Do.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 28	22.8	121,500	.....	.....	.....	4.23	514,000	Double floats.
Mar. 1	22.4	.....	52.49	.....	2,410	.....	.....	Do.
3	21.6	118,700	.....	.....	.....	3.92	465,000	Do.
6	21.2	118,200	.....	.....	.....	4.06	480,000	Do.
7	21.3	118,300	.....	.....	.....	4.06	480,000	Do.
8	21.4	118,300	.....	.....	.....	4.02	476,000	Do.
9	21.3	118,000	.....	.....	.....	3.97	469,000	Do.
10	20.9	117,100	.....	.....	.....	4.09	479,000	Do.
11	20.7	116,600	.....	.....	.....	4.07	474,000	Do.
12	20.7	116,400	.....	.....	.....	3.94	459,000	Do.
15	23.0	122,000	.....	.....	.....	4.40	537,000	Do.
18	25.1	134,200	56.00	.....	2,410	4.82	647,000	Do.
20	26.2	136,200	55.45	.....	2,410	4.95	675,000	Do.
21	26.5	137,700	56.14	.....	2,400	4.91	676,000	Do.
25	28.4	137,700	53.04	.....	2,400	5.26	724,000	Do.
26	29.1	138,700	54.38	.....	2,370	5.37	745,000	Do.
27	29.4	139,800	53.34	.....	2,400	5.34	746,000	Do.
28	29.3	141,000	54.73	.....	2,400	5.26	742,000	Do.
29	29.2	142,600	55.24	.....	2,400	5.26	750,000	Do.
31	28.7	138,300	54.26	.....	2,400	5.29	732,000	Do.
Apr. 2	28.4	142,300	55.69	.....	2,400	5.16	734,000	Do.
4	28.4	139,200	52.68	.....	2,470	5.06	705,000	Do.
6	28.8	138,500	52.48	.....	2,460	5.30	734,000	Do.
8	28.4	137,400	52.95	.....	2,450	5.25	722,000	Do.
11	26.5	133,400	52.66	.....	2,450	4.73	631,000	Do.
12	26.3	.....	53.12	.....	2,450	.....	.....	Do.
13	27.2	138,300	54.26	.....	2,450	5.05	699,000	Do.
14	27.8	131,100	51.02	.....	2,450	5.09	667,000	Do.
19	27.8	134,100	52.20	.....	2,450	4.86	652,000	Do.
20	27.5	132,900	51.98	.....	2,450	4.98	662,000	Do.
21	27.3	131,100	51.98	.....	2,430	5.00	655,000	Do.
22	26.6	133,800	53.10	.....	2,440	4.72	631,000	Do.
23	26.0	131,200	51.44	.....	2,450	4.96	651,000	Do.
24	25.1	125,100	51.06	.....	2,450	4.42	553,000	Do.
25	24.0	124,400	51.89	.....	2,450	4.18	520,000	Do.
27	22.0	120,700	52.48	.....	2,450	4.05	490,000	Do.
28	21.1	119,600	52.81	.....	2,450	3.90	466,000	Do.
29	20.4	117,200	52.71	.....	2,450	3.77	442,000	Do.
30	19.6	113,800	51.32	.....	2,450	3.77	429,000	Do.
May 1	18.8	111,800	52.20	.....	2,450	3.63	405,000	Do.
2	18.0	111,000	52.66	.....	2,450	3.38	375,000	Do.
6	15.2	100,200	50.86	.....	2,450	2.98	298,000	Do.
7	14.6	98,900	50.69	.....	2,450	2.97	293,000	Do.
8	14.1	99,200	51.01	.....	2,450	2.94	291,000	Do.
9	13.6	95,900	49.96	.....	2,450	2.77	265,000	Do.
10	13.3	100,200	51.98	.....	2,450	2.58	259,000	Do.
12	13.0	95,400	49.72	.....	2,450	2.65	253,000	Do.
14	13.0	96,300	50.93	.....	2,450	2.65	255,000	Do.
15	12.8	99,500	52.93	.....	2,450	2.74	273,000	Do.
16	12.5	96,900	52.40	.....	2,450	2.73	265,000	Do.
17	12.3	97,500	52.68	.....	2,450	2.67	260,000	Do.
18	12.2	96,400	51.67	.....	2,450	2.63	253,000	Do.
19	12.2	96,200	50.80	.....	2,450	2.65	255,000	Do.
20	12.2	95,600	52.02	.....	2,450	2.63	251,000	Do.
2	12.1	98,100	52.55	.....	2,450	2.63	259,000	Do.
22	11.8	95,000	51.72	.....	2,450	2.69	255,000	Do.
23	11.4	94,000	51.50	.....	2,450	2.60	244,000	Do.
24	11.2	93,000	51.63	.....	2,450	2.40	224,000	Do.
25	11.2	93,200	51.43	.....	2,450	2.47	230,000	Do.
26	11.2	92,700	51.21	.....	2,450	2.45	227,000	Do.
27	11.3	96,500	52.62	.....	2,450	2.51	242,000	Do.
28	11.2	94,500	52.20	.....	2,450	2.50	236,000	Do.
29	11.3	95,400	52.42	.....	2,450	2.50	238,000	Do.
30	11.7	94,300	51.37	.....	2,450	2.57	243,000	Do.
June 2	14.2	103,600	53.03	.....	2,450	3.07	318,000	Do.
3	14.8	104,600	52.40	.....	2,450	3.10	324,000	Do.
4	15.2	105,700	53.23	.....	2,450	3.02	319,000	Do.
5	15.7	103,400	51.34	.....	2,450	3.19	330,000	Do.
6	16.3	100,400	52.43	.....	2,440	3.30	362,000	Do.

[a] The observations of 1879 were made under direction of Maj. C. R. Suter, at request of Board of Engineers on Low Water Navigation of Mississippi River; the results will appear in Report Chief of Engineers, 1894. Gauge readings are referred to present Mississippi River Commission gauge at Belmont. The discharge section of 1879 is about 1,600 feet above the railroad depot at the lower end of the town of Columbus, and about 1,300 feet above the section of 1893.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
June 7	16.6	108,000	53.02	.....	2,440	3.22	348,000	Double floats.
8	16.4	109,000	52.80	.....	2,445	3.32	361,000	Do.
9	16.3	106,000	51.81	.....	2,440	3.30	350,000	Do.
10	16.2	107,500	52.05	.....	2,450	3.25	349,000	Do.
11	16.2	108,300	52.71	.....	2,450	3.21	348,000	Do.
12	16.0	105,300	51.85	.....	2,450	3.21	338,000	Do.
13	15.6	105,900	52.64	.....	2,450	3.17	336,000	Do.
14	15.4	104,800	52.35	.....	2,450	3.05	320,000	Do.
15	15.5	104,900	52.47	.....	2,450	3.09	324,000	Do.
16	15.6	105,300	51.08	.....	2,450	3.20	337,000	Do.
17	15.6	105,200	52.16	.....	2,450	3.11	328,000	Do.
18	15.5	106,400	53.06	.....	2,450	3.12	332,000	Do.
19	15.4	104,100	52.16	.....	2,450	3.22	336,000	Do.
20	15.4	105,400	51.30	.....	2,450	3.08	324,000	Do.
21	15.6	104,700	52.00	.....	2,450	3.08	322,000	Do.
23	16.5	105,900	52.11	.....	2,450	3.41	361,000	Do.
24	16.6	109,000	52.82	.....	2,450	3.32	362,000	Do.
25	16.4	106,200	51.32	.....	2,450	3.35	356,000	Do.
27	15.7	103,800	52.03	.....	2,450	3.17	329,000	Do.
28	15.3	105,200	52.82	.....	2,450	3.22	339,000	Do.
30	15.2	104,200	51.30	.....	2,450	3.22	366,000	Do.
July 1	17.2	108,100	51.52	.....	2,450	3.62	391,000	Do.
2	18.0	109,300	.....	.....	.....	3.75	410,000	Do.
1881.[a]								
Dec. 17	19.2	126,400	50.3	66.4	2,526	3.46	437,000	Do.
21	26.0	140,600	55.2	73.8	2,544	5.06	711,000	Do.
22	27.8	143,400	56.1	74.4	2,556	5.20	758,000	Do.
23	29.0	148,500	57.9	76.8	2,566	5.55	824,000	Do.
24	30.1	163,900	59.8	80.8	2,575	5.67	872,000	Do.
28	35.5	173,100	65.3	87.2	2,633	6.53	1,123,000	Do.
29	36.1	174,100	66.0	87.9	2,641	6.10	1,062,000	Rod floats.
30	36.3	173,400	65.4	86.9	2,650	6.15	1,066,000	Do.
31	36.3	176,700	66.7	89.5	2,650	6.27	1,109,000	Do.
1882.[a]								
Jan. 3	35.6	180,200	68.1	91.2	2,645	5.91	1,064,000	Do.
5	35.3	174,500	66.1	95.5	2,640	5.75	1,004,000	Do.
6	35.1	172,700	65.5	86.1	2,637	5.74	992,000	Do.
9	34.1	165,800	63.0	88.0	2,632	5.47	907,000	Do.
11	34.3	168,200	63.8	89.0	2,633	5.65	950,000	Do.
14	36.7	172,400	64.8	91.5	2,659	6.30	1,086,000	Do.
17	39.2	178,900	67.1	92.0	2,668	7.36	1,317,000	Rod and double floats.
18	39.7	183,400	68.6	92.0	2,671	7.45	1,366,000	Double floats.
19	40.2	181,600	68.0	94.4	2,672	7.43	1,349,000	Do.
20	40.6	184,800	70.0	95.6	2,672	7.49	1,385,000	Rod floats.
25	41.9	179,400	66.6	91.5	2,693	7.61	1,364,000	Do.
26	42.1	182,400	67.8	95.0	2,694	8.02	1,463,000	Do.
27	42.2	184,600	68.5	94.0	2,694	7.96	1,469,000	Meter.[b]
30	42.3	183,500	68.1	91.0	2,695	7.47	1,370,000	Do.[b]
Feb. 1	42.4	180,300	66.9	91.0	2,695	7.61	1,373,000	Meter[b] and rod floats.
2	42.4	174,700	65.1	83.0	2,695	8.05	1,407,000	Meter.[b]
3	42.3	182,200	67.5	90.0	2,697	7.40	1,348,000	Rod floats.
4	42.4	185,000	68.6	89.5	2,697	7.72	1,420,000	Do.
6	42.2	182,300	67.5	91.2	2,701	7.25	1,322,000	Do.
7	42.0	181,000	67.4	87.0	2,699	7.52	1,367,000	Do.
8	41.9	190,000	70.8	95.0	2,697	7.43	1,418,000	Do.
9	41.6	189,000	70.1	97.5	2,694	7.40	1,399,000	Do.
10	41.4	188,500	70.1	93.5	2,689	7.04	1,326,000	Do.
11	41.0	188,500	70.2	94.5	2,684	6.84	1,289,000	Do.
13	40.4	188,600	70.3	95.0	2,682	6.59	1,243,000	Do.
14	40.4	185,000	69.0	92.5	2,681	6.65	1,230,000	Do.
15	40.2	193,300	71.0	94.5	2,680	6.48	1,253,000	Do.
18	41.0	186,900	69.7	93.0	2,681	6.81	1,272,000	Meter.[b]
22	43.6	197,000	72.0	99.5	2,689	8.14	1,603,000	Rod floats.
28	44.0	191,900	71.2	101.0	2,694	8.12	1,558,000	Do.
Mar. 1	44.7	192,200	68.4	100.5	2,649	8.24	1,502,000	Do.
2	44.3	189,600	71.4	94.0	2,649	8.02	1,521,000	Do.
3	44.2	188,900	71.3	98.0	2,649	8.04	1,518,000	Do.

[a] The 1881-82 series is printed in the Report Chief of Engineers, 1884, p. 2607. The discharge section of this series is about 2,500 feet above the railroad depot and about 2,200 feet above the section of 1893. The gauge readings are referred to the present M. R. C. gauge at Belmont.

[b] Meter velocities observed at mid depth and not corrected.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Mar. 4	44.0	186,500	70.0	98.0	2,649	7.84	1,463,000	Rod floats.
6	43.4	186,100	70.1	95.5	2,654	7.52	1,430,000	Do.
7	43.1	184,000	69.3	89.5	2,653	7.62	1,403,000	Do.
8	42.9	180,600	68.4	89.5	2,641	7.69	1,390,000	Do.
10	42.5	181,800	68.8	90.5	2,641	7.22	1,324,000	Do.
11	42.4	178,600	67.7	88.5	2,639	7.35	1,313,000	Do.
13	42.5	185,100	70.0	92.5	2,644	7.35	1,361,000	Do.
14	42.6	185,800	70.2	92.5	2,646	7.09	1,317,000	Do.
15	42.7	186,000	70.3	89.0	2,646	7.42	1,386,000	Do.
16	42.6	185,800	70.2	92.0	2,646	7.35	1,366,000	Do.
17	42.4	187,600	70.9	88.5	2,645	7.14	1,339,000	Do.
21	41.1	182,900	68.7	84.0	2,635	6.39	1,168,000	Meter.
22	40.5	187,500	71.2	90.0	2,634	6.09	1,142,000	Do.
23	39.8	182,400	69.3	86.0	2,632	5.77	1,053,000	Do.
24	39.1	183,200	69.1	87.0	2,630	5.81	1,065,000	Do.
25	38.6	176,800	67.3	82.0	2,627	5.46	966,000	Do.
27	38.2	178,900	68.1	82.0	2,625	5.60	1,001,000	Do.
28	38.1	178,900	68.1	82.0	2,624	5.43	972,000	Do.
29	38.1	179,800	68.5	82.0	2,624	5.51	991,000	Do.
30	38.2	180,500	68.7	84.0	2,628	6.05	1,092,000	Do.
Apr. 1	38.4	181,400	69.0	86.0	2,630	5.90	1,070,000	Do.
3	38.2	180,900	68.7	86.0	2,631	5.94	1,075,000	Do.
4	37.6	178,600	68.0	86.0	2,628	5.75	1,027,000	Do.
5	30.7	177,700	67.7	85.0	2,625	5.49	976,000	Do.
6	35.2	172,300	65.8	84.0	2,619	5.22	899,000	Do.
8	31.9	162,500	62.7	79.0	2,589	4.76	773,000	Do.
10	32.1	164,300	63.5	81.0	2,589	4.89	803,000	Do.
11	32.2	164,000	63.3	80.0	2,590	4.84	703,000	Do.
12	32.2	164,700	63.6	81.0	2,590	4.94	813,000	Do.
13	32.0	164,000	63.7	80.0	2,590	4.77	786,000	Do.
14	31.7	162,900	63.0	80.0	2,590	4.74	772,000	Do.
15	31.7	162,900	63.0	80.0	2,590	4.78	779,000	Do.
17	32.2	162,300	62.7	80.0	2,590	4.90	795,000	Do.
18	32.2	163,600	63.0	80.0	2,595	4.95	810,000	Do.
19	31.7	160,900	62.1	77.5	2,591	4.41	709,000	Rod floats.
20	30.8	157,000	60.9	75.0	2,578	4.43	695,000	Do.
21	29.8	154,300	60.0	78.0	2,570	4.59	708,000	Meter.
22	29.1	152,100	59.5	70.0	2,558	4.32	656,000	Do.
24	27.6	148,700	58.6	74.0	2,538	4.31	640,000	Do.
25	27.6	150,800	59.4	75.0	2,538	4.37	658,000	Do.
26	28.0	151,900	59.8	74.0	2,540	4.20	638,000	Do.
27	28.4	151,000	59.1	75.0	2,553	4.15	627,000	Do.
29	29.2	153,600	60.1	74.5	2,557	4.19	644,000	Rod floats.
May 1	29.7	153,500	59.8	74.1	2,566	4.30	661,000	Do.
2	29.9	154,800	60.3	76.0	2,568	4.62	715,000	Meter.
3	30.0	154,600	60.2	77.0	2,570	4.50	695,000	Do.
4	30.0	158,900	61.7	76.0	2,575	4.56	725,000	Do.
5	29.8	156,800	61.0	76.0	2,572	4.43	695,000	Do.
6	29.5	153,800	59.9	77.0	2,568	4.54	699,000	Do.
8	28.6	148,500	57.9	74.0	2,565	3.88	577,000	Do.
9	29.8	159,800	61.8	76.0	2,585	4.77	762,000	Do.[a]
10	32.8	161,000	62.1	78.0	2,592	5.32	857,000	Do.
11	34.8	170,000	65.6	81.5	2,603	4.99	851,000	Rod floats.
12	36.4	171,700	65.8	87.0	2,609	5.40	928,000	Do.
13	37.3	181,000	69.0	90.0	2,624	5.55	1,004,000	Do.
15	38.5	181,100	69.0	87.5	2,627	5.79	1,049,000	Do.
16	38.5	181,400	69.1	88.5	2,627	5.74	1,041,000	Do.
17	38.4	181,700	69.2	88.0	2,627	5.57	1,012,000	Do.
18	38.3	175,500	66.7	80.5	2,632	5.69	999,000	Do.
19	38.4	178,200	67.6	86.0	2,635	5.84	1,041,000	Meter.
20	38.4	174,800	66.3	85.0	2,635	5.85	1,022,000	Do.[a]
22	38.9	180,100	68.3	88.0	2,636	6.05	1,090,000	Do.
23	39.0	179,100	67.9	85.0	2,636	6.21	1,111,000	Do.[a]
25	38.2	178,100	67.6	84.0	2,635	5.91	1,052,000	Do.
26	37.4	175,000	66.5	84.0	2,632	5.60	980,000	Do.
27	36.2	171,000	65.2	81.0	2,621	5.25	898,000	Do.
29	34.6	169,700	64.9	81.0	2,613	5.20	883,000	Do.
30	34.6	168,100	64.3	81.0	2,613	5.33	896,000	Do.[a]
31	35.6	172,500	66.0	84.0	2,616	5.53	954,000	Do.[a]
June 1	36.5	174,700	66.5	86.0	2,626	5.78	1,011,000	Do.
2	37.3	175,400	66.0	84.0	2,632	5.93	1,041,000	Do.
3	37.8	180,600	68.5	87.0	2,635	5.93	1,071,000	Do.
5	38.5	178,400	67.6	86.0	2,637	6.16	1,099,000	Do.

[a] Meter velocities observed at mid depth and not corrected.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
June 7	38.6	179,800	68.4	86.5	2,627	5.47	983,000	Rod floats.
8	38.6	179,900	68.5	85.5	2,627	5.48	986,000	Do.
9	38.4	178,500	67.9	86.0	2,627	5.49	980,000	Do.
10	38.0	176,100	67.1	80.0	2,622	5.67	989,000	Meter.
12	36.5	169,600	65.1	82.5	2,622	5.09	863,000	Rod floats.
13	35.5	170,600	65.6	.....	2,600	4.94	843,000	Rod floats and meter.
14	34.2	168,300	64.9	80.0	2,593	4.60	775,000	Rod floats.
15	32.5	162,200	62.8	78.5	2,584	4.38	710,000	Do.
16	31.3	159,000	61.6	76.5	2,580	4.21	669,000	Do.
17	30.4	156,000	60.8	76.0	2,564	4.12	644,000	Do.
19	31.6	157,100	60.8	79.0	2,579	4.76	748,000	Do.
20	33.4	163,200	63.0	81.5	2,589	4.94	806,000	Do.
21	34.7	166,200	64.0	80.8	2,598	4.96	824,000	Do.
22	35.2	168,200	64.5	81.5	2,604	4.95	832,000	Do.
23	35.5	168,800	64.8	83.0	2,605	5.38	909,000	Meter.
24	35.8	166,900	64.1	83.0	2,605	5.39	900,000	Do.[a]
27	35.1	164,800	63.3	83.0	2,604	4.98	820,000	Meter and rod floats.
28	34.3	167,000	64.4	85.0	2,593	5.14	859,000	Meter.[a]
29	33.7	163,000	63.1	83.0	2,585	4.89	797,000	Do.
30	33.1	159,400	61.7	83.0	2,580	4.82	768,000	Do.[a]
July 1	33.1	162,500	63.0	83.0	2,580	4.94	802,000	Do.
3	33.5	162,400	63.0	80.0	2,585	5.05	820,000	Do.
5	34.8	170,800	65.8	82.0	2,596	4.85	828,000	Do.
6	35.4	169,900	65.3	86.0	2,601	5.05	858,000	Do.
7	35.9	171,300	65.7	84.5	2,601	5.39	923,000	Do.
8	36.3	168,400	64.2	86.0	2,608	5.33	898,000	Do.
10	36.1	166,200	63.8	82.0	2,602	5.36	891,000	Do.
11	35.8	167,300	64.4	85.0	2,600	5.37	899,000	Do.
12	35.2	168,500	64.8	84.0	2,599	5.32	896,000	Do.
13	34.4	160,600	61.9	82.0	2,593	5.08	816,000	Do.
14	33.2	160,800	62.2	80.0	2,582	4.86	781,000	Do.
15	32.2	158,200	61.3	78.5	2,579	4.80	759,000	Do.
17	30.4	152,300	59.7	78.0	2,552	4.53	690,000	Do.
18	29.8	150,000	59.2	78.0	2,536	4.31	647,000	Do.
19	29.0	146,700	58.5	76.0	2,527	4.33	636,000	Do.
20	28.4	147,200	58.4	77.0	2,519	4.09	601,000	Do.
21	27.7	143,100	57.2	74.5	2,503	3.99	572,000	Do.
22	27.4	146,600	58.5	76.0	2,497	3.95	579,000	Do.
24	26.2	138,100	55.4	73.0	2,491	3.83	529,000	Do.
25	25.5	138,400	55.7	72.0	2,484	3.69	510,000	Do.
26	24.4	134,700	54.4	71.0	2,477	3.56	479,000	Do.
27	23.3	130,500	53.0	71.0	2,461	3.27	426,000	Do.
28	22.4	129,400	52.6	68.5	2,460	3.23	418,000	Do.
29	21.7	126,600	51.6	68.0	2,455	3.10	392,000	Do.
30	21.2	122,000	49.6	66.0	2,457	2.97	362,000	Meter and rod floats.
Aug. 2	20.0	125,700	51.1	65.5	2,457	2.57	323,000	Rod floats.
3	19.8	127,100	51.7	65.5	2,456	2.54	323,000	Do.
4	19.5	122,000	49.8	64.2	2,462	2.48	304,000	Do.
5	19.5	123,300	50.1	64.2	2,461	2.57	316,000	Do.
7	21.3	137,100	55.6	72.0	2,464	3.05	418,000	Meter.
8	21.9	133,600	54.2	72.5	2,466	3.14	420,000	Do.[a]
9	22.0	137,400	55.6	72.0	2,470	3.22	442,000	Do.
10	21.7	133,000	53.9	70.5	2,468	3.14	418,000	Do.
11	21.5	131,500	53.4	71.5	2,464	3.07	404,000	Do.[a]
12	21.3	133,800	54.4	69.5	2,462	3.00	402,000	Do.
14	20.7	127,200	51.8	69.0	2,456	2.97	378,000	Do.
15	20.2	125,400	51.2	68.0	2,451	2.91	366,000	Do.
16	19.9	127,000	51.9	68.0	2,447	2.82	358,000	Do.
17	19.7	126,700	51.8	68.0	2,446	2.76	349,000	Do.
18	19.5	125,200	51.1	68.0	2,447	2.70	338,000	Do.
19	19.2	122,200	50.0	66.0	2,451	2.71	332,000	Do.
21	18.5	121,700	49.7	67.5	2,447	2.59	316,000	Do.
22	18.0	122,000	50.1	65.0	2,451	2.26	278,000	Rod floats.
23	17.6	122,400	50.1	67.0	2,442	2.49	304,000	Meter.
24	17.0	121,800	49.9	66.0	2,440	2.30	280,000	Do.
25	16.3	119,100	46.7	65.0	2,440	2.31	275,000	Do.
26	15.9	116,900	48.0	64.5	2,438	2.23	261,000	Do.
28	15.1	116,000	47.7	65.0	2,433	2.14	249,000	Do.
29	14.9	115,100	47.4	63.8	2,430	1.90	219,000	Rod floats.
30	14.7	115,500	47.5	63.5	2,428	1.87	216,000	Do.
31	14.7	113,800	46.8	62.0	2,428	2.12	242,000	Meter.

[a] Meter velocities observed at mid depth and not corrected.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	Meter.
Sept. 1	14.7	117,200	48.2	63.0	2,432	2.06	242,000	Do.
2	14.9	115,800	47.5	64.0	2,433	2.15	249,000	Do.
4	15.1	113,160	46.4	63.5	2,440	2.25	254,000	Do.
5	15.3	115,600	47.4	64.0	2,440	2.19	253,000	Do.
6	15.4	116,200	47.6	64.5	2,441	2.13	247,000	Do.[a]
7	15.7	115,800	47.4	64.0	2,443	2.07	239,000	Do.
8	16.0	117,600	48.0	65.0	2,443	2.24	261,000	Do.
9	16.1	116,200	47.6	65.0	2,443	2.30	267,000	Do.
11	15.9	117,300	48.0	63.0	2,441	2.23	261,000	Do.
12	15.6	121,300	49.7	63.2	2,440	1.93	231,000	Rod floats
13	15.3	115,300	47.3	63.0	2,438	2.13	245,000	Meter.
14	14.8	111,800	45.9	63.0	2,435	2.07	232,000	Do.
15	14.6	112,100	46.1	62.0	2,433	2.04	229,000	Do.
16	14.4	112,200	46.2	62.0	2,429	2.09	234,000	Do.
18	16.1	118,700	48.7	64.0	2,439	2.35	279,000	Do.
19	17.0	118,400	48.5	64.2	2,442	2.23	264,000	Rod floats.
20	17.9	122,000	49.7	66.0	2,454	2.65	323,000	Meter.
21	18.1	121,100	49.3	67.0	2,455	2.65	321,000	Do.
22	17.6	121,600	49.6	65.5	2,450	2.51	305,000	Do.
23	16.6	118,800	48.6	65.5	2,445	2.35	279,000	Do.[a]
25	15.3	115,200	47.3	63.5	2,435	2.24	258,000	Do.
26	14.4	112,400	46.2	62.0	2,429	2.17	244,000	Do.
27	13.7	112,800	46.5	62.0	2,425	2.03	229,000	Do.
28	12.8	110,400	45.6	61.0	2,423	1.97	217,000	Do.
29	12.3	108,000	44.6	60.0	2,421	1.90	205,000	Do.
30	12.0	105,500	43.6	59.0	2,420	1.83	193,000	Do.
Oct. 2	11.2	101,300	43.1	59.0	2,417	1.78	186,000	Do.
3	11.0	103,700	42.4	58.0	2,417	1.83	190,000	Do.
4	11.1	104,700	43.3	58.0	2,415	1.55	162,000	Rod floats.
5	11.2	104,200	42.9	58.5	2,416	1.50	156,000	Do.
6	11.3	104,300	43.1	58.0	2,419	1.88	196,000	Meter.
7	11.1	105,100	41.8	59.0	2,418	1.90	200,000	Do.
9	10.9	103,600	42.8	59.0	2,418	1.80	187,000	Do.
10	10.9	104,000	43.0	59.0	2,418	1.81	188,000	Do.
11	10.9	102,600	42.4	59.0	2,418	1.87	192,000	Do.
12	10.9	103,000	42.6	59.0	2,418	1.96	202,000	Do.
13	10.7	102,900	42.5	59.0	2,417	1.87	192,000	Do.
14	10.5	100,500	41.5	57.0	2,416	1.87	187,000	Do.
16	10.0	98,600	40.9	57.5	2,411	1.82	179,000	Do.
17	9.9	100,000	41.5	58.0	2,407	1.85	185,000	Do.
19	9.7	97,100	40.5	57.0	2,406	1.84	179,000	Do.
20	9.6	99,600	41.4	57.0	2,406	1.77	176,000	Do.
21	9.8	100,100	41.6	57.0	2,406	1.80	180,000	Do.
23	10.3	101,600	42.0	58.0	2,421	1.88	190,600	Do.
24	10.3	101,700	41.9	58.0	2,423	1.93	196,000	Do.
26	10.3	101,100	41.7	58.0	2,424	1.86	188,000	Do.
27	10.3	103,600	42.7	58.0	2,425	1.85	191,000	Do.
28	10.4	100,800	41.6	58.0	2,425	1.93	195,000	Do.
30	10.6	103,400	42.6	58.0	2,426	1.96	202,000	Do.
31	10.6	99,800	41.2	59.0	2,424	1.92	192,000	Do.
Nov. 1	10.7	101,300	41.8	58.5	2,424	1.90	192,000	Do.
2	10.9	104,600	43.1	58.0	2,425	1.88	197,000	Do.
3	11.0	103,400	42.6	59.0	2,426	2.01	207,000	Do.
5	11.1	97,200	40.1	57.0	2,426	1.92	187,000	Do.[a]
6	11.1	102,300	42.2	59.0	2,426	1.99	204,000	Do.
7	11.0	104,200	43.0	59.6	2,426	1.96	204,000	Do.
8	11.1	102,500	42.3	58.0	2,426	1.97	202,000	Do.
9	11.4	104,000	42.9	59.0	2,426	1.96	203,000	Do.
10	11.9	104,400	43.0	60.0	2,429	1.93	201,000	Do.
11	12.1	104,300	42.9	59.5	2,431	2.12	221,000	Do.
13	12.7	105,800	43.5	60.0	2,435	2.14	226,000	Do.[a]
14	13.0	106,400	43.7	60.0	2,438	2.20	243,000	Do.
15	12.8	105,700	43.4	61.0	2,438	2.20	238,000	Do.
17	13.1	108,100	44.3	60.0	2,440	2.27	245,000	Do.
18	13.2	107,200	43.9	61.5	2,440	2.28	244,000	Do.
20	12.9	106,300	43.6	61.0	2,438	2.26	240,000	Do.
21	12.6	107,700	43.9	60.0	2,455	1.76	190,000	Rod floats.
22	12.4	104,200	42.5	59.6	2,455	1.81	188,000	Do.
23	12.3	107,600	43.9	59.9	2,452	1.87	201,000	Do.
24	12.2	105,200	43.1	59.8	2,442	1.88	198,000	Do.
25	12.1	105,400	43.3	59.5	2,432	1.80	190,000	Do.
1891.								
Feb. 27	40.5	185,600	59.7	80.5	3,111	7.05	1,300,000	Meter.
28	40.8	189,000	60.7	78.5	3,113	7.22	1,364,000	Do.

[a] Meter velocities observed at mid depth and not corrected.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1891.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	Meter.
Mar. 1	41.0	186,500	59.6	80.0	3,128	7.40	1,381,000	Do.
2	41.1	185,300	59.2	81.5	3,129	7.39	1,370,000	Do.
3	41.2	187,400	59.8	83.0	3,132	7.35	1,378,000	Do.
4	41.3	186,800	59.7	80.0	3,132	7.38	1,378,000	Do.
11	40.6	185,000	59.3	81.0	3,121	6.43	1,189,000	Double floats.
12	40.4	189,100	60.6	83.0	3,118	6.48	1,225,000	Do.
13	40.4	187,800	60.2	83.0	3,117	6.62	1,243,000	Do.
14	40.3	186,300	59.8	82.5	3,116	6.55	1,220,000	Do.
15	40.2	185,400	59.5	82.5	3,116	6.41	1,189,000	Do.
16	40.2	188,500	60.5	82.5	3,116	6.59	1,242,000	Do.
17	40.2	187,700	60.2	82.5	3,116	6.31	1,185,000	Do.
18	40.2	188,200	60.4	82.0	3,116	6.38	1,201,000	Do.
20	40.2	189,500	60.8	82.0	3,116	6.46	1,224,000	Do.
22	40.0	181,000	58.1	.....	3,116	6.27	1,135,000	Do.
23	40.0	183,800	59.0	70.5	3,116	6.43	1,182,000	Do.
24	39.8	184,500	59.2	80.0	3,116	6.26	1,156,000	Do.
25	39.6	184,900	59.3	80.0	3,116	6.32	1,168,000	Do.
1892.								
Apr. 13	41.3	202,600	64.9	86.0	3,122	6.42	1,300,000	Meter.
15	41.2	190,300	60.9	79.8	3,123	6.32	1,203,000	Do.
16	41.0	189,300	60.7	79.8	3,121	6.14	1,163,000	Do.
26	43.0	203,600	64.3	86.0	3,169	6.70	1,364,000	Do.
27	43.0	205,800	64.9	84.5	3,169	6.72	1,384,000	Do.
28	43.1	206,300	65.1	81.0	3,169	6.78	1,398,000	Do.
29	43.1	205,100	64.7	85.0	3,169	6.59	1,352,000	Do.
30	42.9	205,700	64.9	85.0	3,169	6.81	1,401,000	Do.
1893.								
Feb. 20	36.3	175,800	57.1	90.0	3,079	.....	.....	Double floats.
22	38.5	176,900	57.3	84.0	3,080	7.00	1,239,000	Do.
23	39.1	182,300	59.0	90.0	3,090	7.04	1,283,000	Do.
24	39.7	189,900	61.4	85.0	3,094	7.01	1,331,000	Do.
25	40.1	193,500	62.4	84.0	3,103	6.91	1,337,000	Do.
27	40.5	195,500	62.8	84.0	3,111	6.97	1,362,000	Do.
28	40.7	194,500	62.3	81.6	3,123	6.93	1,348,000	Do.
Mar. 1	40.7	193,800	62.1	81.0	3,123	6.81	1,320,000	Do.
2	40.4	191,000	62.4	81.0	3,109	6.61	1,281,000	Do.
6	33.6	167,700	54.6	71.0	3,071	5.10	856,000	Do.
May 5	43.1	203,200	64.7	87.0	3,141	7.11	1,445,000	Do.
6	43.5	[a] 203,300	64.7	.....	3,141	7.30	1,484,000	Do.
7	43.6	207,500	66.1	86.0	3,141	7.26	1,507,000	Do.
8	43.8	208,100	66.3	90.0	3,141	7.20	1,499,000	Do.
9	43.8	206,700	65.8	90.0	3,141	7.39	1,528,000	Do.
10	43.8	204,700	65.2	91.0	3,141	7.00	1,431,000	Do.
11	43.8	204,500	65.1	92.0	3,141	7.19	1,470,000	Do.
12	43.8	205,700	65.5	91.0	3,141	7.41	1,525,000	Do.
13	43.8	206,600	65.8	90.0	3,141	7.37	1,523,000	Do.
15	43.7	207,100	65.9	92.0	3,141	7.11	1,472,000	Do.
16	43.4	207,100	65.9	90.0	3,141	6.90	1,430,000	Do.
17	43.0	201,600	64.6	89.0	3,119	6.96	1,403,000	Do.
18	42.2	202,000	64.8	87.0	3,116	6.58	1,329,000	Do.
19	41.6	199,200	63.9	92.0	3,116	6.67	1,329,000	Do.
20	40.6	193,500	62.2	90.0	3,111	5.91	1,144,000	Do.
1895.[b]								
Oct. 15 a. m.	1.5	57,600	24.4	64.0	2,364	1.54	89,000	
15 p. m.	1.5	58,900	24.9	35.0	2,364	1.63	96,000	
1896.[c]								
Apr. 9	34.8	153,200	49.9	69.8	3,072	5.61	859,000	
10	35.1	151,700	49.4	70.8	3,073	5.53	839,000	
11	35.4	152,000	49.4	71.5	3,074	.....	.....	
13	35.8	150,200	48.8	71.7	3,078	6.19	930,000	
14	35.8	149,400	48.5	72.6	3,078	6.25	933,000	

[a] Only about one-half the section sounded; balance interpolated from the 5th and 7th.

[b] *Notes for low water, 1895.*—Velocities of 1895 observed with a Price meter at six-tenths depth. Observations made under direction of first and second district officer. Report Chief of Engineers 1896, p. 3554.

[c] *Notes for high water, 1896.*—Velocities were observed with a Haskell meter, form "B," with wheel No. 2. The meter was held at six-tenths depth for five minutes at each station for the regular observations. For the so called flanking method, which is fully described in Report Mississippi River Commission 1894, the meter was at 20 feet below the surface, and the velocity at this depth corrected to mean of the vertical. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers 1896, p. 3560.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1896.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Apr. 14	.....	.....	.....	.....	.....	6.32	[a] 944,000	
	.....	.....	.....	.....	.....	6.13	[a] 916,000	
	.....	.....	.....	.....	.....	6.23	[a] 930,000	
15	34.3	146,200	47.6	71.5	3,072	6.17	902,000	
16	31.6	141,700	46.5	68.8	3,048	5.43	769,000	
	.....	.....	.....	.....	.....	5.36	[a] 759,000	
16	.....	.....	.....	.....	.....	5.24	[a] 742,000	
	.....	.....	.....	.....	.....	5.30	[a] 751,000	
17	28.4	132,600	44.1	66.0	3,004	5.08	674,000	
	.....	.....	.....	.....	.....	4.75	[a] 630,000	
17	.....	.....	.....	.....	.....	4.80	[a] 636,000	
	.....	.....	.....	.....	.....	4.77	[a] 633,000	
Nov. 2	6.9	72,100	28.1	42.0	2,568	2.02	146,000	Double floats.
3	7.1	72,500	28.2	41.2	2,572	2.35	170,000	Meter.
4	7.4	72,500	28.1	42.0	2,575	2.22	161,000	Do.
4	7.4	72,500	28.1	42.0	2,575	2.22	161,000	Double floats.
5	7.7	74,900	29.1	42.6	2,577	2.15	161,000	Meter.
5	7.7	74,900	29.1	42.6	2,577	2.03	152,000	Double floats.
6	8.2	76,000	29.5	43.9	2,580	2.17	165,000	Meter.
7	8.6	77,500	30.0	44.1	2,581	1.98	153,000	Do.
9	9.6	80,500	31.0	45.5	2,599	2.35	189,000	Do.
9	9.6	80,000	30.7	46.1	2,604	2.37	190,000	Double floats.
10	9.8	79,400	30.5	46.1	2,608	.....	.....	
1897.								
Mar. 3	39.2	167,400	54.1	78.2	3,096	7.10	1,188,000	Meter.
4	39.9	172,300	55.6	80.4	3,100	7.26	1,250,000	Do.
5	40.6	170,800	55.0	80.3	3,105	8.01	1,368,000	Do.
6	[b] 41.2	172,700	55.6	80.4	3,106	7.35	1,269,000	Do.
6	41.2	172,700	55.6	80.4	3,106	7.76	1,339,000	Double floats.
8	42.3	177,600	57.0	81.0	3,113	7.75	1,377,000	Meter.
9	42.5	178,400	57.3	82.4	3,113	7.81	1,392,000	Do.
9	42.5	178,400	57.3	82.4	3,113	8.20	1,462,000	Double floats.
Nov. 3	2.4	63,500	24.7	35.8	2,573	1.22	78,000	Do.
4	2.4	64,400	25.0	36.0	2,573	1.40	90,000	Meter.
5	2.4	64,800	25.2	36.0	2,573	1.42	92,000	Do.
5	2.4	65,000	25.3	.....	2,573	1.33	86,000	Do.
5	2.4	65,200	25.3	37.0	2,573	1.34	88,000	Double floats.
6	2.2	64,700	25.1	36.8	2,573	1.34	86,000	Meter.
6	2.2	64,500	25.1	35.7	2,573	1.34	86,000	Do.
6	2.2	64,400	25.0	.....	2,573	1.34	87,000	Double floats.
8	2.2	63,900	24.8	37.2	2,571	1.34	86,000	Meter.
8	2.2	64,500	25.0	35.7	2,571	1.38	88,000	Do.
8	2.2	63,960	24.8	35.8	2,571	1.11	71,000	Double floats.
1898.[c]								
Feb. 1	40.5	176,000	56.6	77.6	3,108	6.98	1,228,000	Meter.
3	40.1	175,400	56.4	73.8	3,106	6.73	1,181,000	Do.
3	40.1	175,100	56.4	.....	3,106	6.70	1,174,000	Double floats.
4	39.6	174,100	56.1	74.2	3,103	6.76	1,177,000	Meter.
5	38.7	173,300	55.9	73.7	3,100	6.40	1,109,000	Do.
5	38.7	172,600	55.7	.....	3,100	6.34	1,095,000	Double floats.
Mar. 29	41.6	181,900	59.4	78.4	3,111	7.72	1,428,000	Meter.
31	42.5	186,000	59.7	78.8	3,115	7.91	1,471,000	Do.
31	42.5	186,400	59.8	.....	3,115	8.14	1,517,000	Double floats.
Apr. 1	43.0	188,200	60.4	79.7	3,115	7.72	1,454,000	Meter.
1	43.0	188,500	60.5	.....	3,115	7.68	1,448,000	Double floats.
2	43.4	189,500	60.8	79.8	3,115	7.97	1,511,000	Meter.
2	43.4	189,700	60.9	.....	3,115	7.86	1,492,000	Double floats.
4	43.8	193,000	61.9	82.5	3,115	7.56	1,459,000	Meter.

[a] Flanking observations. Same areas used as for regular observation of that day.

[b] *Notes for low water 1896 and high water 1897.*—River bank full; over bank at some places on Belmont side. Double floats were used, the lower one being at mid-depth. Velocities were observed at six-tenths depth with Haskell meter, form "B," wheel No. 2. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers, 1897, p. 3652.

[c] The discharge section was at same place as in former years, about one-half mile below the Belmont elevator.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

[21.6 miles below Cairo.]

[Columbus M. R. C. gauge whose zero is 280.75 feet above the Cairo datum plane. Observations and reduction under direction of Secretary Mississippi River Commission: 1900, Capt. M. M. Patrick; 1901, Capt. G. P. Howell; 1903 and 1904, Capt. Wm. D. Ladue, Corps of Engineers.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1900.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Nov. 7, a. m.	12.5	90,600	34.6	62.0	2,621	2.30	208,000	Meter.
7, p. m.	12.5	92,700	35.4	51.5	2,621	2.20	204,000	Do.
8, a. m.	12.5	91,300	34.9	51.0	2,621	2.30	210,000	Do.
8, p. m.	12.5	91,300	34.8	51.0	2,622	2.34	214,000	Do.
9, a. m.	12.8	90,800	34.6	51.0	2,622	2.28	207,000	Do.
9, p. m.	12.8	92,600	35.3	52.0	2,622	2.36	218,000	Do.
10, a. m.	13.1	92,500	35.3	53.0	2,624	2.41	223,000	Do.
10, p. m.	13.1	92,700	35.3	53.0	2,624	2.32	215,000	Do.
12, a. m.	12.9	92,400	35.2	53.0	2,625	2.30	212,000	Do.
12, p. m.	12.8	92,400	35.2	53.0	2,625	2.25	208,000	Do.
1901.[b]								
Nov. 16, a. m.	3.98	67,400	27.3	43.7	2,468	1.61	109,000	Double floats
16, p. m.	3.95	69,100	28.0	43.7	2,468	1.58	109,000	Do.
17	3.92	67,200	27.5	43.6	2,444	1.53	103,000	Do.
18, a. m.	3.90	67,300	27.8	43.2	2,420	1.63	110,000	Do.
18, p. m.	3.90	68,400	28.5	43.6	2,396	1.63	112,000	Do.
19, a. m.	3.85	67,600	28.2	43.6	2,396	1.62	109,000	Do.
19, p. m.	3.84	67,800	28.4	43.6	2,388	1.61	109,000	Do.
20, a. m.	3.80	69,400	29.0	43.6	2,396	1.44	100,000	Do.
20, p. m.	3.78	69,200	28.9	43.6	2,396	1.54	106,000	Do.
21	3.75	67,800	28.3	43.6	2,396	1.48	100,000	Do.
25	3.72	69,000	28.8	45.2	2,396	1.58	109,000	Do.
26, a. m.	3.72	68,600	28.6	44.2	2,396	1.53	105,000	Meter.
26, p. m.	3.72	70,700	29.5	45.2	2,396	1.48	105,000	Double floats
27	3.71	69,200	28.9	44.2	2,396	1.47	102,000	Meter.
1903.								
Mar. 16, 17	44.46	193,200	62.6	97.0	3,085	7.68	1,483,000	Do.[c]
1904.								
Apr. 3	43.68	195,800	62.9	87.7	3,115	7.51	1,471,000	Do.
4	43.84	[d] 195,200	.....	.....	.....	7.41	1,447,000	Double floats.
5	43.92	194,000	62.5	90.1	3,115	7.72	1,502,000	Meter.
6	43.82	195,100	62.6	88.9	3,115	7.24	1,413,000	Do.
6	43.80	[d] 195,100	.....	.....	.....	7.15	1,395,000	Double floats.
7	43.56	192,000	61.8	88.0	3,115	7.01	1,358,000	Meter.

[a] Results of 1900 in Report Chief of Engineers, 1901, Supplement, p. 137.
[b] Results of 1901 in Report Chief of Engineers, 1902, Supplement, p. 70.
[c] Haskell meter, run at 0.1, 0.2, 0.3, 0.4, and 0.6 depths. All velocities reduced to 0.6 depth. Report Chief of Engineers, 1903, Supplement, p. 113.
[d] Interpolated. Results of 1904 in Report Chief of Engineers, 1905, Supplement, p. 116.

[22 miles below Cairo.]

[Zero of M. R. C. Standard gauge is 286.76 feet above the Cairo datum plane. The datum line for computing datum areas was at 42.37 on this gauge. The discharge section is practically the same as that of 1904 and is opposite the town of Columbus, Ky. Velocities were measured with Price meter No. 38.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1906.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Apr. 7	42.15	.....	+0.22	177,368	178,049	57.3	57.5	89.5	3,095
8	42.28	.....	+ .13	184,638	184,917	59.7	59.8	90.7	3,095
9	42.37	.....	+ .09	186,050	186,050	60.1	60.1	91.0	3,095
10	42.39	.....	+ .05	[a] 186,112	.....	.....	.....	.....	.....

[a] Derived from cross section of April 9.

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1906.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Apr. 7	.....	7.36	1,305,116	Meter	16	59	V. Light.
8	+6,868	7.31	1,349,109	....do	16	64	V. Brisk.
9	+1,133	6.96	1,295,845	....do	16	75	X. Strong.
10	.....	7.12	1,325,429	Double float	11	....	X. Light.

(21.6 miles below Cairo.)

[M. R. C. gauge at Columbus. Zero is 286.76 above the Cairo datum plane. The readings given correspond to time of discharge observations. The rise or fall is computed from the 8 a. m. readings. Datum line for computing datum areas was taken at 43.2 feet on this gauge for the February observations and at 41.98 for the later observations. The discharge section used in March and April was the same as used in 1903. That used in February was about 200 feet farther up the river on the right bank. Overbank discharge was measured March 27. All overbank discharges were derived from this measurement. Overbank discharge was on the right bank. On March 24 Price meter No. 38 was used. On March 25 Price meter No. 25 was used. On March 28 Price meter No. 38 and Haskell No. 6 were used simultaneously. On March 29 Price meter No. 25 and Haskell No. 6 were used simultaneously. On April 1 Price meters Nos. 25 and 38 were used simultaneously. Where meters were run simultaneously the mean results of the measurements are given. The direction of wind is indicated by the figures of a clock dial, XII o'clock being upstream and denoting a downstream wind, VI denoting an upstream wind, etc. Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. A., secretary Mississippi River Commission.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1907.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Feb. 2	43.20	.....	−0.4	190,620	190,620	60.1	60.1	89.0	3,150
3	42.80	.....	− .4	193,712	194,972	61.5	61.9	89.0	3,150
Mar. 24	41.91	.....	+ .1	183,862	184,076	60.1	60.2	92.0	3,057
25	41.98	.....	+ .1	186,933	186,933	61.1	61.1	93.0	3,057
26	41.92	.....	− .1	180,793	180,976	61.1	61.2	88.0	3,057
28	41.68	.....	− .2	176,753	177,670	57.8	58.1	83.0	3,057
29	41.10	.....	− .3	176,038	177,811	57.6	58.2	78.0	3,057
30	40.98	.....	− .4	175,596	178,653	57.4	58.4	78.0	3,057
Apr. 1	39.65	.....	− .8	169,211	176,334	55.4	57.7	77.0	3,057
1	39.40	.....	.....	168,447	.....	.....	.....	.....	.....

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1907.	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Feb. 2	.....	7.96	1,516,631	26,702	1,543,333	Double floats	20	47	X. Strong.
3	+4,352	7.70	1,491,620	25,755	1,517,375	....do	14	40	XII. Brisk.
Mar. 24	.....	7.79	1,432,175	23,548	1,455,723	Meter	18	77	
25	+2,857	6.84	1,277,733	23,716	1,301,449	....do	18	90	
26	+ 43	6.80	1,269,530	23,082	1,292,612	Double floats	18	63	VII. Strong.
28	−0,306	7.18	1,268,372	23,716	1,292,088	Meter	18	64	
29	+ 141	6.77	1,190,921	22,310	1,213,231	....do	18	51	
30	+ 842	7.01	1,236,120	10,215	1,246,335	Double floats	19	67	XII. Brisk.
Apr. 1	−2,319	6.56	1,110,676	9,810	1,120,486	Meter	18	61	
1	.....	6.51	1,097,198	8,267	1,105,465	....do	18	....	

Results of discharge observations, Mississippi River—Continued.

COLUMBUS, KY.—Continued.

[21.6 miles below Cairo.]

[The zero of the Mississippi River Commission gauge at Columbus, Ky., is 286.70 feet above the Cairo datum plane. The gauge readings tabulated in the local gauge columns were taken on the standard gauge at the time of the discharge observations. The datum line for computing datum areas was taken at 11.20 feet on the gauge. When velocities were measured in the afternoon, the morning soundings were used, corrected for change of stage. Haskell meter No. 105, wheel No. 1, and Price meter No. 22, were used. The meters were run at 0.6 depth and the lower floats at mid-depth. The discharge section is the same as used in 1904 and later years; it is in front of the town of Columbus, Ky. Observations made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission. Reduction made under direction of First Lieut. C. H. Knight, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 31	7.80	7.70	+1.1	81,480	89,995	33.5	37.0	49.0	2,433
Nov. 1	9.5	9.30	+1.6	83,140	87,763	34.2	36.1	50.0	2,433
2	11.0	10.50	+1.3	85,428	87,132	35.1	35.8	51.0	2,433
4, a. m.	11.1	11.20	+.1	86,857	86,857	35.7	35.7	50.0	2,433
4, p. m.	.....	11.20	.....	.....	.....	.....	.....	.....	.....
5, a. m.	10.9	10.98	−.2	86,618	87,153	35.6	35.8	51.0	2,433
5, p. m.	.....	10.93	.....	.....	.....	.....	.....	.....	.....
8	11.1	11.18	+.3	86,249	86,298	35.5	35.5	50.0	2,433
9, a. m.	11.0	11.14	−.1	86,822	86,968	35.7	35.7	51.0	2,433
9; p. m.	.....	11.12	.....	.....	.....	.....	.....	.....	.....
11	10.3	10.30	−.5	84,767	86,957	34.8	35.7	51.0	2,433
12, a. m.	9.75	9.75	−.6	84,513	88,011	34.7	36.2	50.0	2,433
12, p. m.	.....	9.65	.....	.....	.....	.....	.....	.....	.....
13, a. m.	9.10	9.16	−.6	83,043	88,006	34.1	36.2	50.0	2,433
13, p. m.	.....	9.14	.....	.....	.....	.....	.....	.....	.....
16	8.20	8.25	−.3	80,671	87,848	33.2	36.1	47.4	2,433
18, a. m.	7.6	7.66	−.3	79,162	87,775	32.5	36.1	48.0	2,433
18, p. m.	.....	7.64	.....	.....	.....	.....	.....	.....	.....
20	7.3	7.25	−.1	77,595	87,205	31.9	35.8	46.4	2,433
21	7.2	7.20	−.1	77,470	87,202	31.8	35.8	47.4	2,433
22	7.1	7.15	−.1	77,130	86,984	31.7	35.8	47.4	2,433

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Oct. 31	.....	1.89	153,855	Double floats	10	36	I. Light.
Nov. 1	−2,232	2.02	167,786	Meter	9	32	Calm.
2	− 631	2.05	174,831	....do	10	33	Do.
4, a. m.	− 275	2.10	182,331	....do	8	29	XI. Brisk.
4, p. m.	.....	2.13	184,776	....do	12	....	Do.
5, a. m.	+ 296	2.22	192,152	Double floats	11	41	Calm.
5, p. m.	.....	2.13	183,877	Meter	12	....	Do.
8	− 855	2.13	183,803	....do	11	30	
9, a. m.	+ 670	2.17	188,468	....do	13	47	XII. Light.
9, p. m.	.....	2.22	192,929	Double floats	13	....	Do.
11	− 11	2.14	181,428	Meter	12	43	X. Strong.
12, a. m.	+1,084	2.11	178,725	....do	12	38	XII. Light.
12, p. m.	.....	2.11	178,024	Double floats	13	....	X. Light.
13, a. m.	− 35	2.11	175,648	Meter	12	43	XII. Strong.
13, p. m.	.....	2.05	170,333	Double floats	13	....	XII. Light.
16	− 158	1.89	151,551	Meter	12	50	VII. Light to strong.
18, a. m.	− 73	1.88	148,714	....do	13	38	Calm.
18, p. m.	.....	1.86	147,400	Double floats	14	....	Do.
20	− 570	1.85	143,408	Meter	12	38	Do.
21	.....	1.88	145,328	....do	12	39	Do.
22	− 218	1.70	138,275	....do	13	38	VI. Light to strong.

Results of discharge observations, Mississippi River—Continued.

NEW MADRID, MO.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1888.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 1	15.2	125,600	21.3	30.0	5,905	3.46	435,000	Meter.
3	12.8	112,300	19.1	29.6	5,820	3.38	380,000	Do.
4	12.0	103,000	17.5	29.0	5,873	3.26	335,000	Do.
5	11.3	100,200	17.1	28.0	5,870	3.22	323,000	Do.
6	10.4	97,400	16.6	26.0	5,865	3.14	306,000	Do.
7	9.7	94,500	16.4	25.5	5,772	3.23	306,000	Do.
8	9.2	89,800	15.8	25.0	5,657	3.16	284,000	Do.
10	8.6	84,200	16.6	23.0	5,301	3.08	247,000	Do.
11	8.3	80,100	16.0	22.5	5,275	3.08	235,000	Do.
12	8.0	75,900	15.2	22.5	5,267	3.13	223,000	Do.
13	7.7	73,900	19.1	26.0	3,868	2.95	218,000	Do.
14	7.4	73,200	19.2	25.0	3,866	2.98	218,000	Do.
15	7.2	73,100	19.0	25.0	3,866	3.03	221,000	Do.
17	6.9	72,800	18.8	25.5	3,863	2.95	215,000	Do.
18	6.9	75,300	19.5	26.5	3,862	2.89	217,000	Do.
19	7.0	74,200	19.2	26.0	3,864	2.95	219,000	Do.
20	7.2	75,800	19.6	25.5	3,864	2.98	225,000	Do.
21	7.5	75,900	19.7	26.0	3,865	3.02	229,000	Do.
22	8.2	78,500	20.3	26.7	3,878	3.04	239,000	Do.
24	8.9	82,000	21.1	27.5	3,890	3.18	260,000	Do.
25	9.1	85,100	21.8	27.5	3,895	3.20	272,000	Do.
27	9.6	85,300	21.8	28.0	3,908	3.22	275,000	Do.
28	10.2	87,700	22.4	28.3	3,913	3.29	288,000	Do.
29	10.8	89,900	22.9	30.0	3,917	3.36	302,000	Do.
31	12.1	95,300	24.2	31.0	3,935	3.44	326,000	Do.
1889.[a]								
Jan. 1	12.2	97,400	24.7	32.1	3,938	3.45	336,000	Do.
2	12.1	97,200	24.7	32.0	3,936	3.42	332,000	Do.
3	11.9	96,700	24.6	31.5	3,934	3.36	324,000	Do.
4	11.4	93,300	23.8	30.5	3,926	3.32	309,000	Do.
5	11.0	92,000	23.4	29.5	3,924	3.30	304,000	Do.
7	11.2	91,900	23.5	29.5	3,922	3.34	307,000	Do.
8	11.6	93,600	23.9	30.0	3,926	3.38	316,000	Do.
10	13.4	99,800	25.3	32.0	3,949	3.56	355,000	Do.
11	15.0	105,000	26.5	32.5	3,965	3.65	383,000	Do.
12	17.0	111,300	28.0	34.0	3,979	3.99	444,000	Do.
14	19.8	124,400	30.7	38.0	4,007	4.50	559,000	Do.
15	20.3	128,800	32.1	38.7	4,010	4.48	576,000	Do.
17	21.0	130,200	32.4	40.0	4,015	4.58	595,000	Do.
18	21.6	133,200	33.1	40.0	4,023	4.54	605,000	Do.
19	22.2	170,000	28.5	37.0	5,951	3.81	646,000	Do.
21	24.1	177,100	29.7	37.5	5,955	3.91	692,000	Do.
22	24.5	178,300	30.0	38.0	5,959	3.94	702,000	Do.
23	24.2	175,900	29.5	37.0	5,955	3.93	693,000	Do.
24	23.4	173,800	29.2	38.0	5,952	3.85	670,000	Do.
25	22.2	168,800	28.4	37.4	5,942	3.82	645,000	Do.
26	20.9	159,100	27.0	35.0	5,936	3.72	591,000	Do.
28	18.8	147,000	24.8	33.0	5,923	3.62	533,000	Do.
29	18.6	145,300	24.5	32.3	5,923	3.56	519,000	Do.
30	19.1	145,900	24.6	33.5	5,925	3.62	529,000	Do.
31	19.9	150,300	25.3	33.5	5,930	3.70	555,000	Do.
Feb. 1	20.6	156,000	26.3	35.0	5,935	3.68	574,000	Do.
2	21.4	161,000	27.1	34.5	5,940	3.71	598,000	Do.
4	22.4	166,700	28.0	34.8	5,946	3.83	639,000	Do.
5	22.5	166,700	28.0	35.3	5,951	3.84	640,000	Do.
6	22.0	164,800	27.7	35.0	5,950	3.83	632,000	Do.
7	21.1	158,300	26.7	34.3	5,936	3.87	613,000	Do.
8	19.9	148,900	25.1	32.5	5,926	3.59	535,000	Do.
9	18.8	143,400	25.9	32.0	5,917	3.55	509,000	Do.
11	16.5	125,500	21.3	29.5	5,902	3.46	435,000	Do.
12	15.5	114,900	19.5	29.0	5,894	3.39	388,000	Do.
13	13.9	110,000	18.7	28.0	5,887	3.39	373,000	Do.
16	10.5	81,800	21.6	28.0	3,925	3.49	295,000	Do.
18	10.0	84,400	21.5	27.7	3,914	3.48	294,000	Do.
19	11.6	88,800	22.7	29.0	3,926	3.54	314,000	Do.
20	14.8	104,200	26.3	32.7	3,965	3.98	415,000	Do.
21	18.3	118,200	30.0	36.0	3,998	4.39	519,000	Do.
22	20.8	153,500	25.9	34.0	5,930	3.82	586,000	Do.

[a] The series of 1888–89 are printed in Report Chief of Engineers, 1890, p. 3150. Observations were made on two sections 1¼ miles apart. The upper one, called the low-water section, was used from Dec. 13 to Jan. 18, and from Feb. 14 to 21, inclusive. The high-water section was 3½ miles below New Madrid. The gauge readings tabulated are as observed on the M. R. C. N. Madrid gauge at Morrison Landing. The zero of this gauge is 275.80 feet above the Cairo datum plane.

Results of discharge observations, Mississippi River—Continued.

NEW MADRID, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1889.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 24	23.8	170,600	29.0	36.0	5,956	4.00	682,000	Meter.
25	25.1	178,800	30.0	38.0	5,965	4.03	721,000	Do.
26	25.6	185,900	31.2	39.0	5,966	4.06	754,000	Do.
27	25.6	187,600	31.5	39.0	5,967	4.08	761,000	Do.
28	25.4	187,500	31.4	39.5	5,967	4.00	750,000	Do.
Mar. 1	25.0	183,700	30.8	38.8	5,962	4.01	736,000	Do.
2	24.4	179,000	30.0	38.0	5,958	3.94	705,000	Do.
4	22.9	168,000	28.3	38.0	5,948	3.86	648,000	Do.
5	22.7	167,200	28.1	37.0	5,947	3.83	640,000	Do.
6	22.7	166,800	28.0	37.5	5,947	3.84	640,000	Do.
7	22.6	167,400	28.2	36.7	5,947	3.82	639,000	Do.
8	22.4	166,000	27.9	38.0	5,944	3.77	625,000	Do.
9	21.7	163,400	27.5	37.5	5,934	3.75	613,000	Do.
11	20.2	155,000	26.2	35.7	5,927	3.65	566,000	Do.
12	19.6	149,500	25.2	35.3	5,928	3.64	544,000	Do.
13	19.1	145,800	24.7	34.7	5,918	3.63	529,000	Do.
14	18.8	143,000	24.3	34.0	5,915	3.61	519,000	Do.
15	18.4	141,600	24.0	33.7	5,914	3.56	504,000	Do.
16	18.0	139,000	23.6	32.7	5,912	3.55	493,000	Do.
18	17.2	131,600	22.3	32.0	5,905	3.53	464,000	Do.
19	16.7	129,900	22.0	31.8	5,904	3.60	468,000	Do.
20	16.5	127,400	21.6	31.0	5,902	3.43	437,000	Do.
21	16.2	125,400	21.3	31.5	5,900	3.40	426,000	Do.
22	16.2	125,100	21.2	30.5	5,898	3.39	424,000	Do.
23	16.8	128,300	21.7	31.0	5,902	3.46	443,000	Do.
25	19.0	141,300	23.9	33.0	5,910	3.60	508,000	Do.
26	19.4	144,300	24.4	33.7	5,925	3.69	532,000	Do.
28	19.0	143,500	24.2	33.3	5,925	3.67	527,000	Do.
29	18.6	141,100	23.8	33.5	5,920	3.67	518,000	Do.
30	18.0	137,800	23.3	32.0	5,912	3.62	498,000	Do.
Apr. 1	17.3	131,300	22.2	31.5	5,900	3.57	469,000	Do.
2	16.8	128,500	21.7	31.0	5,901	3.44	442,000	Do.
3	16.3	126,100	21.4	30.3	5,896	3.46	437,000	Do.
4	16.1	123,200	20.9	30.3	5,896	3.42	421,000	Do.
5	16.1	123,100	21.4	30.3	5,896	3.42	422,000	Do.
6	16.2	123,200	20.9	30.3	5,896	3.44	424,000	Do.
8	16.2	123,900	21.0	30.5	5,897	3.44	426,000	Do.
9	15.9	122,900	20.9	30.5	5,894	3.42	420,000	Do.
10	15.5	120,400	20.4	30.3	5,892	3.38	407,000	Do.
11	15.1	118,700	20.2	29.7	5,890	3.38	402,000	Do.
12	14.8	116,700	19.8	29.7	5,889	3.35	391,000	Do.
13	14.6	115,200	19.6	29.7	5,887	3.30	380,000	Do.
15	14.1	112,100	19.1	29.0	5,883	3.30	370,000	Do.
16	13.8	109,700	18.7	28.0	5,880	3.29	362,000	Do.
17	13.6	107,800	18.4	27.3	5,880	3.28	353,000	Do.
18	14.2	108,800	18.5	28.0	5,883	3.33	362,000	Do.
19	14.9	113,200	19.2	28.8	5,892	3.36	381,000	Do.
20	15.6	117,100	19.9	29.7	5,899	3.42	402,000	Do.
22	16.6	121,700	20.6	31.0	5,905	3.50	426,000	Do.
23	17.0	125,000	21.2	31.0	5,908	3.51	439,000	Do.
24	17.6	128,400	21.8	32.0	5,912	3.59	461,000	Do.
25	18.3	132,700	22.4	33.2	5,919	3.65	485,000	Do.
26	18.6	136,600	23.1	34.0	5,924	3.67	502,000	Do.
27	18.4	135,100	22.8	33.5	5,921	3.64	492,000	Do.
29	16.0	122,700	20.8	31.5	5,899	3.45	423,000	Do.
30	14.8	115,400	19.6	29.0	5,890	3.36	388,000	Do.
May 1	13.7	108,800	18.5	27.8	5,880	3.29	358,000	Do.
2	12.7	102,400	17.4	26.3	5,876	3.26	334,000	Do.
1890.[a]								
Mar. 25	36.6	239,700	39.5	51.8	6,066	5.55	1,320,000	Do.
Apr. 8	37.7	246,500	40.3	52.0	6,114	.....	.....	Do.
10	36.9	240,900	39.5	53.0	6,106	5.29	1,274,000	Do.
11	36.2	236,000	38.7	52.5	6,091	5.23	1,235,000	Do.
12	35.6	233,100	38.3	53.0	6,085	5.21	1,214,000	Do.
14	34.2	226,200	37.3	52.0	6,058	4.75	1,074,000	Do.

[a] The 1890 discharges are printed in the Report Chief of Engineers, 1890, p. 3157. The discharges of 1893 will appear in Report Chief of Engineers for 1894. The section of 1890 was at same place as the high-water section of 1888-89 and about 3½ miles below New Madrid, Mo. The section of 1893 was also at same place, except that the Kentucky end of section was moved upstream about 200 feet. The gauge readings for 1890 are as observed on the M. R. C. gauge at Morrison Landing, whose zero is 275.80 feet above the Cairo datum plane. The readings tabulated for 1893 are as observed on the M. R. C. gauge at New Madrid, at mouth of St. Johns Bayou. This gauge, which was established in November, 1892, is about 1.3 miles below the gauge at Morrison, and its zero is 275.72 feet above the Cairo datum plane. Morrison Landing gauge was discontinued Oct. 11, 1893.

Results of discharge observations, Mississippi River—Continued.

NEW MADRID, MO.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1893.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 20	31.0	214,600	34.5	53.0	6,215	5.45	1,171,000	Meter.
21	31.8	222,000	35.7	54.0	6,216	5.05	1,122,000	Do.
22	32.7	224,000	36.0	54.0	6,218	5.29	1,184,000	Do.
23	33.1	226,300	36.3	54.5	6,236	5.19	1,174,000	Do.
24	33.6	231,700	37.1	55.0	6,241	5.38	1,246,000	Do.
24	.....	.....	.....	.....	.....	5.06	1,172,000	Double floats.
25	34.0	239,100	38.3	55.0	6,246	5.23	1,251,000	Meter.
25	.....	.....	.....	.....	.....	5.23	1,250,000	Double floats.
27	34.6	233,500	37.4	57.0	6,248	5.46	1,275,000	Meter.
28	34.7	239,300	38.3	55.8	6,248	5.40	1,293,000	Do.
28	.....	.....	.....	.....	.....	5.11	1,222,000	Double floats.
Mar. 1	34.9	242,500	38.8	58.0	6,251	6.54	[a] 1,585,000	Meter.
1	.....	.....	.....	.....	.....	5.26	1,276,000	Double floats.
2	34.9	241,900	38.8	55.0	6,254	5.28	1,283,000	Meter.
2	.....	.....	.....	.....	.....	4.86	1,180,000	Double floats.
3	34.7	[b] 242,500	38.8	.....	6,254	5.13	1,244,000	Meter.
5	33.0	233,600	37.4	53.5	6,248	5.24	1,223,000	Do.
6	30.9	219,000	35.1	52.0	6,239	4.88	1,070,000	Do.
7	28.5	202,800	32.6	49.0	6,228	4.79	971,000	Do.
7	.....	.....	.....	.....	.....	4.48	908,000	Double floats.
May 4	36.0	247,500	39.3	49.5	6,296	5.14	1,273,000	Meter.
4	.....	.....	.....	.....	.....	5.11	1,264,000	Double floats.
5	36.5	253,000	40.3	52.0	6,299	5.41	1,374,000	Meter.
6	37.0	252,800	40.1	50.0	6,302	5.69	1,438,000	Do.
8	37.9	268,500	42.6	54.0	6,305	5.72	1,537,000	Do.
8	.....	.....	.....	.....	.....	5.41	1,454,000	Double floats.
9	38.1	262,800	41.7	51.8	6,306	5.64	1,482,000	Meter.
9	.....	.....	.....	.....	.....	5.52	1,452,000	Double floats.
10	38.1	264,400	41.9	52.0	6,307	5.53	1,462,000	Meter.
10	.....	.....	.....	.....	.....	5.49	1,452,000	Double floats.
11	38.1	258,800	41.0	54.4	6,306	5.89	1,525,000	Meter.
12	38.0	260,000	41.2	54.8	6,306	5.39	1,400,000	Do.
12	.....	.....	.....	.....	.....	5.62	1,461,000	Double floats.
13	38.0	263,600	41.8	54.4	6,307	5.66	1,493,000	Meter.
13	.....	.....	.....	.....	.....	5.57	1,468,000	Double floats.
15	37.9	260,100	41.2	54.4	6,308	5.84	1,518,000	Meter.
15	.....	.....	.....	.....	.....	5.61	1,459,000	Double floats.
16	37.8	257,000	40.7	54.5	6,308	5.75	1,478,000	Meter.
17	37.5	252,400	40.0	53.6	6,307	5.72	1,444,000	Do.
17	.....	.....	.....	.....	.....	5.45	1,375,000	Double floats.
18	37.1	251,100	39.8	53.0	6,304	5.48	1,376,000	Meter.
19	36.5	246,700	39.1	54.0	6,304	5.41	1,336,000	Do.
20	35.9	237,000	37.6	52.7	6,300	5.28	1,252,000	Do.

[70.3 miles below Cairo.]

[Observations and reduction under direction of Capt. M. M. Patrick, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers, 1900, p. 4758, and 1901, supplement, p. 138. Haskell meter used. New Madrid gauge, whose zero is 275.72 feet above the Cairo datum plane.]

1899.								
Oct. 18, a. m.	2.80	53,200	25.2	32.0	2,115	1.69	90,000	Meter.
18, p. m.	2.82	53,600	25.3	31.5	2,115	1.69	91,000	Do.
30, a. m.	2.65	53,500	25.3	33.0	2,117	1.66	89,000	Do.
30, p. m.	2.66	54,100	25.5	32.0	2,117	1.65	89,000	Do.
Dec. 8, a. m.	5.28	58,900	27.7	34.5	2,131	2.20	130,000	Rod floats.
8, p. m.	5.25	58,000	27.7	.....	2,131	2.17	128,000	Meter.
1900.								
Nov. 13, a. m.	10.6	71,300	28.8	44.5	2,470	3.12	222,000	Do.
13, p. m.	10.6	71,400	28.9	43.5	2,470	2.98	213,000	Do.
14, a. m.	10.5	70,300	28.5	43.5	2,470	3.02	212,000	Do.
14, p. m.	10.4	69,900	28.3	42.5	2,470	2.98	209,000	Do.
15, a. m.	10.3	69,900	28.4	44.0	2,463	3.07	214,000	Do.
15, p. m.	10.2	70,000	28.4	43.5	2,463	3.01	211,000	Do.
16, a. m.	10.1	69,400	28.2	43.0	2,461	2.97	206,000	Do.
16, p. m.	10.1	69,500	28.2	42.5	2,461	2.98	208,000	Do.
17, a. m.	9.9	69,300	28.2	42.5	2,459	2.84	197,000	Do.
17, p. m.	9.8	69,300	28.2	42.5	2,458	2.75	191,000	Do.

[a] Observer considers velocities too high, and says to reject this discharge.
[b] Area interpolated from 2d and 5th.

Results of discharge observations, Mississippi River—Continued.

POINT PLEASANT, MO.

[This series of discharges is printed in Report Chief of Engineers, 1887, page 2815. The discharge section was located about 4 miles below Point Pleasant, Mo., and about 13 miles below New Madrid, Mo. The gauge whose readings are tabulated was called the section gauge, its zero was 267.28 feet above the Cairo datum plane. The readings on this gauge below the 8-foot stage do not differ more than 0.4 feet from the readings on the New Madrid gauge; but at higher stages the readings indicate large variation in slope between the two places.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1884.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 14	13.0	105,600	23.0	35.0	4,610	3.68	392,000	Meter.
15	13.3	101,600	22.0	35.0	4,625	3.49	354,000	Do.
20	13.0	96,900	21.0	36.0	4,623	.....	.....	Do.
21	12.7	96,800	21.0	33.5	4,621	.....	.....	Do.
22	12.3	96,800	21.0	34.0	4,618	3.62	350,000	Do.
23	12.0	95,400	20.7	33.5	4,617	3.69	352,000	Do.
24	11.6	101,300	21.9	34.0	4,615	3.41	346,000	Do.
25	11.4	101,000	21.9	34.0	4,614	3.41	344,000	Do.
27	11.5	104,900	22.7	35.0	4,622	3.44	361,000	Do.
29	11.9	93,600	20.2	34.8	4,623	3.70	346,000	Do.
30	11.8	103,200	22.3	37.2	4,622	3.42	353,000	Do.
31	11.6	91,900	19.9	32.2	4,622	3.63	334,000	Do.
Nov. 3	11.0	88,700	19.2	32.4	4,615	3.67	325,000	Do.
5	10.1	83,800	18.2	32.9	4,608	3.51	295,000	Do.
10	8.3	75,200	16.4	30.6	4,596	3.33	250,000	Do.
11	7.9	73,100	15.9	30.3	4,593	3.15	230,000	Do.
14	7.0	69,100	15.1	28.4	4,588	3.38	234,000	Do.
17	6.5	67,200	14.6	28.1	4,586	3.26	219,000	Do.
18	6.5	66,900	14.6	28.5	4,586	3.19	214,000	Do.
19	6.5	66,000	14.4	30.5	4,586	3.16	209,000	Do.
24	5.8	62,600	13.7	28.0	4,583	3.18	199,000	Do.
25	5.7	63,000	13.7	27.5	4,580	3.19	201,000	Do.
26	5.7	63,200	13.8	27.5	4,580	3.16	199,000	Do.
28	7.2	69,200	15.1	29.0	4,595	3.32	230,000	Do.
29	7.6	71,000	15.4	29.5	4,598	3.30	235,000	Do.
Dec. 1	7.6	70,800	15.4	29.5	4,598	3.33	236,000	Do.
2	7.5	70,800	15.4	29.5	4,600	3.25	230,000	Do.
3	7.2	68,900	15.0	29.0	4,603	3.34	230,000	Do.
4	6.7	66,600	14.5	29.0	4,598	3.27	218,000	Do.
5	6.1	63,500	13.8	28.0	4,594	3.24	205,000	Do.
8	4.6	56,100	12.3	26.5	4,575	3.10	174,000	Do.
9	4.2	53,100	12.6	25.5	4,225	3.00	104,000	Do.
10	3.9	52,600	12.6	25.0	4,184	3.14	166,000	Do.
11	4.2	53,200	12.6	25.5	4,225	3.22	171,000	Do.
12	5.0	57,300	12.5	26.5	4,580	3.22	185,000	Do.
13	6.3	63,900	13.9	27.0	4,598	3.30	211,000	Do.
15	8.0	71,900	15.6	29.0	4,613	3.29	237,000	Do.
16	9.0	78,100	16.9	30.0	4,619	3.50	273,000	Do.
31	17.4	114,200	24.5	39.0	4,661	4.40	503,000	Do.
1885.								
Jan. 1	20.0	126,600	27.1	40.0	4,675	4.84	613,000	Do.
7	23.3	143,900	30.7	42.0	4,689	4.95	712,000	Do.
8	23.6	146,000	31.1	43.0	4,689	4.87	711,000	Do.
9	24.0	147,000	31.5	43.0	4,689	5.09	751,000	Do.
10	25.0	153,300	32.7	44.0	4,691	5.00	767,000	Do.
13	27.6	157,400	33.6	46.0	4,698	5.17	816,000	Do.
14	27.8	162,100	34.5	46.5	4,698	5.19	842,000	Do.
Feb. 2	21.3	121,400	26.0	38.0	4,663	4.62	561,000	Do.
3	20.0	115,200	24.7	38.0	4,665	4.42	509,000	Do.
7	17.8	104,700	22.4	35.0	4,663	.....	.....	Do.
9	18.5	106,800	22.0	36.0	4,672	4.54	485,000	Do.
10	19.0	110,100	23.5	36.0	4,689	4.51	497,000	Do.
11	19.3	114,700	24.4	36.0	4,689	4.45	510,000	Do.
Mar. 2	11.4	85,000	18.4	20.0	4,623	3.68	313,000	Do.
3	11.8	86,000	18.6	27.0	4,625	3.71	319,000	Do.
4	12.6	90,100	19.5	28.0	4,630	3.87	349,000	Do.
7	15.3	104,100	22.4	30.0	4,653	4.06	423,000	Do.
9	18.7	119,600	25.6	35.5	4,669	4.26	510,000	Do.
10	20.6	127,700	27.3	35.5	4,677	4.22	539,000	Do.
11	22.0	140,400	30.0	40.0	4,687	4.36	612,000	Do.
13	22.8	146,500	31.2	42.0	4,692	4.46	653,000	Do.
14	23.3	140,200	31.8	42.0	4,692	4.37	652,000	Do.
19	26.6	166,300	35.4	46.0	4,699	4.88	812,000	Do.
20	26.3	163,300	34.7	43.0	4,699	4.77	770,000	Do.
21	26.1	166,100	35.4	43.0	4,699	4.70	795,000	Do.
23	25.5	160,100	34.1	42.0	4,699	4.52	723,000	Do.
24	25.0	157,500	33.5	42.0	4,700	4.42	696,000	Do.
28	21.6	137,900	29.5	38.0	4,683	4.38	603,000	Do.
30	19.1	126,200	27.0	36.0	4,680	4.06	512,000	Do.
31	18.3	119,000	25.5	34.5	4,669	4.04	481,000	Do.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH.—ASHPORT BEND.

[The discharge section is located in Ashport Bend about 1,000 feet below Range 23 T, Survey of Plum Point Reach, and about 153 miles below Cairo. Observations and reductions under direction of M. R. C. first district officer by Assistant B. B. Gordon. The gauge readings given in table are those of M. R. C. gauge at Fulton, whose zero is 228.55 feet above the Cairo datum. The Amelia gauge read −2'.1 on the 8th and 10th. There were 11 velocity stations and 24 soundings on the 8th, and 9 velocity stations and 16 soundings on the 10th. Floats were run and timed between ranges 200 feet apart. The lower float was at about 0.6 depth.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1894.	*Feet*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Nov. 8.....	1.8	38,000	35.0	66.0	1,059	2.17	83,000	Double floats.
10.....	1.0	38,400	36.6	66.0	1,051	2.14	82,000	Do.

PLUM POINT REACH—BULLERTON, ARK.

[All the gauge readings are those of the Fulton standard gauge, whose zero is 228.55 feet above the Cairo datum plane.]

1883.[a]								
Sept. 5.....	[b] 8.4	24,700	25.5	.....	.....	5.10	126,000	Double floats.
5.....	[c] 8.4	18,700	9.2	.....	.....	2.80	52,000	Do.
5.....	[d] 8.4	10,400	7.7	.....	.....	2.50	26,000	Do.
Total.....	.....	.....	.....	.....	.....	.....	204,000	
Oct. 26.....	[b] 8.4	24,200	23.5	36.0	1,029	4.38	106,000	Do.
2[illegible].....	[c] 8.4	18,800	8.7	22.0	2,165	3.60	68,000	Do.
2.....	[d] 8.4	12,000	8.4	10.0	1,419	3.33	40,000	Do.
Total.....	.....	55,100	11.0	36.0	4,613	3.89	214,000	
Dec. 8.....	[b] 18.0	51,500	21.0	37.0	2,457	4.19	216,000	Do.
8.....	[c] 18.0	39,600	36.5	48.0	1,087	4.43	175,000	Do.
8.....	[d] 18.0	.....	.....	.....	.....	.....	113,000	Do.
8.....	[e] 18.0	8,400	12.7	23.5	663	1.19	10,000	Do.
Total.....	.....	.....	.....	.....	.....	.....	514,000	
1884.[f]								
Sept. 15.....	[b] 7.2	20,500	.....	.....	.....	1.65	34,000	Meter.
16.....	[g] 7.2	23,000	.....	.....	.....	1.67	38,000	Do.
15.....	[h] 7.2	13,300	.....	.....	.....	3.35	45,000	Do.
15.....	[i] 7.2	13,600	.....	.....	.....	1.92	26,000	Do.
Total.....	.....	.....	.....	.....	.....	.....	143,000	
1890.[j]								
Mar. 7.....	[k] 32.8	144,400	.....	67.0	2,000	5.28	762,000	Do.
7.....	[l] 32.8	44,000	.....	66.0	1,920	3.24	142,000	Do.
7.....	[m] 32.8	33,300	.....	28.0	1,345	3.39	113,000	Do.
Total.....	.....	221,700	.....	.....	6,165	.....	1,018,000	
Mar. 9.....	[k] 33.6	148,700	.....	67.0	2,000	5.49	816,000	Do.
9.....	[l] 33.6	42,300	.....	62.0	1,920	3.59	152,000	Do.
9.....	[m] 33.6	34,600	.....	29.0	1,345	3.16	109,000	Do.
Total.....	.....	225,600	.....	.....	6,165	.....	1,077,000	

[a] Observations by M. R. C. first district officer. Those of Oct. 26 and part of Dec. 8 reduced in secretary's office. Part of tabulation in Report Chief of Engineers 1884, p. 2791, and part in Report Chief of Engineers 1889, p. 2649.
[b] Bullerton Chute.
[c] Middle channel.
[d] Tennessee Chute.
[e] Osceola Chute.
[f] Observations by M. R. C. first district officer. Tabulation, Report Chief of Engineers 1885, p. 2769.
[g] Channel outside of Bullerton.
[h] Middle Bar channel.
[i] Yankee Bar channel.
[j] M. R. C. first district officer. Tabulation, Report Chief of Engineers 1890, p. 3218.
[k] Main river.
[l] Elmot Chute.
[m] Island No. 30 Chute.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH—BULLERTON, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1890.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Mar. 12	a 34.2	153,600	.....	68.0	2,900	5.54	850,000	Meter.
12	b 34.2	45,300	.....	68.0	1,920	3.57	162,000	Do.
12	c 34.2	34,500	.....	30.0	1,345	3.39	117,000	Do.
Total	.....	233,400	.....	.....	6,165	.....	1,129,000	
Mar. 15	a 34.7	152,400	.....	64.0	2,900	5.76	878,000	Do.
15	b 34.7	49,600	.....	67.0	1,920	3.52	175,000	Do.
15	c 34.7	36,800	.....	31.0	1,345	3.19	117,000	Do.
Total	.....	238,900	.....	.....	6,165	.....	1,170,000	
1891.[d]								
Jan. 6	a 20.1	102,200	37.4	47.0	2,732	5.43	555,000	Do.
6	b 20.1	.....	.....	.....	.....	.....	.....	
6	c 20.1	11,000	11.6	15.0	947	3.41	38,000	Do.
7	a 20.6	103,900	38.0	47.0	2,733	5.41	562,000	Do.
7	b 20.6	19,000	13.6	35.0	1,398	1.89	36,000	Do.
7	c 20.6	11,700	12.3	15.0	951	3.57	42,000	Do.
Total	.....	134,600	.....	.....	5,082	.....	640,000	
Jan. 26	a 16.5	88,800	32.9	41.0	2,696	5.08	451,000	Do.
27	b 15.9	15,000	17.0	33.0	880	1.41	21,000	Do.
26	c 16.5	7,000	7.5	12.0	929	3.28	23,000	Do.
Total	.....	110,700	.....	.....	4,505	.....	495,000	
Jan. 28	a 15.8	80,400	32.1	40.0	2,605	4.66	403,000	Do.
28	b 15.8	14,700	16.7	32.5	880	1.16	17,000	Do.
28	c 15.8	6,100	6.5	12.0	928	3.26	20,000	Do.
Total	.....	107,200	.....	.....	4,503	.....	439,000	
Sept. 19	e 7.2	63,600	26.6	34.0	2,386	2.43	155,000	Do.
21	e 6.7	61,800	25.9	34.0	2,385	2.22	137,000	Do.
22	e 6.5	62,400	26.2	32.0	3,385	2.41	150,000	Do.
20	e 5.9	62,700	26.3	32.0	2,387	2.19	137,000	Do.
Nov. 5	e 2.9	51,700	21.8	29.0	2,376	1.58	82,000	Do.
6	e 2.8	52,400	22.1	30.0	2,376	1.57	82,000	Do.
10	e 2.8	53,200	22.4	28.5	2,377	1.55	82,000	Do.
11	e 2.8	52,500	22.1	28.0	2,377	1.51	79,000	Do.

PLUM POINT REACH—FULTON, TENN.

Observations and reductions by M. R. C. secretary's office. Tabulation, Report M. R. C., 1881, p. 98. Report on observations, Report M. R. C., 1881, p. 74. The gauge readings are those of the Fulton M. R. C. gauge, whose zero is 228.55 feet above the Cairo datum plane.]

1879.								
Nov. 29	8.8	84,700	34.6	43.5	2,456	3.11	264,000	Double floats.
Dec. 1	9.0	83,400	34.0	42.0	2,454	3.08	257,000	Do.
3	9.8	82,100	33.3	42.5	2,469	3.31	272,000	Do.
4	10.0	86,700	35.2	43.0	2,465	3.37	293,000	Do.
6	10.3	87,500	35.4	43.0	2,475	3.42	300,000	Do.
8	11.0	88,900	35.4	44.5	2,485	3.59	320,000	Do.
10	13.3	94,900	37.9	47.0	2,501	4.15	393,000	Do.
12	15.0	99,600	39.6	48.5	2,514	4.70	478,000	Do.
16	21.6	117,900	46.1	56.0	2,556	5.70	672,000	Do.
18	22.8	120,400	47.0	58.0	2,561	5.93	714,000	Do.
19	23.0	121,000	47.2	57.5	2,563	5.96	721,000	Do.
22	22.4	117,900	46.0	54.5	2,562	5.76	678,000	Do.
26	20.7	114,100	44.7	54.0	2,554	5.33	609,000	Do.
28	23.3	122,100	47.8	56.5	2,563	5.83	713,000	Do.
31	27.3	128,800	49.1	61.5	2,583	6.43	828,000	Do.

a Main river.
b Elmot Chute.
c Island No. 30 Chute.
d Observations by M. R. C. first district officer. Reduction in secretary's office. Tabulation, Report Chief of Engineers 1892, p. 3128.
e Elmot Landing. This is total discharge of river.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH—FULTON, TENN.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1880.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Jan. 3	28.8	138,200	53.7	65.0	2,578	6.90	954,000	Double floats.
8	27.7	133,200	51.7	68.0	2,576	6.34	844,000	Do.
9	27.4	132,000	51.5	67.0	2,578	6.10	810,000	Do.
10	27.9	131,900	51.1	64.0	2,582	6.51	859,000	Do.
13	30.2	139,500	54.0	66.0	2,585	6.99	976,000	Do.
15	31.2	141,000	54.6	67.0	2,592	7.37	1,044,000	Do.
17	32.0	142,100	54.8	67.0	2,595	7.49	1,066,000	Do.
19	32.2	145,100	55.9	67.0	2,595	7.23	1,049,000	Do.
21	32.0	144,000	55.4	69.0	2,600	7.13	1,027,000	Do.
23	31.1	138,900	53.6	68.0	2,592	7.14	992,000	Do.
26	27.9	128,700	50.1	63.0	2,569	6.32	807,000	Do.
28	25.4	125,400	48.9	60.0	2,563	5.95	746,000	Do.
31	21.3	114,800	45.0	56.5	2,552	4.98	572,000	Do.
Feb. 3	18.2	106,300	41.9	53.0	2,536	4.59	489,000	Do.
5	16.9	102,000	40.7	50.0	2,522	4.41	453,000	Do.
7	15.5	96,000	38.4	50.0	2,514	4.11	397,000	Do.
9	15.1	97,900	39.1	49.5	2,510	4.08	409,000	Do.
12	14.1	93,700	37.4	48.0	2,506	3.95	370,000	Do.
14	15.2	97,000	38.6	50.0	2,513	4.07	395,000	Do.
16	21.6	114,300	44.8	56.5	2,552	5.50	629,000	Do.
18	26.9	127,400	49.6	62.0	2,575	6.73	858,000	Do.
20	29.1	134,000	51.9	64.0	2,581	7.09	951,000	Do.
23	31.4	139,800	53.5	67.0	2,595	7.33	1,025,000	Do.
25	32.3	138,600	53.1	65.0	2,599	7.50	1,035,000	Do.
Mar. 1	32.9	136,300	52.4	69.0	2,599	7.60	1,037,000	Do.
3	32.8	139,800	53.8	69.0	2,597	7.58	1,060,000	Do.
5	32.7	141,200	54.3	69.0	2,600	7.39	1,044,000	Do.
8	32.3	135,300	52.7	68.0	2,599	7.34	994,000	Do.
10	32.1	138,000	53.5	69.0	2,598	7.47	1,038,000	Do.
12	32.4	136,400	52.4	68.0	2,600	7.56	1,031,000	Do.
16	33.2	137,500	52.9	69.0	2,600	7.57	1,041,000	Do.
18	33.5	140,000	53.7	70.0	2,608	7.91	1,108,000	Do.
20	33.8	142,265	54.5	70.0	2,610	7.50	1,068,000	Do.
22	34.0	142,400	54.6	70.0	2,607	7.41	1,054,000	Do.
24	34.1	144,300	55.2	70.0	2,612	7.75	1,117,000	Do.
26	34.1	143,500	54.9	69.0	2,612	7.45	1,070,000	Do.
29	34.0	140,500	53.7	68.0	2,615	7.74	1,088,000	Do.
31	33.6	141,200	55.2	68.0	2,604	7.55	1,089,000	Do.
Apr. 2	32.5	140,300	54.0	68.0	2,597	7.13	999,000	Do.
3	32.9	138,400	53.4	66.0	2,595	6.87	951,000	Do.
5	29.7	132,000	51.3	64.0	2,584	6.41	850,000	Do.
7	28.0	128,500	50.0	61.0	2,574	6.46	830,000	Do.
9	27.4	123,200	47.4	62.0	2,598	6.31	777,000	Do.
11	27.1	125,500	48.2	61.0	2,602	6.42	806,000	Do.
13	26.6	124,000	47.9	62.5	2,603	6.01	754,000	Do.
15	26.2	124,400	47.8	61.0	2,601	6.17	767,000	Do.
17	24.6	120,000	46.2	60.0	2,595	5.67	680,000	Do.
19	24.2	118,900	45.1	58.5	2,592	5.56	661,000	Do.
21	24.5	121,100	46.6	59.0	2,590	5.78	700,000	Do.
23	25.2	121,100	46.7	60.5	2,603	5.93	722,000	Do.
24	25.4	122,300	47.4	59.5	2,599	5.96	729,000	Do.
27	24.0	119,900	46.1	59.0	2,598	5.84	701,000	Do.
29	23.9	119,900	46.2	60.0	2,596	5.56	667,000	Do.
May 1	24.9	121,200	46.7	59.0	2,599	6.08	737,000	Do.
3	27.1	128,300	49.2	62.5	2,610	6.31	809,000	Do.
4	27.8	129,700	49.7	61.5	2,608	6.56	851,000	Do.
6	28.6	132,300	50.6	64.0	2,611	6.63	877,000	Do.
8	29.0	133,500	51.0	64.0	2,618	6.70	895,000	Do.
10	28.6	132,700	50.7	63.0	2,618	6.57	872,000	Do.
11	28.0	131,400	50.2	62.5	2,616	6.26	823,000	Do.
12	27.0	130,700	50.0	62.5	2,612	6.13	801,000	Do.
13	25.7	128,100	49.2	63.0	2,606	5.89	755,000	Do.
14	24.5	124,500	47.8	60.0	2,606	5.74	714,000	Do.
15	23.2	119,300	45.9	57.0	2,600	5.31	633,000	Do.
17	20.6	111,300	43.2	55.0	2,578	4.78	533,000	Do.
18	19.4	110,100	42.6	55.0	2,586	4.53	499,000	Do.
19	18.3	106,400	41.4	51.5	2,573	4.31	462,000	Do.
20	17.3	102,600	40.0	52.5	2,566	4.10	421,000	Do.
21	16.7	101,900	39.8	50.5	2,558	4.13	421,000	Do.
23	16.1	99,900	39.1	50.0	2,556	3.90	389,000	Do.
24	15.8	98,800	38.6	48.0	2,557	3.95	390,000	Do.
25	15.7	99,100	38.8	49.0	2,557	3.88	385,000	Do.
26	15.6	98,000	38.6	48.5	2,556	3.84	378,000	Do.
27	15.3	98,200	38.4	48.5	2,555	3.76	369,000	Do.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH—FULTON, TENN.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1880.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
May 28	15.2	96,500	37.8	49.0	2,554	3.83	369,000	Double floats.
29	14.8	96,300	37.7	48.5	2,553	3.65	351,000	Do.
31	14.8	95,900	37.6	49.5	2,553	3.77	362,000	Do.
June 1	15.3	97,300	38.9	48.5	2,553	3.90	380,000	Do.
2	16.0	99,000	38.6	50.5	2,565	4.03	399,000	Do.
3	16.8	101,500	39.6	50.0	2,566	4.33	439,000	Do.
4	17.4	102,800	40.0	51.5	2,571	4.39	451,000	Do.
5	18.0	106,200	41.2	54.0	2,579	4.35	462,000	Do.
7	18.4	107,400	41.6	52.5	2,584	4.52	485,000	Do.
8	18.4	108,400	42.0	52.5	2,584	4.66	504,000	Do.
9	18.6	107,500	41.6	54.0	2,584	4.58	492,000	Do.
10	18.5	107,300	41.1	53.0	2,584	4.53	487,000	Do.
11	18.3	106,100	41.1	52.5	2,582	4.49	476,000	Do.
12	17.8	103,900	40.3	51.0	2,575	4.37	455,000	Do.
14	17.4	101,300	40.5	51.5	2,575	4.31	452,000	Do.
15	17.4	103,300	40.1	52.0	2,575	4.36	450,000	Do.
16	17.1	102,400	39.8	51.5	2,572	4.22	432,000	Do.
17	16.7	103,000	40.0	50.5	2,567	4.22	437,000	Do.
18	16.0	100,800	39.3	49.5	2,563	4.01	407,000	Do.
19	15.8	98,100	38.3	49.0	2,561	4.01	397,000	Do.
21	15.5	98,200	38.3	50.0	2,561	4.08	401,000	Do.
22	16.3	102,200	37.8	50.0	2,568	4.19	428,000	Do.
23	16.6	102,000	40.1	51.0	2,569	4.22	435,000	Do.
24	17.2	104,400	40.5	50.5	2,578	4.35	454,000	Do.
25	18.2	106,400	41.2	51.5	2,584	4.47	475,000	Do.
26	18.7	106,000	41.3	52.0	2,589	4.74	507,000	Do.
28	19.7	111,100	42.8	54.0	2,593	4.86	540,000	Do.
29	20.2	111,700	43.4	55.0	2,594	4.93	550,000	Do.
July 1	20.5	111,900	43.2	53.0	2,594	4.96	555,000	Do.
2	20.3	111,200	42.9	54.0	2,592	4.86	541,000	Do.
3	20.2	110,400	42.6	52.5	2,593	5.02	555,000	Do.
5	21.3	113,700	43.7	53.0	2,600	5.19	590,000	Do.
6	23.0	118,000	45.3	56.0	2,604	5.76	679,000	Do.
7	24.0	123,600	47.4	56.5	2,606	5.88	726,000	Do.
8	24.0	123,800	47.4	56.5	2,611	6.04	748,000	Do.
9	25.0	127,300	48.7	60.5	2,613	6.33	805,000	Do.
10	26.0	132,800	50.7	60.5	2,617	6.23	828,000	Do.
12	26.1	126,100	48.2	59.5	2,617	6.29	793,000	Do.
13	25.7	121,700	46.5	56.5	2,616	6.17	752,000	Do.
14	25.2	120,100	45.9	56.0	2,611	5.96	715,000	Do.
15	24.7	118,800	45.4	57.0	2,615	5.98	711,000	Do.
16	23.9	118,000	45.3	56.0	2,607	5.64	666,000	Do.
17	23.3	115,600	44.4	56.0	2,602	5.51	637,000	Do.
19	21.8	113,600	43.8	54.0	2,597	5.18	589,000	Do.
20	21.0	111,300	42.9	53.5	2,593	5.08	565,000	Do.
21	20.1	108,500	41.8	52.0	2,591	4.90	532,000	Do.
22	19.4	105,700	40.8	52.5	2,589	4.78	505,000	Do.
23	18.6	103,700	40.1	50.0	2,585	4.62	479,000	Do.
24	17.8	102,200	39.4	50.0	2,572	4.51	461,000	Do.
26	16.5	99,200	38.8	49.0	2,556	4.09	406,000	Do.
27	16.0	96,800	37.8	47.0	2,557	4.07	394,000	Do.
28	15.5	96,100	37.6	48.0	2,553	3.89	373,000	Do.
29	15.1	96,500	37.8	47.0	2,549	3.96	382,000	Do.
30	14.6	98,500	38.7	48.0	2,546	3.79	373,000	Do.
31	14.2	95,000	37.4	46.5	2,542	3.59	341,000	Do.
Aug. 2	12.9	92,000	36.3	45.0	2,534	3.37	310,000	Do.
3	12.5	90,200	35.6	45.0	2,533	3.38	305,000	Do.
4	11.9	89,400	34.9	44.0	2,529	3.32	297,000	Do.
5	11.6	86,800	34.4	43.5	2,524	3.14	273,000	Do.
6	11.2	84,900	33.6	43.5	2,521	3.05	259,000	Do.
7	10.8	84,900	33.7	44.0	2,519	3.03	257,000	Do.
9	10.2	84,000	33.5	43.5	2,508	2.90	243,000	Do.
10	9.9	82,600	32.9	42.0	2,505	2.82	233,000	Do.
11	9.8	82,000	32.8	43.0	2,504	2.72	224,000	Do.
12	9.6	82,300	32.9	42.0	2,501	2.82	232,000	Do.
13	9.5	81,600	32.7	41.0	2,500	2.78	227,000	Do.
14	9.4	81,800	32.7	42.5	2,499	2.76	226,000	Do.
16	9.2	81,600	32.7	41.0	2,498	2.68	219,000	Do.
17	9.2	80,700	32.3	41.5	2,498	2.71	219,000	Do.
18	9.0	80,500	32.3	41.0	2,495	2.66	214,000	Do.
19	8.8	79,800	32.0	41.0	2,493	2.53	202,000	Do.
20	8.6	79,700	32.0	40.5	2,491	2.50	199,000	Do.
21	8.4	78,300	31.1	41.0	2,484	2.52	198,000	Do.
23	7.9	76,300	30.9	39.0	2,477	2.45	187,000	Do.
24	7.7	76,300	30.9	38.5	2,473	2.36	180,000	Do.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH—FULTON, TENN.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method:
			Mean.	Maximum.				
1880.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Aug. 25	7.3	75,700	30.7	40.0	2,468	2.35	178,000	Double floats.
26	7.0	74,200	30.1	40.0	2,464	2.26	168,000	Do.
27	6.7	72,900	29.6	39.5	2,465	2.20	161,000	Do.
28	6.7	72,900	29.5	39.0	2,465	2.22	161,000	Do.
30	7.4	75,500	30.6	39.0	2,472	2.37	179,000	Do.
31	7.7	76,300	30.8	39.0	2,478	2.49	190,000	Do.
Sept. 1	8.0	78,400	31.6	41.0	2,484	2.59	203,000	Do.
2	8.4	78,700	31.6	41.0	2,488	2.58	203,000	Do.
3	8.8	77,800	31.1	41.0	2,500	2.68	209,000	Do.
4	9.0	79,600	31.8	40.5	2,501	2.76	220,000	Do.
6	9.1	80,400	32.1	42.5	2,502	2.83	228,000	Do.
7	9.5	80,800	32.3	42.0	2,504	2.98	241,000	Do.
8	9.9	84,400	33.6	43.0	2,509	3.13	264,000	Do.
9	10.1	83,800	33.4	43.5	2,508	3.02	252,000	Do.
10	10.1	83,100	33.1	43.0	2,508	3.01	250,000	Do.
11	10.2	84,400	33.6	43.0	2,508	3.03	256,000	Do.
13	10.7	85,800	34.1	43.0	2,520	3.20	275,000	Do.
14	10.9	85,800	34.0	43.0	2,520	3.15	270,000	Do.
15	10.5	84,600	33.6	43.0	2,516	3.09	261,600	Do.
16	10.2	83,700	33.3	43.0	2,510	3.02	253,000	Do.
17	9.6	81,000	32.4	42.0	2,502	2.87	233,000	Do.
18	9.0	80,600	32.3	41.5	2,495	2.70	218,000	Do.
20	8.1	77,900	31.4	41.5	3,481	2.55	199,000	Do.
21	7.8	76,400	30.9	40.5	2,474	2.52	193,000	Do.
22	7.5	77,300	31.3	41.0	2,473	2.51	194,000	Do.
23	7.4	76,500	31.0	40.0	2,469	2.46	188,000	Do.
24	7.2	75,100	30.4	40.0	2,467	2.35	171,000	Do.
26	6.7	73,900	30.0	39.5	2,462	2.25	167,000	Do.
27	6.5	73,500	29.9	39.5	2,462	2.34	172,000	Do.
28	6.4	72,600	29.6	39.5	2,459	2.16	157,000	Do.
29	6.3	73,100	29.7	39.0	2,455	2.25	164,000	Do.
Oct. 1	6.2	72,400	29.4	38.5	2,455	2.13	154,000	Do.
2	6.2	72,800	29.6	39.5	2,455	2.14	156,000	Do.
4	6.2	73,900	30.1	39.0	2,458	2.38	176,000	Do.
5	6.6	73,700	29.9	39.5	2,461	2.30	170,000	Do.
7	7.0	74,800	30.4	40.0	2,463	2.37	177,000	Do.
8	7.1	74,600	30.3	40.0	2,463	2.43	181,000	Do.
1884.[a]								
Feb. 25	35.7	[b] 164,100	59.9	71.2	[c] 2,737	8.60	1,411,000	Do.
26	35.7	168,600	61.6	74.6	2,737	8.44	1,424,000	Do.
Mar. 12	31.4	166,800	62.4	77.8	2,674	6.28	1,047,000	Do.
19	31.8	162,700	60.8	74.8	2,674	7.84	1,275,000	Do.
Apr. 3	35.0	177,800	64.7	80.0	2,749	8.55	1,520,000	Do.
25	30.6	[d] 162,500	60.8	73.1	2,673	7.46	1,213,000	Do.
26	30.0	162,300	60.7	73.0	2,673	7.30	1,185,000	Do.
May 8	28.0	154,500	57.8	71.7	2,673	7.23	1,117,000	Do.
9	28.4	[e] 155,400	58.2	72.1	2,673	7.22	1,122,000	Do.
9	[f] 28.4	209,100	.....	.....	.....	4.45	931,000	Do.
24	[g] 21.22	131,300	.....	.....	.....	4.50	591,000	Do.
June 21	20.4	131,500	.....	.....	.....	4.49	590,000	Do.
Aug. 6	14.2	112,200	.....	.....	.....	3.44	386,000	Do.
Sept. 16	6.9	92,700	.....	.....	.....	2.00	181,000	Do.
Oct. 7	14.6	114,100	.....	.....	2,530	3.50	400,000	
Nov. 12	8.7	87,600	.....	.....	2,470	2.36	207,000	
18	7.6	95,600	.....	.....	2,470	2.10	203,000	
19	7.5	94,200	.....	.....	2,460	2.05	193,000	
21	7.4	92,200	.....	.....	2,420	2.14	196,000	
22	7.3	92,900	.....	.....	2,450	2.11	196,000	
26	6.9	86,500	.....	.....	2,455	1.99	172,000	
28	7.2	92,400	.....	.....	2,455	2.14	202,000	
Dec. 8	6.3	87,700	.....	.....	2,428	1.94	170,000	
9	5.8	88,000	.....	.....	2,420	1.96	173,000	
12	5.5	87,200	.....	.....	2,420	1.79	156,000	

[a] Observations 1884–85 by M. R. C. first district officer. Report and tabulation. Report Chief of Engineers, 1885, page 2760. Results of final reduction of observations to May 9 in secretary's office. Report Chief of Engineers, 1889, page 2048.

[b] If soundings taken the following day are interpolated, this area will be increased nearly 2,000 feet.

[c] These widths are not precise, as the water's edge was not exactly located.

[d] Soundings were taken Apr. 20, and corrected for change of gauge.

[e] Soundings were taken May 8, and corrected for change of gauge.

[f] Head of Island 34. This section was wide and shallow—the opposite of the other. They were so situated that gauging them was equivalent to gauging behind a submerged dam and then on its crest. The dee, section was the same as used in 1879–80.

[g] Gauge reading as corrected by Mr. Seddon from plot.

Results of discharge observations, Mississippi River—Continued.

PLUM POINT REACH—FULTON, TENN.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1885.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Jan. 9	22.2	131,100	.....	.....	2,580	5.10	669,000	
19	27.0	143,900	.....	.....	2,620	6.48	933,000	
Mar. 21	23.9	133,300	.....	.....	2,626	5.67	756,000	Double floats.
Apr. 4	15.8	110,100	.....	.....	2,570	4.27	470,000	Do.
16	23.5	131,300	.....	.....	2,622	5.61	737,000	Do.
1887.								
Feb. 25	33.9	.....	.....	.....	.....	.....	1,122,000	
1891.[b]								
Apr. 1	32.2	155,200	60.0	82.7	2,585	7.01	1,088,000	Meter.
1892.[c]								
Apr. 15	33.0	158,100	61.5	92.0	2,570	7.54	1,192,000	Double floats.
16	33.1	157,800	61.4	92.7	2,570	7.29	1,151,000	Do.
18	33.2	174,800	68.0	99.1	2,570	7.37	1,289,000	Do.
19	33.3	174,000	67.7	93.7	2,570	7.95	1,382,000	Do.
21	33.4	162,200	63.1	92.5	2,570	7.69	1,248,000	Do.
22	33.4	146,700	57.1	82.1	2,570	7.47	1,095,000	Do.
23	33.3	156,100	60.7	86.0	2,570	7.80	1,218,000	Do.
25	33.5	136,400	53.1	73.7	2,570	8.06	1,099,000	Do.
26	33.7	154,600	60.2	84.5	2,570	7.98	1,234,000	Do.
27	33.8	157,200	61.2	83.5	2,570	8.06	1,267,000	Do.
28	34.0	154,300	60.0	83.0	2,570	7.89	1,218,000	Do.
29	34.2	153,000	59.5	85.4	2,570	8.01	1,226,000	Do.
30	34.2	157,000	61.1	84.6	2,570	7.93	1,245,000	Do.
May 2	34.2	160,300	62.4	85.3	2,570	8.04	1,288,000	Do.
3	34.2	158,800	61.8	86.3	2,570	8.08	1,283,000	Do.
1893.[d]								
Feb. 24	30.0	153,700	47.0	70.0	3,268	6.31	970,000	Do.
25	30.5	152,400	46.6	66.6	3,268	6.90	1,051,000	Do.
28	31.4	153,700	46.9	71.1	3,270	6.91	1,062,000	Do.
Mar. 1	31.7	157,300	48.0	69.3	3,278	7.19	1,131,000	Do.
2	31.9	160,800	49.1	74.5	3,278	6.82	1,097,000	Do.
3	32.0	163,400	49.8	73.8	3,282	.....	.....	
4	32.2	163,600	49.8	75.0	3,284	7.43	1,216,000	Do.
6	31.8	160,900	49.0	75.0	3,284	6.76	1,088,000	Do.
7	31.1	158,500	48.4	73.8	3,272	6.67	1,057,000	Do.
May 5	32.8	163,100	49.5	73.3	3,295	6.86	1,120,000	Do.
8	33.9	166,700	50.6	75.6	3,296	7.35	1,225,000	Do.
10	34.4	190,600	57.8	79.5	3,296	7.03	1,340,000	Do.
11	34.5	175,800	53.3	73.8	3,296	7.19	1,264,000	Do.
13	34.0	172,500	52.3	75.6	3,296	7.36	1,270,000	Do.
16	34.6	175,100	53.1	76.7	3,297	6.90	1,208,000	Do.
17	34.6	177,400	53.8	76.1	3,297	7.11	1,262,000	Do.
19	34.4	171,900	52.1	72.2	3,297	6.74	1,158,000	Do.
23	33.1	166,400	50.5	71.1	3,297	6.60	1,098,000	Do.

[a] Observations and reduction by M. R. C. first district officer. Tabulation from Oct. 7, 1884, to Feb. 25, 1887, not heretofore published. Widths from Oct. 7, 1884, to Jan. 19, 1885, scaled from field plots.

[b] Tabulation for 1891 in Report Chief of Engineers, 1892, page 3129.

[c] Section of 1892 is about 5,000 feet above the landing at Fulton, and 1,600 feet above that used in 1879-80. Tabulation in Report Chief of Engineers, 1893, page 3683. Report on observations, Ibid. page 3664.

[d] Tennessee end of 1893 section is 1,000 feet below Fulton Landing. Observations by M. R. C. first district officer. Reduction of observations of 1891, 1892, and 1893 in secretary's office. Tabulation of 1893 observations in Report Chief of Engineers, 1894, page 2827.

Results of discharge observations, Mississippi River—Continued.

MEMPHIS, TENN.

[Discharge section, 1894, at foot of north line of Butler street, Memphis, Tenn.; another range parallel to and 300 feet below this was used for timing floats. Lower float was at middepth. Observations and reduction made under direction of M. R. C. second district officer by Assistant Wm. Gerig. Readings on the U. S. Engineer gauge are given in table. There were 12 velocity stations and 16 soundings on the 8th, and 10 velocity stations and 15 soundings on the 10th.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882[a].	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 29	8.4	68,700	.....	.....	.....	4.32	296,000	Double floats.
31	9.8	75,200	.....	.....	.....	4.30	323,000	Do.
1883.								
Jan. 2	10.4	77,400	.....	.....	.....	4.46	346,000	Do.
Feb. 20	32.8	245,900	.....	.....	.....	4.75	1,167,000	Do.
21	33.3	249,600	.....	.....	.....	4.78	1,194,000	Do.
1890.[b]								
Mar. 17	35.6	159,400	56.0	107.0	2,850	8.36	1,335,000	Meter.
18	35.5	154,400	54.2	107.0	2,851	8.24	1,273,000	Do.
20	35.5	153,500	53.9	105.0	2,851	8.76	1,345,000	Do.
22	35.6	141,800	50.8	109.0	2,851	8.51	1,232,000	Do.
24	35.6	151,500	53.1	107.0	2,851	8.69	1,316,000	Do.
25	35.6	152,000	53.3	108.0	2,851	8.50	1,292,000	Do.
26	35.5	146,600	51.4	104.0	2,851	8.83	1,295,000	Do.
27	35.4	148,000	51.9	105.0	2,851	8.54	1,264,000	Do.
29	35.3	152,200	53.4	96.0	2,851	8.46	1,289,000	Do.
31	35.3	157,700	55.3	104.0	2,851	8.32	1,313,000	Do.
Apr. 1	35.4	145,400	51.0	97.0	2,851	8.29	1,205,000	Do.
1891.[c]								
Mar. 6	34.0	148,800	52.8	106.0	2,819	8.59	1,278,000	Do.
7	34.3	142,400	50.5	103.5	2,819	8.65	1,232,000	Do.
10	34.9	152,000	54.0	106.0	2,814	8.48	1,289,000	Do.
Sept. 29	3.6	69,800	38.1	74.0	1,829	1.78	125,000	Do.
30	3.4	70,300	38.4	74.0	1,829	1.70	120,000	Do.
Oct. 1	3.2	69,800	38.1	74.0	1,829	1.69	118,000	Do.
2	3.0	68,200	37.3	75.0	1,829	1.73	118,000	Do.
3	2.8	68,900	38.4	76.0	1,795	1.67	115,000	Do.
5	2.4	66,700	37.3	76.0	1,788	1.82	121,000	Do.
6	2.2	66,000	36.9	69.0	1,786	1.67	110,000	Do.
8	1.9	67,800	38.0	71.0	1,786	1.49	101,000	Do.
9	1.8	66,000	37.3	71.0	1,772	1.52	100,000	Do.
10	1.7	64,800	36.6	67.0	1,768	1.45	94,000	Do.
12	1.4	64,200	36.4	68.5	1,763	1.41	91,000	Do.
13	1.3	64,000	36.3	66.5	1,762	1.53	98,000	Do.
14	1.3	64,200	36.5	67.5	1,758	1.49	96,000	Do.
15	1.4	64,100	36.5	71.0	1,759	1.52	97,000	Do.
16	1.4	65,100	37.0	69.5	1,761	1.40	91,000	Do.
17	1.6	65,600	37.2	70.0	1,762	1.48	97,000	Do.
19	1.8	66,700	37.6	70.0	1,773	1.64	109,000	Do.
21	2.0	64,400	36.2	70.0	1,778	1.61	104,000	Do.
1892.[d]								
Oct. 25	1.9	71,500	43.8	83.0	1,631	1.53	109,000	Do.
1894.								
Nov. 8	−1.4	57,100	38.4	75.0	1,486	1.47	84,000	Double floats.
10	−1.3	57,000	38.8	75.0	1,486	1.46	84,000	Do.

[a] Discharge section on either side of President's Island. Tabulation, Report Chief of Engineers, 1884, page 2806. Observations and reduction by M. R. C. second district officer.

[b] Discharge section 1890, was about 3,500 feet above the bridge. Observations and reduction by M. R. C. second district officer. Tabulation and report on observations in Report Chief of Engineers, 1890, page 3217.

[c] The low-water section of 1891 is about 2¼ miles above the high-water section, which was the same as in 1890. Tabulation in Report Chief of Engineers, 1892, page 3129. Report on observations, ibidem, page 3118. Observations by M. R. C. second district officer. Reduction in secretary's office.

[d] Section of 1892 same as in 1890 and 1891. Report Chief of Engineers, 1891, page 2858.

Results of discharge observations, Mississippi River—Continued.

MEMPHIS, TENN.—Continued.

[230 miles below Cairo.]

[Discharge section is at same place as in 1890, which is about 3,500 feet above the bridge. Readings from United States Engineer gauge, whose zero is 203.97 feet above Cairo datum. Price meter used. Observations made under direction of 1st and 2d district officer, M. R. C. Report Chief of Engineers, 1896, page 3551.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1895.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 21	−1.7	58,000	36.8	68	1,573	1.52	88,000	Meter.
22	−1.8	58,300	37.1	67	1,573	1.55	90,000	Do.

[231 miles below Cairo.]

[Observations and reduction under direction of Capt. E. W. Van C. Lucas, Corps of Engineers, Mississippi River Commission second district officer. The discharge section is about 1,000 feet above the Memphis bridge. Velocities in main river were measured with a Price current meter, overbank velocities were measured with surface floats. Memphis U. S. Engineer gauge, whose zero is 203.97 feet above the Cairo datum plane. Report Chief of Engineers, 1905.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1904.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	*Cu. ft.*	*Cubic feet.*	
Apr. 9	38.6	153,700	71.9	118.5	2,137	9.66	1,511,000[a]	107,000	[b] 1,618,000	M. and F.

[a] 89,828 cubic feet per second of this overbank discharge was through the openings in Frisco R. R., from bridge to St. Francis levee.

[b] If two soundings in the main river, questioned by the observer, are rejected, this total discharge would be 1,581 865 cu fe feet per second.

HAMPTON LANDING, ARK.

[Section about 12 miles below Memphis. The gauge tabulated was established on the Arkansas side near the section. Its zero was 4.40 feet below the zero of the Memphis standard gauge. Soundings were taken only on those days for which the depths are tabulated. Observations taken under the direction of Maj. W. H. H. Benyaurd. Tabulation, Report Chief of Engineers, 1887, p. 2707. Report on observations, Report Chief of Engineers, 1887, p. 2701.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1878.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 23	20.0	138,300	30.5	37.2	4,534	.....	.....	Double floats.
27	16.9	123,600	.....	.....	.....	3.93	485,000	Do.
28	15.2	116,700	.....	.....	.....	3.98	464,000	Do.
31	10.0	90,500	20.4	28.2	4,441	.....	.....	Do.
1879.								
Jan. 18	13.8	109,900	24.5	30.0	4,483	.....	.....	Do.
22	23.0	150,700	34.4	40.6	4,553	.....	.....	Do.
23	25.0	166,100	.....	.....	.....	4.87	809,000	Do.
24	26.4	172,400	.....	.....	.....	4.86	838,000	Do.
30	28.5	187,400	41.0	47.6	4,569	.....	.....	Do.
Feb. 2	26.7	178,600	.....	.....	.....	4.54	811,000	Do.
5	25.4	172,700	.....	.....	.....	4.50	778,000	Do.
6	25.3	172,200	.....	.....	.....	4.55	783,000	Do.
7	25.3	172,200	.....	.....	.....	4.54	782,000	Do.
8	25.7	174,000	.....	.....	.....	4.60	801,000	Do.
12	27.0	170,000	.....	.....	.....	4.59	825,000	Do.
15	25.4	172,700	.....	.....	.....	4.47	772,000	Do.
18	21.5	140,700	32.9	39.4	4,544	.....	.....	Do.
19	19.8	141,900	.....	.....	.....	3.98	564,000	Do.

Results of discharge observations, Mississippi River—Continued.

HAMPTON LANDING, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Feb. 20	18.2	134,700	.....	.....	.....	3.98	537,000	Double floats.
21	17.0	129,300	.....	.....	.....	3.83	495,000	Do.
24	17.7	132,400	.....	.....	.....	3.96	524,000	Do.
27	19.0	138,300	.....	.....	.....	4.11	568,000	Do.
28	19.1	138,700	.....	.....	.....	4.13	573,000	Do.
Mar. 5	17.5	131,500	.....	.....	.....	3.93	517,000	Do.
6	17.2	130,100	.....	.....	.....	3.92	511,000	Do.
7	17.1	129,700	.....	.....	.....	3.82	495,000	Do.
11	16.8	120,100	27.9	34.1	4,509	.....	.....	Do.
12	16.4	124,300	.....	.....	.....	3.93	489,000	Do.
13	16.1	123,000	.....	.....	.....	3.96	486,000	Do.
19	19.3	139,700	.....	.....	.....	4.16	581,000	Do.
21	21.2	146,100	.....	.....	.....	4.28	625,000	Do.
22	21.8	145,800	.....	.....	.....	4.35	647,000	Do.
24	22.5	155,600	34.1	40.7	4,558	.....	.....	Do.
25	22.9	157,400	.....	.....	.....	4.27	672,000	Do.
28	24.6	165,200	.....	.....	.....	4.44	734,000	Do.
Apr. 2	25.1	167,500	.....	.....	.....	4.36	729,000	Do.
5	24.5	164,700	.....	.....	.....	4.37	719,000	Do.
7	24.7	164,800	36.1	44.5	4,566	.....	.....	Do.
12	23.7	160,200	.....	.....	.....	4.23	678,000	Do.
15	23.3	158,400	.....	.....	.....	4.22	668,000	Do.
23	23.6	159,700	.....	.....	.....	4.27	682,000	Do.
24	22.8	156,100	.....	.....	.....	4.20	656,000	Do.
25	22.4	154,300	.....	.....	.....	4.12	635,000	Do.
28	19.9	143,000	.....	.....	.....	4.03	576,000	Do.
29	18.7	137,000	.....	.....	.....	3.89	536,000	Do.
30	17.7	125,400	27.8	35.6	4,514	.....	.....	Do.
May 2	15.7	116,400	.....	.....	.....	3.74	435,000	Do.
5	13.0	100,900	23.9	31.5	4,472	.....	.....	Do.
8	10.6	96,200	.....	.....	.....	3.42	329,000	Do.
9	9.9	93,100	.....	.....	.....	3.35	312,000	Do.
10	9.3	90,400	.....	.....	.....	3.21	290,000	Do.
13	8.2	85,100	19.3	25.4	4,413	.....	.....	Do.
14	8.2	85,100	.....	.....	.....	3.18	271,000	Do.
15	8.0	84,300	.....	.....	.....	3.16	266,000	Do.
16	7.9	83,800	.....	.....	.....	3.23	271,000	Do.
17	7.8	83,400	.....	.....	.....	3.21	268,000	Do.
19	7.3	80,200	18.2	23.7	4,402	.....	.....	Do.
20	7.2	79,700	.....	.....	.....	3.17	253,000	Do.
21	7.1	79,300	.....	.....	.....	3.22	255,000	Do.
22	7.1	79,300	.....	.....	.....	3.22	255,000	Do.
23	7.0	78,900	.....	.....	.....	3.23	255,000	Do.
26	6.2	76,700	17.5	23.9	4,395	.....	.....	Do.
27	6.1	76,300	.....	.....	.....	3.11	237,000	Do.
28	6.0	75,800	.....	.....	.....	3.11	236,000	Do.
29	6.0	75,800	.....	.....	.....	3.12	236,000	Do.
June 3	7.6	82,000	18.6	24.8	4,410	.....	.....	Do.
4	8.4	.....	.....	.....	.....	.....	.....	Do.
5	9.0	88,200	.....	.....	.....	3.40	300,000	Do.
6	9.5	90,400	.....	.....	.....	3.57	323,000	Do.
7	10.0	92,600	.....	.....	.....	3.53	327,000	Do.
9	11.0	97,700	21.9	27.4	4,453	.....	.....	Do.
10	11.1	98,100	.....	.....	.....	3.53	346,000	Do.
11	11.0	97,700	.....	.....	.....	3.53	344,000	Do.
12	10.9	97,200	.....	.....	.....	3.51	341,000	Do.
13	10.8	96,800	.....	.....	.....	3.59	348,000	Do.
14	10.7	96,400	.....	.....	.....	3.45	332,000	Do.
16	10.1	93,700	.....	.....	.....	3.57	335,000	Do.
17	9.9	92,000	20.7	26.9	4,444	.....	.....	Do.
18	10.0	92,400	.....	.....	.....	3.61	333,000	Do.
19	10.0	92,400	.....	.....	.....	3.55	328,000	Do.
21	9.8	91,500	.....	.....	.....	3.41	312,000	Do.
23	10.0	92,400	.....	.....	.....	3.48	322,000	Do.
24	10.5	94,600	.....	.....	.....	3.59	340,000	Do.
25	10.9	96,400	.....	.....	.....	3.58	345,000	Do.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.

[The gauge readings are all referred to the zero of the United States engineer gauge at Helena, whose zero is 161.98 feet above the Cairo datum plane.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1879.[a]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet*	
Apr. 4	33.2	.....	.....	.....	.....	4.26	729,000	Double floats.
May 12	16.3	.....	.....	.....	.....	3.23	305,000	Do.
22	14.4	.....	.....	.....	.....	3.57	282,000	Do.
June 3	14.2	.....	.....	.....	.....	3.66	295,000	Do.
13	18.3	.....	.....	.....	.....	3.88	386,000	Do.
1882.[b]								
Jan. 17	40.3	209,800	43.5	74.5	4,828	.....	.....	
21	41.7	214,600	44.3	72.0	4,839	5.07	1,088,000	Rod floats.
23	42.2	217,700	44.8	73.0	4,856	5.39	1,174,000	Do.
24	42.4	214,400	44.0	73.2	4,871	5.37	1,151,000	Do.
25	42.6	219,300	45.0	68.5	4,871	5.39	1,181,000	Do.
28	43.3	219,400	45.0	74.8	4,871	(c)	.....	
31	43.8	230,200	47.3	78.5	4,871	5.59	1,287,000	Do.
Feb. 1	43.9	232,500	47.7	77.8	4,871	5.21	1,212,000	Do.
2	44.0	229,700	47.1	78.5	4,871	4.97	1,142,000	Meter.
4	44.4	234,100	48.1	81.3	4,871	4.98	1,166,000	Do.
6	44.6	228,500	46.9	80.0	4,871	4.90	1,119,000	Do.
7	44.8	233,800	48.0	81.5	4,871	5.27	1,231,000	Do.
9	45.4	241,200	49.5	77.5	4,871	5.52	1,330,000	Do.
11	46.0	237,700	48.8	84.0	4,871	5.54	1,317,000	Do.
14	46.6	240,800	49.4	81.0	4,871	5.90	1,420,000	Do.
15	46.6	233,300	47.9	74.6	4,871	5.78	1,348,000	Do.
17	46.3	235,600	48.4	82.0	4,871	5.70	1,343,000	Do.
18	46.1	233,500	47.9	81.4	4,871	6.00	1,400,000	Do.
24	45.5	221,400	45.5	79.8	4,871	5.81	1,287,000	Do.
25	45.5	224,900	46.2	80.2	4,871	5.50	1,238,000	Do.
28	45.5	228,000	46.8	81.4	4,871	5.47	1,247,000	Do.
Mar. 2	45.6	228,700	47.0	83.3	4,871	5.43	1,241,000	Do.
3	45.7	220,300	47.1	78.2	4,871	5.60	1,285,000	Do.
7	47.0	234,200	48.1	84.0	4,871	6.43	1,500,000	Do.
8	47.1	233,400	47.9	86.8	4,871	6.68	1,558,000	Do.
13	46.5	228,200	46.8	82.3	4,871	6.85	1,562,000	Rod floats.
14	46.4	227,000	46.6	81.8	4,871	6.67	1,513,000	Do.
15	46.2	225,500	46.3	83.0	4,871	6.26	1,412,000	Do.
17	46.0	223,800	45.5	78.5	4,871	6.41	1,434,000	Do.
23	45.2	220,300	44.9	81.5	4,871	.....	.....	
27	44.9	226,100	46.1	82.9	4,871	6.09	1,378,000	Meter.
29	44.7	220,300	45.0	84.2	4,871	5.71	1,259,000	Do.
30	44.5	220,300	45.0	84.1	4,871	5.93	1,306,000	Do.
31	44.4	227,000	46.4	83.6	4,871	5.80	1,317,000	Do.
Apr. 3	43.8	223,200	45.8	81.0	4,870	5.56	1,241,000	Do.
4	43.6	221,600	45.5	81.4	4,870	5.55	1,230,000	Do.
6	43.3	218,100	44.8	81.6	4,870	5.55	1,210,000	Do.
7	43.1	222,300	45.6	82.0	4,870	5.77	1,287,000	Do.
8	42.8	221,000	45.4	81.7	4,870	5.48	1,282,000	Do.
10	42.4	217,700	44.9	82.5	4,864	5.10	1,110,000	Do.
11	42.1	216,300	44.6	82.3	4,864	5.37	1,162,000	Do.
12	41.7	214,000	44.3	83.3	4,835	5.11	1,093,000	Do.
13	41.4	213,800	44.2	81.2	4,835	5.02	1,073,000	Do.
14	41.1	212,600	44.0	80.9	4,835	4.81	1,023,000	Do.
15	40.8	201,900	41.8	81.1	4,833	4.78	965,000	Do.
17	40.3	197,400	40.9	79.1	4,830	4.84	957,000	Do.
19	40.0	199,200	41.3	82.1	4,830	4.82	959,000	Do.
20	39.9	199,700	41.4	81.4	4,828	4.75	949,000	Do.
21	39.7	203,800	42.2	82.2	4,828	4.62	940,000	Do.
24	38.1	187,100	38.8	77.8	4,828	4.45	833,000	Do.
25	37.3	189,400	39.2	78.5	4,827	4.24	803,000	Do.
26	36.4	185,300	38.4	77.1	4,826	4.32	800,000	Do.
27	35.6	178,200	36.9	77.1	4,826	4.30	766,000	Do.
29	35.0	181,300	37.6	76.2	4,825	4.25	771,000	Do.
May 1	35.0	177,000	36.7	76.2	4,825	4.33	767,000	Do.
2	35.0	179,700	37.2	76.1	4,825	4.38	788,000	Do.
3	35.1	180,000	37.3	76.2	4,825	4.22	760,000	Do.
4	35.1	181,100	37.5	75.9	4,825	4.37	791,000	Do.
5	35.2	183,600	38.1	76.8	4,825	4.36	801,000	Do.
8	35.4	183,400	38.0	76.2	4,825	4.32	792,000	Do.

[a] Observations and reduction under Maj. C. B. Comstock. Report Chief of Engineers, 1879, p. 1970. The gauge readings for 1879 are as reported by discharge party and differ slightly from the standard records.

[b] Observations and reduction of 1882 under secretary Mississippi River Commission. Report and tabulation, Report Chief of Engineers 1884, p. 2618.

[c] Observations imperfect.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
May 9	35.6	181,800	37.7	78.5	4,820	4.70	856,000	Meter.
10	36.4	184,600	38.2	77.9	4,820	4.32	798,000	Do.
11	37.0	186,300	38.6	78.5	4,828	4.62	861,000	Do.
12	38.1	192,000	39.8	78.9	4,828	4.60	883,000	Do.
13	39.0	195,800	40.5	80.2	4,820	4.63	906,000	Do.
16	40.6	201,800	41.8	81.7	4,831	5.03	1,016,000	Do.
17	41.0	211,600	43.8	80.9	4,833	5.09	1,078,000	Do.
18	41.2	210,200	43.5	80.5	4,833	5.12	1,077,000	Do.
20	41.6	210,900	43.6	81.8	4,835	5.27	1,112,000	Do.
22	41.8	214,500	44.3	83.1	4,837	5.14	1,104,000	Do.
23	41.8	210,700	43.6	83.2	4,837	5.35	1,127,000	Do.
24	41.9	213,000	44.0	83.1	4,837	5.07	1,080,000	Do.
25	41.9	210,600	43.5	81.2	4,837	5.23	1,101,000	Do.
26	41.8	215,300	44.5	82.5	4,837	5.04	1,086,000	Do.
27	41.8	213,600	44.2	82.3	4,837	5.31	1,145,000	Do.
29	41.8	215,900	44.6	83.1	4,837	5.05	1,090,000	Do.
30	41.6	210,600	43.6	82.5	4,835	5.30	1,117,000	Do.
June 1	41.3	215,500	44.6	83.1	4,834	5.08	1,095,000	Do.
2	41.2	212,400	44.0	83.1	4,833	5.01	1,065,000	Do.
3	41.1	211,400	43.7	82.0	4,833	4.93	1,044,000	Do.
6	41.1	210,300	43.5	82.7	4,833	5.04	1,059,000	Do.
8	41.3	210,000	43.4	83.3	4,834	4.94	1,037,000	Do.
10	41.3	209,900	43.4	82.5	4,834	5.13	1,077,000	Do.
12	41.4	211,100	43.7	81.1	4,834	5.09	1,075,000	Do.
16	41.0	212,500	43.9	78.0	4,833	4.84	1,029,000	Rod floats.
20	39.2	202,400	41.9	78.1	4,828	4.62	958,000	Meter.
21	38.8	191,800	40.3	78.5	4,828	4.84	944,000	Do.
22	38.8	198,000	41.0	78.5	4,827	4.72	934,000	Do.
23	38.8	194,600	40.3	78.0	4,828	4.73	920,000	Do.
27	39.6	199,200	41.3	76.1	4,828	4.91	978,000	Do.
28	39.7	196,900	40.8	77.1	4,828	4.91	972,000	Do.
29	39.7	202,400	41.9	75.5	4,828	4.66	942,000	Do.
30	39.7	204,000	43.2	74.7	4,828	5.10	1,041,000	Do.
July 1	39.5	197,900	41.0	77.2	4,828	4.81	952,000	Do.
3	39.2	197,400	40.9	77.7	4,828	4.90	970,000	Do.
5	38.8	193,800	40.2	76.5	4,828	4.99	968,000	Do.
7	38.8	196,300	40.7	76.3	4,828	4.84	949,000	Do.
12	39.7	201,300	41.7	78.9	4,828	5.00	1,019,000	Do.
13	39.8	202,100	41.9	76.5	4,828	4.90	991,000	Do.
14	39.8	198,300	41.1	78.7	4,828	5.08	1,008,000	Do.
15	39.6	199,200	41.2	77.3	4,828	5.16	1,029,000	Do.
17	39.1	196,100	40.6	78.0	4,828	4.64	911,000	Do.
18	38.6	193,700	40.4	78.5	4,827	4.68	907,000	Do.
19	38.0	193,000	40.0	77.5	4,827	4.65	898,000	Do.
20	37.3	188,900	39.1	76.4	4,827	4.55	860,000	Do.
22	35.4	182,600	37.8	72.5	4,827	4.38	800,000	Do.
24	33.6	170,800	35.4	69.9	4,825	4.25	728,000	Do.
25	32.8	168,300	35.0	70.3	4,805	4.30	724,000	Do.
26	32.0	162,900	34.1	69.6	4,782	4.22	687,000	Do.
27	31.0	160,300	33.7	68.8	4,756	4.12	660,000	Do.
29	28.7	146,600	30.9	67.2	4,745	4.07	595,000	Do.
31	26.2	135,500	28.8	64.5	4,710	3.99	540,000	Do.
Aug. 1	25.2	130,100	27.7	62.3	4,689	3.86	502,000	Do.
2	24.2	121,000	26.1	63.7	4,667	3.81	463,000	Do.
3	23.5	161,100	24.9	62.5	4,654	3.78	439,000	Do.
5	22.6	111,100	24.0	62.1	4,639	3.80	422,000	Do.
7	21.8	112,000	24.2	65.3	4,632	3.76	421,000	Do.
8	22.0	111,500	24.1	61.8	4,634	3.74	417,000	Do.
9	22.7	116,800	25.2	62.1	4,637	4.01	469,000	Do.
10	23.6	121,200	26.0	62.8	4,655	3.97	481,000	Do.
11	24.2	126,400	27.1	63.4	4,666	3.86	488,000	Do.
12	24.5	127,800	27.4	61.1	4,670	3.91	500,000	Do.
14	24.0	132,000	28.3	64.0	4,663	3.96	522,000	Do.
16	23.4	119,600	25.6	62.5	4,662	3.82	456,000	Do.
17[a]	23.1	123,800	26.6	61.5	4,659	3.88	480,000	Do.
18	22.6	121,900	26.2	61.9	4,656	3.83	467,000	Do.
19	22.1	119,900	25.8	60.2	4,653	3.65	437,000	Rod floats.
21	21.4	111,800	24.0	61.8	4,648	3.72	416,000	Meter.
22	21.1	112,000	24.1	62.8	4,643	3.77	422,000	Do.
23	20.8	.....	.....	.....	.....	3.66	410,000	Rod floats.
24	20.3	111,800	24.2	62.5	4,626	3.65	409,000	Meter.
25	19.8	104,000	22.5	62.5	4,616	3.55	369,000	Do.
26	19.2	97,400	21.2	60.6	4,603	3.64	354,000	Do.

[a] August 17 rod floats gave mean velocity=3.66 feet and discharge=453,787 cubic feet per second.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Aug. 28	17.9	89,500	19.6	54.8	4,574	3.50	310,000	Meter.
29	17.3	92,100	20.2	58.2	4,562	3.53	325,000	Do.
30	16.8	89,700	19.7	57.5	4,550	3.61	324,000	Rod floats.
31	16.4	82,300	18.1	56.0	4,540	3.38	278,000	Meter.
Sept. 2	15.8	82,000	20.7	57.7	4,000	3.35	277,000	Rod floats.
5	15.6	83,000	22.1	56.4	3,750	3.22	267,000	Do.
6	15.6	78,300	20.9	57.2	3,750	3.17	248,000	Do.
8	15.8	83,600	22.2	55.1	3,770	3.62	302,000	Meter.
9	15.8	87,800	22.0	54.2	4,000	3.38	297,000	Rod floats.
11	16.2	84,100	21.0	54.8	4,015	3.48	293,000	Meter.
13	16.3	91,600	22.8	55.8	4,020	3.47	318,000	Do.
15	16.0	89,400	22.3	55.4	4,010	3.70	331,000	Do.
16	15.7	85,400	22.7	55.1	3,760	3.51	300,000	Do.
18	15.0	84,200	22.5	54.9	3,740	3.22	271,000	Rod floats.
19	14.9	70,400	21.3	55.8	3,730	3.39	269,000	Do.
20	15.2	80,400	21.4	54.6	3,750	3.41	274,000	Do.
22	17.1	89,400	20.2	56.2	4,419	3.67	328,000	Do.
23	17.9	89,800	19.4	53.9	4,633	3.43	308,000	Meter.
25	17.9	94,700	20.4	58.3	4,633	3.74	354,000	Rod floats.
26	17.3	91,100	19.7	56.7	4,625	3.63	331,000	Do.
27	16.5	85,600	18.6	56.0	4,595	3.46	296,000	Do.
28	15.7	81,200	21.3	54.9	3,809	3.29	267,000	Do.
29	15.0	79,300	21.3	53.9	3,730	2.94	233,000	Meter.
29						3.16	251,000	Rod floats.
30	14.2	76,800	21.6	53.6	3,510	3.28	252,000	Do.
Oct. 2	13.0	75,300	22.0	54.0	3,420	3.21	242,000	Do.
3	12.6	72,500	21.5	53.6	3,357	2.79	202,000	Meter.
3	12.6	72,500	21.5	53.6	3,357	3.10	224,000	Rod floats.
4	12.2	70,900	21.7	53.2	3,262	3.11	220,000	Do.
5	11.6	70,200	21.7	52.7	3,226	2.96	208,000	Do.
5						2.81	197,000	Meter.
6	11.5	68,100	22.2	52.4	3,060	2.83	193,000	Do.
6	11.5	68,100	22.2	52.4	3,060	2.98	203,000	Rod floats.
7	11.5	67,400	22.0	52.0	3,060	2.76	186,000	Meter.
7						2.92	197,000	Rod floats.
9	11.5	67,600	22.1	52.0	3,060	2.96	200,000	Meter.
9						2.98	201,000	Rod floats.
10	11.4	65,000	21.2	52.5	3,053	2.98	194,000	Meter.
10						3.04	197,000	Rod floats.
11	11.3	65,200	21.4	52.8	3,037	2.93	191,000	Do.
14	11.1	63,700	20.9	52.4	3,037	2.95	188,000	Do.
17	10.7	64,300	21.3	52.2	3,014	2.80	180,000	Do.
19	10.4	64,000	21.5	52.5	2,970	2.72	174,000	Do.
20	10.1	60,700	20.4	51.3	2,970	2.79	169,000	Meter.
20						2.77	168,000	Rod floats.
21	9.8	59,500	20.0	49.5	2,970	2.89	172,000	Meter.
21						2.76	164,000	Rod floats.
23	9.8	59,100	19.9	49.5	2,970	2.79	165,000	Meter.
23						2.79	165,000	Rod floats.
24	9.8	59,100	19.9	49.5	2,970	2.91	172,000	Meter.
24						2.73	162,000	Rod floats.
25	9.8	59,300	19.9	49.5	2,970	2.91	172,000	Meter.
25	9.8	59,300	19.9	49.5	2,970	2.76	164,000	Rod floats.
27	10.2	60,300	20.3	50.0	2,970	2.95	178,000	Meter.
28	10.2	60,400	20.3	50.0	2,970	3.08	186,000	Do.
28						2.83	171,000	Rod floats.
31	10.3	60,600	20.4	50.1	2,970	3.06	185,000	Do.
Nov. 8	10.9	61,900	22.4	51.9	2,761	3.33	206,000	Meter.
10	11.0	62,800	22.7	52.0	2,761	3.32	208,000	Do.
11	11.1	62,700	22.7	52.1	2,765	3.36	211,000	Do.
1884.[a]								
Oct. 3	14.4	81,200	17.7	54.0	4,590			
4	16.2	93,100	20.2	57.0	4,604	4.14	386,000	Rod floats.
6	19.0	107,600	23.2	60.0	4,634	4.16	448,000	Do.
8	20.2	114,400	24.6	62.0	4,644	3.70	423,000	Meter.
9	20.0	112,000	24.1	62.0	4,644	4.16	466,000	Rod floats.
10	19.5	109,000	23.5	64.5	4,635	3.64	396,000	Meter.
11	19.0	103,000	22.2	61.0	4,628	3.77	388,000	Do.

[a] Observations and reduction under secretary Mississippi River Commission. Report Chief of Engineers 1887, page 2820. The high-water section was a short distance below the elevator. The left bank end of the section of 1884-5 was coincident with that of 1882; but the right bank end was about 200 feet above that of 1882. The low-water section was about three-fourths of a mile above the high-water section. Observations Oct. 3 to 11 regarded as doubtful.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1884.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 13	18.0	97,100	21.0	59.0	4,624	3.78	367,000	Meter.
14	17.8	97,000	21.2	61.4	4,616	3.81	373,000	Do.
15	17.5	98,500	21.4	59.1	4,613	3.70	364,000	Do.
16	17.6	98,300	21.3	59.6	4,614	3.61	355,000	Do.
17	18.0	100,100	21.6	59.5	4,623	3.92	[a] 393,000	Do.
18	18.3	97,900	21.2	58.6	4,625	3.64	356,000	Do.
20	18.4	100,300	21.7	59.6	4,625	3.73	374,000	Do.
21	18.4	100,000	21.6	59.5	4,626	3.69	369,000	Do.
22	18.2	99,300	21.5	60.0	4,624	3.73	371,000	Do.
23	17.8	97,400	21.1	58.5	4,621	3.55	346,000	Do.
25	16.9	93,800	20.0	59.4	4,613	3.81	358,000	Do.
27	16.3	89,600	19.4	59.2	4,609	3.72	334,000	Do.
28	16.0	88,200	19.2	59.0	4,607	3.85	340,000	Do.
29	16.1	87,200	18.9	58.9	4,606	3.84	335,000	Do.
30	16.2	88,300	19.2	59.4	4,608	3.77	333,000	Do.
31	16.4	87,800	19.0	59.4	4,610	3.85	338,000	Do.
Nov. 1	16.3	88,900	19.3	57.4	4,610	3.74	333,000	Do.
3	16.0	87,100	18.9	57.9	4,609	3.77	328,000	Do.
4	15.8	86,300	18.7	58.0	4,607	3.82	329,000	Do.
5	15.5	85,000	18.6	57.0	4,606	3.69	317,000	Do.
6	15.2	84,000	18.4	57.5	4,597	3.83	324,000	Do.
7	14.8	82,800	18.0	56.8	4,594	3.71	308,000	Do.
8	14.2	79,700	17.4	56.5	4,588	3.70	295,000	Do.
10	13.1	75,500	16.5	55.5	4,569	3.75	283,000	Do.
11	12.6	75,200	16.5	57.0	4,557	3.75	282,000	Do.
12	12.1	72,200	15.9	53.0	4,555	3.69	267,000	Do.
13	11.8	68,300	15.0	54.0	4,543	3.74	255,000	Do.
14	11.3	66,900	14.7	52.5	4,541	3.72	249,000	Do.
15	11.0	64,200	14.1	52.0	4,536	3.69	237,000	Do.
17	10.3	61,300	13.5	53.3	4,528	3.74	229,000	Do.
18	10.0	60,300	13.3	53.0	4,521	3.72	224,000	Do.
19	9.9	58,400	12.9	53.2	4,519	3.76	219,000	Do.
20	9.7	57,000	12.6	53.5	4,516	3.60	[a] 205,000	Do.
21	9.6	54,700	16.8	52.5	3,260	3.80	208,000	Do.
22	9.5	54,300	16.7	52.0	3,260	3.89	212,000	Do.
24	9.4	54,100	16.6	52.0	3,260	3.82	206,000	Do.
25	9.3	54,500	16.7	53.0	3,259	3.86	210,000	Do.
26	9.1	53,400	17.2	52.5	3,110	3.76	201,000	Do.
27 [b]	8.9	66,500	18.7	25.0	3,554	2.95	196,000	Do.
28	8.9	65,500	18.4	25.0	3,555	3.17	208,000	Do.
29	9.1	65,500	18.4	25.0	3,556	3.12	205,000	Do.
Dec. 1	10.5	70,800	19.6	25.1	3,611	3.08	218,000	Do.
2	10.8	71,800	19.7	26.5	3,638	3.09	222,000	Do.
3	11.0	71,500	19.7	26.0	3,638	3.14	225,000	Do.
4	10.8	71,500	19.7	26.0	3,632	3.06	219,000	Do.
4 [b]	10.8	63,900	14.1	53.0	4,535	3.82	244,000	Do.
5	10.6	70,500	19.5	26.0	3,618	3.07	217,000	Do.
6	10.3	69,500	19.3	26.0	3,608	3.26	226,000	Do.
8	9.0	64,700	18.1	25.0	3,571	2.91	188,000	Do.
9	8.4	63,100	17.7	24.0	3,558	2.85	180,000	Do.
9 [b]	8.3	50,200	15.8	51.0	3,190	3.59	180,000	Do.
10	7.9	61,400	17.3	23.0	3,547	2.82	173,000	Do.
11	7.5	59,900	17.0	23.0	3,521	2.83	170,000	Do.
12	7.2	59,000	16.8	23.0	3,520	2.87	169,000	Do.
13	7.2	58,700	16.7	22.0	3,517	2.88	169,000	Do.
15	8.5	63,500	17.8	23.5	3,567	3.04	193,000	Do.
16	9.8	67,700	18.8	25.0	3,598	3.16	214,000	Do.
17	10.9	71,900	19.8	27.0	3,638	3.15	226,000	Do.
18	12.1	76,500	20.7	27.5	3,688	3.24	248,000	Do.
19	13.2	80,500	21.6	28.5	3,735	3.27	264,000	Do.
20	14.1	83,500	22.1	29.5	3,774	3.28	274,000	Do.
22	15.2	88,300	23.2	31.0	3,811	3.35	296,000	Do.
23	15.2	87,300	22.9	31.0	3,808	3.35	292,000	Do.
30	15.1	87,000	22.9	29.9	3,806	3.49	304,000	Do.
31	17.6	97,800	24.9	32.5	3,931	3.72	364,000	Do.
1885.								
Jan. 1	20.7	110,200	26.4	35.5	4,173	3.88	428,000	Do.
2	24.0	125,000	29.6	40.0	4,221	4.11	514,000	Do.
3	26.9	137,000	32.2	43.5	4,253	4.42	605,000	Do.
7	31.9	155,000	35.7	47.0	4,338	4.60	[c] 713,000	Do.

[a] Results doubtful; observer says reject.
[b] Excepting Dec. 4 and 9 the low-water section was used from Nov. 27 to Jan. 7.
[c] Chute discharge, 3,500 cubic feet, not included.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1885.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Jan. 7[a]	32.0	163,600	34.3	76.0	4,774	4.22	690,000	Meter.
8	32.2	162,700	34.0	76.0	4,779	4.39	714,000	Do.
9	32.5	164,600	34.4	75.2	4,781	4.30	707,000	Do.
10	32.8	166,800	34.9	75.0	4,783	4.24	708,000	Do.
12	33.6	170,700	35.6	76.5	4,800	4.42	754,000	Do.
13	34.4	174,900	36.4	77.6	4,805	4.47	781,000	Do.
14	35.0	177,300	36.8	78.6	4,820	4.47	792,000	Do.
17	36.9	186,000	38.5	79.0	4,829	4.44	826,000	Do.
19	37.6	188,800	39.1	79.5	4,831	4.50	850,000	Do.
20	38.0	189,500	39.2	81.5	4,831	4.60	873,000	Do.
21	38.3	192,300	39.8	82.2	4,831	4.71	907,000	Do.
22	38.7	195,000	40.4	82.2	4,831	4.71	918,000	Do.
26	40.1	201,400	41.6	83.5	4,841	4.82	970,000	Do.
27	40.4	204,700	42.2	83.5	4,850	4.82	987,000	Do.
28	40.5	205,600	42.4	83.5	4,851	4.96	1,021,000	Do.
29	40.6	206,100	42.5	80.5	4,851	4.91	1,013,000	Do.
Feb. 2	38.5	193,700	40.0	80.0	4,844	4.54	879,000	Do.
3	36.8	185,200	38.3	79.0	4,836	4.40	816,000	Do.
4	34.9	176,000	36.6	78.0	4,810	4.12	726,000	Do.
5	32.7	163,600	34.3	78.0	4,778	4.20	687,000	Do.
6	30.9	156,200	32.8	74.0	4,766	3.98	622,000	Do.
7	29.2	148,800	31.4	72.0	4,739	4.20	625,000	Do.
9	27.0	136,700	29.0	68.0	4,709	4.07	557,000	Do.
10	26.6	134,800	28.6	69.0	4,707	4.04	545,000	Do.
11	26.5	134,000	28.7	70.0	4,707	4.00	539,000	Do.
12	26.7	137,000	29.1	70.0	4,707	4.03	552,000	Do.
13	26.9	137,000	29.1	70.0	4,708	4.04	553,000	Do.
14	27.0	135,700	28.8	69.0	4,714	3.98	541,000	Do.
19	29.5	146,400	30.9	72.0	4,743	4.11	601,000	Do.
20	29.4	145,000	30.6	71.0	4,743	4.13	599,000	Do.
28	18.4	90,900	19.7	58.0	4,621	3.98	361,000	Do.
Mar. 2	16.8	84,400	18.3	57.0	4,607	3.95	334,000	Do.
3	16.5	83,100	18.0	56.0	4,606	3.95	328,000	Do.
4	16.5	83,800	18.2	54.0	4,606	4.00	336,000	Do.
5	16.8	84,900	18.4	55.0	4,612	3.97	337,000	Do.
6	17.4	87,900	19.0	54.0	4,610	4.04	355,000	Do.
7	18.3	91,500	19.8	57.0	4,625	4.05	370,000	Do.
9	20.4	101,200	21.8	57.0	4,645	4.18	423,000	Do.
10	21.9	107,600	23.1	59.0	4,655	4.25	457,000	Do.
11	23.7	116,300	24.9	60.5	4,670	4.22	491,000	Do.
12	25.8	127,200	27.1	63.0	4,695	4.49	571,000	Do.
13	27.5	135,700	28.7	64.4	4,725	4.26	578,000	Do.
14	28.7	142,400	30.0	64.7	4,741	4.43	631,000	Do.
16	30.0	148,900	31.4	67.3	4,747	4.33	644,000	Do.
17	30.7	153,700	32.3	67.6	4,757	4.34	667,000	Do.
18	31.6	157,300	33.0	67.6	4,767	4.43	696,000	Do.
19	32.4	161,100	33.7	69.5	4,775	4.45	717,000	Do.
20	33.1	164,700	34.4	70.0	4,787	4.47	737,000	Do.
23	33.6	167,200	34.8	72.0	4,802	4.41	738,000	Do.
24	33.4	167,000	34.8	71.0	4,801	4.34	724,000	Do.
25	33.2	165,000	34.4	70.0	4,798	4.22	696,000	Do.
26	32.9	163,400	34.1	70.5	4,787	4.25	694,000	Do.
27	32.3	161,700	33.9	69.0	4,773	4.21	681,000	Do.
28	31.5	158,800	33.3	70.0	4,767	4.17	663,000	Do.
30	29.6	147,800	31.2	69.0	4,741	4.15	614,000	Do.
31	28.3	142,000	30.0	66.0	4,729	3.94	560,000	Do.
Apr. 1	26.9	134,600	28.6	65.0	4,712	3.98	536,000	Do.
2	25.6	129,600	27.6	64.0	4,691	3.98	516,000	Do.
3	24.7	124,900	26.7	62.6	4,679	4.04	504 000	Do.
4	23.9	119,700	25.6	63.4	4,669	3.86	462,000	Do.
7	23.1	115,500	24.7	63.3	4,669	3.92	453,000	Do.
9	24.7	124,000	26.5	65.2	4,684	4.15	515,000	Do.
10	26.2	130,800	27.8	65.4	4,700	4.14	542,000	Do.
1888.[b]								
Nov. 28	26.7	134,000	28.3	75.0	4,732	4.22	565,000	Do.
29	26.0	129,500	27.4	72.0	4,725	4.39	569,000	Do.
30	25.0	125,100	26.5	74.4	4,722	4.38	548,000	Do.
Dec. 1	23.8	118,400	25.1	72.0	4,715	4.38	519,000	Do.
3	21.1	107,900	22.9	73.0	4,702	4.57	493,000	Do.
4	19.9	98,500	28.1	74.0	3,505	4.64	457,000	Do.
5	18.6	92,600	28.5	71.0	3,244	4.77	442,000	Do.

[a] High-water section.

[b] Observations and reduction by Mississippi River Commission, second district officer. Report Chief of Engineers, 1890, p. 3158. The section was in about the same place as in 1882 and 1884.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1888.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Dec. 6	17.3	88,000	28.6	67.0	3,090	4.72	418,000	Meter.
7	16.0	83,000	28.5	68.0	2,938	4.40	368,000	Do.
8	14.7	81,500	28.3	68.5	2,887	4.10	334,000	Do.
10	12.7	69,900	26.1	61.0	2,680	4.06	284,000	Do.
11	11.8	67,600	25.3	64.0	2,670	3.93	266,000	Do.
12	11.1	67,300	25.2	61.2	2,666	4.06	273,000	Do.
13	10.5	65,400	25.5	62.3	2,565	4.10	269,000	Do.
14	10.0	64,100	25.6	62.5	2,505	3.95	253,000	Do.
16	9.4	61,900	24.8	60.2	2,500	3.93	243,000	Do.
17	9.4	62,500	25.0	62.3	2,500	3.93	246,000	Do.
18	9.2	62,600	25.0	61.0	2,500	3.83	240,000	Do.
19	9.1	61,400	24.7	60.0	2,490	3.91	240,000	Do.
20	9.0	62,000	25.0	60.0	2,475	3.89	241,000	Do.
21	8.9	60,400	24.5	60.0	2,473	3.92	237,000	Do.
22	9.0	60,200	24.4	60.0	2,470	3.82	220,000	Do.
24	9.6	61,400	24.6	56.0	2,500	3.93	241,000	Do.
25	10.2	63,700	24.9	58.2	2,555	3.95	252,000	Do.
26	11.0	64,800	25.3	59.0	2,562	4.21	273,000	Do.
27	11.4	66,300	25.3	59.0	2,620	4.13	274,000	Do.
28	11.7	67,900	25.4	60.0	2,680	4.13	281,000	Do.
29	12.0	70,000	26.1	60.0	2,680	4.13	289,000	Do.
31	13.1	71,800	26.5	61.0	2,705	4.14	297,000	Do.
1889.								
Jan. 1	13.9	75,100	27.0	63.0	2,785	4.23	318,000	Do.
3	15.3	80,600	28.0	63.7	2,888	4.24	342,000	Do.
5	15.6	79,600	27.1	64.0	2,938	4.35	347,000	Do.
7	14.9	77,300	26.5	63.5	2,888	4.23	327,000	Do.
8	14.5	76,000	26.7	63.2	2,862	4.17	319,000	Do.
9	14.5	77,300	27.0	63.7	2,862	4.29	332,000	Do.
10	14.7	77,200	26.9	63.0	2,873	4.23	327,000	Do.
11	15.4	80,100	27.5	62.8	2,908	4.47	358,000	Do.
12	16.4	84,100	28.2	65.3	2,989	4.48	377,000	Do.
14	19.6	94,600	27.9	67.0	3,394	4.77	450,000	Do.
16	24.3	127,300	27.1	75.0	4,700	4.74	603,000	Do.
17	25.6	131,600	27.8	78.0	4,724	4.78	630,000	Do.
18	26.4	133,900	28.1	78.0	4,734	4.63	620,000	Do.
19	27.0	138,000	29.1	78.5	4,742	4.64	640,000	Do.
21	28.6	141,200	29.6	77.5	4,766	4.65	656,000	Do.
22	29.5	145,800	30.5	79.0	4,777	4.70	685,000	Do.
23	30.4	151,100	31.6	80.0	4,779	5.02	758,000	Do.
24	31.2	161,300	33.7	80.0	4,792	4.80	774,000	Do.
27	30.8	149,400	31.2	79.5	4,787	4.66	696,000	Do.
28	30.1	150,000	31.4	79.5	4,775	4.70	705,000	Do.
29	29.1	142,300	29.9	79 5	4,766	4.70	668,000	Do.
30	28.1	134,900	28.4	77.0	4,755	4.60	620,000	Do.
31	27.2	132,400	27.9	75.0	4,743	4 55	603,000	Do.
Feb. 1	26.9	131,300	27.7	75.0	4,737	4.50	591,000	Do.
2	26.9	133,700	28.2	77.0	4,740	4.47	598,000	Do.
4	27 8	136,600	28.7	76.0	4,756	4.71	643,000	Do.
5	28.4	130,900	29.4	75.2	4,763	4 58	641,000	Do.
6	29 0	140,800	29.5	75.5	4,776	4.67	658,000	Do.
7	29.3	142,400	29.8	77.0	4,777	4.71	671,000	Do.
8	29.3	144,400	30 2	77.2	4,780	4.75	684,000	Do.
9	29.0	142,600	29 8	76.0	4,778	4.60	656,000	Do.
11	27.0	134,200	28.2	76.0	4,769	4.41	592,000	Do.
12	25.6	128,400	27.6	75.0	4,728	4.33	556,000	Do.
13	23 9	117,000	24.8	75 0	4,714	4.42	517,000	Do.
16	18.6	89,400	27.1	67.0	3,293	4.35	389,000	Do.
18	16.2	83,000	27.1	65.0	3,061	4.26	354,000	Do.
19	15.2	80,400	26.9	64 0	2,984	4.20	338,000	Do.
20	14.5	76,800	26.6	62.3	2,883	4.19	322,000	Do.
21	14.7	77,800	27.0	64 0	2,883	4.39	342,000	Do.
22	16.6	83,200	27.1	66 0	3,073	4.60	383,000	Do.
23	20.5	100,400	25.8	70 5	3,897	4.95	497,000	Do.
25	26.0	129,100	27.3	74 2	4,731	4.73	611,000	Do.
26	27.9	140,100	29.4	75.6	4,757	4.80	672,000	Do.
27	29.5	148,000	30.9	77.0	4,780	4.89	724,000	Do.
28	31.0	155,700	32.4	79.5	4,802	4.86	756,000	Do.
Mar. 2	32.3	164,100	34.1	81.2	4,818	4.87	800,000	Do.
4	32.1	163,200	33.9	80 5	4,810	4.57	746,000	Do.
5	31.6	160,800	33.5	80.0	4,804	4.61	741,000	Do.
6	31.1	154,800	32.3	78.0	4,800	4.56	706,000	Do.
7	30.8	154,400	32.2	78.0	4,790	4.58	708,000	Do.
8	30.4	151,500	31.7	78.0	4,785	4.47	678,000	Do.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1889.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Mar. 9	30.3	150,000	31.5	78.0	4,784	4.45	670,000	Meter.
11	29.5	144,000	30.3	76.3	4,779	4.30	635,000	Do.
12	28.8	141,300	29.7	75.5	4,764	4.39	620,000	Do.
13	27.9	137,500	28.8	75.0	4,754	4.38	602,000	Do.
14	27.0	132,000	27.8	75.0	4,751	4.43	585,000	Do.
15	26.1	127,400	26.9	73.5	4,735	4.36	550,000	Do.
16	25.5	124,900	26.4	72.0	4,729	4.34	542,000	Do.
18	24.4	118,000	25.0	72.0	4,723	4.43	523,000	Do.
19	24.0	117,800	25.0	71.0	4,721	4.36	513,000	Do.
20	23.6	114,700	24.3	70.5	4,716	4.40	505,000	Do.
21	22.9	111,100	23.6	72.0	4,713	4.27	474,000	Do.
22	22.3	108,500	23.0	69.5	4,712	4.24	460,000	Do.
23	21.8	105,800	22.5	68.0	4,708	4.34	460,000	Do.
25	21.8	105,000	22.4	68.5	4,708	4.41	466,000	Do.
26	22.6	112,400	23.9	70.5	4,714	4.44	499,000	Do.
27	23.8	117,700	24.9	71.0	4,721	4.40	518,000	Do.
28	24.8	123,000	26.0	72.0	4,731	4.45	547,000	Do.
Apr. 1	25.2	125,700	26.5	74.0	4,732	4.42	555,000	Do.
3	24.5	120,900	25.6	71.8	4,721	4.28	518,000	Do.
5	23.4	115,900	24.6	72.3	4,713	4.34	504,000	Do.
6	22.7	114,100	24.2	72.0	4,711	4.28	489,000	Do.
8	22.0	110,400	23.5	72.0	4,708	4.24	468,000	Do.
9	21.9	110,800	23.5	72.5	4,707	4.34	480,000	Do.
10	21.8	111,000	23.6	73.0	4,707	4.32	479,000	Do.
11	21.6	110,000	23.5	73.5	4,707	4.27	473,000	Do.
13	20.8	101,800	26.3	72.5	3,895	4.35	443,000	Do.
15	19.8	98,300	28.2	70.0	3,495	4.32	425,000	Do.
16	19.5	95,700	28.2	69.1	3,393	4.35	416,000	Do.
17	19.2	94,400	27.9	70.0	3,392	4.44	420,000	Do.
18	18.8	92,000	27.5	69.0	3,341	4.31	397,000	Do.
19	18.5	88,900	27.0	67.5	3,291	4.44	395,000	Do.
20	18.4	88,700	26.9	66.7	3,291	4.35	385,000	Do.
22	19.4	94,100	27.7	70.0	3,393	4.49	423,000	Do.
23	20.2	90,700	26.2	70.3	3,694	4.41	427,000	Do.
24	20.8	102,200	21.7	69.8	4,708	4.44	454,000	Do.
25	21.4	105,500	22.4	71.0	4,708	4.40	464,000	Do.
26	21.9	108,100	22.9	69.2	4,712	4.40	476,000	Do.
27	22.7	110,900	23.6	70.0	4,714	4.48	497,000	Do.
29	23.6	114,400	24.3	71.0	4,715	4.46	509,000	Do.
30	23.2	113,800	24.1	70.2	4,714	4.41	502,000	Do.
May 1	22.3	109,800	23.3	70.0	4,708	4.27	468,000	Do.
2	20.8	102,400	21.9	68.5	4,702	4.27	437,000	Do.
1890.[a]								
Apr. 3[b]	47.4	242,600	.....	99.0	5,183	6.38	1,547,000	Do.
4	47.4	240,900	.....	100.0	5,183	6.36	1,570,000	Do.
5	47.3	230,100	.....	93.0	5,183	6.36	1,501,000	Do.
7[c]	47.2	230,300	.....	94.0	5,183	6.18	1,401,000	Do.
9	47.0	231,200	.....	97.0	5,183	6.05	1,398,000	Do.
10	47.0	238,800	.....	96.0	5,183	5.88	1,405,000	Do.
12	47.1	235,000	.....	93.0	5,183	6.13	1,443,000	Do.
14	47.2	233,000	.....	95.0	5,183	6.29	1,466,000	Do.
16	47.4	237,400	.....	96.0	5,183	6.31	1,497,000	Do.
17	47.5	238,200	.....	95.0	5,183	6.38	1,519,000	Do.
18	47.3	238,700	.....	97.0	5,183	6.23	1,487,000	Do.
19	47.0	228,900	.....	94.0	5,182	6.43	1,471,000	Do.
21	46.0	230,800	.....	94.0	5,182	5.92	1,368,000	Do.
23	44.5	224,100	.....	92.0	5,181	5.66	1,269,000	Do.
Dec. 23	11.8	64,000	32.4	51.5	1,975	3.85	246,000	Do.
24, a. m.	11.2	62,400	31.6	50.0	1,977	3.83	239,000	Do.
24, p. m.	11.1	63,000	31.9	50.5	1,977	3.72	235,000	Do.
26	10.2	60,300	30.9	49.0	1,955	3.70	223,000	Do.
27	10.2	60,000	30.7	49.0	1,955	3.82	[d] 239,000	Do.

[a] Observations by M. R. C. second district officer. April results reduced in the district office. December results in the secretary's office. High-water section was about 900 feet below the wharf boat. Low-water section of 1890 and high water of 1891 was about 7,200 feet below the wharf boat. Tabulation, Report Chief of Engineers, 1891, p. 3536.

[b] Discharge through Austin crevasse, Apr. 3, 37,370 cubic feet per second. Austin is about 18 miles above Helena.

[c] Discharge overbank L. N. O. & T. R. R. Apr. 7, 11,205 cubic feet per second.

[d] The recorded velocity at station 3 for this day seems abnormally high; interpolating a velocity for station 3 as observed on the 24th and 26th, the discharge for this day becomes 224,807 cubic feet per second.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1891.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Mar. 11	43.5	217,600	37.5	82.0	5,795	6.08	1,323,000	Double floats.
12	43.6	218,700	37.7	83.0	5,795	6.24	1,365,000	Do.
13	43.7	219,500	37.9	85.0	5,796	6.23	1,368,000	Do.
17	44.0	220,900	38.1	85.0	5,797	6.24	1,378,000	Do.
18	44.0	223,300	38.5	85.0	5,797	6.47	1,444,000	Do.
19	44.1	221,700	38.2	85.0	5,797	6.20	1,389,000	Do.
20	44.2	225,000	38.8	85.0	5,799	6.32	1,422,000	Do.
21	44.3	225,800	38.9	85.0	5,799	6.44	1,455,000	Do.
22	44.4	223,300	38.5	85.0	5,799	6.42	1,433,000	Do.
23	44.4	222,300	38.3	85.5	5,799	6.39	1,421,000	Do.
24	44.5	224,900	38.8	86.0	5,800	6.34	1,426,000	Do.
25	44.7	224,100	38.6	86.0	5,800	6.36	1,426,000	Do.
26	44.7	227,400	39.2	85.0	5,800	6.26	1,423,000	Do.
27	44.7	225,500	38.9	86.0	5,800	6.35	1,433,000	Do.
28	44.7	229,500	39.6	86.0	5,800	6.25	1,434,000	Do.
30	44.7	223,500	38.5	86.0	5,800	.....	.....	Do.
31	44.7	227,000	39.1	87.0	5,800	6.21	1,410,000	Do.
Apr. 1	44.6	224,800	38.8	87.0	5,800	6.26	1,407,000	Do.
2	44.5	227,100	39.2	86.0	5,800	6.35	1,412,000	Do.
3	44.5	222,000	38.3	85.0	5,800	6.35	1,410,000	Do.
4	44.3	221,100	38.1	85.5	5,800	6.13	1,354,000	Do.
6	44.1	220,500	38.0	87.5	5,800	6.15	1,356,000	Do.
7	44.1	218,400	37.7	86.5	5,800	6.18	1,351,000	Do.
8	44.0	219,900	37.9	85.0	5,800	6.15	1,352,000	Do.
9	44.0	226,200	38.0	85.0	5,799	5.95	1,311,000	Do.
10	44.0	222,400	38.4	86.0	5,799	6.07	1,351,000	Do.
11	44.0	220,300	38.0	86.0	5,799	6.27	1,381,000	Do.
13	44.0	223,000	38.5	85.0	5,799	6.19	1,381,000	Do.
Sept. 30	4.7	52,600	31.8	49.5	1,656	2.70	142,000	Do.
Oct. 1	4.4	50,300	30.6	47.8	1,647	2.55	128,000	Do.
2	4.0	49,500	30.1	46.8	1,645	2.67	132,000	Do.
3	3.7	50,200	30.6	47.3	1,643	2.50	125,000	Do.
5	3.3	50,500	30.8	47.7	1,642	2.64	133,000	Do.
6	3.0	50,500	30.8	47.7	1,638	2.51	127,000	Do.
7	2.7	49,800	30.5	47.9	1,633	2.53	126,000	Do.
8	2.5	48,700	29.8	46.9	1,632	2.42	118,000	Do.
9	2.2	48,600	29.8	47.1	1,631	2.48	121,000	Do.
10	2.0	48,900	30.1	46.8	1,627	2.43	119,000	Do.
12	1.7	48,200	29.7	47.3	1,624	2.25	108,000	Do.
13	1.6	47,900	29.5	46.6	1,624	2.19	105,000	Do.
14	1.5	48,200	29.7	47.1	1,624	2.22	107,000	Do.
15	1.4	48,200	29.7	47.1	1,625	2.20	106,000	Do.
16	1.3	47,900	29.5	46.8	1,624	2.20	105,000	Do.
17	1.4	47,200	29.0	46.4	1,625	2.29	108,000	Do.
19	1.8	48,000	29.5	46.8	1,630	2.43	117,000	Do.
20	2.0	48,100	29.5	47.1	1,632	2.44	117,000	Do.
21	2.2	49,000	30.0	47.0	1,635	2.43	119,000	Do.
22	2.4	48,800	29.8	46.9	1,638	2.56	125,000	Do.
23	2.5	49,100	30.0	47.1	1,640	2.54	125,000	Do.
24	2.5	48,700	29.7	46.8	1,640	2.49	121,000	Do.
26	2.4	48,600	29.7	46.6	1,639	2.52	123,000	Do.
28	2.0	48,200	29.5	46.7	1,635	2.36	113,000	Do.
29	1.9	47,800	29.2	46.7	1,633	2.41	115,000	Do.
30	1.8	47,600	29.2	46.6	1,631	2.25	107,000	Do.
31	1.7	47,100	28.9	45.8	1,631	2.20	104,000	Do.
Nov. 2	1.6	47,700	29.2	47.1	1,632	2.41	115,000	Do.
3	1.5	47,200	28.9	46.2	1,632	2.30	108,000	Do.
4	1.4	46,700	28.6	46.2	1,630	2.32	108,000	Do.
5	1.3	46,300	28.4	45.8	1,629	2.32	108,000	Do.
6	1.1	46,000	28.7	45.9	1,624	2.29	107,000	Do.
7	1.0	46,400	28.6	45.7	1,622	2.24	104,000	Do.
9	0.9	45,500	28.0	45.4	1,623	2.40	109,000	Do.
10	1.0	45,900	28.2	45.3	1,624	2.32	106,000	Do.
11	1.0	45,800	28.2	44.8	1,625	2.29	105,000	Do.
1892.[b]								
Apr. 18	42.6	200,300	40.5	97.0	5,099	5.21	1,074,000	Meter.
19	42.7	215,500	42.3	97.0	5,099	4.83	1,040,000	Do.

[a] Observations, 1891, by M. R. C. second district officer; reduction in secretary's office. Low-water section of 1891 was about 4,500 feet below the wharf boat. Tabulation, Report Chief of Engineers, 1892, page 3130. Report on observations, Report Chief of Engineers, page 3119.

[b] Section is approximately same as 1888-89, and is about 300 feet below the elevator. Observations of 1892 and 1893 taken under M. R. C. second district officer. Reduction at secretary's office. Tabulation, 1892, Report Chief of Engineers, 1893, page 3684. Report on observations, Report Chief of Engineers, 1893, page 3664.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1892.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Apr. 20	42.9	217,000	42.7	96.0	5,100	5.04	1,098,000	Meter.
21	43.2	215,900	42.3	96.0	5,101	5.16	1,114,000	Do.
May 3	44.5	219,300	42.9	98.4	5,118	5.51	1,209,000	Do.
4	44.6	221,700	43.3	97.0	5,118	5.44	1,200,000	Do.
5	44.8	223,400	43.6	96.0	5,118	5.64	1,261,000	Do.
6	44.9	225,400	44.0	96.0	5,118	5.57	1,256,000	Do.
7	45.0	220,500	44.3	96.5	5,118	5.45	1,233,000	Do.
9	45.5	227,800	44.5	96.0	5,119	5.47	1,246,000	Do.
10	45.7	229,200	44.8	97.0	5,119	5.63	1,290,000	Do.
11	45.7	230,800	45.1	97.0	5,119	5.75	1,326,000	Do.
12	45.7	229,500	44.8	97.0	5,119	5.72	1,313,000	Do.
13	45.5	229,800	44.9	97.0	5,119	5.75	1,321,000	Do.
14	45.3	228,300	44.6	96.0	5,118	5.76	1,315,000	Do.
16	44.8	225,800	44.1	96.0	5,117	5.63	1,271,000	Do.
17	44.6	222,700	43.5	96.0	5,117	5.61	1,250,000	Do.
June 1	44.7	220,900	43.2	95.0	5,117	5.65	1,247,000	Do.
2	44.7	221,200	43.2	96.0	5,117	5.40	1,194,000	Do.
3	44.7	218,300	42.7	95.0	5,117	5.39	1,177,000	Do.
4	44.6	219,600	42.9	94.0	5,117	5.37	1,180,000	Do.
6	44.6	218,200	42.6	95.0	5,117	5.43	1,185,000	Do.
7	44.6	219,100	42.8	96.0	5,117	5.37	1,177,000	Do.
8	44.6	221,000	43.2	96.0	5,116	5.42	1,198,000	Do.
9	44.7	223,000	43.6	96.5	5,118	5.40	1,203,000	Do.
10	44.8	224,500	43.9	96.0	5,118	5.35	1,200,000	Do.
11	44.9	225,600	44.1	96.0	5,119	5.42	1,222,000	Do.
13	45.0	225,300	44.0	96.0	5,119	5.36	1,207,000	Do.
14	45.1	226,400	44.2	96.0	5,119	5.42	1,227,000	Do.
15	45.1	227,100	44.4	96.0	5,119	5.42	1,231,000	Do.
16	45.1	228,200	44.6	95.0	5,119	5.47	1,247,000	Do.
17	45.1	227,100	44.4	96.0	5,119	5.33	1,210,000	Do.
18	45.0	226,000	44.1	96.0	5,119	5.56	1,255,000	Do.
20	44.8	226,700	44.3	95.0	5,119	5.46	1,237,000	Do.
21	44.6	224,800	43.9	96.0	5,119	5.30	1,191,000	Do.
22	44.4	225,200	44.0	96.0	5,119	5.15	1,161,000	Do.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1893.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
May 9	43.1	191,000	38.3	86.6	4,982	6.19	1,183,000	7,000	1,190,000	Meter.
10	43.3	193,900	38.9	87.2	4,982	6.20	1,202,000	[b] 8,000	1,210,000	Do.
11	43.5	190,500	38.2	83.6	4,983	6.24	1,189,000	8,000	1,197,000	Do.
12	43.7	198,000	39.7	90.0	4,983	6.17	1,221,000	8,000	1,229,000	Double floats.
13	43.8	202,700	40.7	90.4	4,983	6.19	1,255,000	8,000	1,264,000	Do.
15	44.2	205,200	41.2	91.3	4,983	6.24	1,280,000	9,000	1,289,000	Meter.
15	.....	.....	.....	.....	.....	6.32	1,296,000	9,000	1,305,000	Double floats.
16	44.4	212,400	42.6	94.6	4,983	6.46	1,372,000	9,000	1,382,000	Meter.
16	.....	.....	.....	.....	.....	6.14	1,306,000	9,000	1,315,000	Double floats.
17	44.6	206,100	41.3	91.0	4,984	6.26	1,280,000	10,000	1,290,000	Meter.
17	44.6	206,100	41.3	91.0	4,984	6.09	1,256,000	10,000	1,266,000	Double floats.
18	44.9	211,500	42.4	91.8	4,984	6.35	1,344,000	10,000	1,354,000	Meter.
19	45.2	206,200	41.3	89.1	4,985	6.46	1,332,000	10,000	1,343,000	Do.
19	.....	.....	.....	.....	.....	6.32	1,302,000	10,000	1,313,000	Double floats.
20	45.7	213,500	42.8	92.7	4,988	6.60	1,410,000	11,000	1,421,000	Meter.
22	46.9	227,400	45.5	95.6	4,994	6.37	1,449,000	[b] 13,000	1,462,000	Double floats.
23	47.5	231,200	46.3	96.8	4,995	6.83	1,580,000	14,000	1,594,000	Meter.
23	.....	.....	.....	.....	.....	6.67	1,543,000	14,000	1,556,000	Double floats.
24	47.7	218,300	43.7	93.8	4,999	6.81	1,487,000	14,000	1,501,000	Meter.
24	.....	.....	.....	.....	.....	6.91	1,508,000	14,000	1,512,000	Double floats.
25	47.9	223,400	44.7	94.0	4,999	6.90	1,540,000	14,000	1,555,000	Meter.
25	.....	.....	.....	.....	.....	6.98	1,560,000	14,000	1,574,000	Double floats.
26	47.8	220,700	44.1	94.0	4,999	6.86	1,513,000	14,000	1,527,000	Meter.
26	.....	.....	.....	.....	.....	6.83	1,507,000	14,000	1,521,000	Double floats.
29	47.0	217,800	43.6	92.0	4,998	6.60	1,437,000	13,000	1,449,000	Meter.
29	47.0	217,800	43.6	92.0	4,998	6.67	1,453,000	13,000	1,465,000	Double floats.
31	45.9	210,800	42.2	.....	4,995	6.52	1,373,000	11,000	1,385,000	Meter.
June 1	45.8	211,200	42.3	91.5	4,992	6.64	1,402,000	11,000	1,413,000	Do.
1	.....	.....	.....	.....	.....	6.51	1,375,000	11,000	1,387,000	Double floats.
2 [c]	45.7	210,100	42.1	.....	4,992	6.54	1,375,000	11,000	1,386,000	Meter.
5	45.3	206,600	41.4	91.0	4,990	6.46	1,333,000	10,000	1,344,000	Do.

[a] Section was 4,500 feet below the wharfboat. Tabulation, Report Chief of Engineers 1894, p. 2828. Report on work, Report Chief of Engineers 1894, p. 2822.

[b] Observed; floats used.

[c] Area interpolated from June 1 and 5.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

[306 miles below Cairo.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1895.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Oct. 24, a. m.	− 1.7	36,600	19.1	47.0	1,918	2.53	93,000	.....	.....	Meter.
24, p. m.	− 1.1	36,000	18.7	47.0	1,918	2.44	88,000	.....	.....	Do.
1896.										
Nov. 18.....	7.1	57,900	29.6	51.4	1,955	3.41	197,000	.....	.....	Double floats.
19.....	7.9	59,500	30.5	53.8	1,955	3.42	204,000	.....	.....	Meter.
20.....	8.9	60,800	30.7	53.8	1,980	3.60	219,000	.....	.....	Do.
20.....	8.9	61,400	31.0	54.1	1,980	3.72	229,000	.....	.....	Double floats.
21.....	9.7	63,000	31.8	55.0	1,985	3.56	224,000	.....	.....	Meter.
21.....	9.7	63,400	31.6	57.5	2,005	3.53	224,000	.....	.....	Double floats.
23.....	10.4	65,000	32.4	56.5	2,010	3.80	247,000	.....	.....	Meter.
23.....	10.4	65,300	32.5	56.1	2,010	3.78	247,000	.....	.....	Do.
24.....	10.4	64,500	32.1	56.1	2,010	3.76	242,000	.....	.....	Do.
24.....	10.4	65,000	32.3	56.0	2,010	3.52	228,000	.....	.....	Double floats.
1897.[b]										
Mar. 12.....	42.8	191,400	39.0	83.9	4,902	5.99	1,146,000	.....	.....	Meter.
13.....	[c] 43.5	190,300	38.7	88.0	4,910	6.06	1,154,000	.....	.....	Do.
15.....	44.7	200,700	40.8	88.5	4,916	6.26	1,256,000	.....	.....	Do.
16.....	45.4	206,000	41.9	87.8	4,919	6.22	1,281,000	.....	.....	Do.
17.....	45.8	197,700	40.2	88.9	4,921	6.27	1,240,000	.....	.....	Do.
19.....	47.7	204,800	41.6	90.1	4,926	6.68	1,369,000	[d] 2,000	1,371,000	Do.
20.....	48.4	210,600	42.7	89.7	4,926	6.82	1,435,000	.....	.....	Do.
20.....	48.4	210,600	42.7	89.7	4,926	6.48	1,365,000	.....	.....	Double floats.
22.....	49.0	219,800	44.6	93.1	4,926	6.76	1,486,000	.....	.....	Meter.
22.....	49.0	219,800	44.6	93.1	4,926	6.74	1,481,000	.....	.....	Double floats.
Nov. 17.....	.4	47,100	25.9	47.4	1,817	2.10	99,000	.....	.....	Meter.
18.....	.6	48,000	26.4	47.5	1,818	2.09	101,000	.....	.....	Do.
18.....	.6	49,200	27.1	47.0	1,819	2.13	105,000	.....	.....	Do.
18.....	.6	48,100	26.4	47.2	1,820	2.07	100,000	.....	.....	Double floats.
18.....	.6	49,400	27.1	47.3	1,820	2.06	102,000	.....	.....	Do.
19.....	1.0	49,300	26.9	47.5	1,833	2.17	107,000	.....	.....	Meter.
19.....	1.0	50,100	27.3	47.5	1,834	2.20	110,000	.....	.....	Do.
19.....	1.0	49,600	27.0	47.5	1,836	2.18	108,000	.....	.....	Do.
19.....	1.0	49,000	27.2	47.6	1,836	2.17	108,000	.....	.....	Double floats.
20.....	1.5	49,600	26.9	47.8	1,845	2.30	114,000	.....	.....	Meter.
1898.										
Apr. 9.....	45.6	198,100	40.2	93.6	4,925	6.43	1,274,000	.....	.....	Do.
11.....	46.9	206,100	41.8	95.1	4,933	6.42	1,324,000	.....	.....	Do.
12.....	47.5	208,800	42.3	.....	4,933	6.82	1,424,000	.....	.....	Double floats.
12.....	47.5	209,500	42.5	95.4	4,933	6.55	1,372,000	.....	.....	Meter.
13.....	48.0	214,000	43.4	95.8	4,933	6.49	1,388,000	.....	.....	Do.
14.....	48.4	212,200	43.0	95.0	4,933	6.62	1,405,000	.....	.....	Do.
15.....	48.8	213,300	43.2	.....	4,933	6.68	1,425,000	.....	.....	Double floats.
15.....	48.8	213,500	43.3	97.2	4,933	6.58	1,405,000	.....	.....	Meter.
16.....	49.0	215,400	43.7	96.7	4,933	6.47	1,394,000	.....	.....	Do.

[a] Discharge section is at same place as in 1890, which is about 7,200 feet below the wharf boat. Price meter used. Observations under the direction of the first and second district officer M. R. C. Report Chief of Engineers, 1896, p. 3554. The gauge used was the U. S. Engineer gauge at Helena, whose zero is 161.08 feet above Cairo datum plane.

[b] The discharge section was about one-half mile below Helena. U. S. C. & G. S. Ⓐ N. Base, on right bank, was in line of section. The float observations were taken with double floats, the lower float being at mid-depth. The meter observations were made with the Haskell meter held at 0.6 depth, generally for five minutes. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers, 1897, p. 3653.

[c] Water just over bank at this gauge reading.

[d] Right bank.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

[307 miles below Cairo.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.	Corrected.	
			Mean.	Maximum.					Area.	Discharge.
1901.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*		*Sq. ft.*	*Cu. ft.*
Dec. 3, a. m	1.50	[b]51,100	31.7	49.0	1,610	2.19	112,000	Double floats..	541	118,000
						1.87	96,000	Meter		101,000
3, p. m	1.53					1.93	99,000	....do		105,000
						1.90	100,000	....do		100,000
4, a. m	1.65	[c]53,200	33.0	50.8	1,610	2.10	111,000	Double floats..	562	118,000
						1.96	104,000	Meter		110,000
4, p. m	1.70	[d]52,200	32.4	49.8	1,610	2.03	106,000	....do	554	112,000
						2.19	114,000	Double floats..		121,000
						2.05	107,000	Meter		113,000
5	1.85	53,000	32.9	49.8	1,610	2.22	118,000	Double floats..	562	125,000

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1903.[e]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Mar. 20	49.35	208,100	40.2	98.0	5,178	6.24	1,299,000	[f]59,000	1,358,000	Meter.
21	49.70	215,400	41.6	101.0	5,178	6.22	1,339,000	62,000	1,401,000	Do.
22	50.03	211,400	40.8	100.0	5,178	6.56	1,387,000	[f]64,000	1,452,000	Do.
23	50.40	210,500	40.6	101.3	5,178	6.71	1,413,000	[f]67,000	1,480,000	Do.
24	50.68	212,000	40.9	101.3	5,178	6.46	1,370,000	[f]68,000	1,438,000	Do.
25 a. m	50.88	228,700	44.2	105.3	5,178	6.51	1,489,000	[f]69,000	1,558,000	Do.
25 p. m	50.90	.....	.....	.....	.....	7.07	1,617,000	[f]69,000	1,686,000	Double floats.
26	51.00	218,100	42.1	107.3	5,178	6.71	1,404,000	[f]70,000	1,534,000	Meter.
1904.										
Apr. 6[g]	43.20	181,000	37.0	.....	4,903	6.30	1,144,000	1,000	1,145,000	Do.
9	45.55	193,200	39.4	94.8	4,903	6.85	1,323,000	2,000	1,325,000	Do.
10	46.30	198,000	39.8	96.8	4,927	6.80	1,335,000	2,000	1,336,000	Do.
11	46.90	[h]202,300	41.0	.....	4,936	6.81	1,377,000	2,000	1,379,000	Double floats.
12	47.23	207,400	41.9	96.6	4,945	6.76	1,403,000	2,000	1,405,000	Meter.
13	47.48	209,300	42.3	96.6	4,945	6.71	1,404,000	2,000	1,406,000	Double floats.
14	47.61	209,700	41.8	97.8	4,945	6.82	1,410,000	2,000	1,412,000	Meter.
15	47.62	[i]209,800	41.8	.....	4,945	6.61	1,368,000	2,000	1,370,000	Do.

[a] From the survey made in March, 1903, in which the same triangulation stations used in 1901 on the right bank were again occupied, it appears that an error was made in 1901 in the length of the base line used on the left bank on which the width of discharge section depended. This base was on a sand bar, and the hubs were washed out as the river rose immediately after the observations of 1901; a remeasurement of the original base was therefore impossible.

The areas of cross section and discharges have been recomputed in 1905, using the new value of the base, and the results are given in the columns marked "Corrected" in the table herewith. The new width is 1,707 feet. The original results are also given in the table. Results of 1901 in Report of Chief of Engineers, 1902, supplement, page 71. Mississippi River Commission gauge, at Helena, whose zero is 161.98 feet above the Cairo datum plane. Observations and reduction of 1901 made under direction of Capt. G. P. Howell, Corps of Engineers, secretary Mississippi River Commission.

[b] Derived from four sets of soundings.

[c] Derived from two sets of soundings.

[d] Derived from three sets of soundings.

[e] Observations and reduction of 1901 and 1903 made under direction of Capt. G. P. Howell, Corps of Engineers, secretary Mississippi River Commission; those of 1904 made under direction of Capt. William B. Ladue, Corps of Engineers, secretary Mississippi River Commission. Discharge section same as used in 1898, about one-half mile below Helena. Results of 1903 in report of Chief of Engineers, 1903, Supplement, page 113; results of 1904 in report for 1905, Supplement, page 118. Mississippi River Commission gauge, at Helena, whose zero is 161.98 feet above the Cairo datum plane. In 1904 a Haskell and a Price meter were run simultaneously and the weighted means used.

[f] 1903, overbank discharge measured on left bank. All overbank discharges derived from measurement made on Mar. 21. 1904, overbank discharge measured on right bank. All overbank discharges derived from measurement made on Apr. 10.

[g] Soundings of Apr. 7 mainly used for cross section of Apr. 6.

[h] Interpolated.

[i] Area of Apr. 14 corrected for change of gauge.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1906.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Apr. 14	46.08	.....	+0.70	200,066	201,590	42.0	43.0	105.0	4,703
15	46.42	.....	+ .35	199,016	201,921	41.8	42.4	99.8	4,703
16	46.70	.....	+ .33	204,135	205,707	42.9	43.2	102.4	4,703
17	46.92	.....	+ .17	201,953	.....	.....	.....	.....	.....
18	47.03	.....	+ .15	199,771	199,771	41.9	41.9	100.0	4,703

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1906.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Apr. 14	.....	5.89	1,178,050	Meter	13	83	VIII. Light.
15	−2,660	6.15	1,223,528	.....do	17	71	Calm.
16	+3,786	5.94	1,211,951	.....do	16	64	XII. Light.
17	.....	5.92	1,195,566	Double floats	15	....	Calm.
18	−5,936	6.30	1,258,689	Meter	16	77	Do.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1907.[b]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Jan. 28	45.6	.....	+0.6	202,572	220,313	41.0	45.8	111.0	4,946
29	46.3	.....	+ .6	203,848	224,127	41.2	45.3	113.0	4,946
30	47.0	.....	+ .7	205,698	222,514	41.6	45.0	108.0	4,946
Feb. 1	48.8	.....	+ .9	.....	.....	.....	.....	.....	4,946
3	49.9	.....	+ .6	217,646	220,110	44.0	44.5	112.0	4,946
4	50.2	.....	+ .3	219,275	220,204	44.3	44.5	113.0	4,946
5	50.4	.....	+ .2	217,430	217,430	44.0	44.0	107.0	4,946
6	50.4	.....	.0	.....	.....	.....	.....	.....	4,946

Date	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1907.[b]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Jan. 28	.....	6.34	1,284,993	33,016	1,318,009	Meter	13	84	
29	−2,186	6.50	1,342,615	37,430	1,380,045	.....do	16	94	
30	−1,613	6.81	1,401,614	41,848	1,443,462	.....do	14	50	
Feb. 1	.....	7.42	1,581,132	53,205	1,634,337	.....do	19	....	
3	−2,395	7.49	1,631,026	60,144	1,691,170	.....do	13	42	
4	+ 145	7.23	1,585,652	62,037	1,647,689	.....do	17	58	
5	−2,834	6.47	1,407,637	63,299	1,470,936	Double floats	11	26	II. Light.
6	.....	6.48	1,414,310	63,299	1,477,609	.....do	9	....	II. Brisk.

[a] Observations and reductions made under direction of Capt. W. B. Ladue, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Zero of United States engineer standard gauge is 161.98 feet above the Cairo datum plane. The datum line for computing datum areas was at 47.03 feet on the gauge. The discharge section is about one-half mile below Helena and is the same as that used in 1904. Soundings of April 17 are mainly interpolated from the 16th and 18th. Velocities were measured with Price meter No. 38, except on April 16, when Price meter No. 25 was used and on the 17th when No. 25 was used on part of the section.

[b] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission. Helena, United States engineer gauge; zero is 161.98 feet above the Cairo datum plane. The datum line for computing datum areas was taken at 50.4 feet on the gauge. The readings are given for time of discharge observations; the rise or fall is computed from the 8 a. m. readings. Price meter No. 38 was used. The discharge section was the same as that used in 1904, about one-half mile below Helena, Ark. Overbank discharge was on the left bank. It was measured on February 2. All overbank discharges derived from this measurement.

Results of discharge observations, Mississippi River—Continued.

HELENA, ARK.—Continued.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Mar. 23	44.83	.....	+0.30	[b] 184,470	.....	38.2	.....	.....	4,835
24	45.00	.....	+ .15	185,500	186,080	38.4	38.5	98.0	4,835
25	45.12	.....	+ .15	[b] 186,046	.....	38.5	.....	.....	4,835
26	45.18	.....	+ .08	[b] 187,162	.....	38.7	.....	.....	4,835
27	45.12	.....	− .08	186,876	186,876	38.7	38.7	99.0	4,835
28	45.00	.....	− .08	[b] 186,303	.....	38.5	.....	.....	4,835
29	44.90	.....	− .12	[b] 187,924	.....	38.9	.....	.....	4,835
30	44.58	.....	− .25	186,390	189,001	38.6	39.2	98.0	4,835
31	44.30	.....	− .30	181,945	185,910	37.6	38.5	96.0	4,835

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge overbank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Mar. 23....	.....	7.24	1,335,158	20,750	1,355,908	2 meters.....	14	.....	XI light.
24....	.....	7.10	1,317,582	21,335	1,338,917	.....do.....	16	99	V light.
25....	.....	6.48	1,206,437	21,761	1,228,198	Meter.....	16	.....	VI brisk.
26....	.....	6.55	1,224,555	22,064	1,246,619	.....do.....	16	.....	V light.
27....	+ 796	6.89	1,287,045	20,894	1,308,539	2 meters.....	16	109	VI light.
28....	.....	6.57	1,224,542	19,683	1,244,225	.....do.....	16	.....	V light.
29....	.....	6.50	1,222,221	20,040	1,242,261	.....do.....	16	.....	I light.
30....	+2,125	6.47	1,206,425	18,957	1,225,382	Double floats..	13	99	V light.
31....	−3,091	6.45	1,172,717	17,871	1,190,588	.....do.....	13	80	VI light.

OLD TOWN BEND.

[Discharge section in Old Town Bend, about 325 miles below Cairo. The gauge readings in the table are those of the United States Engineer gauge at Helena, Ark., about 18 miles above the section. The observations and reduction were made under the direction of the Mississippi River Commission, second district officer, by Assistant Chas. Levassieur.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1894.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Nov. 8, a. m.	−2.2	50,200	28.8	52.5	1,745	1.53	77,000	.....	.....	Meter.
8, p. m.	−2.2	50,200	28.7	52.5	1,745	1.75	88,000	.....	.....	Do.
9.....	−2.2	50,300	28.8	52.5	1,745	1.75	88,000	.....	.....	Do.

[a] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Zero of United States engineer standard gauge is 161.98 feet above the Cairo datum plane. The readings are given for the time of discharge observations. The change in twenty-four hours is computed from the 8 a. m. readings. The discharge section is about one-half mile below Helena and is the same as that used in previous years. Overbank discharge measured on the left bank on Mar. 25 and 29. All other overbank discharges derived from these measurements.

[b] Interpolated.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1884.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Oct. 6	16.6	139,400	42.5	80.0	3,282	3.20	455,000	.....	.....	Meter.
7	18.0	145,100	44.2	82.0	3,285	3.34	485,000	.....	.....	Do.
8	19.2	154,000	46.7	82.5	3,298	3.47	535,000	.....	.....	Do.
9	20.0	149,900	45.4	84.5	3,302	3.59	539,000	.....	.....	Do.
10	20.6	159,900	48.4	84.0	3,302	3.45	552,000	.....	.....	Do.
13	20.2	153,100	46.4	82.0	3,299	3.15	482,000	.....	.....	Do.
14	19.5	150,100	45.5	82.0	3,299	2.98	447,000	.....	.....	Do.
15	18.8	145,300	44.1	81.5	3,295	2.92	428,000	.....	.....	Do.
16	18.4	143,700	43.6	81.0	3,295	2.83	406,600	.....	.....	Do.
17	18.2	143,600	43.6	80.0	3,295	2.97	427,000	.....	.....	Do.
18	18.1	144,500	43.8	81.0	3,295	2.86	414,000	.....	.....	Do.
20	18.5	144,500	43.8	81.0	3,296	2.81	405,000	.....	.....	Do.
21	18.5	144,000	43.7	81.5	3,296	2.91	419,000	.....	.....	Do.
22	18.4	143,400	43.5	80.5	3,295	2.89	414,000	.....	.....	Do.
23	18.2	141,900	43.1	79.5	3,295	2.94	418,000	.....	.....	Do.
24	18.0	139,700	42.4	81.0	3,295	2.82	394,000	.....	.....	Do.
25	17.6	138,500	42.1	81.0	3,280	2.71	375,000	.....	.....	Do.
27	16.8	135,400	41.3	77.0	3,281	2.77	376,000	.....	.....	Do.
28	16.4	133,500	40.7	77.0	3,279	2.68	357,000	.....	.....	Do.
29	16.2	131,600	40.1	77.0	3,277	2.69	354,000	.....	.....	Do.
30	16.0	130,100	39.7	77.0	3,277	2.71	352,000	.....	.....	Do.
31	16.3	132,400	40.4	78.0	3,278	2.66	352,000	.....	.....	Do.
Nov. 1	16.5	134,500	41.0	78.0	3,282	2.72	366 000	.....	.....	Do.
3	16.4	131,100	39.9	77.0	3,282	2.69	352,000	.....	.....	Do.
4	16.2	130,400	39.7	77.0	3,281	2.75	359,000	.....	.....	Do.
5	16.1	130,600	39.8	78.0	3,278	2.77	362,000	.....	.....	Do.
6	16.0	130,900	39.9	77.0	3,277	2.74	359,000	.....	.....	Do.
7	15.7	129,400	39.5	77.0	3,275	2.67	345,000	.....	.....	Do.
8	15.2	126,500	38.7	75.5	3,270	2.67	338,000	.....	.....	Do.
10	14.0	121,500	37.2	76.0	3,265	2.58	313,000	.....	.....	Do.
11	13.4	120,400	36.9	74.0	3,260	2.49	299,000	.....	.....	Do.
12	12.8	118,700	36.5	73.0	3,255	2.50	296,000	.....	.....	Do.
13	12.2	115,800	35.6	72.5	3,251	2.46	285,000	.....	.....	Do.
14	11.7	113,600	34.9	72.0	3,248	2.37	269,000	.....	.....	Do.
15	11.2	112,800	34.8	73.0	3,245	2.38	268,000	.....	.....	Do.
17	10.2	108,300	33.6	70.0	3,224	2.35	254,000	.....	.....	Do.
18	9.8	107,100	33.8	68.5	3,165	2.27	243,000	.....	.....	Do.
19	9.5	106,000	33.6	69.0	3,154	2.47	262,000	.....	.....	Do.
20	9.2	104,800	33.6	69.0	3,119	2.30	241,000	.....	.....	Do.
21	9.0	103,400	33.1	68.5	3,119	2.42	250,000	.....	.....	Do.
22	8.9	103,900	33.3	68.3	3,119	2.44	253,000	.....	.....	Do.
24	8.9	103,000	33.0	68.5	3,119	2.52	260,000	.....	.....	Do.
25	8.8	103,000	33.0	69.0	3,119	2.36	243,000	.....	.....	Do.
26	8.7	102,500	32.9	68.5	3,118	2.40	246,000	.....	.....	Do.
27	8.6	101,700	32.7	68.2	3,115	2.34	238,000	.....	.....	Do.
29	8.7	101,800	32.7	68.0	3,115	2.36	241,000	.....	.....	Do.
Dec. 1	9.8	105,400	33.4	69.0	3,154	2.45	259,000	.....	.....	Do.
2	10.7	107,200	33.2	69.5	3,220	2.64	283,000	.....	.....	Do.
3	11.4	110,300	34.0	69.5	3,246	2.61	288,000	.....	.....	Do.
4	11.9	111,800	34.4	70.0	3,248	2.62	292,000	.....	.....	Do.
5	12.0	111,200	34.2	70.5	3,250	2.58	287,000	.....	.....	Do.
6[b]	11.6	110,700	34.1	69.5	3,248	2.89	320,000	.....	.....	Do.
8	10.3	100,800	33.1	69.5	3,220	2.43	260,000	.....	.....	Do.
9	9.6	103,500	32.8	69.0	3,154	2.43	252,000	.....	.....	Do.
10	8.8	100,400	32.2	68.0	3,119	2.46	248,000	.....	.....	Do.
11[b]	8.2	98,300	31.6	67.0	3,115	2.63	258,000	.....	.....	Do.
12	7.8	96,800	31.1	66.4	3,114	2.42	234,000	.....	.....	Do.
13	7.4	94,700	30.4	66.4	3,111	2.34	221,000	.....	.....	Do.
15	8.8	99,700	32.0	67.7	3,115	2.44	243,000	.....	.....	Do.
16	10.9	107,000	33.1	69.2	3,220	2.68	286,000	.....	.....	Do.
17	12.8	112,400	34.5	71.7	3,255	2.85	321,000	.....	.....	Do.
18[b]	15.0	117,000	35.8	74.7	3,268	2.88	337,000	.....	.....	Do.
19	16.6	124,800	38.0	76.2	3,282	2.92	365,000	.....	.....	Do.
20	17.6	127,400	38.8	78.6	3,286	3.06	390,000	.....	.....	Do.
22	18.4	131,900	40.0	77.6	3,296	3.14	415,000	.....	.....	Do.
23	18.4	128,300	38.9	78.1	3,296	3.06	393,000	.....	.....	Do.
24	18.1	129,000	39.1	78.4	3,295	3.03	397,000	.....	.....	Do.
26	16.8	123,400	37.6	75.8	3,281	2.96	365,000	.....	.....	Do.
29	15.0	117,400	35.9	73.5	3,270	2.90	340,000	.....	.....	Do.
30	16.8	121,500	37.0	75.0	3,281	3.09	376,000	.....	.....	Do.
31	20.3	131,400	39.8	77.2	3,299	3.49	458,000	.....	.....	Do.

[a] Observations and reduction, of 1884–85, made under direction of the secretary Mississippi River Commission. Section about one-half mile below Arkansas City. Report on reduction, and tabulation, in Report Chief of Engineers 1887, page 2835.

[b] Reject.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1885.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Jan. 1	23.3	142,400	43.1	77.7	3,305	3.91	557,000	.....	.....	Meter.
2	26.1	154,500	46.6	82.6	3,313	4.12	637,000	.....	.....	Do.
3	28.7	162,500	48.8	87.0	3,328	4.43	720,000	.....	.....	Do.
7	35.6	184,500	54.9	91.9	3,359	4.84	892,000	.....	.....	Do.
9	36.8	194,600	57.7	96.5	3,370	4.98	969,000	.....	.....	Do.
10	37.3	201,600	59.8	102.2	3,370	4.86	981,000	.....	.....	Do.
12	38.1	207,100	61.4	105.2	3,371	4.91	1,016,000	.....	.....	Do.
13	38.5	202,100	59.9	103.4	3,371	4.80	969,000	.....	.....	Do.
14	39.0	202,300	60.0	101.6	3,371	5.17	1,045,000	.....	.....	Do.
16	40.3	207,900	61.7	102.6	3,371	5.37	1,117,000	.....	.....	Do.
17	40.6	207,400	61.5	102.9	3,372	5.15	1,068,000	.....	.....	Do.
19	41.0	207,400	61.5	102.8	3,374	5.31	1,101,000	.....	.....	Do.
20	41.2	209,200	62.6	103.0	3,375	5.11	1,070,000	.....	.....	Do.
22	41.4	207,000	61.6	103.0	3,376	5.16	1,072,000	.....	.....	Do.
23	41.5	211,50	62.6	102.8	3,377	5.16	1,092,000	.....	.....	Do.
30	41.7	218,600	64.7	102.9	3,380	.....	.....	.....	.....	Do.
31	41.7	217,800	64.4	103.9	3,380	4.89	1,064,000	.....	.....	Do.
Feb. 2	41.6	216,200	64.0	103.9	3,380	4.98	1,077,000	.....	.....	Do.
3	41.3	216,300	64.0	103.9	3,380	4.85	1,050,000	.....	.....	Do.
4	40.8	217,100	64.4	103.9	3,374	4.73	1,026,000	.....	.....	Do.
5	39.9	216,000	64.1	103.6	3,371	4.54	981,000	.....	.....	Do.
6	38.7	212,200	63.0	102.7	3,371	4.38	930,000	.....	.....	Do.
7	37.5	205,300	60.9	102.6	3,371	4.23	868,000	.....	.....	Do.
9	35.1	194,000	57.7	99.4	3,364	4.06	787,000	.....	.....	Do.
11	33.6	188,400	56.2	97.1	3,350	3.94	743,000	.....	.....	Do.
12	33.2	184,200	54.9	96.8	3,354	3.97	730,000	.....	.....	Do.
13	32.9	184,800	55.1	95.6	3,354	4.07	753,000	.....	.....	Do.
14	32.7	184,100	54.9	95.5	3,354	4.17	768,000	.....	.....	Do.
16	32.2	179,900	53.6	95.5	3,353	4.08	734,000	.....	.....	Do.
17	32.2	181,800	54.2	95.5	3,353	4.18	759,000	.....	.....	Do.
18	32.2	179,700	53.6	95.6	3,353	4.09	735,000	.....	.....	Do.
20	32.2	181,000	54.0	95.7	3,353	4.19	758,000	.....	.....	Do.
21	32.0	180,200	53.7	94.7	3,353	4.03	726,000	.....	.....	Do.
23	30.5	175,000	52.3	93.3	3,344	3.82	669,000	.....	.....	Do.
24	29.6	168,800	50.5	91.2	3,342	3.71	626,000	.....	.....	Do.
27	25.4	152,200	45.7	85.0	3,331	3.35	510,000	.....	.....	Do.
28	24.0	146,300	43.9	83.7	3,328	3.31	484,000	.....	.....	Do.
Mar. 2	22.1	144,400	43.7	83.7	3,302	3.26	470,000	.....	.....	Do.
3	21.8	144,500	43.8	83.2	3,301	3.17	458,000	.....	.....	Do.
4	21.8	145,800	44.2	82.7	3,301	3.27	476,000	.....	.....	Do.
5	21.8	144,200	43.7	84.5	3,301	3.18	459,000	.....	.....	Do.
6	22.2	145,400	44.1	82.6	3,301	3.24	471,000	.....	.....	Do.
7	22.6	146,900	44.5	85.5	3,302	3.34	491,000	.....	.....	Do.
9	23.8	152,200	45.8	85.2	3,323	3.31	504,000	.....	.....	Do.
10	24.5	154,400	46.4	87.0	3,330	3.46	534,000	.....	.....	Do.
11	25.5	155,600	46.7	87.3	3,332	3.49	543,000	.....	.....	Do.
12	26.7	158,800	47.6	88.1	3,337	3.58	568,000	.....	.....	Do.
13	28.1	164,800	49.3	89.2	3,340	3.83	630,000	.....	.....	Do.
14	29.3	168,400	50.3	91.0	3,346	3.75	631,000	.....	.....	Do.
16	30.9	174,400	52.0	92.1	3,353	4.00	698,000	.....	.....	Do.
17	31.4	174,600	52.0	93.3	3,355	4.11	717,000	.....	.....	Do.
18	32.0	181,000	53.9	96.4	3,359	4.10	742,000	.....	.....	Do.
19	32.7	178,800	53.2	92.0	3,362	4.29	767,000	.....	.....	Do.
20	33.4	180,500	53.6	94.8	3,364	4.32	779,000	.....	.....	Do.
21	34.0	184,900	54.9	96.5	3,367	4.19	774,000	.....	.....	Do.
23	34.8	187,700	55.7	97.6	3,369	4.20	788,000	.....	.....	Do.
24	34.8	192,400	57.1	97.2	3,370	4.16	801,000	.....	.....	Do.
25	34.9	188,800	56.0	96.8	3,370	4.19	792,000	.....	.....	Do.
26	34.8	189,300	56.2	98.9	3,370	4.23	802,000	.....	.....	Do.
27	34.6	188,800	56.0	96.7	3,369	4.18	789,000	.....	.....	Do.
28	34.3	188,200	55.9	96.5	3,365	4.35	819,000	.....	.....	Do.
30	33.3	185,600	55.2	95.5	3,362	4.00	743,000	.....	.....	Do.
31	32.6	181,100	53.9	94.5	3,358	3.95	715,000	.....	.....	Do.
Apr. 1	31.8	178,500	53.2	94.0	3,354	3.85	687,000	.....	.....	Do.
2	30.8	173,900	51.9	94.0	3,350	3.84	669,000	.....	.....	Do.
3	29.9	168,000	50.1	89.5	3,51	3.90	654,000	.....	.....	Do.
4	28.9	165,700	49.5	91.0	3,345	3.73	618,000	.....	.....	Do.
6	27.3	159,900	47.9	86.0	3,340	3.51	562,000	.....	.....	Do
7	26.9	157,800	47.3	86.0	3,339	3.55	561,000	.....	.....	Do.
8	26.8	157,600	47.2	87.0	3,343	3.54	559,000	.....	.....	Do.
9	27.1	157,600	47.1	85.0	3,343	3.60	567,000	.....	.....	Do.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1887.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Mar. 22	46.6	233,100	68.0	95.0	3,414	6.12	1,427,000	.....	.....	Meter.
23	46.6	233,700	68.1	97.0	3,414	6.20	1,448,000	.....	.....	Do.
24	46.6	247,400	72.1	97.0	3,416	5.98	1,480,000	.....	.....	Do.
25	46.6	240,900	70.1	.....	3,420	5.84	1,406,000	.....	.....	Do.
26, a. m.	46.6	234,300	68.2	96.0	3,420	6.08	1,424,000	.....	.....	Do.
26, p. m.	.....	.....	.....	.....	.....	6.02	1,411,000	.....	.....	Do.
1889.										
Jan. 22	33.4	183,600	54.5	81.0	3,371	4.30	789,000	.....	.....	Do.
23	34.1	186,000	55.2	83.0	3,371	4.80	894,000	.....	.....	Do.
24	34.7	190,900	56.6	83.0	3,372	4.44	849,000	.....	.....	Do.
28	35.2	191,400	56.7	85.0	3,373	4.71	901,000	.....	.....	Do.
29	35.0	192,700	57.1	85.0	3,373	4.33	834,000	.....	.....	Do.
30	34.6	191,000	56.7	85.5	3,372	4.42	846,000	.....	.....	Do.
31	34.1	189,500	56.2	86.0	3,372	4.30	815,000	.....	.....	Do
Feb. 2	33.5	187,300	55.6	84.5	3,371	4.54	851,000	.....	.....	Do.
4	33.3	185,400	55.0	85.5	3,371	4.29	795,000	.....	.....	Do.
6	33.5	179,800	53.3	83.0	3,372	4.41	793,000	.....	.....	Do.
7	33.8	178,600	53.0	81.5	3,372	4.38	781,000	.....	.....	Do.
8	33.9	179,800	53.3	83.0	3,372	4.11	738,000	.....	.....	Do.
9	33.8	181,400	53.8	83.0	3,371	4.26	773,000	.....	.....	Do.
11	33.1	175,700	52.1	82.0	3,371	4.11	721,000	.....	.....	Do.
12	32.2	175,200	52.0	81.5	3,370	4.11	720,000	.....	.....	Do.
14	30.0	167,900	49.9	78.0	3,368	3.72	625,000	.....	.....	Do.
16	26.8	142,700	42.7	68.5	3,341	3.58	510,000	.....	.....	Do.
19	22.7	129,000	38.8	63.0	3,321	3.22	416,000	.....	.....	Do.
20	21.5	125,300	38.0	66.0	3,296	3.24	406,000	.....	.....	Do.
21	20.6	125,200	38.1	65.0	3,285	3.23	405,000	.....	.....	Do.
22	20.2	123,900	37.7	65.5	3,284	3.21	398,000	.....	.....	Do.
23	21.0	127,600	38.8	66.0	3,285	3.40	434,000	.....	.....	Do.
25	25.5	143,500	43.1	69.0	3,327	3.71	532,000	.....	.....	Do.
26	27.6	148,100	44.3	73.5	3,346	3.96	587,000	.....	.....	Do.
27	29.2	156,300	46.6	73.5	3,353	3.90	689,000	.....	.....	Do.
28	30.7	160,100	47.7	74.0	3,359	3.97	635,000	.....	.....	Do.
Mar. 2	32.8	168,300	49.9	77.5	3,372	4.15	699,000	.....	.....	Do.
4	33.8	167,600	49.6	78.0	3,376	4.41	739,000	.....	.....	Do.
5	34.1	168,400	49.9	77.5	3,376	4.21	710,000	.....	.....	Do.
6	34.5	172,100	51.0	78.5	3,376	4.34	748,000	.....	.....	Do.
7	34.9	172,800	51.2	78.5	3,376	4.34	750,000	.....	.....	Do.
8	35.0	172,200	51.0	78.0	3,377	4.33	745,000	.....	.....	Do.
9	35.0	173,800	51.5	78.0	3,377	4.19	728,000	.....	.....	Do.
11	34.6	175,000	51.8	79.0	3,377	4.18	731,000	.....	.....	Do.
12	34.2	174,500	51.7	81.0	3,376	4.12	719,000	.....	.....	Do.
13	33.6	171,500	50.8	77.0	3,375	4.07	698,000	.....	.....	Do.
14	32.9	168,200	49.9	74.5	3,374	4.04	679,000	.....	.....	Do.
15	32.1	166,800	49.5	77.5	3,370	4.00	668,000	.....	.....	Do.
16	31.3	162,800	48.4	76.5	3,363	3.90	634,000	.....	.....	Do.
19	29.0	154,900	46.2	73.5	3,352	3.77	585,000	.....	.....	Do.
20	28.6	151,800	45.4	73.5	3,344	3.69	561,000	.....	.....	Do.
21	28.0	150,500	45.1	73.0	3,339	3.72	560,000	.....	.....	Do.
22	27.5	147,800	44.3	71.5	3,337	3.62	535,000	.....	.....	Do.
23	26.9	147,400	44.2	72.0	3,335	3.56	524,000	.....	.....	Do.
25	26.2	145,000	43.5	70.5	3,334	3.57	518,000	.....	.....	Do.
26	26.2	144,900	43.5	70.5	3,334	3.51	508,000	.....	.....	Do.
27	27.1	147,700	44.3	71.0	3,336	3.72	549,000	.....	.....	Do.
28	28.4	152,400	45.6	72.0	3,344	3.90	594,000	.....	.....	Do.
29	30.2	157,700	47.0	74.0	3,355	3.98	627,000	.....	.....	Do.
30	31.2	160,600	47.8	74.0	3,363	4.00	642,000	.....	.....	Do.
Apr. 1	32.1	163,300	48.5	75.0	3,370	4.06	662,000	.....	.....	Do.
2	32.1	164,100	48.7	75.0	3,370	4.00	656,000	.....	.....	Do.
4	31.8	164,700	48.9	75.0	3,368	3.99	657,000	.....	.....	Do.
5	31.4	161,700	48.1	73.5	3,364	3.87	626,000	.....	.....	Do.
6	30.9	160,900	47.9	73.0	3,356	3.84	618,000	.....	.....	Do.
8	29.9	156,500	46.7	72.5	3,354	3.73	584,000	.....	.....	Do.
9	29.4	159,300	47.5	74.5	3,352	3.70	590,000	.....	.....	Do.

[a] The widths tabulated for 1887 were scaled from the plotted cross sections, and were measured from bank to bank. There was a discharge beyond the banks which increased the water width by 320 feet, and the water area by 1,084 square feet; this overflow amounted to 1,666 cubic feet per second the first two days, and subsequently to 1,626 cubic feet per second. The areas and discharges include these quantities. Observations of 1887 and 1889 were made by the Mississippi River Commission third district officer, and reduced at the secretary's office. Report and tabulation in Report Chief of Engineers, 1890, p. 3164; reprinted in Report, 1891, p. 3489; the section at same place as in 1884-85; about one-half mile below Arkansas City. The gauge readings are all referred to the Mississippi River Commission gauge at Arkansas City, whose zero is 116.44 feet above the Cairo datum plane.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1889.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Apr. 10	29.2	155,600	46.4	73.5	3,352	3.68	572,000	.....	.....	Meter.
11	28.9	153,900	45.9	73.5	3,352	3.74	575,000	.....	.....	Do.
12	28.6	152,400	45.6	72.5	3,344	3.79	577,000	.....	.....	Do.
13	23.1	150,600	45.1	72.5	3,340	3.62	546,000	.....	.....	Do.
15	27.1	146,900	44.0	72.0	3,336	3.53	519,000	.....	.....	Do.
16	26.6	144,900	43.5	70.0	3,335	3.52	510,000	.....	.....	Do.
17	26.0	143,000	42.9	69.5	3,333	3.43	491,000	.....	.....	Do.
18	25.4	140,300	42.1	68.5	3,332	3.41	479,000	.....	.....	Do.
19	25.0	138,000	41.4	69.0	3,329	3.31	457,000	.....	.....	Do.
20	24.6	135,200	40.6	68.5	3,327	3.30	446,000	.....	.....	Do.
22	24.3	134,500	40.4	67.0	3,326	3.31	445,000	.....	.....	Do.
23	24.5	133,900	40.2	66.5	3,327	3.40	455,000	.....	.....	Do.
24	24.8	135,700	40.8	67.0	3,329	3.45	468,000	.....	.....	Do.
25	25.2	136,500	41.0	67.0	3,330	3.48	475,000	.....	.....	Do.
26	25.6	136,500	41.0	67.0	3,332	3.49	476,000	.....	.....	Do.
27	26.4	139,200	41.7	69.0	3,334	3.60	500,000	.....	.....	Do.
29	27.9	144,300	43.2	71.0	3,339	3.64	525,000	.....	.....	Do.
May 1	27.9	145,300	43.5	71.5	3,339	3.59	521,000	.....	.....	Do.
1890.[a]										
Mar. 14	48.2	206,600	60.4	83.0	3,420	5.71	1,181,000	5,000	1,186,000	Do.
19	48.8	222,600	65.1	88.5	3,420	6.34	1,410,000	8,000	1,418,000	Do.
25	49.2	225,600	66.0	89.5	3,420	5.36	1,210,000	10,000	1,220,000	Do.
26	49.4	228,300	66.8	86.0	3,420	5.68	1,298,000	10,000	1,308,000	Do.
28	49.2	218,800	64.0	89.0	3,420	5.54	1,213,000	10,000	1,223,000	Do.
30	48.8	231,400	67.7	92.0	3,420	5.37	1,242,000	8,000	1,250,000	Do.
31	48.8	227,700	66.6	92.0	3,420	5.55	1,264,000	8,000	1,272,000	Do.
Apr. 2	48.6	230,100	67.3	89.0	3,420	5.79	1,332,000	7,000	1,339,000	Do.
4	48.3	226,700	66.3	89.0	3,420	5.36	1,216,000	5,000	1,221,000	Do.
7	47.9	223,200	65.3	89.0	3,420	5.30	1,183,000	4,000	1,187,000	Do.
9	48.0	226,300	66.2	89.5	3,420	5.37	1,216,000	4,000	1,220,000	Do.
11	47.9	233,500	68.3	88.0	3,420	5.12	1,196,000	4,000	1,199,000	Do.
13	47.8	241,500	70.6	89.0	3,420	5.51	1,332,000	3,000	1,335,000	Do.
15	47.8	237,400	69.4	91.0	3,420	5.40	1,281,000	3,000	1,284,000	Do.
1891.[b]										
Mar. 6	45.0	211,400	61.7	86.0	3,427	6.04	1,278,000	.....	1,278,000	Do.
7	45.3	209,900	61.3	85.0	3,427	5.98	1,255,000	.....	1,255,000	Do.
8	45.6	204,500	59.7	84.0	3,427	6.00	1,144,000	.....	1,144,000	Do.
9	45.6	206,100	60.1	86.0	3,427	6.06	1,248,000	2,000	1,250,000	Do.
10	45.8	212,400	62.0	88.0	3,427	6.05	1,285,000	2,000	1,287,000	Do.
11	46.1	211,600	61.8	82.5	3,427	5.71	1,209,000	3,000	1,212,000	Do.
12	46.4	220,800	64.4	87.0	3,427	5.22	1,153,000	3,000	1,156,000	Do.
13	46.5	217,700	63.5	87.2	3,427	5.34	1,162,000	3,000	1,165,000	Do.
14	46.6	213,100	62.2	86.2	3,427	5.37	1,144,000	4,000	1,148,000	Do.
16	46.9	219,600	64.1	88.5	3,427	5.49	1,205,000	4,000	1,209,000	Do.
17	46.9	221,000	64.5	88.5	3,427	5.50	1,215,000	4,000	1,219,000	Do.
18	47.0	221,600	64.7	87.5	3,427	5.36	1,189,000	4,000	1,193,000	Do.
19	47.1	217,100	63.3	86.0	3,427	5.33	1,157,000	4,000	1,162,000	Do.
20	47.3	219,500	64.0	87.2	3,427	5.36	1,177,000	5,000	1,182,000	Do.
21	47.3	223,900	65.3	88.2	3,427	5.40	1,209,000	5,000	1,214,000	Do.
22	47.4	229,500	67.0	89.0	3,427	5.36	1,229,000	5,000	1,234,000	Do.
23	47.5	229,300	66.9	90.0	3,427	5.26	1,206,000	5,000	1,211,000	Do.
24	47.6	228,200	66.6	89.8	3,427	5.47	1,248,000	5,000	1,253,000	Do.
28	47.8	231,900	67.7	88.6	3,427	5.97	1,384,000	7,000	1,391,000	Do.
30	47.9	235,700	68.8	92.0	3,427	5.99	1,412,000	7,000	1,419,000	Do.
31	48.0	238,400	69.6	93.0	3,427	5.94	1,417,000	7,000	1,424,000	Do.
Apr. 1	48.1	236,300	68.9	93.0	3,427	5.93	1,401,000	8,000	1,409,000	Do.
3	48.2	238,900	69.7	93.0	3,427	5.91	1,411,000	8,000	1,419,000	Do.
4	48.2	237,100	69.2	92.0	3,427	5.90	1,398,000	8,000	1,406,000	Do.
6	48.2	239,100	69.8	92.0	3,427	5.85	1,399,000	8,000	1,407,000	Do.
7	48.2	239,800	70.0	94.0	3,427	5.91	1,417,000	8,000	1,425,000	Do.
8	48.1	235,900	68.8	91.0	3,427	5.89	1,390,000	8,000	1,398,000	Do.
9	48.0	233,400	68.1	90.0	3,427	6.00	1,400,000	7,000	1,407,000	Do.
10	47.9	233,600	68.2	92.0	3,427	5.81	1,356,000	7,000	1,363,000	Do.
11	47.8	234,100	68.3	93.0	3,427	5.71	1,336,000	6,000	1,342,000	Do.

[a] Section of 1890 is same as in 1889; observations and reduction by third district officer, Mississippi River Commission. Tabulation in Report Chief of Engineers, 1891, p. 3537.

[b] Section of 1891 and 1892 is same as in 1889 and 1890, except that the Mississippi end is moved downstream 100 feet. Report and tabulation for 1891 in Report Chief of Engineers, 1892, pp. 3123 and 3132, respectively; for 1892, Report Chief of Engineers, 1893, pp. 3665, 3677, and 3686, respectively. May 28 and 29, 1892, the overflow discharge between Arkansas City and Trippe was found to be 309,000; May 30 and 31 it was 261,000. Report Chief of Engineers, 1893, p. 3701. Observations of 1891-93 made by third district officer, Mississippi River Commission, and reduced at secretary's office.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1891.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Apr. 13	47.6	230,800	67.3	92.0	3,427	5.60	1,293,000	5,000	1,298,000	Meter.
14	47.5	235,100	68.6	92.0	3,427	5.67	1,334,000	5,000	1,339,000	Do.
15	47.4	234,200	68.3	91.0	3,427	5.54	1,298,000	5,000	1,303,000	Do.
16	47.3	234,800	68.5	91.0	3,427	5.59	1,313,000	4,000	1,317,000	Do.
18	47.2	233,400	68.1	91.0	3,427	5.52	1,288,000	4,000	1,292,000	Do.
20	47.2	232,100	67.7	91.0	3,427	5.45	1,265,000	4,000	1,269,000	Do.
21	47.2	232,300	67.8	91.0	3,427	5.53	1,285,000	4,000	1,289,000	Do.
22	47.1	231,200	67.5	91.0	3,427	5.48	1,266,000	4,000	1,270,000	Do.
23	47.1	231,200	67.5	91.0	3,427	5.53	1,279,000	4,000	1,283,000	Do.
24	47.2	232,900	68.0	91.0	3,427	5.29	1,233,000	4,000	1,237,000	Do.
25	47.3	231,200	67.5	90.0	3,427	5.29	1,224,000	4,000	1,228,000	Do.
27	47.5	226,200	66.0	89.0	3,427	5.41	1,224,000	4,000	1,228,000	Do.
28	47.4	227,700	66.4	90.0	3,427	5.46	1,243,000	4,000	1,247,000	Do.
29	47.3	226,100	66.0	89.0	3,427	5.30	1,197,000	4,000	1,201,000	Do.
30	47.1	226,200	66.0	89.0	3,427	5.24	1,185,000	4,000	1,189,000	Do.
May 2	46.5	223,700	65.3	89.0	3,427	5.29	1,183,000	3,000	1,186,000	Do.
4	45.6	225,700	65.9	87.0	3,427	5.02	1,134,000	2,000	1,136,000	Do.
6	43.9	214,200	62.5	87.0	3,427	4.77	1,022,000	1,000	1,023,000	Do.
7	43.0	210,700	61.6	83.0	3,421	4.68	986,000	.....	986,000	Do.
8	41.7	206,600	60.5	82.0	3,416	4.54	937,000	.....	937,000	Do.
9	40.5	202,400	59.3	81.0	3,411	4.32	874,000	.....	874,000	Do.
11	38.2	193,900	56.9	79.0	3,406	4.22	818,000	.....	818,000	Do.
12	37.0	190,000	55.9	77.0	3,399	4.19	796,000	.....	796,000	Do.
1892.										
Apr. 22[a]	46.0	225,300	65.2	88.0	3,453	5.81	1,308,000	2,000	1,311,000	Do.
23	46.4	241,100	69.8	91.0	3,453	6.00	1,447,000	3,000	1,450,000	Do.
25	46.9	239,800	69.5	93.0	3,453	5.76	1,382,000	3,000	1,385,000	Do.
26	47.1	247,000	71.5	93.0	3,455	6.16	1,522,000	4,000	1,526,000	Do.
27	47.2	246,400	71.3	95.0	3,455	6.47	1,593,000	4,000	1,597,000	Do.
28	47.4	248,900	71.9	95.0	3,461	6.11	1,520,000	4,000	1,525,000	Do.
29	47.6	251,600	72.7	95.0	3,461	6.13	1,542,000	5,000	1,547,000	Do.
30	47.8	252,900	73.1	95.0	3,461	6.26	1,582,000	5,000	1,587,000	Do.
May 2	48.0	246,600	71.2	95.0	3,461	6.56	1,619,000	6,000	1,625,000	Do.
3	48.0	247,600	71.5	94.0	3,461	6.17	1,526,000	6,000	1,533,000	Do.
4, a.m.	48.1	246,400	71.2	95.0	3,461	7.01	1,727,000	7,000	1,734,000	Do.
4, p.m.	48.1	.....	.....	.....	.....	7.04	1,735,000	7,000	1,742,000	Do.
5	48.2	248,700	71.9	93.0	3,461	6.36	1,582,000	7,000	1,589,000	Do.
6	48.3	247,700	71.6	95.0	3,461	6.62	1,641,000	7,000	1,648,000	Do.
7	48.6	247,200	71.4	95.0	3,461	6.50	1,607,000	7,000	1,614,000	Do.
9	48.8	249,600	72.1	95.0	3,461	6.62	1,653,000	7,000	1,660,000	Do.
10	48.8	247,200	71.4	94.9	3,461	6.45	1,594,000	7,000	1,601,000	Do.
11	48.9	248,700	71.8	95.5	3,461	6.98	1,486,000	8,000	1,493,000	Do.
12	49.0	249,800	72.2	94.5	3,461	6.20	1,548,000	8,000	1,556,000	Do.
13	49.1	248,200	71.7	95.5	3,461	5.88	1,459,000	8,000	1,467,000	Do.
14	49.1	243,300	70.3	95.0	3,461	5.76	1,402,000	8,000	1,410,000	Do.
16	49.1	250,900	72.5	90.0	3,461	5.76	1,444,000	8,000	1,452,000	Double floats.
19	49.2	251,400	72.6	95.5	3,461	5.79	1,457,000	8,000	1,465,000	Meter.
21	49.3	247,600	71.5	90.0	3,461	5.65	1,398,000	8,000	1,406,000	Do.
23	49.4	251,000	72.5	96.0	3,461	5.68	1,427,000	8,000	1,435,000	Do.
23	49.4	.....	.....	.....	.....	5.84	1,466,000	8,000	1,475,000	Double floats.
24	49.5	248,000	71.6	95.5	3,461	5.71	1,415,000	8,000	1,424,000	Meter.
26	49.6	251,900	72.8	97.0	3,461	5.70	1,436,000	9,000	1,445,000	Do.
27	49.6	250,900	72.5	96.0	3,461	5.66	1,420,000	9,000	1,429,000	Do.
28	49.7	250,900	72.5	96.0	3,461	5.73	1,437,000	9,000	1,446,000	Do.
30	49.8	249,700	72.1	96.0	3,461	5.74	1,432,000	9,000	1,441,000	Do.
31	49.8	248,300	71.8	94.5	3,461	5.94	1,477,000	9,000	1,485,000	Do.
June 1	49.9	251,300	72.6	95.5	3,461	5.88	1,477,000	9,000	1,485,000	Do.
3	49.7	246,600	71.3	94.0	3,461	5.95	1,468,000	9,000	1,477,000	Do.
4	49.6	245,800	71.0	92.0	3,461	5.87	1,444,000	9,000	1,452,000	Do.
6	49.5	243,500	70.3	91.0	3,461	5.78	1,407,000	8,000	1,416,000	Do.
7	49.4	251,500	72.7	96.0	3,461	5.79	1,455,000	8,000	1,463,000	Do.
8	49.4	251,800	72.7	95.0	3,461	5.78	1,456,000	8,000	1,465,000	Do.
9	49.4	254,800	73.6	96.0	3,461	5.79	1,475,000	8,000	1,484,000	Do.
10	49.4	253,000	73.1	94.0	3,461	5.82	1,473,000	8,000	1,481,000	Do.
11	49.4	253,300	73.2	95.5	3,461	5.74	1,454,000	8,000	1,462,000	Do.
13	49.4	248,400	71.8	94.0	3,461	5.81	1,443,000	8,000	1,451,000	Do.
14	49.4	245,300	70.9	93.0	3,461	5.86	1,438,000	8,000	1,446,000	Do.
14	49.4	[b]242,000	69.9	93.0	3,461	5.85	1,415,000	8,000	1,423,000	Do.
15	49.4	247,200	71.4	93.6	3,461	5.66	1,400,000	8,000	1,408,000	Do.
16	49.4	250,600	72.4	93.5	3,461	5.78	1,449,000	8,000	1,457,000	Do.
17	49.3	249,400	72.1	95.0	3,461	5.73	1,428,000	8,000	1,436,000	Do.

[a] Observations doubtful.

[b] Piano wire soundings.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1892.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet*	*Feet.*	*Feet.*				
June 18.....	49.2	248,100	71.7	94.0	3,461	5.70	1,415,000	8,000	1,422,000	Meter.
20.....	49.0	249,300	72.0	93.0	3,461	5.60	1,397,000	7,000	1,404,000	Do.
20.....	49.0	.....	.....	.....	.....	5.59	1,394,000	7,000	1,401,000	Double floats.
21.....	48.8	247,200	71.4	92.5	3,461	5.62	1,388,000	7,000	1,395,000	Meter.
21.....	48.8	a240,400	69.5	90.0	3,461	5.61	1,348,000	7,000	1,350,000	Do.
23.....	48.5	245,600	71.0	94.0	3,461	5.45	1,338,000	7,000	1,344,000	Do.
24.....	48.3	246,300	71.2	92.5	3,461	5.50	1,354,000	6,000	1,360,000	Do.
27.....	47.5	240,300	69.4	90.0	3,461	4.98	1,196,000	4,000	1,201,000	Do.
28.....	47.2	244,900	70.8	92.0	3,461	4.80	1,175,000	4,000	1,179,000	Do.
29.....	46.6	244,000	70.5	92.0	3,461	4.82	1,177,000	3,000	1,180,000	Do.
30.....	46.1	236,600	68.5	89.0	3,453	5.02	1,189,000	3,000	1,192,000	Do.
30.....	46.1	.....	.....	.....	.....	4.99	1,182,000	3,000	1,184,000	Double floats.
July 1.....	45.5	239,900	69.5	89.0	3,453	4.82	1,156,000	2,000	1,158,000	Meter.
1.....	45.5	.....	.....	.....	.....	4.75	1,140,000	2,000	1,142,000	Double floats.
June 28 b.....	46.9	222,600	54.9	68.5	4,054	5.80	1,292,000	6,000	1,298,000	Meter.
29, a.m b	46.6	224,700	55.4	70.0	4,054	5.59	1,257,000	6,000	1,262,000	Do.
30, a.m b	46.1	217,700	53.7	68.0	4,054	4.78	1,040,000	6,000	1,046,000	Do.
30, p.m b	46.0	.....	.....	.....	.....	4.87	1,059,000	6,000	1,065,000	Do.
July 1 b.....	45.4	219,500	54.1	68.0	4,054	4.65	1,020,000	6,000	1,025,000	Do.
1 b.....	45.3	.....	.....	.....	.....	4.88	1,071,000	6,000	1,077,000	Double floats.
2 b.....	44.6	210,000	51.8	66.5	4,054	5.26	1,104,000	6,000	1,110,000	Meter.
2 b.....	44.6	.....	.....	.....	.....	4.89	1,027,000	6,000	1,033,000	Do.
1893. c										
Mar. 9.....	43.1	222,000	64.5	95.5	3,441	4.75	1,054,000	.....	.....	Do.
9.....	.....	.....	.....	.....	.....	4.83	d1,072,000	.....	.....	Do.
10.....	43.2	218,200	63.4	95.5	3,441	4.75	1,036,000	.....	.....	Do.
10.....	.....	.....	.....	.....	.....	4.83	d1,054,000	.....	.....	Do.
11.....	43.2	224,700	65.3	96.0	3,441	4.49	1,009,000	.....	.....	Do.
11.....	.....	.....	.....	.....	.....	4.57	d1,026,000	.....	.....	Do.
13.....	43.0	221,700	64.4	96.5	3,441	4.99	1,106,000	.....	.....	Do.
18.....	40.7	212,700	61.9	91.5	3,436	4.74	1,007,000	.....	.....	Do.
20.....	40.2	201,800	58.8	92.5	3,434	4.62	931,000	.....	.....	Do.
21.....	40.0	204,300	59.5	95.5	3,433	4.70	960,000	.....	.....	Do.
21.....	.....	.....	.....	.....	.....	4.58	935,000	.....	.....	Do. e
22.....	39.9	206,400	60.2	92.0	3,431	4.76	983,000	.....	.....	Do.
24.....	39.9	205,300	59.8	89.5	3,431	4.58	939,000	.....	.....	Do.
25.....	40.0	205,300	59.9	92.0	3,429	4.61	946,000	.....	.....	Do.
25.....	.....	.....	.....	.....	.....	4.46	916,000	.....	.....	Do. e
27.....	40.0	200,800	58.6	90.0	3,429	4.63	931,000	.....	.....	Do.
27.....	.....	.....	.....	.....	.....	4.64	932,000	.....	.....	Do. e
29.....	39.9	200,600	58.5	92.0	3,429	4.54	911,000	.....	.....	Do.
29 f.....	.....	205,300	46.2	70.0	4,440	4.49	921,000	.....	.....	Do.
30 f.....	39.6	203,000	45.8	69.0	4,437	4.57	928,000	.....	.....	Do.
30.....	.....	202,400	59.1	91.0	3,425	4.59	928,000	.....	.....	Do.
31.....	39.4	205,600	60.0	90.0	3,424	4.41	907,000	.....	.....	Do.
Apr. 1.....	39.0	198,600	58.0	89.0	3,423	4.34	863,000	.....	.....	Do.
1.....	.....	.....	.....	.....	.....	4.36	866,000	.....	.....	Do. e
3.....	38.0	195,400	57.1	86.5	3,421	4.28	836,000	.....	.....	Do.
3.....	.....	.....	.....	.....	.....	4.23	827,000	.....	.....	Do. e
4.....	37.4	192,100	56.2	84.5	3,418	4.27	821,000	.....	.....	Do.
4.....	.....	.....	.....	.....	.....	4.24	814,000	.....	.....	Do. e
4.....	.....	.....	.....	.....	.....	4.27	820,000	.....	.....	Double floats.
5.....	36.6	193,300	56.5	85.0	3,418	4.09	791,000	.....	.....	Meter.
5.....	.....	.....	.....	.....	.....	4.19	809,000	.....	.....	Do. e
6.....	35.8	186,800	54.8	84.0	3,412	4.08	763,000	.....	.....	Do.
6.....	.....	.....	.....	.....	.....	4.06	758,000	.....	.....	Do. e
7.....	35.0	181,800	53.4	83.0	3,407	4.06	738,000	.....	.....	Do.
7.....	.....	.....	.....	.....	.....	3.97	721,000	.....	.....	Do. e
8.....	34.2	179,700	52.8	81.5	3,403	3.96	711,000	.....	.....	Do.
8.....	.....	.....	.....	.....	.....	3.96	711,000	.....	.....	Do. e
May 5.....	46.2	230,700	66.8	96.5	3,455	5.18	1,196,000	3,000	1,198,000	Do.
6.....	46.8	238,900	69.2	99.0	3,455	5.19	1,239,000	3,000	1,243,000	Do.
8.....	48.1	246,300	71.3	101.5	3,455	5.37	1,323,000	g6,000	1,329,000	Do.

a Piano wire soundings.

b Chicot City section, 7 miles above Arkansas City.

c Discharges for 1893 observed at different proportional depths, are all reduced to mean of vertical, unless otherwise noted. Section of 1893 was downstream from section used for several years past. The Arkansas end was 200 feet and Mississippi end 500 feet below former position, its azimuth being changed 6° 40′. Report on work, Report Chief of Engineers, 1894, p. 2822. Tabulation, Chief of Engineers, 1894, p. 2828.

d As observed at 0.6 depth.

e Moving across stream or flanking.

f Upper section.

g Observed.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1893.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
May 8						5.39	1,327,000			Meter.[a]
9	48.4	249,200	72.1	102.0	3,455	5.48	1,367,000	6,000	1,372,000	Do.
9						5.41	1,349,000			Do.[a]
10	48.8	249,600	72.3	102.5	3,455	5.50	1,374,000	6,000	1,380,000	Do.
10						5.52	1,378,000			Do.[a]
11	49.0	252,600	73.1	104.0	3,455	5.54	1,400,000	6,000	1,406,000	Do.
11						5.50	1,390,000			Do.[a]
12	49.1	251,600	72.8	104.5	3,455	5.57	1,401,000	[b] 6,000	1,407,000	Do.
12						5.57	1,400,000			Do.[a]
13	49.2	257,600	74.5	104.5	3,455	5.52	1,422,000	6,000	1,428,000	Do.
13						5.47	1,408,000			Do.[a]
15	49.6	257,000	74.4	103.0	3,455	5.63	1,446,000	7,000	1,453,000	Do.
15						5.51	1,416,000			Do.[a]
16	49.6	254,300	73.6	102.0	3,455	5.59	1,421,000	7,000	1,428,000	Do.
17	49.6	250,300	72.4	104.0	3,455	5.60	1,403,000	8,000	1,411,000	Do
17						5.53	1,384,000			Do.[a]
18	49.6	254,000	73.5	105.5	3,455	5.68	1,443,000	[b] 8,000	1,451,000	Do.
18						5.62	1,429,000			Do.[a]
19	49.6	255,400	73.9	102.5	3,455	5.60	1,430,000	8,000	1,438,000	Do.
19						5.70	[c] 1,455,000			Do.
19						5.76	1,472,000			Do.[a]
20	49.6	254,900	73.8	104.5	3,455	5.62	1,433,000	8,000	1,442,000	Do.
20						5.60	1,426,000			Do.[a]
22	49.6	248,200	71.9	103.0	3,455	5.61	1,400,000	8,000	1,409,000	Do.
22						5.97	1,482,000			Do.[a]
23	49.7	252,900	73.2	102.0	3,455	5.64	1,426,000	8,000	1,434,000	Do.
23						5.62	1,421,000			Do.[a]
24	49.8	258,400	74.8	102;0	3,455	5.66	1,463,000	8,000	1,471,000	Do.
24						5.54	[c] 1,432,000			Do.
24						5.45	[d] 1,408,000			Do.
25	50.0	255,900	74.1	102.0	3,455	5.60	1,432,000	8,000	1,440,000	Do.
25						5.69	1,455,000			Do.[a]
26	50.0	260,800	75.5	104.0	3,455	5.40	1,408,000	[b] 9,000	1,417,000	Do.
26						5.70	1,486,000			Do.[a]
27	50.0	261,000	75.5	104.0	3,455	6.39	1,667,000	9,000	1,676,000	Do.
27						6.00	1,566,000			Do.[a]
29[e]	50.2	259,200	75.0	103.5	3,455	5.90	1,528,000	9,000	1,538,000	Do.
29						5.95	1,542,000			Do.[a]
31	49.8	258,500	74.8	104.0	3,455	5.79	1,496,000	8,000	1,504,000	Do.
June 1	49.6	257,000	74.4	103.0	3,455	5.82	1,495,000	8,000	1,503,000	Do.
1						5.71	1,468,000			Do.[a]
2	49.6	259,600	75.1	105.5	3,455	5.73	1,489,000	8,000	1,496,000	Do.
2						5.81	1,508,000			Do.[a]
3	49.6	259,100	75.0	104.5	3,455	5.70	1,476,000	8,000	1,483,000	Do.
3						5.73	1,486,000			Do.[a]
5	49.6	257,900	74.6	104.0	3,455	5.67	1,462,000	7,000	1,469,000	Do.
5						5.74	1,480,000			Do.[a]
7	49.5	256,700	74.3	103.5	3,455	5.63	1,446,000	7,000	1,453,000	Do.
7						5.58	1,433,000			Do.[a]

[438 miles below Cairo.]

[The regular Mississippi River Commission gauge at Arkansas City was used, the elevation of its zero is 116.44 feet above the Cairo datum plane. Readings are means of 8 a. m. and 4 p. m.]

1895.[f]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
July 8, a.m.	14.0	94,000	28.9	53	3288	3.00	[f] 283,000			Meter.
8, p.m.	14.0	96,000	29.0	52.5	3290	3.15	302,000			Do.
9	15.6	100,700	30.5	53.5	3302	3.18	[f] 321,000			Do.
Aug. 12, a.m.	18.6	109,700	32.8	57.5	3340	3.21	[f] 352,000			Do.
12, p.m.	18.6	108,100	32.4	57	3337	3.27	354,000			Do.

[a] Moving across stream or flanking.
[b] Observed.
[c] As observed at 0.6 depth.
[d] Observed at 0.6 depth and reduced by vertical factor.
[e] Cypress Creek crevasse occurred at 4 a. m.
[f] Flanking method. These are means of two flankings across river in opposite directions. Same section as in 1893. Price meter used. Observations made under direction of third district officer, Mississippi River Commission. Report Chief of Engineers, 1896, p. 3555.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1895.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Oct. 12, a.m..	− 0.7	44,200	14.8	38.5	2977	2.32	[a]103,000	.....	.....	Meter.
12, p.m..	− .7	44,100	14.9	37	2977	2.74	121,000	.....	.....	Do.
14.....	− 1.0	43,800	14.7	38	2972	2.40	[a]105,000	.....	.....	Do.
Dec. 24.....	9.0	71,800	22.9	.....	3136	3.22	[a]232,000	.....	.....	Do.
26, a.m..	15.6	95,400	29.0	.....	3296	3.80	363,000	.....	.....	Do.
26, p.m..	15.6	96,800	29.3	.....	3304	3.76	[a]364,000	.....	.....	Do.
27, a.m..	20.4	110,500	33.0	.....	3352	4.11	[a]454,000	.....	.....	Do.
27, p.m..	20.4	112,600	33.2	.....	3359	4.07	468,000	.....	.....	Do.
28.....	23.9	122,600	36.3	.....	3378	4.49	[a]550,000	.....	.....	Do.
30.....	27.3	137,200	40.3	.....	3401	4.84	[a]664,000	.....	.....	Do.
31.....	28.2	139,800	41.0	.....	3412	4.86	[a]678,000	.....	.....	Do.
1896.										
Jan. 1.....	28.8	141,600	41.5	.....	3414	4.67	[a]662,000	.....	.....	Do.
2.....	29.5	144,700	42.3	.....	3419	4.82	[a]698,000	.....	.....	Do.
3.....	30.2	145,300	42.4	.....	3427	4.86	[a]706,000	.....	.....	Do.
4.....	30.6	148,700	43.3	.....	3431	4.83	[a]717,000	.....	.....	Do.
4.....	30.6	149,200	43.5	.....	3431	4.86	725,000	.....	.....	Do.
6.....	30.8	149,900	43.7	.....	3431	4.64	[a]696,000	.....	.....	Do.
6.....	30.8	150,300	43.8	.....	3431	4.66	700,000	.....	.....	Do.
8.....	29.4	146,300	42.8	.....	3420	4.63	[a]678,000	.....	.....	Do.
9.....	28.3	144,100	42.3	.....	3411	4.56	[a]657,000	.....	.....	Do.
10.....	27.6	142,900	42.0	.....	3406	4.39	[a]628,000	.....	.....	Do.
10.....	27.6	145,700	42.8	.....	3406	4.33	631,000	.....	.....	Do.
11.....	27.2	141,200	41.5	.....	3399	4.31	[a]626,000	.....	.....	Do.
11.....	27.2	143,000	42.1	.....	3399	4.25	608,000	.....	.....	Do.
Dec. 4.....	11.9	78,200	24.0	52.8	3258	3.65	285,000	.....	.....	Do.
5.....	14.2	87,100	26.5	54.9	3282	3.94	343,000	.....	.....	Do.
5.....	14.2	88,400	26.9	55.0	3283	4.05	358,000	.....	.....	Do.
5.....	14.2	89,800	27.3	55.4	3285	4.02	361,000	.....	.....	Double floats
7.....	18.2	103,200	30.9	60.5	3335	4.42	456,000	.....	.....	Meter.
7.....	18.2	105,600	31.5	60.8	3346	4.42	467,000	.....	.....	Do.
8.....	20.0	109,900	32.8	61.8	3352	4.46	490,000	.....	.....	Do.
9.....	21.0	115,100	34.3	63.5	3358	4.38	504,000	.....	.....	Do.
9.....	21.0	116,300	34.6	61.5	3363	4.43	515,000	.....	.....	Do.
9.....	21.0	116,300	34.6	61.5	3363	4.29	499,000	.....	.....	Double floats.
1897.[b]										
Mar. 25.....	50.8	242,400	69.8	94.8	3471	6.54	1,586,000	[c]10,000	1,596,000	Meter.
26[d].....	51.1	234,400	67.5	95.5	3471	6.77	1,587,000	[c]10,000	1,597,000	Do.
27.....	51.4	237,000	68.3	96.8	3471	6.90	1,636,000	[c]10,000	1,646,000	Do.
29.....	51.9	236,800	68.2	96.3	3471	6.79	1,608,000	[e]5,000	[1,618,000	Do.
30.....	51.4	.....	.....	.....	.....	.....	.....	[f]6,000		
30.....	51.4	234,800	67.6	95.7	3471	6.82	1,602,000	10,000	1,613,000	Double floats.

[439 miles below Cairo.]

Upper section.[g]

1901.[h]										
Dec. 8, a. m.	1.4	43,400	16.7	45.7	2,598	2.74	119,000	.....	.....	Meter.
8, a. m.	.....	.....	.....	.....	.....	2.71	118,000	.....	.....	Do.
8, p. m.	1.5	.....	.....	.....	.....	2.74	119,000	.....	.....	Do.
9.....	1.6	45,200	17.4	44.2	2,598	2.90	131,000	.....	.....	Double floats.

[a] Flanking method. These are means of two flankings across river in opposite directions. Same section as in 1893. Price meter used. Observations made under direction of third district officer, Mississippi River Commission. Report Chief of Engineers, 1896, p. 3555.

[b] The discharge section was at same place as in former years, about one-half mile below Arkansas City. Double floats were used, the lower one being at mid-depth. The meter observations were made with the Haskel current meter, held at 0.6 depth for five minutes. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, Secretary Mississippi River Commission. Report Chief of Engineers, 1897, p. 3654.

[c] Deduced from observed overflow of March 29 and 30.

[d] Boils are quite bad from station 11 to 16. They evidently indicate traveling sand. The remarkable changes in depth from the preceding day were checked by resounding.

[e] Left bank.

[f] Right bank.

[g] Upper section same as that of 1898 except that right bank end was 630 feet farther downstream.

[h] Arkansas City Mississippi River Commission gauge, whose zero is 116.44 feet above the Cairo datum plane.

Results of discharge observations, Mississippi River—Continued.

ARKANSAS CITY, ARK.—Continued.

Lower section.[a]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1901.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Dec. 9, p. m.	1.7	48,500	25.6	61.3	1,891	2.61	127,000	.....	.....	Meter.
10, a. m.	1.8	48,000	25.4	60.1	1,891	2.62	126,000	.....	.....	Double floats.
10, a. m.	.....	.....	.....	.....	.....	2.70	129,000	.....	.....	Do.
10, a. m.	.....	.....	.....	.....	.....	2.66	128,000	.....	.....	Meter.
10, p. m.	1.9	.....	.....	.....	.....	2.57	123,000	.....	.....	Do.
10, p. m.	.....	.....	.....	.....	.....	2.49	120,000	.....	.....	Do.
1903.[b]										
Mar. 8.....	48.0	254,400	71.4	96.2	3,562	5.08	1,292,000	.....	.....	Do.
11.....	48.8	238,200	66.9	96.7	3,562	5.40	1,286,000	.....	.....	Do.
12.....	49.0	238,800	67.0	97.8	3,562	5.02	1,198,000	.....	.....	Do.

[438 miles below Cairo.]

1897.[c]										
Nov. 26.....	0.5	56,500	18.5	42.1	3,045	2.23	126,000	.....	.....	Meter.
27.....	.6	57,000	18.7	41.9	3,046	2.34	134,000	.....	.....	Do.
27.....	.6	57,100	18.8	41.5	3,046	2.32	133,000	.....	.....	Do.
29.....	.8	56,000	18.4	41.0	3,050	2.34	131,000	.....	.....	Do.
29.....	.8	56,600	18.6	40.8	3,050	2.37	134,000	.....	.....	Do.
29.....	.8	56,600	18.5	41.2	3,050	2.41	136,000	.....	.....	Do.
29.....	.8	56,900	18.7	41.0	3,050	2.35	134,000	.....	.....	Do.
30.....	.9	56,900	18.6	41.1	3,054	2.39	136,000	.....	.....	Double floats.
30.....	.9	57,200	18.7	40.9	3,054	2.31	132,000	.....	.....	Do.
30.....	.9	57,300	18.8	41.3	3,056	2.38	137,000	.....	.....	Meter.
1898.										
Apr. 20.....	51.1	24,310	68.2	96.6	3,566	6.16	1,497,000	.....	.....	Do.
20.....	51.1	24,310	.....	.....	3,566	6.22	1,514,000	.....	.....	Double floats.

CHICOT CITY, ARK.

[432 miles below Cairo.]

1903.[d]										
Mar. 14.....	49.6	230,700	53.9	78.7	4,276	.....	.....	.....	.....	
16.....	50.4	[e]230,400	53.9	.....	.....	7.54	1,737,000	7,000	1,743,000	Meter.
17.....	50.8	230,200	53.8	71.4	4,276	6.81	1,568,000	[f]8,000	1,576,000	Do.
18.....	51.2	228,800	53.5	69.4	4,276	6.40	1,466,000	[f]9,000	1,475,000	Do.
19.....	51.6	235,400	55.0	71.5	4,276	7.00	1,647,000	[f]11,000	1,657,000	Double floats.
20.....	51.9	239,600	56.0	72.7	4,276	6.84	1,637,000	12,000	1,649,000	Meter.
21 a. m.	52.2	236,400	55.3	71.9	4,276	6.65	1,573,000	[f]11,000	1,584,000	Do.
21 p. m	52.3	.....	.....	.....	.....	6.80	1,600,000	[f]11,000	1,618,000	Double floats.
22.....	52.4	236,300	55.2	73.2	4,276	6.76	1,596,000	[f]11,000	1,607,000	Meter.
23.....	52.6	234,000	54.7	73.3	4,276	6.79	1,588,000	10,000	1,598,000	Do.
24.....	52.7	237,600	55.6	73.6	4,276	6.96	1,654,000	[f]10,000	1,665,000	Do.
25 a. m.	52.7	230,800	54.0	66.5	4,276	6.95	1,604,000	[f]10,000	1,614,000	Do.
25 p. m.	52.8	.....	.....	.....	.....	7.14	1,647,000	[f]10,000	1,657,000	Double floats.
26.....	52.9	234,900	54.9	67.6	4,276	7.24	1,700,000	[f]10,000	1,710,000	Meter.

[a] Lower section 1,800 feet below upper section.

[b] Discharge section same as in 1898. Observations and reduction under direction of secretary of Mississippi River Commission; 1901, Capt. G. P. Howell; 1903, Capt. Wm. B. Ladue, Corps of Engineers. Reports Chief of Engineers 1902, supplement, page 72, and 1903, page 114.

[c] The discharge section was at same place as in former years, about one-half mile below Arkansas City the right-bank end being about 75 feet below the new sawmill; in January, 1898, the left-bank end of the section was moved downstream 5° from its former position to make it more nearly normal to direction of flow. Arkansas City gauge, whose zero is 116.44 feet above the Cairo datum.

[d] Observations and reduction under direction of Capt. Wm. B. Ladue, Corps of Engineers, secretary Mississippi River Commission. Reports Chief of Engineers, 1903, supplement, page 115, and 1905, supplement, page 119. Arkansas City M. R. C. gauge, whose zero is 116.44 feet above the Cairo datum plane. 1904 velocities are means of simultaneous observations with a Haskell and a Price meter.

[e] Interpolated.

[f] Overbank discharge measured March 16, 20, and 23; all overbank discharges deduced from these measurements. The discharge section is 232 meters above a prominent right angle in levee below Chicot, Ark., and 20 meters below church on left bank.

Results of discharge observations, Mississippi River—Continued.

CHICOT CITY, ARK.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1904.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Apr. 11	45.8	218,600	50.8	67.4	4,305	5.63	1,231,000	.....	.....	Meter.
12	46.5	219,600	51.0	68.9	4,305	5.84	1,284,000	.....	.....	Do.
13	47.1	218,800	50.8	65.4	4,305	5.90	1,305,000	.....	.....	Do.
14	47.6	a221,300	51.4	.....	4,305	5.91	1,308,000	.....	.....	Double floats.
15	48.0	a223,500	51.9	.....	4,305	6.10	1,362,000	.....	.....	Meter.
16	48.4	224,900	52.2	68.9	4,305	6.08	1,368,000	.....	.....	Do.
17	48.7	222,200	51.6	63.2	4,305	6.15	1,368,000	.....	.....	Do.
18	48.9	a223,900	52.0	.....	4,305	6.06	1,357,000	.....	.....	Do.
18	.....	a224,300	52.1	.....	4,305	6.17	1,383,000	.....	.....	Double floats.
19	49.0	226,000	52.5	66.9	4,305	6.09	1,377,000	.....	.....	Meter.
20	49.0	226,600	52.6	70.4	4,305	6.19	1,403,000	.....	.....	Do.
21	49.0	225,100	52.3	63.8	4,305	6.11	1,376,000	.....	.....	Do.

Date.	Gauges.			Cross section of discharge.				
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1906.b	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Apr. 15	48.65	48.65	+0.50	222,240	227,967	53.6	54.9	79.0	4,150
16	48.95	48.95	+ .40	222,840	227,322	53.7	54.8	74.8	4,150
17	49.25	49.25	+ .30	a 225,745	.....	.....	.....	.....	.....
18	49.55	49.55	+ .30	226,990	228,982	54.7	55.2	75.0	4,150
19	49.70	49.75	+ .20	a 227,718	.....	.....	.....	.....	.....
19	49.70	49.75	.....	a 227,718	.....	.....	.....	.....	.....
20	49.85	49.95	+ .10	228,445	228,777	55.0	55.1	75.7	4,150
21	49.95	50.03	+ .10	d 228,860	.....	.....	.....	.....	.....

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1906.b	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Apr. 15	.....	6.55	1,456,173	3,610	1,459,783	Meter	19	83	XI. Light.
16	− 645	6.32	1,408,894	c 3,750	1,412,644	.....do	19	108	IX. Brisk.
17	.....	6.37	1,437,845	3,890	1,441,735	Double floats	21	....	IX. Light.
18	+1,660	6.25	1,418,911	4,030	1,422,941	Meter	19	79	Calm.
19	.....	6.40	1,457,808	4,123	1,461,931	.....do	19	....	V. Light.
19	.....	6.31	1,437,392	4,123	1,441,515	Double floats	15	....	V. Light.
20	− 205	6.16	1,407,542	4,152	1,411,694	Meter	19	78	Calm.
21	.....	6.38	1,460,028	4,234	1,464,262	Double floats	18	....	IV. Light.

a Interpolated.

b Zero of M. R. C. gauge at Arkansas City, whose readings are tabulated in standard column, is 116.44 feet above the Cairo datum plane; the 8 a. m. readings are given. Arkansas City is about 8 miles below discharge section. Local gauge at the discharge section was set to read the same as the Arkansas City gauge on April 14; readings given are for time of discharge observations. The datum line for computing datum areas was at 50.03 feet on this local gauge. The discharge section is the same as that used in 1904, and is 232 meters above prominent right angle in levee below Chicot, Ark., and 20 meters below church on left bank. Velocities were measured with Price meter No. 43.

c Discharge measured; overbank discharge for other days derived from this.

d Derived from cross section of April 20.

Results of discharge observations, Mississippi River—Continued.

CHICOT CITY, ARK.—Continued.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width
1907.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Jan. 14, p. m.	44.9	45.18	.....	209,620	240,288	47.6	54.6	67.0	4,400
15.	45.6	45.58	+0.7	211,907	240,595	48.2	54.7	69.5	4,400
16, p. m.	46.2	46.45	+ .6	215,985	240,845	49.1	54.7	65.0	4,400
17, p. m.	46.8	46.95	+ .6	217,529	240,189	49.4	54.6	70.0	4,400
18, a. m.	47.2	47.20	+ .4	221,159	.....	.....	.....	.....	4,400
18, p. m.	.....	47.30	.....	221,599	.....	.....	.....	.....	4,400
19, p. m.	47.5	47.55	+ .3	225,234	244,254	51.2	55.7	72.0	4,400
21, p. m.	47.9	47.90	+ .2	220,134	238,614	50.0	54.2	71.0	4,400
22, a. m.	48.0	47.99	+ .1	220,687	.....	.....	.....	.....	4,400
22, p. m.	.....	48.04	.....	220,907	.....	.....	.....	.....	4,400
23, p. m.	48.1	48.11	+ .1	221,326	238,882	50.3	54.3	70.0	4,400
24.	48.2	48.18	+ .1	219,868	237,116	50.0	53.9	69.0	4,400
26.	48.5	48.54	+ .2	223,158	.....	.....	.....	.....	4,400
28.	49.0	49.10	+ .3	227,339	240,539	51.7	54.7	71.0	4,400
Feb. 1.	50.4	50.68	+ .4	229,438	235,686	52.1	53.6	71.0	4,400
2, a. m.	50.8	50.88	+ .4	231,432	.....	.....	.....	.....	4,400
2, p. m.	.....	51.05	.....	232,136	.....	.....	.....	.....	4,400
4, a. m.	51.5	51.55	+ .3	236,444	238,864	53.7	54.3	77.0	4,400
5, a. m.	51.8	51.90	+ .3	234,605	.....	.....	.....	.....	4,400
5, p. m.	.....	51.95	.....	234,828	.....	.....	.....	.....	4,400
6.	51.9	52.10	+ .1	232,144	232,144	52.8	52.8	71.5	4,400
7.	52.0	52.15	+ .1	232,364	.....	.....	.....	.....	4,400
8.	52.1	52.17	+ .1	232,452	.....	.....	.....	.....	4,400

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1907.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Jan. 14, p. m.	.....	5.85	1,226,266	.....	.....	Meter	8	56	XI. Breeze.
15.	+ 307	5.83	1,235,538	340	1,235,878	.....do	21	50	IX. Brisk.
16, p. m.	+ 250	6.01	1,297,204	1,020	1,298,224	.....do	16	55	VIII. Brisk.
17, p. m.	− 656	5.80	1,261,244	1,445	1,262,689	Double floats	14	91	Do.
18, a. m.	.....	6.07	1,342,928	1,700	1,344,628	Meter	19	....	VIII. Breeze
18, p. m.	.....	5.91	1,310,486	1,785	1,312,271	Double floats	13	....	VIII. Brisk.
19, p. m.	+4,065	5.99	1,349,926	2,040	1,351,966	Meter	19	111	Do.
21, p. m.	−5,640	6.07	1,338,366	2,295	1,340,661	.....do	21	112	VII. Breeze.
22, a. m.	.....	6.08	1,341,144	2,380	1,343,524	.....do	20	....	IX. Breeze.
22, p. m.	.....	6.02	1,329,772	2,380	1,332,152	Double floats	19	....	III. Breeze.
23, p. m.	+ 268	5.95	1,314,242	2,465	1,316,707	Meter	19	97	IX. Breeze.
24.	−1,766	6.16	1,354,268	2,550	1,356,818	.....do	19	80	VIII. Breeze
26.	.....	6.20	1,384,462	2,775	1,387,237	.....do	20	....	III. Breeze.
28.	+3,423	6.07	1,380,782	3,315	1,384,097	.....do	21	104	IV. Breeze.
Feb. 1.	−4,853	6.35	1,455,949	4,675	1,460,624	.....do	18	93	VIII. Light.
2, a. m.	.....	6.57	1,519,648	4,845	1,524,493	.....do	21	....	IX. Brisk.
2, p. m.	.....	6.63	1,539,302	5,015	1,544,317	Double floats	20	....	I. Brisk.
4, a. m.	+3,178	6.63	1,567,660	5,358	1,573,018	Meter	18	98	II. Brisk.
5, a. m.	.....	6.50	1,524,145	5,182	1,529,327	.....do	19	....	IV. Brisk.
5, p. m.	.....	6.83	1,602,938	5,182	1,608,120	Double floats	19	....	Do.
6.	−6,720	6.61	1,535,243	5,182	1,540,425	Meter	18	105	Do.
7.	.....	6.63	1,516,815	5,182	1,521,997	.....do	19	....	I. Breeze.
8.	.....	6.51	1,513,380	5,182	1,518,562	.....do	19	....	Calm.

[a] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Arkansas City M. R. C. gauge; zero is 116.44 feet above the Cairo datum plane. Arkansas City is 6 miles below discharge section. Local gauge used was set January 14 to read the same as Arkansas City M. R. C. gauge. The datum line for computing datum areas was taken at 52.10 feet on the local gauge. Price meter No. 29 and Haskell meter No. 1) were used simultaneously until January 28, and the results given are the means for the two meters. After January 28 Price meters Nos. 25 and 29 were used singly.

Results of discharge observations, Mississippi River—Continued.

CHICOT CITY, ARK.—Continued.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in twenty-four hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1908.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Mar. 7	46.83	.....	+0.3	227,470	228,872	53.5	53.8	68.0	4,250
8	47.06	.....	+ .2	[b] 224,627	.....	52.9	.....	.....	4,250
9	47.16	.....	+ .2	223,945	223,945	52.7	52.7	68.5	4,250
10	47.15	.....	.0	[b] 223,258	.....	52.5	.....	.....	4,250
12	47.05	.....	− .1	[b] 221,022	.....	52.0	.....	.....	4,250
12	.....	.....	.....	.....	.....	.....	.....	.....	.....
13	46.99	.....	.0	220,160	220,882	51.8	52.0	67.5	4,250
15	46.93	.....	.0	[b] 216,485	.....	50.9	.....	.....	4,250
16	46.98	.....	.0	214,880	215,645	50.6	50.7	68.0	4,250
17	47.10	.....	+ .1	[b] 215,411	.....	50.7	.....	.....	4,250
18	47.18	.....	+ .1	[b] 215,730	.....	50.8	.....	.....	4,250

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1908.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Mar. 7	.....	5.77	1,312,192	11,896	1,324,088	Meter.....	19	82	Calm.
8	.....	5.81	1,305,594	12,218	1,317,812	.....do.....	19	....	VIII. Light.
9	−4,927	5.71	1,279,435	12,359	1,291,794	.....do.....	19	110	II. Brisk.
10	.....	5.89	1,315,272	12,343	1,327,615	2 meters.....	19	....	Do.
12	.....	5.85	1,293,497	12,206	1,305,703	.....do.....	19	....	VI. Light.
12	.....	5.88	1,298,759	12,206	1,310,965	Double float...	18	....	Do.
13	−3,063	5.65	1,244,158	12,119	1,256,277	2 meters.....	19	91	X. Brisk.
15	.....	5.85	1,266,674	12,036	1,278,710	.....do.....	18	....	XI. Light.
16	−5,237	6.08	1,306,218	12,108	1,318,326	.....do.....	19	97	VI. Light.
17	.....	6.02	1,297,118	12,273	1,309,391	Meter.....	19	....	VII. Strong.
18	.....	5.92	1,276,051	12,388	1,288,439	Double float...	19	....	VII. Brisk.

[a] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Arkansas City M. R. C. gauge, whose zero is 116.44 feet above the Cairo datum plane; the readings are given for the time of discharge observations; the change in 24 hours is computed from the 8 a. m. readings. The discharge section is 232 meters above a prominent right angle in levee below Chicot, Ark., and 20 meters below church on left bank, and is the same as that used since 1903. It is 6 miles above Arkansas City. Overbank discharges were measured on both right and left banks on March 10; all other overbank discharges are derived from these measurements.

[b] Interpolated.

Results of discharge observations, Mississippi River—Continued.

GREENVILLE, MISS.

[The gauge readings are from the M. R. C. gauge at Greenville, whose zero is 108 above the Cairo datum plane The meter was run at 0.6 depth; velocities used as observed at that depth. Observations and reduction by third district officer, M. R. C.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1894.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Apr. 19, a. m. [a]	28.1	138,700	39.2	94.0	3,538	5.27	[b] 740,000	Meter.
Apr. 19, p. m. [c]	28.2	177,900	34.0	63.5	5,232	3.77	671,000	Do.
Nov. 20 [d]	− 0.5	36,300	13.1	21.5	2,754	2.86	104,000	Do.

LOUISIANA BEND, LA.

[Velocities observed with the Price current meter at 0.6 depth. Louisiana Bend is about 522 miles below Cairo and about 9 miles above Wilson Point, La. Lake Providence gauge reading is given, zero 89.62 feet above the Cairo datum plane. Report of Chief of Engineers, 1892, p. 3135.]

1891.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Oct. 19	1.4	67,400	42.5	77	1,585	1.96	132,000	Meter.

WILSON POINT, LA.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1883. [e]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	
Nov. 28	19.2	114,500	33.9	83.0	3,383	4.29	491,000	Meter.
Dec. 10	25.1	131,900	39.0	85.0	3,383	4.89	645,000	Do.
1884.								
Jan. 31 [f]	25.9	129,900	37.9	75.0	3,425	5.03	653,000	Do.
Feb. 15	34.6	160,300	46.2	86.0	3,467	5.40	865,000	Do.
26	37.4	176,300	50.8	88.0	3,472	5.85	1,031,000	Do.
27	37.5	172,800	49.8	86.0	3,472	6.13	1,059,000	Do.
28	37.5	172,900	49.8	88.0	3,472	5.88	1,016,000	Do.
29	37.6	178,600	51.4	91.5	3,472	5.80	1,036,000	Do.
Mar. 3	37.6	175,300	50.3	88.0	3,484	5.82	1,021,000	Do.
6	37.8	180,300	51.8	88.0	3,484	5.78	1,042,000	Do.
11	38.0	186,000	53.4	90.0	3,484	6.10	1,134,000	Do.
13	38.0	183,000	52.5	89.0	3,484	6.03	1,103,000	Do.
17	37.8	184,600	53.0	87.0	3,484	5.82	1,076,000	Do.
19	37.8	184,700	53.0	89.0	3,484	5.66	1,045,000	Do.
21	37.9	186,900	53.7	89.0	3,484	5.37	1,004,000	Do.
24	38.0	188,100	54.0	89.0	3,484	5.57	1,048,000	Do.
26	37.8	186,200	53.5	86.5	3,484	5.43	1,012,000	Do.
28	37.7	185,600	53.3	86.0	3,484	5.33	989,000	Do.
Apr. 5	37.0	188,300	54.0	85.0	3,484	5.42	1,019,000	Do.
12	36.7	188,200	54.0	85.5	3,484	5.32	1,001,000	Do.
16	36.9	185,400	53.2	85.0	3,484	5.51	1,022,000	Do.
24	36.8	188,900	54.2	88.0	3,484	5.37	1,015,000	Do.

[a] Section 1 mile above Barnes Landing and about 2½ miles above Greenville, Miss. Greenville is 478.3 miles below Cairo. Twelve velocity stations 300 feet apart, and 52 soundings.

[b] Of this total 9,604 cubic feet is chute discharge; the area, depths, velocity, and width include the main river only.

[c] Section at Warfield Point about 5 miles below Greenville, Miss. Eighteen velocity stations 300 feet apart, and 72 soundings.

[d] Section above Warfield Towhead and about 3 miles below Greenville, Miss. Fourteen velocity stations 200 feet apart, and 55 soundings.

[e] Tabulated results 1883 to May, 1890, inclusive, Report Chief of Engineers 1890, page 3173. Report on reduction, Report Chief of Engineers 1890, page 3170. The discharge section was located at about the same place until 1894, when it was moved up opposite Skipwith Towhead. All observations by third district officer, Mississippi River Commission, and reduction made at Secretary's office except for 1894, which was made at district office. The gauge readings tabulated herewith are those of the Wilson Point gauge, whose zero is 93.45 feet above the Cairo datum plane.

[f] These observations were taken in fog and rain with the river full of drift. Meter worked very badly.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method
			Mean.	Maximum.				
1884.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	
May 3	36.6	190,700	54.7	88.0	3,484	5.31	1,012,000	Meter.
10	36.7	182,900	52.5	86.0	3,484	5.29	968,000	Do.
16	36.5	180,500	53.5	85.5	3,484	5.31	991,000	Do.
27	34.6	182,900	52.5	85.0	3,482	4.87	891,000	Do.
June 11	25.2	148,000	42.4	75.0	3,488	3.95	584,000	Do.
17	25.6	147,700	42.3	74.0	3,495	4.18	617,000	Do.
23	26.3	153,300	43.6	75.0	3,520	4.02	617,000	Do.
28	25.4	147,200	41.8	73.5	3,517	4.12	606,000	Do.
July 7	22.8	135,300	38.9	69.5	3,478	4.04	547,000	Do.
22	20.4	133,300	38.4	70.0	3,475	3.94	525,000	Do.
Aug. 14	16.5	115,200	33.1	66.0	3,482	3.21	370,000	Do.
Sept. 17	8.6	90,500	26.1	58.0	3,467	2.80	253,000	Do.
Oct. 21	15.3	115,500	33.5	67.5	3,444	3.28	378,000	Do.
Nov. 25	7.8	89,600	26.1	62.0	3,440	2.74	246,000	Do.
1885.								
Jan. 3[a]	21.7	123,300	35.5	72.0	3,478	3.88	478,000	Do.
8	29.1	156,600	44.9	75.0	3,485	5.00	784,000	Do.
13	31.2	169,500	48.4	79.5	3,502	5.75	975,000	Do.
21	33.8	174,800	49.9	78.5	3,504	5.23	915,000	Do.
26	34.3	176,700	50.4	79.0	3,504	{6.33	[b]1,118,000	Do.
						{6.70	[c]1,183,000	Do.
29	34.5	177,900	50.8	79.0	3,504	5.33	958,000	Do.
Feb. 6	33.6	182,200	52.0	79.0	3,505	5.12	932,000	Do.
14	28.3	157,100	44.8	72.0	3,503	4.37	686,000	Do.
19	27.2	160,600	45.9	71.0	3,502	4.23	695,000	Do.
25	24.9	150,900	43.2	68.0	3,500	4.04	610,000	Do.
Mar. 5	18.2	123,700	35.7	62.0	3,469	3.52	436,000	Do.
13	21.5?	138,200	39.7	66.0	3,488	3.97	548,000	Do.
1887.								
Apr. 19	23.4	139,300	39.3	60.0	3,545	3.89	542,000	Do.
1888.								
Apr. 22	37.8	179,800	50.7	72.0	3,550	6.45	1,160,000	Do.
23	37.8	177,900	50.1	71.0	3,550	6.39	1,137,000	Do.
24	37.8	174,700	49.1	69.0	3,555	6.04	1,054,000	Do.
25	37.8	181,400	51.0	73.0	3,555	6.00	1,088,000	Do.
26	37.7	188,100	53.0	72.0	3,550	6.37	1,199,000	Do.
27	37.6	179,300	50.6	73.0	3,542	6.25	1,120,000	Do.
1889.								
July 3	29.2	133,700	36.9	75.0	3,626	6.39	854,000	Do.
4	28.9	132,500	36.5	76.5	3,626	6.49	860,000	Do.
5	28.3	129,400	35.7	76.5	3,624	6.12	791,000	Do.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1890.[d]	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Jan. 28	34.9	147,700	39.4	78.0	3,744	7.39	1,091,000	.....	1,091,000	Meter.
31	36.0	153,000	40.9	79.0	3,744	6.97	1,067,000	.....	1,067,000	Do.
Feb. 3	37.0	153,800	41.1	80.0	3,744	7.50	1,153,000	.....	1,153,000	Do.
4	37.2	165,800	44.3	82.0	3,744	7.03	1,165,000	.....	1,165,000	Do.
5	37.4	159,200	42.5	81.0	3,744	6.87	1,094,000	5,000	1,099,000	Do.
6	37.6	163,800	43.7	82.0	3,744	6.85	1,121,000	8,000	1,129,000	Do.
8	38.1	171,600	45.8	.....	3,744	6.87	1,179,000	16,000	1,195,000	Do.
10	38.4	178,900	47.8	81.0	3,744	6.83	1,222,000	20,000	1,242,000	Do.
11	38.4	175,200	46.8	81.0	3,744	6.70	1,173,000	23,000	1,196,000	Do.
12	38.4	173,300	46.3	80.0	3,744	6.40	1,110,000	23,000	1,133,000	Do.

[a] These observations taken under unfavorable circumstances and amid much floating drift.
[b] a. m.
[c] p. m.
[d] Tabulated results and report for January–May, 1890, in Report Chief of Engineers, 1890, p. 3171; reprinted in Report Chief of Engineers, 1891, p. 3526. Field results and report for December, 1890, Report Chief of Engineers, 1891, p. 3658, and final results in Report Chief of Engineers, 1892, p. 3144.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1890.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Feb. 13	38.4	174,100	46.5	80.0	3,744	6.32	1,100,000	23,000	1,123,000	Meter.
14	38.6	177,400	47.4	80.0	3,744	6.33	1,123,000	25,000	1,148,000	Do.
15	38.6	171,600	45.8	80.0	3,744	6.19	1,062,000	25,000	1,087,000	Do.
17	38.6	175,500	46.9	80.0	3,744	6.14	1,077,000	26,000	1,103,000	Do.
20	39.0	177,700	47.5	80.0	3,744	5.98	1,063,000	28,000	1,091,000	Do.
21	39.0	180,000	48.1	80.0	3,744	6.33	1,139,000	28,000	1,167,000	Do.
22	39.2	182,300	48.7	80.0	3,744	6.01	1,096,000	29,000	1,125,000	Do.
24	39.4	178,900	47.8	81.0	3,744	6.22	1,113,000	30,000	1,143,000	Do.
25	39.4	181,400	48.4	80.0	3,744	6.11	1,108,000	30,000	1,138,000	Do.
26	39.4	180,100	48.1	80.0	3,744	5.97	1,075,000	30,000	1,105,000	Do.
27	39.6	183,700	49.1	80.0	3,744	5.70	1,063,000	31,000	1,094,000	Do.
Mar. 1	39.4	179,800	48.0	80.0	3,744	5.80	1,043,000	30,000	1,073,000	Do.
3	39.4	183,600	49.0	80.0	3,744	5.91	1,085,000	30,000	1,115,000	Do.
4	39.5	184,900	49.4	81.0	3,744	5.77	1,067,000	31,000	1,098,000	Do.
5	39.6	185,700	49.6	80.0	3,744	5.94	1,103,000	33,000	1,136,000	Do.
6	39.7	190,700	50.9	80.0	3,744	6.01	1,145,000	34,000	1,179,000	Do.
7	40.0	193,000	51.6	81.0	3,744	5.81	1,122,000	40,000	1,162,000	Do.
8	40.1	195,700	52.3	81.0	3,744	5.84	1,143,000	43,000	1,186,000	Do.
10	40.4	197,700	52.8	81.0	3,744	5.97	1,181,000	47,000	1,228,000	Do.
11	40.5	199,100	53.2	82.0	3,744	6.24	1,242,000	47,000	1,289,000	Do.
12	40.7	202,900	54.2	81.0	3,744	5.62	1,141,000	50,000	1,191,000	Do.
13	40.8	203,900	54.5	81.0	3,744	5.53	1,128,000	50,000	1,178,000	Do.
14	40.9	205,200	54.8	81.0	3,744	5.68	1,165,000	50,000	1,215,000	Do.
15	41.0	199,600	53.3	82.0	3,744	5.86	1,171,000	50,000	1,221,000	Do.
17	40.9	200,400	53.5	81.0	3,744	5.91	1,185,000	47,000	1,232,000	Do.
18	40.9	199,500	53.3	82.0	3,744	6.11	1,218,000	45,000	1,263,000	Do.
19	40.6	197,000	52.6	81.0	3,744	6.06	1,193,000	38,000	1,231,000	Do.
20	40.5	200,000	53.4	81.0	3,744	5.65	1,131,000	35,000	1,166,000	Do.
21	40.5	200,700	53.6	80.0	3,744	5.43	1,090,000	35,000	1,125,000	Do.
24	40.5	201,400	53.8	80.0	3,744	5.82	1,173,000	35,000	1,208,000	Do.
25	40.5	200,400	53.5	80.0	3,744	6.08	1,219,000	35,000	1,254,000	Do.
28	40.2	199,400	53.2	79.0	3,744	5.95	1,186,000	30,000	1,216,000	Do.
31	39.8	196,100	52.4	78.0	3,744	5.98	1,173,000	25,000	1,198,000	Do.
Apr. 2	39.7	195,600	52.2	78.0	3,744	5.85	1,144,000	23,000	1,167,000	Do.
3	39.8	195,900	52.3	79.0	3,744	6.03	1,182,000	23,000	1,205,000	Do.
4	39.6	196,500	52.5	78.0	3,744	5.98	1,175,000	22,000	1,196,000	Do.
5	39.4	195,800	52.3	79.0	3,744	5.73	1,122,000	20,000	1,142,000	Do.
7	39.4	195,300	52.2	78.0	3,744	5.78	1,128,000	19,000	1,147,000	Do.
8	39.4	195,700	52.3	78.0	3,744	5.70	1,116,000	18,000	1,134,000	Do.
9	39.4	196,000	52.4	78.0	3,744	5.62	1,102,000	17,000	1,119,000	Do.
10	39.4	192,000	51.3	78.0	3,744	5.73	1,100,000	16,000	1,116,000	Do.
11	39.4	191,800	51.2	77.0	3,744	5.71	1,096,000	15,000	1,111,000	Do.
12	39.4	193,500	51.7	78.0	3,744	5.91	1,144,000	15,000	1,159,000	Do.
14	39.4	193,000	51.5	77.0	3,744	5.59	1,078,000	15,000	1,093,000	Do.
15	39.3	194,300	51.9	77.0	3,744	5.60	1,089,000	14,000	1,103,000	Do.
17	39.3	194,300	51.9	78.0	3,744	5.51	1,071,000	14,000	1,085,000	Do.
18	39.2	194,100	51.9	77.0	3,744	5.57	1,081,000	13,000	1,094,000	Do.
19	39.2	195,500	52.2	77.0	3,744	5.52	1,080,000	12,000	1,092,000	Do.
21	39.2	191,700	51.2	77.0	3,744	5.70	1,093,000	12,000	1,105,000	Do.
22	39.2	192,100	51.3	77.0	3,744	5.60	1,077,000	12,000	1,089,000	Do.
24	39.2	194,300	51.9	77.0	3,744	5.74	1,114,000	12,000	1,126,000	Do.
25	39.2	194,200	51.9	76.0	3,744	5.63	1,093,000	11,000	1,104,000	Do.
26	39.0	195,900	52.3	77.0	3,744	5.56	1,090,000	9,000	1,099,000	Do.
28	38.5	189,400	50.6	75.0	3,744	5.48	1,038,000	5,000	1,043,000	Do.
29	38.3	189,500	50.6	76.0	3,744	5.43	1,029,000	.....	1,029,000	Do.
30	38.2	186,700	49.9	75.0	3,744	5.52	1,031,000	.....	1,031,000	Do.
May 2	38.0	185,800	49.6	75.0	3,744	5.50	1,022,000	.....	.....	Do.
5	37.9	189,400	50.6	75.0	3,744	5.37	1,017,000	.....	.....	Do.
6	37.8	189,900	50.7	73.0	3,744	5.34	1,015,000	.....	.....	Do.
7	37.6	189,000	50.6	.....	3,744	5.17	981,000	.....	.....	Do.
Dec. 28	9.8	78,500	21.5	52.0	3,645	3.29	259,000	.....	.....	Do.
29	9.7	78,900	21.6	52.0	3,645	3.34	263,000	.....	.....	Do.
30	10.0	78,800	21.6	52.0	3,645	3.29	259,000	.....	.....	Do.
1891.[a]										
Mar. 27	40.4	213,400	56.3	86.0	3,788	5.70	1,216,000	16,000	1,232,000	Do.
28	40.5	217,600	57.5	86.0	3,788	5.76	1,253,000	19,000	1,272,000	Do.
30	40.6	217,500	57.4	88.0	3,788	5.83	1,268,000	20,000	1,288,000	Do.
31	40.6	221,900	58.6	88.0	3,788	5.40	1,198,000	21,000	1,219,000	Do.
Apr. 1	40.6	223,300	59.0	86.0	3,788	5.28	1,179,000	22,000	1,201,000	Do.
2	40.7	224,400	59.2	86.0	3,788	5.46	1,225,000	22,000	1,247,000	Do.

[a] Discharge of Concord crevasse [550.5] April 18, 1891, = 100,192 cubic feet per second. Tabulated results of 1891 in Report Chief of Engineers, 1892, p. 3134; report on reduction, Chief of Engineers, p. 3123. Tabulated results of 1892 in Report Chief of Engineers, 1893, p. 3688; report on reduction, Chief of Engineers, p. 3673. Field results and report for 1892 in Report Chief of Engineers, 1892, p. 3188.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1891.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Apr. 3	40.7	222,100	58.6	86.0	3,788	5.65	1,254,000	22,000	1,276,000	Meter.
4	40.6	221,800	58.6	85.0	3,788	5.46	1,212,000	22,000	1,234,000	Do.
6	40.6	222,900	58.8	86.0	3,788	5.27	1,174,000	21,000	1,195,000	Do.
7	40.5	224,700	59.3	86.0	3,788	5.43	1,221,000	20,000	1,241,000	Do.
8	40.5	226,800	59.9	84.0	3,788	5.11	1,159,000	19,000	1,178,000	Do.
10	40.4	225,300	59.5	85.0	3,788	5.26	1,185,000	18,000	1,203,000	Do.
11	40.3	228,800	60.4	84.5	3,788	5.15	1,178,000	17,000	1,195,000	Do.
13	40.0	224,500	59.3	83.5	3,788	5.20	1,168,000	17,000	1,185,000	Do.
14	40.0	221,900	58.6	83.0	3,788	5.27	1,170,000	16,000	1,186,000	Do.
15	39.9	224,800	59.3	82.0	3,788	5.17	1,161,000	16,000	1,177,000	Do.
16	39.8	224,100	59.2	82.5	3,788	5.14	1,153,000	15,000	1,168,000	Do.
17	39.8	223,900	59.1	82.0	3,788	5.06	1,133,000	15,000	1,148,000	Do.
18	39.8	223,400	59.0	82.0	3,788	4.90	1,093,000	14,000	1,107,000	Do.
20	39.7	223,200	58.9	80.0	3,788	4.92	1,097,000	14,000	1,111,000	Do.
21	39.6	224,000	59.1	81.0	3,788	4.91	1,100,000	13,000	1,113,000	Do.
22	39.6	227,900	60.2	81.0	3,788	4.81	1,090,000	13,000	1,109,000	Do.
23	39.6	230,500	60.9	81.5	3,788	4.78	1,102,000	13,000	1,115,000	Do.
24	39.6	235,300	62.1	81.5	3,788	4.62	1,087,000	13,000	1,100,000	Do.
25	39.7	234,700	62.0	81.0	3,788	4.58	1,076,000	14,000	1,090,000	Do.
27	39.8	233,900	61.7	83.5	3,788	4.66	1,090,000	15,000	1,105,000	Do.
28	39.8	233,100	61.5	83.0	3,788	4.68	1,090,000	15,000	1,105,000	Do.
29	39.8	231,100	61.0	84.0	3,788	4.74	1,096,000	15,000	1,111,000	Do.
30	39.7	227,500	60.0	83.5	3,788	5.09	1,157,000	12,000	1,169,000	Do.
May 1	39.5	224,500	59.3	83.0	3,788	4.87	1,094,000	10,000	1,104,000	Do.
2	39.3	223,500	59.0	83.0	3,788	5.18	1,158,000	7,000	1,165,000	Do.
4	38.8	221,900	58.6	80.0	3,788	4.62	1,024,000	7,000	1,031,000	Do.
5	38 4	221,900	58.6	80.0	3,788	4.99	1,108,000	5,000	1,113,000	Do.
7	37.0	219,800	58.0	78.0	3,788	4.68	1,030,000	3,000	1,033,000	Do.
Oct. 16	1.2	68,100	20.7	37.5	3,295	1.96	133,000	.....	.....	Do.
17	1.0	68,400	20.8	37.5	3,295	1.95	133,000	.....	.....	Do.
20	.8	69,000	21.0	38.5	[a]3,293	1.94	134,000	.....	.....	Do.
Nov. 12	.0	63,500	19.4	36.5	3,280	1.84	117,000	.....	.....	Do.
1892:										
Apr. 16	35.6	193,600	49.3	67.0	3,923	5.64	1,091,000	.....	.....	Do.
18	36.6	199,900	50.8	68.0	3,931	5.58	1,116,000	.....	.....	Do.
19	36.8	199,100	50.6	67.5	3,932	5.83	1,160,000	.....	.....	Do.
20	37.2	203,800	51.8	68.5	3,934	5.92	1,207,000	.....	.....	Do.
21	37.4	205,200	52.1	68.0	3,936	5.85	1,199,000	.....	.....	Do.
22	37.8	205,300	52.1	68.5	3,937	5.83	1,197,000	[b] 2,000	1,199,000	Do.
23	38.1	211,600	53.7	70.0	3,939	6.12	1,294,000	2,000	1,297,000	Do.
25	38.7	216,500	54.9	70.5	3,942	6.09	1,318,000	[b] 3,000	1,321,000	Do.
26	39.0	217,600	55.2	70.0	3,944	6.16	1,340,000	4,000	1,344,000	Do.
27	39.2	212,700	53.9	70.5	3,944	6.32	1,345,000	5,000	1,351,000	Do.
28	39.4	215,900	54.7	71.0	3,944	6.42	1,380,000	6,000	1,392,000	Do.
29	39.7	222,800	56.5	71.5	3,944	6.28	1,399,000	7,000	1,406,000	Do.
30	39.8	221,500	56.1	71.0	3,946	6.03	1,336,000	8,000	1,344,000	Do.
May 2	40.1	222,600	56.4	71.0	3,948	6.14	1,368,000	[b]11,000	1,379,000	Do.
3	40.2	222,200	56.3	71.0	3,948	6.28	1,395,000	11,000	1,407,000	Do.
4	40.3	224,800	56.9	71.5	3,948	5.64	1,268,000	11,000	1,279,000	Do.
5	40.5	222,000	56.2	69.5	3,948	6.13	1,361,000	12,000	1,372,000	Do.
6	40.6	221,000	56.0	71.5	3,948	6.00	1,326,000	12,000	1,337,000	Do.
7	40.7	224,300	56.8	71.0	3,948	6.11	1,371,000	12,000	1,383,000	Do.
9	41.0	225,400	57.1	71.0	3,948	6.06	1,366,000	12,000	1,378,000	Do.
10	40.8	224,700	56.9	71.0	3,948	6.29	1,413,000	[b]12,000	1,425,000	Do.
11	40.8	224,700	56.9	71.0	3,948	5.85	1,315,000	13,000	1,328,000	Do.
12	40.8	225,400	57.1	71.0	3,948	6.00	1,352,000	14,000	1,366,000	Do.
14	41.0	226,600	57.4	71.5	3,948	5.68	1,287,000	15,000	1,302,000	Do.
16	40.8	227,300	57.6	71.5	3,948	5.51	1,252,000	16,000	1,269,000	Do.
18	40.8	229,600	58.1	72.5	3,943	5.65	1,298,000	18,000	1,315,000	
19, a. m.	40.8	227,000	57.5	71.5	3,948	5.64	1,279,000	19,000	1,298,000	Do.
19, p. m.	.....	.....	.....	.....	.....	5.52	1,252,000	.....	.....	Double floats
20	40.8	228,800	58.0	72.0	3,948	5.65	1,292,000	19,000	1,312,000	Meter.
21	40.8	230,000	58.2	72.0	3,948	5.74	1,321,000	20,000	1,341,000	Do.
24	40,9	233,000	59.0	74.0	3,948	5.66	1,319,000	22,000	1,341,000	Do.
25	41.0	231,700	58.7	74.0	3,948	5.44	1,261,000	23,000	1,284,000	Do.
26	40.9	231,200	58.6	73.5	3,948	5.64	1,304,000	24,000	1,327,000	Do.
27	41.0	229,500	58.1	73.5	3,948	5.80	1,331,000	24,000	1,356,000	Do.
27	41.0	229,500	58.1	73.5	3,948	5.60	1,285,000	.....	.....	Double floats.
28	41.0	232,500	58.9	74.5	3,948	5.86	1,362,000	25,000	1,387,000	Meter.

[a] Interpolated.

[b] Observed.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1892.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
May 3, a. m.	41.0	232,200	58.8	74.0	3,948	5.38	1,250,000	27,000	1,286,000	Double floats.
3, p.m.	.....	.....	.....	.....	.....	5.43	1,260,000	.....	.....	Meter.
31	41.0	234,400	59.4	74.0	3,948	5.83	1,366,000	27,000	1,393,000	Do.
June 1	41.1	236,500	59.9	74.0	3,948	5.48	1,296,000	[a]28,000	1,324,000	Do.
2	41.2	239,500	60.7	79.0	3,948	5.38	1,289,000	27,000	1,316,000	Do.
3	41.2	242,800	61.5	83.0	3,948	5.20	1,263,000	26,000	1,289,000	Do.
4	41.0	241,800	61.2	79.5	3,948	5.36	1,290,000	25,000	1,321,000	Do.
6, a. m.	40.9	239,300	60.6	84.0	3,948	5.08	1,215,000	23,000	1,238,000	Do.
6, p.m.	40.8	239,300	60.6	84.0	3,948	5.11	1,223,000	22,000	1,232,000	Double floats.
7	40.8	243,100	61.6	86.0	3,948	4.98	1,210,000	.....	.....	Meter.
8	40.8	243,000	61.6	84.0	3,948	5.05	1,227,000	21,000	1,248,000	Do.
9	40.8	243,900	61.8	90.0	3,948	4.87	1,188,000	20,000	1,208,000	Do.
10	40.8	244,700	62.0	88.5	3,948	4.86	1,189,000	19,000	1,208,000	Do.
10 [b]	40.8	238,900	60.5	88.5	3,948	4.87	1,163,000	19,000	1,182,000	Do.
11	40.8	243,000	61.6	87.0	3,948	4.72	1,148,000	[a]18,000	1,166,000	Do.
13	40.8	239,400	60.6	84.5	3,948	4.91	1,176,000	18,000	1,194,000	Do.
14	40.8	241,300	61.1	84.0	3,948	4.80	1,160,000	18,000	1,178,000	Do.
15	40.8	239,800	60.7	83.0	3,948	4.88	1,170,000	18,000	1,188,000	Do.
16	40.8	239,600	60.7	82.0	3,948	4.90	1,174,000	18,000	1,192,000	Do.
17	40.8	237,200	60.1	82.0	3,948	5.05	1,198,000	18,000	1,216,000	Do.
17 [b]	40.8	234,300	59.3	81.5	3,948	5.05	1,183,000	18,000	1,201,000	Do.
20	40.6	235,800	59.7	79.0	3,948	4.81	1,133,000	18,000	1,151,000	Do.
Oct. 26	0.8	79,800	24.0	35.5	3,323	1.82	145,000	.....	.....	Do.
26	0.8	79,800	24.0	35.5	3,323	1.81	144,000	.....	.....	Do.
29	0.8	78,900	23.8	34.0	3,317	1.77	140,000	.....	.....	Do.
Nov. 22 [c]	1.9	81,800	24.3	36.5	3,364	2.09	171,000	.....	.....	Do.
1893. [d]										
Mar. 7	34.4	189,000	49.0	69.0	3,857	5.46	1,032,000	.....	.....	Do.
9	34.8	191,900	49.8	66.5	3,857	5.50	1,055,000	.....	.....	Do.
10	35.1	196,400	50.9	68.0	3,857	5.44	1,069,000	.....	.....	Do.
11	35.2	200,300	51.9	68.5	3,858	5.32	1,065,000	.....	.....	Do.
13	35.3	187,200	48.5	66.0	3,860	5.43	1,016,000	.....	.....	Do.
14	35.1	195,100	50.5	67.0	3,860	5.52	1,077,000	.....	.....	Do.
15	34.8	194,000	50.3	66.5	3,860	5.59	1,085,000	.....	.....	Do.
16	34.5	194,900	50.5	67.5	3,858	5.59	1,090,000	.....	.....	Do.
17	34.3	190,700	49.4	66.0	3,857	5.48	1,045,000	.....	.....	Do.
18	33.9	183,600	47.6	66.0	3,857	5.59	1,026,000	.....	.....	Do.
18	.....	.....	.....	.....	.....	5.50	1,009,000	.....	.....	Double floats.
20	33.5	186,900	48.5	67.0	3,856	5.41	1,011,000	.....	.....	Meter.
21	33.3	185,600	48.0	66.5	3,856	5.41	1,004,000	.....	.....	Double floats
22	33.1	180,800	46.9	66.5	3,856	5.37	972,000	.....	.....	Meter.
23	33.0	180,400	46.8	65.0	3,856	5.38	971,000	.....	.....	Do.
24	33.0	181,800	47.1	65.0	3,856	5.33	969,000	.....	.....	Do.
24	.....	.....	.....	.....	.....	5.28	959,000	.....	.....	Do. [e]
25	32.9	180,200	46.7	65.0	3,856	5.30	955,000	.....	.....	Do.
27	32.9	181,900	47.2	63.5	3,856	5.18	942,000	.....	.....	Do.
27	.....	.....	.....	.....	.....	5.16	939,000	.....	.....	Do. [e]
28	32.9	185,200	48.0	64.0	3,856	5.16	955,000	.....	.....	Do.
28	.....	.....	.....	.....	.....	5.00	927,000	.....	.....	Do. [e]
30	32.8	179,800	46.6	63.0	3,856	5.17	930,000	.....	.....	Do.
30	.....	.....	.....	.....	.....	5.17	931,000	.....	.....	Do. [e]
31	32.6	185,300	48.1	62.5	3,855	5.20	963,000	.....	.....	Do.
31	.....	.....	.....	.....	.....	5.09	944,000	.....	.....	Do. [e]
Apr. 1	32.3	184,600	47.9	62.5	3,855	5.02	927,000	.....	.....	Do.
1	.....	.....	.....	.....	.....	4.86	898,000	.....	.....	Do. [e]
3	31.7	180,100	46.7	62.5	3,855	4.92	886,000	.....	.....	Do.
3	.....	.....	.....	.....	.....	4.72	850,000	.....	.....	Do. [e]
4	31.3	186,000	48.2	62.5	3,855	4.77	887,000	.....	.....	Do.
4	.....	.....	.....	.....	.....	4.72	878,000	.....	.....	Double floats.
4	.....	.....	.....	.....	.....	4.65	865,000	.....	.....	Meter. [e]
5	30.7	180,200	46.7	62.5	3,855	4.70	847,000	.....	.....	Do.
5	.....	.....	.....	.....	.....	4.60	829,000	.....	.....	Do. [e]
6	30.1	177,000	45.9	62.5	3,855	4.73	837,000	.....	.....	Do.
6	.....	.....	.....	.....	.....	4.76	843,000	.....	.....	Do. [e]

[a] Observed.
[b] Piano wire soundings; those of June 10 doubtful.
[c] Results of ordinary method, velocity stations 300 feet apart.
[d] The section of 1893 was about 250′ below the section used in previous years; the direction was also changed about 4½° to make it more nearly perpendicular to the flow. Tabulation, Report Chief of Engineers 1894, p. 2833. Report on work, Report Chief of Engineers, p. 2822.
[e] Moving or flanking across stream.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1893.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Apr. 7	29.6	177,800	46.1	62.0	3,855	4.65	827,000	.....	.....	Meter.
7	.....	.....	.....	.....	.....	4.60	818,000	.....	.....	Do.[a]
8	28.7	174,000	45.1	61.0	3,855	4.51	784,000	.....	.....	Do.
8	.....	.....	.....	.....	.....	4.39	764,000	.....	.....	Do.[a]
May 5	37.3	207,900	53.7	72.0	3,871	5.67	1,179,000	9,000	1,188,000	Do.
5	.....	.....	.....	.....	.....	5.55	1,153,000	.....	.....	Do.[a]
6	37.9	213,300	55.1	72.0	3,871	5.84	1,246,000	11,000	1,258,000	Do.
6	.....	.....	.....	.....	.....	5.73	1,223,000	.....	.....	Do.[a]
8	39.4	221,100	57.1	74.0	3,871	5.91	1,307,000	17,000	1,324,000	Do.
8	.....	.....	.....	.....	.....	5.88	1,299,000	.....	.....	Do.[a]
9	39.9	221,200	57.1	75.5	3,871	6.14	1,358,000	[b]20,000	1,378,000	Do.
9	.....	.....	.....	.....	.....	6.06	1,340,000	.....	.....	Do.[a]
10	40.3	222,200	57.4	74.0	3,871	6.07	1,349,000	22,000	1,371,000	Do.
10	.....	.....	.....	.....	.....	5.96	1,325,000	.....	.....	Do.[a]
11	40.6	227,400	58.7	74.0	3,871	6.14	1,396,000	24,000	1,420,000	Do.
11	.....	.....	.....	.....	.....	5.97	1,357,000	.....	.....	Do.[a]
12	40.6	225,500	58.2	74.0	3,871	6.13	1,383,000	25,000	1,408,000	Do.
12	.....	.....	.....	.....	.....	6.13	1,382,000	.....	.....	Do.[a]
13	40.7	227,200	58.7	75.0	3,871	6.07	1,379,000	27,000	1,405,000	Do.
13	.....	.....	.....	.....	.....	5.96	1,355,000	.....	.....	Do.[a]
15	41.0	231,700	59.9	75.0	3,871	5.94	1,376,000	30,000	1,406,000	Do.[a]
16	41.0	227,300	58.7	73.0	3,871	5.94	1,351,000	[b]31,000	1,382,000	Do.
16	.....	.....	.....	.....	.....	5.91	1,344,000	.....	.....	Do.[a]
17	41.0	230,300	59.5	73.5	3,871	5.85	1,348,000	31,000	1,378,000	Do.
17	.....	.....	.....	.....	.....	5.74	1,321,000	.....	.....	Do.[a]
18	41.0	232,700	60.1	73.5	3,871	5.84	1,359,000	31,000	1,391,000	Do.
18	.....	.....	.....	.....	.....	5.79	1,347,000	.....	.....	Do.[a]
19	41.0	229,800	59.4	74.0	3,871	5.95	1,367,000	31,000	1,398,000	Do.
19	.....	.....	.....	.....	.....	5.86	1,340,000	.....	.....	Do.[a]
20	41.0	231,200	59.7	74.0	3,871	5.87	1,357,000	31,000	1,388,000	Do.
20	.....	.....	.....	.....	.....	5.76	1,332,000	.....	.....	Do.[a]
22	41.0	237,900	61.5	75.0	3,871	5.69	1,355,000	31,000	1,386,000	Do.[a]
23	41.0	235,000	60.7	74.0	3,871	5.81	1,366,000	31,000	1,397,000	Do.
23	.....	.....	.....	.....	.....	5.73	1,346,000	.....	.....	Do.[a]
24	40.3	237,300	61.3	74.0	3,871	6.00	1,424,000	28,000	1,452,000	Do.
24	.....	.....	.....	.....	.....	5.89	1,396,000	.....	.....	Do.[a]
25	40.0	230,700	59.6	74.0	3,871	5.91	1,363,000	24,000	1,387,000	Do.
25	.....	.....	.....	.....	.....	5.85	1,349,000	.....	.....	Do.[a]
27	39.6	230,800	59.6	73.5	3,871	6.09	1,406,000	21,000	1,426,000	Do.
27	.....	.....	.....	.....	.....	6.01	1,387,000	.....	.....	Do.[a]
30	39.4	228,400	59.0	72.0	3,871	5.93	1,355,000	20,000	1,375,000	Do.
30	.....	.....	.....	.....	.....	6.08	1,389,000	.....	.....	Do.[a]
31	39.2	229,700	59.3	73.0	3,871	6.10	1,402,000	20,000	1,422,000	Do.
June 1	39.1	231,400	59.8	73.5	3,871	6.00	1,389,000	19,000	1,409,000	Do.
1	.....	.....	.....	.....	.....	5.95	1,378,000	.....	.....	Do.[a]
2	39.0	228,600	59.0	71.5	3,871	5.88	1,343,000	19,000	1,362,000	Do.
2	.....	.....	.....	.....	.....	5.84	1,336,000	.....	.....	Do.[a]
3	38.9	231,000	59.7	72.0	3,871	5.94	1,372,000	19,000	1,391,000	Do.
3	.....	.....	.....	.....	.....	5.70	1,317,000	.....	.....	Do.[a]
5	38.9	228,300	59.0	71.5	3,871	5.93	1,354,000	18,000	1,372,000	Do.
5	.....	.....	.....	.....	.....	5.87	1,340,000	.....	.....	Do.[a]
6	38.8	227,900	58.9	71.5	3,871	5.82	1,325,000	18,000	1,343,000	Do.
6	.....	.....	.....	.....	.....	5.82	1,327,000	.....	.....	Do.[a]
7	38.8	229,300	59.2	73.0	3,871	5.86	1,344,000	17,000	1,362,000	Do.
7	.....	.....	.....	.....	.....	5.75	1,319,000	.....	.....	Do.[a]
8	38.8	231,900	59.9	73.0	3,871	5.82	1,350,000	17,000	1,367,000	Do.
8	.....	.....	.....	.....	.....	5.81	1,347,000	.....	.....	Do.[a]
Oct. 24	2.1	73,900	20.3	33.0	3,636	2.32	172,000	.....	172,000	Do.
24	.....	.....	.....	.....	.....	2.10	155,000	.....	.....	Do.[a]
1894.[c]										
Sept. 26	2.3	43,900	17.1	27.5	2,571	3.99	175,000	.....	175,000	Do.
27	2.3	44,900	17.5	27.5	2,571	3.95	177,000	.....	177,000	Do.

[a] Moving or flanking across stream.

[b] Observed.

[c] Section of 1894 was located opposite Skipwith Towhead and above the location of former years at Wilson Point. The change was made to avoid the eddy at the old section. Thirteen velocity stations and 51 soundings each day. Velocities used as observed at 0.6 depth. Observations and reduction by third district officer, M. R. C.

Results of discharge observations, Mississippi River—Continued.

WILSON POINT, LA.—Continued.

[531 miles below Cairo.]

Date.	Guage reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second in cubic feet.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1895.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
July 24 a. m.	13.8	107,400	24.5	40.0	4,391	3.48	[b]373,000	.....	.....	Meter.
24 p. m.	13.8	107,200	24.4	40.5	4,391	3.45	370,000	.....	.....	Do.
Oct. 21 a. m.	−3.8	31,500	13.8	20.5	2,285	3.11	[b]98,000	.....	.....	Do.
21 p. m.	−3.8	31,800	13.9	20.1	2,285	3.21	102,000	.....	.....	Do.

[a] Section 2,500 feet below that of 1893, at 531.5 miles on inch-mile map. Lake Providence gauge readings are means of 8 a. m. and 4 p. m. by regular observer; elevation of gauge zero 89.62 feet above Cairo datum. Observations made underdirection of third district officer, M. R. C. Report Chief of Engineers, 1896, p. 3556.

[b] Flanking method. These are means of two flankings across river in opposite directions. Price meter used.

HAYS LANDING, MISS.

[Observations and reduction by M. R. C., secretary's office. Report and tabulation, 1882, in Report Chief of Engineers, 1881, p. 2627. All gauge readings at this station are those of the Hays Landing gauge, whose zero was 86.05 feet above the Cairo datum plane. Hays Landing is 553 miles below Cairo and about 22 miles below Wilson Point.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Jan. 2	29.9	136,700	51.3	91.8	2,665	5.37	734,000	Rod floats.
21	34.3	161,500	59.6	99.0	2,710	6.06	978,000	Do.
23,24	34.6	154,300	56.9	94.7	2,710	5.92	913,000	Do.
25,26	35.0	155,600	57.4	96.7	2,710	5.99	932,000	Do.
31	35.7	158,500	57.5	97.5	2,756	5.86	929,000	Do.
Feb. 1	35.8	158,900	57.7	97.2	2,756	5.85	929,000	Do.
2	35.8	160,800	58.3	95.8	2,756	5.86	942,000	Do.
6	36.1	159,900	58.0	99.7	2,756	5.97	954,000	Do.
10	36.4	165,300	60.0	99.0	2,756	5.88	972,000	Do.
11	36.4	165,600	60.1	99.4	2,756	6.12	1,014,000	Meter and rod floats.
17	36.9	165,300	60.0	101.8	2,756	5.78	956,000	Rod floats.
21	37.2	168,800	61.2	101.9	2,756	6.04	1,019,000	Do.
22	37.2	163,300	59.2	100.1	2,756	5.83	952,000	Do.
23	37.2	167,100	60.6	100.2	2,756	5.84	976,000	Do.
Mar. 2	37.5	169,000	61.7	100.0	2,756	5.70	968,000	Do.
3	37.3	167,900	60.9	99.0	2,756	5.68	954,000	Do.
6	37.1	169,300	61.4	99.5	2,756	5.96	1,009,000	Do.
9	37.3	171,600	62.3	99.0	2,756	5.73	984,000	Do.
13	37.6	172,000	62.4	99.2	2,756	5.71	982,000	Do.
14	37.8	170,400	61.6	100.8	2,765	5.45	928,000	Do.
15	38.0	168,900	61.0	102.2	2,770	5.59	944,000	Meter.
16	38.2	171,900	62.0	102.4	2,770	5.73	985,000	Do.
17	38.3	172,200	62.2	102.0	2,770	5.66	974,000	Do.
20	38.6	172,100	61.0	103.8	2,820	5.44	937,000	Do.
23	36.8	169,800	61.6	101.5	2,756	5.57	946,000	Do.
24	36.6	169,800	61.6	102.5	2,756	5.54	940,000	Do.
29	36.1	164,600	59.7	101.7	2,756	5.56	915,000	Rod floats.
Apr. 4	35.5	164,800	60.4	96.5	2,730	5.56	916,000	Do.
5	35.4	164,100	60.1	99.5	2,730	5.56	913,000	Meter.
6	35.3	163,900	60.1	98.7	2,725	5.66	928,000	Do.
7	35.2	163,400	60.0	98.5	2,725	5.53	903,000	Do.
10	35.0	161,200	59.5	99.5	2,707	5.40	871,000	Do.
13	34.9	165,500	61.1	101.0	2,708	5.57	921,000	Rod floats.
14	34.8	160,400	59.2	98.9	2,708	5.43	871,000	Do.
18	34.6	164,400	60.8	99.2	2,704	5.34	877,000	Do.
19	34.6	160,700	59.4	99.0	2,704	6.04	970,000	Meter.
20	34.5	166,400	61.5	99.5	2,704	5.56	926,000	Do.
21	34.4	163,700	60.5	98.5	2,704	5.50	900,000	Do.
26	34.2	159,900	59.3	98.5	2,699	5.36	857,000	Meter and rod floats.

Results of discharge observations, Mississippi River—Continued.

HAYS LANDING, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Apr. 27	34.0	161,500	59.8	98.0	2,700	5.14	829,000	Meter and rod floats.
28	33.9	159,900	59.2	99.1	2,700	5.18	828,000	Do.
May 1	33.4	160,500	59.7	98.0	2,688	5.29	849,000	Do.
2	33.2	162,000	60.3	97.1	2,688	5.15	834,000	Rod floats.
3	33.1	158,900	59.2	95.3	2,686	5.01	797,000	Do.
4	32.9	155,000	57.7	94.0	2,684	4.93	764,000	Do.
5	32.8	157,300	58.6	95.3	2,682	5.02	790,000	Do.
9	32.7	156,400	58.3	95.0	2,682	4.89	764,000	Do.
10	32.8	159,100	59.3	97.5	2,683	5.04	801,000	Do.
11	33.0	159,000	59.2	95.3	2,686	5.21	828,000	Meter.
12	33.1	158,900	59.1	96.5	2,687	5.30	842,000	Do.
15	33.7	162,800	60.3	99.0	2,701	5.61	913,000	Do.
17	33.9	162,700	60.2	97.0	2,703	5.32	866,000	Rod floats.
19	34.0	163,000	60.3	96.7	2,704	5.67	924,000	Do.
20	34.1	162,700	60.1	99.0	2,705	5.55	903,000	Do.
24	34.2	164,800	60.9	98.5	2,707	5.56	915,000	Do.
25	34.2	160,900	59.4	98.0	2,707	5.63	906,000	Do.
26	34.2	164,200	60.6	99.8	2,707	5.57	915,000	Do.
29	34.2	165,900	61.3	99.2	2,707	5.87	974,000	Meter.
30	34.1	166,100	61.4	98.8	2,707	5.99	995,000	Do.
June 1	34.2	167,400	61.8	98.8	2,707	6.26	1,049,000	Do.
2	34.1	166,800	61.6	99.9	2,707	6.06	1,011,000	Do.
5	34.1	167,400	61.9	99.2	2,707	6.17	1,033,000	Do.
6	34.1	168,100	62.1	99.8	2,707	6.29	1,058,000	Do.
8	34.1	167,000	61.7	100.0	2,707	6.13	1,024,000	Do.
9	34.1	165,800	61.3	98.0	2,707	6.25	1,036,000	Do.
13	34.1	159,900	59.1	97.1	2,707	6.13	981,000	Do.
15	34.0	161,500	59.7	95.2	2,707	5.98	965,000	Do.
16	34.1	161,700	59.7	96.9	2,707	6.19	1,001,000	Do.
19	34.0	161,300	59.6	97.8	2,706	6.22	1,004,000	Do.
21	33.9	161,000	59.5	95.8	2,705	6.14	988,000	Do.
22	33.9	160,100	59.2	95.3	2,705	6.13	981,000	Do.
23	33.8	160,300	59.2	96.7	2,706	6.16	987,000	Do.
29	33.7	160,000	59.4	97.5	2,703	5.91	949,000	Do.
30	33.7	160,000	59.4	97.0	2,702	5.73	920,000	Rod floats.
July 1	33.7	161,200	59.7	96.8	2,702	5.36	865,000	Do.
3	33.6	159,400	59.0	95.5	2,701	5.57	887,000	Do.
6	33.4	158,100	58.6	95.5	2,696	5.49	868,000	Do.
7	33.3	159,900	59.4	95.3	2,693	5.60	896,000	Do.
12	33.3	159,000	59.1	94.6	2,690	5.44	865,000	Do.
13	33.2	158,200	58.8	94.5	2,690	5.64	893,000	Meter.
14	33.2	157,100	58.4	93.8	2,689	5.60	880,000	Rod floats.
15	33.2	158,200	58.8	92.0	2,690	6.04	955,000	Meter.
18	33.1	160,800	59.8	96.0	2,690	5.73	922,000	Meter and rod floats.
19	33.1	160,700	59.8	97.0	2,689	5.75	924,000	Meter.
20	33.0	161,200	60.1	95.0	2,685	5.74	926,000	Do.
25	32.0	156,300	58.2	93.9	2,674	6.02	942,000	Do.
26	31.6	155,100	58.1	92.9	2,671	5.83	904,000	Do.
27	31.1	154,500	57.9	92.9	2,667	5.57	860,000	Do.
28	30.6	153,200	57.5	92.0	2,664	5.40	828,000	Do.
Aug. 1	27.3	145,800	55.1	88.5	2,646	4.81	701,000	Do.
2	26.1	140,800	53.3	86.2	2,643	4.75	669,000	Do.
3	25.0	137,500	52.2	85.8	2,634	4.57	629,000	Do.
4	23.8	135,700	51.7	85.0	2,628	4.27	580,000	Do.
8	19.8	123,300	47.4	78.5	2,601	3.85	474,000	Do.
10	18.8	119,500	46.0	78.5	2,599	4.12	492,000	Do.
11	18.8	119,600	46.0	77.7	2,599	4.27	510,000	Do.
15	19.7	124,200	47.7	80.0	2,601	4.00	496,000	Rod floats.
16	19.6	124,000	47.7	88.5	2,601	3.92	486,000	Do.
17	19.5	123,500	47.5	80.0	2,599	4.02	496,000	Do.
18	19.4	122,900	47.3	78.9	2,599	3.86	474,000	Do.
22	17.6	117,300	45.4	77.7	2,586	4.18	490,000	Meter.
26	16.1	113,600	44.0	75.4	2,579	3.68	418,000	Rod floats.
29	14.6	109,400	42.9	74.0	2,548	3.47	380,000	Do.
30	13.9	106,700	42.0	73.9	2,541	3.34	356,000	Do.
31	13.3	105,500	41.7	72.4	2,529	3.28	346,000	Do.
Sept. 1	12.6	103,100	40.9	71.0	2,522	3.17	327,000	Do.
6	10.9	97,400	39.0	69.2	2,495	3.19	310,000	Do.
7	10.8	97,100	39.0	68.5	2,493	3.10	301,000	Do.
8	10.7	96,900	38.9	69.2	2,490	3.17	307,000	Do.
9	10.6	97,500	39.2	68.2	2,489	3.20	312,000	Do.

Results of discharge observations, Mississippi River—Continued.

HAYS LANDING, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1882.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cubic feet.*	
Sept. 12	10.8	97,400	39.1	69.5	2,490	3.32	323,000	Meter.
13	11.0	98,800	39.6	69.0	2,496	3.56	352,000	Do.
14	11.1	99,000	39.6	70.9	2,497	3.40	337,000	Do.
15	11.2	101,400	40.6	71.2	2,497	3.60	365,000	Do.
16	11.1	100,500	40.2	70.0	2,497	3.59	361,000	Do.
18	10.7	98,000	39.3	69.5	2,491	3.54	347,000	Do.
19	10.4	97,600	39.3	69.0	2,483	3.50	341,000	Do.
20	10.1	96,900	39.1	68.9	2,477	3.45	334,000	Do.
21	9.9	94,800	38.3	68.4	2,476	3.28	311,000	Do.
23	10.4	96,100	38.7	69.5	2,482	3.19	307,000	Rod floats.
25	11.7	100,000	40.1	71.0	2,508	3.45	347,000	Do.
27	12.3	103,000	40.9	73.0	2,520	3.27	337,000	Do.
28	12.1	102,000	40.6	71.3	2,513	3.18	325,000	Meter.
29	11.6	102,000	40.7	71.0	2,507	3.02	307,000	Do.
30	11.0	97,900	39.2	69.9	2,498	3.01	294,000	Do.
Oct. 2	9.7	96,300	39.0	69.0	2,469	3.06	294,000	Do.
3	9.0	95,000	38.9	70.1	2,445	2.91	277,000	Do.
6	7.4	90,900	37.7	67.4	2,414	2.69	245,000	Do.
7	6.9	88,900	37.0	66.8	2,399	2.70	240,000	Do.
10	6.4	89,000	37.2	66.9	2,392	2.60	232,000	Do.
13	6.6	89,000	37.1	65.9	2,394	2.62	234,000	Do.
14	6.4	88,800	37.1	65.9	2,394	2.63	233,000	Do.
17	6.2	88,100	36.8	65.9	2,390	2.28	201,000	Do.
23	6.6	90,400	37.8	66.1	2,394	2.84	257,000	Do.
24	6.7	90,400	37.7	63.1	2,394	2.65	240,000	Do.
25	7.0	91,000	37.9	66.9	2,399	2.68	244,000	Do.
26	7.0	90,900	37.9	67.5	2,401	2.64	240,000	Do.
27	6.8	89,600	37.3	66.0	2,399	2.68	240,000	Do.
28	6.6	89,100	37.1	65.9	2,399	2.62	233,000	Do.
30	6.5	89,100	37.2	65.9	2,397	2.56	228,000	Do.
31	6.4	89,300	37.3	66.0	2,396	2.56	229,000	Do.
Nov. 1	6.3	88,900	37.1	66.1	2,394	2.50	222,000	Do.
2	6.2	88,000	36.8	66.8	2,389	2.52	222,000	Do.
3	6.0	86,800	36.4	65.2	2,387	2.51	218,000	Do.
4	6.1	86,400	36.2	65.2	2,388	2.55	221,000	Do.
6	6.2	86,400	36.2	65.3	2,389	2.61	225,000	Do.
7	6.2	86,600	36.3	65.4	2,389	2.64	228,000	Do.
8	6.2	87,000	36.4	65.0	2,389	2.57	223,000	Do.
9	6.3	88,600	37.1	65.2	2,391	2.61	231,000	Do.
10	6.4	86,200	36.0	66.1	2,392	2.61	225,000	Do.
11	6.4	87,300	36.5	66.1	2,392	2.63	230,000	Do.
13	6.7	86,900	36.3	66.1	2,395	2.75	239,000	Do.
14	6.8	89,100	37.2	66.2	2,396	2.74	244,000	Do.
15	7.0	89,600	37.3	67.1	2,402	2.80	251,000	Do.
16	7.3	87,900	36.5	66.9	2,407	2.86	251,000	Do.
17	7.6	89,400	37.0	67.0	2,416	2.92	261,000	Do.
20	8.7	91,200	37.3	68.1	2,448	3.01	275,000	Do.
21	9.0	92,900	37.9	68.5	2,450	3.07	285,000	Do.
22	9.1	93,600	38.1	68.8	2,453	3.09	289,000	Do.
23	9.3	94,300	38.3	69.8	2,462	3.10	293,000	Do.
1884.[a]								
Feb. 18	35.3	159,500	56.8	84.0	2,810	7.50	1,195,000	Do.
Mar. 16	37.7	171,300	.....	.....	.....	6.23	1,067,000	

[a] Results of February 18 in Report Chief of Engineers, 1891, p. 3488; observations of March 16 taken by "patrol" party, Report Chief of Engineers 1885, p. 2650.

Results of discharge observations, Mississippi River—Continued.

VICKSBURG, MISS.

[Results of 1858 taken from Report on the Mississippi River, by Capt. A. A. Humphreys and Lieut. H. L. Abbot, 1861, p. 598, edition of 1876. The gauge readings have been reduced to present engineer gauge at Vicksburg by subtracting 1.3 feet from readings originally published by H. and A. Zero of present gauge is 66.04 feet above the Cairo datum plane.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1858.	*Feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
Feb. 24	31.3					5.38	734,000			Double floats.
25	31.2					5.37	731,000			Do.
26	30.9					5.39	730,000			Do.
27	30.7					5.31	717,000			Do.
Mar. 4	28.2					5.39	693,000			Do.
5	27.9					5.34	683,000			Do.
6	27.8					5.25	671,000			Do.
8	28.4					5.52	713,000			Do.
9	28.9					5.57	726,000			Do.
10	29.6					5.66	748,000			Do.
11	30.2					5.71	764,000			Do.
12	30.7					5.75	777,000			Do.
13	31.2					5.78	788,000			Do.
15	32.3					5.81	808,000			Do.
17	32.7					6.03	844,000			Do.
18	32.9					6.04	849,000			Do.
19	33.0					5.96	840,000			Do.
20	33.2					5.95	842,000			Do.
23	35.7					6.41	947,000			Do.
24	36.6					6.40	961,000			Do.
25	37.6					6.49	990,000			Do.
26	38.6					6.55	1,017,000			Do.
27	39.5					6.61	1,042,000			Do.
29	41.1					6.74	1,091,000			Do.
30	41.7					6.79	1,109,000			Do.
31	42.5					6.78	1,122,000			Do.
Apr. 1	43.1					6.76	1,129,000			Do.
2	43.6					6.72	1,131,000			Do.
3	44.1					6.71	1,139,000			Do.
5	44.5					6.70	1,144,000			Do.
6	44.6					6.72	1,149,000			Do.
7	44.9					6.64	1,140,000			Do.
8	45.0					6.62	1,141,000			Do.
9	45.1					6.63	1,143,000			Do.
10	45.2					6.60	1,139,000			Do.
12	45.3					6.67	1,152,000			Do.
13	45.2					6.69	1,154,000			Do.
14	45.0					6.71	1,154,000			Do.
15	44.8					6.69	1,147,000			Do.
16	44.6					6.65	1,138,000			Do.
17	44.4					6.62	1,129,000			Do.
20	44.4					6.47	1,103,000			Do.
21	44.4					6.45	1,099,000			Do.
22	44.5					6.51	1,111,000			Do.
23	44.6					6.57	1,123,000			Do.
24	44.8					6.61	1,130,000			Do.
26	45.0					6.64	1,144,000			Do.
27	45.1					6.65	1,146,000			Do.
28	45.2					6.61	1,141,000			Do.
29	45.4					6.59	1,141,000			Do.
30	45.5					6.59	1,143,000			Do.
May 1	45.6					6.68	1,160,000			Do.
3	45.8					6.67	1,162,000			Do.
4	45.9					6.68	1,165,000			Do.
5	45.9					6.69	1,167,000			Do.
6	45.9					6.75	1,178,000			Do.
7	46.0					6.72	1,174,000			Do.
8	46.0					6.76	1,181,000			Do.
10	46.1					6.86	1,200,000			Do.
11	46.2					6.90	1,209,000			Do.
12	46.1					6.86	1,200,000			Do.
13	46.1					6.92	1,211,000			Do.
14	46.0					6.89	1,204,000			Do.
15	46.0					6.97	1,218,000			Do.
17	46.0					7.00	1,223,000			Do.
18	46.1					7.00	1,224,000			Do.
19	46.1					7.03	1,230,000			Do.
20	46.1					7.01	1,225,000			Do.
22	46.1					7.04	1,232,000			Do.

Results of discharge observations, Mississippi River—Continued.

VICKSBURG, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1858.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
May 24	46.2					7.05	1,235,000			Double floats.
25	46.2					7.05	1,235,000			Do.
26	46.2					7.00	1,227,000			Do.
27	46.2					7.00	1,227,000			Do.
28	46.3					7.05	1,236,000			Do.
29	46.3					7.02	1,233,000			Do.
June 1	46.3					7.02	1,232,000			Do.
2	46.3					7.07	1,241,000			Do.
3	46.3					7.02	1,233,000			Do.
4	46.4					7.06	1,241,000			Do.
5	46.4					7.07	1,242,000			Do.
7	46.5					7.03	1,238,000			Do.
8	46.5					6.97	1,227,000			Do.
9	46.6					6.89	1,214,000			Do.
10	46.6					6.92	1,220,000			Do.
12	46.8					6.95	1,229,000			Do.
14	46.8					6.87	1,216,000			Do.
15	46.8					6.89	1,219,000			Do.
16	46.8					6.85	1,212,000			Do.
17	46.8					6.89	1,218,000			Do.
18	46.8					6.91	1,222,000			Do.
19	46.8					6.89	1,218,000			Do.
21	46.7					6.97	1,231,000			Do.
22	46.9					6.99	1,238,000			Do.
23	46.9					6.97	1,234,000			Do.
24	46.9					7.03	1,244,000			Do.
25	46.9					7.01	1,242,000			Do.
26	47.0					6.94	1,231,000			Do.
28	46.9					6.83	1,209,000			Do.
29	46.9					6.82	1,207,000			Do.
30	46.8					6.82	1,206,000			Do.
July 1	46.8					6.88	1,216,000			Do.
2	46.8					6.90	1,219,000			Do.
3	46.7					6.90	1,219,000			Do.
6	46.7					6.86	1,212,000			Do.
7	46.7					6.86	1,212,000			Do.
8	46.7					6.91	1,220,000			Do.
9	46.7					6.93	1,224,000			Do.
10	46.7					6.94	1,226,000			Do.
12	46.8					6.90	1,220,000			Do.
13	46.8					6.89	1,218,000			Do.
14	46.8					6.91	1,222,000			Do.
15	46.8					6.90	1,220,000			Do.
16	46.8					6.90	1,221,000			Do.
17	46.8					6.95	1,229,000			Do.
20	46.6					6.91	1,218,000			Do.
21	46.5					6.91	1,216,000			Do.
22	46.4					6.93	1,218,000			Do.
23	46.3					6.90	1,210,000			Do.
24	46.1					6.79	1,189,000			Do.
26	45.7					6.72	1,170,000			Do.
27	45.6					6.65	1,155,000			Do.
28	45.5					6.68	1,158,000			Do.
29	45.4					6.67	1,155,000			Do.
30	45.2					6.65	1,148,000			Do.
31	45.1					6.66	1,147,000			Do.
Aug. 2	44.7					6.63	1,137,000			Do.
3	44.5					6.54	1,117,000			Do.
4	44.3					6.49	1,104,000			Do.
6	43.6					6.45	1,086,000			Do.
7	43.2					6.38	1,067,000			Do.
9	42.2					6.23	1,026,000			Do.
11	40.9					6.16	993,000			Do.
12	40.5					6.13	982,000			Do.
13	39.9					5.99	951,000			Do.
16	38.4					5.88	909,000			Do.
17	37.8					5.90	904,000			Do.
18	37.3					5.81	882,000			Do.
19	36.8					5.80	873,000			Do.
20	35.8					5.81	860,000			Do.
21	35.2					5.69	832,000			Do.
23	34.2					5.50	791,000			Do.
24	33.2					5.44	768,000			Do.
25	32.9					5.33	749,000			Do.
26	32.1					5.15	714,000			Do.
28	29.8					5.04	672,000			Do.
31	26.3					4.64	575,000			Do.
Sept. 1	25.2					4.47	541,000			Do.

Results of discharge observations, Mississippi River—Continued.

VICKSBURG, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1858.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
Sept. 2	25.2					4.48	534,000			Double floats.
3	23.4					4.53	528,000			Do.
4	22.6					4.54	520,000			Do.
9	20.5					4.14	452,000			Do.
10	20.0					4.09	443,000			Do.
11	19.3					4.09	436,000			Do.
13	18.0					3.99	412,000			Do.
14	17.4					3.98	405,000			Do.
15	16.8					3.86	387,000			Do.
16	16.4					3.85	382,000			Do.
17	15.9					3.90	383,000			Do.
18	15.6					3.92	381,000			Do.
20	16.1					3.91	385,000			Do.
21	16.6					3.97	396,000			Do.
22	17.1					4.03	407,000			Do.
23	17.2					4.09	414,000			Do.
24	17.3					4.02	408,000			Do.
25	17.2					3.89	394,000			Do.
27	16.7					3.85	385,000			Do.
30	15.3					3.73	361,000			Do.
Oct. 1	14.8					3.65	348,000			Do.
4	13.1					3.54	323,000			Do.
5	12.7					3.55	321,000			Do.
6	12.4					3.44	308,000			Do.
7	11.9					3.37	297,000			Do.
8	11.6					3.32	290,000			Do.
9	11.2					3.34	289,000			Do.
12	10.4					3.19	270,000			Do.
13	10.1					3.17	266,000			Do.
14	9.8					3.09	257,000			Do.
15	9.5					3.19	263,000			Do.
16	9.2					3.14	257,000			Do.
25	7.4					3.02	233,000			Do.
26	7.3					3.06	236,000			Do.
Nov. 8	14.0					3.79	354,000			Do.
9	16.4					4.07	405,000			Do.
10	18.1					4.58	474,000			Do.
11	20.1					4.77	517,000			Do.
13	23.4					5.09	594,000			Do.
16	24.1					4.95	586,000			Do.
17	23.8					4.72	556,000			Do.
19	22.8					4.59	528,000			Do.
20	22.3					4.57	520,000			Do.
23	20.3					4.44	484,000			Do.
24	19.8					4.24	457,000			Do.
25	18.9					4.23	447,000			Do.
26	18.5					4.04	422,000			Do.
27	17.9					4.05	417,000			Do.
30	16.1					4.03	397,000			Do.
Dec. 1	15.8					3.75	367,000			Do.
2	15.3					3.75	362,000			Do.
3	14.7					3.66	348,000			Do.
4	14.2					3.65	342,000			Do.
6	13.4					3.56	327,000			Do.
8	13.9					3.63	339,000			Do.
9	14.5					3.70	350,000			Do.
10	15.6					4.11	400,000			Do.
13	20.8					4.73	518,000			Do.
15	25.0					5.35	615,000			Do.

[600 miles below Cairo.]

1903.[a]										
Mar. 31, a. m.	51.38	206,000	86.2	141.7	2,389	7.44	1,532,000	[b]75,000	1,606,000	Meter.
p. m.	51.35					7.47	1,539,000	[b]75,000	1,614,000	Double float.
Apr. 1	51.30	199,800	83.6	141.6	2,389	7.55	1,509,000	[b]74,000	1,583,000	Meter.
2	51.20	199,800	83.6	141.6	2,389	7.38	1,475,000	74,000	1,549,000	Do.
4	50.95	203,500	85.2	141.5	2,389	7.30	1,486,000	[b]73,000	1,559,000	Do.
1904.										
Apr. 23	46.65	205,700	78.1	157.0	2,635	6.72	1,382,000			Do.

[a] Vicksburg United States engineer gauge, whose zero is 66.04 feet above the Cairo datum plane. The discharge section is 365 meters below the Refuge oil mill. Overbank discharge measured on right bank. Observations and reduction under direction of Capt. Wm. B. Ladue, Corps of Engineers, secretary Mississippi River Commission. Reports Chief of Engineers 1903, supplement, page 116, and 1905, page 120. 1904 velocities are means of simultaneous observations with a Haskell and a Price meter.

[b] All overbank discharges deduced from measurement made on Apr. 2.

Results of discharge observations, Mississippi River—Continued.

VICKSBURG, MISS.—Continued.

[600 miles below Cairo.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1906.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Apr. 22	46.70	.....	+0.20	213,036	214,032	92.0	92.4	172.8	2,316
23	46.80	.....	+ .15	220,106	220,870	95.0	95.4	171.0	2,316
23	46.90	.....	.....	[b] 220,338	.....	.....	.....	.....	.....
24	47.00	.....	+ .10	228,015	228,316	98.5	98.6	177.3	2,316
25	47.13	.....	+ .15	220,709	220,709	95.3	95.3	176.5	2,316

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1906.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*				
Apr. 22	.....	6.01	1,408,548	1,373	1,409,916	Meter	10	38	Calm.
23	+6,838	6.24	1,373,974	1,391	1,375,365	.....do.....	11	60	I. Light.
23	.....	6.42	1,414,562	1,408	1,415,970	Double float..	10	.....	Calm.
24	+7,446	6.68	1,523,049	1,426	1,524,475	Meter	11	34	Do.
25	−7,607	6.95	1,534,762	1,443	[c] 1,536,205	.....do.....	10	39	VI. Light.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum	Mean.	Mean datum.	Maximum.	Width.
1907.[d]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Feb. 10, p. m	49.55	.....	+0.1	207,825	208,055	90.4	90.5	170.0	2,300
11, a. m	49.60	.....	+ .1	200,800	200,915	87.3	87.4	170.0	2,300
11, p. m	49.65	.....	+ .05	200,800	.....	.....	.....	.....	2,300
12, a. m	49.65	.....	.0	207,105	207,105	90.0	90.0	170.0	2,300
12, p. m	49.65	.....	.0	207,105	.....	.....	.....	.....	2,300
13, a. m	49.65	.....	.0	197,955	197,955	86.1	86.1	171.0	2,300
13, p. m	49.65	.....	.0	197,955	.....	.....	.....	.....	2,300

[a] Zero of U. S. Engineer standard gauge is 46.16 feet above mean Gulf level. The datum line for computing datum areas was at 47.13 feet on this gauge. The discharge section is the same as that used in 1904; it is 365 meters below the Refuge Oil Mill below Kleinston. Velocities were measured with Price meter No. 38.

[b] Interpolated.

[c] Discharge measured; over-bank discharge for other days derived from this.

[d] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Vicksburg United States engineer gauge; zero is 46.16 feet above mean Gulf level. The datum line for computing datum areas was taken at 49.65 feet on the gauge. Price meter No. 28 was used. Overbank discharge was measured on right bank on February 12. All overbank discharges were derived from this measurement. The discharge section is at same place as that used in 1904—365 meters below the refuge oil mill below Kleinston.

Results of discharge observations, Mississippi River—Continued.

VICKSBURG, MISS.—Continued.

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Discharge over bank per second.	Total discharge of river per second.	Method.	Velocity stations.	Soundings.
1907.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*			
Feb. 10, p. m.	.....	8.03	1,668,009	11,288	1,679,297	Meter	11	36
11, a. m.	−7,140	7.87	1,580,021	12,500	1,592,521	Double floats.	10	36
11, p. m.	.....	8.15	1,637,438	13,711	1,651,149	Meter	8	....
12, a. m.	+6,190	8.05	1,666,172	13,711	1,679,883	.... do	10	27
12, p. m.	.....	8.24	1,707,500	13,711	1,721,211	.....do	9	....
13, a. m.	−9,150	7.78	1,540,040	13,711	1,553,751	Double floats.	10	29
13, p. m.	.....	8.54	1,689,771	13,711	1,703,482	Meter	9	....

[a] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary Mississippi River Commission. Vicksburg United States engineer gauge; zero is 46.16 feet above mean Gulf level. The datum line for computing datum areas was taken at 49.65 feet on the gauge. Price meter No. 28 was used. Overbank discharge was measured on right bank on February 12. All overbank discharges were derived from this measurement. The discharge section is at same place as that used in 1904—365 meters below the refuge oil mill below Kleinston.

WARRENTON, MISS.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1884.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*				
Oct. 8	13.6	88,800	36.2	61.0	2,451	4.63	411,000	.....	.....	Meter.
14	17.9	98,900	38.3	63.0	2,581	4.65	461,000	.....	.....	Do.
15	17.6	97,500	38.2	64.2	2,555	4.33	422,000	.....	.....	Do.
16	17.0	96,900	38.0	64.9	2,553	4.20	407,000	.....	.....	Do.
17	16.4	95,000	37.8	63.8	2,513	4.53	430,000	.....	.....	Do.
22	15.8	91,700	36.6	62.0	2,509	4.02	369,000	.....	.....	Do.
25	15.6	89,900	35.8	62.0	2,508	4.32	389,000	.....	.....	Do.
28	14.6	88,900	36.2	60.2	2,454	3.80	337,000	.....	.....	Do.
30	14.0	87,300	35.7	59.5	2,444	3.84	335,000	.....	.....	Do.
Nov. 4	14.0	85,000	34.8	59.8	2,444	3.94	335,000	.....	.....	Do.
6	13.7	83,600	34.3	59.2	2,438	4.03	337,000	.....	.....	Do.
8	13.4	84,600	34.8	59.3	2,433	3.97	336,000	.....	.....	Do.
10	12.7	82,600	34.3	58.9	2,410	3.79	313,000	.....	.....	Do.
14	10.3	76,300	33.1	56.3	2,303	3.60	275,000	.....	.....	Do.
15	9.8	75,900	33.2	55.8	2,287	3.70	280,000	.....	.....	Do.
17	8.7	72,300	32.1	54.1	2,255	3.44	249,000	.....	.....	Do.
19	7.7	70,200	31.6	55.0	2,222	3.44	242,000	.....	.....	Do.
22	6.5	66,600	30.4	53.7	2,192	3.54	236,000	.....	.....	Do.
24	6.3	67,000	30.9	53.8	2,172	3.38	226,000	.....	.....	Do.
27	6.0	66,300	30.7	53.0	2,160	3.55	235,000	.....	.....	Do.
29	5.8	64,900	30.1	53.3	2,155	3.34	217,000	.....	.....	Do.
Dec. 1	5.9	65,800	30.4	53.8	2,160	3.61	237,000	.....	.....	Do.
3	7.0	68,100	30.9	53.8	2,202	3.25	221,000	.....	.....	Do.
4	7.8	69,600	31.3	54.8	2,221	3.55	247,000	.....	.....	Do.
6	9.0	70,500	31.4	55.4	2,244	3.65	257,000	.....	.....	Do.
9	8.3	69,600	31.4	55.5	2,214	3.43	239,000	.....	.....	Do.
10	7.7	68,000	31.0	55.3	2,196	3.65	248,000	.....	.....	Do.
12	6.2	66,200	30.3	54.1	2,180	3.39	224,000	.....	.....	Do.
13	5.6	64,600	29.6	52.6	2,180	3.34	216,000	.....	.....	Do.
15	4.8	63,400	29.1	52.3	2,177	3.30	209,000	.....	.....	Do.
1885.										
Jan. 2	20.4	105,600	38.7	69.1	2,735	5.02	530,000	.....	.....	Do.
8	34.2	149,200	66.6	81.6	3,205	5.94	886,000	.....	.....	Do.
10	36.0	151,200	46.0	84.2	3,288	5.97	903,000	.....	.....	Do.
12	37.2	154,000	46.0	85.1	3,348	5.76	887,000	.....	.....	Do.
13	37.6	154,900	45.7	85.4	3,388	6.37	987,000	.....	.....	Do.

[Tabulated results in Report of Chief of Engineers, 1887, p. 2843. Report of Chief of Engineers, 1889, p. 2840.]

[a] The sections of 1884–5 are about one-half mile below the landing at Warrenton, Miss. Observations and reduction under the Secretary M. R. C. The gauge readings are those of the standard U. S. Engineer gauge at Vicksburg, whose zero is 66.04 feet above the Cairo datum plane. Warrenton is about 6 miles below Vicksburg.

Results of discharge observations, Mississippi River --Continued.

WARRENTON, MISS.--Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1885.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
Jan. 18	40.2	161,600	46.0	86.7	3,510	6.24	[a]1,008,000			Meter.
21	41.0	170,600	47.0	90.4	3,626	6.40	[b]1,092,000			Do.
22	41.2	171,000	46.9	90.3	3,650	6.73	1,151,000			Do.
23	41.4	172,500	47.0	90.8	3,672	6.38	[c]1,101,000			Do.
25	41.8	175,400	47.5	90.7	3,696	6.18	1,085,000			Do.
28	42.0	175,800	45.8	90.6	3,840	5.86	1,030,000			Do.
29	42.2	175,600	45.8	89.4	3,835	6.26	1,099,000			Do.
30	42.2	175,800	45.8	89.6	3,836	6.10	[d]1,072,000			Do.
Feb. 2	42.4	180,400	47.3	90.6	3,812	5.88	1,060,000			Do.
5	42.2	176,600	46.5	91.6	3,800	6.09	1,076,000			Do.
7	41.4	179,700	49.2	89.3	3,654	5.87	1,055,000			Do.
9	40.0	168,500	47.2	84.8	3,568					Do.
14	36.0	153,400	45.3	79.4	3,386	5.05	774,000			Do.
16	34.9	154,000	45.8	80.5	3,366	5.23	806,600			Do.
19	34.0	152,800	46.2	81.9	3,308	5.12	783,000			Do.
21	33.8	150,300	45.7	81.1	3,292	5.24	787,000			Do.
23	33.0	147,500	45.1	78.9	3,272	5.22	770,000			Do.
25	32.2	147,700	45.5	80.2	3,249	4.89	723,000			Do.
26	31.3	143,300	44.9	78.6	3,193	4.77	684,000			Do.
27	30.2	140,200	44.6	77.9	3,146	4.61	646,000			Do.
28	28.8	136,900	44.1	76.0	3,106	4.50	616,000			Do.
Mar. 2	26.0	125,500	41.9	72.5	2,996	4.31	541,000			Do.
3	24.7	120,900	40.9	70.8	2,961	4.35	526,000			Do.
4	23.6	118,600	40.4	70.4	2,946	4.19	497,000			Do.
5[e]	23.0	119,200	41.3	67.8	2,888	4.11	490,000			Do.
6	22.6	116,300	40.4	66.9	2,875	4.08	475,000			Do.
7	22.4	115,700	40.3	66.8	2,871	4.17	483,000			Do.
9	22.7	119,700	41.8	67.2	2,860	4.23	507,000			Do.
11	23.5	120,300	41.5	68.9	2,897	4.39	529,000			Do.
12	24.2	123,300	42.3	69.8	2,917	4.38	540,000			Do.
13	25.0	124,300	42.3	69.4	2,939	4.46	554,000			Do.
14	26.2	128,900	43.0	70.7	2,995	4.54	585,000			Do.
16	28.6	133,100	43.5	73.0	3,055	4.79	637,000			Do.
17	29.4	138,300	44.6	75.3	3,100	4.80	664,000			Do.
19	30.8	140,500	44.6	75.8	3,155	4.88	686,000			Do.
21	32.2	146,200	45.4	77.1	3,220	4.94	722,000			Do.
23	33.4	148,700	44.8	78.4	3,321	5.24	779,000			Do.
26	34.5	153,000	45.6	80.7	3,352	5.28	808,000			Do.
30	34.2	147,400	44.0	79.5	3,351	5.18	763,000			Do.
31	33.8	148,800	44.7	79.3	3,331	5.10	759,000			Do.
Apr. 1	33.3	149,100	45.0	79.3	3,313	4.72	704,000			Do.
4	31.4	141,000	43.4	76.8	3,251	4.84	682,000			Do.
6	29.6	132,700	41.9	74.5	3,166	4.80	637,000			Do.
1889.[f]										
Mar. 15	32.4	145,600	42.3	78.6	3,439	4.86	707,000			Do.
16	31.9	145,900	42.6	79.4	3,421	4.80	701,000			Do.
20	29.2	138,300	41.2	77.0	3,357	4.78	662,000			Do.
21	28.6	133,300	39.9	76.1	3,343	4.62	616,000			Do.
22	28.0	130,600	39.3	74.9	3,325	4.63	605,000			Do.
23	27.4	130,900	39.7	74.0	3,302	4.53	593,000			Do.
26	25.9	127,300	39.0	72.9	3,267					Do.
27	25.6	123,800	38.0	71.2	3,257	4.28	530,000			Do.
28	25.6	124,100	38.1	71.3	3,253	4.36	541,000			Do.
29	26.2	126,400	38.7	71,3	3,261	4.70	594,000			Do.
30	27.4	132,200	40.2	72.5	3,287	4.77	631,000			Do.
Apr. 1	29.4	141,400	42.2	74.3	3,351	5.01	709,000			Do.
2	29.9	142,200	42.3	75.3	3,360	5.03	715,000			Do.
3	30.2	140,500	41.7	74.8	3,368	4.98	700,000			Do.
4	30.3	139,900	41.5	75.8	3,370	4.93	690,000			Do.
5	30.2	140,900	41.8	75.7	3,369	4.93	695,000			Do.
6	30.0	141,700	42.1	75.7	3,369	4.94	700,000			Do.
8	29.4	139,600	41.6	75.4	3,355	4.78	668,000			Do.
10	28.6	137,000	41.1	74.7	3,335	4.75	650,000			Do.

[a] Slough discharge, 3,002,000 cubic feet.
[b] Slough discharge, 4,236,000 cubic feet.
[c] Slough discharge, 3,700,000 cubic feet.
[d] Slough discharge, 6,640,000 cubic feet.
[e] New section 200 feet above the old one.
[f] The observations of 1889 and 1890 made by Mississippi River Commission, fourth district officer, and reduction by the secretary. The section was about 2,800 feet below the landing at Warrenton and about 200 feet above the section of 1885 and oblique to it. Tabulation, Report Chief of Engineers, 1891, pp. 3512 and 3538.

Results of discharge observations, Mississippi River—Continued.

WARRENTON, MISS.—Continued.

Date.	Gauge reading	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1889.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
Apr. 11	28.2	135,500	40.8	73.8	3,325	4.66	631,000	.....	.....	Meter.
12	27.9	133,400	40.2	73.6	3,316	4.67	622,000	.....	.....	Do.
13	27.6	133,300	40.4	74.8	3,304	4.63	617,000	.....	.....	Do.
15	27.3	133,500	40.5	74.8	3,294	4.55	608,000	.....	.....	Do.
16	26.8	132,500	40.3	74.8	3,285	4.52	[a] 599,000	.....	.....	Do.
17	26.2	130,300	39.7	74.3	3,278	4.58	596,000	.....	.....	Do.
18	25.7	128,000	39.2	73.3	3,264	4.42	565,000	.....	.....	Do.
19	25.1	125,100	38.5	72.7	3,250	4.44	556,000	.....	.....	Do.
20	24.6	123,300	38.1	71.6	3,234	4.31	532,000	.....	.....	Do.
22	23.5	118,800	36.9	70.5	3,223	4.39	522,000	.....	.....	Do.
23	23.2	117,200	36.4	69.6	3,219	4.32	506,000	.....	.....	Do.
24	23.0	116,200	36.2	69.6	3,208	4.41	512,000	.....	.....	Do.
25	23.1	115,600	36.0	69.4	3,208	4.44	513,000	.....	.....	Do.
26	23.2	116,100	36.2	69.6	3,211	4.36	506,000	.....	.....	Do.
27	23.6	118,900	36.9	70.7	3,221	4.44	528,000	.....	.....	Do.
30	25.2	124,600	38.5	71.7	3,239	4.68	582,000	.....	.....	Do.
May 3	25.8	127,100	39.0	72.6	3,261	4.50	580,000	.....	.....	Do.
4	25.2	125,300	38.6	72.0	3,246	4.58	573,000	.....	.....	Do.
6	23.2	116,600	36.2	69.5	3,221	4.41	514,000	.....	.....	Do.
7	22.0	113,400	35.6	68.2	3,186	4.31	489,000	.....	.....	Do.
9	19.4	105,100	33.7	66.1	3,113	4.13	434,000	.....	.....	Do.
10	18.4	100,800	32.8	60.5	3,079	4.06	409,000	.....	.....	Do.
11	17.6	98,100	31.9	59.5	3,071	3.98	391,000	.....	.....	Do.
13	16.2	94,400	31.4	58.8	3,002	3.94	372,000	.....	.....	Do.
14	15.7	91,900	30.7	58.4	2,990	4.00	368,000	.....	.....	Do.
15	15.2	90,800	30.5	57.4	2,977	3.95	359,000	.....	.....	Do.
16	15.0	89,600	30.1	57.5	2,977	4.00	358,000	.....	.....	Do.
17	14.9	88,800	29.8	57.2	2,975	4.02	357,000	.....	.....	Do.
18	14.9	88,900	29.9	57.5	2,975	4.02	357,000	.....	.....	Do.
20	14.4	85,400	28.8	55.0	2,966	4.04	345,000	.....	.....	Do.
21	13.8	84,800	28.7	56.3	2,950	4.01	340,000	.....	.....	Do.
22	13.4	83,100	28.3	55.6	2,935	3.93	326,000	.....	.....	Do.
23	13.2	82,200	28.0	54.7	2,935	3.94	324,000	.....	.....	Do.
24	13.2	81,600	27.9	54.5	2,924	3.97	324,000	.....	.....	Do.
25	13.2	81,700	27.9	54.4	2,924	4.05	331,000	.....	.....	Do.
27	13.3	81,300	27.8	54.4	2,921	4.02	327,000	.....	.....	Do.
28	13.9	84,100	28.5	54.8	2,947	4.04	340,000	.....	.....	Do.
29	15.2	86,600	29.1	55.4	2,977	4.38	379,000	.....	.....	Do.
31	18.8	95,300	30.8	59.3	3,093	4.44	423,000	.....	.....	Do.
1890.										
Mar. 4	46.3	196,600	57.1	102.5	3,441	6.28	1,234,000	2,000	1,236,000	Do.
5	46.4	196,300	57.0	102.0	3,441	6.29	1,234,000	2,000	1,236,000	Do.
6	46.5	196,500	57.1	102.2	3,441	6.30	1,238,000	2,000	1,241,000	Do.
7	46.6	197,400	57.4	104.0	3,441	6.33	1,250,000	3,000	1,253,000	Do.
Apr. 11	47.7	206,600	60.0	109.0	3,441	6.32	1,306,000	3,000	1,309,000	Do.
12	47.9	207,300	60.3	109.7	3,441	6.37	1,321,000	4,000	1,324,000	Do.

[608 miles below Cairo.]

1895.[b]										
Aug. 2	14.0	79,300	29.4	47.5	2,699	3.97	[c] 315,000	.....	.....	Meter.
3	14.1	79,900	29.6	48.5	2,699	4.53	362,000	.....	.....	Do.
Oct. 26	−4.7	38,800	19.6	31.0	1,977	2.50	[c] 97,000	.....	.....	Do.
26	−4.7	38,700	19.6	30.0	1,977	2.63	102,000	.....	.....	Do.
28	−4.9	38,300	19.4	30.5	1,974	2.57	[c] 98,000	.....	.....	Do.
1897.[d]										
Apr. 1	49.35	230,000	61.2	93.9	3,756	7.17	1,649,000	14,000	1,663,000	Do.
2	49.35	223,100	59.4	93.5	3,756	7.32	1,632,000	14,000	1,646,000	Do.

[a] Unreliable.

[b] Section 1½ miles below old Warrenton Landing, at 607.8 miles on inch-mile map and as nearly as practicable in position of old Warrenton range. Vicksburg gauge readings are means of 8 a. m. and 4 p. m. by regular observer. Elevation of zero 66.01 feet above Cairo datum. Price meter used. Observations by third district officer, Mississippi River Commission. Report Chief of Engineers 1896, p. 3557.

[c] Flanking method. These are means of two flankings across river in opposite directions.

[d] The discharge section was at same place as in former years, which is about 1½ miles below old Warrenton Landing, and 607.8 miles on the inch-mile map. The discharge on right bank was measured on Apr. 6 and 14. The first measurement was not extended as far as the overflow, and was corrected by 3,912 cubic feet deduced from the second measurement. This corrected overbank discharge has been adopted for Apr. 1 to 5 and the overbank between Apr. 6 and 14 was interpolated from those dates; that for Apr. 15 was derived from the observed overbank discharge of the 14th. Vicksburg gauge readings taken at 8 a. m.; zero is 66.01 feet above the Cairo datum. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers 1897, p. 3655.

Results of discharge observations, Mississippi River—Continued.

WARRENTON, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1897.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet*	*Cu. feet.*	*Cu. feet.*	
Apr. 3.....	49.25	225,100	59.9	93.0	3,756	7.09	1,595,000	14,000	1,609,000	Meter.
5.....	49.25	227,400	60.5	93.8	3,756	6.74	1,533,000	14,000	1,547,000	Do.
6.....	49.30	[a]228,500	60.8	.....	3,756	6.49	1,484,000	[b]4,000 10,000	1,498,000	Double floats.
7.....	49.35	229,600	61.1	93.6	3,756	6.90	1,583,000	14,000	1,598,000	Meter.
8.....	49.60	233,400	62.1	92.8	3,756	7.04	1,643,000	16,000	1,659,000	Do.
9.....	49.85	238,200	63.4	94.7	3,756	7.00	1,667,000	17,000	1,685,000	Do.
10.....	50.15	240,500	64.0	94.6	3,756	6.73	1,618,000	19,000	1,637,000	Do.
12.....	50.90	241,800	64.4	93.8	3,756	7.04	1,701,000	24,000	1,725,000	Do.
13.....	51.30	237,800	63.3	93.5	3,756	7.23	1,720,000	27,000	1,747,000	Do.
14.....	51.55	[a]243,300	64.8	.....	3,756	6.87	1,672,000	[c]29,000	1,700,000	Double floats.
15.....	51.95	248,800	66.2	93.9	3,756	7.02	1,746,000	31,000	1,777,000	Meter.
1897.[d]										
Dec. 6.....	2.4	84,900	25.7	42.9	3,310	1.93	164,000	.....	.....	Do.
7.....	2.9	87,400	26.4	42.5	3,313	1.96	171,000	.....	.....	Do.
7.....	2.9	86,400	26.1	42.4	3,313	1.95	168,000	.....	.....	Do.
7.....	2.9	86,700	26.2	41.8	3,313	1.98	172,000	.....	.....	Double float.
8.....	3.0	87,400	26.4	42.7	3,322	1.98	173,000	.....	.....	Do.
8.....	3.0	87,100	26.3	42.6	3,322	1.87	163,000	.....	.....	Do.
8.....	3.0	87,500	26.4	42.5	3,322	1.92	168,000	.....	.....	Meter.
8.....	3.0	87,100	26.3	42.6	3,322	1.94	169,000	.....	.....	Do.
9.....	3.2	87,500	26.4	42.8	3,324	2.05	179,000	.....	.....	Do.
9.....	3.2	87,100	26.3	42.6	3,324	2.05	178,000	.....	.....	Do.
1898.										
Apr. 24.....	49.40	254,600	60.4	89.1	4,217	5.65	1,439,000	.....	.....	Do.
25.....	49.40	256,900	60.9	.....	4,217	5.36	1,377,000	.....	.....	Double float.
25.....	49.40	256,900	60.9	87.6	4,217	5.66	1,456,000	.....	.....	Meter.

[a] Interpolated from preceding and following days.
[b] Partly observed.
[c] Observed.
[d] Vicksburg United States engineer gauge at Kleinston, Miss., whose zero is 66.04 feet above the Cairo datum. The discharge section is near present landing below Warrenton, Miss., at same place as in former years, about 607.8 miles below Cairo on the inch-to-mile map. January, 1898, right bank end was swung downstream 15° to make the section more nearly normal to the direction of the flow.

WATERPROOF CUT-OFF.

[Waterproof, La., is 663 miles below Cairo. The discharges through the old channel were observed about the same times, and computed to be 370,465 cubic feet per second in May and 231,174 cubic feet per second in July. Report Chief of Engineers, 1891, p. 3488.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1884.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. feet.*	*Cu. feet.*	
May 25.....	[a]40.7	727	51.9	73.0	1,401	[b]6.46	469,000	.....	.....	Meter.
							[c]370,000	.....	.....	
Total ..	.....	.....	.....	.....	.....	.....	839,000	.....	.....	
July 23.....	21.0	752	59.1	110.0	1,273	[d]4.05	304,000	.....	.....	Double float.
							[c]231,000	.....	.....	
Total ..	.....	.....	.....	.....	.....	.....	535,000	.....	.....	

[a] St. Joseph gauge.
[b] The velocity observations were taken about 100 feet above the section sounded. Water surface was 87.326 feet above the Cairo datum plane.
[c] Discharge through old channel.
[d] In computing the velocities the average departure of the floats, 46.5 feet was assumed for each path.

Results of discharge observations, Mississippi River—Continued.

NATCHEZ, MISS.

[Taken from Humphreys and Abbot's Report on the Mississippi River, page 597, edition of 1876.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1858.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	
Jan. 8	37.9	.....	.....	.....	.....	4.79	845,000	Double floats.
9	37.5	.....	.....	.....	.....	4.71	836,000	Do.
11	37.4	.....	.....	.....	.....	4.66	826,000	Do.
12	37.5	.....	.....	.....	.....	4.73	840,000	Do.
13	38.2	.....	.....	.....	.....	4.88	879,000	Do.
18	40.6	.....	.....	.....	.....	4.80	915,000	Do.
20	40.4	.....	.....	.....	.....	4.74	901,000	Do.
21	40.3	.....	.....	.....	.....	4.69	889,000	Do.
22	40.1	.....	.....	.....	.....	4.72	877,000	Do.
23	39.9	.....	.....	.....	.....	4.62	869,000	Do.
28	39.6	.....	.....	.....	.....	4.69	875,000	Do.
29	39.6	.....	.....	.....	.....	4.67	871,000	Do.
30	39.6	.....	.....	.....	.....	4.69	874,000	Do.
Feb. 1	39.9	.....	.....	.....	.....	4.77	895,000	Do.
4	39.9	.....	.....	.....	.....	4.69	881,000	Do.
5	39.8	.....	.....	.....	.....	4.61	864,000	Do.
6	39.4	.....	.....	.....	.....	4.60	842,000	Do.
8	38.7	.....	.....	.....	.....	4.52	826,000	Do.
9	38.3	.....	.....	.....	.....	4.47	809,000	Do.
10	37.9	.....	.....	.....	.....	4.48	803,000	Do.
11	37.6	.....	.....	.....	.....	4.46	793,000	Do.
13	37.6	.....	.....	.....	.....	4.54	795,000	Do.
16	36.9	.....	.....	.....	.....	4.41	771,000	Do.
17	36.7	.....	.....	.....	.....	4.45	763,000	Do.
18	36.3	.....	.....	.....	.....	4.37	754,000	Do.
19	36.1	.....	.....	.....	.....	4.39	754,000	Do.
20	35.6	.....	.....	.....	.....	4.37	741,000	Do.
1890.								
Mar. 17, a. m.	46.6	147,100	69.8	118.0	2,108	9.36	1,376,000	Meter.
17, p. m.	.....	.....	.....	.....	.....	9.46	1,392,000	Do.
1891.[b]								
Mar. 24	46.1	156,100	73.7	105.3	2,117	9.21	1,437,000	Do.
25	46.1	155,800	73.6	105.8	2,117	9.66	1,506,000	Do.
26	46.2	155,400	73.3	107.2	2,121	8.83	1,372,000	Do.
27	46.2	156,400	73.8	106.7	2,119	8.94	1,399,000	Do.
28	46.2	157,700	74.4	111.8	2,119	8.83	1,393,000	Do.
29	46.2	155,900	73.5	110.9	2,122	8.76	1,365,000	Do.
30	46.2	156,600	73.8	111.2	2,123	9.74	1,525,000	Do.
31	46.3	158,500	74.4	109.4	2,130	9.46	1,499,000	Do.
Apr. 1	46.4	154,700	72.6	116.6	2,130	8.93	1,382,000	Do.
2	46.4	151,500	71.1	109.7	2,130	9.63	1,459,000	Do.
3	46.4	148,200	69.6	106.2	2,130	9.13	1,353,000	Do.
4	46.4	151,100	70.8	107.1	2,135	9.16	1,384,000	Do.
6	46.4	152,900	71.6	109.5	2,135	8.93	1,365,000	Do.
7	46.4	152,600	71.5	115.4	2,135	8.91	1,359,000	Do.
8	46.4	156,600	73.4	116.5	2,135	9.02	1,413,000	Do.
9	46.4	148,700	69.7	118.4	2,135	9.02	1,341,000	Do.
11	46.5	151,100	70.8	115.5	2,135	8.94	1,351,000	Do.
13	46.4	145,500	68.3	119.0	2,130	9.33	1,358,000	Do.
14	46.4	147,000	69.2	118.7	2,124	8.95	1,316,000	Do.
15	46.4	143,300	67.6	118.9	2,119	9.22	1,321,000	Do.
16	46.3	142,900	67.4	118.9	2,119	9.09	1,299,000	Do.
1892.[c]								
May 16[d]	47.0	151,100	69.5	119.3	2,173	9.15	1,383,000	Do.
17[d]	47.1	150,300	69.2	120.2	2,173	9.10	1,368,000	Do.
19[d]	47.2	153,100	70.5	120.3	2,173	8.93	1,367,000	Do.
20	47.2	154,100	70.9	123.8	2,173	9.21	1,419,000	Do.
21	47.1	151,500	69.7	125.0	2,173	9.26	1,402,000	Do.
23	47.1	154,200	71.0	119.8	2,173	9.18	1,416,000	Do.
25	47.1	153,100	70.5	128.1	2,173	9.11	1,395,000	Do.
26	47.0	151,300	69.6	121.4	2,173	9.06	1,371,000	Do.
27	47.0	155,200	71.4	119.0	2,173	8.90	1,381,000	Do.
28	47.1	150,600	69.3	118.6	2,174	8.70	1,310,000	Do.
30	47.1	152,800	70.3	122.8	2,174	8.76	1,339,000	Do.
31	47.2	151,000	69.4	124.3	2,175	9.02	1,363,000	Do.

[a] 4.7 feet have been subtracted from gauge readings of 1858 as originally published to reduce them to present United States engineer gauge at Natchez, whose zero is 36.89 feet above the Cairo datum plane.

[b] Observations by fourth district officer and reduction by Secretary Mississippi River Commission. Tabulation of 1890, Report Chief of Engineers, 1891, p. 3538; of 1891, Chief of Engineers 1892, p. 3136; and of 1893, Chief of Engineers, 1893, p. 3690.

[c] Reports on observations, Chief of Engineers, 1892, p. 3125, and 1893, p. 3679.

[d] Observations unreliable.

Results of discharge observations, Mississippi River—Continued.

NATCHEZ, MISS.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.	Method.
			Mean.	Maximum.				
1892.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	
June 2	47.4	154,000	70.8	121.0	2,176	8.99	1,385,000	Meter.
3	47.4	158,800	72.9	128.4	2,177	8.83	1,403,000	Do.
6	47.4	153,400	70.5	119.6	2,177	9.18	1,408,000	Do.
7	47.4	152,900	70.2	117.6	2,177	8.94	1,367,000	Do.
14	47.6	153,200	70.3	121.3	2,178	8.58	1,315,000	Do.
15	47.7	158,600	72.8	123.5	2,178	8.46	1,341,000	Do.
16	47.7	160,600	73.7	124.0	2,178	8.48	1,362,000	Do.
17	47.8	156,800	72.0	121.6	2,178	8.49	1,331,000	Do.
18	47.9	155,700	71.5	120.9	2,178	8.41	1,309,000	Do.
19	48.0	157,000	72.1	122.3	2,178	8.11	1,273,000	Do.
20	48.0	157,800	72.5	123.1	2,178	8.39	1,324,000	Do.
21	48.1	152,300	69.9	120.2	2,179	8.68	1,322,000	Do.
22	48.1	156,300	71.7	122.2	2,179	8.68	1,357,000	Do.
23[a]	48.1	158,400	72.7	122.5	2,179	8.14	1,289,000	Do.
24[a]	48.1	159,900	73.4	122.3	2,179	8.22	1,315,000	Do.
25	48.1	161,900	74.3	123.1	2,179	8.12	1,314,000	Do.
27	48.1	165,200	75.8	122.8	2,179	8.07	1,333,000	Do.
28	48.0	167,800	77.0	124.6	2,179	7.94	1,332,000	Do.
29	47.9	170,600	78.3	123.6	2,178	7.80	1,330,000	Do.
30	47.7	169,300	77.7	122.1	2,178	7.53	1,274,000	Do.

[a] Observations unreliable.

RED RIVER LANDING, LA.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1851.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. feet.*	*Cu. ft.*	*Cu. feet.*	
Mar. 31	(a)	.....	.....	.....	.....	.....	1,206,000	.....	.....	Double floats.
1881.[b]										
Dec. 14	30.3	150,000	40.0	58.0	3,747	4.42	662,000	.....	.....	Do.
16	28.8	147,100	39.4	59.2	3,736	4.37	643,000	.....	.....	Do.
17	27.8	141,800	38.0	56.0	3,728	4.27	605,000	.....	.....	Do.
19	26.0	133,100	35.9	57.0	3,704	4.26	567,000	.....	.....	Do.
22	23.6	123,700	33.5	53.1	3,691	3.96	490,000	.....	.....	Do.
24	23.0	119,500	32.5	58.0	3,681	4.08	488,000	.....	.....	Do.
27	24.6	125,800	34.0	55.3	3,697	4.15	522,000	.....	.....	Rod floats.
30	28.0	141,800	38.0	56.7	3,734	4.51	640,000	.....	.....	Double floats.
31	29.0	146,200	39.2	56.1	3,731	4.30	629,000	.....	.....	
1882.										
Jan. 3	31.6	159,600	42.6	62.1	3,749	4.52	721,000	.....	.....	Do.
5	32.7	160,700	42.8	59.0	3,757	4.66	749,000	.....	.....	Do.
19	36.6	175,800	46.8	66.5	3,753	5.45	938,000	.....	.....	Do.
21	37.6	177,800	47.3	66.0	3,762	5.91	1,050,000	.....	.....	Do.
23	37.9	176,500	47.2	68.0	3,735	5.72	1,010,000	.....	.....	Do.
24	38.2	179,800	47.7	66.4	3,771	5.59	1,005,000	.....	.....	Do.
26	38.6	182,700	48.6	67.7	3,758	5.51	1,007,000	.....	.....	Do.
28	39.1	188,100	49.9	67.5	3,771	5.71	1,074,000	.....	.....	Do.
Feb. 2	40.0	191,400	50.8	70.0	3,769	5.69	1,090,000	.....	.....	Do.
4	40.5	195,000	51.7	69.0	3,774	6.09	1,188,000	.....	.....	Do.
6	40.8	190,500	50.4	70.0	3,779	6.13	1,167,000	.....	.....	Do.
7	40.9	195,500	51.6	69.0	3,785	6.22	1,217,000	.....	.....	Do.
8	41.1	193,000	51.1	68.0	3,777	6.26	1,209,000	.....	.....	Do.
9	41.3	196,300	51.9	69.0	3,781	5.36	1,053,000	.....	.....	Meter.
10	41.5	192,200	50.9	69.0	3,777	5.72	1,099,000	.....	.....	Meter and double floats.

[a] Delta Survey gauge read 46.3 feet. See Humphreys & Abbot's Report on the Mississippi River, 1861, edition of 1876, pp. 381 and 520.

[b] Observations and reduction 1881-82 by Secretary M. R. C. Section was about 200 feet below the warehouse. Report on work, Report Chief of Engineers 1884, p. 2636; tabulation, ibid. p. 2642. All gauge readings at this station were taken on the United States engineer standard gauge whose zero is 23.85 feet above the Cairo datum plane.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1882.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Feb. 11	41.6	194,300	51.4	70.0	3,783	5.61	1,090,000			Double floats.
14	42.1	196,400	51.8	71.0	3,788	5.92	1,163,000			Do.
15	42.2	197,100	52.2	70.5	3,780	5.90	1,162,000			Do.
17	42.5	200,900	53.0	71.4	3,785	5.88	1,182,000			Do.
18	42.6	204,100	53.9	71.8	3,786	5.75	1,173,000			Double and rod floats.
21	43.2	207,200	54.7	73.0	3,789	5.86	1,213,000			Double floats.
22	43.3	209,800	55.4	72.5	3,791	5.70	1,197,000			Do.
23	43.4	209,900	55.3	73.4	3,793	5.84	1,227,000			Do.
24	43.6	209,400	54.6	71.5	3,831	5.77	1,207,000			Do.
27	44.1	214,000	55.5	72.0	3,853	5.74	1,228,000			Do.
28	44.3	217,300	56.4	72.0	3,853	5.69	1,237,000			Do.
Mar. 2	44.8	218,900	56.0	73.5	3,909	5.63	1,232,000			Meter.
3	45.1	219,200	56.2	74.0	3,899	5.69	1,247,000			Do.
7	46.0	228,400	58.4	76.5	3,914	5.82	1,330,000			Double floats.
8	46.2	229,600	58.7	76.0	3,914	5.81	1,335,000			Do.
9	46.5	230,100	58.8	75.3	3,914	5.91	1,361,000			Do.
10	46.8	230,200	58.8	76.8	3,914	6.07	1,397,000			Do.
11	46.9	231,000	59.2	77.2	3,904	5.94	1,371,000			Do.
13	47.2	233,200	59.7	77.5	3,904	6.04	1,408,000			Do.
14	47.3	233,300	59.8	78.5	3,904	6.00	1,407,000			Do.
15	47.4	233,600	59.6	78.5	3,918	6.28	1,467,000			Do.
16	47.5	237,600	60.6	79.0	3,918	6.08	1,444,000			Do.
17	47.6	237,800	60.7	79.0	3,918	6.17	1,468,000			Do.
18	47.6	234,100	59.7	79.0	3,918	6.20	1,451,000			Do.
20	47.8	234,600	59.9	79.0	3,918	6.00	1,408,000			Do.
23	48.1	231,800	59.2	77.0	3,918	6.09	1,411,000			Do.
24	48.2	234,300	59.8	78.0	3,918	6.29	1,474,000			Do.
25	48.3	231,000	59.0	77.5	3,918	6.36	1,469,000			Do.
27	48.5	234,500	59.8	79.0	3,918	6.22	1,459,000			Do.
28	48.4	237,500	60.9	80.5	3,899	6.46	1,534,000			Do.
29	48.4	237,400	60.9	80.2	3,899	6.48	1,539,000			Do.
30	48.4	234,200	60.1	80.0	3,899	6.43	1,505,000			Do.
31	48.3	235,400	60.4	80.5	3,899	6.78	1,595,000			Do.
Apr. 3	48.1	236,200	60.6	78.0	3,899	6.45	1,523,000			Do.
4	48.0	235,400	60.4	77.0	3,899	6.06	1,427,000			Do.
5	47.8	233,700	59.9	77.0	3,899	6.06	1,416,000			Do.
6	47.7	234,400	60.1	77.5	3,899	6.34	1,485,000			Do.
7	47.6	233,400	59.9	79.0	3,899	6.26	1,460,000			Do.
8	47.4	236,200	60.6	78.5	3,899	5.98	1,412,000			Do.
10	47.0	237,100	61.2	79.5	3,876	6.01	1,426,000			Do.
12	47.0	237,200	61.2	78.7	3,876	6.33	1,502,000			Do.
13	46.9	240,200	62.0	79.5	3,876	6.34	1,522,000			Do.
14	46.8	242,200	62.5	80.0	3,876	6.07	1,471,000			Do.
15	46.6	244,600	63.1	79.8	3,876	5.93	1,451,000			Do.
17	46.3	245,300	63.3	79.8	3,876	5.55	1,361,000			Do.
18	46.1	243,300	62.8	78.6	3,876	5.64	1,372,000			Do.
19	46.0	244,800	63.2	79.7	3,876	5.51	1,348,000			Do.
20	45.9	247,100	63.8	79.2	3,876	5.51	1,363,000			Do.
21	45.8	247,300	63.9	80.0	3,871	5.52	1,364,000			Do.
22	45.8	248,400	64.2	79.5	3,871	5.48	1,362,000			Do.
24	45.6	247,500	63.9	78.7	3,871	5.52	1,365,000			Do.
25	45.5	251,400	64.9	79.5	3,871	5.21	1,309,000			Do.
26	45.4	250,200	64.6	78.6	3,871	5.27	1,317,000			Do.
27	45.3	246,000	63.6	79.4	3,871	5.35	1,317,000			Do.
28	45.1	245,400	63.4	79.3	3,871	5.36	1,315,000			Do.
29	45.0	244,600	63.2	78.7	3,871	5.17	1,265,000			Do.
May 1	44.7	239,600	61.9	79.0	3,871	5.20	1,247,000			Meter and double floats.
2	44.6	239,200	61.8	79.0	3,871	5.12	1,235,000			Double floats.
3	44.3	237,600	61.4	79.0	3,871	5.08	1,208,000			Do.
4	44.2	238,700	61.7	77.0	3,871	5.40	1,289,000			Do.
5	44.1	238,400	61.6	77.2	3,871	5.16	1,230,000			Do.
6	44.0	238,200	61.5	78.0	3,871	5.22	1,243,000			Do.
8	43.9	238,200	61.5	78.0	3,871	5.04	1,202,000			Do.
10	43.6	237,400	61.3	77.5	3,871	4.90	1,164,000			Do.
11	43.3	236,500	62.7	76.3	3,774	4.84	1,145,000			Do.
12	43.1	235,600	62.6	76.8	3,766	5.31	1,251,000			Meter.
13	42.9	234,200	62.2	76.3	3,766	4.97	1,164,000			Do.
15	42.6	236,500	62.8	77.5	3,763	5.16	1,219,000			Do.
16	42.5	235,800	62.6	78.0	3,763	5.01	1,181,000			Do.
17	42.4	235,600	62.6	77.0	3,761	5.06	1,192,000			Do.
18	42.2	236,600	62.9	76.5	3,761	5.12	1,210,000			Do.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1882.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
May 19	42.1	235,500	62.6	77.0	3,762	5.11	1,204,000	.....	.....	Meter.
20	41.9	234,200	62.3	76.7	3,762	5.02	1,175,000	.....	.....	Do.
22	41.9	233,000	62.0	75.7	3,762	4.78	1,114,000	.....	.....	Double floats.
23	41.8	232,200	61.7	75.4	3,761	5.01	1,164,000	.....	.....	Meter.
24	41.6	231,600	61.6	75.0	3,759	4.95	1,146,000	.....	.....	Do.
25	41.5	231,300	61.5	75.2	3,759	4.94	1,142,000	.....	.....	Do.
26	41.4	229,100	61.0	75.3	3,759	4.98	1,142,000	.....	.....	Do.
27	41.4	230,800	61.4	75.0	3,758	5.00	1,155,000	.....	.....	Do.
29	41.3	229,400	61.0	75.2	3,759	4.94	1,132,000	.....	.....	Do.
31	41.4	231,400	61.6	75.2	3,759	4.92	1,138,000	.....	.....	Do.
June 1	41.4	232,200	61.8	76.0	3,759	4.90	1,138,000	.....	.....	Do.
2	41.4	233,800	62.2	76.1	3,759	5.00	1,168,000	.....	.....	Do.
3	41.4	233,100	62.0	75.5	3,759	4.83	1,125,000	.....	.....	Do.
5	41.4	232,200	61.7	76.0	3,765	4.72	1,097,000	.....	.....	Do.
6	41.5	233,500	62.0	74.6	3,765	4.77	1,114,000	.....	.....	Do.
7	41.5	233,900	62.1	74.0	3,765	4.79	1,120,000	.....	.....	Do.
8	41.6	232,400	61.7	72.7	3,767	4.81	1,117,000	.....	.....	Do.
10	41.6	234,500	62.2	75.3	3,772	4.77	1,119,000	.....	.....	Do.
12	41.7	233,800	62.0	75.0	3,768	4.74	1,107,000	.....	.....	Do.
14	41.7	235,600	62.5	75.0	3,768	4.78	1,126,000	.....	.....	Do.
15	41.8	236,300	62.7	75.5	3,769	4.72	1,115,000	.....	.....	Do.
16	41.8	235,800	62.6	75.8	3,769	4.80	1,132,000	.....	.....	Do.
17	41.8	234,000	62.1	75.7	3,769	4.90	1,148,000	.....	.....	Do.
19	41.8	233,800	61.9	76.0	3,774	4.72	1,105,000	.....	.....	Do.
20	41.8	234,400	62.1	76.0	3,774	4.67	1,094,000	.....	.....	Do.
21	41.8	234,200	62.1	74.0	3,774	4.77	1,118,000	.....	.....	Do.
23	41.8	234,000	61.9	73.3	3,778	4.80	1,123,000	.....	.....	Do.
24	41.8	234,100	62.0	73.0	3,778	4.68	1,096,000	.....	.....	Do.
26	41.8	235,200	62.3	73.4	3,778	4.67	1,099,000	.....	.....	Do.
28	41.7	235,400	62.3	74.2	3,777	4.61	1,085,000	.....	.....	Do.
30	41.6	234,100	62.0	75.0	3,776	4.73	1,106,000	.....	.....	Do.
July 1	41.5	232,800	61.6	75.0	3,776	4.68	1,089,000	.....	.....	Do.
3	41.4	232,000	61.4	74.0	3,777	4.58	1,062,000	.....	.....	Do.
4	41.3	232,600	61.6	73.2	3,777	4.57	1,063,000	.....	.....	Do.
5	41.3	233,500	61.8	73.0	3,777	4.57	1,068,000	.....	.....	Do.
7	41.1	233,200	61.7	73.0	3,777	4.54	1,060,000	.....	.....	Do.
8	41.0	231,000	61.2	73.0	3,777	4.52	1,044,000	.....	.....	Do.
10	41.0	234,000	62.0	74.5	3,777	4.44	1,039,000	.....	.....	Do.
12	40.8	233,000	61.7	74.2	3,777	4.38	1,020,000	.....	.....	Do.
13	40.8	233,700	61.9	75.0	3,776	4.40	1,029,000	.....	.....	Do.
14	40.8	234,200	62.0	74.4	3,776	4.46	1,045,000	.....	.....	Do.
15	40.7	231,800	61.4	75.0	3,776	4.49	1,041,000	.....	.....	Do.
17	40.5	230,800	61.1	74.0	3,775	4.50	1,039,000	.....	.....	Do.
19	40.4	231,300	61.4	75.0	3,767	4.42	1,022,000	.....	.....	Do.
20	40.4	230,600	61.2	74.6	3,766	4.37	1,008,000	.....	.....	Do.
21	40.3	231,500	61.5	74.5	3,765	4.45	1,029,000	.....	.....	Do.
22	40.2	231,000	61.4	74.5	3,765	4.38	1,011,000	.....	.....	Do.
24	40.2	231,000	61.4	75.0	3,765	4.35	1,005,000	.....	.....	Do.
26	39.8	228,000	60.7	74.0	3,757	4.21	960,000	.....	.....	Do.
28	39.5	224,600	59.8	72.2	3,756	4.18	940,000	.....	.....	Do.
29	39.3	224,200	59.7	72.4	3,757	4.12	923,000	.....	.....	Do.
31	38.7	221,000	58.8	73.0	3,757	4.10	907,000	.....	.....	Do.
Aug. 1	38.3	219,000	58.3	73.0	3,756	4.06	890,000	.....	.....	Do.
2	37.9	216,800	57.7	72.0	3,756	3.78	820,000	.....	.....	Do.
4	36.7	211,700	56.4	70.5	3,753	3.82	809,000	.....	.....	Do.
5	35.9	209,400	55.8	71.4	3,751	3.68	771,000	.....	.....	Do.
7	34.0	202,200	54.0	68.0	3,746	3.55	718,000	.....	.....	Do.
8	32.8	199,400	53.3	67.3	3,742	3.47	691,000	.....	.....	Do.
10	30.8	190,600	51.0	68.0	3,740	3.19	608,000	.....	.....	Do.
12	28.8	182,600	48.9	65.4	3,733	3.07	560,000	.....	.....	Do.
14	27.6	178,600	48.0	63.0	3,722	3.12	556,000	.....	.....	Do.
15	27.3	177,500	47.7	62.5	3,724	3.15	559,000	.....	.....	Do.
17	26.6	174,100	46.7	60.2	3,726	3.22	560,000	.....	.....	Do.
18	26.2	172,400	46.3	61.3	3,726	2.95	508,000	.....	.....	Do.
19	25.9	173,700	46.7	60.5	3,716	2.94	511,000	.....	.....	Do.
21	25.2	166,600	44.9	59.0	3,711	2.93	488,000	.....	.....	Do.
23	24.0	162,700	43.9	56.2	3,705	2.92	475,000	.....	.....	Do.
24	23.4	159,600	43.1	56.0	3,699	2.98	475,000	.....	.....	Do.
25	22.7	155,200	42.0	54.3	3,698	2.83	439,000	.....	.....	Do.
26	22.1	156,000	42.2	51.5	3,696	2.89	450,000	.....	.....	Do.
28	21.3	151,900	41.1	52.0	3,695	2.90	438,000	.....	.....	Do.
29	20.8	149,900	40.6	50.8	3,695	2.79	419,000	.....	.....	Do.
31	19.6	145,800	39.5	49.0	3,691	2.74	399,000	.....	.....	Do.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method
			Mean.	Maximum.			River.	Bank.	Total.	
1882.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Sept. 2	18.4	140,300	38.1	47.5	3,684	2.62	367,000			Meter.
4	17.2	136,300	37.1	45.8	3,678	2.64	360,000			Do.
5	16.2	134,400	36.6	46.0	3,676	2.64	355,000			Do.
7	15.6	129,200	35.2	45.0	3,668	2.59	334,000			Do.
8	15.3	128,200	35.0	44.6	3,668	2.56	329,000			Do.
11	14.5	124,000	33.9	43.5	3,657	2.46	305,000			Do.
12	14.2	122,200	33.4	43.0	3,656	2.54	310,000			Do.
13	14.0	121,800	33.3	42.6	3,657	2.53	308,000			Do.
15	14.0	122,000	33.4	42.7	3,657	2.45	299,000			Do.
16	14.0	121,100	33.1	43.0	3,657	2.50	303,000			Do.
18	13.8	119,900	32.1	42.6	3,653	2.46	295,000			Do.
19	13.7	120,300	33.0	41.9	3,649	2.46	296,000			Do.
20	13.5	119,600	32.8	42.3	3,651	2.50	300,000			Do.
23	12.7	114,900	31.5	42.0	3,646	2.46	282,000			Do.
25	12.8	115,300	31.6	42.0	3,645	2.47	285,000			Do.
26	13.2	117,300	32.2	42.0	3,646	2.51	296,000			Do.
28	14.1	122,200	33.4	43.0	3,658	2.61	319,000			Do.
30	14.4	122,200	33.4	43.8	3,660	2.46	300,000			Do.
Oct. 3	13.4	119,500	32.7	43.8	3,651	2.39	288,000			Do.
4	12.9	117,600	32.2	42.0	3,650	2.32	273,000			Do.
5	12.3	115,300	31.6	42.0	3,648	2.30	265,000			Do.
6	11.7	112,500	30.9	41.5	3,644	2.28	257,000			Do.
7	11.1	109,800	30.2	41.0	3,640	2.30	252,000			Do.
9	10.3	107,900	29.7	40.0	3,636	2.18	234,000			Do.
10	9.8	105,700	29.1	40.0	3,631	2.14	227,000			Do.
11	9.6	106,600	29.4	40.0	3,631	2.16	230,000			Do.
13	9.4	104,900	28.9	39.0	3,631	2.14	225,000			Do.
14	9.4	104,000	28.6	39.0	3,637	2.23	232,000			Do.
16	9.2	101,900	28.0	38.0	3,635	2.20	224,000			Do.
17	9.2	102,000	28.1	38.0	3,635	2.30	234,000			Do.
21	9.4	101,600	27.9	39.5	3,635	2.22	226,000			Do.
23	9.6	103,600	28.5	39.8	3,635	2.40	248,000			Do.
25	9.9	110,700	30.4	42.6	3,638	2.37	262,000			Do.
26	10.2	102,800	28.2	39.4	3,639	2.44	251,000			Do.
27	10.4	101,800	28.0	40.4	3,642	2.47	252,000			Do.
28	10.6	104,300	28.6	40.7	3,642	2.44	255,000			Do.
30	10.5	103,100	28.3	40.2	3,641	2.42	251,000			Do.
Nov. 1	10.4	103,400	28.4	40.3	3,640	2.53	262,000			Do.
3	9.9	101,300	27.8	40.0	3,640	2.41	244,000			Do.
4	9.8	98,700	27.1	39.8	3,640	2.45	242,000			Do.
6	9.7	99,200	27.3	38.0	3,635	2.42	241,000			Do.
7	9.7	99,900	27.5	39.0	3,635	2.42	241,000			Do.
8	9.7	101,800	28.0	40.5	3,635	2.46	251,000			Do.
10	9.7	102,000	28.1	41.0	3,635	2.50	255,000			Do.
11	9.8	101,700	28.0	41.0	3,637	2.38	242,000			Do.
14	10.3	105,500	29.0	40.5	3,645	2.47	261,000			Do.
15	10.4	105,000	28.8	40.0	3,645	2.45	257,000			Do.
17	10.7	104,600	28.7	41.5	3,650	2.57	269,000			Do.
20	11.8	108,300	29.6	41.2	3,653	2.65	287,000			Do.
21	12.2	111,300	30.5	42.4	3,653	2.63	292,000			Do.
22	12.6	112,300	30.7	42.0	3,658	2.72	305,000			Do.
23	12.9	112,900	30.8	43.0	3,661	2.76	302,000			Do.
1884.[a]										
Mar. 21	46.0	228,300	.....	.....	.....	5.66	1,292,000			Do.
Oct. 6	8.2	98,900	27.8	43.0	3,564	2.53	250,000			Do.
7	9.5	108,500	30.4	46.0	3,568	2.48	269,000			Do.
8	10.9	110,800	30.9	47.0	3,582	2.63	291,000			Do.
9	12.7	123,700	34.4	49.0	3,594	2.75	340,000			Do.
10	13.6	125,400	34.8	51.0	3,605	2.67	335,000			Do.
11	14.6	122,900	34.1	51.0	3,609	2.75	339,000			Do.
13	16.1	129,200	35.7	50.4	3,617	2.95	382,000			Do.
15	16.8	128,200	35.4	51.5	3,620	3.08	395,000			Do.
16	16.7	131,000	36.2	54.0	3,620	3.07	402,000			Do.
17	16.4	130,300	36.0	51.0	3,619	2.98	388,000			Do.
18	16.0	127,800	35.3	51.0	3,617	2.93	374,000			Do.
20	15.5	124,000	34.3	50.0	3,614	2.96	367,000			Do.
21	15.3	126,600	35.0	52.2	3,614	2.98	377,000			Do.
22	15.4	124,500	34.4	50.0	3,614	2.96	368,000			Do.
24	15.4	125,200	34.6	49.0	3,615	2.92	366,000			Do.

[a] Report on observations, and tabulation, Report Chief of Engineers 1887, pp. 2846 and 2852. Section 100 feet below that of 1881–82. This section was used with only a small change until 1892, inclusive. Observations and reduction under secretary Mississippi River Commission. Observation March 21 by "Patrol" party under secretary Mississippi River Commission. Results in Report Chief of Engineers 1885, p. 2650

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1884.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Oct. 25	15.4	126,400	35.0	52.0	3,615	2.92	369,000	.....	.....	Meter.
28	15.2	127,000	35.2	52.2	3,613	2.87	365,000	.....	.....	Do.
30	14.6	125,500	34.8	51.5	3,610	2.78	348,000	.....	.....	Do.
31	14.2	124,100	34.4	50.5	3,604	2.84	353,000	.....	.....	Do.
Nov. 1	14.0	128,200	35.6	52.1	3,605	2.80	359,000	.....	.....	Do.
4	13.8	126,500	35.1	51.2	3,604	2.70	353,000	.....	.....	Do.
5	13.9	124,800	34.6	51.9	3,604	2.75	343,000	.....	.....	Do.
6	13.9	124,800	34.6	50.9	3,605	2.76	344,000	.....	.....	Do.
7	13.8	121,900	33.8	49.0	3,605	2.75	335,000	.....	.....	Do.
8	13.7	123,000	34.1	50.2	3,605	2.71	333,000	.....	.....	Do.
10	13.4	121,100	33.6	50.2	3,599	2.66	323,000	.....	.....	Do.
11	13.1	118,800	33.0	48.1	3,600	2.67	317,000	.....	.....	Do.
12	12.8	117,400	32.7	48.0	3,596	2.72	320,000	.....	.....	Do.
13	12.4	115,400	32.1	47.2	3,590	2.62	303,000	.....	.....	Do.
14	12.0	113,900	31.8	47.1	3,585	2.64	301,000	.....	.....	Do.
15	11.5	113,300	31.6	47.5	3,584	2.55	289,000	.....	.....	Do.
17	10.6	110,900	31.0	46.0	3,578	2.61	289,000	.....	.....	Do.
18	10.2	108,300	30.3	44.5	3,569	2.61	282,000	.....	.....	Do.
19	9.7	107,600	30.2	45.0	3,569	2.43	261,000	.....	.....	Do.
20	9.3	104,600	29.3	44.0	3,567	2.49	260,000	.....	.....	Do.
21	9.0	103,300	29.0	44.2	3,566	2.50	259,000	.....	.....	Do.
24	8.4	101,300	28.4	43.6	3,563	2.43	247,000	.....	.....	Do.
25	8.2	100,400	28.2	43.0	3,561	2.38	239,000	.....	.....	Do.
26	8.0	99,000	27.8	42.5	3,560	2.33	230,000	.....	.....	Do.
28	7.9	100,000	28.1	42.5	3,559	2.25	225,000	.....	.....	Do.
29	7.8	97,600	27.4	40.3	3,559	2.35	229,000	.....	.....	Do.
Dec. 1	7.5	98,800	27.8	41.9	3,555	2.40	237,000	.....	.....	Do.
2	7.5	98,600	27.7	42.0	3,556	2.38	235,000	.....	.....	Do.
3	7.7	98,400	27.7	42.2	3,558	2.36	232,000	.....	.....	Do.
4	8.1	101,600	28.5	43.0	3,560	2.50	254,000	.....	.....	Do.
6	9.6	105,200	29.4	44.0	3,574	2.44	257,000	.....	.....	Do.
8	10.0	107,100	29.9	45.5	3,578	2.46	264,000	.....	.....	Do.
9	10.0	107,000	29.9	45.1	3,578	2.42	259,000	.....	.....	Do.
10	9.8	105,700	29.5	45.2	3,578	2.47	262,000	.....	.....	Do.
12	9.4	103,500	28.9	45.0	3,576	2.48	256,000	.....	.....	Do.
13	8.7	102,400	28.6	44.5	3,574	2.34	239,000	.....	.....	Do.
16	8.0	100,200	28.2	44.0	3,558	2.34	234,000	.....	.....	Do.
19	8.8	102,000	28.6	44.0	3,569	2.46	251,000	.....	.....	Do.
20	10.0	107,200	29.9	45.5	3,576	2.72	291,000	.....	.....	Do.
22	13.2	118,100	32.8	47.0	3,605	2.81	332,000	.....	.....	Do.
23	14.4	122,000	33.8	49.5	3,611	2.76	336,000	.....	.....	Do.
24	15.2	125,800	34.8	48.4	3,617	2.88	362,000	.....	.....	Do.
26	16.0	128,300	35.4	51.2	3,625	2.73	350,000	.....	.....	Do.
30	18.4	136,700	37.5	52.5	3,643	3.08	421,000	.....	.....	Do.
31	19.6	141,200	38.7	55.0	3,646	3.18	449,000	.....	.....	Do
1885.										
Jan. 2	21.2	145,900	39.9	57.0	3,660	3.32	484,000	.....	.....	Do.
3	22.9	153,700	41.9	58.0	3,667	3.40	522,000	.....	.....	Do.
7	31.4	196,700	52.4	69.5	3,758	.....	.....	.....	.....	
8	32.8	202,200	53.7	73.0	3,761	4.09	826,000	.....	.....	Do.
9	34.1	204,400	54.2	75.0	3,770	4.07	832,000	.....	.....	Do.
10	35.1	209,700	55.6	75.1	3,772	4.27	896,000	.....	.....	Do.
12	36.6	217,100	57.5	77.0	3,778	.....	.....	.....	.....	
13	37.2	218,200	57.7	77.0	3,781	4.45	971,000	.....	.....	Do.
16	38.8	227,300	60.0	81.0	3,790	.....	.....	.....	.....	
17	39.1	225,700	59.6	80.0	3,791	4.64	1,048,000	.....	.....	Do.
19	39.7	224,200	59.1	79.5	3,792	4.78	1,073,000	.....	.....	Do.
21	40.2	226,700	59.8	81.0	3,793	4.86	1,101,000	.....	.....	Do.
22	40.5	228,200	60.1	80.5	3,794	4.95	1,130,000	.....	.....	Do.
26	41.5	229,300	60.1	82.5	3,815	4.88	1,120,000	.....	.....	Do.
27	41.7	232,800	61.0	82.0	3,817	4.87	1,134,000	.....	.....	Do.
29	41.8	228,700	59.9	79.0	3,819	4.93	1,127,000	.....	.....	Do.
30	41.9	230,600	60.4	79.2	3,819	5.08	1,171,000	.....	.....	Do.
Feb. 2	42.1	228,600	59.8	87.0	3,821	4.95	1,132,000	.....	.....	Do.
4	42.1	232,500	60.8	85.5	3,821	5.04	1,171,000	.....	.....	Do.
5	42.1	236,700	61.9	85.5	3,822	4.95	1,173,000	.....	.....	Do.
6	42.1	232,200	60.8	87.0	3,822	4.90	1,137,000	.....	.....	Do.
7	42.0	232,300	60.8	84.5	3,822	4.87	1,130,000	.....	.....	Do.
9	41.6	229,900	60.2	84.5	3,818	.....	.....	.....	.....	Do.
10	41.4	235,300	61.7	92.0	3,816	4.73	1,113,000	.....	.....	Do.
11	41.0	229,000	60.2	89.0	3,804	4.56	1,043,000	.....	.....	Do.
12	40.6	229,600	60.4	87.0	3,800	4.59	1,053,000	.....	.....	Do.
14	39.8	223,600	59.0	86.0	3,792	4.38	979,000	.....	.....	Do.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1885.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Feb. 16	39.0	223,000	58.8	86.5	3,792	4.23	943,000			Meter.
17	38.6	220,500	58.2	87.0	3,788	4.37	964,000			Do.
19	37.9	212,300	56.0	86.0	3,788	4.17	886,000			Do.
20	37.7	216,500	57.2	84.5	3,787	4.09	884,000			Do.
21	37.4	215,400	56.9	84.0	3,786	4.04	871,000			Do.
24	37.0	212,300	56.1	86.5	3,784	4.10	870,000			Do.
25	36.9	212,500	56.2	84.0	3,782	4.06	863,000			Do.
27	36.1	209,800	55.6	83.1	3,774	3.88	815,000			Do.
28	35.5	207,300	55.0	80.9	3,770	3.83	793,000			Do.
Mar. 2	34.1	201,100	53.4	81.1	3,769	3.62	729,000			Do.
3	33.2	198,400	52.7	79.5	3,767	3.56	705,000			Do.
5	31.5	190,500	50.6	79.1	3,763	3.48	663,000			Do.
6	30.6	189,400	50.4	79.0	3,759	3.37	638,000			Do.
7	30.0	185,800	49.5	77.0	3,756	3.44	638,000			Do.
9	29.0	179,200	47.8	75.0	3,753	3.44	617,000			Do.
11	28.6	178,600	47.7	78.0	3,741	3.50	625,000			Do.
13	28.9	176,200	47.1	77.5	3,743	3.52	621,000			Do.
14	29.2	179,700	48.0	74.1	3,748	3.47	623,000			Do.
18	31.5	189,900	50.4	76.5	3,768	3.77	715,000			Do.
19	32.0	195,600	51.9	79.0	3,771	3.80	743,000			Do.
20	32.4	198,000	52.5	79.0	3,771	3.83	758,000			Do.
21	33.1	200,300	53.1	80.5	3,772	3.84	769,000			Do.
23	34.0	202,300	53.6	82.5	3,774	3.85	778,000			Do.
24	34.3	203,300	53.8	84.1	3,775	4.08	829,000			Do.
30	35.4	204,900	54.2	84.5	3,777	3.93	806,000			Do.
1889.[a]										
Jan. 10	19.5	112,200	29.7	50.2	3,780	3.84	431,000			Do.
11	19.4	111,900	29.6	49.5	3,780	3.95	442,000			Do.
12	19.2	113,800	30.1	53.0	3,775	3.79	431,000			Do.
14	18.9	114,100	30.3	52.6	3,770	3.85	439,000			Do.
16	19.9	116,400	30.8	52.4	3,780	3.71	432,000			Do
18	22.3	130,400	34.4	56.0	3,790	4.15	541,000			Do.
19	23.6	136,700	36.0	58.0	3,795	4.38	599,000			Do.
27	31.8	170,100	44.2	66.8	3,852	4.69	797,000			Do.
28	32.3	171,600	44.5	68.1	3,857	4.76	817,000			Do.
29	32.6	172,400	44.6	66.8	3,865	4.77	823,000			Do.
30	32.8	176,100	45.5	70.2	3,870	4.69	826,000			Do.
Feb. 1	33.2	175,000	45.1	69.8	3,878	4.36	762,000			Do.
2	33.1	178,900	46.2	70.2	3,875	4.52	809,000			Do.
6	33.0	173,300	44.7	73.8	3,874	4.50	779,000			Do.
7	33.1	170,600	44.0	72.8	3,875	4.33	739,000			Do.
9	33.3	175,200	45.2	69.6	3,878	4.31	756,000			Do.
13	33.5	177,800	45.8	70.4	3,881	4.30	764,000			Do.
14	33.4	176,400	45.5	70.5	3,879	4.34	765,000			Do.
16	32.8	176,700	45.7	70.1	3,865	4.23	748,000			Do.
18	31.6	174,700	45.3	69.8	3,853	4.02	702,000			Do.
20	29.9	166,200	43.3	66.5	3,839	3.94	655,000			Do.
21	29.0	161,900	42.2	65.4	3,834	3.80	616,000			Do.
23	27.0	155,100	40.6	64.9	3,819	3.60	558,000			Do.
25	25.3	148,200	38.9	63.1	3,812	3.82	566,000			Do.
28	26.6	152,200	39.8	64.1	3,820	3.99	608,000			Do.
Mar. 4	31.2	170,100	44.2	68.6	3,850	4.13	702,000			Do.
5	31.8	173,700	45.0	69.8	3,860	4.14	718,000			Do.
6	32.3	176,100	45.6	70.5	3,863	4.25	748,000			Do.
8	33.1	178,900	46.1	70.7	3,877	4.26	762,000			Do.
9	33.4	181,300	46.8	71.8	3,877	4.16	754,000			Do.
13	31.0	183,700	47.2	72.4	3,888	4.35	798,000			Do.
14	33.9	180,500	46.4	72.3	3,888	4.22	762,000			Do.
19	32.5	173,200	44.8	68.9	3,862	4.13	715,000			Do.
21	31.5	172,400	44.8	68.3	3,851	3.99	688,000			Do.
23	30.5	169,000	44.0	68.6	3,839	3.91	660,000			Do.
25	29.6	165,300	43.1	68.3	3,838	3.88	641,000			Do.
28	28.3	156,500	40.9	65.6	3,827	3.94	616,000			Do.
30	28.0	154,700	40.5	63.8	3,824	4.00	618,000			Do.
Apr. 3	29.9	163,400	42.5	67.0	3,842	4.18	682,000			Do.
5	30.5	165,600	43.0	66.3	3,848	4.12	682,000			Do.
6	30.6	166,100	43.2	67.3	3,849	4.08	678,000			Do.
8	30.4	165,300	42.9	67.3	3,849	4.08	675,000			Do.
10	29.9	164,600	42.8	67.7	3,847	4.02	662,000			Do.

[a] Section same as in 1884-85. Report on observations and tabulation, Report Chief of Engineers, 1891, p. 3516. Observations 1889 to 1893 taken under Mississippi River Commission fourth district officer. Reduction in secretary's office.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1889.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Apr. 11	29.6	162,600	42.3	67.7	3,846	4.10	666,000	.....	.....	Meter.
15	28.8	159,300	41.5	67.5	3,838	4.00	638,000	.....	.....	Do.
17	28.4	157,800	41.2	65.9	3,829	3.96	625,000	.....	.....	Do.
18	28.0	156,200	40.8	65.7	3,826	3.90	610,000	.....	.....	Do.
20	27.2	154,200	40.4	65.6	3,820	3.87	597,000	.....	.....	Do.
22	26.3	150,200	39.3	63.7	3,818	3.86	580,000	.....	.....	Do.
24	25.4	147,700	38.8	63.9	3,809	3.74	552,000	.....	.....	Do.
25	25.1	146,500	38.5	61.5	3,808	3.78	553,000	.....	.....	Do.
27	24.8	146,500	38.5	62.5	3,810	3.81	558,000	.....	.....	Do.
May 13	19.2	124,600	33.1	56.3	3,768	3.61	449,000	.....	.....	Do.
15	17.6	118,900	31.6	56.0	3,764	3.64	432,000	.....	.....	Do.
16	17.0	117,200	31.2	55.7	3,757	3.91	458,000	.....	.....	Do.
18	16.4	113,600	30.3	54.0	3,754	3.57	405,000	.....	.....	Do.
20	15.9	110,900	29.6	53.3	3,749	3.59	398,000	.....	.....	Do.
22	15.2	109,700	29.3	52.1	3,740	3.54	388,000	.....	.....	Do.
23	14.8	106,900	28.6	51.0	3,736	3.49	374,000	.....	.....	Do
25	14.0	103,400	27.7	49.9	3,730	3.51	363,000	.....	.....	Do.
27	13.7	101,900	27.3	50.0	3,728	3.53	360,000	.....	.....	Do.
29	13.8	100,800	27.0	51.0	3,728	3.61	364,000	.....	.....	Do.
1890.[a]										
Feb. 22	41.8	196,300	50.2	79.4	3,915	5.25	1,031,000	.....	.....	Do.
23	41.8	196,000	50.1	.....	3,915	5.18	1,016,000	.....	.....	Do.
24	41.9	195,400	49.9	79.7	3,915	5.25	1,026,000	.....	.....	Do.
26	42.3	198,600	50.7	79.2	3,915	5.16	1,024,000	.....	.....	Do.
27	42.3	197,900	50.6	.....	3,915	5.15	1,023,000	.....	.....	Do.
28	42.6	197,900	50.5	80.2	3,920	5.24	1,037,000	.....	.....	Do.
Mar. 3	42.6	201,500	51.4	80.0	3,920	5.18	1,043,000	.....	.....	Do.
18	44.9	209,100	53.1	81.5	3,935	5.42	1,134,000	.....	.....	Do.
28	44.8	210,500	52.8	80.8	3,989	5.29	1,114,000	4,000	1,117,000	Do.
Apr. 1	44.9	213,900	53.6	81.7	3,989	5.22	1,117,000	4,000	1,121,000	Do.
8	46.0	216,600	54.3	83.6	3,990	5.45	1,181,000	4,000	1,185,000	Do.
12	46.7	217,400	54.0	81.9	4,024	5.59	1,215,000	4,000	1,218,000	Do.
16	47.4	218,900	54.4	82.5	4,025	5.70	1,247,000	13,000	1,260,000	Do.
18	47.8	221,000	54.9	82.5	4,025	5.76	1,273,000	10,000	1,283,000	Do.
May 1	47.4	231,400	57.5	77.2	4,025	6.09	1,408,000	10,000	1,418,000	Do.
7	47.2	232,500	57.8	82.3	4,025	6.19	1,439,000	13,000	1,453,000	Do.
10	46.9	234,200	58.2	80.1	4,023	5.79	1,356,000	9,000	1,365,000	Do.
13	46.6	228,100	56.7	79.5	4,022	5.88	1,340,000	11,000	1,351,000	Do.
15	46.5	233,300	58.0	82.4	4,022	5.77	1, 46,000	10,000	1,356,000	Do.
20	46.0	226,200	57.3	82.4	3,950	5.74	1,298,000	6,000	1,304,000	Do.
1891.[b]										
Mar. 10	43.2	210,800	52.8	81.5	3,991	5.13	1,082,000	2,000	1,084,000	Do.
16	44.5	209,800	52.5	81.1	3,993	5.24	1,098,000	2,000	1,100,000	Do.
18	44.8	210,100	52.6	82.7	3,993	5.23	1,100,000	2,000	1,102,000	Do.
20	45.0	211,700	53.0	82.8	3,993	5.23	1,107,000	2,000	1,109,000	Do.
24	45.0	213,500	53.5	79.1	3,993	5.29	1,130,000	3,000	1,132,000	Do.
27	45.0	211,000	52.8	80.7	3,993	5.36	1,131,000	3,000	1,134,000	Do.
Apr. 2	45.2	213,400	53.4	84.2	3,994	5.32	1,136,000	3,000	1,139,000	Do.
7	45.2	211,200	52.9	79.9	3,994	5.34	1,128,000	3,000	1,131,000	Do.
10	45.4	216,900	54.3	82.3	3,994	5.14	1,116,000	3,000	1,118,000	Do.
13	45.5	219,200	54.9	82.1	3,995	5.12	1,122,000	3,000	1,125,000	Do.
16	45.4	218,200	54.6	82.3	3,995	5.08	1,109,000	3,000	1,112,000	Do.
20	45.4	222,700	55.7	83.3	3,995	4.93	1,098,000	3,000	1,100,000	Do.
Oct. 15	2.1	54,000	15.7	37.7	3,446	2.91	157,000	.....	.....	Do.
16	2.0	54,500	15.8	42.3	3,446	2.74	149,000	.....	.....	Do.
17	1.9	52,400	15.2	37.8	3,446	2.72	143,000	.....	.....	Do.
Nov. 21	1.9	53,800	15.6	42.6	3,442	2.63	141,000	.....	.....	Do.
22	3.0	55,100	16.0	44.0	3,445	2.78	153,000	.....	.....	Do.
1892.[c]										
Apr. 3	33.5	166,200	42.3	78.5	3,934	4.42	735,000	.....	.....	Do.
5	34.2	168,700	42.9	78.9	3,934	4.62	779,000	.....	.....	Do.
7	35.0	171,200	43.5	80.9	3,937	4.70	805,000	.....	.....	Do.
21	40.8	192,600	48.6	85.0	3,965	5.20	1,002,000	.....	.....	Do.

[a] Section of 1890 same as in 1884-85. Tabulation in Report Chief of Engineers, 1891, p. 3539.

[b] Tabulation of 1891, Report Chief of Engineers, 1892, p. 3215. Report on work, Report Chief of Engineers, 1892, p. 3125. The discharge over bank is on line of discharge section and partly around the end of an old levee on the right bank. The field notes of this overflow are very incomplete; hence these results are not exact.

[c] Section of 1892 approximately the same as in former years. Tabulation, Report Chief of Engineers, 1893, p. 3691. Report on work, Chief of Engineers, 1893, p. 3679.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1892.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
May 4	43.8	199,600	50.1	87.5	3,981	5.42	1,082,000	.....	.....	Meter.
6	44.1	201,700	50.7	86.8	3,981	5.41	1,092,000	.....	.....	Do.
11	44.8	205,900	51.7	87.7	3,982	5.42	1,117,000	.....	.....	Do.
19	45.4	207,600	51.4	86.2	4,040	5.44	1,130,000	2,000	1,132,000	Do.
21	45.4	208,400	51.6	87.0	4,040	5.43	1,132,000	3,000	1,135,000	Do.
23	45.4	208,800	51.7	89.6	4,040	5.34	1,115,000	4,000	1,119,000	Do.
25	45.5	210,400	52.1	88.7	4,041	5.40	1,137,000	6,000	1,142,000	Do.
27	45.6	211,700	52.4	88.1	4,041	5.38	1,140,000	6,000	1,146,000	Do.
June 1	46.0	212,900	52.7	88.6	4,042	5.40	1,149,000	6,000	1,155,000	Do.
3	46.1	211,300	52.3	87.4	4,043	5.37	1,135,000	7,000	1,141,000	Do.
7	46.5	214,100	52.9	86.6	4,044	5.38	1,152,000	7,000	1,159,000	Do.
9	46.7	219,700	54.3	88.2	4,044	5.32	1,170,000	7,000	1,177,000	Do.
11	47.0	222,400	55.0	87.7	4,044	5.31	1,181,000	7,000	1,188,000	Do.
14	47.4	226,500	56.0	88.9	4,044	5.36	1,213,000	8,000	1,221,000	Do.
16	47.7	229,700	56.8	89.2	4,044	5.45	1,252,000	8,000	1,260,000	Do.
20	48.2	229,600	56.8	89.6	4,045	5.57	1,279,000	9,000	1,288,000	Do.
23	48.6	231,400	57.2	90.0	4,045	5.64	1,304,000	8,000	1,312,000	Do.
25	48.7	229,700	56.8	91.0	4,045	5.77	1,325,000	9,000	1,334,000	Do.
27	48.8	228,600	56.5	91.0	4,046	5.78	1,321,000	10,000	1,331,000	Do.
1893.[a]										
May 23	44.2	199,300	49.4	72.3	4,038	5.32	1,060,000	5,000	1,065,000	Do.
24	44.3	207,900	51.5	80.8	4,038	5.27	1,095,000	5,000	1,100,000	Do.
26	44.4	208,200	51.6	79.6	4,038	5.20	1,084,000	5,000	1,089,000	Do.
29	44.5	208,200	51.6	81.1	4,038	5.11	1,065,000	5,000	1,070,000	Do.
June 1	44.5	208,200	51.5	82.0	4,039	5.07	1,055,000	5,000	1,060,000	Do.
3	44.6	218,600	54.0	80.0	4,044	4.83	1,056,000	5,000	1,061,000	Do.
7	45.0	221,200	54.7	81.1	4,044	4.90	1,084,000	5,000	1,089,000	Do.
9	45.2	221,800	54.8	82.0	4,044	5.07	1,124,000	5,000	1,129,000	Do.
13	45.7	228,800	56.6	81.8	4,044	5.06	1,157,000	5,000	1,162,000	Do.
17	46.5	224,100	55.3	82.7	4,050	5.19	1,164,000	5,000	1,169,000	Do.
22	47.4	229,600	56.8	81.0	4,044	5.33	1,225,000	5,000	1,230,000	Do.
24	47.6	227,800	56.3	83.5	4,044	5.08	1,157,000	6,000	1,163,000	Do.
27	47.7	228,000	56.4	83.3	4,044	5.14	1,172,000	6,000	1,177,000	Do.
July 10	43.1	205,900	51.0	76.7	4,038	4.72	973,000	5,000	977,000	Do.
May 24[b]	44.3	231,000	50.4	58.7	4,585	4.60	1,063,000	.....	.....	Do.
26[b]	44.4	227,500	49.6	56.9	4,585	4.85	1,103,000	.....	.....	Do.
29[b]	44.5	234,200	51.2	62.6	4,573	4.65	1,088,000	.....	.....	Do.
June 3[b]	44.6	240,200	52.4	60.6	4,580	4.61	1,107,000	.....	.....	Do.
7[b]	45.0	240,000	52.4	61.2	4,580	4.60	1,105,000	.....	.....	Do.
9[b]	45.2	243,800	53.2	67.1	4,580	4.82	1,174,000	.....	.....	Do.
13[b]	45.8	251,600	54.9	63.9	4,580	4.80	1,208,000	.....	.....	Do.
17[b]	46.5	252,600	55.1	66.0	4,580	4.81	1,215,000	.....	.....	Do.
20[b]	47.1	256,000	55.7	65.4	4,580	4.80	1,225,000	1,000	1,226,000	Do.
24[b]	47.7	260,000	56.8	63.9	4,580	4.56	1,185,000	1,000	1,186,000	Do.
26[b]	47.7	262,300	57.3	66.5	4,580	4.67	1,225,000	1,000	1,226,000	Do.
27[b]	47.7	263,400	57.5	66.1	4,580	4.60	1,213,000	1,000	1,214,000	Do.
29[b]	47.6	259,300	56.6	65.4	4,580	[c]4.42	1,146,000	1,000	1,147,000	Double floats.
29[b]	47.6	259,300	56.6	65.4	4,580	[d]4.76	1,235,000	1,000	1,236,000	Do.
July 1[b]	47.2	259,000	56.5	64.4	4,580	[e]4.40	1,141,000	1,000	1,141,000	Do.
1[b]	.....	.....	.....	.....	.....	[f]4.60	1,192,000	.....	.....	Do.
9[b]	43.8	241,400	52.7	59.7	4,580	4.23	1,021,000	.....	.....	Meter.
10[b]	43.0	237,500	52.0	58.6	4,570	4.20	997,000	.....	.....	Do.

[a] Report on observations of 1893, Report Chief of Engineers, 1894, p. 2837. Report on work, Chief of Engineers, p. 2823.

[b] Section at Torras Landing, one-half mile above Red River Landing.

[c] Surface floats reduced to mean of vertical.

[d] Floats at 0.8 depth reduced to mean of vertical.

[e] Floats at mid-depth reduced to mean of vertical.

[f] As observed at mid-depth.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

[765 miles below Cairo.]

[Red River Landing gauge; elevation of zero 23.85 feet above Cairo datum.]

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1895.[a]	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Nov. 12	−0.41 −0.43	43,100	12.2	27.8	3,527	2.46	106,000	.....	.....	Meter.
14	−0.41 −0.55	43,400	12.3	27.9	3,527	2.47	107,000	.....	.....	Do.
16	−0.40 −0.65	43,800	12.4	27.8	3,527	2.39	105,000	.....	.....	Do.
17	+0.10 +0.02	43,700	12.3	28.5	3,543	2.16	94,000	.....	.....	Do.
18	+0.21 −0.04	44,600	12.6	28.8	3,544	2.39	107,000	.....	.....	Do.
19	−0.06 −0.30	43,700	12.4	28.3	3,537	2.22	97,000	.....	.....	Do.
20	−0.11 −0.28	43,200	12.2	28.5	3,538	2.47	108,000	.....	.....	Do.
23	+0.03 +0.23	43,500	12.3	28.6	3,543	2.72	118,000	.....	.....	Do.
26	+0.47 +0.31	45,800	12.9	30.2	3,548	2.48	114,000	.....	.....	Do.
27	+0.11 +0.09	44,400	12.5	29.4	3,544	2.63	117,000	.....	.....	Do.
1897.[b]										
Apr. 21	47.70 47.75	213,400	52.5	85.2	4,064	5.72	1,221,000	[c] 6,000	1,227,000	Do.
22	47.85 47.90	212,100	52.2	84.1	4,064	5.79	1,229,000	[d] 6,000	1,235,000	Do.
24	48.00 48.05	220,400	54.2	84.4	4,064	5.58	1,230,000	7,000	1,237,000	Do.
26	48.40 48.45	223,800	55.1	85.5	4,064	5.64	1,261,000	10,000	1,271,000	Do.
28	48.62 48.71	223,800	55.1	84.6	4,066	5.54	1,241,000	10,000	1,251,000	Do.
30	48.95 49.00	227,700	56.0	85.1	4,068	5.52	1,257,000	11,000	1,267,000	Do.
May 3	49.22 49.30	232,300	57.1	84.4	4,068	5.45	1,267,000	13,000	1,280,000	Do.
5	49.52 49.58	234,400	57.6	85.6	4,072	5.32	1,248,000	14,000	1,262,000	Do.
7	49.75 49.78	236,900	58.2	84.5	4,072	5.11	1,210,000	13,000	1,224,000	Do.
10	49.98 50.00	234,600	57.6	84.8	4,072	5.26	1,233,000	16,000	1,249,000	Do.
12	50.10 50.13	236,200	58.0	85.5	4,072	5.39	1,274,000	15,000	1,289,000	Do.
14	50.18 50.20	237,700	58.4	85.4	4,072	5.26	1,251,000	15,000	1,266,000	Do.
14	.....	237,700	58.4	.....	4,072	5.36	1,275,000	15,000	1,290,000	Double floats.
1897.[e]										
Dec. 13	5.30 5.30	60,900	16.7	41.1	3,636	2.96	180,000	.....	.....	Meter.
13	5.30	60,900	.....	.....	3,636	2.99	182,000	.....	.....	Do.
14	5.00 5.00	59,400	16.4	40.6	3,631	3.18	189,000	.....	.....	Double floats.

[a] Discharge section approximately 700 feet below warehouse at Red River Landing and at same place as section of 1884, 1885, 1888, 1889, and 1890. Gauge readings at beginning and end of observations. Price meter used. Observations made under direction of fourth district officer, M. R. C. Report Chief of Engineers 1896, page 3557.

[b] The discharge section was located just below Red River Landing, La., at the same place as in former years. Gauge readings at 8 a. m. and 4 p. m. Double floats were used, the lower float being at mid-depth. The Haskell current meter was used at six-tenths depth at each station for five minutes. Observations and reduction made under direction of Capt. H. E. Waterman, Corps of Engineers, secretary Mississippi River Commission. Report Chief of Engineers 1897, page 3656.

[c] Assumed to be observed as on the following day.

[d] This discharge, which was on the right bank, was through open timber, with very little underbrush. There was no discharge on left bank, but the country was covered with standing water.

[e] United States engineer gauge at Red River Landing, whose zero is 23.85 feet above the Cairo datum.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Gauge reading.	Area of cross section.	Depths.		Width.	Mean velocity per second.	Discharge per second.			Method.
			Mean.	Maximum.			River.	Bank.	Total.	
1897.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Cu. ft.*	*Cu. ft.*	*Cu. ft.*	
Dec. 14.....	5.00	60,100	16.5	39.9	3,630	3.19	192,000	.....	.....	Double floats
14.....	5.00	59,300	16.3	40.4	3,629	3.08	183,000	.....	.....	Meter
14.....	5.00	59,500	16.4	40.7	3,629	3.08	183,000	.....	.....	Do.
15.....	4.70 to 4.70	59,000	16.3	40.4	3,625	3.09	182,000	.....	.....	Do.
15.....	4.70	59,500	16.4	40.0	3,625	3.14	187,000	.....	.....	Do.
15.....	4.70	59,400	16.4	40.6	3,627	3.07	182,000	.....	.....	Do.
15.....	4.70	59,400	.....	.....	3,627	3.12	185,000	.....	.....	Double floats.
1898.										
Apr. 28.....	44.30 to 44.30	192,600	47.2	81.4	4,076	5.63	1,084,000	.....	.....	Meter.
28.....	44.30	192,600	.....	.....	4,076	5.89	1,134,000	.....	.....	Double floats.

The discharge section was just below Red River Landing, at the same place as in former years.

[766 miles below Cairo.]

[1904 velocities are means of simultaneous observations with Haskell meter, wheel No. ½, and Price meter No. 34. Discharge section is the same as used in 1898, just below Red River Landing. Overbank discharge measured on right bank. Observations and reduction under direction of Capt. Wm. B. Ladue, Corps of Engineers, secretary Mississippi River Commission. Reports Chief of Engineers, 1903, supplement, page 117, and 1905, page 120.]

1903.[a]										
Apr. 8.....	49.98	230,300	55.0	82.1	4,187	5.20	1,197,000	9,000	1,206,000	Meter.[d]
10.....	49.98	220,200	52.6	88.4	4,187	5.05	1,112,000	[b] 9,000	1,122,000	Do.[e]
1904.										
Apr. 29.....	43.70	[c] 203,300	48.7	.....	4,174	5.01	1,018,000	.....	.....	Do.
30.....	43.70	203,300	48.7	80.7	4,174	4.95	1,007,000	.....	.....	Do.
May 1.....	43.60	203,100	48.7	81.0	4,174	4.94	1,004,000	.....	.....	Do.

[a] Red River Landing United States engineer gauge, whose zero is 3.57 feet above mean Gulf level.
[b] Deduced from observations of April 8.
[c] Used area of April 30.
[d] Haskell meter, wheel No. ½.
[e] Some velocities measured with Haskell meter, others with Price meter No. 40.

[765.3 miles below Cairo.]

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1906.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Apr. 25.....	44.00	.....	+0.20	200,887	203,716	46.9	47.5	80.0	4,286
26.....	44.12	.....	+ .15	[b] 206,912	.....	.....	.....	.....	.....
27.....	44.30	.....	+ .15	212,937	214,480	49.7	50.0	83.0	4,286
28.....	44.40	.....	+ .13	219,532	220,646	51.2	51.5	87.0	4,286
30.....	44.66	.....	+ .09	218,015	218,015	50.9	50.9	83.0	4,286

[a] Zero of U. S. Engineer standard gauge is 3.57 feet above mean Gulf level. The datum line for computing datum areas is at 44.66 feet on this gauge. The discharge section is the same as that used in 1904 and is just below Red River Landing. Velocities were measured with Price meter No. 43 on April 25 and 26 and with Price meter No. 38 on April 28 and 30.
[b] Interpolated.

Results of discharge observations, Mississippi River—Continued.

RED RIVER LANDING, LA.—Continued.

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1906.	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Apr. 25	.....	4.88	980,160	Meter.....	19	69	II. Strong.
26	.....	4.74	980,772	.....do.....	19	....	I. Light.
27	+10,764	5.16	1,098,801	Double floats .	18	78	VI. Light.
28	+ 6,166	5.08	1,115,637	Meter.....	19	59	Do.
30	− 2,631	4.94	1,076,377	.....do.....	19	60	VII. Light.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Standard gauge.	Local.	Change in 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1907.[a]	*Feet.*	*Feet.*	*Feet.*	*Sq. ft.*	*Sq. ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Feb. 13, p. m.	46.75	.....	+0.1	230,907	231,696	52.6	52.8	92.0	4.386
15	46.93	.....	+ .1	232,441	232,441	53.0	53.0	93.5	4.386
18	46.92	.....	.0	232,441	.....	.....	.....	.....	4.386

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Velocity stations.	Soundings.	Direction and force of wind.
1907.[a]	*Sq. ft.*	*Feet.*	*Cu. ft.*				
Feb. 13, p. m.	.....	5.50	1,275,015	Meter.....	11	63	VIII. Brisk.
15	+745	5.10	1,186,396	.....do.....	16	81	Calm.
18	.....	5.56	1,291,448	Double floats..	16	....	VIII. Brisk.

[a] Observations and reductions made under direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, secretary, Mississippi River Commission. Red River Landing, U. S. E. gauge: Zero is 3.57 feet above mean Gulf level. The datum line for computing datum areas was taken at 46.93 feet on the gauge. Price meter No. 29 was used. The discharge section used is the same as that used in 1904 and is just below Red River Landing.

APPENDIX NO. 20.

PRESENT AND PROSPECTIVE COMMERCE OF THE MISSISSIPPI RIVER FROM ST. LOUIS TO THE GULF OF MEXICO.

[Compiled under direction of the Board on Examination and Survey of Mississippi River.]

The Mississippi River, including its tributaries, drains about half the United States, and it has a total of about 16,000 miles of river (Census Bureau reports) susceptible of navigation. As every one knows, it is not many years since this river was noted for its large steamboat commerce, very large in proportion to the commerce of the entire country; and it, in fact, was the great highway for not only freights but passengers passing into and through the Middle West. For many years, however, its water commerce has been steadily diminishing, while the inland water commerce of the entire country has been as rapidly increasing, so that to-day its water supremacy is gone; and such condition of affairs is well known not only to the Mississippi Valley but to the United States public in general, who are wondering why the river is not more utilized and how it can be made more useful. But it is also well known to the engineering public of the country that the present river conditions of the Mississippi Valley are many times better than in the days of its greatest commerce; the river from St. Paul to deep water above New Orleans having now a navigable depth nearly twice

as great everywhere as in former days, and its obstruction by snags and wrecks being at present so slight as to be rarely mentioned. The marked diminution of commerce, under such circumstances, can not be due to questions of navigation and river engineering, and must be due to other conditions, such as those of demand and supply, water and rail competition, and of business management in general.

This situation on the Mississippi River (and its tributaries) is not the only similar case in the United States. Even Chicago, Ill., in spite of its size, its increasing population and factories, its direct frontage on deep water of the Great Lakes, and its excellent inner harbor (Chicago River) of the olden type, has recently found itself in the same predicament and has been obliged to make special search for the reasons thereof.

Prior to the date when the present Board was ordered by Congress, there was available to the general United States public but little printed matter touching upon such subjects, and few people outside of the large railroad organizations knew much of the fundamental rules governing the development of transportation, nor much of the actual conditions of transportation matters, either abroad or at home. In 1905, however, the Interstate Commerce Commission published its report upon the statistics of railways in the United States for the year 1904, giving in great detail a full description of the United States railway plant, mileage, cost of construction, cost of operation, revenue, rates, etc., which is a most valuable mine of information on transportation matters. This report was too extended in scope to be repeated yearly; and it is still, and must for several years be, the standard of information in such matters, subject to minor changes from year to year as described in later annual reports of the same commission.

By the act of Congress of February 21, 1891, agents of all vessels navigating waterways under federal improvement are required to furnish statements of their vessel cargoes to the United States engineer officer in local charge of such improvements. Copies or summaries of these reports are then furnished by the engineer officers to the Bureau of Statistics, Department of Commerce and Labor, who receive in similar fashion from the collectors of customs and other port officers much other traffic information, publishing the results monthly and annually under the title of "Summary of Commerce and Finance" with a subtitle of "Summary of Internal Commerce of the United States." In 1908 the Department of Commerce and Labor, through its Census Bureau, published a valuable compilation of such reports in a volume entitled "Transportation by Water, 1906," giving for the entire United States (with a separate chapter for the Mississippi River Valley) much the same full information for water transportation as had been given for rail transporation for 1904 by the Interstate Commerce Commission, but adding valuable comparisons with previous similar conditions of 1889.

In 1908 also appeared in print the 1906–7 report of the Ohio River board of 1905-6 (H. Doc. No. 492, 60th Cong., 1st sess.) upon the further improvement of the Ohio River from Pittsburg, Pa., to Cairo, Ill., with a view to giving to it a 9-foot depth throughout the entire year by the aid of locks and dams; the report being favorable to such improvement, and containing a large amount of valuable information as to freight movements by boat and by rail, including costs and freight rates.

In 1907, Chicago, Ill., began to realize that some radical action was necessary to stop its decadence as a commercial port and to build up its commerce anew; and its mayor appointed a special harbor commission to visit other large ports of the United States and of Europe and to examine into the reasons for the waning commerce and to recommend action to restore it. This commission was one of business men interested in the future welfare of the city, and their report, rendered in March, 1909, contained subreports (made and printed in 1908) by Prof. J. P. Goode, of the Chicago University, upon "Modern Development of Commercial Ports;" of Mr. G. C. Sikes (who had had prior experience on street railway commissions and local transportation committees) upon "Obstacles to Chicago's Water Shipping Development;" and of Mr. G. C. Tunell (formerly with United States Treasury Department, and experienced in Lake traffic and railroad traffic research) upon the "Volume and Trend of Traffic to and from the Central West." These reports outline the results of experience at the foreign ports of London, Liverpool, Manchester, Glasgow, Newcastle, Southampton, and Cardiff in Great Britain, and Havre, Antwerp, Rotterdam, and Hamburg in continental Europe, and upon the continental rivers Elbe, Weser, Scheldt, Meuse, and Rhine.

In 1908 the president of the harbor commission of the city of Montreal, Canada, and the chief engineer, St. Lawrence River Ship Canal, realizing that "upon the development and efficiency of its transporation would depend the future prestige of Canadian commerce and the integrity of the nation," submitted to the minister of marine and fisheries, Dominion of Canada, a special report (No. 21C, 1908; Supplement to Fortieth Annual Report, Marine and Fisheries) upon modern British and continental ports with

a view to the development of the port of Montreal and Canadian transportation, containing results of experience at the foreign ports of London, Liverpool, Manchester, Glasgow, Newcastle, Bristol, and Cardiff in Great Britain, and of Havre, Marseilles, Antwerp, and Hamburg on the Continent. In their study of this subject, the Canadian officials were assisted by Mr. R. C. H. Davison, British civil engineer, whose specialty is the development of ports.

In January, 1908, the American Academy of Political and Social Science published, as volume 31 of its Annals, a special collection of monographs entitled "American Waterways," which take up the water transportation of the whole United States by sections, and treat the subject from the point of view of political economists as well as of that of commercial and business men.

To anyone specially interested in the Mississippi River itself, there is, outside of the Mississippi River Commission annual reports (see Annual Reports of Secretary of War and Chief of Engineers, U. S. Army) and other government documents, one book of statistical and general information deserving special mention, viz, the collection of essays entitled "Riparian Lands of the Mississippi River, Past—Present—Prospective," edited and published in 1901 by Frank H. Tompkins, of New Orleans, La. (1 vol., 4to, 640 pp.), containing much back history of the Mississippi River Valley and waterways and much detail as to past methods and future possibilities, the articles having been prepared by Members of Congress, army engineers, civil engineers, steamboat officials, manufacturers, merchants, newspaper editors, and other civilians of all professions and interests.

All the above reports are full of valuable information which should be carefully studied in full by all persons specially interested in transportation development in the United States. These reports are partially quoted or referred to in the exhibits and remarks that follow herewith; but the careful student should familiarize himself with the originals.

There are also two other publications of conference and reports not made public during the meetings of the present Board, which when printed and distributed in 1909 will also contain valuable information upon the question of water and rail commerce and rates and should be looked up. These are the Report of the Proceedings of the Conference of Governors at Washington, D. C., May 13–15, 1908 (especially the paper by Prof. Emory R. Johnson upon navigation resources), and the "Preliminary Report of the Inland Waterways Commission, February 3, 1908," to appear as S. Doc. 325, 60th Cong., 1st sess. (especially the papers on "Navigable Streams of the United States," Commerce of Interior Rivers, Relation of Water and Railroad Rates, Water and Rail Traffic, and Materials Available for Transportation by Inland Waterways).

There are six different points of inquiry to be specially investigated in any serious examination of the present and prospective commerce of any waterway, viz, (a) the extent of population and of manufacturing, agricultural, and other business interests which call for water transportation; (b) the waterway itself, with its navigable channels, and especially their condition and capacity; (c) the boats, including their equipment and service; (d) the amount and character of the freights either actually carried or demanding carriage; (e) the ports or other terminal points of load and discharge, including their harbors, piers, wharves, slips, docks, unloading and loading machinery, and other transfer facilities; and (f) the rail and water competition and their relative capacities, facilities, service, and freight rates. These will be taken up briefly in the above order.

Population and business interests.—The Mississippi River Valley for miles back on each side of the river between St. Louis and the Gulf is mainly an alluvial valley, richly endowed by nature, and susceptible of rapid, extensive, and valuable future development, which is at present delayed mainly by lack of population and funds. Exhibits 1, 2, and 3 apply to the entire valley and Exhibits 4 and 5 to St. Louis.

EXHIBIT No. 1.—*Area and population adjoining Mississippi River, St. Louis to New Orleans.*

West bank.		Counties and cities.	East bank.	
Area in square miles.	Population (1900 census).		Population (1900 census).	Area in square miles.
Missouri.			Illinois.	
544	625,278	St. Louis (including St. Louis city, 575,238).		
		St. Clair (including East St. Louis, 29,655)	86,685	680
687	25,712	Jefferson.		
		Monroe	13,847	385
493	10,359	Ste. Genevieve (including Ste. Genevieve, 1,707).		
		Randolph (including Chester, 2,832)	28,001	580
468	15,134	Perry.		
		Jackson	33,871	558
570	24,315	Cape Girardeau (including Cape Girardeau, 4,815).		
		Union (including Jonesboro, 1,130)	22,610	400
416	13,092	Scott.		
		Alexander (including Cairo, 12,566)	19,384	230
			Kentucky.	
417	11,857	Mississippi.		
		Ballard	10,761	237
		Carlisle	10,195	188
		Hickman (including Columbus, 1,235)	11,745	225
		Fulton (including Hickman, 1,589)	11,546	178
654	11,280	New Madrid (including New Madrid, 1,489).		
			Tennessee.	
		Lake	7,368	128
509	12,115	Pemiscot (including Caruthersville, 2,315).		
		Dyer	23,776	500
Arkansas.				
842	16,384	Mississippi.		
		Lauderdale	21,971	460
		Tipton	29,273	430
		Shelby (including Memphis, 102,320)	153,557	769
			Mississippi.	
623	14,529	Crittenden.		
		De Soto	24,751	551
		Tunica	16,479	449
595	19,409	Lee.		
710	26,561	Phillips (including Helena, 5,550).		
		Coahoma	26,293	592
		Bolivar	35,427	913
725	11,511	Desha (including Arkansas City, 1,091).		
		Washington (including Greenville, 7,642)	49,216	925
616	14,528	Chicot.		
Louisiana.				
		Issaquena	10,400	473
395	11,373	East Carroll (including Lake Providence, 1,256).		
		Warren (including Vicksburg, 14,834)	40,912	601
666	12,322	Madison.		
		Claiborne	20,787	505
665	19,070	Tensas.		
		Jefferson	21,292	519
707	13,559	Concordia (including Vidalia, 1,022).		
		Adams (including Natchez, 12,210)	30,111	428
		Wilkinson	21,453	664

EXHIBIT No. 1.—*Area and population adjoining Mississippi River, St. Louis to New Orleans*—Continued.

West bank.		Counties and cities.	East bank.	
Area in square miles.	Population (1900 census).		Population (1900 census).	Area in square miles.
Louisiana.			Louisiana.	
576	25,777	Pointe Coupee.		
		West Feliciana (including St. Francisville, 1,059)	15,994	386
		East Baton Rouge (including Baton Rouge, 11,269)	31,153	451
286	10,285	West Baton Rouge.		
643	27,006	Iberville (including Plaquemine, 3,590; Whitecastle, 1,850).		
		Ascension (including Donaldsonville, 4,105)	24,142	310
		St. James	20,197	280
		St. John the Baptist	12,330	209
300	9,072	St. Charles.		
413	15,321	Jefferson (including Gretna, 3,332).		
		Orleans (including New Orleans, 287,104)	287,104	197
		St. Bernard	5,031	721
		Plaquemines	13,039	978
13,520	995,829	Total	1,050,701	16,100

Grand total, 2,046,520 population; 29,620 square miles area.

Over two-thirds of the total area is fine alluvium ground capable of high cultivation when drained, protected from floods, and well populated.

The population is about 76 per square mile, including cities, and about 38 per square mile outside of cities.

Areas in square miles taken from Rand-McNally & Co. maps.

EXHIBIT No. 2.—*Cities and towns of over 1,000 inhabitants in 1900 located on the Mississippi River, between St. Louis and New Orleans.*

[From United States Census Report, 1900.]

Name.	Population.	Name.	Population.
St. Louis, Mo	575,238	Vicksburg, Miss	14,834
East St. Louis, Ill	29,655	Vidalia, La	1,022
Cape Girardeau, Mo	4,815	Natchez, Miss	12,210
Cairo, Ill	12,566	St. Francisville, La	1,059
Columbus, Ky	1,235	Baton Rouge, La	11,269
Hickman, Ky	1,589	Plaquemine, La	3,590
New Madrid, Mo	1,489	Whitecastle, La	1,850
Caruthersville, Mo	2,315	Donaldsonville, La	4,105
Memphis, Tenn	102,320	Gretna, La	3,332
Helena, Ark	5,550	New Orleans, La	287,104
Arkansas City, Ark	1,091		
Greenville, Miss	7,642	Total	1,087,136
Lake Providence, La	1,256		

EXHIBIT No. 3.—*Areas, population, and railway mileage of lower Mississippi Valley, 1900 or 1909, as compared with entire United States and Europe.*

[Based upon figures of World Almanac, 1909; American Almanac, 1903; and foreign reports.]

States adjoining lower Mississippi.	Area.	Population.		Railway mileage.		
		Total.	Per square mile.	Total.	Per 1,000 population.	Per 100 square miles.
1900.	*Sq. miles.*			*Miles.*	*Miles.*	*Miles.*
Illinois	56,650	4,821,550	86	12,206	2.5	22
Missouri	69,415	3,106,665	45	8,102	2.6	12
Kentucky	40,400	2,147,174	53	3,484	1.6	9
Tennessee	42,050	2,020,616	48	3,761	1.9	9
Arkansas	53,850	1,311,564	24	4,883	3.7	9
Mississippi	46,810	1,551,270	33	4,169	2.7	9
Louisiana	48,720	1,381,625	28	4,738	3.4	10
Total	357,895	16,340,464	46	41,343	2.5	12
Entire United States (1909)	3,602,990	87,971,000	26	227,671	2.6	6
1909.						
Austria	261,035	46,973,359	180	22,800	0.5	8
Belgium	11,373	7,074,910	620	5,000	0.7	44
France	207,054	38,961,945	190	26,500	0.7	13
Germany	208,830	60,641,278	290	34,400	0.6	16
Holland	12,648	5,591,701	440	1,700	0.3	13
Entire Europe	3,555,000	[a] 380,200,000	107	[b] 175,000	0.5	5

[a] In 1890. [b] In 1909.

The above tables of area, population, and railroad mileage of counties and States along the Mississippi River between St. Louis and the Gulf and of the busy countries of Europe (Exhibits 1, 2, and 3) bring out forcibly the difference between this part of the world and Europe.

It will be seen from these tables that the United States is very much better off than Europe in the amount of land and length of railroads per head of population. Other sources of information give approximate estimates for 1900 of about 4,000 miles of waterways in Austria, 1,400 in Belgium, 7,500 in France, and 8,000 in Germany. This information, all taken together, indicates approximately 5 miles of railway, three-fourths of a mile of waterway, and 11,000 population per 100 square miles of country in Europe, against 6 miles of railway, two-thirds of a mile of waterway, and 2,600 population per 100 square miles in the entire United States. They also indicate that the 7 States adjoining the lower Mississippi River have about one twenty-fourth the population, one-tenth the area, four-tenths the density of population, one-fourth the total railway mileage of entire Europe, giving to the lower Mississippi River States about 5 times as many miles of railroad per head of population, and about 2½ times as many per square mile of land as has Europe; and that these 7 lower Mississippi River States together have about one-fourth the total population, seven-fourths the area, one-seventh the density, and eight-sevenths the total railway mileage of Germany alone. This also gives to the above-named 7 Mississippi Valley States about 4 times as many miles length of railway per head of population as Germany, although only two-thirds as many per square mile, and about 7 times as many miles length of navigated waterways per head of population as Germany, although only about the same number of miles length per square mile.

France and Austria are about 8 times as densely populated as Arkansas, and Belgium about 7 times as densely populated as Illinois.

Although the large cities and towns of the Mississippi Valley are few, they are doing finely in view of their limited population. St. Louis is the fourth and New Orleans the twelfth city in the United States in order of size; and they are first and fourth in rank in the Central West between the Alleghany and Rocky Mountains (omitting the cities on the Great Lakes). Memphis is in size the second city in the United States east of the Rockies and south of the junction of the Ohio and Mississippi rivers. In proportion to their population, these cities, as regards manufactures and other business interests, are on a par with the most advanced cities of other parts of the United States. Cairo, Vicksburg, Natchez, and Baton Rouge are in like manner all large and important cities for their respective States, and are all im-

portant and growing centers of manufactures and railway transportation. When Ohio River coal can be delivered daily at cheap rates at all these Mississippi River towns, their manufacturing and business interests should begin to develop with great rapidity.

But no very large amount of local commerce can be expected when the population is as low as 86 to 24 per square mile, including cities, and where, in a total length of about 1,265 miles, there are only 7 towns or cities of above 10,000 population or only 23 of above 5,000 population each. There is, however, an excellent opportunity for future growth, which must necessarily come in due time. As the population increases in this rich alluvial valley of the lower Mississippi, so will the agricultural and manufacturing industries increase; and the lower valley will have a surplus of products to distribute to the upper valleys or to foreign countries.

The following exhibits (Nos. 4 and 5) show what developments are occurring in St. Louis, as presented by its business men. They indicate a development natural to this section of the country, and which may be expected later at other points after the country is thickly populated.

EXHIBIT No. 4.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

ST. LOUIS IN 1908.

The fourth city of the United States in population.
The largest and most important city in the Louisana purchase.
The largest manufacturer of tobacco in the world.
Has the largest drug house in the United States.
Has the largest woodenware house in America.
Has the largest hardware house in the country.
Is the best dry goods market west of the Alleghanies.
Has the largest shoe house in the world.
The largest shoe distributing city in the Union.
Is the second largest millinery market in America.
The largest inland coffee distributing center.
One of the great railroad centers.
The principal city on the longest river in North America.
The largest hard-wood lumber market in America.
Makes more street and railroad cars than any other point.
The largest horse and mule market in the world.
Holds fourth place as a manufacturing center.
Leads in output of American-made chemicals.
Prominent in manufacture of proprietary medicines.
Receipts of grain in 1908, 70,967,740 bushels.
Receipts of flour in 1908, 2,763,700 barrels.
Flour manufactured in 1908, 965,832 barrels.
Flour shipped in 1908, 3,192,790 barrels.
Banking capital and surplus, 1908, $84,212,110.
Bank clearings in 1908, $3,074,806,759.
Leads in manufacture of stoves and ranges.
Tonnage received and forwarded in 1908, 39,644,900.
Death rate per thousand in 1908, on basis of 722,200 population, 13.56.
Largest brewery in the United States.
Has 105 public schools, with 92,765 scholars.
Largest and most complete railway station in America.
Has 27 public parks, containing 2,318 acres.
St. Louis post-office ranks first in ratio of expenses to receipts.
Receipts at St. Louis post-office in 1908, $3,974,834.
Pieces of mail matter originating in St. Louis in 1908, 309,155,738.
Is renowned for beautiful residence districts.
Has 19 miles of river front.
Real estate transfers in 1908, $39,866,644.
Value of buildings erected in 1908, $21,190,369.
Real and personal property assessed, $524,302,020.
Value of manufactured product in 1908, $314,185,326.
The largest manufacturing stationers for bank and county supplies in the world.

Extract from the report of the St. Louis Merchants' Exchange for 1908.

Area, 62½ square miles.
Population, 750,000.
Real estate and personal, assessed value, $524,302,020.
Bonded debt, $18,344,178.
Houses erected during 1908 (9,119), cost, $21,190,369.
River front, 19 miles.
Public parks, number, 27; 2,318 acres.
Paved streets, 581.47 miles.
Paved alleys, 172.70 miles.
Public sewers, to January, 1909, 648.22 miles; cost, $16,259,628.
Conduits for underground wires, 194 miles.
Water supply, capacity per day, 160,000,000 gallons.
Water supply, average daily consumption, 68,960,000 gallons.
Receipts for water licenses, $1,830,870.
Public schools, 1908: Number, 105; teachers, 2,116; scholars, 92,765; cost, $11,560,534.
Union Station, 32 tracks, covers 11 acres.
Railroad lines terminating in St. Louis, 26.
Street railroads, single track, city, 348.41 miles; county, 107.46 miles; total, 455.87 miles.
Passengers carried, 310,589,278.
Municipal revenue, year ending in April, $8,502,067.
Death rate per thousand, basis 1908 (722,200 population), 13.56.
Post-office, cash receipts, $3,974,834.
Post-office, pieces of mail originating in St. Louis, 309,155,738.
Tonnage, total tons received, 23,871,102.
Tonnage, total tons shipped, 15,772,898.
Manufacturers, product, $314,185,326.
Bank clearings, $3,074,806,759.
Banks and trust companies, capital, surplus, and profits, $84,212,110
Tobacco, manufactured 1908, 72,759,588 pounds.
Tobacco tax paid, $4,452,219.
Grain receipts, 70,967,740 bushels.
Flour manufactured, 965,832 barrels.
Flour received, 2,763,700 barrels.
Public elevators, 8; capacity, 7,000,000 bushels.
Private elevators, 31; capacity, 5,125,000 bushels.
Lead received, 1,998,370 pigs.
Revenue from harbor fund, $135,364.
Zinc and spelter, 3,776,260 slabs.
Cattle received, 1,293,564.
Hogs received, 3,199,922.
Sheep received, 724,781.
Horses and mules received, 120,853.
Cotton receipts, 675,842 bales.
Coal (all kinds) received, 7,365,091 tons.
Goods to the following amount were sold:
Dry goods and notions, $65,000,000.
Millinery, $6,000,000.
Vehicles and implements, $16,000,000.
Plumbers' and steamfitters' supplies, $7,500,000.
Groceries and kindred lines, $70,000,000.
Boots and shoes, $53,000,000.
Tobacco and cigars, $45,000,000.
Hardware, shelf and heavy, $37,000,000.
Woodenware, $18,000,000.
Lumber, $47,000,000.
Candies, $5,500,000.
Beer (3,194,520 barrels), $22,361,640.
Clothing, $11,500,000.
Furniture and kindred lines, $22,700,000.
Stoves, ranges and furnaces, $5,000,000.
Electric supplies, machinery, and lamps, $10,000,000.
Paints, paint oils, and white lead, $12,000,000.
Saddlery and harness, $3,250,000.
Hats, caps, and gloves, $4,200,000.

Drugs and kindred lines, including proprietary goods, druggist sundries, and chemicals, $19,000,000.
Glass, plate and window, ornamental, $3,000,000.
Clay products, $4,500,000.
Furs, $7,500,000.
Railway supplies, $15,000,000.
Trunks and bags, etc., $2,500,000.
Steel castings and foundry and machine shops products, $18,500,000.
Wool receipts, 1908, 23,123,340, $6,500,000.
Hides, receipts, 1908, 70,587,900, $11,500,000.
Carpets and kindred kinds, $5,250,000.
Railroad and street cars manufactured, value, $9,000,000.
Paper, stationery, and envelopes, $9,000,000.
Dry plates, $1,750,000.
Glass and queensware, $2,125,000.
Bakery products, $7,000,000.
Tin and enameled ware, $5,500,000.
Soap and candles, $9,000,000.

EXHIBIT No. 5.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

MANUFACTURING INDUSTRIES IN ST. LOUIS FOR 1908.

[By Edward J. Troy, secretary Missouri Manufacturers' Association.]

The paucity of failures among the manufacturers of St. Louis during the past year, when the panic conditions were prevalent, and in the face of numerous important failures in other commercial centers, this city boasted a record of few industrial failures, and those that were recorded were rather unimportant.

This record suffices to forcibly illustrate the ultraconservatism that characterizes the manufacturing operations of St. Louis concerns, and gives a reason for the steady progress of the manufacturing and dependent industries of this great commonwealth. This conservatism is often made the subject of criticism, but in time of depression, such as was experienced, the criticism becomes the highest form of laudation of a business scheme.

The foresight of the rank and file of manufacturers in this city will enable them to prepare for the inevitable demands of an increased business, which has manifested its coming during the new year by many indications of unmistakable character.

Official statistics of the manufacturing activities of St. Louis during 1907, show a gain of $33,000,000 over the previous year, and it is expected that the official figures for the year just closed will be correspondingly optimistic.

The figures tabulated below, from the state bureau of labor statistics, give a comparison indicating the capital invested, the value of the manufactured products, the number of persons employed, and other interesting topics bearing on the general subject of St. Louis manufactures:

	1906.	1907.
Value of goods manufactured	$281,576,596	$314,185,326
Value of materials and supplies used	160,963,176	183,588,825
Total capital invested	185,986,952	212,908,508
Value of grounds	17,941,021	18,806,262
Value of buildings	31,265,096	36,707,080
Value of machinery, tools, fixtures, etc	61,903,966	71,328,963
Paid in rent	2,629,417	2,767,586
Paid in taxes	10,569,418	11,289,147
Paid in insurance	1,214,473	1,391,041
Total rent, taxes, and insurance	14,413,308	15,447,774
Total amount paid in wages	62,030,485	67,531,220
Male employees	84,740	93,651
Female employees	23,615	25,480
Number of factories	2,724	2,955

Extract from the report of the St. Louis Merchants' Exchange for 1908.

[Manufactures of St. Louis in 1907 as compiled by the State Board of Labor Statistics, J. C. A. Hiller, commissioner.]

	Number of establishments reporting.	Total value of goods manufactured in 1907.		Number of establishments reporting.	Total value of goods manufactured in 1907.
Agricultural implements	2	$269,012	House furnishings	15	$176,371
Asphalt, tar roofing	6	337,941	Ice	8	622,830
Awnings, tents, flags	10	954,858	Iron, structural	19	2,691,088
Badges, regalia	9	121,980	Jewelry	12	417,392
Bags, bagging	5	7,422,949	Leather	16	1,888,845
Bakeries	354	6,890,599	Light, heat, power	5	7,049,488
Bank and store fixtures	19	1,334,217	Liquor, rectifying, blending	39	6,572,992
Boats	1	14,236	Liquor, malt	27	20,289,684
Boiler works	10	1,324,273	Malt	5	337,445
Boots and shoes	22	25,753,158	Millinery	185	2,282,103
Boxes, paper	16	1,041,848	Musical instruments	9	112,173
Boxes, wood	25	2,413,289	Novelties	10	268,882
Brick, tile	20	4,965,479	Oils, grease	10	2,079,960
Brooms, brushes	21	291,421	Packing houses	26	22,788,663
Candy, confections	23	3,346,032	Paints, varnish	28	7,115,713
Canning, preserving	21	3,262,152	Patterns, models	12	86,149
Car works	8	22,851,565	Photographic, art supplies	10	802,252
Carbonated beverages	41	832,701	Planing mills	38	3,294,278
Carriages, wagons	160	7,449,209	Pottery, stoneware	6	67,898
Cigars	292	1,737,098	Printing, binding	156	7,303,917
Cleaners, dyers	16	345,448	Publishing	87	6,044,678
Clothing, women's	44	3,681,637	Rolling mills	2	2,791,738
Coffins, caskets	5	1,229,723	Rope, twine	4	1,263,899
Cooperage	18	1,958,977	Rubber goods	7	449,389
Copper, brass	27	3,686,161	Signs	5	99,078
Cotton mills	2	436,324	Smelters	4	736,945
Concrete, artificial stone	6	995,929	Soaps, candles, glue	14	3,484,466
Creameries	6	811,132	Stationery supplies	9	771,233
Cutlery, tools	24	936,075	Stone, marble	30	1,064,005
Drugs, chemicals	88	9,863,539	Stoves, ranges	19	7,516,364
Electrical apparatus	26	2,394,496	Surgical instruments	8	53,884
Electro plating	10	133,153	Tailors	287	11,686,127
Engraving, electrotyping	32	484,871	Tinware, sheet, galvanized, iron	85	5,975,335
Flour, feed	9	3,199,098	Trunks, valises	12	1,520,770
Foundries, machine shops	107	14,492,260	Tobacco	6	21,127,654
Furniture	50	5,867,662	Wire goods	5	2,913,021
Furs, furnishings	26	983,813	Wood working	41	711,043
Glass	14	1,616,294	Miscellaneous	13	313,077
Grocers' sundries	50	11,704,514			
Hair goods	6	48,000			
Harness, saddles	37	1,512,018	Total	2,955	314,185,326
Hats, caps	11	409,456			

Memphis is typically the same class of city as St. Louis, except as to size, and is one of the most progressive and prosperous cities of the valley.

New Orleans has not been considered as needing special description, because of its well-known standing as a commercial port of size, being the twelfth city in the United States in point of size, and the second city in point of foreign trade. Its foreign trade for 1908 (receipts and shipments) was 3,527,097 tons (Annual Report, Chief of Engineers, U. S. Army) valued at $159,455,773 for exports and $42,785,606 for imports, total $202,241,419 (World Almanac, 1908).

The development of the lower Mississippi River must necessarily affect the development of the entire river basin including the basins of the upper Mississippi above St. Louis, the Missouri, and the Ohio.

The States between St. Louis and St. Paul are still largely undeveloped. On the west side of the river some timber still remains to be cut, iron and cement ores are awaiting cheap transportation, agricultural products and live stock will be raised in larger quantities, and manufacturing plants will be established as the country fills with population. Illinois is richly underlaid with coal, sufficient for many years to furnish considerable quantities for export trade as well as for local demands.

The Missouri River States, Missouri, Kansas, Nebraska, Iowa, and both Dakotas, under increase of population will add enormously to all classes of products, agricultural, mineral, and manufactured, for export after supply of home demands.

The Ohio River Valley (see Ohio River Board report of 1906–1908) has yet large areas of timber, cement, and coal lands to develop and shows every indication of great future development of population, farming, and manufacturing industries.

All these three upriver basins may be expected to interchange their surplus products with those of the lower-river basins, calling upon the latter for such articles as rice, sugar, molasses, etc., which are better produced in the southern alluvial valleys.

The waterway and its channels.—As regards the navigable waterway itself, between the Gulf and the Great Lakes (the only feature connected with the transportation development for which the War Department is in any way responsible), it has been possible for several years, even during low-water seasons, to freely send boats of 25 to 30 feet draft from the Gulf 270 miles to New Orleans, Baton Rouge, and Bayou Sara, 9 feet draft thence 840 miles to Cairo, 8 feet draft thence 182 miles to St. Louis, thence 4½ feet draft 365 miles up the Mississippi and Illinois rivers and through the Illinois State Canal to Chicago. Connected to this through route are good boat channels of at least 4½ feet at low water (7 feet during 1907–8) from the mouth of the Illinois River 620 miles up the Mississippi to St. Paul; and of at least 2½ feet at low water from just above St. Louis 2,285 miles up the Missouri to Fort Benton (with 3½ feet below Sioux City and 4 feet below Kansas City); and of 9 feet at mean stages of water from Cairo about 1,000 miles up the Ohio to Pittsburg (under improvement to 9 feet depths at low water), and thence with 5 feet low-water depth 128 miles up the Monongahela to the Pennsylvania coal fields; and 6 feet at low water for 90 miles up the Kanawha to the West Virginia coal fields, besides long distances at mean and high water stages up all the many other less important tributaries, among which are the Allegheny, Little Kanawha, Muskingum, Kentucky, Cumberland, Tennessee, St. Croix, Minnesota, Osage, Gasconade, St. Francis, Yazoo, Arkansas, Red, all of which carry good depths at mean stages of water and penetrate regions of great fertility and great natural resources, though as yet sparsely settled and largely undeveloped. This waterway system of about 14,000 miles length of navigated rivers, so far as concerns its existing boat channels, their depth and capacity for boat travel, is, as a whole, the equal of anything in Europe, where much of the canal and upriver boat traffic is done on 3 feet draft; most of it is done on 6 to 8 feet draft, and where as much as 10 feet draft is exceptional. All the rivers of the Mississippi Valley, so far improved, are in far better navigable condition at the present time than before improvement work was started.

As to the upper Mississippi River, the last annual reports of the Chief of Engineers and the officer in charge show the river to be far better in every way to-day than formerly, and show also that there is no difficulty whatever in securing for the entire length of river at least 6 feet depth at times of dead low water, with reasonable rapidity, as soon as the cost of the same shall be provided by the Federal Government. During the fiscal year 1907–8 (see annual reports for 1908) there was not at any time at any point of the river from St. Paul to the mouth of the Missouri (except in the Des Moines Rapids Canal) a channel depth of less than 7 feet.

On the Missouri River the work laid down by the Engineer Corps in past years contemplated and prophesied a good channel wherever and whenever provided for by the necessary funds. In this case the work was started at a point between St. Louis and Kansas City and carried on downstream with the idea that the funds would be regularly forthcoming until the work was completed, such arrangement being best suited to quickness and economy of work. But as the appropriations were not continued long enough, the improvement never reached St. Louis. However, in the last annual report (1908) of the Chief of Engineers, including the report of the officer in charge of the Kansas City office of the Missouri River improvement, it is shown that over the completed stretch of river, including 45 miles of the worst parts of the old river, a depth of at least 6 feet at low water has been secured and is still maintained, the construction works are still doing excellent service, much valuable new land has been reclaimed, and much valuable old land has been protected from future destruction. The whole river will be made equally good as soon as funds are forthcoming. Meanwhile 4 feet draft can be carried up to Kansas City, 3½ feet to Sioux City, and 2 feet to Fort Benton every day of the year except when the river is closed by ice.

On the Mississippi River from St. Louis to Cairo the increase in depth and width of channel during past years, while under improvement by the Engineer Corps, has been quite marked, and to-day there are only a few days at a time for a few times each year when a boat drawing 8 feet can not freely go up and down the river anywhere between St. Louis and Cairo. Such improvement affords conveniences and facilities to navigation far in advance of anything at present being utilized or being demanded by the boating interests, and such improvement is practically equal to that which the Ohio Valley interests are at present demanding for their own river, and with which they will be well satisfied. The delays of navigation on this stretch of river from St. Louis to Cairo are trifles in comparison to the winter delays of navigation on the Great Lakes, where the boat commerce is many times greater and where all reasonable demands of commerce are to-day fully met and satisfied.

On the Mississippi River below Cairo the river is also in far better condition now than ever before, and except for a few days a few times each year there has been maintained for several years a least depth of 9 feet, capable of carrying all boats that may reach it from the Ohio River after the improvements in progress thereon shall have been completed.

As a matter of fact, there are very few rivers anywhere in the United States or Europe that are to-day in better condition for navigation than the Missouri, the Mississippi, and the Ohio, taken as an entire system. Moreover, so far as their improvement has been carried out under the Engineer Department methods, the results obtained per dollar of cost have equaled anything in foreign countries, the main trouble to-day being that the improvement is only partial, having been carried on of course only so fast as the Federal Government furnished funds for the work.

The past decrease of commerce and the present lack of increase of commerce on these rivers is not due to lack of depth in the river so much as due to the conflicting interests of land and water transportation, and to the laws governing the movement of raw products toward the centers of manufacture, and of manufactured products toward the centers of consumption, combined, perhaps, with a lack of development in steamboat construction and driving power. No river improvement can be expected to send either grain, or coal, or iron, or manufactured products, from places where their value is high to other places where the values are lower. At the present time the question is one almost entirely of demand and supply. No great development of boat commerce can be expected until it is evident that the goods carried can be moved from a place where they can be bought at low prices to a place where they can be sold at higher prices, so that the freight charges can be paid out of the profits of the sales. The present lack of development of commerce on the Mississippi River is properly due to the economic laws governing natural lines of travel of raw materials and manufactured products, and to the existing conflict of interests between steamboats and railroads.

The small extent of water transportation over the waterways of the United States in the Mississippi Valley, and its marked decadence in recent years, has been a matter of great surprise to many American engineers, as well to the engineers of Europe. The mileage of navigable waterways of the Mississippi basin, including its canals and the depth and width of the navigable channels therein, is great, even in comparison with those of the inland waterways of Europe; and the river facilities, so far as the navigable channel is concerned, were good years ago, and as above shown have been very much improved and increased in recent years. In special cases, such as lumber on the upper Mississippi and coal on the Ohio, the individual load carried by or towed by single boats on the Mississippi is larger than in Europe. But the length of river haul is long per unit of population served; except at New Orleans, the dockage facilities are very slight, sometimes nothing more than a sloping bank, and are always expensive; and except at New Orleans the terminal facilities, including arrangements for transfer to rail connections, are almost entirely lacking. Freight rates by water are therefore high in the Mississippi Valley as compared with the rates by rail between the same terminals.

In Germany and the adjacent European countries, with their dense population, with a less waterway mileage, and only about one-quarter the railway mileage per head of population that there is in the Mississippi Valley, and with high railroad rates, it is comparatively easy for them to keep their waterways full of steamers and barges, distributing to the interior of the country quantities of freight far in excess of anything that can be expected in the United States for many years.

The main feature of difference between the Mississippi Valley system and those of European rivers at the present time is that in the Mississippi Valley (the Ohio River excepted) there is a lack of freight demanding transportation at rates high enough to justify the establishment and operation of good boat service, that the paralleling railroads with gentle grades stand prepared to carry all the freights more directly, more quickly, and more cheaply than steamboats can do even in wide and deep channels such as those between New Orleans and Baton Rouge, and that the local conditions and laws favor the railroad service rather than the boat service in matters of transportation. As population and general business increase, as the railroad service becomes congested, and as the boat service improves in its methods of handling freights and of collecting goods from the shipper and delivering them to the consignee, the waterways will probably again resume their proper place as a valuable and economical method of freight transportation, at least for the heavier and bulkier classes of goods.

The boats with their equipment and service.—The Department of Commerce and Labor, Census Bureau, special report on transportation in 1906 is especially full and complete in the matter of boat description. A few only of its tables are here inserted (Exhibits Nos. 6, 7, 8, and 9) and these have been modified somewhat in arrange-

ment and a few percentages added to better attract attention to certain features For the benefit of persons not accustomed to the daily use of such tables the following explanations may be found useful: Vessel tonnages must not be confused with cargoes or freights, as the tonnage refers usually only to the measured capacity of the vessel, remains the same whether the vessel be loaded or empty, and is usually reported only once a year, while the cargo or freight is an actual load reported each time that the vessel is loaded or unloaded. Moreover, the registered tonnage of a vessel may often differ by 10 to 25 per cent from the tonnage of its full cargo, according to the methods of measurement and loading and to the character of the cargo. River or port commerce or traffic usually means the total of shipments and receipts, which is nearly double that of either alone. Even within the limits of a closed district the shipments and receipts may not agree in amount, owing sometimes to the consumption of the cargo by the vessel or its passengers, sometimes to a credit of some of the freights to other districts, and sometimes to incompleteness of reports.

In descriptions of vessels of the Mississippi system the Department of Commerce and Labor makes St. Louis the dividing point between the upper and lower Mississippi systems, crediting the upper system with whatever it sends to or by or receives from St. Louis, and crediting the lower system in similar fashion, but giving all the local business within its harbor to the lower Mississippi. In its division between rivers of these systems credit is given to a river only when the movement starts or stops within the river, and not to a movement which both starts and stops beyond the limits of the river, so that grain freight from points on the Missouri to points on the Tennessee, or coal freight from the Monongahela to the lower Mississippi, would be credited to these rivers and not to the Ohio through which it passes on its way. This is done to avoid a confusing duplication. The 1889 reports in some cases represent a somewhat different distribution, so that comparisons of 1889 and 1906 reports are subject to minor discrepancies. Where reports are based upon combinations of reports of various departments there are also sometimes slight differences due to the fact that the census reports cover calendar years and all boats of 5 tons or more measurement, while the navigation reports cover fiscal years and only documented boats. In all the census reports the federal vessels have been omitted, as also all boats of less than 5 tons burden. The group of vessels termed "unrigged" by the Census Bureau includes barges, flatboats, lighters, scows, dredges, derricks, pile drivers, hoisting barges, floating elevators, canal boats, and all similar craft, when without means of self-propulsion. The unrigged craft alone or in tows, handled by a small towboat, perform for the river the same functions as are performed by drays and express wagons on land, and are increasing in large numbers every year.

EXHIBIT No. 6.—*Vessels and capacity of the lower Mississippi River from St. Louis to New Orleans for 1906 as specially reported in 1908 by the Department of Commerce and Labor (Census Bureau).*

	Vessels.			
	Number.	Gross tonnage (tons).	Proportion of entire Mississippi system.	
			Number.	Tons.
Commercial vessels:			*Per cent.*	*Per cent.*
Tugs and towboats	131	10,004	21	16
Packet boats	90	17,474	23	32
Barges and tows	354	94,213	4	2
Ferryboats	52	14,496	33	65
Yachts	37	858	17	26
All others	8	437	21	20
Grand total	672	137,482	7	3

EXHIBIT No. 7.—*Vessels, tonnage, and service—Freight vessels of Mississippi Valley, 1906, as compared with entire United States, and with 1889, as reported in 1908 by Department of Commerce and Labor (Census Bureau).*

	Entire Mississippi Valley.				Entire United States.				Ratio of Mississippi Valley to entire United States.			
	Years.		Change since 1889.		Years.		Change since 1889.		Years.		Change since 1889.	
	1906.	1889.	Gain.	Loss.	1906.	1889.	Gain.	Loss.	1906.	1889.	Gain.	Loss.
			Per ct.	*Per ct.*			*Per ct.*		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
Self-propelling vessels:												
Number of vessels	1,435	972	48	.....	9,927	5,603	77	.....	14.5	17.3	.....	16
Gross tonnage	146,227	192,974	.....	24.2	4,059,521	1,710,073	137	.....	3.6	11.3	.....	68
Value of vessels	$13,196,770	$9,622,608	37	.....	$386,772,727	$131,567,427	194	.....	3.4	7.3	.....	53
Gross income	$17,342,038	$16,331,872	6	.....	$262,167,342	$113,715,700	131	.....	6.6	14.4	.....	54
Number of employees	15,016	15,951	.....	5.9	115,525	70,347	64	.....	13.0	22.7	.....	43
Wages	$5,692,117	$5,337,185	7	.....	$61,265,474	$28,521,220	115	.....	9.3	18.7	.....	50
Barges and tows:												
Number of vessels	8,187	6,328	29	.....	20,263	16,937	20	.....	40.4	37.4	8	.....
Gross tonnage	4,265,740	3,171,636	35	.....	7,129,631	4,973,356	43	.....	59.8	63.8	.....	6
Value of vessels	$9,655,372	$4,784,554	102	.....	$64,994,249	$22,231,953	192	.....	14.9	21.5	.....	30
All vessels together:												
Number of vessels	9,622	7,300	32	.....	37,321	30,455	22	.....	26.0	24.0	8	.....
Gross tonnage	4,441,967	3,364,610	31	.....	12,893,429	8,359,135	54	.....	34.0	40.0	.....	15
Value of vessels	$22,852,142	$14,407,162	59	.....	$507,973,121	$206,992,352	145	.....	5.0	7.0	.....	29
Gross income	$17,342,038	$16,331,872	6	.....	$294,854,532	$161,994,066	82	.....	6.0	10.0	.....	40
Number of employees	15,016	15,951	.....	6.0	140,929	113,870	24	.....	11.0	14.0	.....	21
Wages	$5,692,117	$5,337,185	7	.....	$71,636,521	$41,482,812	73	.....	8.0	13.0	.....	38
Number of passengers	14,122,241	10,858,894	30	.....	366,825,663	198,992,438	84	.....	4.0	5.0	.....	20
Ferryboats:												
Number of vessels	166	163	2	.....	536	456	18	.....	31.0	36.0	.....	14
Gross tonnage	22,180	18,593	19	.....	261,073	146,104	79	.....	9.0	13.0	.....	30
Value of vessels	$1,776,360	$1,056,250	68	.....	$29,578,380	$10,442,750	183	.....	6.0	10.0	.....	40
Number of passengers carried	10,022,612	8,474,646	18	.....	330,737,639	182,033,991	82	.....	3.0	5.0	.....	40

EXHIBIT No. 8.—*Number of boats of different tonnage capacities, Mississippi River, 1906, as reported in 1908 by Department of Commerce and Labor (Census Bureau).*

[Omitting ferryboats, yachts, and small pleasure boats.]

By system and class.	Size of boat by tonnage.								
	5 to 49 tons.	50 to 99 tons.	100 to 199 tons.	200 to 299 tons.	300 to 399 tons.	400 to 499 tons	500 to 999 tons.	1,000 to 2,500 tons.	Total all sizes.
Lower Mississippi system:									
Freight and passenger packets	30	21	7	10	4	5	12	1	90
Tugs and towing vessels	68	39	14	6	1	.....	3	.....	131
Barges and tows	28	63	90	52	36	31	43	11	354
Ohio River system:									
Freight and passenger packets	70	29	26	19	9	3	9	2	167
Tugs and towing vessels	168	87	81	20	15	7	20	1	399
Barges and tows	367	189	1,582	651	29	371	1,988	2,227	7,404
Upper Mississippi system:									
Freight and passenger packets	80	22	14	8	1	2	62	.....	133
Tugs and towing vessels	55	24	7	3	.....	.....	.....	.....	89
Barges and tows	200	165	57	5	1	1	.....	.....	429
Whole Mississippi system:									
Freight and passenger packets	180	72	47	37	14	10	27	3	390
Tugs and towing vessels	291	150	102	29	16	7	23	1	619
Barges and tows	595	417	1,729	708	66	403	2,031	2,238	8,187

EXHIBIT No. 9.—*Value of freight-carrying vessels of United States in 1906, as reported in 1908 by Department of Commerce and Labor (Census Bureau).*

By class.	Atlantic and Gulf.	Pacific, including Alaska.	Great Lakes and St. Lawrence.	Mississippi, including tributaries.	All other inland waters.
Average tonnage per vessel:	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Steam (self propeller)	269	486	1,143	102	64
Unrigged (barges and tows)	260	192	270	521	133
Average value per ton:					
Steam	$133	$117	$61	$90	$103
Unrigged	18	30	32	2	10
Average value per vessel:					
Steam	35,826	56,698	69,799	9,196	6,604
Unrigged	4,789	5,776	8,540	1,179	1,310

The table of vessels and capacities of the lower Mississippi (Exhibit No. 6) shows that while the lower river carries two-thirds of the ferry service of the entire Mississippi system it handles only about one-third of the packet-boat freights and only about one-fiftieth of the barge freights, except where it receives these barges from the Ohio River or from the upper Mississippi.

The table of vessels, tonnage, and service of the Mississippi as compared with the United States (Exhibit No. 7) shows that while the Mississippi Valley waterways have, since 1889, actually gained in total number of vessels, value of vessels, and gross income, they have relatively fallen far behind in every way in the general advance by the freight-boat service of the entire country in tonnage, value, income, etc.

The table giving number of boats of different tonnage capacities in the Mississippi River (Exhibit No. 8) shows that on the lower Mississippi the majority of the boats are of less than 200 tons capacity, although barges and towboats are broadly distributed among all sizes up to 2,000 tons. This is in decided contrast with the upper Mississippi River, where the majority of boats are less than 100 tons, and in equally great contrast with the Ohio River, where more than one-half of the barges are over 500 tons. This table, taken in connection with the preceding table, shows very plainly that the mass of the freight in the Mississippi Valley is being carried on barges of comparatively light draft rather than in packet boats.

The table giving the value of freight-carrying vessels in the different parts of the United States (Exhibit No. 9) brings out forcibly the much greater cost of vessels per ton of freight carried along the ocean frontages than on the inland rivers. The greatest contrast between the cost of the barge or tow and the self-propelling vessel per ton of freight carried is in the Mississippi Valley, where the self-propelling vessel shows a first cost per ton 45 times that of the barge.

The Ohio system includes nearly two-thirds of all towboats and a little more than three-fourths of all towboat tonnage of the Mississippi Valley. The lower Mississippi is prominent in ownership of ferryboat tonnage, and the upper Mississippi in the ownership of yachts and pleasure craft.

A little over two-thirds of all the barges and tows in the Mississippi Valley, constituting nearly four-fifths of the total tonnage, belong to 10 owners, all of the Ohio system, i. e., large coal companies of the Pittsburg district. The barge equipment of these 10 owners handled over 40 per cent of all the barge freight, even including all harbor work and car ferries.

The Mississippi River and its tributaries had, in 1906 as well as in 1889, almost as many wooden boats as the rest of the United States, but there is a tendency at the present time, by reason of their short life, higher rate of insurance, and greater cost for repairs, for them to be replaced on the river in the same way as in the past on the ocean and Great Lakes, by iron and steel boats.

The old wooden coal barges, which could be used but once and then sold for rough lumber on their arrival at the lower river ports, are gradually being abandoned in favor of steel barges, which, besides being stronger than the wooden barges, will carry about 20 per cent more cargo on the same draft of water. The barge freight which in 1889 was about six times the barge tonnage, had become in 1906 about four times the barge tonnage.

The flat-bottom stern-wheeler still holds its preeminence as the prevailing and most useful type of steamboat on the Mississippi. Side-wheelers, where used, are employed mainly for packet service, and especially ferry service, and the center-wheelers almost exclusively for ferry service. Screw-propeller boats, while forming nearly 25 per cent of the total number, carry only about 6 per cent of the total tonnage. Gasoline boats amounted in 1906 to nearly 40 per cent of the total number, but their tonnage was only about 4 per cent of the totals and their horsepower about 4 per cent also. A large amount of the river business is being captured by these small gasoline boats, which for light work are replacing the more expensive steamboats. This accounts for the large increase in number of new vessels showing a decrease in average tonnage. The boats in actual use on the Mississippi River at and near St. Louis are shown by Exhibits Nos. 10 and 11.

EXHIBIT No. 10.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

STEAMERS AND BARGES.

Number of vessels and their tonnage enrolled and licensed at the port of St. Louis, Mo., December 31, 1908:

Class of vessel.	Number of vessels.	Gross tonnage.	Net tonnage.
Permanent enrolled wood steamers	55	16,022	15,252
Permanent enrolled barges (wood)	5	431	431
Permanent enrolled steamers (metal)	9	2,940	2,257
Permanent enrolled barges (metal)	1	1,162	1,162
Licensed (under 20 tons) steamers (wood)	27	279	247
Licensed (under 20 tons) barges	1	16	16
Licensed (under 20 tons) steamers (metal)	2	37	21
Permanent enrolled steam yachts (wood)	6	393	269
Permanent enrolled steam yachts (metal)	3	274	220
Licensed (under 20 tons) steam yachts (wood)	6	122	94
Total	115	21,676	19,969

EXHIBIT No. 11.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

STEAMERS PLYING BETWEEN ST. LOUIS AND OTHER PORTS DURING 1908.

"Diamond Jo" Line.—Steamers Sidney, St. Paul, Dubuque, and Quincy, on upper Mississippi River.

Eagle Packet Company.—Steamers Spread Eagle and Bald Eagle, on upper Mississippi River; steamers Grey Eagle, Cape Girardeau, and Eagle, on lower Mississippi River; steamer Alton, excursion boat; tug Echo, St. Louis Harbor.

Lee Line.—Steamers Stacker Lee, Peters Lee, Ferd Herold, and Georgia Lee, on lower Mississippi River.

St. Louis and Tennessee River Packet Company.—Steamers City of Savannah and City of Saltillo, on Tennessee River.

Independent Cape Girardeau Packet Company.—Steamer City of Memphis, on lower Mississippi River.

Missouri River and Kansas City Transportation Company.—Steamers Chester and Tennessee, on Missouri River.

St. Louis and Calhoun Packet Company.—Steamer Belle of Calhoun, on upper Mississippi River.

Barrett Line.—Barrett, Major Slack, and steamer Beaver, on lower Mississippi River.

West Kentucky Coal Company.—Towboats Jno. A. Wood, Harry Brown, Pacific No. 2, Fred. Hartweg, W. W. O'Niel, Wash Hornsbell, and Mariner, on Ohio River.

City boats.—Steamer Erastus Wells, St. Louis Harbor; steamer Saturn, Chesley Island.

Madison County Ferry Company.—Ferryboats Madison and C. S. Greely, North Market street.

Wiggins Ferry Company.—Transfer boats Geo. H. Madill and Henry Sackman; tug Henry C. Haarstick; ferryboats Samuel B. Wiggins, Henry S. Clark, Alonzo C. Church, and Andrew Christy, St. Louis Harbor.

Interstate Car Transfer Company.—Transfer boat Wm. McClelland, transfer barge Holbrook, and tug W. K. Kavanaugh, St. Louis Harbor.

St. Clair Ferry and Transfer Company.—Ferryboat Florence, Sidney street.

Waterloo-Carondelet Ferry Company.—Ferryboat Dr. Frederich Hill, Davis street.

Ivory Station and Missouri Pacific Railroad ferry.—Transfer boat James Y. Lockwood, and barge E. S. Jewett, Ivory street.

Tugs plying in St. Louis Harbor.—Colorado, and R. E. Carr, Union Sand and Material Company; Susie Hazard, Illinois Central Railroad Company; Reliance, Consolidated Coal Company.

Independent packets and towboats.—Steamers New Haven, Helen Blair, and Omaha, upper Mississippi River; steamer J. F. Silber, Missouri River; steamer Mary, Illinois River; steamer Hy. Wohlt, Missouri River; steamer J. M., upper Mississippi River; steamer J. R. Wells, Missouri River.

United States boats.—Steamers Mississippi, J. N. Macomb, Lily, Illinois, H. G. Wright, Missouri.

Pleasure boats.—Steamers City of Providence, Chaperon, David Swain, Alton, Remora, Columbia, Kabekano, W. W., Wanderer, Liberty, D. Cawley, J. S., Swan; yachts Crescent, Geraldine, Mary B. Franklin, Wooden Shoe, Monkey Wrench, Duro, Wildwood, Independence, Columbia, Bachelor, Frolic, Nevermind, Theociste, Josephine, Leisure Hour, Louise Rumsey, Clarence S., Irma, Dragon, Victoria, Nomad, Mary Franklin, Allamakee, Margery II, Jennie M., Idle Hour, Comet, Lydia, Castaline, Kid, Burr Oak, Duchess, Olympia, Navomobile, Harriet, Emma Della, Sylph, Jane, Kity Sparks, Mary Sparks, Come On, Albion, Phyune, Richfield.

On the lower Mississippi and Ohio rivers, as on European improved rivers and canals, the tendency is to seek economy of freight transportation by towed barges rather than by self-propelling packet boats. Wherever the traffic is offered in lots of over 200 to 1,000 tons the use of towboats and barges becomes the most economical.

Three and a half million tons of coal or heavy freights can be sent from Pittsburg to New Orleans by use of 9-foot draft steel barges and stern-wheel towboats in large fleets at a cost not exceeding $7,000,000 for plant and $2,700,000 for annual operation or about 0.03736 cents per ton mile (Ohio River Board report).

One stern-wheel towboat has been known to handle as much as 56,000 tons of freight in one tow (Ohio River Board report), a freightage equal to that of 5 of the largest lake vessels or 3 of the larges ocean steamers, or of 8 to 15 miles length of railroad cars; and to handle as much as 2,000,000 feet of logs, enough to fill 14 trains of 24 cars each by rail (Ex-Governor Van Zant of Minnesota, 1904 Dubuque Convention).

Where the current is swift and the river winding, a small light draft stern-wheel boat lying across the front of the tow of barges is sometimes added to help steer the tow around bends.

In 1864–1891 barges of 500 to 1,000 tons and shallow draft have carried ore and coal between Sulphur Springs, Mo., and Pittsburg, Pa., a 1,127-mile route, at 1.5 mills per ton mile (Ohio River Board report).

On the 1,200 or more miles of Belgian waterways around Antwerp the barge traffic of about 7,500,000 tons is mostly carried on shallow-draft barges of less than 1,200 tons each (Montreal Harbor Commission report).

On the 7,500 or more miles of German waterways connected with Hamburg the barge traffic of about 8,500,000 tons is handled by about 1,400 self-propellers and about 5,000 barges of from 100 to 1,500 tons of from 3 to 6 feet draft (Montreal and Chicago harbor commission reports).

On the Rhine, where the traffic is over 16,000,000 tons, much of the traffic is carried by barges (towed tandem in groups of two to five) of about 460 feet length, 47 feet breadth, and carrying about 3,500 tons when fully loaded to about 10 feet draft, the channel depths varying from 6 to 10 feet (Chicago Harbor Commission report), as well as by smaller barges of 1,000 tons each (Ohio River Board report).

On the Volga, with traffic of over 14,000,000 tons, of which three-fourths is upstream, economical rates of as low as one-half mill per ton-mile are reached during good water by tows of barges of 11 to 12 feet draft (Ohio River Board report). But the controlling depth on crossings of lower 1,300 miles was reported in 1908 as only 5½ feet.

No vessels of over 2,500 tons make use of the Mississippi Valley except in the deep-water portion of the river below the mouth of Red River. Although every deep-draft boat reaching New Orleans could easily proceed up the river about 130 miles further, to Baton Rouge, there is apparently no incentive for its doing so, as the goods can best be put ashore at New Orleans, where the terminal facilities are good, after which railroad charges for delivery at factory sidings are usually less than river freights combined with drayage up the bank and across the city or country to the factory. The daily expense of large steamers is so great that they must avoid all possible delays in loading and unloading in order to be profitable. For example, on the Great Lakes, where modern efficient transportation methods are already in use, a steamer, the *E. J. Earling*, has been fully loaded with 9,277 tons of ore in seventy minutes, averaging 7,288 tons per hour, and the *George W. Perkins* has been fully unloaded of 10,346 tons in four hours and ten minutes, averaging 2,582 tons per hour (Census Bureau Report, 1906). The keynote of cheap transportation service on the Great Lakes is not simply large boats, but is preeminently the reduction to a minimum of all delays at terminals as well as en route.

The Great Lakes have been often referred to as an illustration of the enormous development of freights by reason of the existence of deep draft and as an argument for deep drafts in rivers. The experience of the Great Lakes navigation development is, however, not properly applicable to that of waterways in the other parts of the United States, as the Great Lakes, for the greater part of their distance, have broad, deep channels, more like the ocean than like any rivers of North America except the lower St. Lawrence. The movement of deep-draft boats in broad, open channels can not be properly quoted as an illustration of what would happen to similar boats in narrow, winding, river channels.

Large, deep-draft, heavily loaded boats are unwieldy, especially when trying to back against the current; and when coming downstream such boats can not be handled safely except in wide, deep channels, such as are far greater than can ever be expected in the Mississippi River above the mouth of Red River. While an ocean steamer might safely go slowly up the Mississippi against the current with a draft somewhat less than the channel depth over its bars, it is very doubtful whether it could ever get down the river with safety except during high freshets when all bars were deeply submerged.

In order to put the Mississippi River Valley waterways, as regards facilities of transportation, on a par with the railroad systems of the valley, which have branches or sidetracks to every city or town within easy reach, it would be necessary that the box cars of railroads should be represented on the river by barges of uniform draft for the entire river system, so that one or more barges could be loaded at factories and freighted along the river in large tows, to be later collected at depots at the mouth of each tributary, where new tows could be assembled for through towage to their final destination, each barge, at the end of its route, delivering an unbroken cargo to the consumer. Such condition is practically achieved in Europe by the great number of its light-draft barges and the great number of small harbors or havens scattered along its rivers and canals.

Amount and character of freights carried and demanding carriage by water routes.—Letters were sent out in the fall of 1907 to commercial organizations and individuals supposed to be specially interested or specially well posted as to river valley commerce at all the large cities from the mouth of the Illinois River to New Orleans, asking information as to the existing local shipments and receipts by rail, and especially those which might have been taken care of by boats if a 14-foot draft in the river had been available continuously during the preceding year. Later, in 1908 and the early part of 1909, further letters were sent out to secure additional information and especially to find out what definite information existed among the commercial organizations of the valley as to the relation between boat and rail rates along the river valley. The replies were considerably fewer and less full than expected.

Commercial organizations along this river do not appear to have yet made any special study of the ratio of boat and rail rates or of the reasons for the wide differences of rates in some cases and the lack of differences in others.

The more important of the 1907 letters and their replies are as follows:

EXHIBIT NO. 12.—*Circular to commercial organizations sent out December 27, 1907.*

SIRS: Referring to the agitation of a project for a 14-foot waterway from Chicago to the Gulf, and to the apparent desire of the commercial organizations of the Mississippi Valley for such waterway, and in view of the fact that the action of Congress in the matter will depend not only on the report of the Board on Examination and Survey of the Mississippi River as to the feasibility and practicability of such an undertaking from an engineering standpoint, and its probable cost, but also on the amount of commerce that can reasonably be expected to be carried on such waterway, the Board above mentioned, of which the undersigned is chairman, would be glad to have your cooperation in the compilation of certain commercial statistics, of which the following is an outline of the information desired:

1. What amount of freight (stated in tons, if possible) was received at your city, by rail, during the calendar year 1907?
2. What amount of such freight was carried by roads running approximately parallel to the Mississippi River for any appreciable distance?
3. What amount of such freight, in your opinion, could reasonably be expected to have been carried by boat had the 14-foot channel been in existence during 1907?
4. What amount of freight was shipped from your city, by rail, during the calendar year 1907?
5. What amount of such freight was shipped over roads running approximately parallel to the Mississippi for any appreciable distance?
6. What amount of such freight could reasonably be expected to have been shipped by boat had the 14-foot waterway been in existence during the year 1907?

This request is being sent to commercial organizations at the following places: Grafton, Ill., Alton, Ill., St. Louis, Mo., Cape Girardeau, Mo., Caruthersville, Mo., Chester, Ill., Cairo, Ill., Paducah, Ky., Memphis, Tenn., Greenville, Miss., Rosedale, Miss., Vicksburg, Miss., and New Orleans, La. In order that the entire reach of the river from Grafton to the Gulf may be covered, it is desired that the information supplied by you include not only the freight received and shipped from your own city, but also the freight received and shipped from all shipping points (on both sides of the river) between your city and the city next below you which will receive a copy of this request.

The first paragraph of this letter will indicate the use which is to be made of the information desired. The object is to secure the total amount of freight handled by rail along the Mississippi River during 1907, and the proportion which could have been practically diverted to river transportation. Information concerning the river traffic for 1907 is being compiled from other sources.

The information supplied by you will be merged into a general total, thus burying the individual data for any particular road, which, if desired, will be treated as confidential.

Very respectfully,

CLINTON B. SEARS,
Colonel, Corps of Engineers, U. S. Army.
Senior Member, Board of Examination and Survey Mississippi River.

Memorandum: Under date of December 27, 1907, the above letter requesting data as to freight carried on the Mississippi River was mailed to commercial organizations and individuals at Grafton, Ill.; Alton, Ill.; St. Louis, Mo.; Cape Girardeau, Mo.; Caruthersville, Mo.; Chester, Ill.; Cairo, Ill.; Paducah, Ky.; Memphis, Tenn.; Greenville, Miss.; Rosedale, Miss.; Vicksburg, Miss.; New Orleans, La.

Replies containing some of the information requested were later received from the organizations at St. Louis, Caruthersville, and Rosedale.

EXHIBIT NO. 13.—*Letter of the Lakes-to-the-Gulf Deep Waterway Association.*

ST. LOUIS, MO., *February 8, 1908.*

MY DEAR SIR: Replying to your letter of December 27, I beg leave to answer the questions you propose as follows:

Question 1. What amount of freight (stated in tons, if possible) was received at your city, by rail, during the calendar year 1907?

Answer 1. Freight in tons received by railway at St. Louis during the calendar year 1907, 29,417,845 tons.

Question 2. What amount of such freight was carried by roads running approximately parallel to the Mississippi River for any appreciable distance?

Answer 2. 9,921,748 tons of freight were carried into St. Louis during the calendar year 1907 by railways running parallel to the Mississippi River, this freight being collected by the railways from St. Paul, Minneapolis, New Orleans, Memphis, and points between.

Question 3. What amount of such freight, in your opinion, could reasonably be expected to have been carried by boat had the 14-foot channel been in existence during 1907?

Answer 3. More than 6,000,000 tons of this freight would have been carried by boat had the 14-foot channel been in existence during 1907. This would have left the railways free with their equipment to carry much freight that was not carried on account of the congestion, and the boats also would have carried very much more of the freight that was not carried but was ready to be handled. Moreover, by this ready movement of freight there would have been a very large development of freight which, without the 14-foot channel, is not carried at all.

Question 4. What amount of freight was shipped from your city by rail during the calendar year 1907?

Answer 4. The freight shipped from St. Louis by rail during the calendar year of 1907 was 17,846,155 tons.

Question 5. What amount of such freight was shipped over roads running approximately parallel to the Mississippi for any appreciable distance?

Answer 5. The amount of freight shipped out of St. Louis during the calendar year of 1907 over roads running approximately parallel to the Mississippi River was 5,299,158 tons.

Question 6. What amount of such freight could reasonably be expected to have been shipped by boat had the 14-foot channel been in existence during the year 1907?

Answer 6. More than 3,000,000 tons of this freight would have gone by boat had the 14-foot channel been in existence during the year of 1907.

It is absolutely certain that had the 14-foot channel been in existence during the year of 1907 not only would the boats have carried, as is stated above, more than two-thirds of the total of the freight carried by the railways, but so much more freight would have developed that the railways would have carried as much as they did, which was all they could carry, and the boats not only would have carried two-thirds of the freight carried by the railways, but they would also have carried as much as their capacity would have allowed. In considering the necessity for adding a 14-foot channel to the present rail freight facilities the Mississippi Valley has, it must always be kept in mind that the railways are not carrying the freight which is offered, and that we have not had for ten years an opportunity to test the amount of freight which would be offered to carriers were the facilities adequate.

Very truly, yours,

W. F. SAUNDERS, *Secretary.*

COL. CLINTON B. SEARS,
United States Engineer in Charge,
Room 428, Custom-House, St. Louis, Mo.

EXHIBIT NO. 14.—*Letter of the Board relative to statistics.*

BOARD OF EXAMINATION AND
SURVEY OF MISSISSIPPI RIVER,
OFFICE OF THE SENIOR MEMBER,
ROOM 428, CUSTOM-HOUSE,
St. Louis, Mo., November 20, 1908.

DEAR SIR: Confirming verbal request of several days ago, I have herewith to make official request upon your association that you obtain, as far as possible, and present to me in writing, full statistics as to the present and prospective commerce of the Mississippi River from St. Louis to the Gulf, both local and general, and upstream as well as downstream.

The above information is included in that which, by the act of March 2, 1907, is requested by Congress from the Board of Engineers for the examination of the Mississippi River below St. Louis—commonly known as the 14-foot Waterway Board—of which I am the senior member.

In its past inquiries the Board has met with a great deal of difficulty in obtaining any definite valuable statistics of commerce, although they have been promised by various parties along the river.

Such statistics as have already been received from the St. Louis Business Men's League, while showing considerable traffic on the river, do not in any way seem to indicate that the existing facilities of navigation have been utilized to full extent, and do not seem to indicate any need for a wider or deeper channel for any greater number of days during the year than already exists. A great deal more is yet needed in the way of statistics of present commerce to make evident the fact that the present navigation facilities of the river are insufficient for the commerce of the present time and of the next few years.

The prospective commerce, however, as to which Congress asks full information, may very properly include anything and everything which it is probable will develop in case of the construction of a 14-foot depth channel, of suitable width, from St. Louis to the Gulf. Should there be any evident demand for such commerce, or should there be any progress of construction in steamboats requiring 14-foot draft (or even any other depth between 8 and 14 feet) for proper utilization, it seems desirable to have the matter brought out very fully and plainly. It would be also very desirable to have brought out with equal plainness the future saving in freights, or any other future decided gain to the transportation interests of the country, that will result from the construction and maintenance of a 14-foot depth channel in place of the present good 8-foot depth channel.

It is presumed that as your association is urgent in the demand for this increased facility of navigation from St. Louis to the Gulf, it must either have in its possession, or can easily secure, all the information above called for; and in view of the fact that other parties along the river are not furnishing much information in this direction, it is hoped that you will be able to make your reply as full and complete as possible, and that you will let me have it from you sometime within the next three or four weeks.

Very respectfully,

W. H. BIXBY,
Colonel, Corps of Engineers, U. S. Army,
Senior Member of the Board.

Mr. W. F. SAUNDERS, *Secretary,*
Lakes-to-the-Gulf Deep Waterway Association,
704 Locust Street, St. Louis, Mo.

EXHIBIT No. 15.—*Letter of The Lakes-to-the-Gulf Deep Waterway Association.*

ST. LOUIS, *December 8, 1908.*

MY DEAR COLONEL BIXBY: I have the honor to hand you, with this, figures concerning the tonnage between Chicago, St. Louis, St. Paul, and New Orleans, which I hope will serve the purpose of your letter addressed to me of November 20. These figures have been obtained by Mr. P. W. Coyle, commissioner of the freight bureau of the Business Men's League, after a thorough examination of the records of the railways and after much correspondence with organizations between Chicago and New Orleans and St. Paul and New Orleans, which have records as to tonnage.

I have the honor to add to this statement of Mr. P. W. Coyle information as to tonnage, present and prospective, gathered by myself from correspondence with commercial organizations and with railway freight officials, which information is indorsed by Commissioner Coyle as being accurate.

Very truly, yours,

W. F. SAUNDERS, *Secretary.*

Col. WM. H. BIXBY,
Corps of Engineers, U. S. Army,
428 Custom-House, St. Louis, Mo.

DATA FROM COMMISSIONER P. W. COYLE, OF THE FREIGHT BUREAU OF THE BUSINESS MEN'S LEAGUE.

All rail.—Tonnage between Chicago and points in Michigan and Illinois and St. Louis, 5,500,000 tons.

Between St. Paul, Minneapolis, and Northwestern points and St. Louis, including grain and grain products, 4,500,000 tons.

St. Louis to New Orleans and intermediate points, 3,500,000 tons.

From New Orleans to St. Louis and Chicago, including lumber, sugar, coffee, rice, molasses, and bagging, 7,500,000 tons.

Between Chicago and Michigan points and Ohio River crossings, such as Cincinnati, Louisville, Evansville, etc., originating at or having destination in the Mississippi Valley south of the Ohio River, 3,500,000 tons.

Movement by river to and from St. Louis for the year 1907, 368,075 tons.

DATA FROM WM. F. SAUNDERS, SECRETARY AND GENERAL MANAGER OF THE BUSINESS MEN'S LEAGUE.

Some time ago I had the honor of appearing before the Rivers and Harbors Committee of the House of Representatives and submitting to Mr. Theodore E. Burton, chairman of that committee, through Mr. P. W. Coyle, information as to present and prospective tonnage over the territory to be served by the Lakes-to-the-Gulf deep waterway, which it has taken us nearly a year to prepare. The figures of the present tonnage were prepared for the year ending 1906, which—considering present freight conditions—serve this year fairly well.

There are six roads carrying tonnage between Chicago and St. Louis—the Wabash, the Chicago and Alton, the Illinois Central, the Chicago and Eastern Illinois, and the Chicago, Peoria and St. Louis. These six roads carried in 1906 5,500,000 tons in both directions, the movement being equally divided between north and south.

In addition to this and based upon the actual movement for one month, I believe it is fair to estimate that 1,500,000 move annually between Chicago and what are known as Chicago Junction points and points in the territory south of the river, east of the line of the Mobile and Ohio and west of the Carolinas to the Gulf. I am unable to obtain absolute figures upon which to base an estimate covering the traffic originating in Illinois or at Chicago and beyond moving through Ohio River crossings without passing through St. Louis, but from my experience in the handling of such traffic with a line directly interested in it, I believe it is fair to estimate that the tonnage pasing between that particular territory and the territory south of Cairo, east of the Mississippi River, and west of the line of the Mobile and Ohio, including New Orleans, at 2,000,000 tons annually.[a]

In making estimates I have endeavored to confine myself to the territory from and to which tonnage is moving by rail, a percentage of which is susceptible of diversion or which would naturally seek the improved waterway service. There is in addition to this, of course, immense traffic that would come under the influence of such rates as would necessarily follow the establishment of such a permanent channel.[a]

Mr. William V. Byars, internal-commerce expert, who is well known as a commercial writer, was formerly one of the editors of the New York World and of the St. Louis Republic and is now a special writer for many newspapers, in his report to the Board of Engineers at St. Louis upon the extent of deep-waterway traffic, said:

"The freight passing between Chicago and St. Louis is not separately reported. It is estimated at 20,000,000 tons south, 15,000,000 tons north, annually, including shipments on the Vandalia and the Big Four lines."

Mr. Byars remarks, in further explanation of these figures, that all the freight from Chicago passes by St. Louis just as the very great grain tonnage of Chicago goes by St. Louis, though not through it, and all the tonnage originating at towns between Chicago and St. Louis going in either direction was included in his estimates. Reports of the Chicago and St. Louis boards of trade, such tonnage reports of the railways as are kept of this class of freight, and correspondence with shippers in the towns concerned were the basis of his estimates.

We contend that this proposition should not rest with so much importance on the question of tonnage now moving between Chicago and St. Louis, but that it should be considered upon the broad ground of its effect on the commerce, not only of the Mississippi Valley, but of the entire territory between the Atlantic coast and the Rocky Mountains. It is a fact that the rail lines now operating between Chicago and St. Louis are unable to handle the traffic offered either to their satisfaction or to the satisfaction of the shipper, notwithstanding the fact that within the past ten years their facilities have been increased to the extent of two new through lines and the double trackings of a large part of two of the old lines. It is also a notable fact that during that period the old lines have gradually increased their tonnage until they now carry double what they did ten years ago. Hence it is fair to assume that the projectors of the two new lines could not have based their enterprise on the prospective

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[a] Mr. Coyle is responsible for the statements in these two paragraphs.

tonnage that might be diverted from the old lines, but rather upon the broader ground of general development, just as we insist this enterprise should be based. That there is an immediate necessity for the construction of this deep waterway is shown by the facts already stated, and the further fact that under the present consolidation of rail lines and the concentration of their management we have no reason to expect private capital to invest in railroads to the extent necessary to relieve the present general congestion of traffic. That the establishment of a permanent deep-water channel from Chicago to the Gulf would do this in a large measure must be apparent to those who have given the subject even superficial consideration. In touching on this feature I wish to say in passing that we are convinced from our intercourse with the representatives of the railroads that the broad-minded traffic men of the country to-day would hail this deep waterway as a practical and a conservative measure of relief, and a benefit, not only to the shippers, but to the carriers as well. Many railroads to-day are carrying raw material to the industries on their lines either at cost or at rates that in the abstract do not yield a reasonable profit to the carriers, simply for the purpose of fostering and developing such industries to the end that the carriers may enjoy the profitable traffic of the finished products of such industries. While this project would not, of course, reach all such conditions, it would do so to such a degree that the rail lines would be able to utilize their equipment to a much greater extent than at present in the hauling of the higher class of traffic requiring more expeditious movement, leaving the heavier or raw material traffic to the water lines, who could carry such freight with sufficient dispatch and at rates profitable to themselves and satisfactory to the shipper. This subject can not reasonably be considered as local to the Mississippi Valley in its effect upon rates, but should be considered in the light of a means of establishing a new basis for the readjustment of rates between the Atlantic seaboard, the Great Lakes ports, and the great West, just as the completion of the Panama Canal should establish new basis of rates across the continent. The basis of rates to-day between the Atlantic coast points and the West were established as the results of the rates originally made by the Erie Canal between New York and Buffalo, due to the fact that such rates were the basis of the rates originally established by the New York Central between these points. Then as the rail lines were extended west the basis of rates was predicated on another waterway, and the rates between Chicago and New York are now used as the unit of all the rates by all the rail lines between Atlantic States, the Lake ports, and the Mississippi River. Therefore, as these rates are the basis of the rates to the western territory, it must be apparent to you that the establishment of a permanent deep waterway from the Great Lakes to the Gulf would necessarily establish a new basis of through rates predicated on the water rate to the Mississippi River. This is as vital to the manufacturers at Cleveland, Buffalo, and other lake cities as to the manufacturers of the East and mutually important to all of us. That this project should be viewed with favor by the railroads of the East should be apparent when we take into account the fact that all the lines terminating at Buffalo are largely interested in freight boats plying between that port and Chicago. These boats, like all others plying the Great Lakes, are idle at least three months of the year. Hence the channel proposed would furnish the means of conducting traffic in the more favorable climate of the South during the closed season of the North, thus utilizing a vast capital that now remains idle during that term. Therefore we ask that you favorably consider this proposition for this permanent waterway, first, because it is necessary to relieve the great congestion of traffic that now threatens the welfare of the commerce of the country; second, because it is necessary to the complete development of the great Mississippi Valley, and finally, by so doing, establish a basis upon which the rates may be more equitably adjusted between all our great commercial centers.

From the lower Mississippi were received statements that on the east side of the river there is moved annually for local consumption by the railroads at some points about 15,000 to 20,000 tons of merchandise per mile of river, which might be carried just as well by water as by rail; this being mainly cotton, lumber, grain, and provisions; and that a large part of the cotton and lumber intended for export might be loaded directly onto ocean boats at the point of first shipment if deep water existed all the way from such point to the Gulf. Other statements, from the west side of the river, claim that at some points there were large amounts of freight moved by rail in directions parallel to the river, of which fully two-thirds might have been shipped by boat just as well as by rail if deep water had been available.

Some of the business interests of Chicago have contributed the following communication as representing the importance of development of the north and south connection between the Great Lakes and the Gulf. It is credited to the house of Rothschild, and understood to have been furnished by that business house to the British Government in 1896 during the consideration by that Government of the question of a friendly alliance between it and the United States.

EXHIBIT No. 16.

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"This century will not close before we shall have seen a general reorganization of international relations throughout the world, and alliances and combinations on new lines to meet conditions which have long been changing, silently and slowly, and have reached now the stage where the bud must burst into flower.

"The development of the United States is almost wholly the outgrowth of its railway system.

"The railway system of the United States grew up in meeting temporary emergencies, in meeting the demands of a popular policy covering a desire for most widely scattered and thinly expanded pioneer development; which sought hurriedly to embrace the whole country with very inadequate population and means.

"For a very long period the public lands for settlers, native or immigrant, and great land grants to stimulate railway construction, gave the United States a practical monopoly in European investment money, which at first went largely into railway building and then into collateral enterprises growing out of the opening up of new country. This stimulated a fever, which naturally led to both overbuilding and overcapitalization.

"In the meantime the concentration of capital, skilled labor, machinery, and a high industrial, commercial, and banking organization in the New England States gave them great wealth, which was very heavily reinvested in expanding their local industries for most profitable employment.

"The result of this scramble is now very apparent on any close observation; and it has saddled upon the United States one-half of the railway mileage of the world, in large part very badly located because permanent conditions for sustaining it do not exist. Those portions of the country richest in resources to permanently sustain dense population have been little touched upon, and a shifting of population and industries to them must henceforth come under increasing pressure; and this will bring about widespread readjustment of trade and values.

"To illustrate how badly located are the industrial institutions and population of the United States—a location directly traceable to railway location—the figures show that, for a population of 70,000,000, the railways of the United States are called upon to move a tonnage almost as great as that of Europe for more than five times the population, and whose labor produces a vastly greater output; and when, in addition to this, the average distance hauled in the United States is considered, which is four times as great as in Europe, the discrepancy becomes amazing. For 1894 the tons of freight moved in the United States reached 675,000,000.

"The mileage haul shows that the average distance hauled was about 123 miles, 3 per cent more than the previous year; that is to say, 10 tons per capita 123 miles, against this Europe's haulage of less than 800,000,000 tons an average of 35 miles. Reduced, that it takes at least seventeen times as much railway hauling per capita to serve the population of the United States as to serve that of Europe.

"An examination of the fundamental conditions of the great industrial centers makes plain the reason for this enormous waste. As for instance, the New England States are without natural resources to in any measure sustain their population and institutions. The material they work up, their food, their fuel, their shelter, must all be brought from greatly distant fields. Yet there is concentrated the highest productive capacity of men, machinery, and capital. New York is not greatly different, though better. But through her territory run the great lines of transportation and her harbor monopolizes in great part the trade of the country with other countries.

"England is a shop and a bank and a carrying country. But England has seaway. In the United States it is railway, infinitely more expensive to operate, and every mile of which not only must be maintained but interest on its cost earned day by day.

"One result has been that American railways have already been cut down below the safety point in carrying charges. It is impossible for the industries to share in further cutting. Labor will prevent it on one side, and the manufacturer, with his badly located plant, who has to haul material and fuel and then ship back his products, in competition with other countries, and with only an uncertain margin of customs tax, can not reduce his cost of production and live.

"Yet reduction must continue. Step by step it must invade fixed charges and compel reorganizations so far as the railways are concerned, and removal and relocation by the manufacturers. The emergency work and the emergency conditions of settling new country, and emergency profits, are things of the past. Permanent conditions must be met. The West is each year becoming less and less dependent on eastern industries. Europe each year becomes less dependent on the American

exports, which have heretofore cut so large a figure; and between these upper and nether millstones the great investments in transportation must be ground.

"There are three great central regions of concentrated resources in that portion of the United States lying east of the Rocky Mountains.

"The first in importance and in extent is the mountainous region lying in the center of the Southern States east of the Mississippi, with the Pennsylvania and Ohio coal fields added. This comprises about 130,000 square miles, being 150 to 250 miles wide by over 700 miles long, extending to northern Georgia and Alabama. If this region were settled like the New England State of Massachusetts, it would contain 40,000,000 of people; if like Saxony, it would hold 20,000,000 more than the present total population of the United States; area for area it has resources of all kinds several times greater than those of Saxony. Its natural conditions are all of the highest class and constitute it a natural magazine and workshop not equalled elsewhere in the world.

"Round it on all sides lie estates naturally rich. A great part of it is wilderness. It seems to have been avoided by the railway system of the United States in the South; doubtless because of grades. But its topography bonds it together, its coal field along one side and its minerals and great forests on the other, across a rich valley running through its center for its whole length. Opened up, its conditions would enable it to compete with any country, even with the oriental countries soon to become of the world's account as producers for export. Here the carrying would be even less than in Europe, per capita, considering the resultant product, and the distance. Its proximity to the Altantic coast from Baltimore southward, and to the coast of the Gulf of Mexico, are all in its favor in considering transisthmian and Spanish-American trade.

"The next great region, lying both in the United States and the British Dominion of Canada, surrounds the upper Great Lakes. The possibilities of the development of this region are beyond calculation. Chicago is its natural point for concentration and distribution, and it has many natural centers of minor importance. When the isthmian possibilities are considered, and the relation of North America to Central and South America, it is very plain that the true transcontinental line is not from New York to San Francisco across the high mountain country of the interior, but by the St. Lawrence and Mississippi, with water most of the way, and its summit in the low gap of Chicago, only some 600 feet above sea level. As compared with the line by the middle lakes and the Erie Canal the short cut from Georgian Bay, in Lake Huron, to Lake Ontario, and thence to Montreal by low-grade railways and by water, at an insignificant cost, compared with that of existing trunk lines to New York and their collateral lines—the difference is brought out in very bold relief.

"The region between Georgian Bay and Ontario and the upper St. Lawrence would be a solid belt of manufacturing country. As great power can be created here, all under absolute control, as capital may care to make—as great as that of Niagara, if every foot, too, of that great cascade could be utilized. The difference in the levels of Michigan, Superior, and Huron lakes and that of Ontario is the stored-up dynamic force of that part of the transcontinental line—just as the coal in the southern mountains is the reducing force of that region.

"The level lands and the Mississippi River will give cheap competing rail and water carrying facilities for the current of trade that must change toward the South when the Isthmian Canal is completed.

"Year by year America's trade with Europe will decrease in relative importance, for the reason that as the breadstuffs market is taken up by competing countries American and European surplus products will assume a similarity, and competition for markets will take the place of exchange of products.

"The third great region is around St. Louis. The rich soil of all surrounding States, the coal fields of Illinois and Missouri, and iron and other minerals of Missouri, Arkansas, and Oklahoma, the great forest wealth, and the great waterways are the principal factors."

* * * * * * *

Under the provisions of act of February 21, 1891, all agents of vessels navigating waterways under federal improvement are required to furnish statements of their cargoes, etc., to the United States engineer officer in local charge of such improvements. From such statements the Mississippi River Commission has been able to compile totals of each year's commerce, which are fairly complete so far as concerns the river from St. Louis to New Orleans. Such statistics, put into tabular form as below and also put into graphic form as by attached chart, show the amount and movement of river commerce from St. Louis to Cairo for the calendar year of 1907. The commerce of 1908, though not as yet completely compiled, will show results much the same as those of 1907, although on the whole the receipts and shipments have been somewhat less.

EXHIBIT No. 17a.—*Tonnage and traffic of the Mississippi River, St. Louis, Mo., to New Orleans, La., calendar year 1907.*

Lower Mississippi, St. Louis to New Orleans.	Total number of passengers received and discharged.	Receipts and deliveries at principal ports and way stations.											
		Grain and its products.	Cotton.	Cotton seed.	Live stock.	Coal and coke.	Lumber.	Logs.	Iron, steel, and metals.	Groceries and provisions.	Oil.	Stone, gravel, and sand.	Unclassified and miscellaneous.
DOWNSTREAM.		*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Received at St. Louis	21,251	2,782	.....	.....	319	10	226	375	709	3,485	83	.....	34,863
Received between St. Louis and Cairo	2,981	10,392	.....	.....	374	.....	78	19,800	.....	.....	.....	1,000	3,238
Discharged between St. Louis and Cairo	12,387	1,576	.....	.....	540	.....	214	6,000	444	2,730	78	1,000	17,250
Discharged at Cairo	3,663	11,598	.....	.....	153	10	90	14,175	265	755	5	.....	4,301
Received at Cairo	4,324	.....	.....	.....	.....	1,067,154	.....	.....	27,938	.....	.....	14,200	11,889
Received between Cairo and Memphis	8,756	1,000	10,337	8,201	.....	4,000	8,292	170,980	.....	.....	.....	1,000	5,702
Discharged between Cairo and Memphis	3,576	1,000	.....	1,602	.....	28,950	.....	37,000	676	.....	.....	1,000	16,730
Discharged at Memphis	17,686	.....	10,337	6,599	.....	205,825	8,292	133,980	9,290	.....	.....	1,600	15,347
Received at Memphis	36,408	13,094	.....	40	2,196	24,070	1,952	.....	2,774	12,273	364	10,060	21,510
Received between Memphis and Vicksburg	28,228	3,594	11,811	8,534	2,173	10,520	573	218,000	358	2,940	168	878,294	4,123
Discharged between Memphis and Vicksburg	55,814	16,688	5,171	1,774	4,301	35,129	2,525	153,000	3,374	14,909	525	791,154	25,124
Discharged at Vicksburg	8,647	.....	1,795	4,050	18	24,340	.....	65,000	4,754	304	7	100,000	279
Received at Vicksburg	7,987	410	483	.....	520	.....	732	.....	.....	3,124	19	.....	9,157
Received between Vicksburg and New Orleans	11,731	19,254	29,562	26,458	762	52,200	21,712	167,007	450	43,510	101,497	138,351	96,952
Discharged between Vicksburg and New Orleans	16,251	770	1,467	2,170	1,130	116,200	1,119	87,007	500	15,260	70,028	3,200	21,824
Discharged at New Orleans	3,642	18,894	33,423	27,038	202	747,500	21,325	80,000	12,926	31,374	31,488	144,951	86,579
UPSTREAM.													
Received at New Orleans	5,707	6,989	.....	.....	402	300	8,432	.....	2,125	27,191	86,749	.....	15,802
Received between New Orleans and Vicksburg	16,645	79	3,370	43,034	600	200	13,302	19,800	200	500	29,497	.....	14,894
Discharged between New Orleans and Vicksburg	13,460	7,068	2,489	11,206	1,002	500	724	5,000	2,325	22,052	112,636	.....	30,473
Discharged at Vicksburg	8,192	.....	881	31,828	.....	.....	.....	.....	.....	.....	.....	.....	100
Received at Vicksburg	8,268	3,946	54	.....	102	50	1,840	.....	323	4,372	42	.....	3,363
Received between Vicksburgand Memphis	48,061	1,303	25,913	15,632	3,125	15	121,012	145,895	367	2,422	47	.....	9,174
Discharged between Vicksburg and Memphis	32,963	5,209	9,409	7,288	1,955	65	337	20,200	572	9,715	89	.....	7,928
Discharged at Memphis	23,366	40	16,558	8,344	1,272	.....	15,933	79,795	118	201	3,610	.....	4,732
Received at Memphis	22,626	.....	534	.....	.....	.....	.....	1,800	.....	.....	.....	.....	13,013

Received between Memphis and Cairo	3,456	3,193	1,037	1,075			35,589	218,889					36,342
Discharged between Memphis and Cairo	13,643		19	98				11,000					5,748
Discharged at Cairo	4,138	3,193	572	977			161,718	231,389		2,517			38,437
Received at Cairo	3,943	75	542	260	268	166,350	23,156			195			2,533
Received between Cairo and St. Louis	8,138	8,161			10,114		257		30	700	4		9,149
Discharged between Cairo and St. Louis	1,485	442			28					25			975
Discharged at St. Louis	18,891	7,794	1,522	260	10,354	166,350	24,876	39,000	30	870	4		15,877

EXHIBIT No. 18.—*Mississippi River ferry traffic between St. Louis, Mo., and New Orleans, La., calendar year 1907.*

Location of ferries and transfers.	Number of passengers.	Tonnage of freight carried.						
		Grain and its products.	Cotton.	Cottonseed and its products.	Live stock.	Coal and coke.	Lumber.	Logs.
At St. Louis, Mo.	1,204,404	952,128	44,834	20	9,516	2,798,591	574,996	6,151
At Chester, Ill., Cape Girardeau, Mo., and Commerce, Mo.	53,870	1,165	.....	.....	37,144	500	56	200
At Cairo, Ill., to Birds Point, Mo., Wickliffe, Ky., and Greenville, Mo.; at Belmont, Mo., to Columbus, Ky.; at Hales Point, Tenn., to Wrights Point, Ark.	116,511	111,800	346	1,921	3,397	15,152	158,909	87,376
At Memphis, Tenn., to Hopefield and Mound City, Ark.	120,230	30,695	14,700	3,660	6,880	11,610	28,050	2,730
At Helena, Ark., Arkansas City, Ark., and Ashport, Tenn.	63,739	6,255	5,457	2,376	490	24,225	14,802	122
At Vicksburg, Miss., to Delta Point, La.	87,564	6,168	.....	245	462	31,274	8,641	.....
At Natchez, Miss., Baton Rouge, La., and Donaldsonville, La.	309,084	15,243	5,393	60	1,482	4,283	4,001	.....
At New Orleans, La.	4,009,282	404,107	140,864	167,841	11,860	227,455	407,126	.....

Location of ferries and transfers.	Tonnage of freight carried.					
	Iron, steel, and metals.	Groceries and provisions.	Oil.	Stone, gravel, and sand.	Miscellaneous and unclassified.	Total.
At St. Louis, Mo.	475,837	8,640	20,944	1,010,863	3,032,870	8,935,390
At Chester, Ill., Cape Girardeau, Mo., and Commerce, Mo.	60	1,185	.....	1,100	2,300	43,710
At Cairo, Ill., to Birds Point, Mo., Wickliffe, Ky., and Greenville, Mo.; at Belmont, Mo., to Columbus, Ky.; at Hales Point, Tenn., to Wrights Point, Ark.	16,099	27,963	168	776	113,699	531,606
At Memphis, Tenn., to Hopefield and Mound City, Ark.	5,355	20,475	11,940	429,027	87,710	652,832
At Helena, Ark., Arkansas City, Ark., and Ashport, Tenn.	443	9,842	1,067	.....	10,753	75,832
At Vicksburg, Miss., to Delta Point, La.	22,865	1,071	1,411	1,147	439,749	513,033
At Natchez, Miss., Baton Rouge, La., and Donaldsonville, La.	143	950	.....	.....	25,712	57,267
At New Orleans, La.	118,493	179,875	49,421	21,998	1,469,342	3,198,382

NOTE.—Owing to deficiency and inaccessibility of records of some transportation companies considerable tonnage which should appear under classified heads above has to be included with "Miscellaneous and unclassified."

EXHIBIT No. 19.—*Receipts and shipments at the port of St. Louis, calendar year 1907.*

	Number of passengers.	Receipts and shipments, in tons.					
		Grain and its products.	Cotton.	Cotton seed and its products.	Live stock.	Coal and coke.	Lumber.
Lower Mississippi River	42,167	10,576	1,522	260	10,673	166,360	25,101
Upper Mississippi River	50,735	9,218	.....	.....	7,018	.....	4,084
Missouri River	6,776	2,928	.....	.....	346	.....	132
Illinois River	5,925	2,194	44	.....	6,510	.....	811
Total	[a] 105,603	24,916	1,566	260	24,547	166,360	30,128

	Receipts and shipments, in tons.					
	Logs.	Iron, steel, and metals.	Groceries and provisions.	Oil.	Unclassified and miscellaneous.	Total tonnage.
Lower Mississippi River	39,375	739	4,355	87	50,740	309,788
Upper Mississippi River	1,500	269	4,899	.....	16,460	43,448
Missouri River	.....	98	359	.....	2,241	6,104
Illinois River	.....	85	1,640	.....	5,229	16,513
Total	40,875	1,191	11,253	87	74,670	375,853

[a] The Steamboat-Inspection Service reports 464,259 passengers carried in local excursion traffic.

NOTE.—This table was compiled from reports of the Merchants' Exchange of St. Louis and from records in the office of the secretary of the Mississippi River Commission.

These tables, especially the graphical table (Exhibit No. 17), show very clearly the comparatively small amount of tonnage carried by the Mississippi River between St. Louis and New Orleans; especially small if omitting the coal which comes out of the Ohio River on barges of light draft.

Starting at St. Louis and proceeding downstream, it will be seen that the average load from St. Louis to Cairo by water is only about 80,000 tons, of mixed character. At Cairo, about 1,240,000 tons of coal come into the river, of which about 1,070,000 tons go downstream, about 200,000 tons being dropped off at Memphis and about 120,000 tons more being dropped off at various points in small quantities between Cairo and New Orleans, leaving about 750,000 tons delivered at New Orleans. At various points along the river below Memphis and Vicksburg small quantities of coal come aboard from local mines or storehouses for use either on local steamboats or distribution to local landings in the neighborhood of the points of shipment. Between Cairo and Memphis about 170,000 tons of logs and lumber are picked up by the boats for delivery, mainly at Memphis. Below Memphis, about 900,000 tons of sand and gravel and about 220,000 tons of logs and lumber are taken on board for delivery, mainly at points between Memphis and Vicksburg. Below Vicksburg, about 190,000 tons of logs and lumber, 150,000 tons of sand and gravel, 100,000 tons of oil, and 60,000 tons of cotton and cotton seed are taken up at various points for delivery, mainly at New Orleans. Outside of the above the freight is insignificant. The average through freight from Cairo to New Orleans is less than 900,000 tons of coal, and less than 400,000 tons of all other freights.

The return freights between New Orleans and St. Louis by water comprise about 100,000 tons of oil taken on at New Orleans and delivered between there and Vicksburg, about 50,000 tons of cotton and cotton seed taken on above New Orleans and delivered between there and Vicksburg. Above Vicksburg, about 160,000 tons of logs, 140,000 tons of lumber, and about 40,000 tons of cotton and cotton seed are taken on board for delivery, mainly at points between Memphis and Cairo, inclusive. Above Memphis, about 200,000 tons of logs and about 160,000 tons of lumber come aboard for delivery, mainly at Cairo, although about 40,000 tons of logs and 30,000 tons of lumber go through to St. Louis. At Cairo, out of the coal received from the Ohio River, about

170,000 tons go upstream to St. Louis. The average upstream travel from New Orleans to St. Louis is only about 300,000 tons, mainly lumber, logs, and coal.

The passenger travel, both downstream and upstream, is small, except locally between Memphis and Vicksburg, where it amounts to about 60,000 either way.

The coal, logs, lumber, sand, and gravel are all most advantageously carried on light-draft barges, such as those at present used on the Ohio River. Once that this material has been loaded on the barge moving downstream the cost of transportation will be much less per mile by barge than it will by heavy-draft packet boat, if the cost of the upstream travel of the boat to receive the goods be taken into account.

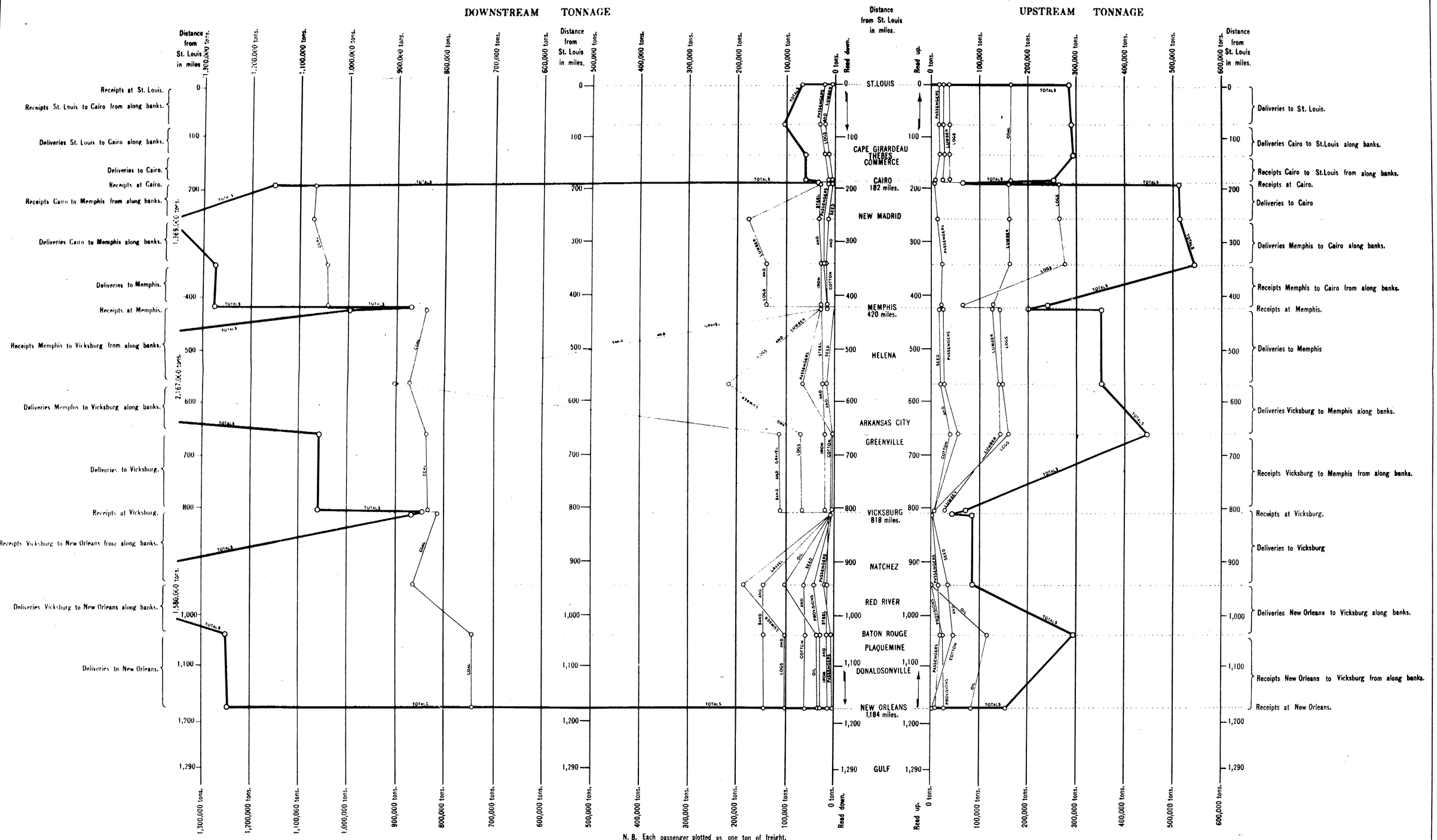
There are no longer any through passenger or packet boats from St. Louis to New Orleans. All through freights (except on barges) must usually be transferred from packet to packet at Memphis and Vicksburg. In the same way passenger or packet boats from New Orleans rarely go up the Mississippi above Vicksburg, where freight must be transferred. Occasionally a few passenger boats make the through trip upstream or down for the benefit of excursionists, as at Mardi Gras, but only a few times per year.

EXHIBIT NO. 20.—*Freight shipments, Mississippi River system, for 1889 and 1906.*

[Arranged by rivers, as reported in 1908 by Department of Commerce and Labor.]

	1906.					1889.	Change since 1889.	
	Self-propellers.		Barges and tows.		Total.	Total.	Gain.	Loss.
	Tons.	*Per ct.*	*Tons.*	*Per ct.*	*Tons.*	*Tons.*	*Per ct.*	*Per ct.*
Upper Mississippi	153,932	25.8	441,953	74.2	595,885	3,947,364	.....	85
Illinois River	32,764	31.0	73,062	69.0	105,826	180,264	.....	41
Missouri River	84,790	8.2	952,269	91.8	1,037,059	2,132,820	.....	42
Other tributaries above St. Louis	1,876	9.7	17,455	90.3	19,331			
Total upper river system	273,362	15.5	1,484,739	84.5	1,758,101	6,260,448	.....	72
Ohio River system	1,246,437	8.2	13,980,368	91.8	15,226,805	15,796,968	.....	3
Lower Mississippi system	835,587	32.8	1,710,600	67.2	2,546,187	6,232,087	.....	59
Total Mississippi system	2,355,386	12.1	17,175,707	87.9	19,531,093	28,289,503	.....	31
Total upper and lower systems	1,108,949	25.6	3,195,339	74.4	4,304,288	12,492,535	.....	65
Details of system, Lower Mississippi River:								
Arkansas	23,175	92.7	1,819	7.3	24,994	1,662,717	.....	85
Ouachita and Black, La	18,125	72.1	7,011	27.9	25,136	93,707	.....	73
Red	14,147	98.1	270	1.9	14,417	105,145	.....	86
White	25,433	57.9	18,500	42.1	43,933	86,393	.....	49
Yazoo	52,751	48.7	55,606	51.3	108,357	77,380	39	.....
Black, Ark	23	.1	20,036	99.9	20,059			
Lower Mississippi proper	693,516	32.0	1,475,065	68.0	2,168,581	4,206,745	.....	45
Other tributaries below Cairo	8,417	6.0	132,293	94.0	140,710			

TONNAGE CARRIED ON MISSISSIPPI RIVER DURING CALENDAR YEAR 1907 FROM ST. LOUIS, MO., TO NEW ORLEANS, LA., AND RETURN.



N. B. Each passenger plotted as one ton of freight.

JULIUS BIEN & CO., LITH., N.Y.

House Doc. No. 50 ; 61st Cong., 1st Sess.

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EXHIBIT No. 21.—*River commerce, lower Mississippi River, St. Louis to New Orleans, 1906, as compared to rest of United States, and to 1889 as reported in 1908 by the Department of Commerce and Labor (Census Bureau).*

Waterway systems.	Freight shipments.				Passengers harbor work.
	Self-propellers.	Barges and tows.	Total.		
			River alone.	River and harbor.	
Lower Mississippi system:					
1906.....tons..	835,587	1,710,600	2,546,187	4,900,241	6,926,616
1889.....do....	(?)	(?)	6,232,087	(?)	(?)
Gain since 1889.....per cent..	(?)	(?)	.....	(?)	(?)
Loss since 1889.....do....	(?)	(?)	59	(?)	(?)
Whole Mississippi system:					
1906.....tons..	2,355,386	17,175,707	19,531,093	27,856,641	14,122,241
1839.....do....	(?)	(?)	28,289,503	29,401,409	10,858,894
Gain since 1889.....per cent..	(?)	(?)	.....	.....	30
Loss since 1889.....do....	(?)	(?)	31	5	....
Entire United States:					
1906.....tons..	(?)	(?)	177,519,758	265,545,804	366,825,663
1889.....do....	(?)	(?)	(?)	129,851,658	198,992,438
Gain since 1889.....per cent..	(?)	(?)	(?)	103	84
Loss since 1889.....do....	(?)	(?)	(?)	.....	.....

EXHIBIT No. 22.—*Freights at important harbors, Mississippi River, 1906, below St. Louis, as reported in 1908 by Department of Commerce and Labor (Census Bureau).*

[Total of shipments and receipts and harbor work.]

Freights through and crossing.	Total.	River freights.	Harbor work.
	Tons.	*Tons.*	*Tons.*
St. Louis, Mo	[a] 1,712,983	743,981	969,002
Cairo, Ill	[a] 261,839	247,239	14,600
Memphis, Tenn	[a] 857,308	662,308	195,000
Helena, Ark	60,463	60,463	.....
Greenville, Miss	178,519	89,519	89,000
Yazoo City, Miss	27,130	27,130	.....
Vicksburg, Miss	375,454	375,454	.....
Natchez, Miss	56,966	56,966	.....
Little Rock, Ark	26,906	5,476	21,430
Pine Bluff, Ark	11,393	11,393	.....
Monroe, La	21,141	21,141	.....
Shreveport, La	4,026	4,026	.....
Alexandria, La	6,147	6,147	.....
Baton Rouge, La	57,908	15,508	42,400
New Orleans, La	[a] 1,144,113	1,036,613	107,500
All other ports	3,838,591	2,923,469	915,122
Total	8,640,387	6,286,833	2,354,054

[a] Does not include freight ferried in railway cars.

The tables of freight shipments for the entire Mississippi River system showing a comparison from 1889 to 1908 (Exhibit No. 20), while bringing out very plainly the great and almost uniform loss in boat commerce since 1889 (the only gain being that of the Yazoo River), shows that the least loss has been in the Ohio River system, where the low-water depths are the least, and where only from one-fourth to one-half of the year is available for boats of 8 to 9 feet draft. At the same time it shows that while on the tributaries a large proportion of the freights are carried by packet boats, the lower Mississippi carries over two-thirds and the Ohio River carries as much as 92 per cent of its freights in barges and tows.

The table of Mississippi River commerce (Exhibit No. 21) as compared with that of the rest of the United States shows how rapidly the Mississippi River system has been falling behind the United States as a whole, the Mississippi having lost while the whole United States has doubled.

The table of freights of important harbors on the lower river (Exhibit No. 22) brings out plainly the large amount of local work in the river as compared with through freights. In order to reconcile this table with the previous table, it must be borne in mind that all freights are counted twice, once for shipment and again for delivery.

As bridges are built across the Mississippi the importance of ferry traffic diminishes. The river below St. Louis is at present crossed only by two bridges, one at Thebes and the other at Memphis.

Freight and passenger cars are ferried across the Mississippi River below St. Louis at eleven points, viz, from Ivory, Mo., to East Ivory, Ill.; Moro, Ill., to Little Rock Landing, Mo.; Cairo, Ill., to Bird Point, Mo.; Columbus, Ky., to Belmont, Mo.; Memphis, Tenn., to Hopefield, Ark.; Helena, Ark., to Trotters Point, Miss.; Vicksburg, Miss., to Delta Point, La.; Natchez, Miss., to Vidalia, La.; Water Valley, mouth of Red River, La., to Angola, Miss.; New Orleans to Gouldsboro, La.; New Orleans to Algiers, La.

The grain traffic of the Mississippi River has for several years decreased very heavily, having lost about 78 per cent since 1889; the decrease on the upper Mississippi being about 60 per cent and that on the lower Mississippi about 96 per cent. The latter decrease is due to the fact that the cost of the boat transportation from St. Louis to New Orleans, added to the extra cost of ocean transportation from New Orleans to Europe, is to-day (1907–8) greater than the rail charges from St. Louis to New York, plus ocean carriage New York to Europe.

Coal, sand, stone, etc., constituted in 1906 about 87 per cent of all barge freight, being about 86 per cent on the upper Mississippi, 92 per cent on the Ohio, and 47 per cent on the lower Mississippi. Next to coal, the chief commodity is sand in short hauls, often entirely within a single harbor.

Ranked by the quantity of river freight handled, New Orleans is third, St. Louis is fourth, Memphis is fifth, Kansas City is seventh, Vicksburg is eighth, and Cairo is ninth in the Mississippi Valley; Pittsburg, Cincinnati, and Louisville on the Ohio River holding the first, second, and fifth places.

While New Orleans is the second most important commercial port of the United States for foreign commerce, its geographical location, combined with small density of population in the adjoining States, and its good railroad connections, renders its good inland water connections of comparatively little usefulness at the present time, except as a safeguard against any serious increase of railroad freight rates or decrease of good railroad service. New Orleans with a population of about 290,000, about 106 miles inland from the Gulf, and having wide channel approaches of over 26 feet depth at low water and with a total export and import trade of about 3,500,000 tons in 1908, sends much less than 5 per cent of this up the valley by water and receives much less than 40 per cent from the valley by water; the downstream receipts having been only about 1,410,000 tons (about two-thirds being coal) and the upstream shipments having been only about 160,000 tons (mainly oil and cotton seed) although the first 132 miles of river up to Baton Rouge has a channel of several hundred feet width and over 30 feet depth—large enough for all ocean vessels reaching New Orleans. In contrast to this Hamburg, Germany, a city of about 850,000 population, on the Elbe, about 160 miles above its mouth, and having channel approaches limited to 650 feet width and 26 feet depth at low water, with an import trade of about 11,000,000 tons, sends over 8,000,000 (73 per cent) into the interior over about 7,500 miles of rivers and canals of less than 8 feet draft; and Antwerp, Belgium, a city of about 400,000 population, on the Scheldt, about 55 miles above its mouth, and having channel approaches with less width but about the same depth as New Orleans, with an import tonnage of about 9,400,000 tons, sends over 7,500,000 tons (80 per cent) into the interior through 1,200 miles of Belgian rivers and canals of less than 10 feet depth; receiving from the canals in return twice as much freight as from the railroads.

Exhibits Nos. 23 to 33, furnished by the business interests of St. Louis, give in detail the freight receipts and shipments of St. Louis both by water and by rail, and the extent of its foreign trade, which it hopes to develop by the aid of the improved Mississippi River and the future Panama Canal.

EXHIBIT No. 23.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

RAIL AND RIVER TONNAGE.

STATEMENT SHOWING THE AMOUNT OF FREIGHT, IN TONS, RECEIVED AT ST. LOUIS BY EACH RAILROAD AND RIVER, FOR THREE YEARS.

Route.	1908.	1907.	1906.
Chicago and Alton R. R. (Missouri division)	232,054	204,990	265,541
Missouri Pacific R. R	1,927,711	2,187,525	2,139,740
St. Louis and San Francisco R. R	1,202,009	1,386,042	1,278,413
Wabash Railway (west)	839,184	575,465	855,600
Chicago, Rock Island and Pacific R. R	267,627	312,381	256,762
Missouri, Kansas and Texas R. R	405,398	462,237	450,785
St. Louis-Southwestern Ry	562,628	565,063	518,569
St. Louis, Iron Mountain and Southern R. R	2,704,703	3,625,010	3,083,056
Illinois Central R. R	1,938,113	2,396,095	2,089,457
Louisville and Nashville R. R	737,628	892,199	1,154,983
Mobile and Ohio R. R	1,728,572	2,444,738	2,363,346
Southern R. R	894,951	1,734,889	1,186,112
Baltimore and Ohio Southwestern R. R	1,264,625	1,502,165	1,436,622
Chicago, Alton and St. Louis (main line)	414,112	430,124	421,082
Cleveland, Cincinnati, Chicago and St. Louis R. R	562,523	627,075	568,124
Vandalia R. R	1,182,791	1,557,427	1,168,039
Wabash Railroad (east)	1,113,133	1,343,041	1,107,605
Toledo, St. Louis and Western R. R	445,739	688,078	772,828
Chicago, Peoria and St. Louis R. R	378,244	443,578	543,729
Chicago, Burlington and Quincy R. R. (east)	504,738	585,759	633,049
Chicago, Burlington and Quincy R. R. (west)	1,279,223	1,557,915	1,577,673
Chicago and Eastern Illinois R. R	271,265	343,057	267,893
St. Louis, Troy and Eastern R. R	938,406	956,955	879,400
Litchfield and Madison R. R	498,046	704,634	604,145
Belleville and Southern R. R	.....	4,595	21,712
St. Louis and Belleville Electric Ry	224,081	284,643	378,685
St. Louis and O'Fallon Ry	815,713	935,086	957,086
East St. Louis and Suburban Ry. Co	243,831	404,252	305,222
Illinois Traction System	874	1,076	6,359
Upper Mississippi River	19,245	21,440	31,140
Lower Mississippi River	70,165	91,325	106,670
Illinois River	9,475	9,115	14,550
Missouri River	4,365	3,655	2,485
Ohio River	185,100	155,470	160,120
Cumberland and Tennessee rivers	4,830	8,570	10,935
Upper Mississippi River by rafts	.....	.....	1,770
Total in tons	23,871,102	29,445,669	27,620,287
Total by rail	23,577,922	29,156,094	27,292,617
Total by river	293,180	289,575	327,670

EXHIBIT No. 24.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

RAIL AND RIVER TONNAGE.

STATEMENT SHOWING THE AMOUNT OF FREIGHT, IN TONS, SHIPPED FROM ST. LOUIS BY EACH RAILROAD AND RIVER FOR THREE YEARS.

Route.	1908.	1907.	1906.
Chicago and Alton R. R. (Missouri division)	312,705	254,892	320,480
Missouri Pacific R. R	1,194,284	1,438,119	1,458,990
St. Louis and San Francisco R. R	1,113,638	1,338,270	1,362,503
Wabash Railway (West)	598,355	354,836	616,893
Chicago, Rock Island and Pacific R. R	216,918	266,479	200,228
Missouri, Kansas and Texas R. R	386,725	586,956	402,293
St. Louis Southwestern Ry	188,204	263,716	173,541
St. Louis, Iron Mountain and Southern R. R	1,910,369	2,351,617	2,322,626
Illinois Central R. R	1,263,855	1,517,972	1,286,318
Louisville and Nashville R. R	530,757	576,168	552,876
Mobile and Ohio R. R	1,266,487	1,549,621	1,395,564
Southern R. R	965,128	1,420,585	1,262,695
Baltimore and Ohio Southwestern R. R	421,263	402,766	381,944
Chicago, Alton and St. Louis R. R. (main line)	498,459	553,247	487,323
Cleveland, Cincinnati, Chicago and St. Louis R. R	495,708	553,408	596,777
Vandalia R. R	818,687	845,362	672,565
Wabash Railway (East)	911,077	1,055,110	1,200,413
Toledo, St. Louis and Western R. R	440,426	545,076	623,522
Chicago, Peoria and St. Louis R. R	384,841	389,752	519,755
Chicago, Burlington and Quincy R. R. (East)	705,416	797,772	629,259
Chicago, Burlington and Quincy R. R. (West)	783,662	1,016,358	1,024,721
Chicago and Eastern Illinois R. R	160,266	191,383	195,456
Litchfield and Madison R. R	122,277	19,933	73,808
Illinois Traction System	10,651	7,018	11,456
Upper Mississippi River	27,280	25,155	36,000
Lower Mississippi River	30,285	35,550	34,905
Illinois River	5,900	7,590	7,835
Missouri River	5,320	3,095	3,565
Ohio, Cumberland, and Tennessee rivers	3,955	7,110	6,880
Total in tons	15,772,898	18,374,916	17,861,191
Total by rail	15,700,158	18,296,416	17,772,006
Total by river	72,740	78,500	89,185

EXHIBIT No. 25.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

SHIPMENTS BY RIVER DURING 1908.

Articles.	By Illinois River boats.	By Missouri River boats.	By Memphis and Way Point boats.	By Tennessee River boats.	By upper Mississippi River boats.
Apples.....barrels..	135	5	3,430	75	720
Ale and beer.....packages..	4,030	100	29,200	565	12,345
Bagging.....pieces..	245	.....	2,300	2,225	700
Barbed wire.....pounds..	63,500	88,400	232,400	20,700	113,400
Butter.....do....	.....	.....	20,360	.....	2,490
Bran.....sacks..	140	.....	390	380	355
Cattle.....head..	153	.....	120	6	1,468
Corn.....sacks..	.....	.....	1,295	1,090	.....
Corn meal.....barrels..	70	.....	1,985	2,150	40
Cotton.....bales..	15	.....	.....	.....	100
Eggs.....packages..	.....	.....	.....	.....	.....
Flour.....barrels..	515	125	4,305	3,485	2,165
Hay.....tons..	25	5	350	40	35
Horses and mules.....head..	388	12	1,453	117	1,066
Hogs.....do....	25	.....	4	.....	2,322
Hominy and grits.....barrels..	.....	35	1,040	500	10
Pork.....do....	.....	.....	.....	.....	.....
Hams.....pounds..	900	1,000	153,200	50,700	7,800
Meats.....do....	5,500	5,100	441,100	126,100	22,200
Lard.....do....	12,400	8,900	294,800	71,900	19,500
Malt.....sacks..	.....	500	5,260	.....	1,220
Oats.....do....	4,240	405	11,910	825	255
Oats in bulk.....bushels..	.....	.....	.....	.....	.....
Onions.....packages..	100	10	2,970	70	1,280
Potatoes.....do....	910	100	6,215	60	4,210
Rye.....sacks..	.....	.....	.....	.....	.....
Sheep.....head..	50	.....	.....	.....	866
Tallow.....pounds..	.....	.....	800	.....	.....
Tobacco.....hogsheads..	.....	.....	.....	.....	.....
Tobacco, manufactured.....pounds..	4,400	3,900	76,000	5,300	19,800
Wheat.....sacks..	.....	.....	.....	.....	.....
Whisky.....barrels..	240	.....	1,640	.....	500
White lead.....pounds..	119,100	9,400	724,600	50,600	1,314,500
Merchandise and sundries.....packages..	74,010	65,470	552,600	76,040	282,645
Total tons.....	5,900	5,320	30,285	3,955	27,280

EXHIBIT No. 26.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

BUSINESS OF THE ST. LOUIS BRIDGES AND FERRIES FOR 1908, AND COMPARISON WITH PREVIOUS YEARS.

AMOUNT OF FREIGHT, IN TONS, TRANSFERRED ACROSS THE RIVER AT ST. LOUIS DURING 1908, FROM ST. LOUIS TO EAST ST. LOUIS, VENICE, MADISON, AND CARONDELET.

By—	Cars.	Tons.	Total tons.
The Eads Bridge.....	121,320	1,777,867	.....
The Eads Bridge, by wagon (estimated).....	.....	600,000	2,377,867
The Merchants' Bridge.....	89,972	.....	1,299,992
The Wiggins Ferry.....	46,409	877,552	.....
The Wiggins Ferry, by wagon.....	.....	246,013	1,123,565
The Ivory Ferry.....	16,458	.....	484,598
The Interstate Car Transfer.....	16,829	.....	452,220
The Madison County Ferry.....	.....	.....	61,000
St. Clair Ferry and Transfer Co.....	.....	.....	9,090
Total tons West to East during 1908.....	.....	.....	5,808,332
1907.....	.....	.....	7,241,198
1906.....	.....	.....	7,324,424
1905.....	.....	.....	6,508,884
1904.....	.....	.....	5,526,745
1903.....	.....	.....	5,368,462
1902.....	.....	.....	5,630,756
1901.....	.....	.....	5,377,208
1900.....	.....	.....	5,425,044
1899.....	.....	.....	4,814,136
1898.....	.....	.....	4,159,809

EXHIBIT No. 26.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*—Continued.

BUSINESS OF THE ST. LOUIS BRIDGES AND FERRIES FOR 1908, AND COMPARISON WITH PREVIOUS YEARS—Continued.

FROM EAST ST. LOUIS, CARONDELET, MADISON, AND VENICE TO ST. LOUIS.

By—	Cars.	Tons.	Total tons.
The Eads Bridge	148,870	3,679,985	.....
The Eads Bridge, by wagon (estimated)	.....	800,000	4,479,985
The Merchants' Bridge	108,571	.....	.....
The Wiggins Ferry	67,402	1,710,315	2,666,324
The Wiggins Ferry, by wagon	.....	230,351	1,940,666
The Ivory Ferry	33,528	.....	1,272,774
The Interstate Car Transfer	6,314	.....	188,175
The Madison County Ferry	.....	.....	50,044
St. Clair Ferry and Transfer Co	.....	.....	18,633
Total tons East to West during 1908	.....	.....	10,616,601
1907	.....	.....	13,063,128
1906	.....	.....	10,929,224
1905	.....	.....	9,653,892
1904	.....	.....	9,541,764
1903	.....	.....	9,538,096
1902	.....	.....	8,943,159
1901	.....	.....	7,933,560
1900	.....	.....	6,415,096
1899	.....	.....	6,659,621
1898	.....	.....	5,984,533
Total both ways, 1908	.....	.....	17,424,933
1907	.....	.....	20,304,326
1906	.....	.....	18,253,648
1905	.....	.....	16,162,776
1904	.....	.....	15,068,509
1903	.....	.....	14,906,558
1902	.....	.....	14,573,924
1901	.....	.....	13,310,768
1900	.....	.....	11,840,140
1899	.....	.....	11,473,757
1898	.....	.....	10,144,342

EXHIBIT No. 27.—*Extract from the Report of the St. Louis Merchants' Exchange for 1908.*

LOCAL AND THROUGH TONNAGE.

	1907.		1908.	
	Tons.	*Per cent.*	*Tons.*	*Per cent.*
Total tons freight received, local	18,807,221	63.87	16,691,153	69.92
Total tons freight received, through	10,638,448	36.13	7,179,949	30.08
Tons freight received by rail, local	18,517,646	63.51	16,397,973	69.55
Tons freight received by rail, through	10,638,448	36.49	7,179,949	30.45
Tons freight, excluding coal, received by rail, local	11,488,252	55.85	10,292,879	62.77
Tons freight, excluding coal, received by rail, through	9,080,265	44.15	6,105,052	37.23
Tons freight received by rail on east side, local	12,692,842	62.84	11,168,717	69.82
Tons freight received by rail on east side, through	7,505,632	37.16	4,826,841	30.18
Tons freight, excluding coal, received by rail on east side, local	5,663,448	48.78	5,063,623	57.44
Tons freight, excluding coal, received by rail on east side, through	5,947,449	51.22	3,751,944	42.56
Tons freight received by rail on west side, local	5,824,804	65.03	5,229,256	68.97
Tons freight received by rail on west side, through	3,132,816	34.97	2,353,108	31.03

EXHIBIT No. 28.

AMOUNT OF COAL RECEIVED IN ST. LOUIS.

Route.	1908.	1907.	1906.	1905.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Baltimore and Ohio Southwestern R. R.	913,282	1,018,855	855,111	606,641
Cleveland, Cincinnati, Chicago and St. Louis R. R.	89,315	68,280	75,885	166,165
Vandalia R. R.	606,770	738,092	554,991	655,154
Illinois Central R. R.	921,220	970,436	982,578	881,874
Wabash R. R.	393,111	371,084	279,009	321,227
Louisville and Nashville R. R.	279,086	387,353	580,238	495,952
Southern R. R.	584,601	1,101,832	773,528	789,994
Mobile and Ohio R. R.	84,662	88,929	101,471	140,606
Toledo, St. Louis and Western R. R.	85,437	84,749	54,414	59,942
St. Louis and O'Fallon R. R.	815,713	935,086	957,086	541,591
St. Louis, Iron Mountain and Southern R. R. (Illinois Division)	425,860	405,180	141,006	209,195
St. Louis, Belleville and Southern R. R.	.....	4,595	21,712	38,641
St. Louis, Troy and Eastern R. R.	923,746	944,623	870,801	922,204
St. Louis and Belleville Electric R. R.	201,362	252,608	359,215	370,006
Chicago and Eastern Illinois R. R.	121,477	118,738	133,720	122,657
Litchfield and Madison R. R.	493,452	699,195	592,602	460,126
East St. Louis and Suburban R. R.	240,897	397,942	303,352	120,220
From Ohio River	185,109	155,470	160,120	125,755
Total tons	7,365,091	8,743,047	7,795,839	7,027,950

RECEIPTS OF ANTHRACITE COAL INCLUDED IN ABOVE RECEIPTS.

	Tons.		Tons.
1894	186,494	1902	60,944
1895	207,784	1903	166,920
1896	218,955	1904	155,097
1897	172,933	1905	158,843
1898	225,606	1906	174,226
1899	292,118	1907	265,571
1900	180,550	1908	236,036
1901	200,797		

LOCAL AND THROUGH RECEIPTS OF ANTHRACITE COAL.

	Tons, local.	Tons, through.
1901	193,673	7,124
1902	58,349	2,595
1903	152,765	13,155
1904	148,095	7,002
1905	154,442	4,401
1906	163,395	10,831
1907	219,817	45,934
1908	207,764	28,272

RECEIPTS OF COKE.

	Tons.		Tons.
1902	163,600	1906	328,400
1903	205,465	1907	371,880
1904	171,162	1908	162,280
1905	222,305		

EXHIBIT No. 29.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

THE RIVERS.

The river traffic of 1908 about held its own, with slightly larger receipts and a small decrease in shipments. The business of the upper river was fairly satisfactory, especially in passengers, while on the lower rivers there was a decline in both passengers and freight.

	1906.	1907.	1908.
Tons received by steamboats and barges	325,900	289,575	293,180
Tons received by rafts	1,770	.....	.....
Tons shipped by steamboats and barges	89,158	78,500	72,740
Total	416,855	368,075	365,920

The upper river traffic closed November 1, except for the Alton and Illinois River packets, which continued their trips till the middle of December. Navigation southward ceased on December 22, on account of low stage of water. On January 6 the first ice formed, and on the 12th the river was frozen over at Alton. Navigation was suspended entirely during January, on account of running ice and low water, and was not resumed until February 5.

There was a good stage of water out to Cairo during the season of navigation, the least depth on bars being 6 to 7 feet from August 1 to the close of the year.

Mr. Isaac P. Lusk, general freight and passenger agent of the Diamond Jo Line, makes the following report of the upper river traffic:

Notwithstanding the commercial depression extending over the country from the effects of the panic of 1907, our freight and passenger business for 1908 was very good, and showed somewhat of an increase in the passenger business over the previous year.

The large side-wheel steamers *St. Paul* and *Quincy*, each accommodating 300 first-class passengers, were in service between St. Louis, Mo., and St. Paul, Minn., from June until the middle of September.

The steamers *Sidney* and *Dubuque* were in service between St. Louis and Burlington and Davenport from April 10 to November 1.

Our service, both to St. Paul and to Keokuk and Burlington, was discontinued early in the season on account of low water, although there was a very fair stage of water in the upper Mississippi River until about the 1st of September.

With the improvement of the upper Mississippi River there would be a large increase in the freight traffic, for frequently this last season, by refusing heavy freight shipments, we could run our steamers through to St. Paul and take care of the passenger traffic, but on account of low water our earnings from freight were materially decreased.

All of the local packets running short distances on the upper Mississippi River report a good business for 1908.

Mr. John E. Massengale, traffic manager of the St. Louis and Tennessee River Packet Company, gives the following statement of the Tennessee River business:

Regarding our Tennessee River business for the year 1908, beg to say that we felt the panic to an extent during the greater part of the year, as the decline on lumber and other products of the forest stopped a great many mills, and thus curtailed its movement, but we found no material change in the movement of products of the farm. Tennessee Valley, as a rule, made a good crop of cotton, tobacco, and peanuts. Our movement of merchandise and provisions from St. Louis and other cities serving that territory was about normal. We were not able to run as many steamboats during the season as we have in the past, but our business was very good, and the year winds up satisfactorily.

Capt. D. M. Conners, superintendent and general agent of the Lee Line steamers, running to Memphis, reports as follows:

I am sorry to say that both the passenger and freight business for 1908 was the lightest that the Lee Line has experienced since in the St. Louis and Memphis trade. Our outbound fell short one-third of 1907, and our inbound fully one-half of 1907.

And our passenger business fell off fully one-half of 1907, which, no doubt, was caused by the money panic, which caused so many of the working class to be laid off, and they therefore could not spare the money to go away. In former years they got their vacation with pay for one or two weeks, but in 1908 the majority of the class of

people we handle most of did not leave the city, as they were laid off without pay, and had no surety of their position or when they would be put back to work.

The class rates, per 100 pounds, from St. Louis to Memphis were as follows:

	Cents.
First class	50
Second class	37½
Third class	33
Fourth class	27
Fifth class	22½
Sixth class	19
Class A	12

Flour, meal, and bacon and grain, and buggies and vehicles, same rate as 1907, and the same rate applied to Helena, Ark., Greenville, Miss., and Vicksburg, Miss., that applied in 1907.

Prosperity has not struck us, but we are trusting that it will do so at the opening of navigation in 1909.

EXHIBIT No. 30.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

ARRIVALS AND DEPARTURES OF STEAMBOATS AND BARGES, 1908.

ARRIVALS.

1908.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Ohio.	Cumberland and Tennessee.	Total steamers.	Barges and scows.	Tons of freight received.
January	.....	13	.....	.....	.....	.....	13	21	9,660
February	.....	4	.....	.....	.....	.....	4	1	400
March	11	29	6	.....	.....	4	50	46	19,710
April	28	43	8	4	.....	4	87	85	62,060
May	40	32	9	7	.....	5	93	61	45,230
June	43	36	10	16	.....	3	108	76	46,590
July	53	46	12	10	.....	6	127	80	53,855
August	61	33	10	10	.....	4	118	49	26,620
September	58	22	12	5	.....	4	101	11	9,805
October	51	21	24	4	.....	.....	100	10	8,450
November	39	19	13	.....	.....	3	74	3	6,990
December	10	11	6	.....	.....	1	28	1	3,810
Total	394	309	110	56	.....	34	903	444	293,180

DEPARTURES.

1908.	Upper Mississippi.	Lower Mississippi.	Illinois.	Missouri.	Tennessee.	Ohio.	Total departures.	Tons shipped.
January	.....	13	.....	.....	.....	.....	13	1,620
February	1	5	.....	.....	.....	.....	6	400
March	12	27	6	.....	2	.....	47	4,840
April	30	30	9	5	5	.....	79	6,270
May	42	30	10	10	3	.....	95	8,915
June	42	31	8	13	6	.....	110	9,270
July	56	42	10	14	5	.....	127	10,945
August	64	30	10	9	2	.....	115	10,725
September	61	26	9	4	4	.....	104	6,485
October	56	24	19	5	.....	.....	104	6,725
November	37	19	13	.....	5	.....	74	3,605
December	6	10	6	.....	7	.....	29	2,940
Total	407	287	110	60	39	.....	903	72,740

EXHIBIT No. 30.—*Extract from the report of the St. Louis Merchants' Exchange for 1908*—Continued.

ARRIVALS AND DEPARTURES FOR TWENTY YEARS.

Arrivals.					Departures.		
Year.	Boats.	Barges.	Tons of freight received.	Tons of lumber and logs by raft received.	Year.	Boats.	Tons of freight shipped.
1908	903	444	293,180	.....	1908	903	72,740
1907	942	388	289,575	.....	1907	931	78,500
1906	1,029	417	325,900	1,770	1906	1,013	89,185
1905	1,074	385	288,640	1,210	1905	1,057	80,575
1904	1,222	413	291,425	3,945	1904	1,182	82,567
1903	1,271	519	335,710	4,700	1903	1,205	212,202
1902	1,465	451	386,045	30,875	1902	1,448	224,261
1901	1,541	592	412,255	50,550	1901	1,519	209,270
1900	1,622	595	438,670	73,340	1900	1,605	245,585
1899	1,570	680	394,650	71,960	1899	1,532	203,203
1898	1,580	792	449,525	57,060	1898	1,514	399,585
1897	1,692	927	507,105	69,565	1897	1,576	469,360
1896	2,065	1,425	587,755	84,010	1896	1,945	572,415
1895	2,007	1,126	410,145	98,685	1895	1,904	303,350
1894	2,061	1,245	455,175	128,355	1894	1,993	363,080
1893	2,037	1,003	472,895	126,510	1893	2,009	436,905
1892	2,053	1,090	556,980	130,220	1892	2,013	502,210
1891	1,881	1,019	450,050	142,090	1891	1,845	512,935
1890	1,927	1,274	530,790	132,940	1890	1,910	617,980
1889	2,195	1,474	543,990	127,695	1889	2,211	712,705

EXHIBIT No. 31.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

FOREIGN TRADE OF ST. LOUIS.

[By James Arbuckle, manager Latin-American and Foreign Trade Association.]

The year of 1908 will stand as an off year in the movement of the foreign commerce, not only of this country but of nearly all the countries of the world.

The panic which came in October, 1907, seemed to induce very heavy exports for several months thereafter, and the record of January, 1908, for exports, went up as high as two hundred and six millions; this was more than it ever had been for one month, and served in a measure to deplete the surplus stock of manufactured goods and agricultural products. Whilst the imports only amounted, for the same month, to eighty-five millions.

With exports two and one-half times greater than imports, the money situation became greatly relieved. The imports fell, in December, 1907, to ninety-two millions, and as low as eighty-four millions in May, 1908. This was, however, in one sense harmful, and showed that the industrial interests were suffering in manufacturers' materials not being imported.

For the calendar year, the exports shows a falling off of three hundred millions, and the imports a falling off of about a hundred and fifty millions.

The excess of exports over imports, will approximate six hundred and fifty millions, which is nearly equal to the highest surplus in any one year in the past fifteen years.

The comparison with other countries shows to the advantage of the United States, and we can look forward to prosperous times for some time to come.

The trade of the Mississippi Valley has been affected by the general conditions prevailing, and whilst the statistics of exports and imports are not yet fully compiled, there will be a considerable falling off in the movement.

MEXICO.

The financial situation was severely felt in Mexico, and the trade with St. Louis was considerably reduced in all lines.

No statistics are yet available to show this, but the general consensus of opinion in all quarters is that there is a decided reduction in the exports from this city to Mexico.

The Mexican coffee crop for 1908 is estimated at 750,000 bags of approximate value of $15,000,000, which is divided between Germany, England, France, and the United States.

CENTRAL AMERICA.

We have to note a larger movement with Central American points, indicated by the number of mercantile reports asked for on firms in this region. It is well that we should sell more goods there, to equalize the quantity of bananas that is imported from there via New Orleans. This is a fruitful field, and the merchants of New Orleans are especially reaping some advantages from this trade.

CUBA.

Cuban trade has likewise been affected by the poor conditions, except the flour and grain interests.

The flour shipments show an increase of $201,706.80 over the year of 1907.

The following are the records from the Cuban consulate of this city, of cereal shipments:

Articles.	1907.	1908.
Flour	$1,051,005.17	$1,252,711.97
Corn	107,148.45	264,184.24
Bran	50,806.66	.....
Oats	26,489.71	2,512.50
Hay	1,476.24	52,146.14

Value of the articles exported from St. Louis, Mo., to Cuba during 1907 and 1908 according to the records of the vice-consulate, as reported by Alberto Santiso, vice-consul:

Articles.	1907.	1908.
Flour	$1,051,005.17	$1,252,711.97
Corn	107,148.45	264,184.24
Machinery	20,846.61	84,540.36
Beer	94,611.10	78,437.96
Hay	1,476.24	52,146.14
Drugs	34,492.35	46,037.96
Shoes	58,121.64	27,653.06
Bricks and pipes	19,608.50	18,353.40
Hardware	70,897.55	16,325.92
Broom material	15,871.22	12,646.05
Barrel material	.....	7,000.07
Jewelry	10,311.19	5,002.32
Photo supplies	5,504.73	4,812.98
Furniture	3,440.98	3,949.37
Barber chairs	.....	3,852.06
Oats	26,489.71	2,512.50
Canvas shoes	.....	1,682.62
Groceries	5,799.71	1,363.77
Electric motors	1,255.09	1,354.96
Various articles	1,886.52	1,320.00
Roofing supplies	486.63	1,241.86
Steel wires	.....	1,238.47
Electrical appliances	4,040.99	1,222.05
Water pumps	.....	807.40
Water-closets and supplies	7,533.84	800.62
Books and stationery	11,811.18	688.41
Leather goods	313.60	668.91
Electric incandescent and supplies	.....	609.99
Crystal plates	.....	536.41
Lightning-rod ornaments	.....	484.94
Electric fans	1,714.56	446.30
Hay presses	.....	334.35
Coffins	1,726.81	221.21
Picture frames	95.03	198.83
Advertising matter	117.28	140.00
Labels	.....	98.37
Broom presses	.....	39.00
Optical supplies	100.70	4.51
Bran	50,806.86	.....
Chains	656.04	.....
Boilers	19,346.58	.....
Coaches, carriages	2,336.75	.....
Dishwashers	290.00	.....
Tapestry	231.87	.....
Perfumery	271.53	.....
Condensed milk	463.89	.....
Total	1,691,410.90	1,895,669.34

EXHIBIT No. 32.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

FOREIGN SHIPMENTS OF FLOUR AND GRAIN.

ON THROUGH BILLS OF LADING FROM ST. LOUIS BY RAILROADS FOR THE YEAR 1908.

Destination.	Flour.	Wheat.	Corn.	Oats.
	Barrels.	*Bushels.*	*Bushels.*	*Bushels.*
England	225,179	8,127	3,300	.....
Germany	35,166	1,774	1,088	.....
Scotland	93,615	.....	.....	.....
Ireland	9,089	.....	.....	.....
Denmark	17,506	.....	.....	.....
Norway	3,235	.....	.....	.....
Holland	85,661	.....	1,250	.....
Belgium	1,485	.....	.....	.....
Spain	1,251	.....	.....	.....
Sweden	5,118	.....	.....	.....
Venezuela	3,167	.....	.....	.....
Newfoundland	6,294	.....	.....	.....
Finland	9,333	.....	.....	.....
Canada	1,138	.....	9,442	.....
Cuba	172,577	.....	368,200	13,750
Porto Rico	40,154	.....	.....	.....
Central America	2,106	.....	.....	.....
South America	1,456	.....	.....	.....
Mexico	676	.....	.....	.....
Africa	1,260	.....	.....	.....
Italy	220	.....	.....	.....
Portugal	250	.....	.....	.....
Trinidad	990	.....	.....	.....
Seaboard for export	43,662	657,630	92,383	39,581
Total for export	760,588	667,531	474,413	53,331

Rye to seaboard for export ..... 4,435 bushels.
Bran exported to Germany ..... 20 tons.
Bran exported to England ..... 60 tons.

EXHIBIT No. 33.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

EXPORTS OF ST. LOUIS MANUFACTURES DURING 1907.

[From the annual report of J. C. A. Hiller, Commissioner of State Bureau of Labor Statistics.]

To Europe: Agricultural implements, drugs and medicines, foundry work, furniture, printing, tobacco, metal goods, shoes, type, electric supplies, flour, leather belting, packing-house products, rubber goods, and soap and candles.

To Germany: Shoes, novelties, and packing-house products.

To Norway, Sweden, and Denmark: Flour and feed, leather belting, packing-house products, foundry work.

To South and Central America: Street cars and supplies, drilling tools, drugs and medicines, flour and feed, foundry work, liquors, surgical instruments, shirts.

To Hawaii and Porto Rico and Philippine Islands: Chemicals, foundry work, novelties, saddlery, shirts, shoes, trunks, and wire goods.

To Canada: Awnings and tents, pretzels, show cases, brick tiling, brooms and brushes, coopers' tools, shovels, drugs and medicines, electrical apparatus, engraving, foundry work, furniture, glassware, grocers' sundries, leather belting, musical instruments, novelties, oils and paints, photographic supplies, rubber goods, soap and candles, stores, surgical instruments, trunks, tobacco, wire goods, and wood work.

To Mexico: Brandies, bags and bagging, show cases, boots and shoes, brick tiling, brooms and brushes, canned preserves, vehicles, railway cars, coffins, cooperage, brass castings, metal goods, type, shovels, milling machinery, drugs and medicines, chemicals, electrical supplies, engravings, foundry work, adding machines, furniture, furs, glassware, grocers' sundries, hair goods and saddlery, structural iron, leather belting, malt, musical instruments, paints, oils and grease, photographic supplies, pottery, soap and candles, stoves, surgical instruments, tin goods, trunks, shirts, and tobacco.

To Cuba: Show cases, paper boxes, brick tiling, canned preserves, grocers' sundries, coffins, drugs and medicines, chemicals, flour and feed, foundry work, furniture, liquors, novelties, photographic supplies.

Ports and terminals for water traffic.—The Montreal Harbor Commission report makes a useful distinction between the words "port," "harbor," and "dock;" using the term "harbor" to mean a place of shelter for shipping, the term "dock" to mean an interior basin, and the term "port" to mean not only the collection of piers, slips, wharves, docks, harbors, roadsteads, entrance channels, but also the terminal accommodations and equipments by which freights are exchanged between boats and land conveyances.

Using a somewhat similar set of definitions the Chicago Harbor Commission unites with the Montreal Harbor Commission in bringing out forcibly the fact that water frontage alone does not make a port, and harbors and docks alone do not make a great port; but that the supremacy of a port depends mainly upon its ability to exchange land and water commerce easily, readily, and economically.

The Mississippi River from St. Louis to the Gulf has at present only one real port, New Orleans; and that one is so far but partially developed and most of its developments are limited to the interchange of ocean freights with steam railroads and common roads, without much attention to interchange with inland boats.

So far as channel approaches and water frontage are concerned Baton Rouge is as well provided as Manchester, England, or Antwerp, or Hamburg; but the latter cities have each recently spent amounts varying from $25,000,000 to $100,000,000 to provide themselves with the terminal facilities, useful wharves, docks, piers, slips, unloading and loading machinery, warehouses, railway sidings, railway storage, etc., necessary to transform them from harbors to ports.

St. Louis, Mo., has little wharfage either public or private except the graded river bank; East St. Louis has almost no public landings and few private ones; Cairo, Ill., has several piers and slips and some few floating boat landings and warehouses, but all under private monopoly. Memphis and Vicksburg have limited public landings consisting merely of graded banks and occasional floating warehouses. The other cities are less well provided. Such transfer facilities as exist at the Lake Superior and Lake Erie grain, ore, and coal harbors are unknown on the Mississippi. The injury to freights and cost of transfer by reason of necessary rehandling at the water's edge and subsequent cartage up the bank and across the city to the consignee are usually sufficient to outbalance a decided higher freight rate by rail.

The only people in the Mississippi Valley who have paid much attention to terminal facilities for freights are the railroads; and consequently they command the transportation business. Individual boats and small corporations can not afford to pay for such terminal facilities and the cities and towns have either not yet seriously considered the question of establishment of such facilities or are not prepared to pay for them.

Even on the Great Lakes, the railroads so dominate this situation that (Chicago Harbor Commission report) for the past many years only one out of many steamboats lines has been able to stand alone without being under the control of railroad terminals; and it is the water rates which are now being gradually raised to equal the rail rates, instead of the rail rates being lowered to or controlled by the water rates.

The harbor commissioners of Montreal in their report of 1908, of comparative study of modern port development in Europe, have the following suggestions to make as regards the best development of commerce and harbors:

"The success of passenger and mail service depends upon the existence of costly ships, fast trains, first-class hotel accommodations at the terminals, direct route from business center to center, and harbors of sure and easy approach.

"Freight service and the handling of freight cargoes requires freight-handling devices that will handle freight in the least possible time, large storage areas for the collection of freight as near as possible to the ship's side, and direct railway or inland waterway connection to the centers of production and consumption.

"The ideal harbor for both passengers, mails, and freights will be one that attracts a paying business by its comfort, regularity, safety, as regards passenger service, and by its regularity of cargoes, efficient port management and equipment, and good locality as regards freights. These requirements mean the necessity of good channel approaches and of large-tonnage vessels, with rapid transfer appliances for mail."

According to foreign experience and present practice, every city should be required, or at least urged and encouraged, to provide extensive free landings and good connections from the same to the center of the business part of the city easy for passengers and freight. The General Government can well afford to contribute much to the improvement of river fronts past good free landings and docks, because of the general development resulting from the establishment of good harbors at large commercial cities; but foreign practice indicates that the General Government should discourage the establishment of docks by private owners on governmentally improved streams except where there already exist free landings sufficient for ordinary service of all boats and where, at the same time, the private docks shall furnish improved

facilities fully worth their dock charges, and that especial care should be urged upon all States and municipalities to see that rights of way given to railroads shall not unnecessarily prevent the later establishment of boat landings or prevent the free use of existing and future landings or their easy and free connection with the business portion of the adjoining communities, and that where such facilities are not provided the river-front improvement should be assessed upon the dock owners or left undone in favor of other places where such requirements have been fulfilled.

That St. Louis at least is beginning to realize something of the above is shown by Exhibit No. 34.

EXHIBIT No. 34.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

TERMINAL FACILITIES.

The credit of a city as a distributive center is largely measured by the promptness with which shipments are handled, and while during the past year there has not been much complaint of delays in St. Louis terminals, we must recognize the fact that these facilities are inadequate to take care of a tonnage like 1907 or the tonnage that we may anticipate for the year 1910. It behooves every industry to construct and acquire reasonable facilities for the accommodation of their traffic, and too much importance can not be attached to the necessity for the lines serving St. Louis enlarging their present facilities by the addition of further team tracks, the erection of warehouses for the handling of merchandise and increased hold tracks, and the citizens of St. Louis should lend their support within reasonable limits toward the attainment of such results, reserving to ourselves at all times the right which the city has, in the granting of these franchises, of surrounding same with reasonable regulations looking to the protection of our business and the development thereof in the future.

Better service, by the more expeditious handling of our freight, is being rendered by the carriers. We are no longer confronted with delays and congestions incident to the enormous tonnage handled during 1907. The carriers have had an opportunity to study out plans and perfect operating conditions under which freight can be handled more expeditiously, and, with the development of business, these measures should be continued.

RIVER TRANSPORTATION.

The success of a manufacturing and distributing community is largely dependent upon the ability to avail itself of cheap transportation for the purpose of handling its surplus and carriage of low-class freight, a condition which is taken advantage of in foreign countries through the development of their waterways and construction of a system of canals. There is no one thing that would give greater impetus to the business of this community than the development of our waterways and in particular the Mississippi River, by the means of which large quantities of our low-class freight would receive the measure of the lowest transportation charge. Determined efforts should be made to interest capital in the project of securing needed facilities for the handling of this river traffic, and the construction of suitable elevators and warehouses to be operated in connection therewith.

Regarding the best method in which the General Government and other interested parties can share in supplying the funds necessary for the development of inland navigation, the Eleventh International Congress of Navigation (St. Petersburg, 1908), in its summary of the proceedings, concludes that taxation is, as a rule, the best method of collecting the necessary funds, and that the taxes should be so arranged as to absorb a part of the profit obtained by the reduction of the cost of transportation due to the establishment or improvement of the navigable highway, such taxes to be levied on the boats or the freight charges, and also by taxes on the increased value of the lands and buildings connected with the improvement, not to exceed in amount a half of the increased value; such taxes to cease as soon as the work has been paid for. It further concludes that local bodies, such as municipalities, boroughs, associations, industrial societies, etc., may be intrusted to secure the funds necessary for the construction, extension, or improvement, of river ports, landings, docks, warehouses, and the various equipments of the ports, as well as for the construction of local lines of approach and their connections, from settlements, factories, and centers of production, to the navigable highway.

From all the above investigations of the Chicago and Montreal harbor commissions and other modern engineering study, it seems to be quite generally admitted that all general governments may properly assume all responsibility for construction and

first cost of public waterway improvements so far as concerns the securing of through channel routes of necessary widths and depths; but most foreign countries consider the improvement of terminals, including landings, wharves, piers, slips, docks, transfer machinery and sidings, etc., to belong largely if not wholly to the localities directly concerned. Where the General Government assumes control of the improvement of terminals it generally limits such control to the direction of supervision of work, assessing the cost upon the locality.

Rail and water competition.—The Chicago and Montreal harbor commission reports show plainly that one of the main reasons for the great use of inland waterways abroad is their better terminal facilities and their higher freight rates, combined with the denser population and the greater need of transportation. Although the water rates abroad are less than the rail rates, the foreign water rate is often higher than the United States rail rates.

As recently explained by the Interstate Commerce Commission (Opinion No. 787, January 7, 1909), traffic entirely by water and traffic entirely within a State are outside of federal control; and (Opinion No. 848, March 8, 1909) the first railroad from St. Louis to New Orleans was obliged to make its rates as low as the then existing rates by water, all subsequent railroads being obliged to regulate their own rates accordingly in order to get any business. By strict attention to business and by improving their terminal facilities and their collecting and distributing arrangements, the railroads can to-day make profits at rates which are no longer profitable to steamboats. A comparison of rail rates and water rates from New Orleans to upriver points above Baton Rouge, and of rail rates and water rates from St. Louis to downriver points below Cairo (see Exhibits 44–45) will make this point quite evident. Until terminal facilities at the water's edge are much improved there is little to be gained by any increase of draft in the river greater than necessary to float barges of the draft found most economical in the Ohio and in Europe.

Railroad development in the United States, and especially in the Mississippi River basin, has been so enormous as to have attracted the attention of all foreign engineers; but such development is notable by reason of the enormous mileage for the total country, and for each 1,000 of population, and not by reason of the mileage per square mile, or other unit of area, as to which middle Europe is ahead of us; and the freight carried by American railroads is notable by the total for individual localities, or route, or 1,000 of population, and not for amount by the square mile or other unit of area. In the United States single trains often carry loads five times as great as in Europe. The habits of the United States public demand more freights and longer hauls per unit of population than in Europe. The large areas of comparatively level country in the southern Mississippi Valley, the northern Ohio Valley, and the great plains east of the Rocky Mountains have made possible in the United States long hauls and heavily loaded trains over gentle grades, resulting in low costs, impossible in Europe, and approaching even in the United States in some cases very closely to the cost of water transportation. The railroad freight of the United States in the last twenty years has nearly tripled in consequence. Existing rates, though low, would probably be carried still lower were it not for the fact that the demand for railroad freights has increased much faster than the mileage of terminal facilities of the railroads, requiring at the present time enormous expenditures for the latter in order to enable them to keep up with the business.

Waterways as routes for transportation possess over railways certain decided advantages, as follows: Foremost in importance is the fact that the United States waterways are public highways, open to every boat irrespective of its ownership; second, their channels are usually so wide that boats can always freely pass each other, and each boat is usually independent of all others as to use of both channel and landings; third, landings can usually be made and passengers and freight discharged at any point along the route at the will of the boat agents; fourth, the use of the waterway and landing places is usually either free from tolls or charge for cost of construction and maintenance, or else the charge is slight. Other advantages exist, but they are of minor importance. In proportion as any of these conditions are restricted by nature or by monopoly or by tariff charges the advantages diminish very promptly.

On the other hand, waterways as routes for transportation in comparison with railways have disadvantages, as follows: They are rarely straight, and so are usually much longer than corresponding rail routes, almost always 1.5 times as long and often three times. They are subject to special delays by weather conditions, as by fogs liable to occur at any time of day or night for uncertain and very variable intervals and by low water, freshets, and ice formations, occurring less often but lasting longer at a time. They naturally occupy the lowest levels of large areas, so that necessarily all freights after being unloaded must be hauled uphill in order to reach a place of actual use or sale. Good natural wharves and landings are few; good artificial wharves or landings are too expensive for construction by small communities, and cost of rehan-

dling from shipper to boat and from boat to consignee is usually large. Boat service being easy of installation and comparatively free of monopoly and control is not easily organized under large companies; through shipments are not easily arranged and guaranteed between distant points. Repeated rehandling by irresponsible persons often becomes necessary, and damage to through freights is not easily prevented nor its responsibility easily determined nor its cost easily adjusted. In proportion as these conditions are intensified the final cost of transportation increases and the freight charge must be increased or the boat must go out of business. These disadvantages may often be so great as to determine shipment by rail even when the ton-per-mile freight charge by water is considerably less.

While boats can afford to carry bulky and heavy goods at much lower rates per ton-mile than do railways, the difference may easily be more than counterbalanced by the damage to lumber and furniture and frail materials by careless or repeated rehandling and also by the cost of haulage between the boat and the places of business of the shipper and consumer. Again, the rehandling to and from cars is almost always done under cover from rain and sun, while that from boats is usually done in the open. Furthermore, it must be remembered that in many cases of shipment by rail the shipper himself places the goods inside the car on a siding at his own factory or warehouse and the consignee unpacks the same in the same way, and not only does the rail freight charge cover the entire cost of delivery from shipper to consignee, but the lesser amount of handling by rail diminishes both the risk of damage and the insurance charges. For a proper comparison of the final cost of shipment by the two routes the boat and rail rates must both be increased by the cost of movement at both ends of the route between the terminals and warehouses. A similar increase must be made in any proper comparison of time delays in shipment by the two routes. These conditions alone are sufficient to explain why the lumber yards of Chicago and many other large cities are losing their lake and river business, even though located at the water's edge, and also why most of the Mississippi boat traffic is at present restricted to local business, which can not be easily or economically reached by railroad sidings, and also why the Mississippi River is so little used over its 130 miles between New Orleans and Baton Rouge, where there has existed from time immemorial at all hours of the day and every day of the year a clear channel of several hundred feet width and about 30 feet depth. The above remarks should be constantly kept in mind in inspecting and comparing the tables (Exhibits 35 to 45) which follow and which show the comparative water and rail rates within the Mississippi Valley and between it and the Atlantic coast and Europe.

(A fuller statement of some of these rates and other interesting comparisons of the same may be found in the Ohio River Board Report of 1905–6, previously mentioned in this same appendix.)

EXHIBIT No. 35.—*All and part rail freight rates on grain and grain products, November, 1908, from Chicago and St. Louis to East, as reported November, 1908, by United States Bureau of Statistics.*

[All rates in cents per 100 pounds.]

Destination.	Local rates from—							
	Chicago.				East St. Louis.			
	Grain products.		Flour.		Grain products.		Flour.	
	Domestic.	Exported.	Domestic.	Exported.	Domestic.	Exported.	Domestic.	Exported.
New York	17½	17	17½	16	19½	18½	19½	17½
Boston	19½	17	19½	16	21½	18½	21½	17½
Philadelphia	15½	15	15½	15	17½	16½	17½	16½
Baltimore	14½	14	14½	14	16½	15½	16½	15½

Proportional domestic rates for Chicago are 2.8 cents less than local.
Proportional export rates for Chicago are 4 cents less than local.
Proportional domestic rates for East St. Louis are 1.5 cents less than local.
Proportional export rates for East St. Louis are 3 cents less than local.

EXHIBIT No. 36.—*Class rates from East St. Louis to East, November, 1908, as reported November, 1908, by United States Bureau of Statistics.*

[All rates in cents per 100 pounds.]

Destination.		Class No.					
		1.	2.	3.	4.	5.	6.
Boston	All rail	88	76	59	41	35	29
	Lake and rail	83	72	56	38	33	28
New York	All rail	88	76	59	41	35	29
	Lake and rail	78	68	53	37	31	26
Philadelphia	All rail	82	70	57	39	33	27
	Lake and rail	72	62	51	35	29	24
Baltimore	All rail	80	68	56	38	32	26
	Lake and rail	70	60	50	34	28	23

Sea and rail rates for New York and Boston all year and for Philadelphia and Baltimore during summer are same as lake and rail rates; but Philadelphia and Baltimore winter rates are from 1 to 2 cents higher than summer rates.

St. Louis class rates, November, 1908, to East were same as East St. Louis.

EXHIBIT No. 37.—*Range of ocean freights, November, 1908, to Liverpool, as reported November, 1908, by Department of Commerce and Labor (Bureau of Statistics).*

Article.	Boston.	New York.	Baltimore.	New Orleans.
Grain, per bushel	2-2¼ pence.	1¾-2 pence.	.....	.....
Flour, per 100 pounds	6 cents.	7 cents.	8-9 cents.	.....
Hard lumber, per 100 pounds	9 cents.	10 cents.	.....	18-20 cents.
Soft lumber, per 100 pounds	11 cents.	17 cents.	.....	21-22 cents.
Oil cake, per 100 pounds	6 cents.	7 cents.	8-9 cents.	.....
Cotton, per 100 pounds	12 cents.	12-15 cents.	20 cents.	.....
Tobacco, per 100 pounds	13 cents.	15 cents.	18-20 cents.	.....

EXHIBIT No. 38.—*Range of ocean freights, November, 1908, to Hamburg, as reported November, 1908, by Department of Commerce and Labor (Bureau of Statistics).*

Article.	Boston.	New York.	Baltimore.	New Orleans.
Grain, per bushel	[a]36-42 cents.	22½-30 pfennigs.	.....	3½ pence.
Flour, per 100 pounds	12-13 cents.	11 cents.	12-13 cents.	16 cents.
Hard lumber, per 100 pounds	16-18 cents.	16-17 cents.	18-19 cents.	18-20 cents.
Soft lumber, per 100 pounds	19-21 cents.	19-20 cents.	21-22 cents.	21-22 cents.
Oil cake, per 100 pounds	12-13 cents.	11 cents.	12-13 cents.	[c]14 shillings.
Cotton, per 100 pounds	25 cents.	25 cents.	22 cents.	30-35 cents.
Tobacco, per 100 pounds	25-30 cents.	[b]$5.50	25 cents.	30-35 cents.

[a] Per 448 pounds. [b] Per hogshead. [c] Per 2,240 pounds.

EXHIBIT No. 39.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

AVERAGE PUBLISHED RATES OF FREIGHT ON GRAIN IN CENTS.

FROM ST. LOUIS TO LIVERPOOL VIA RIVER TO NEW ORLEANS AND VIA RAIL TO NEW YORK.

Year.	To New Orleans by river.		On wheat to New York by rail, per 100 pounds.	To Liverpool.	
	On grain in sacks, per 100 pounds.	On wheat in bulk, per bushel.		Via New Orleans, on wheat, per bushel.	Via New York, on wheat, per bushel.
1887	18½	6	32⅞	15	24½
1888	15	6½	29½	15⅛	22.95
1889	17.93	5.95	28½	17½	24.97
1890	15.66	6.58	27⅝	14½	21.48
1891	16.28	6.87½	29	15½	23.55
1892	16.87	6.50	26.62	14	21
1893	17.54	6.55	28.50	14.71	21.72
1894	17.14	5.89	24.73	11.69	18.71
1895	13.00	5.95	23.57	12½	18.33
1896	14.54	5.00	23.00	13.50	19.67½
1897	10.83	4.88	23.64	12.89	20.33
1898	10.00	4.50	22.25	14.24	20.32
1899	10.00	4.50	21.95	12.33	17.88
1900	10.00	a 4.25	19.38	14.64	18.41
1901	10.00	a 4.25	19.33	9.48	14.03
1902	10.00	a 4.20	20.66	8.53	15.33
1903	10.00	a 5	22.25	10.00	16.02
1904	.....	.....	21.51	.....	15.25
1905	.....	.....	20.50	.....	15.60
1906	.....	.....	20.50	.....	15.23
1907	.....	.....	20.50	.....	15.87
1908	.....	.....	19.50	.....	14.78

Average rate of freight on wheat per bushel, by steamer, from New Orleans to Liverpool during 1907 and 1908.

Month.	Rates in cents.	
	1908.	1907.
January	7	4⅜
February	6	4⅛
March	6	4⅛
April	6	4⅛
May	5½	4⅛
June	4	4⅛
July	5	3 9/16
August	6	3 9/16
September	6	3 9/16
October	6	3 9/16
November	6	4⅛
December	6	4⅛

Average rate of freight on wheat per bushel, by steamer, from New York to Liverpool during 1907 and 1908.

Month.	Rates in cents.	
	1908.	1907.
January	4⅛	3½
February	3½	3½
March	3	2⅞
April	2½	2½
May	2½	2½
June	3⅛	3
July	3	2⅞
August	3	3½
September	3	3½
October	3	3½
November	3⅞	5⅛
December	3½	6

a F. o. b. New Orleans.

EXHIBIT No. 40.—*Extract from the report of the St. Louis Merchants' Exchange for 1908.*

ALL-RAIL RATES OF FREIGHT, IN CENTS, FROM ST. LOUIS TO SOUTHERN CITIES DURING 1908.

Articles.	Memphis, Tenn.	Vicksburg, Miss.	New Orleans, La.
Flour per barrel, C. L	22	36	36
Wheat, C. L	a 8	18	a b 13
Other grain and feed, per 100 pounds, C. L	a 7	a 12	a 12
Meat, packed, per 100 pounds, C. L	c 18	c 30	c 30
Meat, loose, per 100 pounds, C. L	c 18	c 30	c 30
Hay, per 100 pounds, C. L	a d 10	a d 17½	a d 17½

a Proportional rate.
b Canceled November 1, 1908.
c Advanced 3 cents, effective September 1, 1908.
d Canceled March 16, 1908. Class rates apply, Memphis, 12 cents; New Orleans and Vicksburg, 20 cents.
Except as otherwise provided above St. Louis and East St. Louis rates are the same.

EXHIBIT No. 41.

PUBLISHED RATES OF FREIGHT BY RAIL FROM ST. LOUIS TO NEW YORK DURING 1908.

Date.	Meats, per 100 pounds.	Corn, kaffir corn, wheat.	Barley, oats, rye, speltz.	Grain products.	Flour, per barrel.	Compressed cotton, per 100 pounds.
January 1 to May 1	.....	20½	20½	20½	41	.....
May 1 to December 31	.....	19	20	20	40	.....
January 1 to December 31	35	.....	.....	.....	.....	[a] 30

[a] East St. Louis.

Grain and grain products to Boston, 2 cents higher than New York; to Philadelphia, 2 cents lower than New York; to Baltimore, 3 cents lower than New York.

Cotton to Boston, 5 cents higher; to Philadelphia 2 cents and Baltimore 3 cents lower than New York rates.

Meats to Boston, 3 cents higher; to Philadelphia 2 cents and Baltimore 3 cents lower than New York rates.

CLASS RATES FROM ST. LOUIS.

[From January 1 to December 31, 1908.]

	1.	2.	3.	4.	5.	6.
To New York	87½	76	58½	41	35	29
To Boston	94½	82	63½	45	38	31
To Philadelphia	85½	74	56½	39	33	27
To Baltimore	84½	73	55½	38	32	26

EXHIBIT No. 42.

PUBLISHED AVERAGE RATE OF FREIGHT BY RAIL ON GRAIN FROM EAST ST. LOUIS TO NEW YORK.

[Per 100 pounds.]

	Cents.		Cents.
1908 (also from St. Louis)	19.63	1898 on corn	20½
1907	20.50	1897 on corn for export	17½
1906	20.50	1897 on grain	23-26
1905	20.71	1896	23
1904	21.57	1895	23.57
1903	21.25	1894	24.73
1902	20.66	1893	28.50
1901	19.33	1892 on grain	26.62
1900	19.38	1891 on wheat	29
1899 on grain (except corn)	21.05	1891 on corn	28½
1899 on corn	20 7/10		

EXHIBIT No. 43.

The reports of the Interstate Commerce Commission, 1906-7, give the following average freight rates on railroads paralleling to some extent the Mississippi River system:

Railroad.	Average revenue (freight) per ton-mile.	
	1906.	1907.
	Cents.	*Cents.*
Louisville and Nashville R. R. south of Ohio River	0.808	0.804
Illinois Central R. R., line south of Ohio River	.588	.621
Mobile and Ohio R. R., line south of Cairo, Ill	.667	.653
Cincinnati, New Orleans and Texas Pacific R. R., within limits of Group V—Kentucky, Tennessee, Mississippi, Alabama, Georgia, and Florida	.719	.761
Missouri, Kansas, and Texas R. R.:		
Line north of Denison, Tex	1.024	1.030
Line south of Denison, Tex	1.152	1.160
St. Louis, Iron Mountain and Southern R. R	.706	.733
International and Great Northern R. R., Texas and Louisiana	1.040	1.057
(Galveston, Houston and Northern R. R. (1906) changed to Galveston, Harrisburg and St. Anthony Ry. (1907))	1.543	.746
Entire United States, all railroads for all classes of freight, taken as a whole	.746	.759

EXHIBIT No. 44.—*Freight rates per ton, by rail, as reported by various parties, December, 1908.*

Terminal points.	Articles transported.																			
	Mileage distance.*	Lumber and wood.	Sand and gravel.	Rock, lime, and clay.	Cement and brick.	Building stone.	Salt.	Oil.	Coal.	Iron ore.	Other metals.	Manufactured iron.	Grains and seeds.	Flour.	Cotton.	Sugar and molasses.	Tobacco.	Naval stores.	Provisions.	General merchandise.
From Chicago, Ill.:																				
To Kansas City, Mo. and Kans.	*Mills.* 458	$3.20	.....	.....	$2.30	.....	.....	$5.40	$2.30	.....	$2.00	$3.25	.....	$2.95	.....	$4.50	$6.40	$7.80	$5.40	$16.00
St. Louis, Mo.	284	1.70	$1.30	$1.30	1.40	$1.30	$1.77	1.70	.....	$1.50	1.40	1.80	$1.40	1.60	$5.00	1.90	3.40	2.60	3.00	.....
Vicksburg, Miss.	747	5.20	4.20	4.87	3.80	4.80	4.00	4.60	.....	.....	.....	5.20	4.20	4.60	.....	.....	10.40	.....	.....	8.50
New Orleans, La.	912	4.80	4.10	6.20	4.00	6.20	3.80	4.60	.....	8.20	.....	5.00	.....	.....	.....	5.00	22.00	.....	6.40	.....
From Kansas City, Mo. and Kans.:																				
To St. Paul, Minn.	563	.....	.....	.....	2.25	.....	.....	5.60	.....	.....	.....	3.30	2.95	.....	.....	4.70	6.80	7.40	5.60	17.00
Chicago, Ill.	458	3.20	.....	.....	2.30	.....	.....	5.40	2.30	.....	2.00	3.25	.....	2.95	.....	4.50	6.40	7.60	5.40	16.00
St. Louis, Mo.	277	.....	1.60	3.40	1.50	2.20	2.00	3.40	.....	2.20	1.25	4.40	2.15	2.35	12.00	3.70	5.40	4.40	8.80	.....
Cairo, Ill.	427	3.20	3.20	2.50	2.50	3.20	3.40	5.40	2.25	2.96	.....	3.50	2.60	2.80	.....	4.70	6.40	7.00	5.40	16.00
Memphis, Tenn.	484	3.20	3.20	2.50	2.50	3.20	3.40	5.40	2.25	2.96	.....	3.50	2.60	2.80	.....	4.70	6.40	7.00	5.40	16.00
Greenville, Miss.	635	5.20	4.40	5.00	4.40	5.00	4.70	8.40	.....	.....	.....	6.40	3.80	4.00	.....	4.60	12.00	.....	7.00	23.00
Vicksburg, Miss.	704	5.20	4.40	5.00	4.40	5.00	4.70	8.40	.....	.....	.....	6.40	3.80	4.00	.....	4.60	12.00	.....	7.00	23.00
Natchez, Miss.	783	5.20	4.40	5.00	4.40	5.00	4.70	8.40	.....	.....	.....	6.40	3.80	4.00	.....	4.60	12.00	.....	7.00	23.00
Baton Rouge, La.	791	5.20	4.40	5.00	4.40	5.00	4.70	8.40	.....	.....	.....	6.40	3.80	4.00	.....	4.60	12.00	.....	7.00	23.00
New Orleans, La.	880	5.20	4.40	5.00	4.40	5.00	4.70	8.40	.....	.....	.....	6.40	3.80	4.00	.....	4.60	12.00	.....	7.00	23.00
From St. Louis, Mo.:																				
To St. Paul, Minn.	576	3.00	1.70	2.60	2.10	2.10	2.60	4.20	.....	3.00	3.00	4.20	3.00	2.80	5.20	3.20	5.20	4.20	4.20	.....
Chicago, Ill.	284	1.70	1.30	1.30	1.40	1.30	1.77	1.70	.....	1.50	1.40	1.80	1.40	1.60	5.00	1.90	3.40	2.60	3.00	.....
Kansas City, Mo.	277	.....	1.60	3.40	1.50	2.20	2.00	3.40	.....	2.70	1.25	4.40	2.15	2.35	12.00	3.70	5.40	4.40	4.40	.....
Cairo, Ill.	150	1.40	.75	1.50	1.30	1.68	3.20	1.60	1.00	1.68	1.68	2.10	.....	1.60	.....	2.72	3.62	1.88	1.88	.....
Memphis, Tenn.	311	3.00	1.60	2.40	1.80	2.80	1.60	2.40	1.90	3.00	5.00	2.60	2.40	2.20	2.20	6.00	4.00	5.00	4.00	.....
Greenville, Miss.	448	4.00	3.00	3.80	3.00	5.00	3.27	3.60	3.25	5.00	7.00	4.40	2.40	3.60	.....	8.00	5.40	7.00	6.00	.....
Vicksburg, Miss.	531	4.00	3.00	3.80	3.00	5.00	3.27	3.60	3.25	5.00	7.00	4.40	2.40	3.60	.....	8.00	5.40	7.00	6.00	.....
Natchez, Miss.	614	4.00	3.00	3.80	3.00	5.00	3.27	3.60	3.25	5.00	7.00	4.40	2.40	3.60	.....	8.00	5.40	7.00	6.00	.....
Baton Rouge, La.	677	4.00	3.00	3.80	3.00	5.00	3.27	3.60	3.25	5.00	7.00	4.40	2.40	3.60	.....	8.00	5.40	7.00	6.00	.....
New Orleans, La.	699	4.00	3.00	3.80	3.00	5.00	3.27	3.60	3.25	5.00	7.00	4.40	2.40	3.60	.....	8.00	5.40	7.00	6.00	.....
From New Orleans, La.:																				
To St. Paul, Minn.	1,275	6.40	.....	.....	4.30	8.60	4.60	8.60	.....	5.80	.....	8.60	.....	.....	.....	6.80	24.00	.....	8.60	.....
Chicago, Ill.	912	4.80	4.10	6.20	4.00	6.20	3.80	4.60	.....	8.20	.....	5.00	.....	.....	.....	5.00	22.00	.....	6.40	.....
Kansas City, Mo.	880	4.60	.....	4.60	3.30	7.60	4.80	7.00	.....	4.80	.....	7.60	3.80	4.00	.....	5.00	22.00	.....	7.60	2.30
St. Louis, Mo.	699	7.00	3.60	5.00	3.40	5.00	3.00	3.60	.....	5.00	7.00	4.40	4.00	5.00	6.00	3.40	.....	9.40	5.40	.....
Cairo, Ill.	554	2.80	3.20	.....	3.00	4.20	3.00	5.80	.....	5.80	.....	3.60	.....	.....	.....	3.40	15.00	.....	4.80	.....
Memphis, Tenn.	396	.....	1.60	2.40	1.60	2.40	1.80	6.40	.....	3.40	.....	2.40	2.40	2.40	.....	2.40	9.00	.....	3.00	.....
Greenville, Miss.	310	.....	1.60	2.40	1.60	2.40	1.80	6.40	.....	3.40	.....	2.40	2.40	2.40	.....	2.00	9.00	.....	3.00	.....
Vicksburg, Miss.	227	.....	1.60	2.40	1.60	2.40	1.80	6.40	.....	3.40	.....	2.40	2.40	2.40	.....	2.00	9.00	.....	3.00	.....
Natchez, Miss.	214	.....	1.60	2.40	1.60	2.40	1.80	6.40	.....	3.40	.....	2.40	2.40	2.40	.....	2.00	9.00	.....	3.00	.....
Baton Rouge, La.	89	.....	1.40	1.40	1.25	1.60	1.60	.....	.....	1.40	.....	2.20	1.60	1.60	3.00	1.50	5.00	.....	2.40	.....

* Distance taken from United States Army mileage book.

EXHIBIT No. 45.—*Freight rates per ton by water, as reported by various parties, December, 1908.*

Terminal points.	Mileage distances.[a]	Lumber and wood.	Sand and gravel.	Rock, lime, and clay.	Cement and brick.	Building stone.	Salt.	Oil.	Coal.	Iron ore.	Other metals.	Manufactured iron.	Grains and seeds.	Flour.	Cotton.	Sugar and molasses.	Tobacco.	Naval stores.	Provisions.	General merchandise.
From St. Louis, Mo.:	*Miles.*																			
To St. Paul, Minn.	729	$2.80	$2.00	$2.40	$2.00	$2.00	$3.40	$2.80	.....	$2.00	.....	$2.80	$2.80	.....	$8.00	$3.40	$3.40	$5.40	.....	.....
Cairo, Ill.	182	.....	.....	2.00	1.60	1.60	1.60	2.00	.....	.....	$2.00	2.00	3.00	$1.40	.....	2.00	3.00	3.00	$3.00	$4.00
Memphis, Tenn.	420	2.50	.....	3.00	3.00	.....	2.50	3.00	.....	.....	3.00	3.00	5.00	2.00	3.00	2.50	7.40	6.00	6.00	5.00
Kansas City, Mo.	(b)	(b)	(b)	(b)	(b)	(b)	3.00	.....	.....	.....	3.00	3.00	1.00	1.00	4.60	3.00	4.60	4.60	3.00	5.00
From New Orleans, La.:																				
To Vicksburg, Miss.	366	.....	2.50	.....	1.60	.....	2.40	.....	.....	.....	.....	.....	2.40	2.50	4.00	2.00	4.80	5.00	5.00	3.00
Natchez, Miss.	284	.....	.....	.....	1.60	.....	2.40	.....	.....	.....	.....	.....	2.40	2.50	4.00	2.00	4.80	5.00	5.00	.....
Baton Rouge, La.	132	.....	.30	1.25	.....	2.00	.....	.....	.....	.....	.....	.....	2.00	2.00	3.00	2.00	4.00	.....	3.60	.....

[a] Distances are channel routes according to United States engineer maps.

[b] Same rates either direction.

N. B.—The above rates by rail and water have been received from commercial associations or terminal agents and are believed to be sufficiently correct for purposes of comparisons.

A comparison of the last table with the first shows that from St. Louis to St. Paul the rates are lower by rail for sand and gravel, salt, cotton, sugar and molasses, and naval stores; and lower by water for lumber, rock, lime, and clay, cement and brick, building stone, oil, manufactured iron, and tobacco. From St. Louis to Cairo the rates are lower by rail for rock, lime and clay, cement and brick, oil, other metals, grains and seeds, naval stores, and provisions; and are lower by water for building stone, salt, manufactured iron, flour, sugar and molasses, and tobacco. From St. Louis to Memphis the rates are lower by rail on rock, lime and clay, cement and brick, salt, oil, manufactured iron, grains and seeds, tobacco, naval stores, provisions; and lower by water for lumber, other metals, flour, and sugar and molasses.

From New Orleans to Baton Rouge, where the width and depth of channel is sufficient for ocean boats, the rates are lower by rail on building stone, grains and seeds, flour, sugar and molasses, and provisions; and lower by water on sand and gravel, rock, lime and clay, and tobacco. From New Orleans to Natchez and Vicksburg the rates are lowest by water only on tobacco.

As the railroads will carry almost all articles of freight from New Orleans, 396 miles, to Memphis at the same rates as 214 miles to Natchez, shippers, having little to gain by using water transportation from New Orleans to Baton Rouge, have nothing to gain to points above Natchez. In the same way, shippers have little to gain by using water transportation from St. Louis to points below Memphis and nothing to points below Greenville. Consequently packets plying between Memphis and Natchez must depend for their support on local business within the limits, so long as the railroads maintain these rates and can take care of the business. Within these geographical limits barges and tows are the only boats that can successfully compete with the railroads.

APPENDIX No. 21.

FIELD AND OFFICE OPERATIONS CARRIED ON UNDER THE DIRECTION OF THE BOARD ON EXAMINATION AND SURVEY OF MISSISSIPPI RIVER, IN CONNECTION WITH THE PREPARATION OF ITS REPORT.

[Prepared by the recorder of the Board.]

In the absence of any complete and recent maps of that district, it was decided by the Board, as being requisite to a proper study of the problem before it, that a topographic and hydrographic survey of the alluvial valley of the Mississippi River be made between St. Louis, Mo., and Cairo, Ill.; and that surveys be made below Cairo to determine the length of caving banks and the number of bars having less than 14 feet of water over them at any stage.

The office, force, and plant of the Mississippi River Commission having been placed at the service of the Board by the act of Congress approved March 2, 1907, and the Chief of Engineers having authorized the employment of a part of the clerical and engineering force of the United States engineer office, St. Louis, on the work of the Board and the use of vessels operating under the direction of that office for the distribution of supplies needed by parties engaged on the St. Louis-Cairo survey, work was undertaken with the intent of completing field-survey operations before the high-water season of 1908, if possible.

The survey was so planned and executed as to provide data for determining—

First, the number of bars having less than 14 feet of water over them at all stages of water and the annual cost of dredging them so as to maintain a depth of 14 feet;

Second, the cost of a system of regulation works and the depths that it is practicable to obtain by such method of improvement;

Third, the locations of movable dams and their cost so as to obtain 14 feet of water; and

Fourth, the location and cost of a lateral canal or canals similar to the one proposed from Alton to St. Louis.

Assistant Engineer Wm. M. Penniman was transferred from the United States engineer office, St. Louis, Mo., and placed in charge of the field operations and office work of the survey of the stretch of river between St. Louis and Cairo. The supervision of the measurement, in the stretch between the Ohio and Red rivers, the length of caving banks and determination of the number of bars having less than 14 feet of water over them at any stage, was under the immediate direction of Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, recorder of the Board. He also, as secretary of the Mississippi River Commission, had charge of the regular 9-foot dredging and the experimental 14-foot dredging carried on below Cairo by the Mississippi River Commission. These duties are here mentioned, as the operations, especially the experimental dredging, have been a source of valuable information for the Board's use, and the operations were in part carried on with the Board's cooperation.

FIELD OPERATIONS ABOVE CAIRO.

These operations were under the general direction of the recorder and under the immediate supervision of Assistant Engineer Wm. M. Penniman.

Assistant Engineer Penniman reported for duty August 19, 1907, and immediately formulated a project for the prosecution of the survey of the district between St. Louis and Cairo in accordance with the requirements of the Board.

Requirements of survey.—As the requirements of the act creating the Board called not only for recommendation in regard to the improvement of the open river, but also for the consideration of the feasibility of a lateral canal or canals for a part of the route, it was deemed necessary, in the absence of any suitable maps, that this survey cover the entire bottom lands between the high bluffs from St. Louis to Cairo. It was also considered advisable to obtain the controlling elevations of bed rock at certain points in the district that seemed by nature suitable as locations for dams for either a lateral canal system or river canalization.

Project.—A project for this survey, based on a preliminary examination of data and existing maps of the district on file in the office of the secretary of the Mississippi River Commission and in the St. Louis United States engineer office, submitted on August 27, 1907, was approved by the Board August 29, and the organization of the necessary field and office parties for the work was at once commenced.

Secondary triangulation points and precise bench marks of a survey of the river in this district made by the Mississippi River Commission, established in 1880 to 1881, were utilized as a basis for the Board's survey; use was also made of sections of the topography as determined by the Mississippi River Commission survey in 1884–89, where no changes had since occurred.

The survey made by the Board broadly divides, under two general heads, as "river survey" and "valley survey."

The "river survey" embraced, besides the necessary triangulation, survey of shore lines of both banks of the river and of tops of natural banks; of improvements; of timbered and cultivated areas; of islands, sand bars, sloughs, and all secondary channels of the river; a determination of the slope of the water surface, especially in the pools above and below each "crossing;" soundings sufficient to develop all shoals, or channel crossings, at various stages of the river during both rising and falling intervals; lines of channel soundings at high and at low stages of the river, and borings to determine the elevation of bed rock at selected points along and across the channel.

The "valley survey" comprised the taking of topography from the river except that unchanged and depicted on published maps to and including the front slope of the bluffs in Illinois and in Missouri; all characteristic features of the topography were taken; authentic high-water marks, especially those of 1844, 1851, 1858, and 1903, were determined, and borings at selected localities to develop bed rock if within reasonable distance of the surface.

Methods.—The methods used by all parties were those of the Mississippi River Commission on similar work and governed by its published instructions. The main features of these methods are the use of the stadia for topography, with distances in meters and elevations in feet. Each topographer was required to make an accurate sketch of his work in the field, using protractor and scale, the sketches being to the same scale as the detailed maps, but intended merely as a guide in the final platting.

Three sets of soundings were taken—cross river and channel, at the time of the survey of the banks; and continuous lines of channel soundings throughout the stretch, St. Louis-Cairo, at times of high and low water.

The cross-river soundings of the Board's survey were taken on ranges about 1,000 feet apart and were located by intersections, using an instrument on the bank and a range line. The channel soundings were located by a transit on shore and a sextant on the boat. The continuous channel-line soundings were located by double sextant angles from the steamer.

A continuous line of levels was run generally on only one side of the river and between successive bench marks, connecting where convenient with the topographer's stakes, and determining the water-surface elevations at sounding ranges. Temporary gauges were also established near the base of the work and elevations of their zeros determined. These gauges were read twice daily and their readings recorded.

A base line run near the bluffs when at a distance from the river was measured with steel tape, checked by stadia readings, and connected with the secondary triangulation stations on the bluffs; stakes were determined about every quarter mile, and permanent points were established from 1 to 2 miles apart by setting iron pipes.

The valley topography was surveyed by running a series of cross-section lines about one-half mile apart, beginning at the stakes of the "river survey" and joining on the base-line stakes near the bluffs.

A level line was carried over the base-line stakes, giving the topographers a level elevation at each end of their lines; in places where the valley was more than ordinarily wide another line of levels was run midway between the bluffs and the river and connected with the neighboring topographic stakes.

Field parties.—It was decided to place four survey parties in the field—plant being available for that number—three to be engaged on the "river" and the "valley" surveys, and the fourth to make the test borings necessary to determine elevations of bed rock.

When the "valley" survey was undertaken it was proposed to use hand cars to assist the detached parties working near the bluffs. Four such cars were obtained the latter part of March, 1908, through the courtesy of Mr. A. W. Sullivan, general manager of the St. Louis, Iron Mountain and Southern Railway, and were used to advantage by parties Nos. 1 and 2.

Considerable delay was encountered in procuring the necessary instruments and field equipment for the parties, the manufacturers not being able promptly to furnish instruments of the character required for the work, and some delays developed in obtaining the requisite floating plant for quarters.

As the season was becoming late, the work of all parties was confined to the waterway of the river—the main and secondary channels and the islands and bars within the high-water lines—in order to complete that part of the work during the low-water season then existing, and the survey between the bluffs and the river banks was left to be made during the following winter and spring.

Chiefs of party.—For duty as chief of parties Nos. 1, 2, 3, and 4, respectively, Junior Engineer George H. Wolbrecht, and Assistant Engineers Eugene L. Harman and George H. French were temporarily transferred from the force of the secretary's office, Mississippi River Commission, and Junior Engineer Philip Florreich, jr., from the United

States engineer office, St. Louis. Messrs. Harman, French, and Wolbrecht were in charge of the parties performing survey work proper, and Mr. Florreich was given charge of the boring operations.

The river survey.—The survey of the river, as such, was made by the three parties, taking the field about October 1, 1907, in two and one-half months of actual field work, and included the topography between high banks. This was completed from the termination of the deep waterway survey between Chicago and St. Louis (head of Arsenal Island) to the mouth of the Ohio River, and 5 miles up the Ohio, to Mound City, Ill.

In addition to the regular hydrographic survey (in which was later included St. Louis Harbor from head of Arsenal Island to the Chain of Rocks) a continuous double line of channel soundings was made from St. Louis to Cairo in December, 1907, during the lowest water of the season, and a single line of channel soundings between the same points during the flood of June, 1908. The total river distance covered by the survey is about 200 miles.

The valley survey.—The topographic survey of the bottom lands, covering about 600 square miles of territory, was completed in four months average time, by the three parties, including some additional levels and topography taken after the completion of the general field work.

Observations for the measurement of discharge of the tributaries of the Mississippi River between Alton and Cairo were taken in the following streams: The Big Muddy, at Sand Ridge and at Murphysboro; of the Wood River, about 2 miles above the mouth; of the Kaskaskia (Okaw) River, about 4 miles above the mouth; of the Meramec River, at Valley Park, and of the River Des Peres.

The stage of the water being then unfavorable for work near Cairo, and repairs being required on both steamers assigned to this work, topographical parties Nos. 1 and 2 were withdrawn from the field on completion of work by No. 1 in the upper part of the district, opposite Brickeys, Mo. (mile 46 below Eads Bridge, St. Louis), on April 20, 1908, and by No. 2 near the foot of Liberty Island (mile 85) on May 2, and they were then engaged in the office work necessary to complete the field plats.

Party No. 3 was disbanded about the middle of December, 1907, the chief of party and a few surveyors working up field notes in the St. Louis office till May 25, 1908, when, reorganized, it again took the field and completed the work near Cairo and Mound City.

Test borings.—Survey party No. 4 (borings) took the field November 8, 1907, and made 117 borings from government floating plant on 13 lines crossing the river and on a longitudinal line extending from St. Louis to Cairo and lying approximately 3,000 feet from the bluffs nearest the river. Nineteen land borings made under contract completed the transvalley lines.

Seven of the cross sections developed extend entirely across the alluvial valley, one across the main glacial channel at the head of the St. Francis basin, one at Grays Point, and one at Commerce, the head and foot of the narrow gorge through which the river passes; the three others are partial transvalley sections.

FIELD ORGANIZATION AND WORK.

The three topographic survey parties were intended to have practically the same general organization as to the instrument parties comprising each, and the same methods of work in the field; but the number of subparties engaged with each was subject to change to meet the varying requirements of the different sections of the district of river they were operating in, and the immediate needs that could be best served by change in such general arrangement.

As a result the organization varied as to the number of subparties engaged in the different classes of field work at any one time, but in general it may be said that the average organization for each of the three survey parties adhered closely to the following outline:

One assistant engineer (or junior engineer), as chief of party; the necessary number of surveyors (including a junior engineer if his services were available), with the requisite number of recorders, survey men, axmen, and boatmen, to constitute four transit parties, and one level party, and allow, additionally, a surveyor and recorder for work in the field quarters on general office reduction of notes and computations. Each transit party was composed of one instrument man, one recorder, and from three to five stadia rodmen; the level party consisted of one observer and two level rodmen. Three of these transit parties were to be engaged on topographic work exclusively, and the fourth party, to be in charge of the junior engineer, was, in addition to such work, to engage in the tertiary triangulation that might be required. One of the transit parties was also available for the work of sounding cross-section and

local channel lines. Boatmen and axmen were assigned to these parties as required to meet the needs of their work.

The following statement of the field operations of the three parties engaged on topographic and hydrographic survey work proper, and of the boring party, are taken from the reports of the several chiefs of party.

Survey party No. 1.—Junior Engineer Geo. H. Wolbrecht reported for duty with the Board September 21, 1907, and was engaged in the organization of the party and in other preparatory work until October 4, when the party entered the field. It completed its field work April 21, 1908, and returned to St. Louis, and there completed the field maps and engaged in other office work.

The floating plant of this party consisted, at the beginning, of one large quarter boat, six skiffs, and a fuel barge; the outfit was increased later by the addition of a small steam tender for towing the quarter boat, for sounding, and for transportation of field parties to and from work. This plant was all obtained by loan from the United States engineer office, St. Louis. The quarter boat, becoming unserviceable, was replaced by a small office and survey boat.

On January 1, the steam tender was returned to the fleet, as soundings had been completed and ice was running in the river. February 18, 1908, the steamer *Mercury* was obtained from the dredge fleet of the Mississippi River Commission. This boat being found incapable of towing the outfit upstream, was returned and the steamer *Choctaw* from the same fleet replaced it on March 6. This boat, together with the office boat, fuel barge, and skiffs, was continued in use till the end of the field season.

The party, consisting at the start of 32 men, was reduced in number January 1, 1908, to about 20, engaged in mapping and the reduction of notes, no field work being contemplated during the severe weather and period of running ice. Mild weather toward the end of January permitted the increase of the party to the full force, and it entered the field again February 1. During February and March, to expedite the work, the party was increased to about 54 men.

The field work of party No. 1 consisted of the topographic and hydrographic survey of the river and valley between and including the bluffs, extending from Guthrie street at St. Louis (4 miles below Eads Bridge) to Fort Gage, Ill. (mile 66). This was afterwards changed to include the "valley survey" as far as Red Rock Landing, Mo. (mile 89), with the exception of the east half of Kaskaskia Island which had been surveyed, but including the "Old River" back of that island, making a total of 72 miles of hydrographic survey and of 277 square miles of "valley survey."

The hydrographic survey was completed to Fort Gage (mile 66) December 1, 1907, and included the survey of the Missouri Valley to that point with all small islands and sloughs.

The "valley survey" of the Illinois Bottoms was immediately begun on completing the "river survey," and during the month of December about 45 square miles of topography was taken. The party then moved into winter harbor at the United States engineer fleet, Claryville, Mo. (mile 73), and the steamer was laid up. Field work was resumed toward the end of January, 1908, the party remaining in the Claryville Harbor and carrying on work in that vicinity as advantageous. The remainder of the Missouri Valley, including the Bois Brule Bottoms, was completed by detached parties boarding at farmhouses near the work. Progress was retarded by the muddy condition of the swamp lands, but this part of the survey was completed February 17. On March 6, the party transferred quarters to the steamer *Choctaw*, moved to St. Louis, and commenced work on the unfinished part of the "valley survey." Repairs were made to the steamer at the engineer depot, St. Louis, and the detached parties were transported by small tender. On April 20 this field work was completed and the party returned to St. Louis the day following.

In all, the party was in the field one hundred and ninety-seven days, of which time work was suspended for twenty days on account of winter and for thirty-four Sundays and holidays, thirteen days were lost on account of rain and snow, leaving an actual total of one hundred and thirty working days in the field. The discharge observations of the River des Peres, Meramec, Wood, Big Muddy, and Kaskaskia rivers were taken by this party.

Survey party No. 2.—Assistant Engineer Eugene L. Harman was transferred to the service of the Board on September 1, 1907, perfected the organization of his party, and entered the field on October 5, 1907, on the survey steamer *Patrol*, furnished by the Mississippi River Commission from its West Memphis dredge depot. This party varied in numbers from 35 to 65, the total of employees being dependent on both the needs of the field work and the possibility of continuing operations during inclement weather from winter quarters.

The survey was begun immediately on arrival of the party at Fort Gage, Ill. (mile 66 below Eads Bridge, St. Louis), the upper point of the stretch of the river and valley survey originally assigned to this party, which was to extend from the head of Kas-

kaskia Island (mile 65) to Moccasin Springs, Mo. (mile 117). Work on both river and valley surveys was continued until October 18, when the party was instructed to discontinue the simultaneous survey of both river and valley, and to concentrate efforts solely on the river survey and hydrography. This work was completed to a point near Moccasin Springs on December 3, the party then proceeding to Commerce, Mo. (mile 144), whence it continued the "river" survey downstream to connect with similar work of party No. 3, then proceeding upstream from Cairo. The joining of river survey work by these two parties was effected on December 12, and the steamer *Patrol* took party No. 3 in tow to the Fayville fleet of the United States engineer office; party No. 2 proceeded to St. Louis in order to make a continuous line of low-water channel soundings throughout the entire district from St. Louis to Cairo. This work was accomplished in five days, from December 17 to 21, and the party then returned to the Fayville fleet for winter harbor, running ice being expected.

Operating from this point as a base, topography was taken above Fayville to a short distance above Thebes, Ill. (mile 140), and also across the neck of land between the Mississippi and the Ohio rivers, from Fayville toward Mound City (Ohio River, 5 miles above Cairo). Work in this territory was continued until back water in the Cache River from the Ohio put a stop to further operations in that locality.

On the redistribution of the "valley survey" to parties Nos. 1 and 2, this party was assigned the stretch extending from Cora, Ill. (opposite the foot of Liberty Island, mile 84), to Gale, Ill. The survey of the valley was completed in this district, with but eight days' intervening delay on account of ice, on May 2, and the party returned to St. Louis to work up notes and complete the field maps of their territory.

In June, 1908, during and practically at the crest of the 1908 flood, a continuous line of high-water channel soundings was made from St. Louis to the mouth of the Ohio River by this party. It also made measurements of the volume of discharge of the Big Muddy River at Sand Ridge, and at Murphysboro, Ill., during their period of active field work.

Survey party No. 3.—Assistant Engineer Geo. H. French entered on his duties as chief of this party on September 1, 1907, and as the assignment of territory gave him the lower part of the St. Louis-Cairo district, the outfit for his party was made ready before that of the two other parties. This party, completely organized, entered the field September 18, 1907, being subsisted on a quarter boat obtained by loan from the United States engineer office, St. Louis, which had been fitted up at the engineer depot for the use of that party.

The first distribution of survey territory gave for this party the stretch of river and valley extending from Moccasin Springs, Mo. (mile 117 below Eads Bridge, St. Louis), to Cairo, Ill. (mile 185), the mouth of the Ohio River, and thence to farther extend up the Ohio River to Mound City, Ill. (Ohio River 5).

The party arrived at Moccasin Springs on September 21 and began field operations on September 23. Work was started at the head of Vancill Towhead (mile 115) and topography was taken on the left bank to the Illinois Central Railway tracks, a distance of 2½ miles from the river, as a limit. This procedure was continued till October 16, when the entire force was directed to engage in the "river" survey alone. This work was carried to Grays Point, Mo. (mile 137), on November 7, when the party was transferred to Brewers Point (mile 166) to continue in the same manner of work to Cairo, and thence up the Ohio River to Mound City. On this assignment work was commenced at the lower end of Greenleaf Bend (mile 168) on November 8 and completed from Brewers Point to Mound City on November 23. The outfit was then moved to Hacker Towhead (mile 157) on the 24th, and work was resumed upstream to connect with the work of party No. 2, and that connection was made at Commerce, Mo. (mile 144), on December 11. The party then moved to Fayville fleet of the United States engineer office, and from that point as a base of operations resumed work at Grays Point, which was continued until connection was established with the work of party No. 2 at Commerce, Mo., on December 18.

The party was disbanded on December 19, and Assistant Engineer French, with two surveyors and two recorders, proceeded to the St. Louis office and engaged in the reduction of notes and the completion of their field maps.

On the 25th of May, 1908, the party was reorganized to complete some unfinished topographical work in the vicinity of Greenleaf Bend (mile 168), Bird Point, Mo. (mile 181), and Mound City, Ill.

This latter work of the party was done with the steamer *Patrol*, and the field work consisted of filling in the gaps omitted in the previous survey, and the survey of the entire peninsula from Beechridge (mile 169), including the village of Mounds (mile 173), on the Mississippi, and the town of Mound City (mile 5), on the Ohio, to and including the city of Cairo, and a stretch of country west of Bird Point (mile 181) and north of the St. Louis, Iron Mountain and Southern Railway to Stevenson's Bayou (mile 178) and 5 miles west of Bird Point. Also country on the left bank of the Ohio from Cache

Island and the railroad bridge to a point above Wickliffe, Ky. Work was continued till June 26, when high water interfered and the outfit was taken to the Fayville fleet of the United States engineer office, the party disbanded, and the steamer *Patrol* returned to the Mississippi River Commission dredge depot. Assistant Engineer French and 10 surveyors and recorders returned to St. Louis to prepare field maps of the work.

Survey party No. 4.—The boring party, organized in the first part of November, 1907, with Junior Engineer Philip Florreich, jr., in charge, a foreman, pilot, steam engineer, recorder, and necessary subordinate help, made all borings in the river and supervised those made on land. The large number of the river borings as well as their nature and the expensive floating plant required, almost precluded the possibility of having them made by contract labor. The land borings were made by James Kinney, jr., under contract; his outfit was transported by river by the United States.

The floating plant borrowed from the United States engineer office, St. Louis, consisted of an office and survey boat, steam tender, pile driver, fuel barge, wooden flat, and three skiffs. As the work progressed another pile driver and a crew of foreman, recorder, and six men were added on December 16, and later a repair-shop boat. When the line of channel borings was begun, a surveyor, three inspectors, two recorders, and additional stokers and watchmen were added, the office boat and tender returned, and the steamer *Choctaw*, of the Mississippi River Commission, obtained by transfer from survey party No. 2, as the tender was not of sufficient power to move the larger plant and land-boring outfit expeditiously and economically and quarters were not adequate to accommodate the increased force.

The river borings were made from pile drivers by means of a pipe with jet drill attached, operated in a casing formed by a larger pipe. The water from the jet returned through the space between the pipes, bringing up pieces of the material penetrated, and was discharged at the upper end. The casing was forced down by a drop hammer, while material at the bottom was broken and loosened by the churning of the drill attached to the jet pipe combined with the action of the water jet. The discharged specimens of material were taken for record. When bed rock was struck it was penetrated sufficiently to distinguish it positively from alluvium. Bed-rock penetration varied from three-tenths of a foot to 2 feet.

Location of boring ranges.—Borings were made on various cross-section lines and also on a longitudinal line. The cross-section lines were located at points of least distance between bluffs on opposite sides of the river, also where floating plant could operate entirely across the river from bluff to bluff. Partial sections were also made where especially favorable circumstances made other borings possible without great additional cost or much loss of time.

Borings on the longitudinal line from St. Louis to Cairo were as nearly as possible 3,000 feet from either the Missouri or the Illinois bluffs, and spaced from 3 to 5 miles apart.

In downstream order from St. Louis, cross-section ranges were as follows: Cliff Cave, Meramec River, Danby Landing, Mudds Landing, Ste. Genevieve Bend, Menard, Liberty Bend, Fountain Bluff, Union Point, Devils Tea Table, Head of St. Francis Basin, Grays Point, and Commerce. Of these the Menard and Liberty Bend cross sections were made with the floating plant and extended across the entire alluvial valley. Cliff Cave, Mudds Landing, Devils Tea Table, and Fountain Bluff ranges were made with both the river and land boring plants. On Ste. Genevieve Bend section only four borings were made, with the river plant alone, but it forms another very fair section extending across the entire valley. The cross section at the head of the St. Francis Basin was developed by borings along the shore in Cape Girardeau Bend and extends from the bluffs at Cape Girardeau to the upstream side of the isolated ridge at Grays Point.

The other sections, at Meramec River, Danby Landing, and Union Point, are partial sections not extending beyond the river banks.

The drivers were moved into position by steamboat and moored to the banks or to piles specially driven, or anchored. For channel borings where the depths were too great to drive piles, two anchors for head lines and two or more for side lines were used.

In boring, the lead end of the driver was downstream, and a wooden flat was placed immediately below, on which to couple pipe and carry all boring apparatus; when drawing the casing the flat was placed partly under the leads of the driver, thus giving additional buoyancy.

Casing of 4-inch double extra strong pipe was used and found very satisfactory, affording enough bearing surface at joints to stand driving and possessing sufficient strength and thickness to prevent bending. Sections in use were firmly joined with double extra strong hydraulic couplings.

It was found by experience that the most satisfactory form of drill was a cross or X bit with five jet holes so designed as to give a maximum cutting edge without reducing the jet stream. Several other types were tried, but none found equal to this drill, and the successful results of the boring operations are largely due to its use. The churning of the drill was done with a line from the end of the jet pipe passing over a pulley in the top of the leads to a winch on the hoisting engine.

Drive shoes on the end of the casing were also tried. They were found of no advantage, and as they were soon broken and badly worn, their use was discontinued and the casing was driven without protection of the lower end.

The casing was connected to a nipple fitted permanently into drive head. This was found necessary, as from constant use the shoulder of the drive head became battered and worn, spoiling the threads of the casing that entered, which in turn ruined the joints between the following sections, necessitating frequent renewals. By inserting the nipple permanently the coupling on the end of the sleeve replaced the threaded portion of the drive head, with the advantage that when worn it could be replaced with another coupling. In this way wear on the threads of the casing pipe was practically eliminated.

Drive heads were used in two forms, one circular made from 6-inch round steel, and one with square top of cast steel, and were designed for driving either 4-inch or 6-inch casing. Both were found very satisfactory with the exception noted, that of stripping the threads of the casing by continued service, which was overcome by use of a nipple. There were two openings in the heads so that discharge of material could be made on the flat.

A 6-foot length of 4-inch ordinary pipe was screwed into the upper end of the drive head, serving as a standpipe to keep discharge water from overflowing, as a guide for the hammers, and as a protection for the jet pipe. A cast-steel plate 12 inches square and 2 inches thick beneath an oak block 12 inches thick was placed immediately over the drive heads to distribute the blow of the hammer and act as a buffer.

For a hammer use was made of two pile followers or guides, with hole to allow vertical movement on the standpipe, and a casting of similar shape, but not dished, which was used below the hammer to prevent wear on the buffer block. The weights composing the hammer (totaling about 1,400 pounds) were fastened with iron cable to which were attached the ends of the bridle line passing over a pair of pulleys in the top of the leads and thence by single line to the hoisting drum. The hammer, drill, and water jet were operated simultaneously, the hammer at about 40 blows per minute, with an average drop of 1½ feet; the churning was done independently of the driving and required constant attention to prevent penetration of the drill below the casing, which would result in loss of back flow through the casing, permit the entrance of gravel, the clogging of jet, packing by sand, and minor troubles depending on character of material penetrated.

Land borings.—The land borings were made under contract, using three Keystone well-drilling outfits. Of the borings made 16 were to complete cross sections on which the river borings were already made, 4 being necessary at Cliff Cave, 5 at Mudds Landing, 5 at Devils Tea Table, 2 at Fountain Bluff, and 3, for special examination, were on almost straight line between Fayville (old river town of Santa Fe) and Beechridge, Ill.

The casing used was 6 inches in diameter, both ordinary and extra strong pipe being employed. It was driven with the regular drop weight of about 1,500 pounds. The material was broken down with a churn drill consisting of stem and bit that together weighed about 800 pounds; the casing was bailed with the regular sand pump.

The land-boring party was engaged from May 28 to August 21, a period of almost three months, working one hundred and fifty drill days of eight hours each and making 19 borings. This time does not include that required for movement of contractor's plant from one locality to another by the United States boring party.

Notes and records.—For determining depths of river borings the leads of the driver were graduated in feet and half feet, the water surface being zero. The top of the casing pipe was used as the index of the depth. The lengths of pipe sections were recorded when attached, and when put in position the height above water surface as indicated in the leads was noted.

A record of fluctuations in river stage while a river boring was being made was obtained by a temporary gauge near the borings or from readings of a permanent gauge if near the work. Soundings were taken at the drivers for a better determination of the bottom depth, as the depth shown by the top of the casing when first lowered was generally too great on account of the casing sinking into the bed of the river for several feet. A similar method of determining depths penetrated was followed in the case of land borings, using a graduated rod erected near the boring, having its zero at the ground surface, the elevation of which was determined.

The record of the borings kept in notebooks was supplemented by a complete and independent record on tags attached to the cans in which the specimens were temporarily kept; subsequently samples were prepared in glass tubes on a scale of one-fourth inch to 1 foot for study and comparison of strata.

Character of strata penetrated.—The material forming the river bed consisted almost entirely of glacial drift varying in size from fine silt to coarse gravel and bowlders. For convenience it may be classified into silt, quicksand, fine and coarse building sand, fine and coarse gravel, and bowlders. Besides this glacial drift there were also various clays and soils as Loess clay, which occurred near the bluffs, various colored gumbo, sticky impervious clay (hardpan), and ordinary tillable or humus soil. Logs and particles of lignite were often encountered. Fire clays, slate, shale, and various siliceous formations were encountered overlying the bed rock. These were generally only a few feet in thickness while the thickness of the alluvium proper varied greatly. However, the silica formation, according to records of oil-well boring at Grand Tower, was 250 feet in thickness.

A close study of the sample tubes fails to show stratification or any regularity in the occurrence of the material. In chemical composition the particles of sand and gravel varied slightly, being in almost all cases particles of acid crystalline rocks consisting of quartz, granite gneiss, porphyry, and other siliceous rock, quartz predominating. While the arrangement of the material was very irregular the classification of the different varieties according to size and color was very distinct, sands of same size of particles but of different colors being distinctly separated and rarely found mixed and then mostly in the sands near the surface. Thus a green sand will be free from particles of different color, though sands of apparently the same size and density but of different colors will be found in close proximity on the same boring. This would seem to indicate that the material was deposited and transported in frozen masses by glacial action rather than as sediment by flowing water.

The local sedimentary rocks, limestone, and sandstone were seldom found except as bowlders near the bluff shores. Bowlders of quartz, granite, and potsdam sandstone a foot or more in diameter were sometimes also encountered.

Number of borings.—The total number of borings made by United States party (not including experimental ones and those abandoned on account of extreme depth of bed rock or other reasons) was 117, with a total penetration of 12,060 feet, an average depth for each boring of 103.1 feet below the water surface or 91.8 feet below the bottom.

The number of borings made on land by the contractor was 19, with a total penetration of 2,473 feet to an average depth of 130 feet below the surface of the ground.

In addition to the regular work jet borings were made with pile driver in the latter part of December, 1908, to investigate the nature of the river bottom in the gorge between Grays Point and Commerce, particularly in the vicinity of the Paul Jones rock, where it was suspected as a result of comparisons of cross sections developed by surveys in different years that bed rock might be found within short distance of low water. The borings disclosed bed rock approaching to about 17 feet below low water over the greater part of the cross section.

FIELD OPERATIONS BELOW CAIRO.

[These operations were carried on under the direction of the recorder.]

During 1907 the Mississippi River Commission carried on experimental dredging at three crossings with a view to determining the feasibility of obtaining and maintaining a 14-foot channel by that means. The Board took cognizance of these operations, and, having access to the reports and records of the commission, has made a study of the results of the experiments. The 14-foot experimental dredging was resumed by the Mississippi River Commission at the beginning of the low-water season of 1908, and the Board was authorized by the commission to select, in the interests of the Board's work, the localities for the operations. The Board selected three localities—Corona, Uzells, and Linda—and the dredging was prosecuted at the first two of those points throughout the season and at the third after October 28.

Measurement of the length of caving banks between the mouths of the Ohio and Red rivers was carried on under the Board's direction during the low-water season of 1907, and the entire stretch was covered between October 9, 1907, and January 31, 1908. This work was done by the Mississippi River Commission gauge inspection and survey parties specially organized to carry on the extra work of measuring the caving banks.

These parties also made soundings of crossings between the mouths of the Ohio and Red rivers to determine which ones had at any time channel depths less than 14 feet.

OFFICE WORK.

General.—The preparation of the final charts of the Board's survey of the stretch of river between St. Louis and Cairo was accomplished by the regular drafting force of the secretary's office, Mississippi River Commission, under the personal direction of Assistant Engineer C. W. Clark. These are detailed topographic maps, drawn in 17 sheets, 44 by 72 inches, on a scale of 1:10,000, depicting the various features of topography, hydrography, and bed-rock determinations, and other details as to protection works that have been constructed for the improvement of the river in that district and of such works as are still existing, with tables showing the stages of the river and graphical depiction of the principal data of each gauge shown or referred to.

The drafting of the maps comprised the projection and index charting of the 17 sheets and the transference to them of the topography and hydrography depicted on the field sheets, which were forwarded by the survey parties as completed.

Various survey data pertaining to the sections of the Mississippi River above or below the mouth of the Ohio River, as mentioned later, were also placed on these maps.

These maps were completed early in October, and as they had been prepared with a view to the reproduction on reduced scale, advantage was taken by the St. Louis United States engineer office and Mississippi River Commission of the interval between their completion and the termination of investigations then in hand by the Board to accomplish their reproduction on a scale of 1:20,000, the work being done by the United States Lake Survey, Detroit, Mich.

Mr. Clark personally prepared a small scale general map showing the territory adjacent to the proposed 14-foot waterway between the Great Lakes and the Gulf of Mexico.

A graphical representation of the discharges of the Mississippi River from Grafton, Ill., to Red River was prepared, and tables of all available discharge data of the same stretch of river were compiled under the direction of Assistant Engineer Kivas Tully. He also prepared a general statement of past projects and of total appropriations for the improvement of the Mississippi River between St. Louis and the Gulf.

A condensed statement of the main physical characteristics of the Mississippi River between St. Louis and the Gulf of Mexico was prepared by the recorder under the direction of the Board, with accompanying diagrams and tables.

A comprehensive profile of the Mississippi River from St. Louis to the mouth of the river was prepared showing high and low water planes, and bed of the river.

A curve of discharge of the Mississippi River at St. Louis was constructed from data obtained from the Mississippi River Commission, 1880–81, and a similar curve from the data obtained by the United States engineers office, St. Louis, in 1900–1904, were prepared for the purpose of comparison.

Hydrographs were prepared of the principal gauges between St. Louis and Cairo for the fiscal year 1907–8, for use in connection with the maps from the Board's survey; also a comprehensive hydrograph of these same gauges for the periods since they were established up to June 30, 1908.

Hydrographs of these principal gauges were made for the period from 1896 to 1907, inclusive, showing the mean, maximum, and minimum stages for each day of the year.

A sheet of typical cross sections of the Mississippi River in wide, narrow, and medium width reaches with a datum plane, was prepared, and show also high and low water marks; the location of these typical cross sections has been indicated on the original maps.

The bench marks, triangulation stations, high-water marks, and similar data, pertaining to the Board's survey of the St. Louis-Cairo stretch of river, has been tabulated, and the descriptions prepared.

A condensed profile of the stretch of river between St. Louis and Cairo was prepared and shows comparative thalweg of river bed in 1907 and in 1884–89 (Mississippi River Commission survey); planes of floods and low water and the underlying bed rock.

Profiles in three sheets each, prepared to accompany the slack water and the lateral canal projects, and two profiles, a single sheet each, were prepared on blueprints of the condensed profile for the project for complete regulation works.

Sets of the photolithographic reproductions of the Board's St. Louis-Cairo survey were also prepared to show the proposed works under the first two of these projects.

Cross sections showing bed rock as developed by borings, and also the location and depth of all borings made, have been shown on the detailed charts; a longitudinal profile of bed rock along the approximate channel of the river from St. Louis to Cairo was prepared, showing the depth of the borings and the character of the strata penetrated, also showing planes of floods and low water and the river bed. Cross sections showing similar details were also prepared for the transvalley lines of borings.

Borings made by bridge companies, and in investigations by the United States engineer office, St. Louis, have been platted, and cross sections at the bridges showing bed-rock profile, clearances above high water, etc., have been placed on the final charts.

Sample tubes for all borings have been made for study of the strata penetrated.

Tables were prepared giving river stages at principal gages between St. Louis and Cairo, from the dates of establishment of the gauges to June 30, 1908.

Reports of the experimental dredging operations of the season of 1907 and 1908 were received and digested. Surveys of the crossings before, during, and after the 14-foot dredging were studied, and reports on the operation of both seasons were prepared by the recorder (for the first year in his capacity as secretary of the commission, for that body, and in the second year in his capacity as recorder of the Board). The recorder's report of 1908 operations appears in Appendix No. 9.

The reports and maps of caving banks between the mouths of the Ohio and Red rivers, as received from the field were compiled and tabulated. A diagram in 7 sheets in colors has been prepared showing the length of caving banks and their approximate location, and the rate of caving throughout the stretch. A map covering the entire stretch was prepared in 1 sheet and gives the approximate locations and the lengths of caving banks.

All authoritative reports of soundings on crossings between mouths of the Ohio and Red rivers were tabulated in cooperation with the Mississippi River Commission for both years, and all maps of bar surveys in the stretch were examined, and from the results a table was prepared for each of the two years, giving the names and locations of all the bars in the stretch where a channel depth of less than 14 feet occurred during the low-water seasons, and giving also the least depth found on each of these bars during each year.

The data as above obtained and the reports on past dredging and bank protection and contraction operations under the Mississippi River Commission and the gauge records of the district were studied and an estimate of cost of the improvement of the river between Cairo and the Red River was prepared under the direction of the Board by the recorder.

Except as noted below, all maps, profiles, tables, and other data used by the Board and enumerated above were prepared under the general supervision of the recorder; those pertaining to the stretch of river above Cairo were prepared under the immediate supervision of Assistant Engineer Wm. M. Penniman. The regular drafting force of the Mississippi River Commission, augmented by the computing and drafting force of the Board, performed all computing, mapping, and preparation of hydrographs, profiles, and miscellaneous data.

At the United States engineer office, St. Louis, some work was done under the direction of Assistant Engineer Wm. S. Mitchell (in addition to his preparation of a 14-foot dredging project for the district between St. Louis and Cairo), and consisted of the preparation of data for the use of the Board in its investigations; the more important items of this work were the tabulation of a statement of cost of work done under that office for the improvement of the St. Louis to Cairo stretch, with estimates of the cost of work to complete that project; a comparative curve showing the relation between depths on crossings and to river stages for the St. Louis-Cairo district; a measurement of the eroded areas and their volumes in that district for the last three decades; a tabular statement regarding the permanent and perishable works of improvement in the Mississippi River between St. Louis and Cairo, with showing of cost and character, prepared for the use of the Board in its studies. Also the compilation of data for the preparation of the hydrograph of the St. Louis gauge for the period from 1861 to 1908.

PROJECTS FOR IMPROVEMENT.

Projects have been prepared for the improvement of the Mississippi River below St. Louis to the Gulf of Mexico, to produce and maintain a waterway having a navigable depth of 14 feet; the entire route has not been treated as a unit, but has been considered in two sections—above the mouth of the Ohio River from St. Louis to Cairo and below the mouth of the Ohio from Cairo to permanently deep water.

For the section above Cairo the following projects have been prepared:

For obtaining and maintaining the desired channel by means of hydraulic dredging alone, by Assistant Engineer Wm. S. Mitchell.

For complete regulation of the open river by means of works of permanent improvement, by Assistant Engineer Wm. M. Penniman.

For slack-water navigation within the river itself by means of a system of movable dams, by Assistant Engineer J. W. Woermann.

For a system of canal or canals, several routes being offered by Assistant Engineer J. W. Woermann.

For the section below Cairo a project has been prepared for improvement—

By means of hydraulic dredging, with contraction and bank-protection works, by Capt. G. R. Lukesh, Corps of Engineers, U. S. Army, recorder of the Board.

ADMINISTRATION

All office and field work under the Board, except such as was done by members or by committees, was under the general supervision of the recorder, Capt. G. R. Lukesh, Corps of Engineers, U. S. Army. He retained personal charge of the field and office work below Cairo and general supervision of work throughout the entire stretch. The field and office work in the district between St. Louis and Cairo was under the immediate supervision of Assistant Engineer Wm. M. Penniman.

The disbursement of the funds of the Board was handled entirely by the secretary of the Mississippi River Commission. (Until November 30, 1908, the recorder of the Board was the secretary of the Mississippi River Commission, and since that date First Lieut. C. H. Knight, Corps of Engineers, U. S. Army, the secretary of the commission, has been the disbursing officer of the Board.)

One clerk, James N. Patrick, formed the permanent staff of the Board, and was engaged on Board duties exclusively.

Purchases of instruments, plant, and supplies such as could not be obtained from the Mississippi River Commission or the United States engineer office, St. Louis, were made by the secretary of the Mississippi River Commission. The survey parties above Cairo were supplied and outfitted principally by the St. Louis engineer office, using the plant of that office, but at the expense of funds in the hands of the disbursing officer of the Board.

Miscellaneous office work, property accounts, correspondence, typewriting, and so on, was divided between the offices of the recorder of the Board and the secretary of the Mississippi River Commission.

APPENDIX No. 22.

A COMPILATION OF DATA IN REGARD TO PERMANENT MARKS OF MISSISSIPPI RIVER SURVEY, ST. LOUIS, MO., TO CAIRO, ILL., WITH A BRIEF HISTORY OF THE PRINCIPAL GAUGES OF THE MISSISSIPPI RIVER BETWEEN ST. LOUIS AND CAIRO AND A RECORD OF EXTREME HIGH-WATER MARKS BETWEEN GRAFTON, ILL., AND COLUMBUS, KY.

[Prepared under the direction of the Board on Examination and Survey of Mississippi River (created by act of Congress March 2, 1907) by Wm. M. Penniman and J. W. Skelly, assistant engineers, and Geo. H. Wolbrecht and Philip Florreich, jr., junior engineers.]

The following data, with descriptions, of permanent marks of United States surveys in the alluvial valley of the Mississippi River between St. Louis, Mo., and Cairo, Ill., is designed to embrace all such marks now in existence.

Its scope includes the permanent marks shown on the charts (published in seventeen sheets) of the survey of 1907–8 of the Board on Examination and Survey of Mississippi River, or located within the territory covered by them, and also a few permanent marks of unusual importance or prominence closely adjacent to but not within the limits of those charts.

The compilation includes the secondary and tertiary triangulation stations, the precise level and the stone-line bench marks of the Mississippi River Commission; the tertiary triangulation stations and bench marks of the United States engineer office, St. Louis, Mo., and the tertiary triangulation and base-line stations of the Board on Examination and Survey of Mississippi River.

The latitudes and longitudes of the secondary triangulation system of the Mississippi River Commission, 1880–81, are derived geodetically from the United States engineer astronomical station of 1876 at Cairo, Ill., and all other geographic positions contained herein are controlled by that system of triangulation.

The elevations given are based on the precise levels of the Mississippi River Commission of 1880–81, and are shown in feet above Memphis datum plane, which is 190.84 feet below the zero of the United States engineer gauge at Memphis, Tenn., 420.84 feet below the St. Louis "City directrix," and approximately 6.84 feet below mean sea or gulf level.

With a few exceptions, the stations marked "U. S. Coast and Geodetic Survey" were included in the secondary triangulation of the Mississippi River Commission, and, unless otherwise stated, only the latter determinations are given. For the latest United States Coast and Geodetic Survey values for such stations see their Special Publication No. 4, 1900, "The Transcontinental Triangulation," as follows: Descriptions, pages 77–79; geodetic positions, page 859.

The stations are scheduled in the downstream order of the seventeen charts from St. Louis to Cairo; the stations pertaining to each separate chart are arranged in descending order by latitudes.

The authority and survey date is indicated for each station; the chart number following title indicates that station is plotted on the chart so referenced; "not plotted" follows the reference for stations within the limits of the charts but not depicted. Stations not within the limits of the maps are so noted.

The latitudes and longitudes are given to seconds and hundredths; the equivalents of the seconds are given in meters to the nearest meter, the positive value first with plus sign, and followed by the minute complement with minus sign.

The expression of azimuths, distances, and elevations has been carried only to such degree as is considered commensurate with the accuracy of the determining survey, or with the value of the reference. Those which occur as whole numbers are given without use of decimal point and zeros.

The descriptions of the permanent marks are the latest available; they were compiled largely from the field notes and original records, and all published data of the various offices and surveys cited as authorities have been used.

The following symbols are used to designate the class of a permanent mark: ⊛ = secondary triangulation; ▲ = tertiary triangulation; ⊙ = permanent bench mark, determined by precise levels; ⊡ = stone-line or other bench mark, determined by ordinary levels; and ⊕ = base-line station of the Board on Examination and Survey of Mississippi River.

A brief history, or description, of the principal river gauges of the Mississippi River between St. Louis and the mouth of the Ohio River, and of the Ohio River gauge at Cairo is given, with mention of bench marks conveniently located for the verification of the gauge elevations; and the authorities for the data given are also cited.

A record of extreme high-water marks of the Mississippi River between Grafton, Ill., and Columbus, Ky., completes this appendix. Data were obtained from various sources for this compilation; and for the floods of 1785 and of 1844 the record embraces all authentic marks and references of value that could be found. Below Thompson Landing, Mo., the Ohio River flood of 1883 is the highest reliably recorded, and appropriate notes on that flood have been included under the 1844 record.

PERMANENT MARKS OF MISSISSIPPI RIVER SURVEY BETWEEN ST. LOUIS, MO., AND CAIRO, ILL.

⊛ KENDALL.

Missouri River Commission, 1887. (Not in limits of Board on Examination and Survey of Mississippi River charts.)

Latitude 38° 50′ 39″.69, meters +1,224, −626.

Longitude 90° 02′ 40″.58; meters +979, −468.

To⊛Sugar Loaf, azimuth 348° 39′ 24″, distance 16,176.1 meters.

To▲Intake Tower, azimuth 50° 32′ (1905).

To▲Chain of Rocks, azimuth 52° 26′ (1905).

To▲Madison Chimney, azimuth 44° 51′ (1905).

To▲Granite City, azimuth 31° 21′ (1905).

Stone post, marked with 6-inch iron pipe with cap, 6 inches above ground, in Illinois; 75 feet north of the Alton and Edwardsville road; about one-half mile north and one-fourth mile west from the southeast corner of section 36, township 4, range 9, west, at which corner is the railroad station, Wanda. It is on the highest point of the bluff; in thick brush 30 feet south of the road that leads to house of Simpson brothers, owners of sourrounding land. (The latitude and longitude given above were derived by adjusting the Missouri River Commission values for this station to the Mississippi River Commission triangulation, and the azimuth to ⊛ Sugar Loaf was like wise adjusted.)

▲ MISSOURI RIVER.

United States engineer office, St. Louis, Mo., 1901. (Not in limits of Board on Examination and Survey of Mississippi River charts.)

Latitude 38° 49′ 35″.64; meters +1,099, −751.

Longitude 90° 06′ 31″.53; meters +761, −687.

To▲Levee, azimuth 13° 26′ 05″, distance 2,860.7 meters.

To⊙P. B. M. 11, azimuth 289° 42′ 52″, distance 399.5 meters.

Iron pipe, flush with surface of revetment opposite mouth of Missouri River. It is 48 feet southwest from blazed elm tree; 42.7 feet west from another blazed elm tree; 31.7 feet west from a spike about 6 inches above ground in a large elm tree with crotch, near river bank. The 1,500-foot stake of the United States engineer office revetment or bank protection is 1 foot west and 1 foot south of this spike. The station is on edge of revetment and 1,310.8 feet from P. B. M. 11, Mississippi River Commission.

⊙ P. B. M. 11.

Mississippi River Commission, 1880. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 49′ 31″.27; meters +964, −886.
Longitude 90° 06′ 15″.94; meters +385, −1,063.
Elevation: 420.70.
To△Missouri River, azimuth 109° 43′ 01″, distance 399.5 meters.
Top of copper bolt in stone post in woods; 2 meters north of a honey-locust tree; about 10 meters north of road; and 11 miles below Alton, Ill. Stone is 400 meters back from river bank, opposite the point of Missouri shore, at upper mouth of Missouri River. There is a road leading back from the river past the station. The road leads through the woods and is nearly grown over now.

△ LEVEE.

United States engineer office, St. Louis, Mo., 1901. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 48′ 05″.41; meters +167, −1,683.
Longitude 90° 06′ 59″.08; meters +1,426, −22.
To△Missouri River, azimuth 193° 25′ 48″, distance 2,860.7 meters.
Iron pipe, about 6 inches below the surface and on the end of a broken levee in Illinois; near the foot of the "Missouri River" revetment, in 1901. A mound of stone covers and marks the station. Four elm trees on the slopes of the levee are blazed with nail and triangle. Their distances are: To tree northeast from station, 20.80 feet; southeast, 14.64 feet; southwest, 16.85 feet; northwest, 18.18 feet.

△ CHOUTEAU ISLAND NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 46′ 56″.72; meters +1,749, −101.
Longitude 90° 09′ 06″.57; meters +159, −1,290.
Iron pipe, 6 inches above ground, 235.6 feet back from△Chouteau Island, in Illinois; 12 feet west from field and 4.96 feet east from spike in blazed willow 8 inches in diameter; 20.7 feet north from spike in blazed willow 7 inches in diameter on same slope; and 32.6 feet south from spike in willow, 6 inches in diameter, blazed 5 feet above the ground.

◬ AMERICAN BOTTOM UPPER BASE.

United States Coast and Geodetic Survey, 1872. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 39′ 50″.16; meters +1,547, −303.
Longitude 90° 00′ 58″.61; meters +1,417, −34.
Elevation: 528.44.
To◬Insane Asylum, azimuth 73° 51′ 10″.81, distance 23,849.45 meters; back azimuth, 253° 41′ 19″.72.
To◬Clarks Mound, azimuth 26° 44′ 35″.69, distance 10,509.11 meters; back azimuth 206° 42′ 33″.75.
To◬American Bottom, azimuth 24° 40′ 11″.88, distance 7,266.884 meters; Lower Base, back azimuth 204° 38′ 53″.62.
The station is situated on the west slope of the Illinois bluffs, on the east side of the American bottom in Madison County, Ill., opposite St. Louis; on land belonging to Mr. A. Sumner; about one-fourth mile north of the road from East St. Louis to Collinsville, and a short distance east of the road running north from the Collinsville road along the foot of the bluffs. The center is marked by a cross cut on a copper bolt set in the top of a limestone monument 12 by 14 by 40 inches, inscribed in a similar manner as the monument at Lower Base. An earthenware pyramid is buried 4 feet below the surface of the ground directly under the cross on the copper bolt. Two reference posts were set, one in prolongation of the base, and one at right angles to the eastward, each 5 by 5 by 30 inches, and distant 24 feet from the center.
The center of the head of the copper bolt inserted in the stone monument marking the base is B. M. "H_3" of the United States Coast and Geodetic Survey.
Elevation derived by adding 6.87 feet to the United States Coast and Geodetic Survey mean sea level value of 1903. (See note under "K_3" St. Louis City Directrix; and for latitude, longitude, azimuths, and lengths of lines, see "Note" under Lower Base.)

◬ AMERICAN BOTTOM LOWER BASE.

United States Coast and Geodetic Survey, 1872. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 36′ 15″.98; meters +493, −1,357.
Longitude 90° 03′ 03″.96; meters +96, −1,356.
To◬Insane Asylum, azimuth 89° 53′ 40″.73, distance 19,875.51 meters; back azimuth 269° 45′ 08″.24.
This station is situated on the west slope of the Illinois bluffs, on the east side of the American bottom, in St. Clair County, Ill.; opposite St. Louis, on land belonging to Mr. Francis Simoin; and on the west side of the road running north from the Belleville rock road along the foot of the bluffs through the small settlement of French Village. It is about 1 mile from the rock road and one-fourth mile from the village; 4 meters west of the fence at the side of the road; and about 193 meters north of Mr. Davenrol's house. The center is marked by a cross cut on a copper bolt set in the top of a limestone monument 12 by 14 by 40 inches, having the letters U. S. C. S. cut on the side facing the base, 1872 on one side, and BASE on another. An earthenware pyramid is buried 4 feet below the surface of the ground, under the cross on the copper bolt Two reference stones were set, one in prolongation of the base, distant 39.37 feet, and the other at right angles to the eastward, distant 63 feet from the center.
NOTE.—The values of the latitudes and longitudes given for both ends of base were derived by comparison of the published results of the surveys of the United States Coast and Geodetic Survey (Special Publication No. 4, 1900) and of the Mississippi River Commission secondary triangulation, and reduced to the latter system. The lengths and azimuths of lines from both stations are the United States Coast and Geodetic Survey values taken from the same publication.

◬ INSANE ASYLUM.

United States Coast and Geodetic Survey, 1871, redetermined by Mississippi River Commission, 1880–81. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 36′ 13″.99; meters +431, −1,419.
Longitude 90° 16′ 45″.37; meters +1,098, −354.
To◬Clarks Mound, azimuth 278° 26′ 41″.11, distance 18,387.10 meters.
To◬Dryer, azimuth 328° 13′ 50″.30, distance 13,331.28 meters.
To◬Standpipe, azimuth 219° 42′ 23″.41, distance 9,606.16 meters.
Is about 5 miles southwesterly from the court-house at St. Louis and about 500 feet south of Arsenal street, at a point about one-half mile westerly from its intersection with Kingshighway, at Brannon avenue and Arsenal street. The geodetic point is the finial of the cupola of the building. Eccentric stations were occupied on the main floor of the cupola.

◬ CLARKS MOUND.

United States Coast and Geodetic Survey, 1872, and Mississippi River Commission, 1880–81. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 34′ 45″.75; meters +1,411, −439.
Longitude 90° 04′ 13″.97; meters +338, −1,115.
To◬Standpipe, azimuth 130° 04′ 14″.84, distance 15,717.51 meters.
To◬Dryer, azimuth 52° 25′ 32″.25, distance 14,116.73 meters.
To◬Insane Asylum, azimuth 98° 34′ 29″.80, distance 18,387.10 meters.
To◬Sugar Loaf, azimuth 201° 51′ 33″.35, distance 14,606.56 meters.
A United States Coast and Geodetic Survey station on Clarks Mound (supposed to be of Indian origin) situated on bluffs about three-fourths of a mile south of French Village and Belleville rock road, St. Clair County, Ill. The station can best be reached by a road leading off the Belleville rock road to a farmhouse belonging to Mr. Ogle and tenanted in 1872 by Mr. Mitchell. The road spoken of leaves the Belleville road about 1 mile east of French Village. Geodetic point is an earthenware pyramid buried about 4 feet under the surface. Surface mark is a marble post 6 inches square about 10 inches above ground, marked U. S. C. and G. S.

⊙ P. B. M. 12.

Mississippi River Commission, 1880 and 1889. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 38° 46′ 52″.70; meters +1,625, −225.
Longitude 90° 10′ 55″.72; meters +1,345, −103.
Elevation: 464.76.

Top of copper bolt in stone post on right bank; in corner of grove; 66 feet west of Columbia Bottom road; 1¼ miles upstream from Chain of Rocks; on land of B. M. Chambers; and 2,300 feet upstream from bridge on Columbia Bottom road over Watkin's Creek.

△ CHOUTEAU BAR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 46′ 12″.52; meters + 386, −1,464.
Longitude 90° 10′ 13″.34; meters +322, −1,127.
To △ Intake Tower, azimuth 24° 19′ 37″, distance 1,421.5 meters.
To △ Chain of Rocks, azimuth 46° 40′ 06″, distance 1,688.8 meters.
Iron pipe on foot of high willow bar on Illinois side of river and opposite group of houses above waterworks at Chain of Rocks. Top of pipe is about 6 inches above surface of ground; 105 feet west of willow tree 6 inches in diameter blazed with triangle. Station is in line with this tree and one and one-half story white frame house opposite the station.

⊡ $\frac{57}{3}$

Mississippi River Commission, 1889; redetermined by United States engineer office, St. Louis, Mo., 1901. (Chart No. 1.)
Latitude 38° 46′ 10″.51; meters + 324, −1,526.
Longitude 90° 10′ 55″.71; meters +1,345, −104.
Elevation: Stone, 435.89; pipe, 440.98.
To ⊡ 57/2, azimuth 278° 47′, distance 1,948 meters.
Flat stone and iron pipe on east side of Columbia Bottom road; 7 meters from center of road; one-half mile above Chain of Rocks, Mo.; on land of Ed Dowling; and 94 meters north of southwest corner of his land; 600 meters below bridge, over Watkins Creek, on Columbia Bottom road. There is a vineyard on east side of hill, back of pipe.

⊡ $\frac{57}{2}$

Mississippi River Commission, 1889; redetermined by United States engineer office, St. Louis, Mo., 1901. (Chart No. 1.)
Latitude 38° 46′ 00″.86; meters +27, −1,823.
Longitude 90° 09′ 36″.26; meters +875, −573.
Elevation: Stone, 419.50; pipe, 424.59.
To ⊡ 57/1, azimuth 278° 47′, distance 843 meters.
To ⊡ 57/3, azimuth 98° 47′, distance 1,948 meters.
Flat stone and iron pipe, on Chouteau Island, Illinois; opposite a point one-half mile above Chain of Rocks; on land of F. Kahle; on back side of levee; in cultivated field; 140 meters back of river bank; 160 meters south of a grove between bank and levee; a little below a one-story house that stands 300 meters back of levee; and 910 meters below where north and south levee ends at the river.

⊡ $\frac{57}{1}$

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 45′ 56″.43; meters +1,740, −110.
Longitude 90° 09′ 01″.41; meters +34, −1,415.
Elevation: Stone, 417.14; pipe, 422.23.
To ⊡ 57/2, azimuth 98° 47′, distance 843 meters.
Flat stone and iron pipe, on Chouteau Island, Illinois; near the middle of the island; on east side of north and south township road; in cultivated field of J. W. Siegers; and about 325 meters south of schoolhouse.

△ CHAIN OF ROCKS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 45′ 34″.94; meters +1,077, −773.
Longitude 90° 11′ 04″.22; meters +102, −1,347.
Center of the large brick chimney of the St. Louis waterworks at Chain of Rocks, Mo.

△ CITY LIMITS No. 161.

City of St. Louis; redetermined by United States engineer office, St. Louis, Mo., 1903. (Chart No. 1.)
Latitude 38° 45′ 31″.71; meters +978, −872.
Longitude 90° 11′ 19″.04; meters +460, −989.
Elevation: 580.98.
To ◉ Robinson, azimuth 323° 26′, distance 35 meters.
Top of stone, marked "161," with hole in top; stone is between 8 and 12 inches square, is in the northern boundary line of the city of St. Louis and is 175 meters west of Columbia Bottom road; on land of Mr. Robinson.

◉ ROBINSON.

Mississippi River Commission, 1880–81. (Chart No. 1.)
Latitude 38° 45′ 30″.68; meters +946, −904.
Longitude 90° 11′ 18″.10; meters +437, −1,012.
Elevation: 584.37.
To ◉ Soechtig, azimuth 321° 49′ 01″.23, distance 5,758.84 meters.
To ◉ Standpipe, azimuth 10° 17′ 13″.59, distance 9,937.31 meters.
To △ Cabaret, azimuth 342° 47′ 58″, distance 2,413.6 meters.
To △ Chain, azimuth 319° 28′ 33″, distance 630.3 meters.
To △ Granite City, azimuth 338° 39′ 22″, distance 7,198.1 meters.
To △ Chain of Rocks, azimuth 248° 38′ 07″, distance 359.9 meters.
Center of hole in stone post 6 inches square, set on top of bluff at Chain of Rocks, Mo.; about 527 feet downstream from northwest corner of north settling basin, measured in the direction of Columbia Bottom road; and 470 feet west of center of road. Station is 25 feet west of crest of bluff; 220 feet northeast of nail driven 3 feet above ground into southwest side of 15-inch white-oak tree, 12 feet west of fence; and 14 feet from nail in 15-inch elm tree 13 feet east of fence.

△ INTAKE TOWER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 45′ 30″.52; meters +941, −909.
Longitude 90° 10′ 37″.59; meters +908, −541.
The finial of the intake tower of the St. Louis Waterworks at Chain of Rocks, Mo.

△ CHAIN.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 45′ 15″.15; meters +467, −1,383.
Longitude 90° 11′ 01″.14; meters +28, −1,421.
To ◉ Robinson, azimuth 139° 28′ 44″, distance 630.3 meters.
Iron pipe painted red, set flush with surface of ground on top of high bank and 2 meters west of edge of concrete revetment at Chain of Rocks, Mo. A small pile of crushed stone and gravel covers and marks the station, which is in front of the third gatehouse from the north and about 5 meters north of drainpipe from same house. Three railroad spikes are driven in the revetment and about 3 feet from its western edge; they are 15.3 feet northeast of station, 8.8 feet east or in front of station, and 14.5 feet southeast of station, respectively.

△ CABARET.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 44′ 15″.91; meters +491, −1,359.
Longitude 90° 10′ 48″.55; meters +1,173, −276.
To ◉ Standpipe, azimuth 18° 25′ 27″, distance 7,875.4 meters.
To ◉ Robinson, azimuth 162° 48′ 17″, distance 2,413.6 meters.
To △ Merchants Bridge, azimuth 0° 05′ 49″, distance 6,833.4 meters.
To △ Portland Cement, azimuth 84° 05′ 32″, distance 3,168.9 meters.
Iron pipe, set flush with surface of ground in northeast corner of embankment of settling basins at Madison and Granite City Waterworks near head of Cabaret Island. Station is 26.1 feet from southwest corner of brick pump house and 52.4 feet from an elm tree standing about 12 feet west of the concrete edge of the basin.

△ PORTLAND CEMENT.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 44′ 05″.31; meters +164, —1,686.
Longitude 90° 12′ 59″.05; meters + 1,426, — 23.
Center of large brick chimney of the St. Louis Portland Cement Company, near St. Cyr avenue in north St. Louis.

⊡ 56/4

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 44′ 03″.57; meters +110, —1,740.
Longitude 90° 12′ 52″.87; meters +1,277, — 172.
Elevation: Stone, 451.31; pipe, 456.40.
To⊡56/3, azimuth 298° 00′, distance 89 meters.
Flat stone and iron pipe, on south side of St. Cyr avenue, in north St. Louis; 89 meters west of north corner of Columbia Bottom road and St. Cyr avenue.

⊡ 56/3

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 44′ 02″.24; meters +69, —1,781.
Longitude 90° 12′ 49″.60; meters +1,198, —251.
Elevation: 436.50.
To⊡56/2, azimuth 298° 20′.
To⊡56/4, azimuth 118° 00′, distance 89 meters.
Corner stone, at northwest corner of intersection of St. Cyr avenue and Columbia Bottom road in north St. Louis.

⊡ 56/2

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 43′ 14″.01; meters +432, —1,418.
Longitude 90° 10′ 55″.55; meters +1,342, —108.
Elevation: Stone, 421.16; pipe, 426.25.
To⊡56/1, azimuth 298° 15′, distance 1,314 meters.
Flat stone and iron pipe, on Cabaret Island; due south of Madison and Granite City waterworks. It is 1¼ miles below head of island and 690 meters back from the river bank; 150 meters upstream from a two-story yellow house; on east side of field road; on edge of prominent ridge; and 412 meters downstream from an old unoccupied house.

△ SAWYER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 43′ 06″.63; meters +204, —1,646.
Longitude 90° 13′ 00″.49; meters +12, —1,438.
To△Merchants Bridge, azimuth 325° 54′ 57″, distance 5,670.3 meters.
To△Bend, azimuth 00° 28′ 53″, distance 891.3 meters.
To△Baden, azimuth 62° 58′ 28″, distance 1,215.9 meters.
Iron pipe, set flush with surface of high bank in Sawyer Bend, Mo., and covered with mound of earth and broken stone. It is 670 feet downstream from original head of revetment; 12 feet from its western edge; 68 feet from a 600-foot stake; 35 feet from 700-foot stake on edge of revetment; and 32 feet from the 700-foot stake on high bank.

◎ SOECHTIG.

Mississippi River Commission, 1880–81. (Chart No. 1.)
Latitude 38° 43′ 03″.85; meters +119, —1,731.
Longitude 90° 08′ 50″.74; meters +1,226, —224.
Elevation: 427.29.
To◎Standpipe, azimuth 45° 28′ 43″.07, distance 7,485.29 meters.
To◎Robinson, azimuth 141° 50′ 34″.45, distance 5,758.84 meters.
To⊡56/1, azimuth 80° 25′, distance 1,877 meters.
Stone post, in Illinois; about 1 mile back of Cabaret Island and 430 meters northwest from the track of the Chicago and Alton Railroad; at a point opposite two houses; at south end of a clump of timber; and on north bank of a large gully.

⊡ 56/1

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 42′ 53″.58; meters +1,652, −198.
Longitude 90° 10′ 07″.33; meters +177, −1,273.
Elevation: Stone, 423.09; pipe, 428.18.
To ⊡ 56/2, azimuth 118° 15′, distance 1,314 meters.
Flat stone and iron pipe, on top of levee in Illinois and back of middle of Cabaret Island; 65 meters east of left bank of slough; 175 meters north of northwest corner of orchard at levee. There are houses in the near vicinity on both sides of levee. A road runs along edge of bank of slough and turns east with the levee, 150 meters north from the station.

△ BADEN.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 42′ 48″.70; meters +1,502, −348.
Longitude 90° 13′ 45″.32; meters +1,095, −355.
Center of large brick chimney of St. Louis waterworks at Baden, north St. Louis.

⊙ P. B. M. 13.

Mississippi River Commission, 1880. (Chart No. 1.)
Latitude 38° 42′ 41″.19; meters +1,270, −580.
Longitude 90° 13′ 48″.75; meters +1,178, −272.
Elevation: 438.46.
Top of copper bolt in top of stone, in ground in small grove on east side of street-car tracks in north St. Louis and 6.4 miles upstream from Eads Bridge. It is 110 meters south and 37 meters east of the north terminus of street-car line. It is opposite a point in Broadway 50 meters below the Seven Mile or "Wedge" house in angle of Broadway and Halls Ferry road. It is 8 meters north, on north line of Baden avenue, and 30 meters east of northeast corner of Broadway (Bellefontaine road) and Baden avenue.

△ BEND.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 42′ 37″.72; meters +1,163, −687.
Longitude 90° 13′ 00″.80; meters +19, −1,431.
To ⊛ Standpipe, azimuth 350° 56′ 54″, distance 4,500.3 meters.
To △ Sawyer, azimuth 180° 28′ 52″, distance 891.3 meters.
To △ Merchants Bridge, azimuth 320° 04′ 00″, distance 4,962.2 meters.
To △ Baden, azimuth 107° 28′ 59″, distance 1,127.7 meters.
Iron pipe, set flush with surface of ground in Sawyer Bend, Mo.; at top of high bank; 9.3 feet from western edge of revetment and covered with mound of broken stone. Station is 6.6 feet south of a point, on river bank, which is 200 feet from east rail of east railroad track and in line with telegraph pole and a large cottonwood tree west of railroad. Station is 9.5 feet from edge of revetment on line with same cottonwood. The following references are to stakes used in construction of revetment: 29.9 feet to No. 36 in edge of revetment; 72.2 feet to No. 37 in edge of revetment; 28.8 feet to No. 36 on high bank; and 72.5 feet to No. 37 on high bank.

⊛ SUGAR LOAF.

United States Coast and Geodetic Survey, 1872; redetermined, Mississippi River Commission, 1880–81. (Chart No. 1, station not plotted.)
Latitude 38° 42′ 05″.33; meters +164, −1,686.
Longitude 90° 00′ 28″.91; meters +699, −751.
To ⊛ Clarks Mound, azimuth 21° 53′ 53″.89, distance 14,606.56 meters.
To ⊛ Robinson, azimuth 112° 02′ 44″.30, distance 16,911.19 meters.
To ⊛ Standpipe, azimuth 78° 54′ 07″.49, distance 17,801.48 meters.
United States Coast and Geodetic Survey station, on and a little north of the center of a prominent mound about 50 feet high, situated on bluffs on Mr. Moore's farm, about 2 miles northwest of Collinsville, Ill. The geodetic point was marked by the United States Coast and Geodetic Survey and is point of earthenware pyramid buried about 3½ feet. Surface mark is a marble post 6 inches square, about 10 inches above ground, marked U. S. C. & G. S.

▲ GRANITE CITY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 41′ 53″.25; meters +1,642, −208.
Longitude 90° 09′ 29″.69; meters +718, −733.
Center of symmetrical roof and finial of shot tower, in Granite City, Ill. From ▲ Merchants Bridge the words "shot tower" were distinguishable.

⊡ 55/1

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 41′ 34″.05; meters +1,050, −800.
Longitude 90° 10′ 35″.09; meters +848, −602.
Elevation: Stone, 417.19; pipe, 422.27.
To ⊡ 55/2, azimuth 63° 20′, distance 570 meters.
Flat stone and iron pipe, on eastern bank of Kerr Island; in edge of field about one-half mile above West Madison, Ill.; 1,400 meters above east-and-west road crossing island and slough. Sycamore tree 2 feet in diameter stands 5 meters south.

⊡ 55/2

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 41′ 25″.62; meters +790, −1,060.
Longitude 90° 10′ 56″.27; meters +1,360, −90.
Elevation: Stone, 420.84; pipe, 425.93.
To ⊛ Standpipe, azimuth 46° 00′.
To ⊡ 55/1, azimuth 243° 20′, distance 570 meters.
To ⊡ 55/3, azimuth 65° 10′, distance 1,652 meters.
Flat stone and iron pipe, on Kerr Island, Illinois; 1 mile above the Merchants Bridge; 450 meters back from old main bank of river; 720 meters from river at foot of Cabaret Island; 13 meters from west edge of field; in cultivated field west edge of which terminates at top of sharp slope; about 180 meters above "turning row" shown as road on map, and in view of a house that stands about same distance below this "road."

⊡ 55/3

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 41′ 03″.15; meters +97, −1,753.
Longitude 90° 11′ 58″.34; meters +1,410, −40.
Elevation: 421.79.
To ⊡ 55/4, azimuth 57° 05′, distance 699 meters.
To ⊡ 55/2, azimuth 245° 10′, distance 1,652 meters.
Corner stone, at southwest corner of Withers avenue and Powder street, north St. Louis; at northeast corner of powder magazine; 155 meters from river bank and one-half mile above East Grand avenue.

⊡ 55/4

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 40′ 51″.00; meters +1,573, −277.
Longitude 90° 12′ 22″.48; meters +543, −907.
Elevation: 431.97.
To ⊡ 55/3, azimuth 237° 05′, distance 699 meters.
Cross cut on top of catch-basin, at northwest corner of Withers avenue and Wabash Railroad; 850 meters from river bank and one-half mile above East Grand avenue at the St. Louis waterworks.

▲ MERCHANTS BRIDGE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 40′ 34″.30; meters +1,058, −792.
Longitude 90° 10′ 49″.03; meters +1,185, −265.
To ⊛ Standpipe, azimuth 75° 33′ 05″, distance 2,558.4 meters.
To ⊛ Robinson, azimuth 175° 36′ 28″, distance 9,166.0 meters.
To ▲ Bend, azimuth 140° 05′ 22″, distance 4,962.2 meters.
To ▲ Sawyer, azimuth 145° 56′ 19″, distance 5,670.3 meters.
To ▲ Bissell, azimuth 84° 12′ 58″, distance 925.1 meters.
To ▲ Farmers elevator, azimuth 7° 40′ 28″, distance 2,990.6 meters.
To ▲ Granite City, azimuth 218° 13′ 25″, distance 3,098.8 meters.

Cross on top of half-inch square copper bolt, leaded into the concrete abutment and surrounded by 3-inch triangle, at the extreme east end of the Merchants Bridge, in Illinois. Station is 3.76 feet north of center of north rail; 1.26 feet east of west face of concrete; 0.57 feet west of east face; 2.44 feet from northwest corner and 1.20 feet from northeast corner of concrete. A tangent from standpipe to the curve (east of bridge) in north rail of south track, intersects the station.

△ BISSELL NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 40′ 33″.43; meters +1,031, −819.
Longitude 90° 11′ 28″.58; meters +691, −759.
To △ Bissell, azimuth 331° 39′ 24″, distance 75.3 meters.
To △ Dock No. 2, azimuth 348° 46′ 50″, distance 1,908.5 meters.
Iron pipe, set a little below the surface of the ground, at Bissell Point, north St. Louis; 39.35 feet from the northeast corner and 74.96 feet from the northwest corner of the north main building of the Bissell Point waterworks. The pipe was set to mark approximately the intersection of the old west wharf line and the old (1855) northern boundary line of the city and is 0.06 foot east from the former, and 4.25 feet south from the latter line as determined by the survey of 1901.

△ BISSELL.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 40′ 31″.28; meters +964, −886.
Longitude 90° 11′ 27″.10; meters +655, −796.
To ◉ Standpipe, azimuth 70° 41′ 56″, distance 1,649.8 meters.
To △ Merchants Bridge, azimuth 264° 12′ 34″, distance 925.1 meters.
Iron pipe, 79.13 feet from southeast corner of south building and 77.10 feet from southwest corner of east building of waterworks at Bissell Point, north St. Louis; 4.9 feet to southeast corner of cast-iron base of fire-plug cover; 4.85 feet to northeast corner of same; and 5.5 feet from bolt in anchor post on river side of station.

⊙ P. B. M. 14.

Mississippi River Commission, 1880. (Chart No. 1.)
Latitude 38° 40′ 30″.55; meters +942, −908.
Longitude 90° 11′ 56″.26; meters +1,360, −91.
Elevation: 433.46.
Small hole in center of copper bolt, leaded horizontally in third course of stones on north side of western engine room of St. Louis waterworks, Bissell Point, and 1.47 meters west of west coping to main entrance to building. The letters "U. S. P. B. M." are cut near the bolt.

◉ STANDPIPE.

Mississippi River Commission, 1880–1881. (Chart No. 1.)
Latitude 38° 40′ 13″.59; meters +419, −1,431.
Longitude 90° 12′ 31″.51; meters +762, −689.
To ◉ Sugar Loaf, azimuth 258° 46′ 35″.83, distance 17,801.48 meters.
To ◉ Robinson, azimuth 190° 16′ 27″.68, distance 9,937.31 meters.
To ◉ Insane Asylum, azimuth 39° 45′ 01″.92, distance 9,606.16 meters.
To △ Bend, azimuth 170° 57′ 12″, distance 4,500.3 meters.
To △ Merchants Bridge, azimuth 255° 32′ 01″, distance 2,558.4 meters.
To △ Bissell, azimuth 250° 41′ 16″, distance 1,649.8 meters.
To △ Mullanphy Bank, azimuth 330° 32′ 48″, distance 3,968.9 meters.
To △ Portland Cement, azimuth 174° 40′ 50″, distance 7,176.3 meters.
To △ Granite City, azimuth 235° 01′ 17″, distance 5,362.4 meters.
A dot in small triangle (three-quarters inch) cut in iron floor inside iron railing on top of old standpipe at intersection of Grand avenue and Twentieth street, St. Louis; 2.41 feet northwest of northwest side of the iron post directly southwest of extreme east part of the railing; 2.47 feet southwest of the southwest side of iron post directly northwest of extreme [illegible] t part of railing; and 2.57 feet east of east corner of iron bolt at circular edge of iron floor. (Colby's description, survey of city of St. Louis.)

⊡ 54/5 (Ritter).

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 39′ 51″.50; meters +1,588, −262.
Longitude 90° 10′ 39″.41; meters +953, −498.
Elevation: 407.31.
To ⊡ No. 7 (Field), azimuth 44° 15′, distance 1,005 meters.
Top of nut, on bolt through plank bolted to pile at southwest corner of the Venice, Ill., elevator; 5 nails are driven above the nut.

△ VENICE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 39′ 46″.82; meters +1,444, −406.
Longitude 90° 10′ 44″.09; meters +1,066, −385.
Elevation: 419.71.
Iron pipe, set flush with surface of paved levee at Ferry Landing, Venice, Ill.; 16 feet west of porch of frame building (saloon in 1901); 7.5 feet north of south line of the same building; and about 11 feet north of south edge of paving.

△ DOCK NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 39′ 32″.72; meters +1,009, −841.
Longitude 90° 11′ 13″.22; meters +320, −1,131.
To △ Bissell No. 2, azimuth 168° 46′ 59″, distance 1,908.5 meters.
The intersection of the north line of Dock street and the northern portion of the old west wharf line; 14 feet east from southeast corner of brick building occupied in 1901 by the Federal Chemical Company of the United States.

⊡ No. 7 (Field).

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 39′ 28″.15; meters +868, −982.
Longitude 90° 11′ 08″.48; meters +205, −1,246.
Elevation: 407.35.
To ⊡ 54/5 (Ritter), azimuth 224° 15′, distance 1,005 meters.
A raised knob, cut on the northwest corner of sewer cap at foot of Branch street, St. Louis.

△ FARMERS ELEVATOR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 58″.19; meters +1,794, −56.
Longitude 90° 11′ 05″.54; meters +134, −1,317.
The finial of the dome or clock tower of the elevator near the foot of Clinton street, St. Louis.

⊡ 54/2

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 38′ 47″.32; meters +1,459, −391.
Longitude 90° 10′ 00″.16; meters +4, −1,447.
Elevation: Stone, 421.85; pipe, 426.94.
Flat stone and iron pipe, in Illinois; just west of the Chicago and Alton Railroad; and 320 meters north of the northeast corner of settling basins of East St. Louis waterworks.

△ HURDLE 11, No. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 41″.84; meters +1,290, −560.
Longitude 90° 10′ 25″.38; meters +614, −837.
To △ Mound, azimuth 74° 49′ 41″, distance 735.5 meters.
To △ East Eads, azimuth 7° 24′ 00″, distance 1,820.6 meters.
Iron pipe, set near edge of high left bank; 50 feet below △ Hurdle 11; 1,200 feet below Hurdle No. 11; and 2,200 feet above old United States engineer △ North Base in East St. Louis. A mound of stone and brickbats covers the pipe.

△ VICTORIA ELEVATOR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 36″.26; meters +1,118, —732.
Longitude 90° 11′, 00″.14; meters +3, —1,448.
The center of the lower part of the flagstaff on top of elevator near foot of Mound street, St. Louis.

△ MOUND.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 35″.61; meters +1,098, —752.
Longitude 90° 10′ 54″.73; meters +1,324, —127.
To△Hurdle 11 No. 2, azimuth 254° 49′ 23″, distance 735.5 meters.
To△Union Elevator, azimuth 317° 25′ 17″, distance 971.6 meters.
To△East Eads, azimuth 343° 34′ 24″, distance 1,681.6 meters.
To△West Eads, azimuth 00° 36′ 05″, distance 1,546.7 meters.
Iron pipe, set flush with surface and covered with mound of stone and earth, at foot of Mound street, St. Louis; 15.7 feet east of east rail of railroad siding nearest river; 14.8 feet, measured parallel to track, north from 8-inch iron drain pipe about 7 feet lower than station; 61.9 feet (right angle distance) south from a point in the north line of Mound street prolonged, which point is 197.45 feet east from the northwest corner of Mound street and wharf.

⊡ 54/3

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 38′ 35″.67; meters +1,100, —750.
Longitude 90° 10′ 57″.13; meters +1,382, —69.
Elevation: 427.60.
Cross, with letters "U. S." cut on the corner of stone foundation of a brick building at the southeast corner of Mound street and wharf, St. Louis.

⊡ 54/4

Mississippi River Commission, 1889. (Chart No. 1.)
Latitude 38° 38′ 35″.35; meters +1,090, —760.
Longitude 90° 11′ 00″.29; meters +7, —1,444.
Elevation: 442.19.
Cross, with figures and letters "54/4 U. S." cut on stone wall which surrounds the northern gasometer of the Laclede Gas Works, southeast corner of Mound and Main streets, St. Louis.

△ MULLANPHY BANK.

City of St. Louis; redetermined, United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 21″.50; meters +663, —1,187.
Longitude 90° 11′ 10″.82; meters +262, —1,189.
To⊕Standpipe, azimuth 150° 33′ 38″, distance 3,968.9 meters.
To△Union Elevator, azimuth 285° 00′ 22″, distance 1,083.5 meters.
Copper rivet, in highest part of gravel roof surrounded by an iron railing at northeast corner of the old Mullanphy Bank, a three-story mansard roof brick building, at southwest corner of Cass avenue and Broadway, St. Louis; about 7 feet south of Cass avenue and 10 feet west of Broadway; 5.34 feet from north post of iron railing; 4.68 feet from east post; 4.66 feet from south post; and 5.22 feet from west post. (Colby's description, Survey of City of St. Louis.) In 1901 a flagpole stood about 1 foot north of the station.

△ NORTH BASE.

United States engineer office, St. Louis, Mo., 1889; redetermined, 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 20″.97; meters +646, —1,204.
Longitude 90° 10′ 23″.54; meters +569, —882.
To△South Base, azimuth 9° 03′ 22″, distance 1,182.1 meters. (Calculated by the inverse solution from the coordinates.)

The northeast corner of the end of the west curb line of Front street, East St. Louis, Ill.; diagonally across the street and southwest from the Toledo, St. Louis and Western Railroad freight depot; and just south of a switch track to the freight yards. It is probable that the curb line has been extended since 1889; the inverse solution shows the length of the line north base-south base to be 3,878.2 feet instead of 3,800.84 feet, as given in the original survey of 1889.

△ SMITH.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 20″.86; meters +643, −1,207.
Longitude 90° 10′ 53″.76; meters +1,300, −151.
To△Union Elevator, azimuth 292° 21′ 28″, distance 685.5 meters.
To△Smith No. 2, azimuth 45° 56′ 50″, distance 22.7 meters.
The southeast corner of the brick building at the northwest corner of Smith street and wharf, St. Louis; 5.75 feet south from the north line of Smith street and 58.5 feet east from a mark, correct for old west wharf line, on south face of same building.

△ SMITH No. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 20″.35; meters +627, −1,223.
Longitude 90° 10′ 54″.44; meters +1,317, −134.
To△Smith, azimuth 225° 56′ 50″, distance 22.7 meters.
To△Ashley, azimuth 356° 07′ 58″, distance 227.0 meters.
To△Biddle, azimuth 356° 02′ 27″, distance 422.8 meters.
City stone, marking the southwest corner of Smith street and wharf, St. Louis.

△ LACLEDE POWER COMPANY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 17″.27; meters +532, −1,318.
Longitude 90° 10′ 54″.83; meters +1,326, −125.
The lightning rod, on south side of the large brick chimney of the Laclede Power Company near the foot of Dickson street, St. Louis.

△ ASHLEY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 13″.01; meters +401, −1,449.
Longitude 90° 10′ 53″.80; meters +1,301, −150.
To△Union Elevator, azimuth 271° 40′ 15″, distance 635.3 meters.
The southeast corner of the Laclede Power Company's brick building, near the foot of Ashley street, St. Louis; 59.1 feet (right angle distance) north from a point in the north line of Ashley street prolonged, which point is 138.9 feet east from the northwest corner of Ashley and Lewis streets.

△ UNION ELEVATOR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 12″.40; meters +382, −1,468.
Longitude 90° 10′ 27″.55; meters +666, −785.
Elevation: 411.10.
To△Mullanphy Bank, azimuth 105° 00′ 49″, distance 1,083.5 meters.
To△Biddle, azimuth 74° 07′ 01″, distance 645.8 meters.
To△East Eads, azimuth 11° 27′ 39″, distance 915.7 meters.
Center of 1½ inch square head iron bolt, driven in the paved levee south of the Union Elevator in East St. Louis, Ill.; in line with Mullanphy Bank flagstaff and north edge of large brick chimney north of Laclede Power House; at southeast corner of flat stone 2 feet 6 inches long (north to south) and 11 inches wide; 71 feet from southeast corner of river house, in line with and 31½ feet from a ring-bolt 39½ feet

from the river house; 5 feet east of prolongation of line through east face of sill of first carrier bent from river house and 90 feet from three nails driven in east face of same sill; 58 feet from west rail of railroad siding nearest river; and 178.5 feet from west curb of Front street.

△ BIDDLE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 38′ 06″.67; meters +206, −1,644.
Longitude 90° 10′ 53″.23; meters +1,288, −163.
To△East Eads, azimuth 328° 38′ 18″, distance 844.0 meters.
To△West Eads, azimuth 4° 35′ 19″, distance 656.4 meters.
To△Union Elevator, azimuth 254° 06′ 45″, distance 645.8 meters.
Iron pipe, set below granite paving which was replaced and a cross cut in the paving block over the pipe; 91.41 feet east from corner and on line with north side of brick building at southwest corner of Biddle street and wharf, St. Louis; 0.04 foot south of south line of Biddle street and 91 feet east from southwest corner of Biddle street and wharf.

△ MORGAN.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 50″.10; meters +1,545, −305.
Longitude 90° 10′ 55″.75; meters + 1,348, −103.
To△Biddle, azimuth 186° 48′ 27″, distance 514.7 meters.
To△East Eads, azimuth 292° 43′ 54″, distance 542.4 meters.
Center of one-half inch hole and cross cut in the anchor stone for ring bolt, outside the railroad track at the foot of Morgan street, St. Louis; 10.6 feet (right angle distance) north from a point in the north line of Morgan street prolonged, which point is 78.3 feet east from the northwest corner of Morgan street and wharf; 49.69 feet from center one of three notches 6 inches above iron base on inner (southeast) edge of northeast angle iron in northeast pillar of viaduct at foot of Morgan street; and 67.68 feet from center one of three notches 1 inch above iron base on northeast corner of the southeast angle iron in the southeast pillar of viaduct.

⊙ P. B. M. 15.

Mississippi River Commission, 1880. (Chart No. 1.)
Latitude 38° 37′ 45″.53; meters +1,404, −446.
Longitude 90° 10′ 57″.74; meters +1,396, −55.
Elevation: 423.53.
Small hole in copper bolt, leaded horizontally in the west pier of arch No. 4, on east side of pier of Eads Bridge at St. Louis; 6.14 meters south of north end of pier and 0.14 meters above top course of granite. The letters "U. S." are cut in the granite below the bench mark.

△ WEST EADS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 45″.45; meters +1,401, −449.
Longitude 90° 10′ 55″.40; meters +1,340, −111.
To△Market, azimuth 18° 23′ 00″, distance 627.2 meters.
To△East Eads, azimuth 277° 41′ 12″, distance 496.2 meters.
To△Pittsburg, azimuth 0° 07′ 21″, distance 1,777.3 meters.
To△Biddle, azimuth 184° 35′ 18″, distance 656.4 meters.
To△Laclede Power Company, azimuth 180° 48′ 42″, distance 981.3 meters.
Cross on top of one-half inch square copper bolt, leaded into the masonry on top of the north end of west shore pier of the Eads Bridge at St. Louis, Mo.; 3.14 feet south of base or collar around north or center post (4½ inches in diameter) of iron railing and 0.43 foot west of center line of pier or seam in masonry. Two 1-inch iron posts in the railing are: West 4.22 feet; east 4.86 feet. Station is 496.21 meters from△East Eads (base line measurement).

△ EAST EADS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 43″.30; meters +1,335, −515.
Longitude 90° 10′ 35″.07; meters +848, −603.
To △ West Eads, azimuth 97° 41′ 25″, distance 496.2 meters.
To △ Biddle, azimuth 148° 38′ 29″, distance 844 meters.
To △ Union Elevator, azimuth 191° 27′ 34″, distance 915.7 meters.
To △ Pittsburg, azimuth 16° 09′ 24″, distance 1,781.2 meters.
To △ Laclede Power Company, azimuth 155° 29′, distance 1,151.4 meters.
To △ Court-house, azimuth 73° 42′ 17″, distance 1,193.2 meters.
Cross on top of one-half inch square copper bolt, leaded into the masonry on the north end of east shore pier of the Eads Bridge, at East St. Louis, Ill.; 3.04 feet south of base or collar around north or center post (4½ inches in diameter) of iron railing and 0.16 foot east of center line of pier or seam in masonry. Two 1-inch iron posts in the railing are: East 4.40 feet; west 4.68 feet.

△ SOUTH BASE.

United States engineer office, St. Louis, Mo., 1889; redetermined, 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 43″.11; meters +1,329, −521.
Longitude 90° 10′ 31″.23; meters +755, −696.
To △ North Base, azimuth 189° 03′ 18″, distance 1,182.1 meters. (Calculated by inverse solution from the coordinates.)
A nail in joint between curbstones in west curb of Front street, East St. Louis, Ill.; north and 25 feet from iron viaduct pier or column of Eads Bridge and according to survey of 1889, 3,800.84 feet from △ North Base.

⊙ K 3. (City Directrix.)

United States Coast and Geodetic Survey, 1882, and Mississippi River Commission, 1880 and 1889. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 25″.62; meters +790, −1,060.
Longitude 90° 11′ 05″.13; meters +124, −1,228.
Elevation: 420.84.
Known at St. Louis as the "City Directrix." It has been in use for many years, and was originally the top surface of the pedestal of a monument which stood on Front street (now wharf) near Market street. The monument shaft was destroyed at the time of the great fire in that locality, but the pedestal remained. It is now level with the curbstone, and forms a part thereof. A "T" mark has since been cut to indicate the point used for a bench mark.
NOTE.—Elevation above mean sea or gulf level, 126.1776 meters (probable error ±32 millimeters) or 413.97 feet (United States Coast and Geodetic Survey, Report 1903). Elevation above Cairo datum plane, 132.2742 meters equals 433.97 feet (Mississippi River Commission precise levels, 1880), or 420.84 feet Memphis datum plane. Correction to reduce United States Coast and Geodetic Survey mean sea level values, vicinity of St. Louis, to Memphis datum plane is therefore +6.87 feet.
This station was destroyed in 1890, but owing to its historic value the former description and the elevations are given.

⊙ I_2

United States Coast and Geodetic Survey, 1882, and Mississippi River Commission, 1889. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 43″.13; meters +1,330, −520.
Longitude 90° 10′ 31″.13; meters +753, −698.
Elevation: 420.84.
A mark on a large bronze plate inserted in the south face of the eastern land pier of the Eads Bridge at East St. Louis, Ill.
The plate bears the inscription:

U. S. Coast and Geodetic
Survey Bench Mark, 1882.

Elevation derived by adding 6.87 feet to the United States Coast and Geodetic Survey mean sea level value of 1903. (See note under "K_2," St. Louis City Directrix.)

⊙ J_3

United States Coast and Geodetic Survey, 1882, and Mississippi River Commission, 1889. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 44″.98; meters +1,387, —463.
Longitude 90° 10′ 55″.85; meters +1,351, —100.
Elevation: 420.85.
A large bronze plate (similar to that described under "I_3") inserted in the western land pier of the Eads Bridge at St. Louis, Mo. Bench marks "I_3" and "J_3" were placed as nearly as possible on the same level as the St. Louis City Directrix described under "K_3."
Elevation derived by adding 6.87 feet to the United States Coast and Geodetic Survey mean sea level value of 1903. (See note under "K_3," St. Louis City Directrix.)

△ LOCUST.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 37″.15; meters +1,146, —704.
Longitude 90° 10′ 59″.17; meters +1,431, —20.
To △ Morgan, azimuth 191° 42′ 04″, distance 407.6 meters.
To △ East Eads, azimuth 251° 59′ 10″, distance 613 meters.
Center of one-half inch hole drilled in anchor stone for ring bolt, at the foot of Locust street, St. Louis, Mo.; 1.12 feet south from cross cut on top of eyebolt leaded in same stone; 83.34 feet from brick corner at northwest corner of Locust street and wharf; 57.06 feet to middle one of three notches cut in southeast corner upright angle iron at northeast corner pillar to elevated railroad; 50.66 feet to middle one of three notches cut in northeast corner upright angle iron at southwest corner pillar to elevated railroad; 80.35 feet from a mark in top edge of base stone and 1.52 feet south from northeast corner of building at the southwest corner of Locust street and wharf; 6.8 feet (right-angle distance) south from a point in the center line of Locust street, which point is 78.4 feet east from the intersection of said center line and the south prolongation of the east line of city block No. 12.

△ COURT-HOUSE.

United States Coast and Geodetic Survey, 1871; redetermined by United States engineer office, St. Louis, Mo., 1901. (Chart No. 1.)
Latitude 38° 37′ 32″.44; meters +1,000, —850.
Longitude 90° 11′ 22″.42; meters +542, —910.
Finial of dome or center of flagstaff of court-house, in block bounded by Broadway, Fourth, Market, and Chestnut streets, St. Louis, Mo.

△ MARKET.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 26″.15; meters +806, —1,044.
Longitude 90° 11′ 03″.58; meters +87, —1,365.
To △ East Eads, azimuth 232° 30′ 55″, distance 869 meters.
To △ Pittsburg, azimuth 350° 40′ 45″, distance 1,197.9 meters.
To △ West Eads, azimuth 198° 22′ 55″, distance 627.2 meters.
To △ Spruce, azimuth 19° 17′ 49″, distance 368.4 meters.
Center of one-half inch hole and cross cut in granite paving block, outside the railroad tracks on St. Louis wharf at the foot of Market street; 55.33 feet south of the southwest corner "corner stone" of the harbor office; 63.88 feet from the southeast corner (as seen from station) of brickwork of same building; angle from △ West Eads to this last corner 31° 38′ 30″; 24.25 feet to cross on eyebolt in anchor rock southeast at angle of 159° 06′ from "corner stone;" 13.0 feet (right-angle distance) north from a point in the south line of Market street prolonged, which point is 85.2 feet east from the southwest corner of Market street and the wharf.

△ SPRUCE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)
Latitude 38° 37′ 14″.87; meters +459, —1,391.
Longitude 90° 11′ 08″.61; meters +208, —1,243.

The center of the arc light suspended (1901) from the east side of the elevated railroad at the foot and near the center of Spruce street, St. Louis, Mo. It is 40.8 feet from the brickwork at the northwest corner and 42.7 feet from the brickwork at the southwest corner of Spruce street and wharf; also 17.57 feet from northeast corner southeast angle iron, middle notch of three, 18 inches above base stone in southeast pillar; and 19.04 feet from southeast corner, northeast angle iron; middle notch of three, 20 inches above base stone in northeast pillar of the elevated railroad. It is 0.4 foot north from a point in the center line of Spruce street prolonged, which point is 38.9 feet east from intersection of said center line and the west line of wharf.

△ CHOUTEAU.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)

Latitude 38° 36′ 55″.86; meters +1,722, −128.
Longitude 90° 11′ 15″.57; meters +377, −1,075.
To △ Market, azimuth 197° 15′ 18″, distance 978.2 meters.
To △ Pittsburg, azimuth 297° 06′ 47″, distance 544 meters.

Center of one-half inch hole in top of paving stone, 3.32 feet east from east rail of west railroad track on the St. Louis wharf near foot of Chouteau avenue; 66.55 feet, on slope, northeast from northeast corner of top course of foundation masonry of Central "B" elevator; 91.74 feet, on slope, southeast from northeast corner of brickwork (at top of eighth course of brick) of north engine house of elevator; 83.45 feet north from a notch cut in center of north edge of base plate of north iron pillar in west bent supporting the carrier to elevator river house; and 41.43 feet east from cross cut in east face of west curb of wharf 30 feet north from north end of elevator.

△ CHOUTEAU NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)

Latitude 38° 36′ 52″.73; meters +1,626, −224.
Longitude 90° 11′ 18″.03; meters +436, −1,016.

Cross on curb, near southwest corner of Chouteau avenue and wharf, St. Louis, Mo.; 19.33 feet east from the west line of the wharf; 371.77 feet from △ Chouteau (calculated); 129.2 feet from southwest corner of brick engine house of elevator; 65.99 feet from Moulton's mark for old west wharf line, on foundation of elevator; 63.52 feet from another mark, 6.1 feet east from Moulton's; and 72.43 feet from cross on curb at northeast corner of Chouteau avenue and the wharf.

▲ PITTSBURG.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 1, station not plotted.)

Latitude 38° 36′ 47″.82; meters +1,474, −376.
Longitude 90° 10′ 55″.56; meters +1,344, −108.
To △ Chouteau, azimuth 117° 07′ 00″, distance 544 meters.
To △ Market, azimuth 170° 40′ 50″, distance 1,197.9 meters.
To △ East Eads, azimuth 196° 09′ 12″, distance 1,781.2 meters.
To △ West Eads, azimuth 180° 07′ 21″, distance 1,777.3 meters.
To △ Lesperance, azimuth 43° 56′ 49″, distance 1,451.1 meters.
To △ Spruce, azimuth 159° 16′ 20″, distance 892.2 meters.
To △ SS. Peter and Paul, azimuth 70° 18′ 28″, distance 2,000.9 meters.
To △ Court House, azimuth 154° 43′ 23″, distance 1,521.7 meters.

Center of one-half inch hole and cross cut in the highest part of the northwest corner of masonry of Pittsburg dike in Illinois; 2½ feet from the northwest corner and 1.25 feet east of west face of stone; 12.55 feet from old plane table station of 1899—hole in boards surrounded by triangle of nails; station is in a stone about 4 feet long which lies on top of three other stones in the masonry.

△ VALLEY ELEVATOR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 36′ 26″.80; meters +826, −1,024.
Longitude 90° 10′ 56″.12; meters +1,358, −94.

Center of large brick chimney of the McReynolds "C" elevator, south of East St. Louis and Pittsburg dike in Illinois.

▲ SAINTS PETER AND PAUL.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 36′ 25″.94; meters +800, −1,050.
Longitude 90° 12′ 13″.41; meters +325, −1,127.
The center of the one remaining spire of the church at the northeast corner of Allen avenue and Eighth street, St. Louis, Mo.

△ LESPERANCE No. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 36′ 14″.53; meters +448, −1,402.
Longitude 90° 11′ 38″.72; meters +937, −515.
To △ Lesperance, azimuth 296° 12′ 44″, distance 41.8 meters.
Cross on city stone, marking the northwest corner of Lesperance street and wharf, St. Louis, Mo.

⊡ $\frac{53}{3}$

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 36′ 14″.01; meters +432, −1,418.
Longitude 90° 11′ 39″.38; meters +953, −499.
Elevation: 424.23.
Cross cut in curbstone, south side of Lesperance street, St. Louis, Mo.; in railroad yards near wharf. It is marked "53/3 U. S.," and is 95 meters from shore line at foot of railroad incline.

△ LESPERANCE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 36′ 13″.93; meters +430, −1,420.
Longitude 90° 11′ 37″.18; meters +900, −552.
To △ Pittsburg, azimuth 223° 56′ 23″, distance 1,451.1 meters.
To △ Lesperance No. 2, azimuth 116° 12′ 45″, distance 41.8 meters.
To △ Valley Elevator, azimuth 248° 13′ 41″, distance 1,069.7 meters.
Center of one-half inch round hole in anchor stone, to which three iron rings are attached by an eyebolt; 4 inches west of the eyebolt and about 7 feet east of east rail of eastern railroad siding. It is on the St. Louis wharf, 3.9 feet south from the north line of Lesperance street prolonged; and 137.1 feet from city stone, △ Lesperance No. 2.

△ VICTOR.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 50″.22; meters +1,548, −302.
Longitude 90° 11′ 55″.21; meters +1,336, −116.
To △ Ferry, azimuth 352° 49′ 34″, distance 1,008.1 meters.
To △ St. George, azimuth 35° 54′ 33″, distance 181.7 meters.
Center of one-half inch hole and cross cut in large anchor stone (with two ring bolts) at top of wharf and about 3 feet south from south curb line (prolonged) of Victor street, St. Louis, Mo.; about 36 feet east from east railroad track; 1.1 feet south from north edge of anchor stone; 1.5 feet west from east edge of same; 0.6 foot east from north eyebolt; 8.7 feet (right-angle distance) north from a point in the south line of Victor street prolonged, which point is 106.2 feet east from the southwest corner of Victor street and the wharf.

⊡ $\frac{53}{1}$

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 35′ 49″.91; meters +1,539, −311.
Longitude 90° 10′ 41″.65; meters +1,008, −444.
Elevation: Stone 419.01; pipe, 424.09.
Flat stone and iron pipe, in Illinois; about 2 meters east of the center of track of Conlogue Railroad; 1 mile south of Mobile and Ohio Railroad crossing.

△ BRICK CHIMNEY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 48″.59; meters +1,498, −352.
Longitude 90° 12′ 45″.11; meters +1,092, −360.
The center of the north main brick chimney of the Anheuser-Busch Brewery, west of Broadway (Ninth and Pestalozzi streets), South St. Louis, Mo. It is 90 feet north of south main chimney, which is 2 feet higher.

△ ST. GEORGE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 45″.45; meters +1,401, −449.
Longitude 90° 11′ 59″.61; meters +1,442, −9.
To △ Victor, azimuth 215° 54′ 30″, distance 181.7 meters.
To △ Ferry, azimuth 344° 45′ 28″, distance 884.2 meters.
Center of crosscut in 1-inch square head of iron bolt, driven in ground 1 inch below surface in wharf near foot of St. George street, St. Louis, Mo., 75 feet (right angle distance) north from a point in the north line (prolonged) of St. George street, which point is 95 feet east from the northwest corner of St. George street and the wharf, and 7 feet east of east railroad siding. Three reference points are center notches in three sets of three notches each, cut on east flange of east rail, angles read from △ Ferry: South reference point 89° 44′—10.94 feet; middle reference point 139° 50′—6.96 feet, and this point is in line with southeast corner of Rowing Club, brick building with square cupola, north of St. George street; north reference point 188° 09′—10.40 feet, and this point is in line with southeast of red sheet-iron building. Station is nearly in line with southern side of Rowing Club; 95.18 feet from southeast corner, and 97.92 feet from northeast corner of same; and 100.08 feet from northeast corner of saloon building at northwest corner of St. George street and wharf.

△ LIGHTNING ROD.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 44″.77; meters +1,381, −469.
Longitude 90° 12′ 03″.28; meters +79, −1,373.
Lightning rod on square brick chimney at foot of St. George street, St. Louis, Mo.; station located by plane table survey of the United States engineer office, St. Louis, Mo., in 1889.

△ RED CHIMNEY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 38″.60; meters +1,190 −660.
Longitude 90° 12′ 26″.86; meters +650, −802.
The north side of the ladder attached to the high red iron stack of the Anheuser-Busch Brewery, north of Arsenal street and east of Broadway, South St. Louis, Mo.

△ ADDITION.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 38″.59; meters +1,190, −660.
Longitude 90° 12′ 05″.07; meters +123, −1,329.
To △ Ferry, azimuth 330° 23′ 07″, distance 737.9 meters.
To △ Western Rowing Club, azimuth 59° 37′ 35″, distance 154.3 meters.
To △ Lightning Rod, azimuth 192° 50′ 40″, distance 195.7 meters.
To △ Well House, azimuth 45° 23′ 44″, distance 432.2 meters.
Iron pipe set 6 inches below the surface on the high bank in a lumber yard near the south line of the St. George addition, between Louisa and Lynch streets, St. Louis, Mo. A point in the east rail of the east siding of railroad is 114 feet west of the station, and the angle from the flagstaff of the old Western Rowing Club to this point is 82° 02′. This same point is 460.1 feet north from city stone at northeast corner of Rowing Club and the triangulation station is 460 feet from said city stone. The station is 3 feet south of the north line of an old frame blacksmith shop and 36.6

feet east from same building; also 123.7 feet (right-angle distance) north from a point in the south boundary line (prolonged) of the St. George addition, which point is 419 feet east from the intersection of said south boundary line and the east line of First street.

△ WESTERN ROWING CLUB.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 36″.05; meters +1,112, −738.

Longitude 90° 12′ 10″.58; meters +256, −1,196.

The flag pole on the old Western Rowing Club building at the foot of Lynch street, St. Louis, Mo.

△ DORCAS NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 32″.92; meters +1,015 −835.

Longitude 90° 12′ 13″.66; meters +331, −1,121.

Cross on city stone, in the east line of city block No. 773, St. Louis, Mo.; 39.87 feet (right-angle distance) north from a point in the center line of Dorcas street, which point is 2,315.6 feet (average record distance) from the intersection of said center line and the east line of Broadway.

△ WELL HOUSE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 28″.74; meters +886, −964.

Longitude 90° 12′ 17″.79; meters +431, −1,022.

Conical roof of pumping station of Anheuser-Busch Brewery; north of and near foot of Arsenal street, St. Louis, Mo.

△ ARSENAL.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 28″.61; meters +882, −968.

Longitude 90° 12′ 23″.87; meters +578, −874.

To△Ferry, azimuth 292° 09′ 29″, distance 885 meters.

Center of one-half inch hole and cross, cut on top and in the center of the stone masonry pillar marking the northeast corner of the old United States arsenal tract; east of St. Louis, Iron Mountain and Southern Railway tracks, at foot of Arsenal street, St. Louis, Mo. It is 857.2 feet east from the east line of Second street (a mark on north face of arsenal wall). Azimuth to center of pillar, northwest corner of tract 139° 53′ 30″.

△ GATE.

United States engineer office, St. Louis, Mo., 1889; redetermined in 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 24″.32; meters +750, −1,100.

Longitude 90° 12′ 28″.65; meters +693, −759.

To△Ferry, azimuth 282° 10′ 02″, distance 956.7 meters.

Center of 1-inch hole, drilled in center of stone coping above the arch of the gate or sally port in the east or river wall of the old Arsenal tract and in the present United States engineer depot grounds at the foot of Arsenal street, St. Louis, Mo. The old name of this triangulation station was "U. S. Engineer Depot."

△ HOME BREWERY.

City of St. Louis, redetermined by United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)

Latitude 38° 35′ 19″.16; meters +591, −1,259.

Longitude 90° 13′ 16″.81; meters +407, −1,045.

To△Ferry, azimuth 271° 09′ 00″, distance 2,101.4 meters.

A copper rivet, in gravel roof, near the northeast corner of Home Brewery Building; 9 feet west of west side of Salina street and 110 feet south of south side of Miami street. It is 7.59 feet south of fire wall; 7.88 feet west of fire wall; 10.88 feet from intersection of two fire walls; and 15.95 feet north of Scuttle (Colby's description, survey of city of St. Louis, Mo.). Station was not occupied in 1901.

△ FERRY.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 17″.78; meters +548, —1,302.
Longitude 90° 11′ 50″.01; meters +1,210, —242.
To △ Home Brewery, azimuth 91° 09′ 54″, distance 2,101.4 meters.
To △ Addition, azimuth 150° 23′ 16″, distance 737.9 meters.
To △ Zepp, azimuth 86° 13′ 49″, distance 1,315.9 meters.
To △ Brick Chimney, azimuth 125° 28′ 35″, distance 1,637.4 meters.
To △ Red Chimney, azimuth 125° 44′ 51″, distance 1,098.9 meters.
To △ Western Rowing Club, azimuth 138° 32′ 43″, distance 751.9 meters.
To △ Well House, azimuth 116° 41′ 29″, distance 752.6 meters.
Iron pipe on high bank, Illinois shore, at the Sidney street (St. Louis, Mo.) ferry landing. It is about 8 feet south of center line of old Rock Road from ferry landing to Cahokia, Ill.; 44.8 feet north of nearest pile south of rock road; and 77.5 feet south of nearest pile north of rock road. Pile north of station is burnt to a sharp top.

△ ZEPP.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 35′ 14″.97; meters +462, —1,388.
Longitude 90° 12′ 44″.26; meters +1,071, —381.
To △ Keokuk, azimuth 56° 27′ 02″, distance 860.9 meters.
To △ Ferry, azimuth 266° 13′ 15″, distance 1,315.9 meters.
To △ Red Chimney, azimuth 210° 01′ 30″, distance 841.5 meters.
Iron pipe, set flush with surface of dump outside the railroad tracks at the foot of Zepp street, St. Louis, Mo.; 47.43 feet east from southeast corner of shanty boat on high bank; 46.09 feet east from northeast corner of same boat; 30.43 feet south from southeast corner of latrine; 7 feet (right angle distance) south from a point in the center line of Zepp street, prolonged, which point is 326.5 feet east from intersection of said center line with the east line of Barracks avenue. Station covered in 1908.

△ KEOKUK.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 34′ 59″.54; meters +1,836, —14.
Longitude 90° 13′ 13″.90; meters +336, —1,116.
To △ Meramec, azimuth 37° 44′ 12″, distance 724 meters.
To △ Zepp, azimuth 226° 26′ 44″, distance 860.9 meters.
Iron pipe, near front edge of Missouri bluffs; 52.1 feet south (right-angle distance) from a point in the eastern prolongation of the south line of Keokuk street (west of Marine avenue), St. Louis; and this point is 117.3 feet east from the intersection of said south line with the east line of Kosciusko street; station is in the southern prolongation of the line Zepp-Well House. References (angles referenced from △ Meramec): Arrow mark on fence southwest of station, 37° 56′—25.65 feet; southeast corner of latrine west of station, 95° 29′—19.88 feet; arrow mark on fence north of station, 170° 26′—10.91 feet.

⊙ P. B. M. 16.

Mississippi River Commission, 1880–81. (Chart No. 2.)
Latitude 38° 34′ 49″ .14; meters +1,515, —335.
Longitude 90° 13′ 42″ .96; meters +1,040, —412.
Elevation: 509.66.
Top of copper bolt, leaded vertically in east end of doorstep of second door from northeast corner of brick saloon adjoining Riverside Park, at junction of Piedmont avenue and Broadway, St. Louis, Mo.; 11 inches from front face and 4 inches west of buttress adjoining doorstep. (Station is plotted on chart 01′ too far west.

△ SACRED HEART CONVENT.

United States Coast and Geodetic Survey, 1871; redetermined by United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 34′ 43″ .94; meters +1,355, —495.
Longitude 90° 14′ 12″ .65; meters +306, —1,146.
Center of cross on Sacred Heart Convent, Meramec street and Nebraska avenue, St. Louis, Mo.

△ MERAMEC NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 34′ 43″ .48; meters +1,341, −509.
Longitude 90° 13′ 35″ .54; meters +860, −593.
Elevation: 455.67.
To△Tucker, azimuth 33° 39′ 01″, distance 1,285.2 meters.
Center of a one-half inch copper bolt, leaded in rock ledge at the foot of Meramec street, St. Louis, Mo.; west of the railroad on a flat shelf north of retaining wall and 23 feet northwardly from a sycamore tree below the wall. A nail is driven into the tree near the elevation of the station. Letters "U. S." are cut in vertical face of ledge just west of station; the "U" is 2.2 feet distant; and the north edge of an old drill-hole is 3.72 feet southwest. A cross on next shelf, about 3 inches higher, is 2.53 feet northwest. A city stone, on the east line of Marine avenue 230.5 feet from the center line of Meramec street, is 309.45 feet, 240° 58′ from the station. Also the station is 23 feet (right-angle distance) north from a point in the center line of Meramec street and this point is 158.2 feet west from intersection of said center line and the east line of Marine avenue.

△ FLAG 5.—⊡$\frac{52}{4}$

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 34′ 29″ .45; meters +908, −942.
Longitude 90° 13′ 53″ .46; meters +1,294, −158.
Elevation: 536.38.
Stone post, with top broken off; on top of bluff, in south St. Louis, Mo.; 400 meters from and nearly south of Workhouse; 66 meters from the railroad below the bluff. Bench mark is southeast corner of the stone which is cut to a knob.

△ ARSENAL ISLAND NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 34′ 22″ .38; meters +690, −1,160.
Longitude 90° 13′ 18″ .48; meters +447, −1,005.
Iron pipe, on left bank of river; on Arsenal Island; on the line Revetment–Arsenal Island, between the stations and 41.51 feet from the latter; 5.83 feet inshore from center nail in 10-inch blazed willow on edge of river bank.

△ NEOSHO.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 34′ 19″ .83; meters +611, −1,239.
Longitude 90° 14′ 00″ .44; meters +11, −1,442.
Iron pipe, on edge of bluff in south St. Louis, Mo.; 39.9 feet (right-angle distance) south from a point in the eastern prolongation of the north line of Neosho street (60 feet wide) and this point is 730 feet east from intersection of said north line with the west line of Oregon avenue. A city stone is 90 feet (right-angle distance) north from a point in said north line of Neosho street and this latter point is 59.3 feet west from the point first described.

△ SUMMER HOUSE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 34′ 13″.39; meters +413, −1,437.
Longitude 90° 14′ 02″.49; meters +60, −1,393.
The flagpole on summer house at Tucker railroad station near the foot of Itaska street, St. Louis.

△ TUCKER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 34′ 08″.79; meters +271, −1,579.
Longitude 90° 14′ 04″.96; meters +120, −1,333.
Elevation: 428.71.
To△Meramec No. 2, azimuth 213° 38′ 43″, distance 1,285.2 meters.
To△Dover, azimuth 32° 32′ 45″, distance 1,147.6 meters.
To△Summer House, azimuth 202° 52′ 25″, distance 153.9 meters.

Iron pipe, set flush with embankment on east side of railroad near Tucker station and about halfway between Maeder and Neosho streets, St. Louis, Mo. A mound of broken stone covers and marks the station. It is 16.4 feet east of east rail of east track; 30.3 feet east of east rail of west track; 43.85 feet from a cross on a bowlder which is about 12 feet north, and west of west track; 77 feet south from a 16-inch sewer pipe projecting through the embankm[illegible]; 126.75 feet north from center one of four nails and triangle blazed on yard lim[illegible]ost; 99.80 feet, actual, to a cross cut on ledge (elevation about 10 feet) west of [illegible] and under tool house above road leading to quarry; 82.65 feet, actual, to a cr[illegible]ut on ledge (elevation about 12 feet) west of track, and near north limit of quarr[illegible], 190[illegible] The length of the line Tucker-Dover, by base-line measurement, is 3,765.16 fe[illegible].

⊡ $\frac{52}{2}$

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 34′ 08″.54; meters +263, −1,587.
Longitude 90° 13′ 18″.01; meters +436, −1,017.
Elevation: Stone, 407.15; pipe, 412.25.
To⊡52/1, azimuth 307° 00′, distance 1,059 meters.
To△Flag 5=⊡52/4, azimuth 127° 05′.
Flat stone and iron pipe, on left bank of river; on Arsenal Island, 950 meters below its head, and 263 meters back from river bank; opposite Herf and Frerich's chemical works; among cottonwood trees and willows. (Covered up by deposit; not found in 1908.)

△ MAEDER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 33′ 59″.26; meters +1,827, −23.
Longitude 90° 14′ 13″.75; meters +333, −1,120.
To△Shoulder No. 2, azimuth 297° 16′ 40″, distance 668.6 meters.
Center of one-half inch hole and cross, cut on top and about 5 feet from edge of bare prominent ledge near the north line of Maeder street, St. Louis, Mo.; and west of the St. Louis, Iron Mountain and Southern Railway. It is 66.4 feet (right-angle distance) north from a point in the eastern prolongation of the center line of Maeder street, and this point is 399 feet east from intersection of said center line with the east line of Broadway.

△ SCULLIN.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 33′ 51″.88; meters +1,600, −250.
Longitude 90° 14′ 21″.24; meters +514, −939.
Center of conical roof and weather vane on Mr. Scullin's house on the bluffs in south St. Louis, Mo. (5200 South Broadway.)

△ SUMMER HOUSE NO. 2.

United States engineer office, St. Louis, Mo.; redetermined, 1901. (Chart No. 2, station not plotted.)
Latitude 38° 33′ 49″.23; meters +1,518, −332.
Longitude 90° 14′ 21″.60; meters +523, −930.
The finial and lightning rod of the summer house belonging to the old Chouteau residence, now the "Altenheim," in south St. Louis, Mo. (Old point of the United States engineer office survey of 1889.)

△ SHOULDER NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 33′ 49″.32; meters +1,521, −329.
Longitude 90° 13′ 49″.21; meters +1,191, −262.
To△Maeder, azimuth 117° 16′ 55″, distance 668.6 meters.
Iron pipe, 14 inches above surface of ground; on Arsenal Island (left bank of river); in prolongation of line Maeder-Shoulder, and 62.32 feet from the latter station; 2 feet southwest of spike at foot of 1-foot cottonwood tree; and top of pipe is 3.77 feet from head of another spike in triangular blaze on same tree and about 4 feet above ground.

⊡ $\frac{52}{I}$

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 33′ 47″.75; meters +1,472, −378.
Longitude 90° 12′ 42″.86; meters +1,038, −415.
Elevation: Stone, 409.61; pipe, 414.69.
To ⊡ 52/2, azimuth 127° 00′, distance 1,059 meters.
Flat stone and iron pipe, on land of Henry Morton; about 1 mile southwest of the town of Cahokia, Ill., and 1 mile northwest of the village of Prairie du Pont; behind Arsenal Island and 196 meters from left bank of chute; in grove of small trees; 20 feet above road leading back from house; and almost directly back of old hurdle across chute; 200 meters west of Mobile and Ohio Railroad where it crosses road; 4 meters west of blazed elm tree 1 foot in diameter. (The elevation given on chart was found to be incorrect.)

△ EILER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 33′ 47″.23; meters + 1,456, −394.
Longitude 90° 14′ 24″.19; meters +586, −867.
To △ Scullin, azimuth 206° 30′ 49″, distance 190.2 meters.
A temporary station, 28.8 feet west of brick wall near edge of bluff in "Altenheim" (old Chouteau) yard, in south St. Louis, Mo.; 26.7 feet (right-angle distance) north from a point in the south line of Eiler street prolonged, and this point is 274.2 feet east from intersection of said south line with the east side of Broadway.

▲ DOVER.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 33′ 37″.41; meters +1,154, −696.
Longitude 90° 14′ 30″.46; meters + 737, −716.
Elevation: 429.89.
To △ Tucker, azimuth 212° 32′ 29″, distance 1,147.6 meters.
To △ Kansas, azimuth 32° 20′ 33″, distance 696.5 meters.
Iron pipe, set about 6 inches below surface, in cinders and stone embankment on the east side of the railway and about 300 feet north of Dover street, St. Louis, Mo. Three reference crosses are cut in the solid rock on the west side of the track. Distance from south cross, 67.88 feet; from middle cross, 28.68 feet; and from north cross, 44.07 feet. Distance between south and middle crosses, 61.2 feet; between middle and north crosses, 34.3 feet. Station is 275.3 feet (right-angle distance) north from a point in the eastern prolongation of the north line of Dover street, and this point is 301.6 feet east from the northeast corner of Dover street and Broadway.

△ KANSAS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 33′ 18″.33; meters +565, −1,285.
Longitude 90° 14′ 45″.85; meters +1,110, −343.
To △ Kraus, azimuth 43° 25′ 47″, distance 478.6 meters.
To △ Incline, azimuth 344° 37′ 30″, distance 870.3 meters.
To △ Dover, azimuth 212° 20′ 09″, distance 696.5 meters.
To △ Steins, azimuth 26° 11′ 43″, distance 1,341.5 meters.
Large iron driftbolt, driven into prominent point of slag dump at the foot of Kansas street, St. Louis, Mo.; 113.8 feet from the northeast corner of a barn and 117 feet from the southeast corner of same; 27.4 feet north of center of small sewer; 123.1 feet (right-angle distance) north from a point in the south line of Kansas street prolonged and this point is 694.8 feet east from the intersection of said south line with the east line of Broadway. (Covered in 1908.)

△ KRAUS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 33′ 07″.06; meters +218, −1,632.
Longitude 90° 14′ 59″.43; meters +1,439, −14.
Elevation: 416.61.
To △ Incline, azimuth 311° 17′ 24″, distance 745 meters.
To △ Kansas, azimuth 223° 25′ 39″, distance 478.5 meters.

Iron pipe, near the edge of the high bank at the foot of Kraus street, St. Louis, Mo.; 10.82 feet east by north to a bolt in the base of lamp-post at south side of street; 60 feet from northeast corner of frame building south of street; 40 feet from southeast corner of frame building on north side of street. Station is 11.2 feet (right-angle distance) north from a point in the south line of Kraus street, and this point is 642.3 feet east from the southeast corner of Kraus street and Broadway.

△ INCLINE.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 32′ 51″.11; meters +1,576, −274.
Longitude 90° 14′ 36″.32; meters +879, −574.
To△Steins, azimuth 66° 06′ 24″, distance 900.1 meters.
To△Kansas, azimuth 164° 37′ 36″, distance 870.3 meters.
To△Waterloo, azimuth 33° 14′ 08″, distance 1,403.5 meters.
To△Kraus, azimuth 131° 17′ 39″, distance 745 meters.
Iron pipe, set flush with surface of ground, with mound of stone 1 foot high piled around it; in the stone embankment of the high-water railroad incline in Illinois and opposite Kraus street, St. Louis, Mo.; 6.92 feet west of inside edge of west rail and 4 feet from the edge of the embankment. There are five 9-pile clumps on the east side of the track, and the station is about equidistant from the northernmost two, which are surrounded by mounds of riprap 4 feet high.
The southernmost middle pile of the north clump and the northernmost middle pile of the next clump south are blazed with triangles, about 7 feet above the ground which are painted white with a spike in the center and the actual distance between these spikes is 52.73 feet. At a point in this same line, 30.37 feet from spike in north clump, or 22.36 feet from spike in south clump, the cross on the Sisters of St. Joseph Convent is seen in range with the station, which is 41.82 feet from this same point. The station is 51.05 feet, actual, from spike in north clump and 48.72 feet from spike in next clump south. (Covered in 1908.)

△ STEINS.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 32′ 39″.29; meters +1,211, −639.
Longitude 90° 15′ 10″.30; meters +249, −1,204.
Elevation: 421.88.
To△Jupiter, azimuth 26° 08′ 52″, distance 589.4 meters.
To△Waterloo, azimuth 356° 11′ 49″, distance 811.1 meters.
To△Incline, azimuth 246° 06′ 03″, distance 900.1 meters.
Copper bolt, leaded into the masonry of the ruins of the elevator at the foot of Steins street, south St. Louis, Mo.; 57.4 feet to the southeast corner and 59.4 feet to southwest corner of ruins; 5.38 feet northeast and 8.3 feet northwest, respectively, to bolts in masonry; and 52.8 feet from east rail of railroad track; 68.1 feet (right-angle distance) north from a point in the north line of Steins street, and this point is 1,869.7 feet east from the northeast corner of Steins street and Broadway and 831.4 feet from the intersection of said north line of Steins street and the center line of Reilly avenue.

△ CARONDELET SCHOOL.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 32′ 38″.64; meters +1,191, −659.
Longitude 90° 15′ 56″.66; meters +1,372, −81.
To◉Insane Asylum, azimuth 169° 56′ 19″, distance 6,744.3 meters.
To△Sacred Heart, azimuth 213° 05′ 17″, distance 4,611.7 meters.
To△Notre Dame, azimuth 13° 03′ 19″, distance 2,332.2 meters.
A copper rivet, in intersection of the northeast and west slopes of the roof of the Carondelet School at Davis street and Minnesota avenue, south St. Louis, Mo.; 34.76 feet from the northwest corner of the tin roof; 34.78 feet from the northeast corner; 36.66 feet from the southeast corner; and 36.80 feet from the southwest corner (Colby's description, survey of city of St. Louis). The center part of the roof, vertex of the four slopes, has been cut away for a ventilator which is about 12 feet square, 6 feet high, and covered with a flat tin roof. A nail in this tin roof and approximately over the intersection of the original roof slopes marks the station used in 1901.

The following measurements were taken when the angles were observed:
To△Des Peres (destroyed) 00° 00′.
To the northwest corner of tin roof, 35.76 feet, 187° 25′.
To the northeast corner of tin roof, 35.56 feet, 274° 24′.
To the southeast corner of tin roof, 35.57 feet, 7° 33′.
To the southwest corner of tin roof, 35.96 feet, 94° 37′.

⊕ 3 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 2.)
Latitude 38° 32′ 37″.20; meters +1,147, −703.
Longitude 90° 10′ 25″.72; meters +623, −830.
Elevation: 421.92.
To△Tank, U. S. Magazine, azimuth 71° 23′.
To spire of church, azimuth 89° 17′.
To gable of house, azimuth 88° 45′.
To gable of stone crusher, azimuth 273° 10′.
Iron pipe, set in ground and projecting about 10 inches above the surface; in Illinois bottom land opposite Stolle quarries, about 5 miles below East St. Louis, Ill.; and about one-fourth mile west from stone residence of quarry superintendent; on small levee 6.5 feet south of center of track of Illinois Central (Belleville and East Carondelet) Railroad; 50 meters west of road crossing; 16 meters from northwest corner of orchard; and 352 meters east of house on south side of tracks.

⊕ STOLLE.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 2.)
Latitude 38° 32′ 26″.27; meters +810, −1,040.
Longitude 90° 10′ 07″.04; meters +171, −1,283.
To⊛Insane Asylum, azimuth 126° 06′.
To△Tank, U. S. Magazine, azimuth 74° 04′.
To△Notre Dame, azimuth 78° 10′.
To△Scullin, azimuth 113° 14′.
To△Sacred Heart, azimuth 125° 31′.
To△Saints Peter and Paul, azimuth 157° 31′.
Hole in cap of 3-inch iron pipe, 5 inches below surface of ground, on Illinois bluffs and about 5 miles below East St. Louis, Ill.; on highest mound back of stone residence of superintendent of Stolle quarries, and about 50 meters downstream from same; 16 meters back from edge of bluff and about 5 meters southwest of top of mound. References: 36-inch oak stump, 280° 20′—35 meters; burnt snag, 61° 45′—57 meters; northeast corner of stone residence, 179° 15′—292 meters; two 18-inch black oak trees, 1 foot apart, and at upper edge of scattered timber, triangle blazed on east one, 71° 55′—83 meters.

△ JUPITER.

United States engineer office, St. Louis, Mo., 1901 and 1903. (Chart No. 2.)
Latitude 38° 32′ 22″.13; meters +682, −1,168 (1901).
Longitude 90° 15′ 21″.02; meters +509, −944 (1901).
Latitude 38° 32′ 22″.13; meters +682, −1,168 (1903).
Longitude 90° 15′ 21″.07; meters +510, −943 (1903).
To△Waterloo, azimuth 311° 47′ 39″, distance 420.5 meters (1901).
To△Waterloo, azimuth 311° 48′ 31″, distance 420.6 meters (1903).
To△Vulcan, azimuth 33° 47′ 08″, distance 740.2 meters (1901).
To△Vulcan, azimuth 33° 48′ 02″, distance 740.4 meters (1903).
To△Steins, azimuth 206° 08′ 46″, distance 589.4 meters (1901).
Cross on square head of 1-inch iron bolt, driven into the slag dump flush with surface, near the old Jupiter Furnace and north from the foot of Davis street, St. Louis, Mo. A mound of stone covers and marks the station which is on prominent point and 12 feet from edge of the dump; 28.6 feet upstream from a snubbing post in which 3 nails forming a triangle are driven; 176.5 feet from northeast corner of main furnace building and 130 feet downstream from outer end of a plank bridge over a ditch; 286.9 feet (right angle distance) north from a point in the north line of Davis street, and this point is 1,323.9 feet east from the intersection of said north line and the east line of Reilly avenue, 447.7 feet east from a "mark correct for Davis street" in the west face of the southwest corner of an old brick house east of the St. Louis, Iron Mountain and Southern Railway, and 219 feet from a mark on foundation of old furnace 2.2 feet south of the north line of Davis street.

△ WATERLOO.

United States engineer office, St. Louis, Mo., 1901 and 1903. (Chart No. 2.)
Latitude 38° 32′ 13″.04; meters +402, −1,448 (1901).
Longitude 90° 15′ 08″.08; meters +196, −1,257 (1901).
Latitude 38° 32′ 13″.04; meters +402, −1,448 (1903).
Longitude 90° 15′ 08″.13; meters +197, −1,256 (1903).
Elevation: 404.84.
To △ Steins, azimuth 176° 11′ 50″, distance 811.1 meters.
To △ Incline, azimuth 213° 13′ 48″, distance 1,403.5 meters.
To △ Jupiter, azimuth 131° 47′ 47″, distance 420.5 meters.
To △ Jupiter, azimuth 131° 48′ 40″, distance 420.6 meters (1903).
Nail hole surrounded by triangle of three nails, on west main longitudinal stringer of the railroad incline in Illinois, south of the Waterloo road, and opposite Davis street, St. Louis, Mo. Station is close to and below the west rail and over the third cross sill from the revetment. Three notches are cut on the rail flange just above the point. Two triangles with ax notches and two triangles of tacks are on the ties nearest north and south.

△ CITY LIMITS NO. 2.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 32′ 02″.54; meters +78, −1,772.
Longitude 90° 15′ 48″.06; meters +1,164, −289.
Stone post, marking the southern boundary line of the city of St. Louis, Mo.; about 200 feet south from center of River des Peres; on the east side of the St. Louis, Iron Mountain and Southern Railway; and 521.4 feet from △ City Limits No. 1.

△ VULCAN.

United States engineer office, St. Louis, Mo., 1901 and 1903. (Chart No. 2, station not plotted.)
Latitude 38° 32′ 02″.18; meters +67, −1,783 (1901).
Longitude 90° 15′ 38″.02; meters +921, −532 (1901).
Latitude 38° 32′ 02″.18; meters +67, −1,783 (1903).
Longitude 90° 15′ 38″.08; meters +922, −531 (1903).
To △ Jupiter, azimuth 213° 46′ 57″, distance 740.2 meters.
To △ Jupiter, azimuth 213° 47′ 51″, distance 740.4 meters (1903).
To △ Opposite Vulcan, azimuth 289° 20′ 54″, distance 573.6 meters (1903).
To △ Du Pont, azimuth 338° 07′ 47″, distance 867.5 meters (1903).
Iron pipe, set flush with surface of ground and covered with mound of earth and stone on prominent point about 100 feet north of the River des Peres and near the foot of Lorenz street, St. Louis, Mo.; 149.2 feet from old △ Vulcan Chimney (destroyed); 401.9 feet from △ City Limits No. 1; and 76.6 feet (right angle distance) south from a point in the center line of Lorenz street prolonged, and this point is 1,290.1 feet east from the intersection of said center line with the east line of Polk street.

△ CITY LIMITS NO. 1.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2, station not plotted.)
Latitude 38° 32′ 00″.07; meters +2, −1,848.
Longitude 90° 15′ 42″.30; meters +1,024, −429.
Stone post, marking the southern boundary line of the city of St. Louis, Mo.; about 200 feet south from center of River des Peres; 140 feet west from high bank of Mississippi River; and 402 feet from △ Vulcan.

⊡ 51/3

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 31′ 57″.57; meters +1,775, −75.
Longitude 90° 15′ 58″.53; meters +1,418, −36.
Elevation: Stone, 417.82; pipe, 422.91.
To ⊡ 51/2, azimuth 293° 20′.
Flat stone and iron pipe, 170 meters south of River des Peres, at nearest point; 40 meters west of St. Louis, Iron Mountain and Southern Railway tracks; in east edge of open timber; beside path and near fence along the right of way. (Not found in 1908.)

△ OPPOSITE VULCAN.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 31′ 56″.01; meters +1,727, —123.
Longitude 90° 15′ 15″.73; meters +381, —1,073.
To △ Du Pont, azimuth 19° 31′ 22″, distance 652.6 meters.
To △ Vulcan, azimuth 109° 21′ 08″, distance 573.6 meters.
Iron pipe, on left bank, 10 inches above surface of ground; 25 feet from top of bank in line with south end of railroad bridge over River des Peres and flagstaff of Mount St. Rose Hospital; and 20 feet southeast of 12-inch blazed cottonwood tree.

⊕ 4 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 2.)
Latitude 38° 31′ 38″.63; meters +1,191, —659.
Longitude 90° 12′ 26″.92; meters +652, —801.
Elevation: 419.53.
To △ Notre Dame, azimuth 85° 44′.
To △ Sacred Heart, azimuth 155° 52′.
To water tank, Bixby, Ill., azimuth 20° 30′.
To church spire, azimuth 154° 20′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 600 meters above roundhouse at Dupo, Ill.; 1¼ miles below the junction of Illinois Central (Belleville and East Carondelet) Railroad and St. Louis, Iron Mountain and Southern Railway (Illinois division); 11.3 feet east of center of northbound track; 234 meters below Seileman's house; 83 meters above telegraph pole; 5/15 and 190 meters below pole 5/10.

⊡ 51/2

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 31′ 37″.52; meters +1,157, —693.
Longitude 90° 14′ 59″.35; meters +1,437, —16.
Elevation: Stone, 412.12; pipe, 417.20.
To ⊡ 51/1, azimuth 292° 45′, distance 708 meters.
To ⊡ 51/3, azimuth 113° 20′.
Flat stone and iron pipe, on little knoll, distant about 60 meters west from Prairie du Pont Creek; in timber and about 1¼ miles below East Carondelet, Ill. It is just south of the St. Louis, Iron Mountain and Southern Railway (Illinois division, river branch).

△ DU PONT.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 31′ 36″.07; meters +1,112, —738.
Longitude 90° 15′ 24″.74; meters +599, —854.
To △ Meyer, azimuth 12° 25′ 07″, distance 1,154.6 meters.
To △ Ivory, azimuth 50° 08′ 38″, distance 1,386.9 meters.
To △ Vulcan, azimuth 158° 07′ 55″, distance 867.5 meters.
To △ Opposite Vulcan, azimuth 199° 31′ 17″, distance 652.6 meters.
Iron pipe, on left bank, 10 inches above surface of ground; about 300 feet north of mouth of Prairie du Pont Creek; 20.5 feet northeast of 6-inch blazed willow tree and 700 feet south of railroad incline.

⊡ 51/1

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 31′ 28″.61; meters +882, —968.
Longitude 90° 14′ 32″.32; meters +783, —671.
Elevation: Stone, 408.52; pipe, 413.61.
To ⊡ 51/2, azimuth 112° 45′, distance 708 meters.
Flat stone and iron pipe, about 1¼ miles below East Carondelet, Ill.; under elm tree blazed and marked "U. S. B. M. No. 51;" 194 meters east of the Mobile and Ohio Railroad; 100 meters west of the St. Louis and Columbia Rock road; in cultivated field.

△ NOTRE DAME.

United States engineer office, St. Louis, Mo., 1901. (Chart No. 2.)
Latitude 38° 31′ 24″.96; meters +770, −1,080.
Longitude 90° 16′ 18″.41; meters +446, −1,008.
Center of the tower and cross, on Notre Dame Convent, south of River des Peres.

△ D 4.

United States engineer office, St. Louis, Mo.; redetermined, 1903. (Chart No. 2, station not plotted.)
Latitude 38° 31′ 00″.07; meters +2, −1,848.
Longitude 90° 16′ 14″.90; meters +361, −1,093.
To△Meyer, azimuth 271° 01′ 27″, distance 967.2 meters.
Hole in rock, near edge of Missouri bluffs; immediately west of railroad; 650 feet below old stone gatepost of United States powder depot; 320 feet east of brick house; and 885 feet (measured along track) north of sign post "Barracks one mile."

△ MEYER.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 30′ 59″.50; meters +1,835, −15.
Longitude 90° 15′ 34″.99; meters +848, −606.
To△Ivory, azimuth 106° 18′ 21″, distance 850.6 meters.
To△Jefferson Barracks, azimuth 57° 30′ 21″, distance 1,272.4 meters.
To△D 4, azimuth 91° 02′ 52″, distance 967.2 meters.
To△Du Pont, azimuth 192° 25′ 00″, distance 1,154.6 meters.
To△Tank, U. S. Magazine, azimuth 87° 50′ 50″, distance 1,523.3 meters.
Iron pipe, in Illinois; 10 inches above surface of ground; 6 feet from top of bank; on land of Meyer Land Company; and on line with△Flagstaff and center of railroad station at Jefferson Barracks, Mo.

△ TANK, U. S. MAGAZINE.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 30′ 57″.64; meters +1,777, −73.
Longitude 90° 16′ 37″.82; meters +916, −548.
Center of conical roof of water tank on grounds of United States powder depot, Jefferson Barracks, Mo.

▲ FLAG 7.

Mississippi River Commission, 1880–1881. (Chart No. 2.)
Latitude 38° 30′ 38″.77; meters +1,195, −655.
Longitude 90° 15′ 16″.85; meters +408, −1,045.
Elevation: Stone, 414.28.
To◬Twin Hollow (MRC), azimuth 27° 19′ 50″, distance 7,406.9 meters.
To◬Dryer, azimuth 281° 34′ 54″, distance 4,975 meters.
To ⊡ 5 (Field), azimuth 62° 55′, distance 2,119 meters.
Stone post, on left bank and opposite the United States powder depot; just west of north and south road; and south of east and west road; on land of John Eugea and 175 meters north of his house; John Eugea's orchard is east of and across the road from stone. A pipe was placed over the stone in 1901. (Elevation, 441.87, given on chart is incorrect.)

▲ JEFFERSON BARRACKS.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 30′ 37″.32; meters +1,151, −699.
Longitude 90° 16′ 19″.28; meters +467, −987.
To△G 4, azimuth 16° 09′ 15″, distance 1,733.6 meters.
To△Opposite G 4, azimuth 348° 32′ 18″, distance 1,713.7 meters.
To△Ivory, azimuth 195° 33′ 12″, distance 9,575.5 meters.
Hole in rock ledge, in Missouri; on east or river side of St. Louis, Iron Mountain and Southern Railway tracks and nearly opposite the officers' quarters at Jefferson Barracks, Mo.

▲ FLAGSTAFF.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 30′ 11″.59; meters +357, −1,493.
Longitude 90° 16′ 37″.26; meters +903, −551.
To△Opposite G 4, azimuth 318° 46′ 41″, distance 1,177.9 meters. Flagstaff at Jefferson Barracks, Mo.

⊕ 5 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 2.)
Latitude 38° 30′ 11″.11; meters +343, −1,507.
Longitude 90° 13′ 08″.42; meters +204, −1,250.
Elevation: 418.75.
To△Tank, U. S. Magazine, azimuth 106° 01′.
To△Notre Dame, azimuth 111° 20′.
To cross on church spire, azimuth 128° 41′.
To smokestack, Dupo (middle), azimuth 198° 10′.
To finial of water tank, Bixby, azimuth 20° 41′.
Cross in end of railroad rail, 1 inch above surface of ground in Illinois bottom land; three-quarters of a mile above Bixby; 137 meters below telegraph pole 7/5; 127 meters above telegraph pole 7/10; and 5½ meters above switch stand.
Rail is set vertically in St. Louis, Iron Mountain and Southern Railway (Illinois Division) right of way, about 8 inches east of center of track.

⊛ DRYER.

United States Coast and Geodetic Survey, 1871, and Mississippi River Commission, 1880-81. (Chart No. 2.)
Latitude 38° 30′ 06″.33; meters +195, −1,655.
Longitude 90° 11′ 55″.71; meters +1,350, −104.
Elevation: 682.2.
To⊛Insane Asylum, azimuth 148° 16′ 50″.83, distance 13,331.28 meters.
To⊛Clarks Mound, azimuth 232° 20′ 44″.56, distance 14,116.73 meters.
To⊛Twin Hollow (MRC), azimuth 56° 02′ 04″.10, distance 9,980.80 meters.
To△Flag 7, azimuth 101° 36′ 59″, distance 4,975.0 meters.
An earthenware pyramid, marked "U. S. C. S." placed 3 feet below the surface of the ground, on Illinois bluffs; 2 miles below Falling Spring; 1½ miles southeast of Dupo, Ill.; and near the lower end of Bluff Lake. It is on the south side of a large ravine; about one-quarter mile from the perpendicular face of bluff; and almost on line with the wagon road that crosses the lower end of Bluff Lake and enters Dupo on the south. Marble surface marking stone has been destroyed.

△ G 4.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 29′ 43″.32; meters +1,336, −514.
Longitude 90° 16′ 39″.18; meters +949, −505.
To△Jefferson Barracks, azimuth 196° 09′ 02″, distance 1,733.6 meters.
To△Davis, azimuth 10° 59′ 08″, distance 939.3 meters.
To△Opposite G 4, azimuth 270° 59′ 51″, distance 823 meters.
To△Wilson, azimuth 330° 44′ 14″, distance 1,540.6 meters.
Hole in rock ledge, on first bluff below Jefferson Barracks, Mo.

△ OPPOSITE G 4.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 29′ 42″.86; meters +1,322, −528.
Longitude 90° 16′ 05″.23; meters +127, −1,327.
To△Davis, azimuth 47° 49′ 36″, distance 1,351.9 meters.
To△Flagstaff, azimuth 138° 47′ 01″, distance 1,177.9 meters.
To△Jefferson Barracks, azimuth 168° 32′ 27″, distance 1,713.7 meters.
Iron pipe, in Illinois; opposite United States gauge at Jefferson Barracks, Mo.; and on point halfway between old hurdles Nos. 31½ and 32.

⊡ 50/4

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 29′ 33″.79; meters +1,042, −808.
Longitude 90° 16′ 41″.67; meters +1,010, −444.
Elevation: 431.41.
To⊡50/3, distance 48 meters.
Cross cut on vertical face of natural rock, about 20 feet west of the railroad track and 1,300 meters below new railroad depot at Jefferson Barracks, Mo.

⊡ 50/3

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 29′ 33″.40; meters +1,030, −820.
Longitude 90° 16′ 39″.61; meters +960, −494.
Elevation: 392.27.
To⊡50/4, distance 48 meters.
Cross cut horizontally on smooth rock ledge near the water's edge and 1,300 meters below the new railroad depot at Jefferson Barracks, Mo.

⊡ 50/1

Mississippi River Commission, 1889. (Chart No. 2.)
Latitude 38° 29′ 16″.86; meters +520, −1,330.
Longitude 90° 14′ 36″.56; meters +886, −568.
Elevation: Stone, 407.65; pipe, 412.76.
Flat stone and iron pipe, on east bank of Fish Lake, Ill.; at fence in front of barn on H. Wecker's place; 120 meters below where road along bank of Fish Lake crosses the Mobile and Ohio Railroad.

△ DAVIS.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 29′ 13″.42; meters +414, −1,436.
Longitude 90° 16′ 46″.57; meters +1,129, −325.
To△Bussen, azimuth 13° 39′ 37″, distance 1,468.1 meters.
To△Wilson, azimuth 294° 21′ 15″, distance 1,023.1 meters.
Hole surrounded by triangle in rock ledge in Missouri; on land of Davis (old Forder place, above first bluff above Quarantine); 4½ feet back from edge of bluff; 70 feet below signpost "Barracks one mile;" and between two quarries.

△ CULVERT.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2.)
Latitude 38° 29′ 03″.55; meters +109, −1,741.
Longitude 90° 16′ 50″.38; meters +1,221, −233.
To△Carroll, azimuth 335° 34′ 50″, distance 1,634.0 meters.
To△Wilson, azimuth 276° 33′ 13″, distance 1,031.2 meters.
Hole in 1.8 by 2 foot stone, 1 foot south of center line on east side of stone arch culvert of St. Louis, Iron Mountain and Southern Railway, above Quarantine, Mo. Top of stone is 6 inches below top of rail.

△ WILSON.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 28′ 59″.73; meters +1,842, −8.
Longitude 90° 16′ 08″.11; meters +197, −1,258.
To△Carroll, azimuth 14° 17′ 39″, distance 1,413.8 meters.
To△Bussen, azimuth 51° 51′ 09″, distance 1,626.2 meters.
To△Davis, azimuth 114° 21′ 39″, distance 1,023.1 meters.
To△Culvert, azimuth 96° 33′ 40″, distance 1,031.2 meters.
Iron pipe in Illinois opposite culvert of St. Louis, Iron Mountain and Southern Railway just above Quarantine, Mo.; and on the upper high bank of the upper one of two sloughs that go in just above Carroll Island.

⊕ 6 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 2.)
Latitude 38° 28′ 40″.30; meters +1,243, −607.
Longitude 90° 13′ 50″.91; meters +1,234, −221.
Elevation: 417.97.
To△Tank, U. S. Magazine, azimuth 136° 24′.
To△Notre Dame, azimuth 144° 51′.
To finial of water tank, Bixby, azimuth 199° 56′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 1 mile below Bixby, Ill.; 490 meters above junction of Mobile and Ohio Railroad and St. Louis, Iron Mountain and Southern Railway (Illinois Division); 18.1 feet east of center of track of latter road; 84 meters above whistle post; and 41 meters below semaphore.

△ BUSSEN.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 28′ 27″.15; meters +837, −1,013.
Longitude 90° 17′ 00″.87; meters +21, −1,434.
To△Ripling, '03, azimuth 339° 39′ 22″, distance 1, 910.1 meters.
To△Carroll, azimuth 291° 27′ 16″, distance 999.1 meters.
To△Wilson, azimuth 231° 50′ 37″, distance 1,626.2 meters.
Hole in rock, on first bluff below Quarantine, Mo.; 7 feet back from edge of bluff; 125 feet below center of large sinkhole. Established and used as plane-table station by United States engineer office, St. Louis, Mo., 1899. Description, 1907: Fifteen telegraph poles below quarry and opposite first telegraph pole above concrete culvert; witness trees blazed with triangles are as follows: Dead post oak 18 inches in diameter, south 60° west, 25 feet; 10-inch blackjack, north 40° west, 9 feet; 6-inch tree, north 15° west, 28 feet; station is in east end of fracture in rock.

△ CARROLL.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 2, station not plotted.)
Latitude 38° 28′ 15″.30; meters +472, −1,378.
Longitude 90° 16′ 22″.51; meters +546, −909.
To△Bussen, azimuth 111° 27′ 40″, distance 999.1 meters.
To△Ripling, '03, azimuth 10° 34′ 10″, distance 1,450.1 meters.
To△Mott '99, azimuth 51° 56′ 44″, distance 1,661.0 meters.
To△Culvert, azimuth 155° 35′ 07″, distance 1,634.0 meters.
Iron pipe, on high bank of Carroll Island, 75 feet from shore (left bank of river) and about one-half way between the middle hurdles. (Covered in 1908.)

△ MOTT '99.

United States engineer office, St. Louis, Mo., 1899; redetermined, 1903. (Chart No. 3.)
Latitude 38° 27′ 42″.09; meters +1,298, −552.
Longitude 90° 17′ 16″.46; meters +399, −1,056.
To◎Twin Hollow (MRC), azimuth 23° 49′ 00″, distance 1,238.3 meters.
To△Ripling '03, azimuth 291° 04′ 13″, distance 1,116.7 meters.
Hole surrounded by triangle in rock; 3 feet from edge of first bluff above Cliff Cave Hollow, Mo.; 60 feet below signpost "Bousan one mile"; and opposite a sign "For sale" painted on bluff.

△ RIPLING '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3.)
Latitude 38° 27′ 29″.16; meters +899, −951.
Longitude 90° 16′ 33″.23; meters +806, −649.
To◎Twin Hollow (MRC), azimuth 64° 38′ 00″, distance 1,713.6 meters.
Iron pipe, 4 inches above surface of ground; in edge of field back of lower end of small willows; 575 meters below slough at the foot of Carroll Island; 30 meters above fringe of large timber on left main bank and nearly opposite Cliff Cave, Mo. Station was set on the line Twin Hollow (MRC) Ripling (temporary) and 22.57 feet back of latter.

⊕ HICKMAN.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3, station not plotted.)
Latitude 38° 27′ 26″.74; meters +825, −1,025.
Longitude 90° 16′ 28″.32; meters +687, −868.
To △ Ripling '03, azimuth 108° 44′, distance 231.4 meters.
To chimney, azimuth 46° 04′ 30″.
Cross cut in top of 6-inch by 10-inch irregular stone, 6 inches above surface of ground in field, in Illinois and opposite Cliff Cave, Mo.; 5 meters east of wagon road; 18 meters above walnut tree 2½ feet in diameter; 240 meters from river bank; 140 meters below forked sycamore tree 3 feet in diameter; 198 meters below two-story frame house on Ripling's land; and about three-eighths of a mile above brick house of John Delmar.

⊕ TWIN HOLLOW.

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 27′ 05″.35; meters +165, −1,685.
Longitude 90° 17′ 37″.08; meters +899, −556.
To ⊕ Dryer, azimuth 235° 58′ 31″.70, distance 9,980.80 meters.
To △ Warner, azimuth 24° 38′ 48″, distance 2,659.4 meters.
To △ Pulltight'03, azimuth 309° 53′ 52″, distance 1,296.8 meters.
To △ Mott '99, azimuth 203° 48′ 48″, distance 1,238.3 meters.
Stone post, on point of bluff 500 feet above the upper Twin Hollow; 30 feet back from edge of bluff; and five-eighths of a mile below Cliff Cave, Mo.

△ TWIN HOLLOWS. (Engineers.)

United States engineer office, St. Louis, Mo., 1887; redetermined 1903. (Chart No. 3, station not plotted.)
Latitude 38° 27′ 05″.24; meters +162, −1,688.
Longitude 90° 17′ 36″.86; meters +894, −561.
To ⊕ Twin Hollow (MRC), azimuth 121° 57′ 35″, distance 6.44 meters.
Hole surrounded by triangle, in rock near edge of Missouri bluffs and 21.12 feet southeast of ⊕ Twin Hollow (MRC), which is a stone post on point of bluff 500 feet above the upper Twin Hollow and 30 feet back from edge of bluff.

⊕ 7 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3.)
Latitude 38° 26′ 52″.77; meters +1,627, −223.
Longitude 90° 14′ 38″.41; meters +931, −524.
Elevation: 426.16.
To △ Tank, U. S. Magazine, azimuth 159° 01′.
To △ Notre Dame, azimuth 163° 52′.
To Columbia church spire, azimuth 280° 39′.
To Columbia church spire (No. 2), azimuth 279° 47′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 3 miles below Bixby, Ill.; on levee; 74½ meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); at lower end of trestle No. 11 over drainage ditch; 114 meters above telegraph pole 11/10; and 176 meters below pole 11/5.

△ GEBHARDT.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3, station not plotted.)
Latitude 38° 26′ 43″.83; meters +1,351, −499.
Longitude 90° 17′ 49″.65; meters +1,204, −251.
Cedar post, on edge of Missouri bluffs; 400 feet above sign post "Cliff Cave one mile;" 100 feet north of small orchard and 6 feet west of large dead cedar tree.

△ PULLTIGHT '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3.)
Latitude 38° 26′ 38″.37; meters +1,183, −667.
Longitude 90° 16′ 56″.06; meters +1,360, −95.
Elevation: 411.30.
To ⊕ Twin Hollow (MRC), azimuth 129° 54′ 18″, distance 1,296.8 meters.

Iron pipe, 10 inches above surface of ground in Illinois; on high bank; 500 feet above outlet of Fish Lake; 48 feet from top of high bank; and 43 feet west of a blazed cottonwood tree 2 feet in diameter. Station was set on line Twin Hollow-Pulltight (temporary) and 90.79 feet back of the latter station.

△ BEYERS '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3.)
Latitude 38° 26′ 22″.90; meters +706, −1,144.
Longitude 90° 18′ 02″.27; meters +55, −1,400.
Hole surrounded by triangle in rock, near edge of bluff; 1,200 feet below mile post 14 (St. Louis, Iron Mountain and Southern Railway), and 1¾ miles above Whitehouse, Mo.

△ GAAB.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3, station not plotted.)
Latitude 38° 25′ 56″.13; meters +1,731, −119.
Longitude 90° 18′ 17″.67; meters +429, −1,027.
Hole surrounded by triangle in rock, near edge of perpendicular bluff in Missouri; 1,200 feet above milepost 15 of the St. Louis, Iron Mountain and Southern Railway; in front of small orchard at head of timber and in front of long, low house with chimney in center, occupied by Frank Gaab. To reach station, go up path below △ Schierhoff and follow road along crest of bluff.

△ WARNER.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3, station not plotted.)
Latitude 38° 25′ 46″.95; meters +1,448, −402.
Longitude 90° 18′ 22″.80; meters +553, −903.
To ◬ Twin Hollow (MRC), azimuth 204° 38′ 20″, distance 2,659.4 meters.
Hole surrounded by triangle in rock, on projecting point of Missouri bluffs; on land of Warner; 30 feet below milepost 15; 15 feet southeast of 14-inch blazed postoak, and 20 feet south of two 4-inch boxelders.

⊕ 8 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3).
Latitude 38° 25′ 23″.83; meters +735, −1,115.
Longitude 90° 15′ 26″.83; meters +651, −805.
Elevation: 413.00.
To upper gable of house, azimuth 166° 23′.
To gable of brick house, azimuth 267° 00′.
To gable of house, azimuth 285° 27′.
To gable of house, azimuth 284° 58′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 4 miles below Bixby, Ill.; 78 meters west of St. Louis, Iron Mountain and Southern Railway (Illinois Division) track. Pipe is on waste bank; 8 meters below middle of ditch, below trestle No. 15; 124 meters to telegraph pole 13/15, 335° 10′; 200 meters to pole 13, 226° 35′; pecan tree 3 feet in diameter, 280° 15′—38 meters; pecan tree 30 inches in diameter, 298° 50′—57 meters; pecan tree 24 inches in diameter, 6° 30′—56 meters.

△ SCHIERHOFF.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3, station not plotted.)
Latitude 38° 25′ 19″.71; meters +608, −1,242.
Longitude 90° 18′ 41″.50; meters +1,007, −449.
To ◬ Salt Bluff, azimuth 356° 00′ 04″, distance 12,489.1 meters.
Hole surrounded by triangle in smooth ledge rock, in quarry and on top of Missouri bluffs; about 2,400 feet above large rock culvert at Whitehouse railroad station; about 600 feet below small vineyard on bluff near house of Herman Schierhoff. Station established and located by plane-table survey of United States engineer office, St. Louis, Mo., in 1899, is best reached by path going up hillside just below projecting point on which station is located.

▲ WHITEHOUSE '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3.)
Latitude 38° 24′ 49″.01; meters +1,511, −339.
Longitude 90° 19′ 11″.12; meters +270, −1,186.
Iron pipe, 6 inches above surface of ground on slope of hill below Whitehouse station, Mo. It is 35 feet west of center of main track of St. Louis, Iron Mountain and Southern Railway; 20 feet east of 8-inch sassafras tree; 180 feet south of switch-block opposite face of quarry; 300 feet below lower end of Whitehouse siding; and 100 feet upstream from boiler house on hillside.

◉ MERAMEC ⊡ $\frac{48}{4}$

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 24′ 23″.78; meters +733, −1,117.
Longitude 90° 19′ 36″.79; meters +893, −563.
Elevation: 564.
To ◬ Salt Bluff, azimuth 348° 20′ 36″.86, distance 10,959.89 meters.
To ◬ Sulphur Springs, azimuth 26° 00′ 20″.93, distance 9,697.15 meters.
To ⊡ 48/2, azimuth 312° 06′, distance 1,500 meters.
Stone post, on Missouri bluff; 65 meters back from St. Louis, Iron Mountain and Southern Railway; and 1¼ miles above the mouth of the Meramec River. Stone was reset in old position in 1903, and therefore given elevation is only approximate.

⊡ $\frac{48}{3}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 24′ 22″.31; meters +688, −1,162.
Longitude 90° 19′ 34″.74; meters +843, −613.
Elevation: 422.34.
To ⊡ 48/2, azimuth 312° 06′, distance 1,432 meters.
Stone post, in Missouri; just east of the St. Louis, Iron Mountain and Southern Railway track; seven-eights of a mile below Whitehouse station. Stone stands 68 meters directly in front of ◬ Meramec.

△ FINES BLUFF.

United States engineer office, St. Louis, Mo., 1887; redetermined, 1900–1903. (Chart No. 3.)
Latitude 38° 24′ 07″.72; meters +238, −1,612.
Longitude 90° 19′ 55″.82; meters +1,354, −101.
To ◬ Salt Bluff, azimuth 345° 20′ 56″, distance 10,582.5 meters.
To ◬ Sulphur Springs, azimuth 24° 45′ 03″, distance 9,051.7 meters.
To △ Simpson 23, azimuth 40° 17′ 13″, distance 3,945.5 meters.
To △ Chesley '03, azimuth 34° 09′ 01″, distance 2,451.6 meters.
Hole surrounded by triangle in rock, on lower end of Fines Bluff, Mo., and immediately above a quarry.

⊕ 9 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3.)
Latitude 38° 23′ 49″.39; meters +1,523, −327.
Longitude 90° 16′ 07″.57; meters +184, −1,272.
Elevation: 414.19.
To cupola of barn, azimuth 334° 14′.
To gable of red barn, azimuth 150° 50′.
To gable of barn, Missouri bluffs, azimuth 147° 16′.
To gable of barn, Illinois, azimuth 147° 04′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 192 meters above Warnock depot door; 16 meters below telegraph pole 15; 102 meters above upper end of trestle No. 19; 3.5 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division).

△ FLAG 9.

Mississippi River Commission, 1880–81. (Chart No. 3, station not plotted.)
Latitude 38° 23′ 45″.27; meters +1,396, −454.
Longitude 90° 19′ 05″.72; meters +139, −1,317.
To ◎ Twin Hollow (MRC), azimuth 199° 12′ 31″, distance 6,533.2 meters.
To ◎ Meramec, azimuth 147° 35′ 25″, distance 1,406.9 meters.
To ◎ Salt Bluff, azimuth 351° 18′ 35″, distance 9,657 meters.
Stone post, a little below foot of Widow Beards Island; 1¼ miles above Smith Landing, Ill.; 40 feet from willows and in cultivated field; 7 feet 10 inches southeast of 2½-foot sycamore tree.

⊡ $\frac{48}{1}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 23′ 30″.81; meters +950, −900.
Longitude 90° 18′ 21″.75; meters +528, −928.
Elevation: 409.76.
Stone post, in Illinois; 690 meters south of prominent angle in levee and about 3 miles northeast of Merrimac Point; on land of Louis Schroeder, at the southwest corner of his barn, which stands a short distance west of his house. An orchard is just east of the house.

⊙ P. B. M. 21.

Mississippi River Commission, 1880. (Chart No. 3.)
Latitude 38° 23′ 17″.14; meters +528, −1,322.
Longitude 90° 21′ 27″.32; meters +663, −793.
Elevation: 413.54.
Top of copper bolt, leaded vertically in top stone directly over keystone of arch on north side of culvert at "Island View;" 600 meters below Wickes Station, Mo., on St. Louis, Iron Mountain and Southern Railway. The letters "U. S. P. B. M." are cut near the bolt. (Latitude and longitude given above were scaled from chart.)

△ CHESLEY '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 3.)
Latitude 38° 23′ 02″.34; meters +72, −1,778.
Longitude 90° 20′ 53″.14; meters +1,290, −166.
To △ Fines Bluff, azimuth 214° 08′ 25″, distance 2,451.6 meters.
Iron pipe, 1 foot above surface of ground in cleared field, near lone building on Chesley Island. Station is 65 feet from top of high bank, and a short distance above lower end of revetment.

△ SIMPSON 23.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1900. (Chart No. 3.)
Latitude 38° 22′ 30″.10; meters +928, −922.
Longitude 90° 21′ 40″.92; meters +993, −464.
To ◎ Salt Bluff, azimuth 324° 06′ 24″, distance 8,921 meters.
Hole drilled in top of "Chimney Rock," a prominent formation in Missouri bluffs about three-quarters of a mile above Kimmswick railroad station.

⊕ 10 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3.)
Latitude 38° 22′ 18″.61; meters +574, −1,276.
Longitude 90° 16′ 50″.43; meters +1,224, −233.
Elevation: 413.75.
To cupola of barn, azimuth 238° 00′.
To gable of house, Missouri bluffs, azimuth 137° 40′.
To gable of barn ventilator, azimuth 154° 32′.
To top gable of elevator, azimuth 18° 34′.
Two-inch iron pipe, about 1 foot above surface of ground, in Illinois bottom land; three-quarters of a mile above Fountain, Ill.; 2.5 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 63 meters above upper end of trestle No. 23; 128 meters above sign "Warnock one mile;" 13 meters west of telegraph pole 16/25; and 4 meters below private road crossing.

⊡ $\frac{47}{3}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 22′ 10″.70; meters +330, −1,520.
Longitude 90° 21′ 41″.89; meters +1,017, −440.
Elevation: 438.12.
To ⊡ 47/2, azimuth 281° 22′, distance 2,016 meters.
Stone post, on knoll, about three-eighths of a mile north of Kimmswick, Mo., railroad station; 50 feet west of St. Louis, Iron Mountain and Southern Railway track; inside of fence of Montesano Springs Park and 170 meters southeast of dancing pavilion. (Found in 1908—disturbed.)

⊡ $\frac{47}{2}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 21′ 57″.73; meters +1,780, −70.
Longitude 90° 20′ 20″.51; meters +498, −959.
Elevation: 407.99.
To ⊡ 47/1, azimuth 284° 22′, distance 1,047 meters.
To ⊡ 47/3, azimuth 101° 22′, distance 2,018 meters.
Stone post, on back slope of levee, in Illinois; opposite Kimmswick, Mo.; 215 meters back from left bank on land of the State Savings Bank; 650 meters south of where road leading west from village of Merrimac crosses levee; and 400 meters south of angle in levee.

⊡ $\frac{47}{1}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 21′ 49″.23; meters +1,518, −332.
Longitude 90° 19′ 38″.71; meters +940, −517.
Elevation: 402.09.
To ⊡ 47/2, azimuth 104° 22′, distance 1,047 meters.
Flat stone, beneath the surface of ground in center of road in Illinois; and 5 feet north of a notch cut in a 3-foot elm tree (the first large tree west of Esquire Wylie's house, on south side of road); 1,050 meters back of levee on land of State Savings Bank, opposite Kimmswick, Mo. It is 122° 45′—360 meters from right angle in road, which angle is 200 meters west of above house.
Pipe has been moved and reset 3 meters southwest of stone.

⊙ P. B. M. 22.

Mississippi River Commission, 1880. (Chart No. 3.)
Latitude 38° 21′ 48″.81; meters +1,505, −345.
Longitude 90° 21′ 43″.86; meters +1,065, −392.
Elevation: 415.65.
Top of copper bolt, leaded vertically in south abutment to south approach to railroad bridge on St. Louis, Iron Mountain and Southern Railway at Kimmswick, Mo., and on east side of track.

▲ FLAG 10.

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 21′ 43″.31; meters +1,335, −515.
Longitude 90° 21′ 35″.21; meters +855, −602.
Elevation: 411.86 (1907, 412.17).
To ▲ Meramec, azimuth 210° 08′ 46″, distance 5,722.2 meters.
To ▲ Sulphur Springs, azimuth 20° 03′ 29″, distance 4,011.1 meters.
Stone post on Waters Point, Mo.; 250 meters below the mouth of Rock Creek, at Kimmswick, Mo. Benchmark is highest point on stone.

▲ SIMPSON 25.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1900. (Chart No. 3.)
Latitude 38° 21′ 38″.56; meters +1,189, −661.
Longitude 90° 21′ 35″.17; meters +854, −603.
Elevation: 414.34 (by duplicate levels from P. B. M. 22, 1907, 414.65).
To ▲ Salt Bluff, azimuth 317° 55′ 23″, distance 7,596.1 meters.

To ◉ Sulphur Springs, azimuth 20° 48′ 36″, distance 3,874.7 meters.
Cross on top of vertical piece of railroad rail, in Widow Waters's yard on Waters Point, Mo.; 30 feet from top of high bank and near gate leading to adjoining place which has summer house in front.

⊕ 11 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3.)
Latitude 38° 20′ 42″.53; meters +1,311, −539.
Longitude 90° 17′ 35″.11; meters +853, −604.
Elevation: 412.15.
To gable of elevator, azimuth 200° 28′.
To gable of house, azimuth 204° 24′.
To gable of house, azimuth 145° 17′.
To gable of barn, azimuth 114° 28′.
Two-inch iron pipe, about 1 foot above the surface of ground in Illinois bottom land; 1½ miles below Fountain, Ill.; 3.2 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 128 meters below sign "Fountain one mile;" 80 meters above private road crossing; opposite and 6 meters distant from telegraph pole 18/25.

△ SIMPSON 27.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1900. (Chart No. 3.)
Latitude 38° 20′ 39″.64; meters +1,222, −628.
Longitude 90° 22′ 13″.36; meters +324, −1,133.
Elevation: 424.10.
To ◉ Salt Bluff, azimuth 302° 24′ 33″, distance 7,128.7 meters.
Hole drilled in rock ledge, on prominent point at Flemings, Mo.; between railroad track and river; in front of place formerly occupied by Captain Fleming and sometimes known as "Sunnyside;" just below the 22-mile post and about 1½ miles below Kimmswick, Mo. Blazed tree 24 feet back from and below, and another 14 feet back from and above the station.

⊡ $\frac{46}{3}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 19′ 43″.94; meters +1,355, −495.
Longitude 90° 22′ 31″.37; meters +762, −695.
Elevation: Stone, 434.55; pipe, 439.65.
To ⊡ 46/2, azimuth 281° 50′, distance 1,785 meters.
Flat stone and iron pipe, just west of railroad track; one-half mile below Sulphur Springs, Mo., and 85 meters north of ◉ Sulphur Springs. (Pipe found bent over in 1908.)

◉ SULPHUR SPRINGS.

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 19′ 41″.09; meters +1,267, −583
Longitude 90° 22′ 31″.84; meters +773, −684.
Elevation: 534.75.
To ◉ Salt Bluff, azimuth 287° 18′ 23″.78, distance 6,773.94 meters.
To ◉ Herculaneum, azimuth 357° 33′ 33″.93, distance 8,164.13 meters.
To ◉ Meramec, azimuth 205° 58′ 32″.28, distance 9,697.15 meters.
To △ Simpson 25, azimuth 200° 48′ 01″, distance 3,874.7 meters.
To △ Simpson 27, azimuth 193° 57′ 26″, distance 1,860.2 meters.
To △ Bushberg '88, azimuth 00° 11′ 53″, distance 2,276.4 meters.
Stone post, on top of bluff; about one-half mile below the town of Sulphur Springs, Mo.; and 40 meters west of railroad track. Bench mark is upstream corner, farthest from the river. Stone has been cracked on river side, and through the center.

△ SECOND CUT.

United States engineer office, St. Louis, Mo., 1900. (Chart No. 3.)
Latitude 38° 19′ 37″.82; meters +1,166, −684.
Longitude 90° 22′ 29″.55; meters +718, −740.
Elevation: 429.60.
To ◉ Salt Bluff, azimuth 286° 37′ 25″, distance 6,691.3 meters.
To △ Bushberg '88, azimuth 1° 40′ 22″, distance 2,176.4 meters.

Hole surrounded by triangle in rock, on second knob outside of railroad; 1,100 meters below Sulphur Springs, Mo. Station is 7 feet from outer edge of rock; 15 feet from upstream edge; and 5 feet diagonally upstream from large fissure separating bed rock from large detached bowlder on downstream corner.

⊡ $\frac{46}{2}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 19′ 32″.01; meters +987, −863.
Longitude 90° 21′ 19″.55; meters +475, −982.
Elevation: Stone, 406.27; pipe, 411.37.
To◎Sulphur Springs, azimuth 279° 05′, distance 1,781 meters.
To⊡46/1, azimuth 281° 40′, distance 668 meters.
To⊡46/3, azimuth 101° 50′, distance 1,785 meters.
Flat stone and iron pipe, 900 meters from top of left bank of river; on west side of road on levee; 1,200 meters above the head of Foster Island; 400 meters above house occupied by Alex. Douglas, on land owned by Morrison Brothers. Elm tree, blazed triangle facing store, stands 6 meters away.

⊡ $\frac{46}{1}$

Mississippi River Commission, 1889. (Chart No. 3.)
Latitude 38° 19′ 27″.57; meters +850, −1,000.
Longitude 90° 20′ 52″.48; meters +1,275, −183.
Elevation: Stone, 406.01; pipe, 411.12.
To⊡46/2, azimuth 101° 40′, distance 668 meters.
Flat stone and iron pipe, on left bank; about 1 mile from river and one-half mile below Sulphur Springs, Mo.; on top of the second or back levee on land owned by Morrison Brothers; and 360 meters north of a road.

△ FLAG 12.

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 18′ 57″.18; meters +1,763, −87.
Longitude 90° 21′ 12″.02; meters +292, −1,166.
Elevation: 405.87.
To◎Sulphur Springs, azimuth 124° 55′, distance 2,368 meters.
Stone post, on land of Henry Smith; 110 meters from top of left bank; opposite the head of Foster Island; and due east from a point 500 meters south of Glen Park, Mo., railroad station. (Latitudes and longitudes given are approximate values.)

◎ SALT BLUFF.

Mississippi River Commission, 1880–81. (Chart No. 3.)
Latitude 38° 18′ 35″.65; meters +1,099, −751.
Longitude 90° 18′ 05″.65; meters +137, −1,321.
To◎Herculaneum, azimuth 44° 56′ 35″.33′, distance 8,669.98 meters.
To◎Meramec, azimuth 163° 21′ 33″.42, distance 10,959.89 meters.
To◎Sulphur Springs, azimuth 107° 21′ 08″.83′, distance 6,773.94 meters.
To△Schierhoff, azimuth 176° 00′ 27″, distance 12,489.1 meters.
To△Fines Bluff, azimuth 165° 22′ 04″, distance 10,582.5 meters.
To△Simpson 25, azimuth 137° 57′ 33″, distance 7,596.1 meters.
To△Simpson 27, azimuth 122° 27′ 07″, distance 7,128.7 meters.
To△Bushberg '88, azimuth 87° 44′ 07″, distance 6,480.4 meters.
To△Second Cut, azimuth 106° 40′ 09″, distance 6,691.3 meters.
To△Simpson 23, azimuth 144° 08′ 38″, distance 8,921.0 meters.
To△Simpson 35, azimuth 53° 16′ 02″, distance 7,911.2 meters.
Iron pipe, in cleared spot on highest point of a very prominent bluff known locally as Salt Bluff, Salt Lake Bluff, and Eagle Cliff. The bluff is situated back of Murdock Lake, near Valmeyer, and northeast of Harrisonville, Ill.

⊕ 12 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 3.)
Latitude 38° 18′ 32″.80; meters +1,011, −839.
Longitude 90° 18′ 35″.94; meters +873, −585.
Elevation: 409.30.
To ◎ Salt Bluff, azimuth 263° 11′.
To cupola of schoolhouse, azimuth 21° 39′.
To finial of water tank, azimuth 15° 49′.
To top gable of elevator, azimuth 11° 57.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land three-fourths of a mile above Valmeyer, Ill.; 3 meters southwest of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 22 meters above telegraph pole 21/15; and 2 meters below road crossing.

△ BUSHBERG, '88.

United States engineer office, St. Louis, Mo., 1888; redetermined, 1902. (Chart No. 4.)
Latitude 38° 18′ 27″.26; meters +841, −1,009.
Longitude 90° 22′ 32″.16; meters +781, −676.
To ◎ Herculaneum, azimuth 356° 32′ 25″, distance 5,891.1 meters.
To ◎ Sulphur Springs, azimuth 180° 11′ 52″, distance 2,276.4 meters.
To ◎ Salt Bluff, azimuth 267° 41′ 22″, distance 6,480.4 meters.
To △ Second Cut, azimuth 181° 40′ 21″, distance 2,176.4 meters.
Hole drilled in 12 by 12 inch stone, in ledge of rock at top of bluff; 1,600 feet north of Bushberg station, Mo.; and 520 feet north from milepost 25 on railroad. Blazed trees; 18-inch white oak, west 45 feet; 10-inch black oak, northwest 35 feet.

△ ILLINOIS, '88.

United States engineer office, St. Louis, Mo., 1888; redetermined, 1902. (Chart No. 4.)
Latitude 38° 17′ 29″.70; meters +916, −934.
Longitude 90° 22′ 38″.11; meters +926, −532.
Elevation: 408.36.
Hole drilled in large rock, about 600 meters north of Riverside station, Mo., on St. Louis, Iron Mountain and Southern Railway; 60 feet east of track; about 500 feet south from milepost 26; on third main shelf below the track; and about one-third of the distance between fourth and fifth telegraph poles standing north of high switchstand.

⊡ $\frac{45}{1}$

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 17′ 04″.65; meters +143, −1,707.
Longitude 90° 20′ 58″.59; meters +1,424, −34.
Elevation: Stone, 400; pipe, 405.08.
To ⊡ 45/2, azimuth 85° 00′, distance 754 meters.
Flat stone and iron pipe, on west side of road; one-half mile north of where main roads cross, in town of Harrisonville, Ill.; 125 meters north of crossroads; on pasture land of Patrick Murray and 85 meters north of his house. Walnut tree 2 feet in diameter, blaze facing pipe, 230° 00′—4 meters distant; another walnut tree 4 feet in diameter, blaze facing pipe, 310° 00′—10 meters distant.

⊡ $\frac{45}{2}$

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 17′ 02″.49; meters +77, −1,773.
Longitude 90° 21′ 29″.50; meters +717, −741.
Elevation: Stone, 399.19; pipe, 404.28.
To ⊡ 45/1, azimuth 265° 00′, distance 754 meters.
To ⊡ 45/3, azimuth 84° 55′, distance 1,750 meters.
Flat stone and iron pipe, on land of Tom James; at foot and on east side of levee; 35 meters south of east-and-west road to Harrisonville Landing, Ill.; 250 meters above the foot of Foster Island and 330 meters east from east bank of chute.

⊕ 13 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 4.)
Latitude 38° 17′ 00″.13; meters +4, −1,846.
Longitude 90° 18′ 37″.69; meters +916, −542.
Elevation: 406.90.
To top gable of elevator, azimuth 166° 44′.
To middle elevator chimney, azimuth 165° 24′.
To gable of house, azimuth 28° 16′.
To gable of barn, azimuth 27° 19′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; three-quarters of a mile below Valmeyer, Ill.; 3.83 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 384 meters below telegraph pole 23/5; 2 meters above private road crossing, and 103 meters above upper end of trestle No. 32.

⊡ 45/3

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 16′ 57″.40; meters +1,770, −80.
Longitude 90° 22′ 41″.14; meters +1,000, −459.
Elevation: 408.39.
To ⊡45/2, azimuth 264° 55′, distance 1,750 meters.
Stone post, under sycamore tree 2½ feet in diameter on north bank of first creek below Riverside, Mo., and just north of north end of Lucas Bluff; 500 meters southeast of Riverside railroad station; 50 meters from right bank of river and about 20 meters east of the Mississippi River and Bonne Terre Railway.

△ SIMPSON 35.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1902. (Chart No. 4.)
Latitude 38° 16′ 02″.11; meters +65, −1,785.
Longitude 90° 22′ 26″.46; meters +643, −816.
To ◉ Salt Bluff, azimuth 233° 13′ 20″, distance 7,911.2 meters.
To ◉ Herculaneum, azimuth 351° 13′ 47″, distance 1,421.5 meters.
To △ Simpson 45, azimuth 341° 34′ 11″, distance 8,162.4 meters.
Hole drilled in bare rock, over "Natural Bridge," on first point of rock and on bluff above Herculaneum, Mo.

▲ TANK.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 15′ 38″.96; meters +1,201, −649.
Longitude 90° 22′ 29″.75; meters +723, −736.
Finial on railroad water tank at Herculaneum, Mo.

▲ CHIMNEY.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 15′ 37″.25; meters +1,149, −701.
Longitude 90° 22′ 36″.80; meters +895, −564.
Large square brick chimney of St. Joe Lead Company at Herculaneum, Mo.

⊕ 14 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 4.)
Latitude 38° 15′ 23″.80; meters +734, −1,116.
Longitude 90° 18′ 00″.20; meters +5, −1,454.
Elevation: 403.76.
To gable of house, azimuth 310° 57′.
To gable of house, azimuth 341° 54′.
To gable of house, azimuth 342° 16′.
To gable of barn, azimuth 312° 53′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 2¼ miles below Valmeyer, Ill.; 3 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 102 meters above telegraph pole 25/10; 172 meters below telegraph pole 25/5; 26 meters below road crossing and 1.5 meters above sign "Railroad crossing."

◉ HERCULANEUM.

Mississippi River Commission, 1880–81. (Chart No. 4.)
Latitude 38° 15′ 16″.55; meters +510, —1,340.
Longitude 90° 22′ 17″.54; meters +426, —1,033.
Elevation: 494.60.
To◉Salt Bluff, azimuth 224° 53′ 59″.27, distance 8,669.98 meters.
To◉Caesars, azimuth 330° 51′ 00″.44, distance 11,887.10 meters.
To◉Sulphur Springs, azimuth 177° 33′ 42″.79, distance 8,164.13 meters.
To△Simpson 35, azimuth 171° 13′ 53″, distance 1,421.5 meters.
To△Riverside, azimuth 171° 54′ 52″, distance 2,704 meters.
To△Bushberg 88, azimuth 176° 32′ 34″, distance 5,891.1 meters.
To△Chimney, azimuth 143° 43′ 35″, distance 791.5 meters.
To△Tank, azimuth 156° 45′ 30″, distance 752 meters.
Iron pipe, 10 feet back from most prominent point at upper end of Joachim Bluff, Mo.; 720 meters below the mouth of Joachim Creek; and about 2½ miles above Crystal City, Mo.

△ JOACHIM.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 15′ 11″.00; meters +339, —1,511.
Longitude 90° 22′ 13″.89; meters +338, —1,121.
Elevation: 416.26.
To△Simpson 35, azimuth 169° 01′ 59″, distance 1,605.2 meters.
To△Riverside, azimuth 170° 38′ 57″, distance 2,886.4 meters.
Iron pipe, 9 inches above surface of first prominent rock point below Joachim Bluff, Mo., and about 1,000 meters below the town of Herculaneum, Mo.; 20 feet outside of east rail of track of the Mississippi River and Bonne Terre Railway; 36.5 feet from a cross cut on rock about 10 feet south of normal from pipe to rail and 15 feet west of rail; also 64.9 feet from a similar cross upstream, the actual distance between the two crosses being 62 feet.

△ QUARRY.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 14′ 52″.24; meters +1,611, —239.
Longitude 90° 22′ 14″.83; meters +361, —1,098.
To◉Salt Bluff, azimuth 221° 18′ 05″, distance 9,175.5 meters.
To△Crystal, azimuth 343° 32′ 19″, distance 4,179.8 meters.
Hole surrounded by triangle in rock, on Missouri bluffs; at north end of old quarry; 3,000 feet above the old house above Platin Rock and about 1,900 feet below△ Joachim.

⊡ 44/1

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 14′ 31″.78; meters +980, —870.
Longitude 90° 20′ 51″.39; meters +1,250, —209.
Elevation: Stone, 404.12; pipe, 409.22.
Flat stone and iron pipe, on top of levee; in Illinois and 680 meters back of head of Calico Island; 160 meters south of Henry Althoff's house; azimuth to schoolhouse 293° 35′, distance 640 meters; Ivy and Harrisonville road on top of same levee.

⊡ 44/8

Mississippi River Commission, 1889; redetermined by United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 14′ 17″.68; meters +545, —1,305.
Longitude 90° 22′ 15″.15; meters +368, —1,091.
Elevation: 421.71.
To◉Salt Bluff, azimuth 217° 18′ 09″, distance 10,002.4 meters.
Stone post, 6 inches above surface of ground; in young timber on débris slope under bluff above Hugs Landing, Mo.; 462 feet below an old stone house; 101 feet above whistle post; 38 feet back of railroad fence; 15 feet back of small ditch inside of fence; and nearly opposite upstream end of old loading platform on river bank.

⊕ 15 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 4.)
Latitude 38° 14′ 16″.21; meters +500, −1,350.
Longitude 90° 17′ 25″.79; meters +627, −832.
Elevation: 404.36.
To gable of depot, Maeys, azimuth 332° 28′.
To top gable of elevator, azimuth 331° 48′.
To gable of house, azimuth 353° 55′.
To gable of house, azimuth 334° 16′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 1¼ miles above Maeys railroad station; 3.5 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 31 meters above upper end of trestle No. 35; 224 meters below telegraph pole 26/15; 6.5 meters west of telegraph pole 26/20; and 65 meters below whistle post.

⊡ No. 3 (Field).

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 14′ 13″.78; meters +425, −1,425.
Longitude 90° 22′ 09″.66; meters +235, −1,224.
Elevation: 384.23.
To⊡44/3, azimuth 132° 09′, distance 184 meters.
Top of large ring bolt, in northern end of Platin Rock, about 1¼ miles above Crystal City, Mo.; on point farthest out in river; 205 meters from northeast corner of large icehouse, 400 meters above Hugs Landing, Mo.

△ PLATIN '02.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 14′ 09″.95; meters +307, −1,543.
Longitude 90° 22′ 11″.91; meters +290, −1,169.
Elevation: 405.02.
To⊛Salt Bluff, azimuth 216° 08′ 03″, distance 10,146.2 meters.
Iron pipe, back of Platin Rock, about 1¼ miles above Crystal City, Mo.; on high right bank; 2 feet from edge; 6.8 feet outside of outside rail of railroad incline of the Pittsburg Plate Glass Company. To point of frog of incline, northwest, 74 feet; to point of frog of spur, southwest, 33.9 feet; to top of switch stand spur, 51 feet; to top of sycamore stump, east, 9 feet. Pipe reset from the above references, December 9, 1904.

⊕ 16 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 4.)
Latitude 38° 12′ 49″.61; meters +1,530, −320.
Longitude 90° 16′ 27″.75; meters +675, −785.
Elevation: 413.09.
To top gable of elevator, azimuth 152° 42′.
To gable of Maeys depot, azimuth 151° 32′.
To gable of house, azimuth 23° 40′.
To gable of house, azimuth 159° 53′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 1,000 meters below Maeys railroad station; 3.5 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 36 meters below telegraph pole 28/15; 3 meters above private road crossing. (Not correctly plotted on chart.)

▲ CRYSTAL.

United States engineer office, St. Louis, Mo., 1888; redetermined, 1902. (Chart No. 4.)
Latitude 38° 12′ 42″.23; meters +1,302, −548.
Longitude 90° 21′ 26″.15; meters +636, −824.
To⊛Salt Bluff, azimuth 204° 04′ 58″, distance 11,937.7 meters.
To△Platin '02, azimuth 157° 38′ 10″, distance 2,924.9 meters.
To△Quarry, azimuth 163° 32′ 49″, distance 4,179.8 meters.
To△Bushberg '88, azimuth 171° 25′ 34″, distance 10,758.8 meters.
To⊡44/3, azimuth 157° 57′ 26″, distance 3,175.2 meters.

Iron pipe, 30 feet from eastern edge of "Buck Knob," first bluff in Missouri below Platin Creek. Station is on edge of field or peach orchard; 65 feet from southeast corner of same; 58 feet northwest from spike in blazed cedar tree; 24.2 feet northeast, and 28.3 feet southeast from peach trees. Pipe was set in 1903, replacing cedar post set in 1888.

⊡ 43/1

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 12′ 38″.40; meters +1,184, −666.
Longitude 90° 19′ 03″.90; meters +95, −1,365.
Elevation: Stone, 393.12 (approximate); pipe, 398.22.
To ⊡ 43/2, azimuth 51° 20′, distance 958 meters.
Flat stone and iron pipe, back of James Landing, Ill.; 40 meters north of east-and-west road; in pecan grove, on land of Edward Schoening; blazed pecan tree 18 inches in diameter, 1 meter north of pipe. Cap of pipe rusted on, could not be removed; difference between stone and cap assumed to be 5.1 feet—the average of the differences for other similar stations.

⊡ 43/2

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 12′ 18″.84; meters +582, −1,268.
Longitude 90° 19′ 34″.64; meters +843, −617.
Elevation: 404.91.
To ⊡ 43/1, azimuth 231° 20′, distance 958 meters
Stone post, on top of levee; directly back of James Landing, Ill.; 230 meters from left bank; on land of Edward Schoening; 300 meters above schoolhouse, just inside of levee. (Not found in 1908.)

△ SIMPSON 45.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1902. (Chart No. 4.)
Latitude 38° 11′ 50″.95; meters +1,571, −279.
Longitude 90° 20′ 40″.41; meters +983, −477.
To ◎ Salt Bluff, azimuth 196° 46′ 04″, distance 13,033.2 meters.
To △ Crystal, azimuth 144° 51′ 53″, distance 1,933.5 meters.
To △ Simpson 35, azimuth 161° 35′ 16″, distance 8,162.4 meters.
To △ Bushberg '88, azimuth 167° 28′ 22″, distance 12,518 meters.
Hole in rock, with "45" cut on river side, on downstream slope and about one-quarter way down from the top of first bluff above Kennetts Castle, at Selma, Mo. Station is best reached from the Castle by following path near edge of the bluffs.

⊡ 43/3

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 11′ 42″.32; meters +1,305, −545.
Longitude 90° 20′ 32″.17; meters +783, −677.
Elevation: 410.49.
Stone post, 300 feet above northeast corner of Kennetts Castle at Selma, Mo.; 19 feet west of triangle formed with boat spikes in tie and in center of railroad track; 10½ feet north of the fifth telegraph pole above Selma station; two blazed cottonwood trees east of track, 69 feet northeast and 81 feet southeast.

⊡ No. 2 (Field).

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 11′ 34″.70; meters +1,070, −780.
Longitude 90° 20′ 27″.31; meters + 665, −795.
Elevation: 418.97.
Cross cut on the upstream end of the bottom step of the stone steps ascending the bluff from Selma, Mo., railroad station to Kennetts Castle. Azimuth to northeast corner of Kennetts Castle, 143° 15′, distance 135 meters.

⊕ 17 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 4.)
Latitude 38° 11′ 34″.34; meters +1,059, −791.
Longitude 90° 15′ 11″.34; meters +276, −1,184.
Elevation: 400.43.
To middle of chimney on house, azimuth 52° 56′.
To gable of house, azimuth 81° 09′.
To gable of barn, azimuth 239° 20′.
To south dormer window, azimuth 240° 46′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 2½ miles below Macys railroad station; 5 meters north of road crossing; 48 meters east of stone-arch wagon bridge; 3 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); and 105 meters below telegraph pole 30/10. (Not correctly plotted on chart.)

▲ SIMPSON 47.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1902. (Chart No. 4.)
Latitude 38° 11′ 07″.37; meters +227, −1,623.
Longitude 90° 20′ 01″.09; meters +27, −1,434.
To◉Salt Bluff, azimuth 191° 28′ 12″, distance 14,103.9 meters.
To△Bushberg '88, azimuth 164° 51′ 27″, distance 14,051.8 meters.
To△Ellis '02, azimuth 274° 47′ 01″, distance 2,915.8 meters.
Hole drilled in rock, with figures "47" cut adjacent; on high point jutting out at lower end of first bluff below Kennetts Castle; 1,050 meters below railroad station at Selma, Mo.; and 400 meters above railroad trestle at Cliffdale Hollow.

▲ ELLIS '02.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 4.)
Latitude 38° 10′ 59″.47; meters +1,834, −16.
Longitude 90° 18′ 01″.70; meters +41, −1,419.
Elevation: 403.19.
To◉Caesars, azimuth 10° 06′ 38″, distance 2,495.9 meters.
To△Simpson 47, azimuth 94° 48′ 14″, distance 2,915.8 meters.
To△Simpson 51, azimuth 30° 54′ 15″, distance 1,999.2 meters.
Iron pipe, on levee in Illinois; 10 feet west of levee crest; opposite head of Michaels (Osborne) towhead; 335 feet south of tree in front yard of John Ellis' house; and 315 feet north of hackberry tree on west slope of levee.

⊡ 42/1

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 10′ 51″.63; meters +1,592, −258.
Longitude 90° 16′ 54″.72; meters +1,332, −128.
Elevation: Stone, 387.78; pipe, 392.86.
To⊡42/2, azimuth 43° 15′, distance 755 meters.
Flat stone and iron pipe, directly back from Lowrys Landing, Ill.; at edge of timber; main ditch 150 meters back of pipe; a blazed oak tree, 1 foot in diameter, 1 meter north of pipe. (Not found in 1908.)

⊡ 42/2

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 10′ 33″.72; meters +1,040, −810.
Longitude 90° 17′ 15″.82; meters +385, −1,075.
Elevation: 402.67.
To⊡42/1, azimuth 223° 15′, distance 755 meters.
Stone post, on east side of top of levee in Illinois; directly back and 300 meters from Lowrys Landing on left bank; 60 meters above Frank Wine's house; 260 meters below Peter Lowry's house; 580 meters above a schoolhouse, within levee and on Thompson's place; opposite two oak trees 6 inches and 12 inches in diameter. (Not found in 1908.)

⊙ T. B. M. 150.

Mississippi River Commission, 1880. (Chart No. 4.)
Latitude 38° 10′ 14″.98; meters +462, −1,388.
Longitude 90° 18′ 55″.74; meters +1,357, −104.
Elevation: 385.71.
Point on rock, 30 meters below small run; 160 meters below railroad trestle at Michaels Hollow, Mo.; and 250 meters above old hurdle.

△ SIMPSON 51.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1902. (Chart No. 4.)
Latitude 38° 10′ 03″.84; meters +118, −1,732.
Longitude 90° 18′ 43″.88; meters +1,068, −393.
To△Ellis '02, azimuth 210° 53′ 49″, distance 1,999.2 meters.
Hole drilled in rock, on second bluff south of Michaels Landing, Mo.; 1 foot back from the figures "51" also cut in the rock, and in the direction indicated by the figure "1." To reach the station go over first bluff below Michaels Landing, up the second and two-thirds way down, station being on the first ledge above the succeeding depression.

⊡ $\frac{42}{3}$

Mississippi River Commission, 1889. (Chart No. 4.)
Latitude 38° 09′ 42″.06; meters +1,297, −553.
Longitude 90° 18′ 16″.34; meters +398, −1,063.
Elevation: 415.97.
Stone post, on right bank; on side of hill; in front of, under◬Caesars, and 105 meters from it; almost in line with old hurdle; about 60 meters above Robbers Rock; just outside of railroad and 45 meters from shore.

◬ CAESARS.

Mississippi River Commission, 1880–81. (Chart No. 4.)
Latitude 38° 09′ 39″.78; meters +1,227, −623.
Longitude 90° 18′ 19″.70; meters +480, −981.
Elevation: 729.80.
To◬Kidd, azimuth 260° 25′ 22″.94, distance 7,937.86 meters.
To◬Brickey, azimuth 315° 34′ 49″.31, distance 11,518.81 meters.
To◬Herculaneum, azimuth 150° 53′ 27″.55, distance 11,887.10 meters.
To△Simpson 51, azimuth 141° 33′ 39″, distance 946.9 meters.
To△Simpson 53, azimuth 321° 00′ 54″, distance 473.6 meters.
To△Simpson 59, azimuth 319° 07′ 12″, distance 8,025.0 meters.
To△Ellis '02, azimuth 190° 06′ 27″, distance 2,495.9 meters.
Stone post, with corners chipped off; 10 feet west from face of cliff on third prominent bluff below Michaels Hollow, Mo.; and opposite foot of third stone dike below Michaels Hollow.

△ SIMPSON 53.

United States engineer office, St. Louis, Mo., 1881; redetermined 1902. (Chart No. 4.)
Latitude 38° 09′ 27″.84; meters +858, −992.
Longitude 90° 18′ 07″.46; meters +182, −1,279.
To◬Caesars, azimuth 141° 01′ 01″, distance 473.6 meters.
Hole in rock, on Missouri bluffs; at extreme top of first bluff downstream from bluff on which is◬Caesars.

◬ KIDD.

Mississippi River Commission, 1880–81. (Chart No. 5.)
Latitude 38° 10′ 22″.49; meters +693, −1,157.
Longitude 90° 12′ 58″.13; meters +1,415, −46.
To◬Brickey, azimuth 358° 38′ 45″.38, distance 9,550.64 meters.
To◬Caesars, azimuth 80° 28′ 41″.65, distance 7,937.86 meters.
To◬County Line, azimuth 309° 36′ 06″.32, distance 10,648.12 meters.
To△Ellis '02, azimuth 98° 47′ 56″, distance 7,476.1 meters.
To△Simpson 59, azimuth 19° 16′ 15″, distance 7,824.1 meters.
To△Simpson 57, azimuth 44° 06′ 41″, distance 6,845.7 meters.
To△Simpson 55, azimuth 69° 06′ 31″, distance 7,205.7 meters.

Center of stone post, on bluff in Illinois; 4 meters from edge of cliff; seven-eighths of a mile northwest of Jacob Fultz's house; one-quarter mile south of Jacob Frich's house and on his land. To reach station from foot of bluffs follow left-hand road, leading up the bluffs from Jacob Fultz's house, for about three-quarters of a mile, then take road to Jacob Frich's house and go south up bluff to edge of cliff.

⊕ 18 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 5.)
Latitude 38° 10′ 20″.69; meters +638, −1,212.
Longitude 90° 13′ 30″.10; meters +733, −728.
Elevation: 399.54.
To ⊛ Kidd, azimuth 266° 01′.
To Brownsburg church spire, azimuth 308° 03′.
To top gable of elevator, azimuth 312° 13′.
To gable of red barn, azimuth 96° 40′.
To gable of house, azimuth 95° 27′.
To gable of schoolhouse, azimuth 353° 14′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land, 3 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); and about 1 mile above Brownsburg station (Fults, post-office); 55 meters above telegraph pole 32/15; 200 meters below pole 32/10; 120 meters below lower end of trestle No. 42A; and 191 meters below sign "Brownsburg one mile."

⊕ 19 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 5.)
Latitude 38° 09′ 23″.24; meters +717, −1,133.
Longitude 90° 12′ 11″.61; meters +283, −1,178.
Elevation: 401.04.
To top gable of elevator, azimuth 133° 45′.
To gable of barn, azimuth 121° 07′.
To gable of house, azimuth 135° 59′.
To gable of house, azimuth 18° 22′.
Two-inch iron pipe, about 1 foot above surface of ground, in Illinois bottom land; 4 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); one-half mile below Brownsburg station (Fults, post-office); 81 meters above telegraph pole 34/5 and 121 meters below switchstand.

⊡ $\frac{41}{1}$

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 09′ 04″.22; meters +130, −1,720.
Longitude 90° 14′ 47″.23; meters +1,150, −311.
Elevation: Stone, 395.30; pipe, 400.40.
To ⊛ Kidd, azimuth 227° 32′.
To ⊡ 41/2, azimuth 48° 45′, distance 800 meters.
Flat stone and iron pipe, one-half mile above Ivy Landing (village), Monroe County, Ill.; 250 meters east of flood gate in levee crossing large drainage ditch; in cultivated field owned by Wm. Winkleman and under a leaning 24-inch pecan tree. To house beyond smaller (east and west) ditch, azimuth 109° 30′, distance 270 meters; to another house, azimuth 7° 00′, distance 380 meters. (Found in 1908; pipe bent over.)

△ SIMPSON 55.

United States engineer office, St. Louis, Mo., 1881; redetermined, 1902. (Chart No. 5.)
Latitude 38° 08′ 59″.06; meters +1,821, −29.
Longitude 90° 17′ 34″.61; meters +843, −618.
To ⊛ Kidd, azimuth 249° 03′ 40″, distance 7,205.7 meters.
Iron pin, leaded into rock, in Missouri bluffs; 20 feet northwest of old location of shot tower, on bluff north of Rush Tower, Mo.; and 275 meters above (northwest of) railroad trestle over Muddy Creek.

⊡ 41/2

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 08′ 47″.19; meters +1,455, −395.
Longitude 90° 15′ 11″.79; meters +287, −1,174.
Elevation: 394.04.
To ⊡41/1, azimuth 228° 45′, distance 800 meters.
Stone post, about three-fourths of a mile west from Ivy Landing (village), Ill.; 180 meters back from left bank; in cultivated field and about 240 meters north of shore end of hurdle. Stone is covered a foot or more with sand.

⊕ 20 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 5.)
Latitude 38° 08′ 23″.53; meters +726, −1,124.
Longitude 90° 10′ 49″.13; meters +1,197, −264.
Elevation: 398.38.
To top gable of Renault elevator, azimuth 313° 04′.
To gable of barn, azimuth 319° 26′.
To gable of house, azimuth 345° 53′.
To gable of house, azimuth 279° 17′.
To top gable of Brownsburg elevator, azimuth 132° 51′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 3 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1¼ miles above Renault, Ill.; 130 meters above telegraph pole 35/25; 292 meters above sign "Renault one mile;" 150 meters above upper end of trestle No. 49, and 3 meters above road crossing.

⊡ 41/3

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 07′ 55″.62; meters +1,715, −135.
Longitude 90° 16′ 23″.93; meters +583, −878.
Elevation: 448.25.
Cross cut on natural rock wall, 1½ miles below Rush Tower, Mo.; on point of Missouri bluffs, just back of Danby Landing; 800 meters from the river bank; 80 meters below Big Hollow; and 19 meters southeast of point of rocks that projects toward the river. Inverted figures "3/41" are cut on the wall near the bench mark.

△ SIMPSON 57.

United States engineer office, St. Louis, Mo., 1881; redetermined, 1902. (Chart No. 5.)
Latitude 38° 07′ 43″.03; meters +1,327, −523.
Longitude 90° 16′ 13″.77; meters +335, −1,126.
To ⊙ Kidd, azimuth 224° 04′ 40″, distance 6,845.7 meters.
Hole drilled in rock on extreme top of fourth bluff below Rush Tower, Mo.

⊡ 40/4

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 07′ 03″.50; meters +108, −1,742.
Longitude 90° 15′ 31″.11; meters +758, −704.
Elevation: 400.37.
Stone post, near foot of Missouri bluffs; near west side of road; on land of Leo Lynch and 115 meters north of his house; 1½ miles below Danby Landing, Mo.; and 150 meters above point where Isle De Bois Creek leaves the bluffs.

△ FISH BEND.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 06′ 54″.40; meters +1,677, −173.
Longitude 90° 13′ 29″.36; meters +715, −747.
To △ Simpson 59, azimuth 61° 57′ 46″, distance 2,063.6 meters.
Iron pipe, set on the line Cassiedy (temporary)–Simpson 59, and 53.77 meters back from △ Cassiedy; 548 meters above Fish Bend Slough; on Salt Lake Towhead, left bank of river; and three-eighths mile above Penitentiary Point, Ill.; 29 meters from 8-inch cottonwood stump. Three blazed 8-inch cottonwood trees are: 8 feet south; 28 feet northeast; and 38 feet northwest.

◉ COUNTY LINE.

Mississippi River Commission, 1880-81. (Chart No. 5.)
Latitude 38° 06′ 42″.21; meters +1,301, —549.
Longitude 90° 07′ 21″.36; meters +520, —942.
To ◬ Magnolia, azimuth 14° 32′ 16″.52, distance 7,634.70 meters.
To ◬ Brickeys, azimuth 70° 58′ 25″.53, distance 8,442.63 meters.
To ◬ Correll, azimuth 342° 52′ 12″.14, distance 12,136.64 meters.
To ◬ Kidd, azimuth 129° 39′ 34″.32, distance 10,648.12 meters.
Center of stone post, on Illinois bluffs; about 3¾ miles southeast of Glasgow City, and about 2 miles northwest of Prairie du Rocher, Ill. It is on the line between Monroe and Randolph counties, and 1.5 meters back of a county line stone.

⊕ 21 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 5.)
Latitude 38° 06′ 34″.69; meters +1,070, —780.
Longitude 90° 08′ 19″.64; meters +478, —983.
Elevation: 397.91.
To top gable of elevator, azimuth 132° 22′.
To finial of water tank, Prairie du Rocher, azimuth 312° 47′.
To gable of house, azimuth 337° 03′.
To gable of house, azimuth 66° 19′.
To middle of chimney of residence, azimuth 133° 29′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land, 3.5 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1¼ miles below Renault, Ill.; 53 meters below telegraph pole 38/25; 75 meters above post on railroad marked "County Line;" and about seven-eighths of a mile west of ◬ County Line.

▲ SIMPSON 59.

United States engineer office, St. Louis, Mo., 1889; redetermined, 1903. (Chart No. 5.)
Latitude 38° 06′ 22″.94; meters +707, —1,143.
Longitude 90° 14′ 44″.12; meters +1,075, —387.
To ◬ Brickeys, azimuth 307° 34′ 51″, distance 3,544 meters.
To ◬ Cæsars, azimuth 139° 09′ 25″, distance 8,024.9 meters.
To ◬ Kidd, azimuth 199° 15′ 10″, distance 7,824.1 meters.
To △ Simpson 67, azimuth 306° 59′ 40″, distance 2,345 meters.
Hole drilled in rock, on Missouri bluffs; on downstream slope of seventh bluff above Brickeys, Mo., or second bluff below Isle de Bois Creek.

▲ HARTIG.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 06′ 22″.78; meters +702, —1,148.
Longitude 90° 12′ 53″.65; meters +1,307, —155.
Elevation: 394.42.
To ◬ Ames, azimuth 28° 08′ 49″, distance 1,635.7 meters.
To ◬ Simpson 69, azimuth 356° 19′ 42″, distance 2,073.5 meters.
Iron pipe, in Illinois; 3 meters from top of revetted high bank; 700 meters below Penitentiary Point, and 296 meters above shore end of hurdle.

⊡ $\frac{39}{1}$

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 05′ 45″.89; meters +1,415, —435.
Longitude 90° 12′ 04″.84; meters +118, —1,344.
Elevation: Stone, 394.91; pipe, 400.01.
Flat stone and iron pipe, on levee following old high bank in Illinois; opposite ◬ Brickleys, Mo.; 230 meters back from top of river bank; near south line of land of Edward Ahern; and 550 meters below (southeast of) a sharp turn in the levee. (Found in 1908; cap gone and pipe bent over.)

△ SIMPSON 67.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1903. (Chart No. 5.)
Latitude 38° 05′ 37″.17; meters +1,146, −704.
Longitude 90° 13′ 27″.26; meters +664, −798.
To △ Simpson 59, azimuth 127° 00′ 27″, distance 2,345 meters.
Hole drilled in small rock, in group of three bowlders on Missouri shore and about 1 mile above Brickey Mill; 900 meters below railroad trestle at Morrison Hollow; and 130 meters below the next trestle south.

△ AMES.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 05′ 36″; meters +1,110, −740.
Longitude 90° 13′ 25″.32; meters +617, −845.
To △ Hartig, azimuth 208° 08′ 29″, distance 1,635.7 meters.
To △ Simpson 69, azimuth 304° 43′ 48″, distance 1,100.5 meters.
To △ Simpson 59, azimuth 127° 00′ 46″, distance 2,404.3 meters.
Iron pipe, on projecting point, outside of small railroad cut, 1 mile above Brickeys, Mo.; 59 meters below (southeast of) △ Simpson 67, and on the line Simpson 67–Simpson 59; 490 meters above second railroad trestle above Brickeys, Mo.; and 180 meters below first railroad trestle below Morrison Hollow.

⊡ B. M. 40 HOLMAN.

United States engineer office, St. Louis, Mo., 1879; redetermined by Mississippi River Commission, 1880 and 1889. (Chart No. 5.)
Latitude 38° 05′ 21″.50; meters +663, −1,187.
Longitude 90° 12′ 58″.87; meters +1,435, −27.
Elevation: 379.90. (Precise levels of 1880.)
To ⊡ B. M. 18=41 Holman, azimuth 306° 45′, distance 752 meters.
Raised triangle with letter "B" cut on rock ledge, on Missouri shore; 770 meters above (northwest of) upstream corner of Brickey Mill; and 100 meters above first railroad trestle above Brickeys, Mo.

⊕ 22 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 5.)
Latitude 38° 05′ 18″.45; meters +569, −1,281.
Longitude 90° 06′ 34″.57; meters +843, −620.
Elevation: 397.24.
To church spire, azimuth 306° 09′.
To top gable of elevator, azimuth 312° 23′.
To finial of water tank, azimuth 313° 54′.
To corner of brick building at top, azimuth 292° 17′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 10.8 meters east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); one-half mile above the railroad station at Prairie du Rocher, Ill.; 107 meters below telegraph pole 41; 91 meters below switch stand; and 102 meters northwest of highway bridge over drainage ditch.

△ SIMPSON 69.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1903. (Chart No. 5.)
Latitude 38° 05′ 15″.66; meters +483, −1,367.
Longitude 90° 12′ 48″.20; meters +1,175, −287.
To △ Rombauer, azimuth 307° 17′ 07″, distance 569.9 meters.
To △ Hartig, azimuth 176° 19′ 46″, distance 2,073.5 meters.
One-inch hole in stone, 4 feet by 3½ feet and surrounded by bowlders; on Missouri shore; 460 meters above mill at Brickeys, Mo.; and 6 meters from upper end of first bluff above Brickeys.

◉ BRICKEY ⊡ = $\frac{37}{3}$

Mississippi River Commission, 1880–81. (Chart No. 5.)
Latitude 38° 05′ 12″.82; meters +395, −1,455.
Longitude 90° 12′ 48″.87; meters +1,191, −271.
Elevation: 601.14.
To ◉ County line, azimuth 250° 55′ 03″.44, distance 8,442.63 meters.
To ◉ Caesars, azimuth 135° 38′ 13″.55, distance 11,518.81 meters.
To ◉ Kidd, azimuth 178° 38′ 51″.10, distance 9,550.64 meters.
To ◉ Magnolia, azimuth 307° 21′ 45″.18, distance 7,630.95 meters.
To △ Simpson 59, azimuth 127° 36′ 02″, distance 3,544.0 meters.
Center of stone post, on top of Missouri bluffs; 100 meters back from shore line; and one-quarter mile above (northwest of) Brickeys, Mo. Stone has been shattered and the bench mark is a dressed knob.

⊡ B. M. 18–41 HOLMAN.

United States engineer office, St. Louis, Mo., 1872 and 1879; redetermined, Mississippi River Commission, 1880 and 1889. (Chart No. 5.)
Latitude 38° 05′ 06″.94; meters +214, −1,636.
Longitude 90° 12′ 34″.05; meters +830, −632.
Elevation: 384.55. (Precise levels, 1880.)
To ⊡ B. M. 40 Holman, azimuth 126° 45′, distance 752 meters.
Raised square, with letters U. S. B. M. above and the number 18 below, cut on horizontal surface of natural rock; 20 meters above the upstream corner of mill at Brickeys, Mo. This bench mark was established by Smith in 1872, elevation 385.74; by Holman in 1879, elevation 384.25; and by Mississippi River Commission precise levels in 1880.

△ ROMBAUER.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 05′ 04″.47; meters +138, −1,712.
Longitude 90° 12′ 29″.60; meters +721, −741.
To △ Snell, azimuth 307° 14′ 09″, distance 961.5 meters.
To △ Simpson 69, azimuth 127° 17′ 19″; distance 569.9 meters.
Iron pipe, on edge of high bank at Brickeys, Mo.; in southeast corner of front yard of large two-story frame house belonging to Judge R. E. Rombauer and east of "Frisco" railroad.

△ CARR.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5, station not plotted.)
Latitude 38° 05′ 04″.01; meters +124, −1,726.
Longitude 90° 11′ 35″.77; meters +872, −590.
To △ Snell, azimuth 43° 53′ 32″, distance 787.9 meters.
To △ Hickory, azimuth 352° 11′ 41″, distance 1,087.9 meters.
Iron pipe, on bar in front of and about 150 meters from Carr's house at old Sycamore Landing, Ill.; and opposite Snell Hollow in Missouri bluffs. (Not found in 1908.)

△ PLUM NO. 2.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 04′ 50″.33; meters +1,552, −298.
Longitude 90° 10′ 40″.58; meters +989, −473.
To △ Simpson 75, azimuth 359° 13′ 26″, distance 1,597.7 meters.
Iron pipe, on edge of revetted high bank, in front of Dickey Field, Ill.; and 1½ miles below Brickeys, Mo.; 335 meters above small shanty; and 15 meters east of wild plum tree near edge of bank.

△ SNELL.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 04′ 45″.60; meters +1,406, −444.
Longitude 90° 11′ 58″.19; meters +1,418, −44.
To △ Carr, azimuth 223° 53′ 18″, distance 787.9 meters.
To △ Hickory, azimuth 306° 18′ 28″, distance 861.3 meters.
To △ Rombauer, azimuth 127° 14′ 28″, distance 961.5 meters.
Iron pipe, about 960 meters below railroad station at Brickeys, Mo.; in front of middle of first bluff above Snell Hollow and near edge of high railroad embankment.

□ 38/1

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 04′ 44″.50; meters +1,372, −478.
Longitude 90° 08′ 42″.99; meters +1,048, −415.
Elevation: Stone, 392.61; pipe, 397.71.
To □38/2, azimuth 41° 30′, distance 894 meters.
Flat stone and iron pipe, on top of old high bank in Illinois and back of Fort Chartres Island; at edge of timber and cultivated field; 140 meters southwest of floodgate in drainage ditch; 900 meters from river bank; and 1,050 meters north of Fort Chartres Landing, Ill. To an oak tree, azimuth 101° 40′ −6 meters; and to a house, 215° 21′ −90 meters.

△ PAWPAW NO. 2.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 04′ 37″.54; meters +1,157, −692.
Longitude 90° 09′ 47″.70; meters +1,163, −300.
To △Simpson 75, azimuth 46° 28′ 03″, distance 1,747.7 meters.
Iron pipe on Fort Chartres Island, Ill., and about one-third of the distance from Dickey Field down to Fort Chartres Landing, Ill.; 37.8 meters back from △Pawpaw (temporary) on the line Pawpaw–Simpson 75; 10 meters from 11-inch pecan tree; 11.6 meters from 18-inch hackberry tree; and 8.3 meters from 16-inch pecan tree.

△ HICKORY.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 04′ 29″.05; meters +896, −954.
Longitude 90° 11′ 29″.71; meters +724, −739.
To △Simpson 75, azimuth 307° 41′ 19″, distance 1540.9 meters.
To △Carr, azimuth 172° 11′ 44″, distance 1,087.9 meters.
Iron pipe, on Missouri shore; on flat accretion at upper end of Fort Chartres hurdles; 30.5 meters upstream from third large ravine below Brickeys, Mo.; 39.6 meters in front (east of) "Frisco" railroad track; and on line with △Snell and the western side of old mill at Brickeys.

□ 38/2

Mississippi River Commission, 1889. (Chart No. 5.)
Latitude 38° 04′ 22″.80; meters +703, −1,147.
Longitude 90° 09′ 07″.26; meters +177, −1,286.
Elevation: 391.90.
To □38/1, azimuth 221° 30′, distance 894 meters.
Stone post, 35 meters back from river bank; 875 meters upstream from Fort Chartres Landing, Ill.; in the timber and near foot of 18-inch boxelder tree. (Not found in 1908.)

△ SIMPSON 75.

United States engineer office, St. Louis, Mo., 1879; redetermined, 1892 and 1903. (Chart No. 5.)
Latitude 38° 03′ 58″.48; meters +1,803, −47 (1892).
Longitude 90° 10′ 39″.67; meters +967, −496 (1892).
Latitude 38° 03′ 58″.50; meters +1,804, −46 (1903).
Longitude 90° 10′ 39″.69; meters +968, −495 (1903).
To ⊛Magnolia, azimuth 308° 46′ 05″, distance 3,738.3 meters (1892).
To △Simpson 77, azimuth 307° 53′ 22″, distance 3,971.7 meters (1892).
To ⊛Magnolia, azimuth 308° 45′ 57″, distance 3,739 meters (1903).
To △Plum No. 2, azimuth 179° 13′ 27″, distance 1,597.7 meters (1903).
To △Pawpaw No. 2, azimuth 226° 28′ 03″, distance 1,747.7 meters (1903).
To △Hickory, azimuth 127° 41′ 50″, distance 1,540.9 meters (1903).
Hole in rock, Missouri; on second bluff above Establishment Creek; 230 feet below old shot tower, below Salt Point, and opposite head of Establishment (or Bruce) Island; and on line with hurdle No. 0 of Fort Chartres system. To reach station follow road that goes up bluff in first ravine above Establishment Creek until the shoulder of bluff is reached, then turn east and get on line with hurdle No. 0.

△ CROSS.

United States engineer office, St. Louis, Mo., 1892. (Chart No. 5, station not plotted.)
Latitude 38° 03′ 32″.80; meters +1,011, —839.
Longitude 90° 10′ 03″.26; meters +79, —1,384.
To ◬ Magnolia, azimuth 307° 23′ 26″, distance 2,551 meters.
Hole in rock, in Missouri; halfway up first bluff above Establishment Creek; on line of old Fort Chartres Dam or hurdle No. 2 present series; and very near ⊙ P. B. M. 29 = ⊡ 38/3.

△ BRUCE.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 5.)
Latitude 38° 03′ 24″.39; meters +752, —1,098.
Longitude 90° 08′ 55″.67; meters +1,357, —106.
To △ Cambria, azimuth 323° 28′ 33″, distance 2,308.9 meters.
Iron pipe, near lower end of Establishment (or Bruce) Island; on Missouri side of river and nearly opposite Fort Chartres Landing, Ill.; about 500 feet below point of timber, on old foot of island, and lower end of revetment now covered, on sand ridge on east side of island; and in thicket of small willows.

⊙ P. B. M. 29 ⊡ $\frac{38}{3}$

Mississippi River Commission, 1880 and 1889. (Chart No. 5.)
Latitude 38° 03′ 32″.92; meters +1,015, —835.
Longitude 90° 10′ 03″.40; meters +83, —1,380.
Elevation: 416.79.
Copper bolt, leaded horizontally into point of limestone bluff in Missouri; about 1 foot above surface of ground; 50 meters north of farmhouse; 440 meters above (northeast of) railroad bridge across Establishment Creek; and directly opposite main shore end of hurdle No. 2 of the Fort Chartres system.

⊕ 23 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 38° 04′ 14″.06; meters +434, —1,416.
Longitude 90° 05′ 07″.13; meters +174, —1,289.
Elevation: 398.71.
To finial of water tank, azimuth 132° 34′.
To top gable of elevator, azimuth 133° 12′.
To church spire, azimuth 142° 46′.
To school cupola, azimuth 140° 20′.
To gable of barn, azimuth 269° 11′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 3.34 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about 1¼ miles below Prairie du Rocher depot; 293 meters below sign "Prairie du Rocher one mile"; 300 meters below telegraph pole 42/20; 34 meters below telegraph pole 42/25; and 126 meters above road crossing.

◈ BREWERVILLE.

Mississippi River Commission, 1880–81. (Chart No. 6.)
Latitude 38° 03′ 35″.35; meters +1,090, —760.
Longitude 90° 03′ 23″.89; meters +583, —880.
To ◈ Correll, azimuth 20° 48′ 30″.50, distance 6,244.91 meters.
To ◈ Magnolia, azimuth 78° 06′ 10″.47, distance 7,880.26 meters.
To △ Ziegler, azimuth 346° 04′ 30″, distance 12,055.4 meters.
To △ Ste. Genevieve, azimuth 354° 41′ 10″, distance 8,988.5 meters.
Center of stone post, with top broken off, on Illinois bluffs 1 mile above (northwest of) Modoc, Ill.; 2½ miles below Prairie du Rocher, near edge of low cliff; on bare spot in pasture owned by Francis Boniew.

⊕ 24 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 38° 03′ 27″.15; meters +837, —1,013.
Longitude 90° 04′ 02″.65; meters +65, —1,398.
Elevation: 401.08.

To top gable of elevator, azimuth 312° 21′.
To finial of water tank, azimuth 132° 39′.
To top gable of elevator, azimuth 132° 57′.
To gable of barn, azimuth 213° 54′.
To gable of house, azimuth 273° 12′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 3 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1⅛ miles above Modoc, Ill., railroad station; 44 meters below telegraph pole 42/5; 1,000 meters westwardly from ◎ Brewerville.

◎ MAGNOLIA.

Mississippi River Commission, 1880–81. (Chart No. 6.)
Latitude 38° 02′ 42″.54; meters +1,312, −538.
Longitude 90° 08′ 40″.13; meters +979, −484.
Elevation: 664.60.
To ◎ County Line, azimuth 194° 33′ 27″.94, distance 7,634.70 meters.
To ◎ Correll, azimuth 307° 26′ 09″.04, distance 6,922.23 meters.
To ◎ Brewerville, azimuth 258° 02′ 55″.55, distance 7,880.26 meters.
To ◎ Brickey, azimuth 127° 24′ 18″.54, distance 7,630.95 meters.
To △ Simpson 75, azimuth 128° 47′ 11″, distance 3,739 meters (1903).
To △ Simpson 75, azimuth 128° 47′ 19″, distance 3,738.3 meters (1892).
To △ Cross, azimuth 127° 24′ 18″, distance 2,551 meters.
To ⊡ 37/1, azimuth 257° 15′.
To ⊡ 37/2, azimuth 269° 35′.
Center of stone post, with top broken off, on highest point of high hill, 120 meters above trestle at Cambria Hollow, Mo.; 1,500 meters below railroad bridge across Establishment Creek; and 100 meters back from railroad.

△ SIMPSON 77.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1892 and 1903. (Chart No. 6.)
Latitude 38° 02′ 39″.35; meters +1,213, −637 (1892).
Longitude 90° 08′ 31″.12; meters +759, −704 (1892).
Latitude 38° 02′ 39″.36; meters +1,214, −636 (1903).
Longitude 90° 08′ 31″.12; meters +759, −704 (1903).
To △ Simpson 75, azimuth 127° 54′ 41″, distance 3,971.7 meters (1892).
To △ Simpson 75, azimuth 127° 54′ 29″, distance 3,972.2 meters (1903).
Hole in rock, on Missouri bluffs; close to edge of prominent ledge on lower side of first bluff below Establishment Creek; 245 meters below (southeast of) ◎ Magnolia; 65 meters back from railroad; and 1,000 meters above Cambria Hollow.

△ CAMBRIA.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 02′ 24″.21; meters +746, −1,104.
Longitude 90° 07′ 59″.32; meters +1,447, −16.
Elevation: 381.91.
To △ Turkey, azimuth 270° 20′ 42″, distance 1,618.7 meters.
To △ Glendale, azimuth 311° 40′ 11″, distance 752.3 meters.
One-inch hole, 2 inches deep, in center of triangle cut on large bowlder, in Missouri; 73 meters above (northwest of) railroad bridge at Cambria Hollow; 22 meters from face of bluff; and 8.5 meters from foot of railroad embankment.

△ TURKEY.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 02′ 23″.89; meters +737, −1,113.
Longitude 90° 06′ 52″.94; meters +1,291, −172.
To △ Whitesand, azimuth 18° 38′ 14″, distance 1,097.1 meters.
To △ Glendale, azimuth 65° 07′ 05″, distance 1,165 meters.
To △ Elms, azimuth 323° 40′ 26″, distance 1,147.7 meters.
Iron pipe, in Illinois; on head of Turkey Island; on south bank of depression or old slough; opposite Magnolia Hollow, Mo.; 3 meters from 20-inch cottonwood tree; and 7 meters from 12-inch cottonwood.

⊙ P. B. M. 30.

Mississippi River Commission, 1880. (Chart No. 6.)
Latitude 38° 02′ 08″.27; meters +255, —1,595.
Longitude 90° 07′ 35″.97; meters +877, —586.
Elevation: 395.95.
Center of copper bolt, leaded horizontally in natural rock in Missouri bluff; 1,300 meters above White Sand Depot; and about 250 meters above lower end of bluff. The letters "U. S. P. B. M." are cut near the bolt. (Not found, 1908.)

△ GLENDALE.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 02′ 07″.99; meters +246, —1,604.
Longitude 90° 07′ 36″.27; meters +884, —579.
To △Elms, azimuth 284° 02′ 19″, distance 1,790.3 meters.
To △Simpson 83, azimuth 308° 24′ 38″, distance 2,042.1 meters.
To △Cambria, azimuth 131° 40′ 25″, distance 752.3 meters.
To △Turkey, azimuth 245° 06′ 39″, distance 1,165 meters.
Hole in rock, on Missouri bluffs, first bluff above Magnolia Hollow; on highest stripped ledge; 25 feet out from top of bluff and 1 meter from edge of cliff.

⊕ 25 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 38° 02′ 04″.64; meters +143, —1,707.
Longitude 90° 02′ 00″.16; meters +4, —1,459.
Elevation: 390.56.
To gable of house, azimuth 217° 00′.
To middle of chimney, azimuth 217° 01′.
To middle of sign "R. R. Crossing," azimuth 302° 27′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 10.26 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about three-quarters of a mile below Modoc, Ill.; 120 meters above telegraph pole 46/20; and 150 meters below telegraph pole 46/15.

⊡ $\frac{36}{1}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 01′ 55″.29; meters +1,705, —145.
Longitude 90° 04′ 05″.93; meters +145, —1,319.
Elevation: Stone, 384.90; pipe, 390.01.
To ⊡36/2, azimuth 24° 45′, distance 628 meters.
Flat stone and iron pipe, in Illinois, 1⅛ miles back from the foot of Turkey Island; in cultivated field; southwest of old slough or lake and 130 meters therefrom; and 200 meters southwest of Frank Schifferdecker's house, on opposite side of lake. (Found 1908; pipe slightly bent over.)

△ ELMS.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 01′ 53″.89; meters +1,662, —188.
Longitude 90° 06′ 25″.06; meters +612, —852.
To △White Sand, azimuth 83° 38′ 28″, distance 1,036.9 meters.
To △Simpson 83, azimuth 9° 18′ 51″, distance 845.6 meters.
To △Simms, azimuth 304° 44′ 43″, distance 1,307.8 meters.
To △Turkey, azimuth 143° 40′ 43″, distance 1,147.7 meters.
To △Glendale, azimuth 104° 03′ 02″, distance 1,790.3 meters.
Iron pipe, at Turkey Island Landing, in Illinois; 120 meters northwest from house; 18.5 meters below 36-inch elm tree; 19 meters below 24-inch sycamore tree; 24.5 meters from river bank; and 98 feet west of northwest corner of cornerib.

⊡ U. S. B. M. 20 =47 HOLMAN.

United States engineer office, St. Louis, Mo., 1872 and 1879; Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 01′ 53″.77; meters +1,658, —192.
Longitude 90° 07′ 12″.71; meters +310, —1,154.
Elevation: 372.00. (Adjusted to precise levels, 1880.)
To⊙P. B. M. 30, azimuth 128° 25′, distance 719 meters.
Raised square, with letters and number "U. S. B. M. 20" cut on solid flat rock on Missouri shore; 600 meters above White Sand Depot; 175 meters above△Whitesand; and 310 meters below railroad trestle at Magnolia Hollow; about 5 feet from edge of rock and 62 meters below lower end of another ledge. This bench mark was established by Smith in 1872; elevations: 371.67 by Holman in 1879; and 372, indirectly by Mississippi River Commission precise levels to Nos. 46 and 48, Holman, in 1880. Location determined by Mississippi River Commission in 1889.

⊡ $\frac{37}{3}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 01′ 51″.89; meters +1,600, —250.
Longitude 90° 07′ 11″.68; meters +285, —1,179.
Elevation: 431.30.
Round knob, cut on horizontal surface of natural rock, 550 meters above White Sand Depot, Mo.; just above the first rock bluff (Bald Rock) upstream from the landing; and 40 meters from shore. "U. S. B. M. 37/3" is cut on the vertical face of the rock near the knob.

△ WHITESAND.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 01′ 50″.17; meters +1,547, —303.
Longitude 90° 07′ 07″.31; meters +178, —1,285.
Elevation: 392.65.
To△Elms, azimuth 263° 38′ 02″, distance 1,036.9 meters.
To△Turkey, azimuth 198° 38′ 05″, distance 1,097.1 meters.
Hole in center of triangle, cut in a large bowlder in front of middle of first bluff above White Sand Depot, Mo.; about 50 feet from center of railroad track and 3 feet lower in elevation; and opposite crevice in face of bluff.

⊡ $\frac{36}{2}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 01′ 36″.97; meters +1,140, —710.
Longitude 90° 04′ 16″.68; meters +407, —1,057.
Elevation: 393.16.
To⊡36/1, azimuth 204° 45′, distance 628 meters.
To⊡36/3, azimuth 24° 45′, distance 1,925 meters.
Stone post, in Illinois; nearly opposite Rubicon Hollow in Missouri bluffs; 630 meters back from high bank of river; in a cultivated field; and on south bank of dry slough. (Found in 1908; disturbed.)

△ SIMMS.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 01′ 29″.72; meters +916, —934.
Longitude 90° 05′ 41″.00; meters +1,000, —464.
To△B. M. 49 Holman, azimuth 353° 16′ 02″, distance 979.1 meters.
To△Simpson 85, azimuth 55° 56′ 51″, distance 791.5 meters.
To△Elms, azimuth 124° 45′ 10″, distance 1,307.8 meters.
To△Simpson 83, azimuth 85° 48′ 13″, distance 1,214.8 meters.
Iron pipe, on lower end of prominent ridge in woods on Illinois shore; on west side of Turkey Island and about three-fourths of a mile upstream from a point opposite Sims (Grays) Cave in Missouri bluffs; 200 feet below edge of cultivated field; 5 feet west of 10-inch elm tree; 12.5 feet northeast of 12-inch elm; and 25.5 feet east of 12-inch elm. Trees are blazed with triangles facing pipe. (Not found in 1908.)

△ SIMPSON 83.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1903. (Chart No. 6.)
Latitude 38° 01′ 26″.83; meters +827, −1,023.
Longitude 90° 06′ 30″.67; meters +748, −716.
Elevation: 376.29.
To△Elms, azimuth 189° 18′ 48″, distance 845.6 meters.
To△Simms, azimuth 265° 47′ 43″, distance 1,214.8 meters.
To△Simpson 85, azimuth 302° 30′ 48″, distance 659.1 meters.
To△Glendale, azimuth 128° 25′ 18″, distance 2,042.1 meters.
Two-inch hole in center of triangle, cut in lower edge of rock ledge in Missouri; and 250 feet below upper edge of first bluff below Frenchman Creek; 100 feet from foot of railroad embankment; 130 feet from center of track; and 200 feet from 14-inch blazed oak near top of bluff.

△ SIMPSON 85.

United States engineer office, St. Louis, Mo., 1874; redetermined, 1903. (Chart No. 6.)
Latitude 38° 01′ 15″.34; meters +473, −1,377.
Longitude 90° 06′ 07″.89; meters +193, −1,271.
Elevation: 378.20.
To△Simpson 83, azimuth 122° 31′ 02″, distance 659.1 meters.
To△Holman, azimuth 299° 10′ 01″, distance 2,183.5 meters.
To△Simms, azimuth 235° 56′ 35″, distance 791.5 meters.
Two-inch hole, 4 inches deep, in center of triangle, cut on triangular bowlder 8 by 5 by 5 feet, and abreast of middle of first bluff below Frenchman Creek, in Missouri; 20 feet from foot of railroad embankment and 77 feet from center of track; opposite second telegraph pole above pole 60/20; and 27 feet above (northwest of) three prominent bowlders. The number "85" is cut in bowlder near hole.

⊕ 26 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 38° 01′ 00″.40; meters +12, −1,838.
Longitude 89° 59′ 54″.18; meters +1,322, −142.
Elevation: 387.89.
To gable of depot at Roots, azimuth 303° 13′.
To gable of barn, azimuth 69° 36′.
To gable of barn, azimuth 70° 34′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 1⅛ miles above Roots station ("Iron Mountain"); 395 meters above junction of Illinois Southern Railway and St. Louis, Iron Mountain and Southern Railway (Illinois Division); and 2.76 meters east of center of track of latter road; 166 meters above telegraph pole 49; 165 meters above sign "Roots one mile;" 52 meters below telegraph pole 48/25; and 2 meters below private road crossing.

△ B. M. 49 (HOLMAN).

United States engineer office, St. Louis, Mo. (levels of 1879), 1903. (Chart No. 6.)
Latitude 38° 00′ 58″.18; meters +1,794, −56.
Longitude 90° 05′ 36″.29; meters +885, −579.
Elevation: 380.41. (Adjusted to precise levels, 1880.)
To△Simms, azimuth 173° 16′ 05″, distance 979.1 meters.
Raised knob in triangle, cut on bench ledge of rock on Missouri shore; opposite highest point of bluff below Lower Frenchman Hollow; 500 feet below railroad bridge at same hollow; 61 feet out from center of track and 19 feet from foot of railroad embankment; and 37.3 feet from lower northeast corner of bowlder 4 by 3 by 3.5 feet. The letters "B. M." are cut in the perpendicular face of rock, slightly inshore from and below the triangle. Triangulation station Simpson 87, exposed at 18-foot stage, St. Louis gauge, is 12 feet upstream from this station, and 14.5 feet from center of lettering "B. M."

△ HOLMAN.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 00′ 40″.82; meters +1,259, −591.
Longitude 90° 04′ 49″.73; meters +1,213, −251.
To△Richards, azimuth 286° 00′ 37″, distance 819.7 meters.
To△Simpson 85, azimuth 119° 10′ 49″, distance 2,183.5 meters.
Hole in center of triangle, cut in bowlder on Missouri shore; 335 feet below ⊡ B. M. 50 Holman, a raised knob in a triangle, elevation 377.06, opposite first telegraph pole south of pole 61/25; 780 feet below railroad bridge at Rubicon Hollow and abreast of large projecting bowlder on top of bluff; 40.5 feet from center of railroad track and 5 feet from foot of railroad embankment; opposite telegraph pole 62/28; 34 feet below large flat bowlder and 27 feet above large bowlder standing on edge. A piece of three-quarter-inch iron gas pipe was placed in hole to assist in relocating the station.

⊡ $\frac{36}{3}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 00′ 40″.21; meters +1,240, −610.
Longitude 90° 04′ 49″.59; meters +1,210, −254.
Elevation: 396.35.
To ⊡ 36/2, azimuth 204° 45′, distance 1,925 meters.
Knob cut on bowlder, on Missouri shore, 3 miles above Ste. Genevieve, Mo., and 25 meters from shore line. The letters and numbers "U. S. B. M. 36/3" are cut beside the knob on the bowlder. (Not found in 1908.)

△ BOTTOM.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 38° 00′ 40″.19; meters +1,239, −611.
Longitude 90° 02′ 17″.36; meters +424, −1,040.
To◎Correll, azimuth 83° 30′ 55″, distance 3,866.4 meters.
To△Wilder, azimuth 57° 59′ 27″, distance 2,493.7 meters.
To△Ziegler, azimuth 348° 32′ 45″, distance 6,429.3 meters.
To△Maxwell, azimuth 21° 55′ 20″, distance 2,590.5 meters.
Iron pipe, in Illinois bottomland; on west side of road leading from ferry landing opposite Little Rock Landing, Mo., to Moro station on the Illinois Southern Railway; about 400 feet west of point where road crosses track; and 300 feet west of south end of levee. (Not found in 1908.)

△ RICHARDS.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 00′ 33″.48; meters +1,032, −818.
Longitude 90° 04′ 17″.43; meters +425, −1,039.
To△Holman, azimuth 106° 00′ 56″, distance 819.7 meters.
Hole in large flint nodule and limestone bowlder, at foot of railroad embankment; a little upstream from the middle of second bluff above Little Rock Landing, Mo.; 385 feet east of mouth of natural drain, in face of bluff. A piece of three-quarter-inch iron gas pipe was placed in hole to assist in relocating the station.

◎ CORRELL=⊡ $\frac{36}{4}$

Mississippi River Commission, 1880–81. (Chart No. 6.)
Latitude 38° 00′ 26″.00; meters +802, −1,048.
Longitude 90° 04′ 54″.81; meters +1,337, −127.
Elevation: 624 (approximate).
To◎County line, azimuth 162° 53′ 42″.47, distance 12,136.64 meters.
To◎Brewerville, azimuth 200° 47′ 34″.48, distance 6,244.91 meters.
To◎Magnolia, azimuth 127° 28′ 27″.83, distance 6,922.23 meters.
To◎Vause, azimuth 321° 53′ 18″.67, distance 13,233.07 meters.
To△Bottom, azimuth 263° 29′ 18″, distance 3,866.4 meters.
To△Wilder, azimuth 297° 06′ 26″, distance 1,940.7 meters.
To△Hurst, azimuth 290° 31′ 12″, distance 5,855.7 meters.
To△Ziegler, azimuth 318° 51′ 34″, distance 7,784.1 meters.
To△Ste. Genevieve, azimuth 315° 33′ 20″, distance 4,358.3 meters.
Originally a stone post, replaced with an iron pipe in 1899, 3 miles upstream from Ste. Genevieve, Mo.; 480 meters back from river bank; in cultivated field, on top of hill; 1¼ miles westwardly from Little Rock Landing, Mo.

⊕ 27 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 38° 00′ 25″.60; meters +789, —1,061.
Longitude 89° 58′ 46″.93; meters +1,145, —319.
Elevation: 389.84.
To △Ste. Genevieve, azimuth 62° 25′.
To St. Leo's church spire, azimuth 179° 01′.
To top gable of elevator, azimuth 229° 25′.
To gable of depot at Roots, azimuth 303° 28′.
To gable of house, azimuth 260° 51′.
To gable of house, azimuth 80° 14′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; about one-half mile northwest of Roots station ("Iron Mountain"); 2.46 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 182 meters below telegraph pole 50; 92 meters above telegraph pole 50/5; 184 meters below switch stand; and 1,566 meters below junction of the Illinois Southern Railway and the "Iron Mountain" Railway.

△ CRANE.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 00′ 21″.91; meters +676, —1,174.
Longitude 90° 03′ 44″.75; meters +1,092, —372.
Elevation: 396.94.
To △Southern, azimuth 319° 18′ 56″, distance 879.3 meters.
Iron pipe, on railroad embankment in lower (Wilder) quarry; 6 feet from telegraph pole near first trestle above Little Rock Landing, Mo.

△ LITTLE ROCK.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 38° 00′ 15″.59; meters +481, —1,369.
Longitude 90° 03′ 34″.59; meters +844, —620.
Hole in rock, on high bank; immediately in front of 2-story frame building; and about 35 meters below Little Rock Landing, Mo.

△ TANK.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 00′ 13″.58; meters +419, —1,431.
Longitude 90° 03′ 36″.83; meters +899, —565.
Finial of water tank of Illinois Southern Railway near Little Rock Landing, Mo.; and directly back from △ Little Rock.

$\boxdot \frac{35}{1}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 38° 00′ 13″.53; meters +417, —1,433.
Longitude 90° 00′ 42″.96; meters +1,048, —416.
Elevation: Stone, 388.08; pipe, 393.17.
To ⊡ 35/2, azimuth 37° 15′, distance 1,297 meters.
Flat stone and iron pipe, in west edge of cultivated field, on Ste. Genevieve Island (now in Illinois); 1,600 meters from the Mississippi River and opposite Ste. Genevieve, Mo.

△ SOUTHERN.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 6.)
Latitude 38° 00′ 00″.28; meters +9, —1,841.
Longitude 90° 03′ 21″.26; meters +519, —945.
To △Maxwell, azimuth 333° 11′ 14″, distance 1,313.3 meters.
To △Crane, azimuth 139° 19′ 10″, distance 879.3 meters.
Iron pipe, near middle of second bluff on hill below Little Rock Landing, Mo.; about 60 feet back from edge of bluff and on contour about 10 feet lower than crest. An 18-inch white oak and a 20-inch black oak, about 30 feet apart and blazed with triangles, are 22 feet in front of the station.

△ WILDER.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 59′ 57″.31; meters +1,767, —83.
Longitude 90° 03′ 44″.03; meters +1,074, —390.
To ◎Correll, azimuth 117° 07′ 09″, distance 1,940.7 meters.
To △Maxwell, azimuth 313° 17′ 19″, distance 1,576.7 meters.
To △Bottom, azimuth 237° 58′ 34″, distance 2,493.7 meters.
Iron pipe, in Missouri; on top of first hill below Little Rock Landing; about 550 meters from the river; and nearly in line with water tank and southeast corner of old mill at the landing.

⊕ 28 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 37° 59′ 50″.07; meters +1,544, —306.
Longitude 89° 57′ 37″.61; meters +918, —546.
Elevation: 387.61.
To gable of house, azimuth 347° 03′.
To gable of house, azimuth 343° 54′.
To gable of barn, azimuth 33° 02′.
To gable of barn, azimuth 98° 06′.
To gable of barn, azimuth 33° 42′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; seven-eighths mile below Roots station ("Iron Mountain"); on mound in borrow pit on south side of wagon road; about 620 meters above (west of) drawbridge over Kaskaskia River; 76 meters below telegraph pole 51/10; about 90 meters below point of curve of St. Louis, Iron Mountain and Southern Railway (Illinois division); 15 meters west of center of track and 18 meters southwest of lower end of trestle No. 68.

⊡ $\frac{35}{2}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 37° 59′ 40″.06; meters +1,235, —615.
Longitude 90° 01′ 15″.08; meters +368, —1,096.
Elevation: 384.99.
To ⊡35/1, azimuth 217° 15′, distance 1,279 meters.
To ⊡35/3, azimuth 36° 40′, distance 2,102 meters.
Stone post, in field, on Ste. Genevieve Island (now in Illinois); opposite Ste. Genevieve, Mo.; 400 meters back from river bank; 415 meters west of northeast corner, and 285 meters north of northwest corner of scattered timber; and 270 meters northeast, directly back from buildings near the river.

⊕ 29 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 6.)
Latitude 37° 59′ 23″.50; meters +725, —1,125.
Longitude 89° 55′ 57″.49; meters +1,403, —61.
Elevation: 389.42.
To top gable of elevator, azimuth 322° 18′.
To middle of chimney, Reily Lake depot, azimuth 322° 26′.
To east edge of farmhouse chimney, azimuth 318° 17′.
To west edge of outside chimney, azimuth 319° 00′.
Two-inch iron pipe, about 16 inches above surface of ground in Illinois bottomland; 3 meters west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about 1 mile above Reily Lake depot; 166 meters above telegraph pole 53/5; 116 meters below telegraph pole 53; 7 meters below lower end of trestle No. 72, over a ditch 3 meters wide (running water).

△ MAXWELL.

United States engineer office, St. Louis, Mo., 1899 and 1903. (Chart No. 6.)
Latitude 37° 59′ 22″.25; meters +686, —1,164 (1899).
Longitude 90° 02′ 56″.99; meters +1,391, —73 (1899).
Latitude 37° 59′ 22″.27; meters +687, —1,163 (1903).
Longitude 90° 02′ 56″.98; meters +1,390, —74 (1903).
To△Vieux Village, azimuth 307° 22′ 15″, distance 6,092.8 meters (1899).

To△Bottom, azimuth 201° 54′ 55″, distance 2,590.5 meters (1899).
To△Wilder, azimuth 133° 17′ 49″, distance 1,576.7 meters (1899).
To△Warehouse=⊡35/3, azimuth 312° 50′ 52″, distance 1,668.8 meters (1899).
To△Southern, azimuth 153° 11′ 29″, distance 1,313.3 meters (1903).
Iron pipe, on top of first prominent hill above Ste. Genevieve, Mo.; in open field a little northeast of crest of hill, and about 225 meters below the Bantz stone house.

△ HURST.

United States engineer office, St. Louis, Mo., 1900. (Chart No. 6.)
Latitude 37° 59′ 19″.37; meters +597, −1,253.
Longitude 90° 01′ 10″.09; meters +246, −1,218.
Elevation: 387.34.
To◎Correll, azimuth 110° 33′ 30″, distance 5,855.7 meters.
To△Ziegler, azimuth 5° 28′ 50″, distance 3,826.8 meters.
Iron pipe, on Ste. Genevieve Island (in Illinois); about 1,060 meters above slough between Ste. Genevieve and Moro islands; 10 feet from edge of bank; 10 feet above an old road leading down the bank; to northwest corner of white house, azimuth 240°, distance 100 feet; dead twin stump, south, 6 feet; blazed 8-inch boxelder, 150° −10 feet.

△ WAREHOUSE=⊡ 35/3

Mississippi River Commission, 1889; redetermined, United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 58′ 45″.43; meters +1,401, −449.
Longitude 90° 02′ 06″.86; meters +167, −1,297.
Elevation: 390.92.
To△Maxwell, azimuth 132° 51′ 23″, distance 1,668.8 meters.
To△Ste. Genevieve, azimuth 89° 35′, distance 1,053 meters.
To⊡35/4, azimuth 36° 50′, distance 806 meters.
To⊡35/2, azimuth 216° 40′, distance 2,102 meters.
Stone post, in cultivated field, one-quarter mile east of and below Ste. Genevieve, Mo.; 25 meters back from old high bank; about 270 meters east of bridge over South Gabouri Creek; and 370 meters north of "Frisco" railroad bridge over Valley Spring Branch.

△ STE. GENEVIEVE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 58′ 45″.06; meters +1,389, −461.
Longitude 90° 02′ 49″.78; meters +1,215, −250.
Center of spire and cross of the cathedral at Ste. Genevieve, Mo.

⊙ P. B. M. 33.

Mississippi River Commission, 1880. (Chart No. 6.)
Latitude 37° 58′ 43″.14; meters +1,330, −520.
Longitude 90° 02′ 38″.72; meters +945, −520.
Elevation: 407.86.
Center of copper bolt, leaded horizontally in south side of southeast corner of public school building in Ste. Genevieve, Mo.; 4 inches from corner in fifth course of stone below the bricks. The letters "U. S. P. B. M." are cut near the bolt.

⊡ 35/4

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 37° 58′ 24″.16; meters +745, −1,105.
Longitude 90° 02′ 26″.50; meters +647, −818.
Elevation: Stone, 397.27; pipe, 402.37.
To△Ste. Genevieve, azimuth 138° 30′, distance 855 meters.
To⊡35/3, azimuth 216° 50′, distance 806 meters.
Flat stone and iron pipe, inside of fence on west side of main road leading south from Ste. Genevieve, Mo.; 20 meters north of lane leading west from main road and about 350 meters south of South Gabouri Creek.

△ FAIRY.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 57′ 36″.83; meters +1,136, −714.
Longitude 89° 58′ 22″.05; meters +538, −927.
Elevation: 382.11.
To◎Kaskaskia, azimuth 266° 06′ 27″, distance 5,756.5 meters.
To◎Vause, azimuth 15° 26′ 01″, distance 5,386.2 meters.
Iron pipe, on Missouri shore; 3½ miles below Ste. Genevieve, Mo.; 185 meters north and in front of McClary's house and opposite flat section of revetted bank; about 60 meters from water's edge at mean stage and 9 meters from high bank; blazed trees: sycamore, northwest, 149 meters; cottonwood, northeast, 123 meters. Pipe set a few inches below surface of ground with mound of stone for surface mark.

⊡ $\frac{34}{4}$

Mississippi River Commission, 1889. (Chart No. 6.)
Latitude 37° 57′ 24″.00; meters +740, −1,110.
Longitude 89° 58′ 27″.97; meters +683, −782.
Elevation: Stone, 378.25; pipe, 383.34.
Flat stone and iron pipe, in Missouri, about 3½ miles below Ste. Genevieve; in cultivated field about 120 meters west of road leading south from river; 470 meters south of river bank; and 700 meters north of buildings owned by Jules Detchmendy.

△ VIEUX VILLAGE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 57′ 22″.25; meters +686, −1,164.
Longitude 89° 59′ 38″.65; meters +944, −521.
Elevation: 386.37.
To△Ziegler, azimuth 85° 38′ 25″, distance 2,605.4 meters.
To△Maxwell, azimuth 127° 24′ 18″, distance 6,092.8 meters.
To△Double flag (probably covered), azimuth 127° 56′ 35″, distance 2,045.6 meters.
Iron pipe, in Missouri, about 3 miles below Ste. Genevieve; on slight ridge in cultivated field 100 meters back from river; 17 meters from high bank; and 275 meters upstream from shore end of hurdle No. 18, Ste. Genevieve works. Nearly on line with mouth of Kaskaskia (Okaw) River and shore end of this hurdle. A mound of stone piled around the pipe serves as a surface mark.

△ ZIEGLER.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 6.)
Latitude 37° 57′ 15″.82; meters +488, −1,362.
Longitude 90° 01′ 25″.06; meters +612, −853.
To◎Brewerville, azimuth 166° 05′ 43″, distance 12,055.4 meters.
To◎Correll, azimuth 138° 53′ 43″, distance 7,784.1 meters.
To△Bottom, azimuth 168° 33′ 17″, distance 6,429.3 meters.
To△Hurst, azimuth 185° 28′ 40″, distance 3,826.8 meters.
To△Vieux village, azimuth 265° 37′ 19″, distance 2,605.4 meters.
To△Double flag (probably covered), azimuth 214° 03′ 14″, distance 1,757.6 meters.
Square stone post, with top marked "U. S.;" in cultivated field on hill about 2 miles below Ste. Genevieve, Mo.; about 900 meters west of large Indian mounds in Big Field; 122 meters west of main road at foot of bluffs and 245 meters south of prolongation of road to river; 73 meters west of edge of timber; 153 meters southwest of sinkhole. To 15-inch blazed pecan tree, 350° −8 meters.

⊡ $\frac{33}{1}$

Mississippi River Commission, 1889. (Chart No. 7.)
Latitude 37° 58′ 58″.81; meters +1,813, −37.
Longitude 89° 55′ 37″.61; meters +918, −547.
Elevation: Stone, 378.28; pipe, 383.38.
To⊡33/2, azimuth 346° 50′, distance 289 meters.

Flat stone and iron pipe, 675 meters above railway station at Reily Lake, Ill.; 75 meters west from the St. Louis, Iron Mountain and Southern Railway (Illinois Division); on the inside of fence around the field of J. Morrison and 400 meters east of southwest corner; on edge of timber and 600 meters from the left bank of Kaskaskia River. Two blazed honey-locust trees on south side of road are: south 23° east, and south 68° east, respectively. (Stone found, 1908; pipe missing.)

⊡ $\frac{33}{2}$

Mississippi River Commission, 1889. (Chart No. 7.
Latitude 37° 58′ 49″.69; meters +1,532, −318.
Longitude 89° 55′ 34″.99; meters +854, −611.
Elevation: 370.62.
To⊡33/1, azimuth 166° 50′, distance 289 meters.
Stone post, set in willows, about one-fourth mile west of Reily Lake, Ill.; on north bank of small creek and 195 meters southwest of "Iron Mountain" railway bridge over same; nearly opposite southeast corner of J. Morrison's field; at foot of dead 3-foot water-oak blazed and marked "U. S. B. M.", south 70° west; an 18-inch elm also marked "U. S. B. M.", south 25° east. (Not found, 1908; probably covered.)

Ⓓ 30 W.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 7.)
Latitude 37° 58′ 36″.28; meters +1,119, −731.
Longitude 89° 55′ 11″.91; meters +291, −1,174.
Elevation: 387.58.
To east edge of brick store front, azimuth 157° 37′.
To gable of house, azimuth 138° 09′.
To gable of house, azimuth 163° 16′.
To switchstand, azimuth 142° 31′.
Two-inch iron pipe, about 1 foot above surface of ground in Illinois bottom land; 344 meters below depot door at Reily Lake, Ill.; 3 meters east of center of main track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 108 meters above upper end of trestle No. 74; 15 meters below one switchstand and 85 meters above another; 37 meters below road crossing; and 80 meters below telegraph pole 54/5.

△ MONUMENT.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 7.)
Latitude 37° 58′ 01″.07; meters +33, −1,817.
Longitude 89° 54′ 31″.16; meters +761, −704.
Center of prominent shaft, in Kaskaskia Cemetery; on bluff above and about 600 meters north of Fort Gage, Ill.

Ⓚ KASKASKIA.

Mississippi River Commission, 1880–81. (Chart No. 7.)
Latitude 37° 57′ 49″.43; meters +1,524, −326.
Longitude 89° 54′ 26″.77; meters +653, −811.
To Ⓚ Vause, azimuth 52° 09′ 38″.42, distance 9,092.33 meters.
To Ⓚ Rozier, azimuth 3° 28′ 51″.37, distance 11,101.40 meters.
To △ Fairy, azimuth 86° 08′ 52″, distance 5,756.5 meters.
To △ Commons, azimuth 45° 34′ 01″, distance 1,869.7 meters.
To △ Commons No. 2, azimuth 21° 03′ 07″, distance 1,124.9 meters.
To △ New Kaskaskia, azimuth 8° 25′ 26″, distance 4,662.9 meters.
To ⊡33/4, azimuth 56° 20′, distance 1,268 meters.
Hole in center of stone post, near top of Illinois bluff at Fort Gage; on edge of old earthwork fortification; and about 4 feet east of oak picket fence. The footpath in rear of Lynn's store leads to the station.

⊡ $\frac{33}{4}$

Mississippi River Commission, 1889. (Chart No. 7.)
Latitude 37° 57′ 26″.60; meters +820, −1,030.
Longitude 89° 55′ 10″.02; meters +245, −1,220.
Elevation: Stone, 374.83; pipe, 379.93.
To Ⓚ Kaskaskia, azimuth 236° 20′, distance 1,268 meters.

Flat stone and iron pipe, on old Kaskaskia Commons; near the north end of Kaskaskia Island (now on right bank of river); and opposite Fort Gage, Ill.; 2½ miles north of the new town of Kaskaskia, Ill.; 140 meters east of a building; 180 meters north of a grove; about 330 meters back from river bank; and 120 meters west of road leading south from the old town of Kaskaskia. A blazed pecan tree stands southwest, 5 meters.

△ COMMONS NO. 2.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 7.)
Latitude 37° 57′ 15″.38; meters +474, —1,376.
Longitude 89° 54′ 43″.33; meters +1,058, —407.
To ◎ Kaskaskia, azimuth 201° 02′ 57″, distance 1,124.9 meters.
To △ Commons, azimuth 74° 26′ 38″, distance 966.4 meters.
Iron pipe, near head of Kaskaskia Island (now on right bank of river); nearly opposite first large ditch below Fort Gage, Ill.; about 65 meters from river bank.

△ COMMONS.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 7.)
Latitude 37° 57′ 06″.97; meters +215, —1,635.
Longitude 89° 55′ 21″.46; meters +524, —941.
To ◎ Kaskaskia, azimuth 225° 33′ 27″, distance 1,869.7 meters.
To △ Commons No. 2, azimuth 254° 26′ 14″, distance 966.4 meters.
Iron pipe, near head of Kaskaskia Island (now on right bank of river); 8 inches above surface of ground, in cultivated field; about 1,000 meters back from river and about 400 meters east of Old River; 95 feet southeast of a pecan tree, on edge of clump of small brush; 45 feet west of road with telephone line on east side; 140 feet north of telephone pole, standing northwest of locust tree blazed and marked with nails forming the letter "I."

⊡ $\frac{32}{2}$

Mississippi River Commission, 1889. (Chart No. 7.)
Latitude 37° 56′ 52″.93; meters +1,632, —218.
Longitude 89° 53′ 23″.66; meters +578, —887.
Elevation: Stone, 394.59; pipe, 399.68.
To 32/3, azimuth 50° 25′, distance 1,280 meters.
Flat stone and iron pipe, near foot of Illinois bluffs; 1¼ miles below Fort Gage, Ill.; between wagon road and Illinois Southern Railway; 75 meters southeast of wagon bridge; 80 meters southeast of the north corner of a field; 35 meters northeast of orchard; and 600 meters from the river bank.

⊡ $\frac{32}{3}$

Mississippi River Commission, 1889. (Chart No. 7.)
Latitude 37° 56′ 26″.59; meters +820, —1,030.
Longitude 89° 54′ 04″.09; meters +100, —1,365.
Elevation: 378.64.
To ⊡ 32/4, azimuth 50° 25′, distance 560 meters.
Stone post, on Kaskaskia Island (now on right bank of river); about 1½ miles below Fort Gage, Ill.; on the land of Mr. Delassus; and 130 meters back from river bank. To a blazed elm tree, azimuth 300° 50′, distance 20 meters; to a blazed locust tree, 221° 22′ —27 meters.

⊡ $\frac{32}{4}$

Mississippi River Commission, 1889. (Chart No. 7.)
Latitude 37° 56′ 14″.92; meters +460, —1,390.
Longitude 89° 54′ 21″.91; meters +535, —930.
Elevation: 382.68.
To ⊡ 32/3, azimuth 230° 25′, distance 560 meters.
Stone post, on Kaskaskia Island (now on right bank of river); about 1½ miles below Fort Gage, Ill.; on crest of ridge, land of Mr. Delassus; and 700 meters from the river; 120 meters east of road from old Kaskaskia to the foot of the island and 180 meters southeast of junction of roads; at foot of pecan tree blazed and marked "B. M."; blazed pecan trees stand northeast 36 meters, and another, west 39 meters, respectively.

△ NEW KASKASKIA.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 7.)
Latitude 37° 55′ 19″.83; meters +611, −1,239.
Longitude 89° 54′ 54″.74; meters +1,337, −129.
Center of cross and spire of the church at Kaskaskia, Ill. (new town); on Kaskaskia Island (now on right bank of river).

$$\triangle 56 = \boxdot \frac{31}{1}$$

Mississippi River Commission, 1888. (Chart No. 7.)
Latitude 37° 55′ 15″.94; meters +492, −1,358.
Longitude 89° 51′ 17″.54; meters +428, −1,037.
Elevation: 515.88.
To△45 1/2, azimuth 328° 44′, distance 3,000 meters.

To⊡31/2, azimuth 17° 03′, distance 32.5 meters.
Stone post, on southern slope of Illinois bluffs; about 1 mile above Southern Illinois Penitentiary; 125 meters east of road at foot of bluffs; 200 meters north from first wagon bridge above the penitentiary; outside a field, near south corner, and 25 meters from the fence.

$$\boxdot \frac{31}{2}$$

Mississippi River Commission, 1888. (Chart No. 7.)
Latitude 37° 55′ 14″.94; meters +460, −1,390.
Longitude 89° 51′ 17″.93; meters +438, −1,024.
Elevation: 477.47.
To$\triangle 56 = \boxdot \frac{31}{1}$, azimuth 197° 03′, distance 32.5 meters.
Cross mark, on solid rock below△56=⊡31/1; near 24-inch blazed oak.

△ CHURCH SPIRE (CHESTER, ILL.).

Mississippi River Commission, 1880–81. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 37° 54′ 55″.36; meters +1,707, −143.
Longitude 89° 49′ 21″.22; meters +518, −948.
The most prominent church spire in Chester, Ill.; in northeastern part of city; and about 1 mile from river.

◬ VAUSE.

Mississippi River Commission, 1880–81. (Chart No. 7.)
Latitude 37° 54′ 48″.43; meters +1,493, −357.
Longitude 89° 59′ 20″.73; meters +506, −960.
Elevation: 568.59, and 567.84. (See description.)
To◬Rozier, azimuth 310° 10′ 28″.69, distance 8,521.73 meters.
To◬Kaskaskia, azimuth 232° 06′ 37″.69, distance 9,092.33 meters.
To◬Chester, azimuth 274° 20′ 16″.62, distance 15,611.56 meters.
To◬Correll, azimuth 141° 56′ 44″.19, distance 13,223.07 meters.
To△Fairy, azimuth 195° 25′ 25″, distance 5,386.2 meters.
To△Church Spire, Chester, azimuth 269° 06′ 47″, distance 14,645.8 meters.
To△New Kaskaskia, azimuth 261° 30′ 04″, distance 6,568.7 meters.
Center of stone post, with top broken off, on high bluff in Missouri; 300 meters back from old river; 3 miles above St. Marys, Mo.; one-half mile below River Aux Vases; and about 1 mile above Saline Creek. First elevation is top of stone; the second is a shoulder cut on downstream side of stone and about 0.3 feet below ground.

△ IRON PIPE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 7.)
Latitude 37° 54′ 14″.32; meters +441, −1,409.
Longitude 89° 50′ 53″.55; meters +1,308, −158.
Iron pipe, on Horse Island, on right bank of river; nearly opposite Southern Illinois Penitentiary; about 1,400 feet below head of revetment; in front of negro cabins; and 10 feet downstream from railroad spike driven in blazed 30-inch sycamore tree.

△ SIMPSON 121.

United States engineer office, St. Louis, Mo., 1880; stadia determination by Board on Examination and Survey of Mississippi River, 1908. (Chart No. 7.)
Latitude 37° 54′ 19″.82; meters +611, −1,239.
Longitude 89° 58′ 47″.76; meters +1,167, −299.
One-inch hole in rock, in center of irregular elevation on Missouri bluffs; above old quarry and about 3 miles above St. Marys, Mo.; about 450 meters above Saline Creek; 5.2 feet from outer corner of rock; 20 feet north of and slightly back from an oblong bowlder 4 by 8 by 3 feet, lying on edge of bluff; and 6.5 feet below a rail fence. Blazed trees: 5-inch red oak, 7 feet back; 10-inch white oak, 17 feet back and slightly downstream; 10-inch red oak, 30 feet back and upstream; clump of three small cedars 6 feet directly in front.

◎ CHESTER.

Mississippi River Commission, 1880–81. (Chart No. 7.)
Latitude 37° 54′ 09″.65; meters +298, −1,552.
Longitude 89° 48′ 43″.55; meters +1,064, −402.
To◎Vause, azimuth 94° 26′ 48″.10, distance 15,611.56 meters.
To◎Killion, azimuth 350° 29′ 03″ .03, distance 11,219.89 meters.
To◎Rozier, azimuth 64° 37′ 19″.35, distance 10,031.77 meters.
To△Church Spire, Chester, Ill., azimuth 146° 51′ 10″, distance 1,683.1 meters.
Center of hole in top of stone marking-post, on highest point of Illinois bluffs about one-half mile below Chester, Ill.; and about one-half mile back of Cole's Mill; in cultivated field on Widow Cole's property; and downstream from angle in road leading from the eastern part of Chester down the bluffs to Cole's Mill.

△ FLAG 27.

Mississippi River Commission, 1880–81. (Chart No. 7, station not plotted.)
Latitude 37° 53′ 55″.92; meters +1,724, −126.
Longitude 89° 52′ 51″.44; meters +1,257, −209.
To◎Rozier, azimuth 37° 44′ 48″, distance 4,907.9 meters.
To◎Chester, azimuth 265° 58′ 54″, distance 6,071.0 meters.
Stone post, on south side of Kaskaskia Island (now on right bank of river); opposite foot of Cousin Wills Island; about 200 meters back from old river bank; near road leading to Dozaville; and 4.7 feet from 2-foot cottonwood tree.

△ 45½

Mississippi River Commission, 1880–81; redetermined, United States engineer office, St. Louis, Mo., 1893. (Chart No. 7.)
Latitude 37° 53′ 52″.79; meters +1,628, −222.
Longitude 89° 50′ 13″.75; meters +336, −1,130.
Elevation: 378.01.
To△56=⊡31/1, azimuth 148° 44′ 19″, distance 3,000 meters.
To I. O. O. F. hall, azimuth 230° 28′ 54″, distance 1,032 meters.
To Presbyterian Church spire, Chester, Ill., azimuth 256° 56′ 39″, distance 1,059 meters.
Stone post near the foot of Horse Island, on right bank of river; on well-defined ridge 180 meters from river and 230 meters from foot of island.

△ SIMPSON 125.

United States engineer office, St. Louis, Mo., 1880; redetermined, Board on Examination and Survey of Mississippi River, 1908. (Chart No. 7.)
Latitude 37° 53′ 16″.75; meters +517, −1,334.
Longitude 89° 57′ 37″.50; meters +916, −550.
Elevation: 370.95.
Iron pin, cemented in flat detached rock on Missouri shore; 21 feet above low water; 375 feet north from north corner of Mr. Rozier's barn; 500 feet upstream from first railroad trestle above St. Marys, Mo.; and 52.75 feet out from blazed 1-foot sycamore tree. "U. S. 125" is cut in outer edge of rock 4 feet from station. (On Board on Examination and Survey of Mississippi River chart station is erroneously marked "Simpson 123".)

△ FLAG 28.

Mississippi River Commission, 1880-81. (Chart No. 7, station not plotted.)
Latitude 37° 53′ 16″.35; meters +504, −1,346.
Longitude 89° 52′ 06″.85; meters +167, −1,299.
To ⑤ Rozier, azimuth 56° 59′ 13″, distance 4,882.7 meters.
To ⑤ Chester, azimuth 251° 40′ 40″, distance 5,231.9 meters.
Stone post, in Missouri; on right bank of Old River; about 1 mile above head of Horse Island; under 29-inch cottonwood tree in edge of woods and about 10 feet west of fence corner on land owned by Frank Smith; about 180 meters southeast of high bank of river and about 150 meters southeast of a house. A wooden triangle was nailed on the cottonwood tree and three deep notches were cut in tree under triangle.

⊡ $\frac{30}{2}$

Mississippi River Commission, 1888; redetermined, United States engineer office, St. Louis, Mo., 1893. (Chart No. 7.)
Latitude 37° 53′ 05″.15; meters +159, −1,691.
Longitude 89° 47′ 51″.70; meters +1,263, −203.
Elevation: 399.40.
To △ Flag 29 1/2, azimuth 44° 24′ 31″, distance 1,420.3 meters.
To ⊡ 30/3, azimuth 39° 02′, distance 1,977 meters.
Stone post, in Illinois and about 1,250 meters upstream from the mouth of Marys River; 73 meters from river bank; and 30 meters back from the Wabash, Chester and Western Railroad. There is a stone culvert 2 by 2.5 feet under railroad directly in front of stone.

△ FLAG 29.

Mississippi River Commission, 1880-81. (Chart No. 7.)
Latitude 37° 52′ 53″.29; meters +1,643, −207.
Longitude 89° 49′ 07″.12; meters +174, −1,293.
Elevation: 376.85. (377.00, 1900, Skelly.)
To △ Rozier, azimuth 77° 05′, distance 8,707.6 meters.
T ⊡ 30/3, azimuth 333° 00′, distance 1,315 meters.
Stone post, on right bank; three-quarters of a mile below Claryville, Mo.; about 200 meters below a house; 120 meters north of building on west side of road; about 240 meters from river and 75 meters west of a fence on west side of lane running toward the river; on land of Charles Cole; immediately back of a fence and under a large sycamore tree. (Elevation 377.52 on chart is erroneous.)

⊙ P. B. M. 35.

Mississippi River Commission, 1880. (Chart No. 7.)
Latitude 37° 52′ 45″.90; meters +1,415, −435.
Longitude 89° 56′ 58″.51; meters +1,430, −37.
Elevation: 395.87.
Center of copper bolt, leaded horizontally in west end of water table in southwest corner of storehouse belonging to E. S. Lanbaugh, on northeast corner of Second and Walnut streets, St. Marys, Mo. The bolt is set back about 5 millimeters in the stone and the letters "U. S. P. B. M." are cut near the bolt.

⊙ P. B. M. 36.

Mississippi River Commission, 1880. (Chart No. 7.)
Latitude 37° 52′ 45″.02; meters +1,388, −462.
Longitude 89° 56′ 59″.34; meters +1,450, −17.
Elevation: 402.81.
Center of copper bolt, leaded horizontally in southwest corner of Martin Roundstone's ice house on east side of Walnut street, St. Marys, Mo. The letters "U. S. P. B. M." are cut near the bolt, which is in the fifth course of stone from the bottom.

△ FLAG 29½

Mississippi River Commission, 1880-81. (Chart No. 7.)
Latitude 37° 52′ 32″.17; meters +992, −858.
Longitude 89° 48′ 32″.36; meters +791, −676.
Elevation: 377.74.

To ⊡30/2, azimuth 224° 24′ 06″, distance 1,420.3 meters.
To ⊡30/3, azimuth 25° 54′, distance 579 meters.
To ⊡B. M. Copper Bolt, = △ Simpson 182, azimuth 271° 11′, distance 3,382 meters.
Stone post, marked "U. S.," on right bank 1½ miles below Claryville, Mo.; about 100 meters from river bank; 400 meters below Blocks Landing, Mo.; and 1,700 meters above head of Crains Island.

⊡ $\frac{30}{3}$

Mississippi River Commission, 1888. (Chart No. 7.)
Latitude 37° 52′ 15″.28; meters +471, −1,379.
Longitude 89° 48′ 42″.71; meters +1,044, −423.
Elevation: 377.63.
To △ Flag 29, azimuth 153° 00′, distance 1,315 meters.
To △ Flag 29 1/2, azimuth 205° 54′, distance 579 meters.
To ⊡30/2, azimuth 219° 02′, distance 1,977 meters.
To ⊡30/4, azimuth 39° 03′, distance 363 meters.
Stone post, in Missouri and about 1,700 meters upstream from head of Crain Island; about 650 meters from right bank of river; on the west side of public road; east of rail fence and 25 meters north of wire fence.

⊡ $\frac{30}{4}$

Mississippi River Commission, 1888. (Chart No. 7.)
Latitude 37° 52′ 06″.14; meters +189, −1,661.
Longitude 89° 48′ 52″.06; meters +1,273, −194.
Elevation: Stone, 372.34; pipe, 377.42.
To ⊡30/3, azimuth 219° 03′, distance 363 meters.
Flat stone and iron pipe, on right bank; 1⅞ miles below Claryville, Mo.; and 970 meters from the river; 30 meters west of a hedge; 350 meters west of a public road; and 160 meters from a fence corner at edge of timber.

⊛ ROZIER.

Mississippi River Commission, 1880-81. (Chart No. 7.)
Latitude 37° 51′ 50″.03; meters +1,542, −308.
Longitude 89° 54′ 54″.35; meters +1,329, −138.
To ⊛ Vause, azimuth 130° 13′ 12″.29, distance 8,521.73 meters.
To ⊛ Killion, azimuth 301° 43′ 20″.60, distance 12,845.01 meters.
To ⊛ Chester, azimuth 244° 33′ 31″.66, distance 10,031.77 meters.
To ⊛ Kaskaskia, azimuth 183° 28′ 34″.43, distance 11,101.40 meters.
To △ Church Spire, Chester, Ill., azimuth 234° 54′ 20″, distance 9,945.2 meters.
Center of hole in top of stone marking post (shattered), on highest point of first prominent bluff below and about 2 miles from St. Marys, Mo. A path up the bluff to the station leaves the "Frisco" railroad at a point 390 meters above Perryville Junction, Mo.

⊡ B. M. COPPER BOLT = △ SIMPSON 182.

Mississippi River Commission, 1889; redetermined, United States engineer office, St. Louis, Mo., 1893. (Chart No. 8.)
Latitude 37° 52′ 29″.92; meters +922, −928.
Longitude 89° 46′ 14″.02; meters +343, −1,124.
Elevation: 354.66 (head of arrow).
To △ Flag 29 1/2, azimuth 91° 13′, distance 3,382 meters.
To △ Simpson 184, azimuth 311° 31′ 55″, distance 760.1 meters.
Bolt leaded in rock ledge, on Illinois shore (low water); 300 meters below Crains Creek; and 1,350 meters below Marys River. Bolt was gone in 1908, and ledge was marked with an arrow.

△ SIMPSON 184.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1893. (Chart No. 8.)
Latitude 37° 52′ 13″.57; meters +418, −1,432.
Longitude 89° 45′ 50″.74; meters +1,240, −227.
To △ Simpson 182, azimuth 131° 32′ 09″, distance 760.1 meters.

Hole with number "184" roughly cut, in large stone standing on edge, 20 feet from edge of high bank in Illinois; on second stony point below and 1½ miles from Marys River; 88 feet south of a 3-foot blazed elm; and 46 feet west of 3-inch blazed locust tree.

△ KIRK '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 51′ 51″.89; meters +1,600, —250.
Longitude 89° 45′ 08″.60; meters +210, —1,257.
To△Waters '03, azimuth 339° 40′ 40″, distance 2,697.6 meters.
To◎Killion, azimuth 26° 31′ 44″, distance 7,620.3 meters.
Iron pipe, 6 inches above surface of ground, on front slope of Illinois bluffs; between railroad and highway; 950 feet above Kirks Landing; and 225 feet below large ravine. To a blazed 10-inch hickory tree, 200° —36.5 feet.

△ MANSKER '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 51′ 38″.09; meters +1,174, —676.
Longitude 89° 44′ 27″.34; meters +668, —798.
To◎Lower base, azimuth 342° 04′ 59″, distance 4,198.3 meters.
To◎Killion, azimuth 34° 37′ 16″, distance 7,767.3 meters.
To△Bishop '03, azimuth 332° 40′ 13″, distance 5,175.2 meters.
To△Waters '03, azimuth 1° 57′ 40″, distance 2,105.4 meters.
Hole drilled in rock and surrounded by triangle, on prominent point of Illinois bluffs; directly back of Mansker's house; opposite foot of Crains Island; on right bank about midway between mouth of Marys River and Rockwood, Ill.; 175 meters below railroad trestle.

$\boxed{\frac{29}{2}}$

Mississippi River Commission, 1888; redetermined, United States engineer office, St. Louis, Mo., 1893 and 1903. (Chart No. 8.)
Latitude 37° 51′ 33″.15; meters +1,022, —828.
Longitude 89° 44′ 28″.35; meters +693, —774.
Elevation: 407.41. (Levels of 1908, 407.77.)
To◎Lower base, azimuth 341° 05′ 23″, distance 4,061.5 meters.
To◎Killion, azimuth 35° 07′ 07″, distance 7,628.1 meters.
To△Waters '03, azimuth 1° 23′ 18″, distance 1,952.4 meters.
To⊡29/3, azimuth 33° 17′ 29″, distance 1,944.7 meters (1893).
Stone post, 12 inches above surface of ground, in pasture, on front slope of Illinois bluffs; 3 miles above Rockwood, Ill.; 400 feet below Mansker's house, and about 60 feet back from wagon road.

△ HEINEMANN HOUSE.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8; station not plotted.)
Laititude 37° 50′ 44″.15; meters +1,361, —489.
Longitude 89° 42′ 30″.42; meters +744, —723.
Finial on cupola of prominent white house on Illinois bluffs one-half mile above Rockwood, Ill.

△ WATERS '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 50′ 29″.84; meters +920,—930.
Longitude 89° 44′ 30″.29; meters +741,—726.
Elevation: 377.67.
To◎Lower base, azimuth 324° 11′ 49″, distance 2,330.9 meters.
To◎Killion, azimuth 45° 21′ 11″, distance 6,100.5 meters.
To△Bois Brule '03, azimuth 326° 40′ 40″, distance 1,166.4 meters.
To△Kirk '03, azimuth 159° 41′ 08″, distance 2,697.6 meters.
To△Mansker '03, azimuth 181° 57′ 38″, distance 2,105.4 meters.
To⊡29/2, azimuth 181° 23′ 17″, distance 1,952.4 meters.
Iron pipe, 3 inches above surface of ground at Waters Landing, Mo.; nearly opposite the head of Liberty Island (on left bank); 81 feet below warehouse, on west side of road; outside of rail fence; 40 feet from top of bank (1903); 362 feet below end of hurdle and 326 feet below prominent cottonwood tree.

⊡ $\frac{28}{1}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 50′ 04″.61; meters +142, —1,708.
Longitude 89° 41′ 20″.11; meters +492, —975.
Elevation: Stone, 386.29; pipe, 391.38.
To⊡28/2, azimuth 44° 56′, distance 1,155 meters.
Flat stone and iron pipe, at foot of Illinois bluffs; back of Liberty Island; 250 meters below a ravine near lower end of Rockwood, Ill.; 1,180 meters below the post-office; on river side of Grand Tower and Chester road; and in fence corner, inside a small, narrow field.

△ FLAG 31.

Mississippi River Commission, 1880–81. (Chart No. 8, station not plotted.)
Latitude 37° 50′ 04″.48; meters +138,—1,712.
Longitude 89° 42′ 54″.76; meters +1,339,—128.
To◎Rozier, azimuth 100° 32′ 30″, distance 17,891.2 meters.
To◎Killion, azimuth 62° 19′ 33″, distance 7,543.7 meters.
To◎Chester, azimuth 131° 36′ 00″, distance 11,390.8 meters.
Stone post, on western side of and about 1 mile below head of Liberty Island; about 170 meters back from high bank; 20 meters back from large growth of cottonwood and sycamore; and 2 feet 10 inches northeast of a 32-inch sycamore tree.

△ BOIS BRULE '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 49′ 58″.23; meters +1,795, —55.
Longitude 89° 44′ 04″.08; meters +100, —1,368.
Elevation: 374.24.
To◎Lower base, azimuth 321° 43′ 16″, distance 1,166.7 meters.
To△Waters '03, azimuth 146° 40′ 56″, distance 1,166.4 meters.
Iron pipe, 3 inches above surface of ground, on land of Meredith at Anchor Landing, Mo., formerly Bois Brule post-office. Station is on fence row back of upper warehouse; 47.4 feet back of line of west end of store building; and 212 feet from top of bank. To northwest corner of store, 295° 40′ —188.8 feet; blazed trees; 24-inch pecan, 21° 20′ —177 feet; 23-inch pecan 147° 20′ —402 feet; 6-inch peach (not blazed) 120° 15′ —23 feet.

⊡ $\frac{28}{2}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 49′ 38″.08; meters +1,174, —676.
Longitude 89° 41′ 53″.48; meters +1,308, —160.
Elevation: 368.27.
To⊡28/1, azimuth 224° 56′, distance 1,155 meters.
To⊡28/3, azimuth 44° 35′, distance 2,388 meters.
Stone post, near middle of Liberty Island, on left bank; about 620 meters from river and nearly opposite Bishop Landing, Mo.; close to a north-and-south fence and in timber; on the De Holland place; 140 meters south of a bend in fence and about 30 meters from edge of timber.

◎ LOWER BASE.

Mississippi River Commission, 1880–81. (Chart No. 8.)
Latitude 37° 49′ 28″.52; meters +879, —971.
Longitude 89° 43′ 34″.53; meters +845, —623.
Elevation: Copper rivet in stone, 373.73; pipe, 376.65 (1908, pipe, 376.75).
To◎Killion, azimuth 67° 12′ 55″.46, distance 6,187.72 meters.
To△Bois Brule '03, azimuth 141° 43′ 34″, distance 1,166.7 meters.
To△Waters '03, azimuth 144° 12′ 23″, distance 2,330.9 meters.
To△Mansker '03, azimuth 162° 05′ 32″, distance 4,198.3 meters.
To△Bishop '03, azimuth 299° 04′ 43″, distance 1,240.7 meters.
To⊡29/2, azimuth 161° 05′ 50″, distance 4,061.5 meters.
To△Heinemann House, azimuth 213° 54′ 33″, distance 2,809.6 meters.
Stone and pipe, in Missouri; three-quarters of a mile above Bishop Landing; 385 feet from high bank, at top of slope, on land of Barney Huber; between fourth and fifth hurdles above Bishop Landing, 900 feet and 456 feet from their respective shore

ends. References: Stone chimney, Mansker house, 161° 10′; north gable of Vessells's house, 295° 37′; north gable of schoolhouse 352° 07′; south gable Huber's house, 107° 10′; 3½-foot sycamore tree, northwest corner of field, 148° 12′; walnut stump on same ridge, back of station, 78° 42′ —227 feet. Blazed trees: 32-inch pecan, 274° 48′ —356 feet; 38-inch elm, 282° 11′ —585 feet; 6½-foot sycamore, 3° 58′ —965 feet. Geodetic point is cross on copper rivet leaded in stone marking post set 2 feet under ground; surface mark is center of cap on iron pipe 14 inches above surface.

◎ O'HARRAH.

Mississippi River Commission, 1880-81. (Chart No. 8.)
Latitude 37° 49′ 21″.42; meters +660, —1,190.
Longitude 89° 38′ 41″.57; meters +1,017, —451.
To◎ Backbone, azimuth 11° 45′ 58″.62, distance 8,587.07 meters.
To◎ Killion, azimuth 80° 25′ 59″.04, distance 13,053.34 meters.
To◎ Worthen, azimuth 290° 56′ 02″.60, distance 16,180.86 meters.
To◎ Fountain Bluff, azimuth 318° 15′ 20″, distance 19,186.2 meters.
To△ Flag 37, azimuth 329° 39′ 18″, distance 15,568.5 meters.
To△ Levee '99, azimuth 46° 01′ 17″, distance 2,762.2 meters.
To△ Illinois, azimuth 44° 25′ 11″, distance 2,809 meters.
To△ Seventy-six, azimuth 347° 02′ 28″, distance 11,667.8 meters.
To△ Pinnacle, azimuth 347° 17′ 45″, distance 11,647 meters.
To⊕ 51 H, azimuth 342° 16′, distance 1,502 meters.

Stone post, near top of narrow, high ridge on Illinois bluffs; on second prominent peak below Cora City, Ill.; on land of O'Harrah. To reach station from the river: Take road from Hamilton Landing, about one-half mile below Liberty Island, to Cora City; thence go down road beyond frame church to first house and well on east side of road then go up bluff to top of narrow ridge.

△ BISHOP '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 49′ 08″.96; meters +276, —1,574.
Longtiude 89° 42′ 50″.20; meters +1,228, —240.
Elevation: 375.12.
To◎ Lower Base, azimuth 119° 05′ 10″, distance 1,240.7 meters.
To△ Mansker '03, azimuth 152° 41′ 12″, distance 5,175.2 meters.
To△ Heinemann House, azimuth 189° 21′ 17″, distance 2,974.2 meters.

Iron pipe, set flush with surface of ground, on upstream side of revetted point at Bishop Landing, Mo. References: U. S. light, 260° —11.5 feet; lone sycamore tree, 20° —12.2 feet. (Elevation on chart is incorrect.)

⊕ 52 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 8.)
Latitude 37° 48′ 54″.23; meters +1,672, —178.
Longitude 89° 39′ 01″.69; meters,+41, —1,427.
Elevation: 375.43.
To⊕ 51 H, azimuth 301° 47′, distance 1,117 meters.

Two-inch iron pipe, in Illinois bottomland; directly back of Hamilton Landing; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1,100 feet below first road crossing below Cora City, and 60 feet above milepost 73.

⊡ $\frac{28}{3}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 48′ 42″.92; meters +1,323, —527.
Longitude 89° 43′ 02″.00; meters +49, —1,419.
Elevation: 375.72.
To⊡ 28/4, azimuth 44° 29′, distance 1,040 meters.
To⊡ 28/2, azimuth 224° 35′, distance 2,388 meters.

Stone post, in cultivated field; 850 meters back and southwest from Bishop Landing, Mo.; about 150 meters west of church, and about 125 meters south of a wagon road.

⊙ 51 H.

Board of Examination and Survey of Mississippi River, 1908. (Chart No. 8.)
Latitude 37° 48′ 35″.03; meters +1,080, −770.
Longitude 89° 38′ 22″.87; meters +560, −908.
Elevation: 374.43.
To◎O'Harrah, azimuth 162° 16′, distance 1,502 meters.
To⊙50 H, azimuth 308° 15′, distance 1,784 meters.
Two-inch iron pipe, in Illinois bottomland; 2 miles below Cora City, Ill.; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); near point of intersection of tangents of first curve below Cora City.

△ LEVEE '99

United States engineer office, St. Louis, Mo., 1899. (Chart No. 8.)
Latitude 37° 48′ 19″.20; meters +592, −1,258.
Longitude 89° 40′ 02″.82; meters +69, −1,399.
To◎Backbone, azimuth 357° 53′ 52″, distance 6,492.9 meters.
To◎O'Harrah, azimuth 226° 00′ 27″, distance 2,762.2 meters.
Iron pipe, on Illinois shore; on a small levee between road and river, and about 2 feet higher than road; 4 feet from edge of high bank; 331 feet north of piling at upper end of Liberty Bend revetment; 81 feet north of blazed cottonwood tree, and 38 feet west of road.

⊡ $\frac{28}{4}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 48′ 18″.86; meters +581, −1,269.
Longitude 89° 43′ 31″.79; meters +778, −690.
Elevation: Stone, 370.93; pipe, 376.03.
To⊡28/3, azimuth 224° 29′, distance 1,040 meters.
Flat stone and iron pipe, in cultivated field; 1,800 meters back of Bishop Landing, Mo. References: To upper one of two buildings 118° 30′ −385 meters; and to lower one of two buildings 50° 30′ −275 meters. The four buildings stand on western side of road running back from landing past the station and down the river.

△ ILLINOIS.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 8.)
Latitude 37° 48′ 16″.34; meters +504, −1,346.
Longitude 89° 40′ 01″.93; meters +47, −1,421.
Elevation: 372.30.
To◎Backbone, azimuth 358° 03′ 45″, distance 6,403.9 meters.
To◎O'Harrah, azimuth 224° 24′ 22″, distance 2,809 meters.
Iron pipe (set 1903) on levee, 3 feet high, on Illinois shore; between the river and the wagon road from Hamilton Landing to Wagner Landing; five-eighths of a mile below foot of Liberty Island; 41 feet from high bank; and 38 feet above upper end of bank protection marked by six clumps of piles.

◎ KILLION.

Mississippi River Commission, 1880–81. (Chart No. 8.)
Latitude 37° 48′ 10″.73; meters +331, −1,519.
Longitude 89° 47′ 27″.73; meters +678, −790.
To◎Lower Base, azimuth 247° 10′ 32″.49, distance 6,187.72 meters.
To◎Backbone, azimuth 299° 11′ 48″.38, distance 12,750.39 meters.
To◎Chester, azimuth 170° 29′ 49″.56, distance 11,219.89 meters.
To◎O'Harrah, azimuth 260° 20′ 36″.46, distance 13,053.34 meters.
To◎Rozier, azimuth 121° 47′ 54″.55, distance 12,845.01 meters.
To△Kirk '03, azimuth 206° 30′ 18″, distance 7,620.3 meters.
To△Mansker '03, azimuth 214° 35′ 26″, distance 7,767.3 meters.
To△Waters '03, azimuth 225° 19′ 22″, distance 6,100.5 meters.
To△Flag 31, azimuth 242° 16′ 46″, distance 7,543.7 meters.
To⊡29/2, azimuth 215° 05′ 17″, distance 7,628.1 meters.

Stone post, on high bluff in Missouri; back of Belgique village on land of Thomas Heiss. To reach station from the river, take the road from Belgique to the bluffs, crossing under railway before reaching Widow Burn's place; follow the first road to the left along the foot of the bluffs about 1 mile nearly to F. Mattingley's house; then cross small ravine and ascend bluff. Blazed trees with spike in center of blaze: 18-inch red oak, 285° —29.56 feet; 8-inch black oak, 75° —9.22 feet; 12-inch post oak, 55° —31.45 feet.

⊕ 50 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 8.)
Latitude 37° 47′ 59″.29; meters +1,828, —22.
Longitude 89° 37′ 25″.58; meters +626, —842.
Elevation: 383.82.
To⊕49 H, azimuth 307° 42′, distance 2,217 meters.
Two-inch iron pipe, in Illinois bottomland; 1⅞ miles above Raddle station; 35 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); opposite center of cut and on highest point of waste bank; near right-of-way fence and 15 feet below private road crossing to house.

△ WAGNER '03.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 8.)
Latitude 37° 47′ 36″.67; meters +1,131, —719.
Longitude 89° 39′ 38″.89; meters +952, —516.
Elevation: 373.49.
Iron pipe, 6 inches above surface of ground, on Illinois bank; 805 feet below warehouse at Wagner Landing; on a prominent point in pasture, immediately above a large drainage ditch, and about 20 feet from top of bank. Station was established on azimuth 271° 20′, distance 15.86 feet from △Wagner '99 (oak stake).

⊡ $\frac{27}{3}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 47′ 13″.09; meters +404, —1,446.
Longitude 89° 41′ 03″.30; meters +81, —1,387.
Elevation: 371.08.
To⊡27/4, azimuth 89° 56′, distance 864 meters.
Stone post, near Jones Point, Mo., and back of Liberty Bar; 180 meters below lane between property of Barney Hoover and William P. Faherty; on east side of fence at road; 225 meters back of high bank and 190 meters south of right angle in road at Jones Point.

⊡ $\frac{27}{4}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 47′ 13″.06; meters +403, —1,447.
Longitude 89° 41′ 38″.61; meters +945, —523.
Elevation: Stone, 372.02; pipe, 377.11.
To⊡27/3, azimuth 269° 56′, distance 864 meters.
Flat stone and iron pipe, in Missouri bottom land; 1¾ miles northeast of Menfro, Mo.; in cultivated field of William P. Faherty; 850 meters back of Jones Point; 270 meters southeast of angle in road; 350 meters westwardly from three buildings; and 40 meters east of old slough in timber.

⊡ $\frac{27}{1}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 47′ 12″.66; meters +390, —1,460.
Longitude 89° 39′ 06″.58; meters +161, —1,307.
Elevation: Stone, 365.06; pipe, 370.15.
Flat stone and iron pipe, 2 feet above surface of ground, in Illinois bottom land; 2¼ miles above McLeans Point; just 2 meters east of fence, on east side of county road; on land of John Tudor; 75 meters south of house; 50 meters south of 5-foot elm tree in road; 670 meters north from where line between townships 8 and 9 crosses the Wilkinson-Wagners Landing road; on east bank of old slough, near its upper end.

△ STONE LINE NO. 2.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 8.)
Latitude 37° 47′ 12″.92; meters +398, −1,452.
Longitude 89° 39′ 26″.40; meters +646, −822.
Elevation: 373.24.
Iron pipe, 6 inches above surface of ground, on Illinois shore; 30 feet from high bank; 1,935 feet below warehouse at Whites Landing; 500 feet west of tall dead blazed tree; 2,400 feet below mouth of large drainage ditch.

⊙ P. B. M. 42.

Mississippi River Commission, 1880. (Chart No. 8.)
Latitude 37° 45′ 09″.74; meters +300, −1,550 (scaled from chart).
Longitude 89° 40′ 46″.73; meters +1,144, −315 (scaled from chart).
Elevation: 378.69.
Center of copper bolt, set horizontally in vertical face of natural rock at upper extremity of Missouri bluff, about 640 meters below Grand Eddy, Mo. It is about 14 meters below extreme upper point of the bluff rocks and the letters "U. S. P. B. M." are cut in the rock near the bolt.

⊡ $\frac{26}{1}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 45′ 41″.04; meters +1,265, −585.
Longitude 89° 39′ 12″.02; meters +294, −1,165.
Elevation: Stone, 364.21; pipe, 369.30.
To⊡26/2, azimuth 31° 56′, distance 910 meters.
Flat stone and iron pipe, in Illinois bottom land; at back edge of field owned by William Wilkinson; 1 meter from east-and-west fence; 20 meters from house near head of Wilkinson Island; 600 meters south and 150 meters east of Pleasant Grove schoolhouse at the southwest corner of section 3, township 9 south, range 5 west; 1,400 meters back of McLeans Point; and 160 meters south of and near the upper end of narrow slough.

△ BRICK HOUSE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 8, station not plotted.)
Latitude 37° 45′ 19″.78; meters +610, −1,240.
Longitude 89° 41′ 09″.74; meters +238, −1,231.
Chimney, in north gable of brick house on bluffs at Grand Eddy, Mo.

⊡ $\frac{26}{2}$

Mississippi River Commission, 1888. (Chart No. 8.)
Latitude 37° 45′ 16″.01; meters +494, −1,356.
Longitude 89° 39′ 31″.68; meters +776, −693.
Elevation: 366.38.
To⊡26/1, azimuth 211° 56′, distance 910 meters.
Stone post, in Illinois, and near head of old Wilkinson Island; 450 meters from left bank of river; one-half mile northeast of Red Rock Landing, Mo.; in cultivated field on first ridge from river; 300 meters west from road and board fence around large field of William Wilkinson; and 350 meters north of a levee. (Not found in 1908.)

△ SIMPSON 209.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1893. (Chart No. 8, station not plotted.)
Latitude 37° 45′ 07″.87; meters +243, −1,607.
Longitude 89° 40′ 36″.95; meters +905, −564.
To△Simpson 211, azimuth 292° 01′ 01″, distance 1,060.7 meters.
Hole in rock, about 10 feet above low water; 260 meters below upper end of the first bluff below Grand Eddy, Mo. (Covered in 1908.)

△ FLAG 34.

Mississippi River Commission, 1880–81. (Chart No. 8.)
Latitude 37° 45′ 02″.55; meters +79, —1,771.
Longitude 89° 38′ 54″.83; meters +1,342, —127.
Elevation: 369.37.
To ⊗ Backbone, azimuth 73° 23′ 39″, distance 1,488.4 meters.
To ⊗ Fountain Bluff, azimuth 295° 48′ 13″, distance 14,550.1 meters.
Stone post on left bank, 1,200 meters above upper Wilkinson Landing, Ill.; 6 meters inside of fence at road; between houses belonging to Wilkinson and 15 meters below the one occupied by H. C. Henning; and about 25 meters from edge of old river bank (200 meters from present bank) at foot of cottonwood bar opposite Devils Backbone.

△ SIMPSON 211.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1893. (Chart No. 8.)
Latitude 37° 44′ 54″.98; meters +1,695, —155.
Longitude 89° 39′ 56″.78; meters +1,390, —79.
To △ Simpson 209, azimuth 112° 01′ 26″, distance 1,060.7 meters.
Hole in rock, on Missouri shore; at upstream end of Devils Backbone; about 12 feet above low water; and 340 meters below Red Rock Landing, Mo.

⊗ BACKBONE =
⊡ $\frac{20}{4}$

Mississippi River Commission, 1880–81. (Chart No. 8.)
Latitude 37° 44′ 48″.74; meters +1,503, —347.
Longitude 89° 39′ 53″.09; meters +1,300, —169.
Elevation: 568.13.
To ⊗ O'Harrah, azimuth 191° 45′ 14″.79, distance 8,587.07 meters.
To ⊗ Fountain Bluff, azimuth 292° 07′ 23″.96, distance 15,681.23 meters.
To ⊗ Worthen, azimuth 261° 08′ 21″.34, distance 17,066.99 meters.
To ⊗ Killion, azimuth 119° 16′ 26″.87, distance 12,750.39 meters.
To △ Illinois, azimuth 178° 03′ 51″, distance 6,403.9 meters.
To △ Levee '99, azimuth 177° 53′ 58″, distance 6,492.9 meters.
To △ Flag 38, azimuth 289° 09′ 49″, distance 10,511.2 meters.
To △ Flag 37, azimuth 297° 35′ 41″, distance 10,852 meters.
To △ Flag 34, azimuth 253° 23′ 04″, distance 1,488.4 meters.
Stone post, on top of hill in Missouri; directly back of rock ledge known as Devils Backbone; three-eighths of a mile below Red Rock, Mo. Stone stands on river side of an oak tree, the top of which was sawed off.

⊕ 49 II.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 47′ 15″.29; meters +471, —1,379.
Longitude 89° 36′ 13″.87; meters +339, —1,129.
Elevation: 373.55.
To ⊕ 48 II, azimuth 307° 46′, distance 2,358 meters.
Two-inch iron pipe, in Illinois bottom land; three-quarters mile above Raddle railroad station; 9.5 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 30 feet south of a road crossing; 900 feet below milepost 76; 550 feet below bridge No. 111.

⊗ WORTHEN.

Mississippi River Commission, 1880–81. (Chart No. 9.)
Latitude 37° 46′ 13″.45; meters +415, —1,435.
Longitude 89° 28′ 24″.07; meters +589, —880.
To ⊗ Fountain Bluff, azimuth 15° 25′ 42″.99, distance 8,848.50 meters.
To ⊗ Backbone, azimuth 81° 15′ 23″.25, distance 17,066.99 meters.
To ⊗ O'Harrah, azimuth 111° 02′ 21″.04, distance 16,180.86 meters.
To ⊗ Swallow Rock, azimuth 325° 27′ 30″.14, distance 10,560.46 meters.
To △ Flag 37, azimuth 43° 32′ 23″, distance 10,541 meters.
To ⊕ 44 II, azimuth 44° 33′, distance 5,600 meters.
To ⊕ 46 II, azimuth 72° 47′, distance 6,770 meters.

Center of stone post (top broken off) on a high point of Illinois bluffs about 1¾ miles above point where bluffs turn back forming upper boundary of Big Muddy River bottom; about 3½ miles above Sand Ridge, Ill., on the Illinois Central Railroad; 2 miles northwest of Grimsby on the St. Louis, Iron Mountain and Southern Railway (Illinois Division). A road turning up bluffs one-half mile above Kinkaid Bridge leads past the station about 1½ miles farther on. Land is owned by Worthen heirs and station is a few rods from line between their property and the railroad lands. In 1908 the station was found in a low chicken house, the last remnant of an old homestead in small clearing.

⊕ 48 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 46′ 28″.43; meters +877, −973.
Longitude 89° 34′ 57″.69; meters +1,412, −57.
Elevation: 373.92.
To⊕47 H, azimuth 308° 06′, distance 2,243 meters.
Two-inch iron pipe, in Illinois bottom land; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); one-half mile below Raddle station, and 350 feet above telegraph pole 77/20.

⊕ 47 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 45′ 43″.53; meters +1,342, −508.
Longitude 89° 33′ 45″.58; meters +1,116, −353.
Elevation: 372.37.
To⊕46 H, azimuth 307° 39′, distance 1,773 meters.
Two-inch iron pipe, in Illinois bottom land; between Jacob and Raddle, and 1⅞ miles from each; 15 feet north of mile post 79; and southwest of abandoned sawmill on Laith's spur.

⊕ JONES H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 45′ 32″.26; meters +995, −855.
Longitude 89° 26′ 32″.55; meters +797, −672.
Elevation: 549 (stadia).
To⊕Wye H, azimuth 38° 17′, distance 6,053 meters.
Two-inch iron pipe, on Illinois bluffs between Kinkaid Creek and Big Muddy River; on prolongation of tangent from Gorham to Grimsby, on Herrin Branch of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 18 feet south of black oak; 50 feet north of white oak; 10 feet west of fence; 20 feet from intersection of fences; west of orchard and 100 feet northwest of Jones's house.

⊕ 46 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 45′ 08″.39; meters +259, −1,591.
Longitude 89° 32′ 48″.25; meters +1,181, −288.
Elevation: 370.66.
To⊛Fountain Bluff, azimuth 327° 44′, distance 7,713 meters.
Two-inch iron pipe, in Illinois bottom land; seven-eighths mile above Jacob railroad station; 9.7 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Divison); 55 feet south of milepost 80; 270 feet north of beginning of timber on west side of track. A small clump of scrub timber is on flat ground directly east.

△ WILKINSON.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 9.)
Latitude 37° 44′ 55″.92; meters +1,724, −126.
Longitude 89° 38′ 21″.99; meters, +538, −931.
Elevation: 369.17.
To⊛Fountain Bluff, azimuth 296° 30′ 10″, distance 13,738.3 meters.
To△Seventy-six, azimuth 326° 08′ 40″, distance 3,835.8 meters.
Iron pipe, about 330 feet above Wilkinson Upper Landing, Ill., and 100 feet from high bank.

⊡ 25/I

Mississippi River Commission, 1888. (Chart No. 9.)
Latitude 37° 44′ 50″.72; meters +1,564, −286.
Longitude 89° 35′ 54″.90; meters +1,344, −125.
Elevation: Stone, 363.96; pipe, 369.05.
To⊡25/2, azimuth 38° 25′, distance 740 meters.
Flat stone and iron pipe, in cultivated field in Illinois, and about 2 miles below Lower Wilkinson Landing; 30 meters northeast of a northwest-southeast fence; and 240 meters nearly due north of northeast corner of orchard. This stone line intersects the left bank about 180 meters below Lower Wilkinson Landing.

⊕ 45 II.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 44′ 47″.93; meters +1,478, −372.
Longitude 89° 32′ 15″.17; meters +371, −1,098.
Elevation: 369.46.
To⊕44 II, azimuth 308° 04′, distance 2,196 meters.
To⊕46 II, azimuth 127° 55′, distance 1,026 meters.
Two-inch iron pipe, in Illinois bottom land; 9.6 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 30 feet south of bridge No. 118; 515 feet north of wagon road crossing track about 200 feet north of depot at Jacob, Ill.

⊕ 44 II.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 44′ 03″.99; meters +123, −1,727.
Longitude 89° 31′ 04″.56; meters +112, −1,357.
Elevation: 370.03.
To◬Fountain Bluff, azimuth 340° 50′, distance 4,804 meters.
To◬Worthen, azimuth 224° 32′, distance 5,600 meters.
To⊕43 II, azimuth 307° 49′, distance 3,039 meters.
Two-inch iron pipe, in Illinois bottom land; 9.5 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 60 feet south of road crossing; 40 feet southeast of signboard "One mile to Jacob;" 200 feet north of bridge No. 120. A large two-story white house in cultivated field on east side of track is about 1,100 feet from pipe.

⊡ 25/3

Mississippi River Commission, 1888; redetermined, United States engineer office, St. Louis, Mo., 1899. (Chart No. 9.)
Latitude 37° 43′ 30″.51; meters +941, −909.
Longitude 89° 37′ 18″.20; meters +446, −1,023.
Elevation: 393.24.
To⊡25/2, azimuth 219° 51′, distance 2,464 meters.
Stone post, 1 foot above surface of ground on east side of Missouri bluffs; in timber about 15 meters west of its eastern edge and 15 meters back of railroad fence; 900 meters above Seventysix, Mo., and 1,100 meters below Linnhoff Landing near first creek above Seventysix. Eight-inch blazed hickory tree stands northwest 4 meters.

⊡ 24/I

Mississippi River Commission, 1888. (Chart No. 9.)
Latitude 37° 43′ 29″.43, meters +907, −943.
Longitude 89° 33′ 53″.02; meters +1,298, −172.
Elevation: Stone, 358.89; pipe, 363.98.
To⊡24/2, azimuth 00° 04′, distance 816 meters.
Flat stone and iron pipe, in woods, 1 mile due north from river bank, at a point 900 meters above Estell Landing, Ill. It is 400 meters west of the middle of the west side of field belonging to Robert Moekel.

△ PINNACLE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 9, station not plotted.)
Latitude 37° 43′ 12″.88; meters +397, −1,453.
Longitude 89° 36′ 56″.99; meters +1,396, −74.
Highest piont of roof of house belonging to Mr. Hatch, on hill just above Seventysix, Mo., and 56 meters west of △Seventysix.

△ SEVENTYSIX.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 9, station not plotted.)
Latitude 37° 43′ 12″.59; meters +388, −1,462.
Longitude 89° 36′ 54″.73; meters +1,340, −129.
To◎Fountain Bluff, azimuth 286° 11′ 02″, distance 10,576 meters.
To◎O'Harrah, azimuth 167° 03′ 33″, distance 11,667.8 meters.
To△Wilkinson, azimuth 146° 09′ 33″, distance 3,835.9 meters.
To△Pinnacle, azimuth 99° 02′ 16″, distance 55.9 meters.
Iron pipe, set on Missouri bluff above Seventysix, Mo.; at south end of orchard, on land of Mr. Hatch; and 175 feet from his house.

⊕ 43 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 43′ 03″.44; meters +106, −1,744.
Longitude 89° 29′ 26″.47; meters +648, −822.
Elevation: 369.91.
To⊕42 H, azimuth 308° 03′, distance 1,830 meters.
Two-inch iron pipe, in Illinois bottom land; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 210 feet above north end of bridge No. 123; and 360 feet above pumping station at Gorham, Ill.

⊡ 24/2

Mississippi River Commission, 1888. (Chart No. 9.)
Latitude 37° 43′ 02″.96; meters +91, −1,759.
Longitude 89° 33′ 53″.06; meters +1,300, −170.
Elevation: 363.92.
To⊡24/1, azimuth 180° 04′, distance 816 meters.
Stone post, in woods on left bank; 800 meters from river and opposite a point about ½ mile above Saw Mill Hollow in Missouri; 120 meters back of dry chute; 400 meters below foot of small towhead; midway between foot of Lacour Island and Estell Landing; and opposite a point 1 mile below Star Landing, Mo.

⊕ WYE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 9.)
Latitude 37° 42′ 58″.11; meters +1,792, −58.
Longitude 89° 29′ 05″.67; meters +139, −1,331.
Elevation: 371.17.
To⊕ Jones H., azimuth 218° 15′, distance 6,053 meters.
A stake, in Illinois bottom land; at angle of "Y," at west end of tangent between Gorham and Grimsby, of Herrin Branch of St. Louis, Iron Mountain and Southern Railway (Illinois Division).

△ FLAG 38.

Mississippi River Commission, 1880–81. (Chart No. 9.)
Latitude 37° 42′ 56″.63; meters +1,746, −104.
Longitude 89° 33′ 07″.71; meters +189, −1,281.
Elevation: 360.65.
To◎Fountain Bluff, azimuth 289° 10′ 08″, distance 5,212.4 meters.
To◎Backbone, azimuth 109° 13′ 57″, distance 10,511.2 meters.

Stone post, on left bank behind Hat Island (old location); about 1 mile above foot of the same and 2 miles above Cape Cinque Hommes, in Missouri; timber has been partly cut and a space of about 1 acre around stone is comparatively open; all around it is thick underbrush and brier vines. Stone is 1 meter west of an 18-inch gum tree; 900 meters from river bank; and 5 meters east of a road.

⊡ $\frac{24}{3}$

Mississippi River Commission, 1888. (Chart No. 9.)
Latitude 37° 42′ 13″.18; meters +406, —1,444.
Longitude 89° 33′ 53″.34; meters +1,307, —163.
Elevation: 383.73.
To△Simpson 233, azimuth 271° 37′, distance 287 meters.
Stone post, on front slope of Missouri bluffs; 60 meters from river bank; about 290 meters upstream from the Cumberland Rocks; and 800 meters above Saw Mill Hollow.

⊡ U. S. B. M. 33.

United States engineer office, St. Louis, Mo., 1872; redetermined, Mississippi River Commission, 1888. (Chart No. 9.)
Latitude 37° 42′ 12″.34; meters +380, —1,470.
Longitude 89° 33′ 39″.92; meters +978, —492.
Elevation: 350.77.
To△Simpson 233, azimuth 113° 16′, distance 45 meters.
Raised square, cut on top corner of shelf of a large bowlder (Cumberland Rocks), on Missouri shore; 830 meters above Saw Mill Hollow; 6 meters from water surface at low water; and back of second large bowlder below △ Simpson 233. "B. M. 33" is cut near the square, established by Smith in 1872.

△ SIMPSON 233.

United States engineer office, St. Louis, Mo., 1878; redetermined, Mississippi River Commission, 1888. (Chart No. 9, station not plotted.)
Latitude 37° 42′ 12″.92; meters +398, —1,452.
Longitude 89° 33′ 41″.61; meters +1,019, —451.
Elevation: 354.28.
To△Flag 37, azimuth 293° 49′, distance 566 meters.
To⊡U. S. B. M. 33, azimuth 293° 16′, distance 45 meters.
To⊡24/3, azimuth 91° 37′, distance 287 meters.
Center of hole in large bowlder (one of three known as Cumberland Rocks), on Missouri shore; 2 miles above Cape Cinque Hommes; 800 meters above Saw Mill Hollow; and 200 meters below bridge 98–4, on the "Frisco" railroad. "U. S. 33" is cut on bowlder near hole. (Elevation given for lowest point of rock surrounding hole).

△ FLAG 37.

Mississippi River Commission, 1880–81. (Chart No. 9, station not plotted.)
Latitude 37° 42′ 05″.51; meters +170, —1,680.
Longitude 89° 33′ 20″.49; meters +502, —968.
Elevation: 386.14.
To◬O'Harrah, azimuth 149° 42′ 35″, distance 15,568.5 meters.
To◬Fountain Bluff, azimuth 280° 12′ 38″, distance 4,987.1 meters.
To◬Backbone, azimuth 117° 39′ 41″, distance 10,852 meters.
To◬Worthen, azimuth 223° 29′ 22″, distance 10,541 meters.
To△Simpson 233, azimuth 113° 49′, distance 566 meters.
Stone post, on right bank; in Saw Mill Hollow, about 1¼ miles above Cape Cinque Hommes; 30 meters below creek; about 200 meters below point of very large detached rocks; 35 meters northeast of point where creek jumps ledge; 2 meters northeast of 24-inch burr-oak tree, on point of hill 27 meters from river bank; and about 300 meters above grassy valley, orchard and old log cabin.

⊕ 42 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 47′ 26″.83; meters +827, —1,023.
Longitude 89° 28′ 27″.62; meters +676, —792.
Elevation: 367.58.
To⊕41 H, azimuth 345° 57′, distance 2,060 meters.

A stake, in cultivated field in Illinois bottom land, and near extreme northeast point of Fountain Bluff; 161.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division) and almost at point of intersection of tangents; 2,000 feet below "Iron Mountain" and "Illinois Central" railroad crossing, which is 2,000 feet northeast of Leo Rock station, on Illinois Central Railroad.

⊡ $\frac{23}{1}$

Mississippi River Commission, 1888. (Chart No. 10.)
Latitude 37° 42′ 01″.45; meters +45, −1,805.
Longitude 89° 29′ 53″.76; meters +1,317, −153.
Elevation: Stone, 372.75; pipe, 377.77.
To⊡23/2, azimuth 60° 40′, distance 799 meters.
Flat stone and iron pipe, 100 meters above Illinois Central railroad station at Fountain Bluff, Ill.; 16 meters northwest of railroad; in fence corner of field; 42 meters south of ruins of burned house; 21 meters west of blazed locust tree; and about 1,100 meters from river bank.

⊡ $\frac{23}{2}$

Mississippi River Commission, 1888. (Chart No. 10.)
Latitude 37° 41′ 48″.76; meters +1,503, −347.
Longitude 89° 30′ 22″.17; meters +543, −927.
Elevation: 365.57.
To△Simpson 246, azimuth 3° 17′, distance 1,169 meters.
To⊡23/1, azimuth 240° 40′, distance 799 meters.
To⊡23/3, azimuth 60° 33′, distance 1,852 meters.
Stone post, in fence corner of field on land owned by F. Wells; between Fountain Bluff (Ill.) railroad station and the river; 700 meters from the former and 325 meters from the latter; on west side of Mill Ditch and 170 meters south of bridge across it; and 2 meters from a walnut tree.

Ⓐ FOUNTAIN BLUFF.

Mississippi River Commission, 1880-81. (Chart No. 10.)
Latitude 37° 41′ 36″.77; meters +1,134, −716.
Longitude 89° 30′ 00″.16; meters +4, −1,466.
Elevation: 781.46.
ToⒶBackbone, azimuth 112° 13′ 26″.72, distance 15,681.23 meters.
ToⒶSwallow Rock, azimuth 271° 08′ 43″.28, distance 8,343.58 meters.
ToⒶSilica, azimuth 10° 49′ 50″.45, distance 9,261.35 meters.
ToⒶWorthen, azimuth 195° 24′ 44″.19, distance 8,848.50 meters.
ToⒶBig Muddy, azimuth 336° 29′ 59″.48, distance 14,245.30 meters.
ToⒶO'Harrah, azimuth 138° 20′ 39″, distance 19,186.2 meters.
To△Flag 34, azimuth 115° 53′ 40″, distance 14,550.1 meters.
To△Flag 37, azimuth 100° 14′ 40″, distance 4,987.1 meters.
To△Flag 38, azimuth 118° 12′ 03″, distance 5,212.4 meters.
To△Wilkinson, azimuth 116° 35′ 17″, distance 13,738.3 meters.
To△Seventysix, azimuth 106° 15′ 16″, distance 10,576 meters.
Center of hole in top of stone post, on the highest part of Fountain Bluff in Illinois; about one-half mile south of the Illinois Central railroad station at Fountain Bluff; and in the center of a woods road following top of ridge. Stone post is broken off about 8 inches under ground. The top has been fitted and placed over old part of stone in ground and referenced by two United States Engineer Department iron pipes, about 1 foot above surface of ground set 3 meters due north and due south of center of stone, respectively. To reach station, enter Fountain Bluff Hollow (at railroad station) turn up bluff to right and follow ridge until reaching highest point. A small knoll toward river is a little higher than the ground at the station.

⊕ 41 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 41′ 22″.12; meters +682, −1,168.
Longitude 89° 28′ 06″.74; meters +165, −1,305.
Elevation: 374.79.
To⊕40 H, azimuth 356° 47′, distance 971.4 meters.
Wooden stake, in Illinois bottom land; 3 miles above Cave Valley, Ill.; 500 meters above railroad culvert for drainage ditch; 7 feet inside of right-of-way fence and 32.3 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); near second point of intersection of tangents below Gorham, Ill.

◎ SWALLOW ROCK.

Mississippi River Commission, 1880–81. (Chart No. 10.)
Latitude 37° 41′ 31″.23; meters +963, −887.
Longitude 89° 24′ 19″.67; meters +482, −988.
To◎Big Muddy, azimuth 11° 43′ 05″.99, distance 13,168.78 meters.
To◎Worthen, azimuth 145° 29′ 59″.70, distance 10,560.46 meters.
To◎Fountain Bluff, azimuth 91° 12′ 11″.46, distance 8,343.58 meters.
Center of stone post, in Illinois; on top of high bluff known as Swallow Rock; nearly east and 4 miles from upper end of Fountain Bluff; and 1½ miles north of Cedar Creek flowing into Big Muddy River. To reach station, cross Big Muddy River near lower end of Swallow Rock Cliff, and go up valley of Big Run Creek to a point where a stream leaves the cliff, then follow cliff to the highest point of hill where station is situated. Top part of stone is broken off.

⊡ 23/3

Mississippi River Commission, 1888. (Chart No. 10.)
Latitude 37° 41′ 19″.23; meters +593, −1,257.
Longitude 89° 31′ 27″.98; meters +686, −784.
Elevation: 386.11.
To△Simpson 246, azimuth 279° 25′, distance 1,567 meters.
To⊡23/2, azimuth 240° 33′, distance 1,852 meters.
Stone post, on side of Missouri bluffs at Cape Cinque Hommes; 2½ miles above Wittenberg, Mo.; on land of Estell and Weinhold, 1 meter west of a north-and-south fence; 250 meters from river bank; and 500 meters above mouth of Owl Creek.

△ SIMPSON 246.

United States engineer office, St. Louis, Mo., 1878; redetermined, Mississippi River Commission, 1880–81. (Chart No. 10.)
Latitude 37° 41′ 10″.91; meters +336, −1,514.
Longitude 89° 30′ 24″.90; meters +610, −860.
Elevation: 346.90.
To△Simpson 248, azimuth 19° 56′ 17″, distance 1,467.1 meters.
To⊡23/2, azimuth 183° 17′, distance 1,169 meters.
To⊡23/3, azimuth 99° 25′, distance 1,567 meters.
Center of hole in large bowlder, on Illinois shore, on west side of Fountain Bluff; nearly opposite the mouth of Owl Creek in Missouri; a short distance below where the Illinois Central Railroad leaves the river; 105 meters below upper end of large bowlders on left bank; 45 meters below railroad post marked "G. M. 91–56," and 115 meters below post marked "G. M. 91–49;" 35 meters upstream from a large bowlder close to railroad track on river side, the only one near railroad in this vicinity; and about 20 feet above low water. "U. S. 46" is cut in rock 2 feet north of hole.

⊕ 40 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 40′ 50″.66, meters +1,562, −288.
Longitude 89° 28′ 04″.51; meters +111, −1,360.
Elevation: 375.51.
To⊕39 H, azimuth 357° 15′, distance 1,487 meters.
Two-inch iron pipe, in Illinois bottom land; 2½ miles above Cave Valley, Ill.; 450 meters above drainage ditch and open railroad culvert; 10 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 20 meters south of road crossing, about 20 meters southwest of barn, and 10 meters southeast of mile-post 87.

△ SIMPSON 248.

United States engineer office, St. Louis, Mo., 1878; redetermined, Mississippi River Commission, 1880–81. (Chart No. 10.)
Latitude 37° 40′ 26″.18; meters +807, −1,043.
Longitude 89° 30′ 45″.31, meters +1,110, −361.
Elevation: 371.28.
To△Simpson 246, azimuth 199° 56′ 05″, distance 1,467.1 meters.

One and one-half inch hole, 4 inches deep, in ridge of largest rock on west side of Fountain Bluff, Illinois shore; 3 miles above Illinois Central railroad station at Grand Tower, Ill.; 500 meters above Trestle Hollow; 30 meters west of Illinois Central Railroad; 6 meters south of railroad post, on east side of track, marked G. M. 92-43; and about two-thirds distance along ridge of rock from the lower end. "U. S. 48" is cut in rock 3 feet south of hole. The bench mark is point of rock 2 inches upstream from the hole, elevation therefor on chart being 0.20 foot too high.

⊕ 39 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 40′ 02″.47; meters +76, −1,774.
Longitude 89° 28′ 01″.59; meters +39, −1,432.
Elevation: 366.55.
To ⊕ 38 H, azimuth 366° 53′, distance 2,366 meters.
A stake, in Illinois bottom land; 1½ miles above Cave Valley, Ill.; 9.5 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 2,230 feet south of headblock to Johns Spur; 2,000 feet south of sawmill; and 300 feet north of milepost 88.

△ SIMPSON 250.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1899. (Chart No. 10.)
Latitude 37° 39′ 56″.09; meters +1,729, −121.
Longitude 89° 30′ 49″.22; meters +1,206, −264.
Elevation: 369.65.
To △ Bakeoven, azimuth 1° 18′ 25″, distance 2,556.8 meters.
To △ Simpson 249, azimuth 15° 52′ 18″, distance 2,025.5 meters.
To △ Road, azimuth 60° 18′ 42″, distance 885.9 meters.
One-inch hole, 3 inches deep, 1 meter north of south end of large sand bowlder on left bank of river where it begins to leave Fountain Bluff; about 120 meters above ruins of old dry dock; 2½ miles above railroad station at Grand Tower, Ill.; 450 meters below Trestle Hollow, in Fountain Bluff; and 30 meters west of Illinois Central Railroad. "U. S. 50" is cut in the rock 1½ meters northeast of the hole. There are two iron ring bolts in this same bowlder, and the elevation of the lower or downstream one, 3 meters north of the triangulation station, is 368.79.

△ ROAD.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 39′ 41″.85; meters +1,290, −560.
Longitude 89° 31′ 20″.62; meters +505, −967.
To △ Fairview, azimuth 321° 50′ 51″, distance 4,021.7 meters.
To △ Tower, azimuth 348° 47′ 57″, distance 3,554.9 meters.
To △ Simpson 249, azimuth 351° 51′ 51″, distance 1,524.9 meters.
To △ Simpson 250, azimuth 240° 18′ 23″, distance 885.9 meters.
To △ Bluff, azimuth 285° 15′ 55″, distance 1,421.6 meters.
To ⊡ 22/3, azimuth 353° 49′ 21″, distance 1,516.3 meters.
Iron pipe, in Missouri, set in middle of farm road running south of east and directly toward △ Bluff, in Illinois; 500 meters above "Frisco" railroad station at Wittenberg, Mo.; on first ridge or terrace, 150 meters from river; a large lone tree is 75 meters south of the road at a point 110 meters west from the station. (Station is incorrectly plotted on chart.)

△ BLUFF.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 39′ 29″.71; meters +916, −934.
Longitude 89° 30′ 24″.67; meters +605, −866.
To △ Fairview, azimuth 338° 14′ 55″, distance 3,002.2 meters.
To △ Tower, azimuth 12° 20′ 51″, distance 3,186.5 meters.
To △ Road, azimuth 105° 16′ 29″, distance 1,421.6 meters.
To △ Simpson 249, azimuth 45° 31′ 11″, distance 1,620 meters.
To ⊡ 22/3, azimuth 46° 50′ 46″, distance 1,656.5 meters.
One-half inch hole surrounded by triangle, in high ledge on south end of Fountain Bluff, on left bank of river; 2 miles above Illinois Central Railroad station at Grand

Tower, Ill.; a little west of prolongation of line of railroad tangent, running through cut in bluff and out to river. To reach station from river, land at small creek at lower end of Fountain Bluff and follow road southeast to farmhouse, a little more than one-quarter mile from river; then take path which leads up the bluff, and walk along edge of bluff toward river until on line with railroad tangent through cut in bluff above Grand Tower.

⊕ CRAWSHAW II.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 39′ 06″.61; meters +204, −1,646.
Longitude 89° 29′ 37″.97; meters +931, −540.
To △ Fairview, azimuth 00° 54′, distance 2,076 meters.
To △ Grand, azimuth 31° 40′, distance 2,331 meters.
Two-inch iron pipe, on extreme southwest point of Fountain Bluff; about 2 miles, along public road, above Grand Tower, Ill.; 1¾ miles west of Cave Valley, Ill.; on top of high point or knoll on land of Mrs. Minnie Crawshaw; about 150 feet north of edge of of sharp break in the slope of the hill; 450 feet north of smaller point or knoll which is due north of house occupied by Wm. South; also nearly on line with two houses in cultivated field and △ Grand on bluff immediately above Grand Tower; a wagon road from South's barnyard to top of ridge passes 6 feet south of pipe.

⊡ $\frac{22}{3}$

Mississippi River Commission, 1884; redetermined, United States engineer office St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 38′ 52″.96; meters +1,633, −217.
Longitude 89° 31′ 13″.96; meters +342, −1,129.
Elevation: 430.39.
To △ Bluff, azimuth 226° 50′ 16″, distance 1,656.5 meters.
To △ Road, azimuth 173° 49′ 25″, distance 1,516.3 meters.
To △ Simpson 249, azimuth 272° 06′, distance 53 meters.
Top of stone post, 15 inches above surface of ground, on eastern slope of Missouri bluffs; 500 meters below Wittenberg, Mo.; about 5 meters back from sliding bank, due to railroad cut; 60 meters southwest of Government light and 60 meters from right bank of river. A 10-inch walnut tree stands 5 meters west and an 8-inch oak 5 meters south, each blazed with a triangle facing stone.

△ SIMPSON 249.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1899, also by Mississippi River Commission, 1880–81. (Chart No. 10.)
Latitude 37° 38′ 52″.89; meters +1,631, −219 (1899).
Longitude 89° 31′ 11″.82; meters +290, −1,181 (1899).
Latitude 37° 38′ 52″.95; meters +1,632, −218 (1880–81).
Longitude 89° 31′ 11″.75; meters +288, −1,183 (1880–81).
Elevation: 350.43.
To △ Bake Oven, azimuth 320° 48′ 01″, distance 784.3 meters (1899).
To △ Bluff, azimuth 225° 30′ 42″, distance 1,620 meters (1899).
To △ Road, azimuth 171° 51′ 56″, distance 1,524.9 meters (1899).
To △ Simpson 250, azimuth 195° 52′ 05″, distance 2,025.5 meters (1899).
To △ Simpson 250, azimuth 195° 51′ 44″, distance 2,023.8 meters (1880–81).
To △ Flag 40, azimuth 309° 59′ 35″, distance 903.2 meters (1880–81).
To ⊡ 22/2, azimuth 272° 12′, distance 1,063 meters (1884).
To ⊡ 22/3, azimuth 92° 06′, distance 53 meters (1884).
One and one-half inch hole, 3 inches deep, in smooth ledge of rock sloping toward the river on first prominent point below and 500 meters from Wittenberg, Mo.; 1 meter east of high edge of ledge and about 20 meters from water's edge at low water. "U. S. 49" is cut in rock 2½ feet northwest of hole.

⊙ P. B. M. 45.

Mississippi River Commission, 1880. (Chart No. 10, position not determined.)
Elevation: 369.41.
Center of copper bolt, leaded horizontally in stone foundation wall of flour mill at Wittenberg, Mo.; on side of mill facing the river; between the ground floor door and down-river corner.

⊡ 22/2

Mississippi River Commission, 1884. (Chart No. 10.)
Latitude 37° 38′ 51″.63; meters +1,592, −258.
Longitude 89° 30′ 28″.41; meters +696, −795.
Elevation: 373.64.
To △ Flag 40, azimuth 34° 27′, distance 655 meters.
To △ Simpson 249, azimuth 92° 12′, distance 1,063 meters.
Stone post, in schoolhouse yard, on left bank of river; 1,850 meters above Grand Tower, Ill.; 800 meters above Devils Bake Oven; 250 meters from river bank; 73 meters east from railroad track; 16 meters from northeast corner of schoolhouse; and 3 meters from northeast corner of yard.

⊕ 38 II.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 38′ 45″.83; meters +1,413, −437.
Longitude 89° 27′ 56″.33; meters +1,381, −90.
Elevation: 366.87.
To ⊕ 37 II, azimuth 357° 12′, distance 1,857 meters.
A stake, in Illinois bottom land; 10 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 150 meters south of sawmill at Cave Valley, Ill.; about 17 meters west of spur track; and 150 meters south of headblock.

△ FLAG 40.

Mississippi River Commission, 1880–81. (Chart No. 10.)
Latitude 37° 38′ 34″.12; meters +1,052, −798.
Longitude 89° 30′ 43″.52; meters +1,067, −404.
Elevation: 374.33.
To △ Simpson 249, azimuth 129° 59′ 52″, distance 903.2 meters.
To ⊡ 22/2, azimuth 214° 27′, distance 655 meters.
Stone post, on left bank; 1 mile above railroad station at Grand Tower, Ill.; 200 meters east of Devils Bake Oven; 70 meters from river bank; 80.5 meters northeast from the northeast corner of Mrs. Howard Oliphant's house; 58.7 meters from fence running parallel with river; 41.1 meters northwest of fence corner; and 2 meters from an east-and-west fence.

△ BAKE OVEN.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 38′ 33″.17; meters +1,023, −827.
Longitude 89° 30′ 51″.60; meters +1,265, −206.
Elevation: 368.89.
To △ Simpson 249, azimuth 140° 48′ 14″, distance 784.3 meters.
To △ Simpson 250, azimuth 181° 18′ 23″, distance 2,556.8 meters.
Iron pipe, about 10 feet from left high bank; 1 mile above railroad station at Grand Tower, Ill.; directly back of and about 150 feet upstream from Devils Bake Oven; 80 feet downstream from large walnut tree; 50 feet north of blazed sycamore; and 8 feet from oak post in barbed-wire fence.

△ GRAND '99.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 38′ 02″.25; meters +69, −1,781.
Longitude 89° 30′ 27″.88; meters +684, −787.
Elevation: 522.80.
To ⊛ Big Muddy, azimuth 315° 23′ 52″, distance 9,058.2 meters.
To ⊛ Silica, azimuth 23° 07′ 45″, distance 2,699.7 meters.
To △ Mc Lean, azimuth 327° 29′ 22″, distance 2,040.6 meters.
To △ Mouth, azimuth 15° 26′ 24″, distance 5,644.5 meters.
To △ Church Spire, azimuth 316° 03′ 49″, distance 978 meters.
To △ Fairview, azimuth 274° 25′ 13″, distance 1,194.8 meters.
To △ Flag, azimuth 337° 51′ 55″, distance 4,184.4 meters.
To △ Tower, azimuth 55° 21′ 39″, distance 732.6 meters.
Iron pipe, set on highest point of hill immediately north of the coal dump and the main part of Grand Tower, Ill.

△ FAIRVIEW.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 37′ 59″.26; meters +1,827,—23.
Longitude 89° 29′ 39″.29; meters +964,—508.
Elevation: 472.40.
To ◎ Silica, azimuth 43° 17′ 38″, distance 3,284 meters.
To ◎ Big Muddy, azimuth 320° 53′ 35″, distance 8,193.8 meters.
To △ Grand '99, azimuth 94° 25′ 43″, distance 1,194.8 meters.
To △ Bluff, azimuth 158° 15′ 23″, distance 3,002.2 meters.
To △ Tower, azimuth 79° 45′ 35″, distance 1,823.1 meters.
To △ Church Spire, azimuth 39° 57′ 10″, distance 798.5 meters.
To △ Flag, azimuth 354° 11′ 31″, distance 3,803.5 meters.
To △ Mouth, azimuth 26° 44′ 27″, distance 5,988.8 meters.
To △ Road, azimuth 141° 51′ 53″, distance 4,021.7 meters.
Iron pipe, on east end of ridge of Grand Tower, Ill., and southeast of graveyard; at point of timber and under large white-oak tree.

△ TOWER.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 37′ 48″.74; meters +1,503,—347.
Longitude 89° 30′ 52″.46; meters +1,286,—185.
To △ Fairview, azimuth 259° 44′ 50″, distance 1,823.1 meters.
To △ Grand '99, azimuth 235° 21′ 24″, distance 732.6 meters.
To △ Mc Lean, azimuth 307° 30′ 08″, distance 2,142.3 meters.
To △ Bluff, azimuth 192° 20′ 34″, distance 3,186.5 meters.
To △ Road, azimuth 168° 48′ 14″, distance 3,554.9 meters.
Iron pipe, in Missouri; on west side of highest point of hill south of Tower Rock and opposite Grand Tower, Ill.; about 15 feet east of a blazed oak tree, the only tree on crest of hill. (Not found in 1908.)

⊕ 37 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 37′ 45″.66; meters +1,408,—442.
Longitude 89° 27′ 52″.64; meters +1,291,—181.
Elevation: 365.77.
To ⊕ 36 H, azimuth 357° 03′, distance 2,215 meters.
A stake, in Illinois bottom land; 9.5 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 40 meters south of southeast corner of depot at Howardton, Ill.; 4 meters south of cattle guard; and 13 meters south of road crossing.

△ CHURCH SPIRE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 37′ 39″.41; meters +1,215,—635.
Longitude 89° 30′ 00″.20; meters +5,—1,467.
Center of tall white church spire in Grand Tower, Ill.

△ MC LEAN.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 37′ 06″.43; meters +198,—1,652.
Longitude 89° 29′ 43″.16; meters +1,059,—413.
Elevation: 361.48.
To △ Tower, azimuth 127° 30′ 50″, distance 2,142.3 meters.
To △ Grand '99, azimuth 147° 29′ 49″, distance 2,040.6 meters.
Iron pipe, in field, owned by George Wolf, one-half mile south from old furnace dump at Grand Tower, Ill.; 160 feet from river bank; 4 feet east of fence on east side of road to Grand Tower; and about 200 feet upstream from Wolf's house.

◎ SILICA.

Mississippi River Commission, 1880-81. (Chart No. 10.)
Latitude 37° 36′ 41″.72; meters +1,286,—564.
Longitude 89° 31′ 11″.11; meters +273,—1,199.

To ◉ Big Muddy, azimuth 298° 07′ 08″.58, distance 8,414.61 meters.
To ◉ Rich, azimuth 325° 37′ 11″.79, distance 13,603.45 meters.
To ◉ Indian Creek, azimuth 353° 44′ 54″.04, distance 10,609.97 meters.
To ◉ Fountain Bluff, azimuth 190° 49′ 07″.10, distance 9,261.35 meters.
To △ Fairview, azimuth 223° 16′ 42″, distance 3,284 meters.
To △ Grand '99, azimuth 203° 07′ 18″, distance 2,699.7 meters.

Stone post, on a prominent peak on Missouri bluffs; about one-quarter mile below head of Grand Tower Island; one-quarter mile below railroad trestle over Pattons Creek; and directly back of silica banks.

⊕ 36 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 10.)
Latitude 37° 36′ 33″.91; meters +1,045, −805.
Longitude 89° 27′ 47″.98; meters +1,177, −295.
Elevation: 363.07.
To ⊕ 35 H, azimuth 357° 01′, distance 1,643 meters.
To ⊕ Cemetery H, azimuth 282° 51′, distance 2,297 meters.
To ⊕ River Bluff H, azimuth 252° 32′, distance 2,784 meters.

Two-inch iron pipe, in Illinois bottom land; 1.4 miles below railroad station at Howardton, Ill.; 11.3 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 265 feet above milepost 92, and 725 feet south of bridge No. 127.

⊡ $\frac{21}{1}$

Mississippi River Commission, 1884. (Chart No. 10.)
Latitude 37° 36′ 33″.76; meters +1,041, −809.
Longitude 89° 28′ 34″.23; meters +840, −632.
Elevation: 363.25.
To ⊡ 21/2, azimuth 58° 13′, distance 746 meters.

Stone post, at edge of cultivated field and small timber in low ground; 400 meters east of Illinois Central Railroad tracks, at a point 2 miles south from the station at Grand Tower, Ill.; 800 meters back from left bank of river, at head of Big Muddy Island; 136 meters south of fence, and 175 meters north of road.

⊡ $\frac{21}{2}$

Mississippi River Commission, 1884. (Chart No. 10.)
Latitude 37° 36′ 21″.02; meters +648, −1,202.
Longitude 89° 29′ 00″.08; meters +2, −1,470.
Elevation: 363.90.
To ⊡ 21/1, azimuth 238° 13′, distance 746 meters.
To ⊡ 21/3, azimuth 58° 12′, distance 1,318 meters.

Stone post, on land of Gilbert Gay, in Illinois bottom land; 2 miles below Grand Tower, Ill.; 325 meters west from Illinois Central Railroad; 215 meters above old chute behind Big Muddy Island; on northeast side of Grand Tower road; one-half meter north of fence at southwest edge of orchard; and 5 meters above a large elm tree on land of Wilson, on opposite side of road.

⊡ $\frac{21}{3}$

Mississippi River Commission, 1884. (Chart No. 10.)
Latitude 37° 35′ 58″.50; meters +1,804, −46.
Longitude 89° 29′ 45″.75; meters +1,122, −350.
Elevation: 360.65.
To ⊡ 21/2, azimuth 238° 12′, distance 1,318 meters.

Stone post, on small ridge on east side of Grand Tower Island; 1,500 meters below head of island; and 25 meters from the main high bank; three blazed, 12-inch cottonwood trees face the stone.

△ FLAG.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 35′ 56″.52; meters +1,743, −107
Longitude 89° 29′ 23″.60; meters +579, −893.

To ◎ Big Muddy, azimuth 298° 17′ 20″, distance 5,432.1 meters.
To △ Grand '99, azimuth 157° 52′ 35″, distance 4,184.4 meters.
To △ Fairview, azimuth 174° 11′ 41″, distance 3,803.5 meters.
Iron pipe, on east side and 1 mile below the head of Grand Tower Island; about 80 feet north from bend in wire fence where line of cottonwood timber commences; 4 feet east from fence and between two posts marked with triangles.

△ LINE NO. 2.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 35′ 23″.14; meters +713, −1,137.
Longitude 89° 31′ 25″.99; meters +638, −734.
Elevation: 371.98.
To ◎ Indian Creek, azimuth 349° 23′ 35″, distance 8,265 meters.
To ◎ Big Muddy, azimuth 281° 12′ 34″, distance 7,938 meters.
Iron pipe, on high river bank; in Missouri, opposite timber line on lower end of Grand Tower Island; 125 feet south of John Cleary's house; and 3 feet east of wire fence near the river.

△ POINT NO. 2.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 10.)
Latitude 37° 35′ 00″.00; meters +0, −1,850.
Longitude 89° 30′ 53″.74; meters +1,319, −153.
To △ Mouth, azimuth 101° 33′ 44″, distance 886.4 meters.
Iron pipe, in cultivated field in Illinois; on lower point of old Big Muddy Island, at mouth of Tower Bend Chute and opposite the lower end of Grand Tower Island. Station is in line with and between a large pecan tree in field and a blazed cottonwood tree in edge of timber about 135 feet west of the station. (Not found in 1908.)

⊕ RIVER BLUFF H

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 37′ 01″.01; meters +31, −1,819.
Longitude 89° 25′ 59″.69; meters +1,464, −8.
To ⊕ 36 H, azimuth 73° 33′, distance 2,784 meters.
To ⊕ Cemetery H, azimuth 17° 13′, distance 1,409 meters.
A stake, on center of knoll on Illinois bluffs, 4 miles east of Grand Tower, Ill.; about 2 miles southeast of Howardton, Ill.; 1¼ miles above line between Jackson and Union counties and ¾ of a mile below Rattlesnake Ferry on the Big Muddy River; 60 feet from edge of bluff, 50 feet from Big Muddy River; 15 feet north of burnt white oak snag; 10 feet east of white oak; and 6 feet west of hickory tree blazed on bluff side. A small log cabin is on the river bank just below the station.

⊕ CEMETERY H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 36′ 17″.33; meters +534, −1,316.
Longitude 89° 26′ 16″.71; meters +410, −1,062.
Elevation: 615.5 (stadia).
To ◎ Big Muddy, azimuth 356° 30′, distance 3,222 meters.
To ⊕ 34 H, azimuth 41° 24′, distance 3,159 meters.
To ⊕ 36 H, azimuth 102° 52′, distance 2,297 meters.
A stake, on highest point of Illinois bluffs along the Big Muddy River; 4 miles southeast of Grand Tower, Ill.; 2 miles south of Howardton, Ill.; one-half mile above large hollow or ravine, due east; 1½ miles from a point where the wagon road, between Jackson and Union counties, and leading to sawmill in same hollow, crosses the St. Louis, Iron Mountain and Southern Railway (Illinois division). The station is directly above a cemetery on hillside, and 10 feet southwest of black-oak tree blazed with symbol "⊕."

⊕ 35 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 35′ 40″.69; meters +1,254, −596.
Longitude 89° 27′ 44″.50; meters +1,092, −380.
Elevation: 361.59.
To ⊕ 34 H, azimuth 357° 02′, distance 1,243 meters.

Two-inch iron pipe, in Illinois bottom land; 2½ miles below Howardton, Ill.; 10 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 150 meters above milepost 93; 320 feet above end of first cut above Big Muddy River; and northwest of house occupied by H. B. Henson, 200 feet east of track.

△ MOUTH.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 35′ 05″.76; meters +178, −1,672.
Longitude 89° 31′ 29″.13; meters +715, −757.
Elevation: 369.48.
To△Grand '99, azimuth 195° 25′ 46″, distance 5,644.5 meters.
To△Point No. 2, azimuth 281° 33′ 23″, distance 886.4 meters.
To△Fairview, azimuth 206° 43′ 20″, distance 5,988.8 meters.
Iron pipe, on high bank in Missouri, opposite mouth of chute in Tower Island Bend; 1½ miles above railroad trestle over Apple Creek; above flat shelving rock on shore; and about 30 feet below small ravine.

⊕ 34 H

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 35′ 00″.43; meters +13, −1,837.
Longitude 89° 27′ 41″.87; meters +1,027, −445.
Elevation: 361.88.
To◬Big Muddy, azimuth 290° 18′, distance 2,438 meters.
To⊕33 H, azimuth 331° 42′, distance 1,674 meters.
Two-inch iron pipe, in Illinois bottom land; 3½ miles below Howardton, Ill.; 10.1 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 340 feet south of telegraph pole 93/20; near upper point of first curve above Big Muddy River; 800 feet south of road crossing; and opposite log cabin and shed in cultivated field.

◬ BIG MUDDY.

Mississippi River Commission, 1880–81. (Chart No. 11.)
Latitude 37° 34′ 32″.97; meters +1,016, −834.
Longitude 89° 26′ 08″.67; meters +213, −1,260.
To◬Silica, azimuth 118° 10′ 13″.09, distance 8,414.61 meters.
To◬Fountain Bluff, azimuth 156° 32′ 20″.83, distance 14,245.30 meters.
To◬Indian Creek, azimuth 43° 38′ 48″.47, distance 9,086.99 meters.
To◬Swallow Rock, azimuth 191° 41′ 59″.43, distance 13,168.78 meters.
To△Grand '99, azimuth 135° 26′ 31″, distance 9,058.2 meters.
To△Flag, azimuth 118° 19′ 19″, distance 5,432.1 meters.
To△Flag 43, azimuth 80° 50′ 47″, distance 8,168.3 meters (1880–81).
To△Flag 43, azimuth 80° 50′ 54″, distance 8,168.9 meters (1899).
To△Fairview, azimuth 140° 55′ 43″, distance 8,193.8 meters.
To⊕33 H, azimuth 67° 13′, distance 1,620 meters.
Stone post, on high bluff in Illinois; about 5 miles southeast of Grand Tower, Ill.; due east from bridge of the St. Louis, Iron Mountain and Southern Railway (Illinois division) over Big Muddy River; and about 1½ miles down the bluffs from Kings Ferry. To reach station from Mississippi River, go via Big Muddy River to a ferry and road about ½ mile above "Iron Mountain" bridge; take road to bluffs, thence south about ½ mile to a point where road turns into a valley, just above a white frame house; from this point go southeast, up northwest slope of bluff, directly to station on prominent point of highest ridge.

⊕ 33 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 34′ 12″.51; meters +386, −1,464.
Longitude 89° 27′ 09″.45; meters +232, −1,241.
Elevation: 362.21.
To◬Big Muddy, azimuth 247° 12′, distance 1,620 meters.
To⊕Aldridge H, azimuth 285° 40′, distance 1,294 meters.
To⊕32 H, azimuth 1° 36′, distance 2,525 meters.
Two-inch iron pipe, in Illinois bottom land; 1½ miles above La Rue; 7 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 2,400 feet below "Iron Mountain" bridge over Big Muddy River; 3 feet south of road crossing and near lower end of first curve south of the Big Muddy River.

⊕ ALDRIDGE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 34′ 01″.27; meters +39, −1,811.
Longitude 89° 26′ 18″.73; meters +460, −1,013.
Elevation: 823.9 (stadia).
To ⊛ Big Muddy, azimuth 194° 10′, distance 1,008 meters.
A stake, on first prominent point of Illinois bluffs below ⊛ Big Muddy; northeastwardly and 2 miles from Aldridge, Ill.; in line with a 10-acre field, surrounded by timber, and the Illinois Central Railroad bridge over the Big Muddy River, and 10 feet in front of a large white oak tree. The Aldridge road, on the east bank of the Big Muddy River, crosses the St. Louis, Iron Mountain and Southern Railway (Illinois Division) 1¼ miles above La Rue and leads to a small farmhouse about one-quarter of a mile below the station.

△ STRAW.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 33′ 56″.38; meters +1,738, −112.
Longitude 89° 30′ 53″.17; meters +1,305, −168.
Elevation: 358.98.
To ⊛ Indian Creek, azimuth 352° 31′ 40″, distance 5,496.7 meters.
To △ Flag 43, azimuth 80° 48′ 00″, distance 1,096.7 meters.
To △ Simpson 271, azimuth 46° 57′ 17″, distance 1,352.7 meters.
Iron pipe, on left bank and 60 feet from Mississippi River; on the line Big Muddy—Flag 43; on west bank of slough bearing toward Crawford Landing; 1,000 meters south of the Big Muddy River and opposite the mouth of Apple Creek in Missouri.

△ FLAG 43.

Mississippi River Commission, 1880–81; redetermined, United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 33′ 50″.70; meters +1,563, −287.
Longitude 89° 31′ 37″.28; meters +915, −558.
Elevation: 366.64.
To ⊛ Silica, azimuth 186° 56′ 04″, distance 5,311.4 meters (1880–81).
To ⊛ Big Muddy, azimuth 260° 47′ 27″, distance 8,168.3 meters (1880–81).
To ⊛ Big Muddy, azimuth 260° 47′ 33″, distance 8,168.9 meters (1899).
To ⊛ Indian Creek, azimuth 341° 10′ 33″, distance 5,572.2 meters (1880–81).
To ⊛ Indian Creek, azimuth 341° 10′ 30″, distance 5,572.5 meters (1899).
To △ Straw, azimuth 260° 47′ 34″, distance 1,096.7 meters (1899).
To △ Crawford, azimuth 346° 18′ 23″, distance 3,840.4 meters (1899).
Stone post, on high right bank and rocky point just below mouth of Apple Creek and one-half mile below Birmingham, Mo.; 3 feet south of stump of poplar tree; and 70 feet toward river from triangle of three spikes driven in tie, between rails, in cut of "Frisco" railroad and 425 feet below bridge over Apple Creek.

⊡ $\frac{20}{1}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 33′ 47″.41; meters +1,462, −388.
Longitude 89° 30′ 25″.55; meters +627, −846.
Elevation: 357.63.
To ⊡ 20/2, azimuth 74° 59′, distance 490 meters.
Stone post, 630 meters east from left river bank and 1,200 meters below the mouth of Big Muddy River; in woods on land of C. S. Freeman and 170 meters back from north-and-south fence at west edge of timber; 175 meters southeast of fence corner at end of north-and-south lane. Trees adjacent to stone are blazed.

⊡ $\frac{20}{2}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 33′ 43″.29; meters +1,335, −515.
Longitude 89° 30′ 44″.83; meters +1,100, −373.
Elevation: 359.62.
To ⊡ 20/1, azimuth 254° 59′, distance 490 meters.
Stone post, 150 meters from left river bank and 1,400 meters below the mouth of the Big Muddy River; on top of ridge; and at back edge of patch of timber on land of S. Spring. An 18-inch hickory stands 4 meters below the stone.

⊕ SOUTH BASE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 33′ 41″.48; meters +1,279, −571.
Longitude 89° 27′ 10″.56; meters +259, −1,214.
Elevation: 361.92.
To⊕Aldridge H, azimuth 244° 22′, distance 1,411 meters.
To⊕33 H, azimuth 181° 32′, distance 960 meters.
Two-inch iron pipe, in Illinois bottom land; 1¼ miles above La Rue, Ill.; 7 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); and 75 meters north of a railroad bridge.

△ SIMPSON 271.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1899. (Chart No. 11.)
Latitude 37° 33′ 20″.43, meters +815, −1,035.
Longitude 89° 31′ 33″.45; meters +821, −652.
Elevation: 348.17.
To△Straw, azimuth 226° 56′ 52″, distance 1,352.7 meters.
Hole surrounded by triangle in rock, on Missouri shore; 900 meters below mouth of Apple Creek; 100 feet below house at Hines Landing, Mo.; about 20 feet out and a little upstream from a 30-inch elm tree with roots exposed; on highest shelf, and exposed at a 25-foot stage, St. Louis gauge.

⊕ 32 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 32′ 50″.69; meters +1,563, −287.
Longitude 89° 27′ 12″.26; meters +301, −1,172.
Elevation: 362.7 (stadia).
To⊕31 H, azimuth 359° 04′, distance 316 meters.
A stake, in Illinois bottom land; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about 100 feet north of bridge above La Rue and over Running Lake; and 1,000 feet north of road crossing at La Rue.

⊕ 31 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 32′ 40″.45; meters +1,247, −603.
Longitude 89° 27′ 12″.05; meters +296, −1,177.
Elevation: 361.44.
To⊕30 H, azimuth 345° 47′, distance 1,570 meters.
Two-inch iron pipe, in Illinois bottom land; 20 meters south of post-office at La Rue; 6 meters north of bridge No. 134; and near a 26-inch hickory tree in southwest angle of intersection of main track and switch of log tramway. (Elevation on chart 0.12 too low.)

⊕ WOLF LAKE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 32′ 16″.84; meters +519, −1,331.
Longitude 89° 26′ 10″.86; meters +267, −1,206.
Elevation: 702 (stadia).
To⊕29 H, azimuth 21° 41′, distance 2,181 meters.
A stake, on Illinois bluffs; opposite widest part of Wolf Lake; and three-quarters of a mile below quarry at end of old spur that leaves main track of St. Louis, Iron Mountain and Southern Railway (Illinois division) about three-quarters of a mile above La Rue station.

⊕ 30 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 31′ 51″.05; meters +1,574, −276.
Longitude 89° 26′ 56″.34; meters +1,383, −90.
Elevation: 364.68.
To⊕29 H, azimuth 345° 51′, distance 1,270 meters.
A stake, in Illinois bottom land; 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); about 1,500 meters below bridge No. 134; and 1,100 meters above first road crossing south of La Rue, Ill.

△ CRAWFORD.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 11, station not plotted.)
Latitude 37° 31′ 49″.66; meters +1,531, −319.
Longitude 89° 31′ 00″.25; meters +6, −1,467.
To△Flag 43, azimuth 166° 18′ 45″, distance 3,840.4 meters.
Iron pipe, 2½ miles above "Frisco" railroad station at Neely Landing, Mo.; 400 meters below railroad trestle over Crawford Creek; on west side of knoll, outside of railroad and 2.85 feet due west from iron pipe (△Crawford No. 2). The knoll is the result of the only through railroad cut in the vicinity. The others are side-hill cuts.

△ CRAWFORD No. 2.

United States engineer office, St. Louis, Mo., 1906. (Chart No. 11, station not plotted.)
Latitude 37° 31′ 49″.66; meters +1,531, −319.
Longitude 89° 31′ 00″.21; meters +5, −1,468.
Iron pipe, 2½ miles above "Frisco" railroad station at Neely Landing, Mo.; 400 meters below railroad trestle over Crawford Creek; on knoll, outside of railroad and 2.85 feet due east from iron pipe (△Crawford). The knoll is the result of the only through railroad cut in this vicinity. The others are side-hill cuts.

⊡ 19/1

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 31′ 33″.72; meters +1,040, −810.
Longitude 89° 29′ 22″.57; meters +554, −920.
Elevation: 357.20.
To⊡19/2, azimuth 55° 05′, distance 608 meters.
Stone post, about one-quarter mile above Hanging Dog Island; 1,550 meters below Spring Landing, Ill.; 800 meters from river bank; 220 meters southeast of fence corner of cultivated field; 180 meters northeast of northeast corner of another field; and 50 meters west of an old slough. The station is in woods and surrounded by blazed trees.

△ FLAG 44.

Mississippi River Commission, 1884; redetermined, United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 31′ 25″.67; meters +791, −1,059 (1884).
Longitude 89° 29′ 48″.37; meters +1,188, −286 (1884).
Latitude 37° 31′ 25″.58; meters +789, −1,061 (1899).
Longitude 89° 29′ 48″.28; meters +1,186, −288 (1899).
Elevation: 355.06.
To△Indian Creek, azimuth 47° 38′ 55″, distance 1,188.2 meters (1884).
To△Indian Creek, azimuth 47° 38′ 22″, distance 1,189 meters (1899).
To⊡19/2, azimuth 305° 55′, distance 165 meters (1884).
Stone post, on land of George Andrews, in Illinois and about three-eighths mile above head of Hanging Dog Island; opposite Hanging Dog Rock in Missouri; 100 meters from top of bank; and 5½ feet north of 18-inch sycamore stump with triangle cut in top and pointing toward stone which is flush with surface of ground.

⊡ 19/2

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 31′ 22″.43; meters +692, −1,158.
Longitude 89° 29′ 42″.87; meters +1,053, −421.
Elevation: Stone, 355.25; pipe, 360.34.
To△Flag 44, azimuth 125° 55′, distance 165 meters.
To⊡19/1, azimuth 235° 05′, distance 608 meters.
To⊡19/3, azimuth 57° 51′, distance 1,172 meters.
Flat stone and iron pipe, in cultivated field in Illinois; 200 meters back from river bank; on left bank of slough behind Hanging Dog Island and about one-quarter of a mile above heavy timber on island; 1½ meters from fence, on west side of road; 100 meters below a house on west side of road and about 200 meters from river bank. Pipe is 3 feet out of ground (1907).

⊕ 29 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 31′ 11″.09; meters +342, −1,508.
Longitude 89° 26′ 43″.69; meters +1,073, −401.
Elevation: 364.94.
To ⊕ 28 H, azimuth 346° 00′, distance 589 meters.
Two-inch iron pipe, in Illinois bottom land; about 660 feet below a road crossing 1¼ miles north of Wolf Lake, Ill.; and 9.5 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division).

⊡ $\frac{19}{3}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 31′ 02″.21; meters +68, −1,782.
Longitude 89° 30′ 23″.27; meters +572, −902.
Elevation: 352.82.
To ⍋ Indian Creek, azimuth 13° 30′, distance 83 meters.
To ⊡ 19/2, azimuth 237° 51′, distance 1,172 meters.
Hole drilled vertically into ledge of rock, at junction with the soil, on the same bluff as ⍋ Indian Creek; 1,900 meters above Neely Landing, Mo.; and 700 meters below Hanging Dog Creek.

⊙ P. B. M. 49.

Mississippi River Commission, 1880. (Chart No. 11.)
Latitude 37° 31′ 52″.87; meters +1,630, −220 (scaled from map).
Longitude 89° 31′ 03″.22; meters +79, −1,395 (scaled from map).
Elevation: 348.42.
Top of copper bolt, leaded vertically in bluff rock in Missouri; 2½ miles below mouth of Apple Creek; and about 260 meters below Crawford Creek. Three large partly detached rocks are in front of the bench mark.

⍋ INDIAN CREEK.

Mississippi River Commission, 1880–81. (Chart No. 11.)
Latitude 37° 30′ 59″.60; meters +1,837, −13.
Longitude 89° 30′ 24″.06; meters +591, −883
Elevation: 481.92.
To ⍋ Rich, azimuth 275° 57′ 29″.33, distance 6,561.56 meters.
To ⍋ Moccasin Springs, azimuth 330° 43′ 52″.75, distance 9,577.75 meters.
To ⍋ Silica, azimuth 173° 45′ 22″.72, distance 10,609.97 meters.
To ⍋ Big Muddy, azimuth 223° 36′ 12″.83, distance 9,086.99 meters.
To △ Flag 44, azimuth 227° 38′ 00″, distance 1,189 meters (1899).
To △ Flag 44, azimuth 227° 38′ 33″, distance 1,188.2 meters (1884).
To △ Flag 43, azimuth 161° 11′ 15″, distance 5,572.5 meters (1899)
To △ Flag 43, azimuth 161° 11′ 18″, distance 5,572.2 meters (1880).
To △ Line No. 2, azimuth 169° 24′ 12″, distance 8,265 meters (1899).
To △ Straw, azimuth 172° 31′ 58″, distance 5,496.7 meters (1899).
Stone post, on top of prominent bluff, on right bank; 1⅛ miles above Neely Landing, Mo.; one-half mile below Hanging Dog Creek; and 60 meters west of "Frisco" railroad.

⊕ 28 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 30′ 52″.56; meters +1,620, −230.
Longitude 89° 26′ 37″.89; meters +931, −543.
Elevation: 362.2 (stadia).
To ⊕ 27 H, azimuth 335° 27′, distance 640 meters.
A stake, in Illinois bottom land; 4½ feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 4,300 feet above lower road crossing at Wolf Lake, Ill.; 2,600 feet below another road crossing; and near the northern end of a tangent ("Iron Mountain") about 1,700 feet in length and paralleling the Illinois Central Railroad.

△ SIMPSON 279.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1899. (Chart No. 11, station not plotted.)
Latitude 37° 30′ 45″.71; meters +1,409, −441.
Longitude 89° 30′ 16″.38; meters +402, −1,072.
Iron pin in rock shelf, on right bank; 25 feet above low water, and 1,350 meters above Neely Landing, Mo.

◉ RICH.

Mississippi River Commission, 1880–81. (Chart No. 11.)
Latitude 37° 30′ 37″.42; meters +1,154, −696.
Longitude 89° 25′ 58″.33; meters +1,433, −41.
Elevation: 491 (stadia).
To◉Bluff Lake, azimuth 321° 42′ 29″.64, distance 12,544.38 meters.
To◉Indian Creek, azimuth 96° 00′ 11″.14, distance 6,561.56 meters.
To◉Silica, azimuth 145° 40′ 22″.45, distance 13,603.45 meters.
To◉Moccasin Springs, azimuth 13° 33′ 11″.09, distance 7,892.25 meters.
To△Vancill, azimuth 44° 25′ 52″, distance 5,982.7 meters.
To△Bee Bluff, azimuth 13° 27′ 53″, distance 7,419.6 meters.
To⊕26 H, azimuth 352° 00′, distance 1,409 meters.
Six-inch square stone, on slope of prominent western spur of Illinois bluffs; due east from a point on St. Louis, Iron Mountain and Southern Railway (Illinois division) that is one-half mile above Wolf Lake, Ill.; about 1,800 feet northwest of house belonging to Carl Rich; 12 inches above surface of ground, on edge of bluff and about halfway from top.

⊕ 27 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 30′ 33″.67; meters +1,038, −812.
Longitude 89° 26′ 27″.06; meters +665, −809.
Elevation: 363.05.
To◉Rich, azimuth 260° 41′, distance 715 meters.
To⊕26 H, azimuth 324° 49′, distance 1,566 meters.
Two-inch iron pipe, in Illinois bottom land; on west side of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 22 feet above lower road crossing at Wolf Lake, Ill., and near the southern end of a tangent ("Iron Mountain") about 1,700 feet in length and paralleling the Illinois Central Railroad.

⊕ 26 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 29′ 52″.15; meters +1,608, −242.
Longitude 89° 25′ 50″.33; meters +1,236, −238.
Elevation: 359.30.
To⊕25 H, azimuth 324° 53′, distance 1,767 meters.
Two-inch iron pipe, in Illinois bottom land; 11.7 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); 3,000 feet below lower road crossing at Wolf Lake, Ill., and 800 feet below St. Louis, Iron Mountain and Southern Railway station; 1,000 feet above small creek; and 200 feet below milepost 100. (Elevation on chart 0.33 too high.)

△ STUMP.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 29′ 24″.02; meters +741, −1,109.
Longitude 89° 28′ 41″.03; meters +1,008, −466.
Elevation: 360.47.
To△Dutch, azimuth 88° 27′ 40″, distance 1,645.1 meters.
Iron pipe, on old high river bank in Illinois; near foot of Hanging Dog Island; 10 feet west of road in front of house; 10 feet south of path; about 180 feet upstream from sycamore tree blazed with triangles; and 25 feet from stump, near dooryard gate.

△ DUTCH.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 11.)
Latitude 37° 29′ 22″.58; meters +696, −1,154.
Longitude 89° 20′ 47″.97; meters +1,179, −296.

Elevation: 357.70.
To △ Stump, azimuth 268° 27′ 00″, distance 1,645.1 meters.
Iron pipe, in Missouri, about 4,000 feet below Neely Landing, Mo.; 3 feet north of east-and-west rail fence; on land of Wagner; between the "Frisco" Railroad and the river; about in line with outer point of Neely Landing and highest trees on top of bluff below Hanging Dog Rock; 45 feet east of lower headblock of Neely siding; and 115 feet north of cattle guard.

⊡ $\frac{18}{1}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 29′ 21″.39; meters +659, −1,191.
Longitude 89° 28′ 01″.90; meters +47, −1,427.
Elevation: 361.23.
To ⊡ 18/2, azimuth 59° 37′, distance 547 meters.
Stone post, on land of C. Moury, in Illinois; nearly opposite Devils Tea Table in Missouri; 700 meters from main river bank and 1,450 meters above Illinois end of hurdle dam behind Vancill Towhead; 1 meter south of east-and-west fence at north end of cultivated field; 25 meters from the northeast corner of field. Immediately north of field is low ground covered with bushes and vines.

⊡ $\frac{18}{2}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 29′ 12″.42; meters +383, −1,467.
Longitude 89° 28′ 21″.09; meters +518, −956.
Elevation: Stone, 352.85; pipe, 357.93.
To ⊡ 18/1, azimuth 239° 37′, distance 547 meters.
To ⊡ 18/3, azimuth 59° 41′, distance 1,485 meters.
Flat stone and iron pipe, 200 meters back from left bank of river and 1,420 meters above Illinois end of hurdle dam behind Vancill Towhead; 1 meter back of rail fence at edge of timber and on east side of road; on the west edge of same field that ⊡ 18/1 is in; 75 meters north of bend in fence; and about 140 meters north of C. Moury's house.

△ GATE 3.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 11.)
Latitude 37° 29′ 05″.38; meters +166, −1,684.
Longitude 89° 28′ 22″.47; meters +552, −922.
Elevation: 353.65.
To △ Vancill, azimuth 24° 14′ 04″, distance 1,574.3 meters.
Iron pipe, in Illinois; 12 meters back from edge of secondary bank; 104 meters from southwest corner of C. Moury's house and 102 meters from southwest corner of barn, on high bank; about 1,280 meters above Illinois end of hurdle dam behind Vancill Towhead; 1 foot from fallen sycamore tree; 15 meters downstream from blazed elm tree near the bank; and 21 meters south of blazed sycamore tree.

⊕ 25 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 29′ 05″.21; meters +161, −1,689.
Longitude 89° 25′ 08″.94; meters +220, −1,254.
Elevation: 357.29.
To ⊕ 24 H, azimuth 324° 47′, distance 1,357 meters.
A stake, in Illinois bottom land; about 1½ miles below railroad station at Wolf Lake, Ill.; 9.6 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois division); and 60 feet above telegraph pole 101/5.

⊡ $\frac{18}{3}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 28′ 48″.11; meters +1,483, −367.
Longitude 89° 29′ 13″.25; meters +326, −1,148.
Elevation: 362.99.
To ⊡ 18/2, azimuth 239° 41′, distance 1,485 meters.
Stone post, set in ground near foot of Missouri bluffs; 260 meters below Devils Tea Table; 10 meters from river bank; 75 meters above where bluff rock juts out from hillside; and 5 meters above a large blazed black oak tree.

⊕ MILLER H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 28′ 43″.08; meters +1,328, −522.
Longitude 89° 22′ 45″.21; meters +1,111, −363.
Elevation: 549.8 (stadia).
To⊕22 H, azimuth 51° 12′, distance 2,542 meters.
A stake, on top of Illinois bluffs; about 1½ miles upstream from Ware, Ill.; immediately back (southeast) from a point where Clear Creek, crossed by a wagon bridge leaves the foot of the bluffs.

⊙ P. B. M. 50.

Mississippi River Commission, 1881. (Chart No. 11.)
Latitude 37° 28′ 36″.75; meters +1,133, −717.
Longitude 89° 29′ 02″.09; meters +51, −1,423.
Elevation: 348.51.
Center of copper bolt, leaded horizontally in natural rock in Missouri bluffs; 2,250 feet below rock called "Devils Tea Table" (destroyed), just below Indian Creek in Cape Girardeau County, Mo.

⊕ 24 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 28′ 29″.14; meters +898, −952.
Longitude 89° 24′ 37″.10; meters +912, −562.
Elevation: 358.19.
To⊕23 H, azimuth 324° 43′, distance 988 meters.
Two-inch iron pipe, in Illinois bottom land; 15 feet east of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 500 feet above bridge in dike between Goodwin and Miller lakes; 3,800 feet above road crossing; and 2 miles above Ware, Ill. (Elevation given on chart is 0.11 foot too high.)

△ VANCILL.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 11.)
Latitude 37° 28′ 18″.81; meters +580, −1,270.
Longitude 89° 28′ 48″.77; meters +1,198, −276.
To◬Bluff Lake, azimuth 294° 57′ 16″, distance 13,196.3 meters.
To◬Rich, azimuth 224° 24′ 08″, distance 5,982.7 meters.
To△Bee Bluff, azimuth 320° 04′ 41″, distance 3,836.5 meters.
To△Gate 3, azimuth 204° 13′ 48″, distance 1,574.3 meters.
Iron pipe, on top of prominent stone-faced bluff, 1,400 meters above Vancill Landing, Mo.; 300 meters above hollow above Sublett Hollow; 1,300 meters below Indian Creek; 50 feet west of face of bluff; 25 feet east of a 14-inch oak, blazed with a triangle.

⊕ 23 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 28′ 02″.87; meters +89, −1,761.
Longitude 89° 24′ 13″.87; meters +341, −1,133.
Elevation: 363.49.
To⊕22 H, azimuth 330° 49′, distance 406 meters.
A stake, in Illinois bottom land; 26 feet east of center of track of St. Louis, Iron Mountain & Southern Railway (Illinois Division); 600 feet above road crossing; and about 1½ miles above Ware, Ill.

⊕ 22 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 27′ 51″.38; meters +1,584, −266.
Longitude 89° 24′ 05″.82; meters +143, −1,331.
Elevation: 359.
To⊕21 H, azimuth 341° 00′, distance 1,316 meters.
Two-inch iron pipe, in Illinois bottom land; 3.3 feet east of center of track of St. Louis, Iron Mountain & Southern Railway (Illinois Division); 800 feet below road crossing; and about 1¼ miles above Ware, Ill.

⊡ $\frac{17}{1}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 27′ 40″.36; meters +1,244, −606.
Longitude 89° 26′ 26″.13; meters +642, −833.
Elevation: Stone, 350.38; pipe, 355.48.
To ⊡ 17/2, azimuth 45° 15′, distance 623 meters.
Flat stone and iron pipe, one-half mile from river bank at Willard Landing, Ill.; 5 feet in front of fence on northeast side of "long field," which belongs to Willard heirs; and 550 feet above eastern corner of field.

⊡ $\frac{17}{2}$

Mississippi River Commission, 1884. (Chart No. 11.)
Latitude 37° 27′ 26″.13; meters +806, −1,044.
Longitude 89° 26′ 44″.14; meters +1,085, −390.
Elevation: 353.60.
To ◬ Moccasin Springs, azimuth 22° 10′, distance 1,917 meters.
To ⊡ 17/1, azimuth 225° 15′, distance 623 meters.
Stone post, in cultivated field of Willard estate, at Willard Landing, Ill.; 400 feet from river bank; 80 feet back of fence; 500 feet above log cabin; and 100 feet east of farmhouse.

⊕ 21 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 11.)
Latitude 37° 27′ 11″.02; meters +340, −1,510.
Longitude 89° 23′ 48″.39; meters +1,189, −286.
Elevation: 358.62.
To ⊕ 20 H, azimuth 350° 20′, distance 1,478 meters.
Two-inch iron pipe, in Illinois bottom land; west of the St. Louis, Iron Mountain and Southern Railway (Illinois Division); 600 meters above road crossing at Ware, Ill.; and 170 meters below northern end of siding.

△ SIMPSON 297.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1897. (Chart No. 11, station not plotted.)
Latitude 37° 26′ 44″.37; meters +1,368, −482.
Longitude 89° 27′ 05″.03; meters +124, −1,351.
To △ Simpson 299, azimuth 328° 45′ 49″, distance 1,443.8 meters.
Iron pin in rock, below high bank; on second point below Moccasin Springs, Mo.; 920 meters below river gauge; and in front of △ Bee Bluff.

△ BEE BLUFF.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 11.)
Latitude 37° 26′ 43″.36; meters +1,337, −513.
Longitude 89° 27′ 08″.62; meters +212, −1,263.
To ◬ Rich, azimuth 193° 27′ 10″, distance 7,419.6 meters.
To △ Vancill, azimuth 140° 05′ 42″, distance 3,836.5 meters.
Iron pipe, on highest part of Bee Bluff, Mo. (first bluff below and 3,200 feet from Moccasin Springs); 25 feet west of face of bluff; and 45 feet south of 20-inch oak tree blazed with triangle.

◬ MOCCASIN SPRINGS.

Mississippi River Commission, 1880–81. (Chart No. 11.)
Latitude 37° 26′ 28″.54; meters +880, −970.
Longitude 89° 27′ 13″.57; meters +334, −1,141.
To ◬ Bluff Lake, azimuth 282° 42′ 47″.70, distance 9,865.18 meters.
To ◬ Rich, azimuth 193° 32′ 25″.31, distance 7,892.25 meters.
To ◬ Clear Creek, azimuth 331° 17′ 03″.42, distance 13,769.21 meters.
To ◬ Indian Creek, azimuth 150° 45′ 48″.65, distance 9,577.75 meters.
To ⊡ 17/2, azimuth 202° 10′, distance 1,917 meters.
Stone marking post (top broken off), on highest point of Missouri bluffs; about seven-eighths mile below Moccasin Springs, Mo.; about 2½ miles above Bainbridge, Mo.; and 1,000 feet from river. Main ridge from small waterfall leads direct to station. Scattering timber in vicinity of station.

△ SIMPSON 299.

United States engineer office, St. Louis, Mo., 1878; redetermined 1897. (Chart No. 12, station not plotted.)
Latitude 37° 26′ 04″.33; meters +134, −1,716.
Longitude 89° 26′ 34″.58; meters +850, −625.
To △ Simpson 297, azimuth 148° 46′ 07″, distance 1,443.8 meters.
Iron pin in rock, on Missouri shore; downstream from Bee Bluff and 3,750 feet upstream from house at Sheppard Point. The rock is exposed at a 7-foot stage, St. Louis gauge.

⊕ WARE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 26′ 46″.25; meters +1,426, −424.
Longitude 89° 21′ 19″.08; meters +469, −1,006.
Elevation: 567.1 (stadia).
To ⊕ 20 H, azimuth 78° 34′, distance 3,491 meters.
A stake, on southwest slope of highest part of Illinois bluffs, due east of Ware, Ill., on St. Louis, Iron Mountain and Southern Railway (Illinois Division). The road that runs east from Ware turns southwardly along the bluffs, 600 meters above the station.

⊕ 20 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 26′ 23″.75; meters +732, −1,118.
Longitude 89° 23′ 38″.28; meters +941, −534.
Elevation: 356.57.
To ⊕ 19 H, azimuth 350° 18′, distance 894 meters.
A stake, in Illinois bottom land; 14.8 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); and 870 meters below road crossing at Ware, Ill.

⊕ 19 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 25′ 55″.18; meters +1,701, −149.
Longitude 89° 23′ 32″.14; meters +790, −685.
Elevation: 354.27.
To ⊕ 18 H, azimuth 350° 17′, distance 1,878 meters.
Two-inch iron pipe, in Illinois bottom land; 14.8 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1,780 meters below road crossing at Ware, Ill.; and 183 meters below signpost "One mile to Ware."

△ SHEPPARD.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 12.)
Latitude 37° 25′ 49″.95; meters +1,540, −310.
Longitude 89° 26′ 28″.02; meters +689, −786.
To △ Hurdle 5, '99, azimuth 265° 15′ 02″, distance 1,772.4 meters.
Iron pipe, on brow of the southernmost stone-faced bluff, above Sheppard Point, Mo.; 2,600 meters above Bainbridge Creek; 18 meters west of face of bluff, and 253 meters north of rail fence between timber and field.

⊙ P. B. M. 51.

Mississippi River Commission, 1881 and 1889; redetermined, United States engineer office, St. Louis, Mo., 1897. (Chart No. 12.)
Latitude 37° 25′ 44″.98; meters +1,387, −463.
Longitude 89° 26′ 23″.36; meters +574, −901.
Elevation: 344.92.
Center of copper bolt, leaded in the steeply inclined face of the last reliable ledge of rocks of the chain extending south from Moccasin Springs, Mo.; just above Sheppard Point where the bluffs begin to recede from the river; 2,400 meters above Bainbridge Creek; and 350 meters above railroad trestle above Widow Sheppard's house. The letters "U. S." are cut in the rock.

△ 8 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 25′ 42″.49; meters +1,310, −540.
Longitude 89° 26′ 23″.17; meters +570, −905.
To△10 F, azimuth 353° 47′, distance 926 meters.
Iron pipe, at Sheppard Point, Mo.; on slope of hill 9 meters back from "Frisco" railroad; 58½ meters above cattle guard at road crossing; 280 meters above railroad trestle above Sheppard's house; 16½ meters below telegraph pole 120/25; and 20 meters and 58 meters, respectively, above fences joining west right-of-way fence.

◎ BLUFF LAKE.

Mississippi River Commission, 1880–81. (Chart No. 12.)
Latitude 37° 25′ 17″.94; meters +553, −1,297.
Longitude 89° 20′ 42″.20; meters +1,038, −437.
To◎Clear Creek, azimuth 16° 57′ 27″.73, distance 10,351.34 meters.
To◎Rich, azimuth 141° 45′ 41″.94, distance 12,544.38 meters.
To◎Floral, azimuth 54° 22′ 49″.55, distance 14,149.53 meters.
To◎Moccasin Springs, azimuth 102° 46′ 45″.58, distance 9,865.18 meters.
To△Vancill, azimuth 115° 02′ 12″, distance 13,196.3 meters.
To△Flag 52, azimuth 46° 19′ 49″, distance 13,783.3 meters.
To⊕Lower Base H, azimuth 38° 04′, distance 6,260 meters.
To⊕Upper Base H, azimuth 68° 15′, distance 4,157 meters.
A 6-inch square stone post, broken off 2 inches below the ground, with small hole drilled in center of stone; 1,300 meters below the Hamburg and Jonesboro road; upon a grassy knob, about halfway down the slope from a long, narrow orchard on top of high bluff. Old burnt stump bears north 11° east 8½ feet; 18-inch white-oak blazed with triangle, north 88° east 24½ feet; blazed 12-inch hickory, south 25½° west 34 feet; black oak north 20.4 feet.

△ 10 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 25′ 12″.64; meters +390, −1,460.
Longitude 89° 26′ 19″.07; meters +469, −1,006.
To△12 F, azimuth 350° 10′, distance 961 meters.
Iron pipe, on highest point of knoll, opposite railroad cut halfway between Bowman, Mo., post-office (Bainbridge station) and Sheppard Point; 8 meters east of "Frisco" railroad; and 135 meters above upper end of Bainbridge siding.

⊕ 18 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 24′ 55″.26; meters +1,704, −146.
Longitude 89° 23′ 19″.22; meters +473, −1,003.
Elevation: 349.37.
To⊕Upper Base H, azimuth 00° 00′, distance 842 meters.
Two-inch iron pipe, in Illinois bottom land; 2¼ miles below Ware, Ill.; on St. Louis, Iron Mountain and Southern Railway (Illinois Division) and 1,300 meters above Illinois Central railroad station, Vineland; 13.1 feet west of center of track and about halfway down the embankment; about 600 meters above road crossing above Vineland; and 30 meters above trestle No. 141.

△ 12 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 24′ 41″.94; meters +1,293, −557.
Longitude 89° 26′ 12″.39; meters +305, −1,171.
Iron pipe, at Bainbridge, Mo. (Bowman post-office); 29 meters east from center of "Frisco" railroad and opposite the upper end of house track; 5 meters south of upper end of a revetment; 50 meters from milepost 122; 118 meters above road crossing; and 168 meters above northeast corner of railroad station.

⊡ $\frac{16}{1}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 24′ 35″.26; meters +1,087, −763.

Longitude 89° 24′ 12″.98; meters +319, −1,157.
Elevation: Stone, 344.92; pipe, 350.00.
To ⊡ 16/2, azimuth 73° 57′, distance 797 meters.
Flat stone and iron pipe, in Illinois; ¼ mile from left bank of river (foot of Hamburg Island); 1 meter west of rail fence which divides cultivated fields; and 350 meters north of fence corner at road.

⊡ $\frac{16}{2}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 24′ 28″.00; meters +863, −987.
Longitude 89° 24′ 44″.12; meters +1,085, −391.
Elevation: 349.34.
To ⊡ 16/1, azimuth 253° 57′, distance 797 meters.
Stone post, one-half mile back of foot of Hamburg Island, Ill.; 1 meter from back fence in orchard; 68 meters south of fence corner; 156 meters north of fence corner at road; and 110 meters from log house.

△ 14 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 23′ 30″.19; meters +931, −919.
Longitude 89° 26′ 03″.41; meters +84, −1,392.
To △ 12 F, azimuth 174° 17′, distance 2,222 meters.
Iron pipe, at Schenimann, Mo., 1¼ miles below Bainbridge, Mo. (Bowman post-office); 2 meters back from edge of projecting rock bluff, just west of "Frisco" railroad; at end of field where rock-faced bluff begins; and 178 meters below road crossing.

⊕ UPPER BASE, H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 24′ 27″.94; meters +862, −988.
Longitude 89° 23′ 19″.21; meters +473, −1,003.
Elevation: 349.03.
To ⊛ Bluff Lake, azimuth 248° 13′, distance 4,157 meters.
To ⊕ Lower Base H, azimuth 359° 58′, distance 3,387 meters.
To ⊕ 18 H, azimuth 180° 00′, distance 842 meters.
A stake, 10 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about 3 miles above Reynoldsville, Ill.; 250 meters below road crossing and about one-fourth of a mile above Vineland on the "Illinois Central."

⊙ P. B. M. 52.

Mississippi River Commission, 1881 and 1884. (Chart No. 12.)
Latitude 37° 23′ 14″.88; meters +459, −1,391.
Longitude 89° 26′ 03″.42; meters +84, −1,392.
Elevation: 349.65.
Center of copper bolt, leaded horizontally in vertical face of rock bluff in Missouri; about 1½ miles below Bainbridge Landing; directly back of "Frisco" railroad; on land of Sheppard heirs; 220 meters from right bank of river; 775 meters below Henry Schenimann's house; and 565 meters above the lower end of the bluff. The bolt is 1.2 meters above the ground and in a rock stratum 35 centimeters in thickness.

⊕ 17 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 23′ 07″.75; meters +239, −1,611.
Longitude 89° 23′ 19″.17; meters +472, −1,004.
Elevation: 352.23.
To ⊕ 16 H, azimuth 5° 10′, distance 1,028 meters.
Two-inch iron pipe, 1¾ miles above Reynoldsville, Ill.; 9.3 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); and 10 feet north of road crossing.

⊕ REYNOLDS H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 22′ 38″.36; meters +1,183, −667.
Longitude 89° 21′ 04″.79; meters +118, −1,358.
Elevation: 582.0 (stadia).
To ⊛ Clear Creek, azimuth 26° 19′, distance 5,556 meters.
A stake, on first prominent point of Illinois bluffs above valley or ravine where the Reynoldsville and bluff roads join, and about 900 meters therefrom.

⊕ LOWER BASE H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 22′ 37″.99; meters +1,171, −679.
Longitude 89° 23′ 19″.19; meters +472, −1,004.
Elevation: 351.83.
To⊕16 H, azimuth 41° 31′, distance 142 meters.
To⊕Upper Base H, azimuth, 179° 58′, distance 3,387 meters.
A stake, 7 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois division); three-quarters of a mile above Reynoldsville, Ill.; and 350 feet below road crossing.

⊕ 16 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 22′ 34″.55; meters +1,065, −785.
Longitude 89° 23′ 23″.01; meters +566, −910.
Elevation: 352.61.
To⊕15 H, azimuth 12° 57′, distance 1,294 meters.
To⊕Reynolds H, azimuth 268° 00′, distance 3,402 meters.
To⊕17 H, azimuth 185° 11′, distance 1,028 meters.
Iron pipe, 1,100 meters above Reynoldsville, Ill.; east of Illinois Central Railroad near wagon road paralleling same railroad and making slight turn near the pipe; 215 meters below angle in road; and in a fence corner.

⊕ 15 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 21′ 53″.59; meters +1,652, −198.
Longitude 89° 23′ 34″.80; meters +856, −621.
Elevation: 348.81.
To⊕14 H, azimuth 22° 48′, distance 2,269 meters
A stake, 500 feet below railroad station at Reynoldsville, Ill.; 750 feet below road crossing; and 7 feet east of track of St. Louis, Iron Mountain and Southern Railway (Illinois division).

⊡ $\frac{15}{3}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 21′ 51″.19; meters +1,578, −272.
Longitude 89° 26′ 00″.35; meters +9, −1,468.
Elevation: 350.38.
To⊡15/4, azimuth 109° 19′, distance 1,049 meters.
Stone post, on Kinney Point, Mo.; on top of ridge in cultivated field of W. A. Minton; 87 meters north of fence; 270 meters back from river; 1,100 meters below Poe Landing; and 350 meters above Taylor Landing, Mo.

△ FLAG 50.

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 21′ 17″.53; meters +540, −1,310.
Longitude 89° 24′ 33″.02; meters +813, −664.
Elevation: 352.14.
Stone post, in Illinois; back of Swift Sure Towhead; 1¼ miles above head of Devils Island; 700 meters from bank of chute back of towhead; beside road running down old river bank; in front of first barn below a schoolhouse; 2 feet south of a blazed cottonwood tree, on land of J. K. Walton; 3 feet west of fence; and 120 meters from schoolhouse. (Stone found leaning in 1908.)

⊡ $\frac{15}{1}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 21′ 17″.52; meters +540, −1,310.
Longitude 89° 23′ 59″.82; meters +1,472, −5.
Elevation: Stone, 348.45; pipe, 353.54.
Flat stone and iron pipe, in Illinois; 1¾ miles above head of Devils Island; about 70 meters west of Illinois Central Railroad and 1,500 meters below Reynoldsville; 1 meter from a rail fence on eastern side of a wide and deep slough; in edge of cultivated field; 60 meters south of corner of stableyard; and 120 meters south of house on land of J. K. Walton.

△ SWIFTSURE.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 12.)
Latitude 37° 21′ 00″.34; meters +11, −1,839.
Longitude 89° 25′ 18″.69; meters +460, −1,017.
To △ Devils '99, azimuth 45° 48′ 40″, distance 1,014.7 meters.
Iron pipe, in Illinois; ⅝ mile above head of Devils Island; 10 meters back from top and about 1,800 meters below head of the Swift Sure revetment; directly in front of and 13.5 feet from blazed 6-inch cottonwood tree and 13.9 feet from another blazed cottonwood.

⊛ FLORAL.

Mississippi River Commission, 1880–81. (Chart No. 12.)
Latitude 37° 20′ 50″.38; meters +1,553, −297.
Longitude 89° 28′ 29″.53; meters +727, −750.
Elevation: 453.0.
To ⊛ Sextons, azimuth 346° 08′ 41″.71, distance 10,963.46 meters.
To ⊛ Cape La Croix, azimuth 356° 57′ 08″.36, distance 11,016.98 meters.
To ⊛ Clear Creek, azimuth 280° 59′ 48″.75, distance 8,644.05 meters.
To ⊛ Bluff Lake, azimuth 234° 18′ 05″.81, distance 14,149.53 meters.
To △ Cape Girardeau, azimuth 41° 36′ 26″, distance 5,909.5 meters.
To △ Flag 52, azimuth 309° 43′ 20″, distance 1,994.3 meters.
Stone post, on right bank of river; about 4 miles above Cape Girardeau, Mo.; on top of highest bluff and directly back from mouth of Flora Creek; on land owned by Doyle Brothers; in heavy timber; close to river face of bluff and 4 inches above surface of ground. A timber road passes along the ridge 4 meters back of the station; and a 30-inch white oak tree blazed with triangle facing stone is 125°, 4 meters distant.

⊕ 14 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 20′ 45″.73; meters +1,410, −440.
Longitude 89° 24′ 10″.53; meters +259, −1,218.
Elevation: 351.47.
To ⊛ Clear Creek, azimuth 305° 35′, distance 2,594 meters.
Iron pipe, on Illinois Central Railroad right of way near point of intersection of curve, 1½ miles below Reynoldsville, Ill., and 15 feet east of track; between said railroad and St. Louis, Iron Mountain and Southern Railway (Illinois Division); 80 feet west of the latter and 1,200 meters below a road crossing both railroads.

△ DEVILS '99.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 12.)
Latitude 37° 20′ 37″.40; meters +1,153, −697.
Longitude 89° 25′ 48″.25; meters +1,188, −289.
To △ Hurdle 11, azimuth 75° 08′ 22″, distance 3,384 meters.
To △ Swiftsure, azimuth 225° 48′ 22″, distance 1,014.7 meters.
Iron pipe, head of Devils Island, Ill.; at top of revetment and near its upstream end; 22.5 feet from 15-inch blazed elm stump, in revetment; and 11.1 feet out from 12-inch blazed hackberry tree.

⊡ $\frac{14}{3}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 20′ 29″.11; meters +897, −953.
Longitude 89° 29′ 13″.17; meters +324, −1,153.
Elevation: Stone, 390.36.
To ⊡ 14/2, azimuth 338° 17′, distance 1,859 meters.
Flat stone and iron pipe, in Missouri; on land of Edmond Hubbs; 400 meters from river bank; about 1 mile above Cape Rock; 500 meters below Little Flora Creek; on top of second ridge east of a well-traveled road and 1 meter from fence. (Pipe was missing in 1908.)

△ HURDLE 11.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 12.)
Latitude 37° 20′ 09″.23; meters +285, −1,565.

Longitude 89° 28′ 01″.12; meters + 28, −1,449.
To△ Devils '99, azimuth 255° 07′ 02″, distance 3,384 meters.
Nail in center of pile, in second row of clumps in hurdle No. 11, near foot of Devils Island and about 730 feet from shore end of hurdle. Five clumps in upper row above station have piles to full height. Station is between fourth and fifth of these clumps from shore end. The pile is marked on downstream side by red-and-white signal pole. Nail is in southwest pile of clump and is surrounded by six other nails.

△ FLAG 52.

Mississippi River Commission, 1880–81. (Chart No. 12.)
Latitude 37° 20′ 09″.04; meters +279, −1,571.
Longitude 89° 27′ 27″.21; meters +670, −807.
Elevation: 346.91.
To◬ Bluff Lake, azimuth 226° 15′ 44″, distance 13,783.3 meters.
To◬ Floral, azimuth 129° 43′ 58″, distance 1,994.3 meters.
Stone post, on Devils Island, on left bank of river; 1 mile from foot of island; 300 feet from river bank in woods and 30 feet from fence; 300 feet from northeast corner of field, and 650 feet east of hurdle No. 9. A 12-inch blazed elm tree stands 40 feet east; a 10-inch blazed hackberry 20 feet south. A wooden post stands beside stone.

△ DEVILS No. 2.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 12.)
Latitude 37° 20′ 08″.59; meters +265, −1,585.
Longitude 89° 27′ 45″.83; meters +1,128, −349.
Iron pipe, on Devils Island, Ill.; ½ mile above a point opposite mouth of Flora Creek, in Missouri; on north edge of old stone dike, exposed at about a 16-foot stage, St. Louis gauge; 60 feet west of high bank on which stands a house, and 900 feet south of new hurdle No. 9.

◬ CLEAR CREEK.

Mississippi River Commission, 1880–81. (Chart No. 12.)
Latitude 37° 19′ 56″.75; meters +1,750, −100.
Longitude 89° 22′ 44″.84; meters +1,104, −373.
Elevation: 615.2 (stadia).
To◬ Floral, azimuth 101° 03′ 17″.82, distance 8,644.05 meters.
To◬ Sextons, azimuth 33° 08′ 21″.30, distance 10,735.88 meters.
To◬ Bluff Lake, azimuth 196° 56′ 13″.28, distance 10,351.34 meters.
To◬ Moccasin Springs, azimuth 151° 19′ 46″.59, distance 13,769.21 meters.
To△ Cape Girardeau, azimuth 77° 28′ 35″.
To△ Flag 57, azimuth 56° 10′ 18″, distance 12,354 meters.
To△ Flag 54, azimuth 82° 24′ 28″, distance 9,875.7 meters.
Stone marking post, in Illinois; on bluffs about east of the village of Clear Creek; on land owned by Mr. Cox. To reach the station take the road leading up Clear Creek from Clear Creek Village and follow it about three-quarters of a mile beyond where road comes to bluffs; station stands on high point just above this road. In front of little ravine leading up to station the road has been cut quite a little below general level of land by water running down it. Geodetic point is hole in top of stone.

⊕ 13 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 19′ 49″.93; meters +1,539, −311.
Longitude 89° 24′ 44″.33; meters +1,091, −386.
Elevation: 351.87.
To◬ Clear Creek, azimuth 265° 55′, distance 2,949 meters.
To⊕ 14 H, azimuth 205° 50′, distance 1,910 meters.
Iron pipe in Illinois; 25 feet east of Illinois Central Railroad and 85 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about three-quarters of a mile above McClure Station and five-eighths of a mile above bridge at Clear Creek; near point of curve of "Illinois Central," where the latter leaves the "Iron Mountain" and 75 feet west of ⊕ 12 H.

⊕ 12 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 19′ 49″.60; meters +1,529, −321.
Longitude 89° 24′ 43″.50; meters +1,071, −406.
Elevation: 348.42.
A stake, in Illinois; 9.3 feet west of center of track of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about three-quarters of a mile above McClure Station; five-eighths of a mile above Clear Creek; and nearly opposite point of curve of the "Illinois Central" where it leaves the "Iron Mountain."

△ CAPE ROCK '04.

United States engineer office, St. Louis, Mo., 1904. (Chart No. 12.)
Latitude 37° 19′ 41″.13; meters +1,268, −582.
Longitude 89° 29′ 43″.68; meters +1,075, −402.
To △ Minton, azimuth 4° 02′ 16″, distance 1,212.1 meters.
To △ Cape Girardeau, azimuth 42° 33′ 12″, distance 3,101.8 meters.
Hole surrounded by triangle in large rock, with surface sloping toward river and inclined about 30° from the horizontal; about 2½ miles above Cape Girardeau, Mo.; on point at Cape Rock; on slope of bank; 140 meters below Cape Creek; and near Government light.

⊡ $\frac{14}{2}$

Mississippi River Commission, 1884. (Chart No. 12.)
Latitude 37° 19′ 33″.09; meters +1,020, −830.
Longitude 89° 28′ 45″.23; meters +1,113, −364.
Elevation: 350.22.
To ⊡ 14/1, azimuth 338° 21′, distance 994 meters.
To ⊡ 14/3, azimuth 158° 17′, distance 1,859 meters.
Stone post, on Minton Point, Ill.; in cultivated field; 1 meter from fence and 130 meters above a fence corner; 200 meters from river bank; and 430 meters below mouth of Devils Island chute. There is a well-traveled wagon road just in front of fence and fringe of large timber between the road and river.

⊕ 11 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 12.)
Latitude 37° 19′ 11″.31; meters +349, −1,501.
Longitude 89° 25′ 06″.62; meters +163, −1,314.
Elevation: 350.38.
To ⊕ 12 H, azimuth 205° 46′, distance 1,310 meters.
Iron pipe, at McClure Station, Ill.; 8 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 250 meters below Clear Creek; and 8 meters south of wagon road crossing, about 100 meters above the depot. It is 1,000 meters east of the town of McClure on the Illinois Central.

△ FLAG 54.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 19′ 14″.24; meters +439, −1,411.
Longitude 89° 29′ 22″.42; meters +552, −925.
Elevation: 350.30.
To ◎ Clear Creek, azimuth 262° 20′ 27″, distance 9,875.7 meters.
To ◎ Cape La Croix, azimuth 346° 46′ 15″, distance 8,256.5 meters.
To ◎ Sextons, azimuth 332° 54′ 24″, distance 8,627.1 meters.
Stone post, on left bank; 1 mile below Minton Point; 1,300 meters above East Cape Girardeau, Ill., on land of Jesse Minton; 130 meters from river bank; south side of road leading east from Barney Randall's warehouse; 100 meters back of farmhouse; 6 feet northwest of 2-foot blazed cottonwood tree; and 2 feet southwest of a 1-foot blazed sycamore.

⊡ $\frac{14}{1}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 19′ 03″.12; meters +96, −1,754.
Longitude 89° 28′ 30″.33; meters +747, −730.
Elevation: Stone 341.70; pipe, 346.80.
To ⊡ 14/2, azimuth 158° 21′, distance 994 meters.

Flat stone and iron pipe, in Illinois and 1,250 meters south from Minton Point; 1,900 meters east from △Minton, on land of Eliza McGee; 1 meter from rail fence on south side of large field; and 80 meters east of corner of field. A lane runs alone east side of field to river.

△ MINTON.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13.)
Latitude 37° 19′ 01″.91; meters +59, —1,791.
Longitude 89° 29′ 47″.15; meters +1,161, —316.
Elevation: 346.41.
To△Court House, azimuth 57° 20′ 13″, distance 2,521.8 meters.
To△Union Mill, azimuth 58° 35′ 30″, distance 2,237.6 meters.
To△Cape Rock '04, azimuth 184° 02′ 14″, distance 1,212.1 meters.
To△Cape Girardeau, azimuth 61° 52′ 09″, distance 2,281.8 meters.
To△St. Vincent, azimuth 43° 32′ 16″, distance 3,203.7 meters.
To△Pumping Station, azimuth 80° 36′ 47″, distance 1,702.2 meters.
To△Marble City Mills, azimuth 62° 38′ 37″, distance 2,153 meters.
Iron pipe, painted white, on left bank and one-half mile above East Cape Girardeau, Ill.; near group of large trees on river side of road; about 200 feet above Hurdle No. 1; 300 feet south of southwest corner of house; 46 feet west of 36-inch blazed cottonwood tree and 41 feet north of 30-inch blazed sycamore tree.

△ PUMPING STATION.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13.)
Latitude 37° 18′ 52″.90; meters +1,631, —219.
Longitude 89° 30′ 55″.35; meters +1,363, —115.
Iron stack of waterworks above Cape Girardeau, Mo.

△ MARBLE CITY MILLS.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13, station not plotted.)
Latitude 37° 18′ 29″.81; meters +919, —931.
Longitude 89° 31′ 04″.80; meters +118, —1,359.
Brick chimney of the Marble City mills at Cape Girardeau, Mo.

△ CAPE GIRARDEAU = ⊡ 13/3

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 18′ 27″.01; meters +833, —1,017.
Longitude 89° 31′ 08″.86; meters +218, —1,260.
Elevation: 439.48.
To◎Floral, azimuth 221° 34′ 50″, distance 5,909.5 meters.
To◎Cape La Croix, azimuth 325° 33′ 30″, distance 7,979.4 meters.
To◎Clear Creek, azimuth 257° 23′ 29″.
To◎Sextons, azimuth 313° 31′ 20″.
To△Minton, azimuth 241° 51′ 19″, distance 2,281.8 meters.
To△Cape Rock, azimuth 222° 32′ 20″, distance 3,101.8 meters.
To△College Point, azimuth 0° 30′ 54″, distance 1,147.5 meters.
To△Flag 55, azimuth 308° 52′ 43″, distance 1,515.2 meters.
To△Flag 57, azimuth 332° 21′ 57″, distance 4,647.1 meters.
To△St. Vincent, azimuth 8° 51′ 18″, distance 1,261.7 meters.
To⊙P. B. M. 54, azimuth 326° 10′, distance 191 meters.
To⊡13/2, azimuth 281° 52′, distance 1,642 meters.
Square stone post, on site of old Fort "A" in Cape Girardeau, Mo.; on high hill near old lime kiln, between Marble City mill and Union flour mill; just north of Belleview street; 3 feet east of fence and 15 feet north of southeast corner of garden.

△ UNION MILL (Cape Girardeau.)

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13, station not plotted.)
Latitude 37° 18′ 24″.08; meters +742, —1,108.
Longitude 89° 31′ 04″.69; meters +116, —1,362.
Brick chimney of Union mill at Cape Girardeau, Mo.

⊙ P. B. M. 54.

Mississippi River Commission, 1881 and 1884. (Chart No. 13.)
Latitude 37° 18′ 21″.87; meters +674, —1,176.
Longitude 89° 31′ 04.″54; meters +112, —1,366.
Elevation: 353.51.
To △ Cape Girardeau, azimuth 146° 10′, distance 191 meters.
Center of horizontal copper bolt, in the outer vertical face of stone step, which extends under buttress at the northeast corner, second entrance from the north, to Riverview Hotel on Water street, Cape Girardeau, Mo.

△ COURT-HOUSE.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13.)
Latitude 37° 18′ 17″.76; meters +548, —1,302.
Longitude 89° 31′ 13″.35; meters +329, —1,149.
Center of dome of court-house at Cape Girardeau, Mo.

⊡ $\frac{13}{2}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 18′ 16″.06; meters +495, —1,355.
Longitude 89° 30′ 03″.62; meters +89, —1,389.
Elevation: 344.23.
To △ Cape Girardeau, azimuth 101° 52′, distance 1,642 meters.
To △ Flag 55, azimuth 34° 54′, distance 748 meters.
To ⊡ 13/1, azimuth 281° 48′, distance 609 meters.
Stone post, on the east bank of a prominent slough in Illinois; due east from dome of court-house in Cape Girardeau, Mo.; 400 meters from river bank; 275 meters south of road running east from river; 6 meters southeast of pecan tree; a little south of east from a two-story house, with square, flat roof, east of old railroad incline.

⊡ $\frac{13}{1}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 18′ 12″.03; meters +371, —1,479.
Longitude 89° 29′ 39″.43; meters +971, —507.
Elevation: Stone, 343.86; pipe, 350.03.
To ⊡ 13/2, azimuth 101° 48′, distance 609 meters.
Flat stone and iron pipe, 1,000 meters from old "Illinois Central" incline below East Cape Girardeau, Ill.; on land of C. Cherry; 375 meters south of road running east from river; directly south of log house standing near and on south side of lane; and about 400 meters west of lane running north and south.

△ FLAG 55.

Mississippi River Commission, 1880-81. (Chart No. 13.)
Latitude 37° 17′ 56″.17; meters +1,732, —118.
Longitude 89° 30′ 20″.99; meters +517, —961.
Elevation: 346.94.
To ◎ Sextons, azimuth 314° 27′ 54″, distance 7,527.7 meters.
To ◎ Cape La Croix, azimuth 329° 22′ 40″, distance 6,543 meters.
To △ Cape Girardeau, azimuth 128° 53′ 12″, distance 1,515.2 meters.
To ⊡ 13/2, azimuth 214° 54′, distance 748 meters.
Stone post, in Illinois and opposite Young Ladies' Academy at Cape Girardeau, Mo.; on land of Lawyer Houck; 650 feet from river bank; and 4 feet south of a blazed 2-foot cottonwood tree.

△ COLLEGE POINT.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 13, station not plotted.)
Latitude 37° 17′ 49″.79; meters +1,535, —315.
Longitude 89° 31′ 09″.28; meters +229, —1,249.
To △ Cape Girardeau, azimuth 180° 30′ 54,″ distance 1,147.5 meters.
Iron pipe, on prominent point on right bank of river; near northern boundary of St. Vincent College in Cape Girardeau, Mo.; on small grassy mound on high rock bank; 1,150 feet below train shed; 850 feet below lower stone dike; and 45 feet on river side of main railroad track. (Not found, 1908.)

△ ST. VINCENT.

United States engineer office, St. Louis, Mo., 1897. (Chart No. 13.)
Latitude 37° 17′ 46″.57; meters +1,436, −414.
Longitude 89° 31′ 16″.75; meters +413, −1,065.
Center of cross on St. Vincent College at Cape Girardeau, Mo.

⊕ 10 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 17′ 44″.56; meters +1,374, −476.
Longitude 89° 25′ 59″.03; meters +1,454, −24.
Elevation: 346.65.
To⊕11 H, azimuth 205° 47′, distance 2,968 meters.
Iron pipe, 8 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 1¼ miles below station at McClure, Ill.; and 640 feet below trestle No. 143.

△ LEMING'S MILL.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 13.)
Latitude 37° 17′ 29″.47; meters +909, −941.
Longitude 89° 31′ 20″.17; meters +497, −981.
Round iron stack of Leming's upper sawmill near lower part of Cape Girardeau, Mo.

⊕ 8 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 17′ 28″.86; meters +890, −960.
Longitude 89° 26′ 05″.27; meters +130, −1,348.
Elevation: 345.09.
To⊕9 H, azimuth 193° 14′, distance 252 meters.
Iron pipe, 25 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); about 2 miles below station at McClure, Ill.; 550 feet below trestle No. 144; and near lower point of curve.

⊡ $\frac{12}{1}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 16′ 21″.91; meters +676, −1,174.
Longitude 89° 30′ 07″.87; meters +194, −1,284.
Elevation: Stone, 345.04; pipe, 350.13. (Pipe, 348.51, 1908.)
To△Flag 57, azimuth 291° 45′, distance 703 meters.
To⊡12/2, azimuth 58° 49′, distance 608 meters.
Flat stone and iron pipe, in Illinois bottom land; 700 meters from river bank and about 1,100 meters below Giboney Island; near edge of timber; and 2 meters from southwest bank of old slough

△ FLAG 57.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 16′ 13″.46; meters +415, −1,435.
Longitude 89° 29′ 41″.36; meters +1,019, −459.
Elevation: 344.35.
To◬Sexton's, azimuth 295° 35′ 54″, distance 4,873.7 meters.
To◬Clear Creek, azimuth 236° 06′ 06″, distance 12,354 meters.
To◬Cape La Croix, azimuth 316° 16′ 34″, distance 3,409.8 meters.
To△Cape Girardeau, azimuth 152° 22′ 50″, distance 4,647.1 meters.
To⊡12/1, azimuth 111° 45′, distance 703 meters.
Stone post, on left bank; 2½ miles below East Cape Girardeau, Ill.; 300 feet west of county road; 3,300 feet from river bank; 175 feet southwest of A. Weather's house; and 7 feet northwest of a 30-inch blazed cotton-wood tree.

⊕ 7 H.

Board on Examinaton and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 16′ 11″.78; meters +363, −1,487.
Longitude 89° 26′ 18″.54; meters +457, −1,021.
Elevation: 344.59.
To⊕8 H, azimuth 187° 50′, distance 2,397 meters.

Iron pipe, 10.7 feet west of St. Louis, Iron Mountain and Southern Railway (Illinois Division); 17 feet east from spur track leading to Illinois Central Railroad; 1¼ miles above Gale, Ill.; 1,250 meters above bridge over Sexton Creek; and at point of nearest approach of creek to railroad in this vicinity.

⊡ $\frac{12}{2}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 16′ 11″.70; meters +361, —1,489.
Longitude 89° 30′ 28″.97; meters +714, —764.
Elevation: 344.05.
To⊡12/1, azimuth 238° 49′, distance 608 meters.
Stone post, 75 meters from left bank of river; about 1,150 meters below Giboney Island; in timber and 600 meters below edge of cultivated field.

⊡ $\frac{11}{1}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 15′ 39″.28; meters +1,211, —639.
Longitude 89° 27′ 20″.53; meters +506, —973.
Elevation: Stone, 336.42; pipe, 341.51.
To⊡11/2, azimuth 38° 21′, distance 658 meters.
Flat stone and iron pipe, 1,300 meters above roundhouse at Gale, Ill.; 1,000 meters from river bank, opposite Grays Point, Mo.; in cultivated field; and 100 meters toward river from edge of timber. (Pipe lying on ground, stone not found, 1907.)

⊡ $\frac{12}{3}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 15′ 36″.48; meters +1,124, —726.
Longitude 89° 31′ 40″.78; meters +1,005, —474.
Elevation: 344.63.
To⊡12/4, azimuth 58° 26′, distance 758 meters.
Stone post, on right bank and 3 miles below Cape Girardeau, Mo.; on land of St. Vincent College; 150 meters from river bank; 10 meters east of Cape La Croix Creek; 3 meters west of fence running to a large two-story white house; and 75 meters from bend in fence.

⊕ 3 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 15′ 34″.24; meters +1,056, —794.
Longitude 89° 26′ 31″.45; meters +775, —704.
Elevation: 340.67.
Iron pipe, in Illinois bottom land; 22 feet east of main track of Illinois Central Railroad (Carbondale and Cairo Division); directly opposite and west of wagon and railroad bridges over Sexton Creek; ¾ mile above Gale, Ill.; and just above upper end of the Illinois Central Railroad yards.

⊡ $\frac{12}{4}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 15′ 23″.62; meters +728, —1,122.
Longitude 89° 32′ 06″.97; meters +172, —1,307.
Elevation: Stone, 342.03; pipe, 347.13.
To⊡12/3, azimuth 238° 26′, distance 758 meters.
Flat stone and iron pipe, on right bank of river and 3 miles below Cape Girardeau, Mo.; 900 meters from river bank and 700 meters back from Cape La Croix Creek; on land of St. Vincent College; 1 meter north of fence, on north side of field; about 250 meters out from timber; 150 meters from northwest corner of field; and 2 meters north of a 6-foot cotton-wood tree.

⊡ 11/2

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 15′ 22″.55; meters +695, −1,155.
Longitude 89° 27′ 37″.10; meters +914, −565.
Elevation: 340.23.
To◬Cape La Croix, azimuth 38° 16′, distance 1,140 meters.
To⊡11/1, azimuth, 218° 21′, distance 658 meters.
Stone post, in Illinois bottom land and opposite Grays Point, Mo.; 1,050 meters above roundhouse at Gale, Ill.; 300 meters from river bank; in field, and 125 meters back from road along old high river bank.

⊕ 2 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 15′ 14″.14; meters +436, −1,414.
Longitude 89° 26′ 47″.16; meters +1,162, −317.
Elevation: 340.22.
To◬Sextons, azimuth 339° 58′, distance 298 meters.
To⊕3 H, azimuth 211° 58′, distance 730 meters.
A stake, on left bank of river; 23 feet east of center of track of Illinois Central Railroad (Carbondale and Cairo Division); about 880 feet above northern end of Gales railroad station (Illinois Central); and near lower end of the railroad yards.

⊕ 1 H.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 13.)
Latitude 37° 15′ 06″.87; meters +212, −1,638.
Longitude 89° 26′ 52″.76; meters +1,300, −179.
Elevation: 344.00.
To◬Sextons, azimuth 283° 03′, distance 247 meters.
To⊕2 H, azimuth 211° 48′, distance 264 meters.
Iron pipe, 25 feet east of center of main track of Illinois Central Railroad (Carbondale and Cairo division); at lower end of main side tracks of the Illinois Central Railroad, and 15.8 feet north of northern end of Gale station.

◬ SEXTONS.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 15′ 05″.07; meters +156, −1,694.
Longitude 89° 26′ 42″.99; meters +1,059, −420.
To◬Cape La Croix, azimuth 80° 05′ 31″.57, distance 2,070.64 meters.
To◬Day, azimuth 21° 26′ 22″.24, distance 2,153.77 meters.
To◬Floral, azimuth 166° 09′ 46″.26, distance 10,963.46 meters.
To◬Clear Creek, azimuth 213° 05′ 57″.00, distance 10,735.88 meters.
To△Cape Girardeau, azimuth 133° 34′ 00″.
To△Flag 55, azimuth 134° 30′ 06″, distance 7,527.7 meters.
To△Flag 57, azimuth 115° 37′ 42″, distance 4,873.7 meters.
Hole in center of stone marking post, on Illinois bluffs; on second high point of first high bluff above the mouth of Sexton Creek; east from Illinois Central Railroad station at Gale, Ill.; on land owned by J. N. Gale. To reach the station take road leading back from river bank near the head of Rock Island; follow road across creek and both railroads to signboard "Robinson spur," then turning to the left follow the woods road, beginning at that point, up the bluff; road passes 2 meters west of station.

⊡ B. M. E.=△ GRAYS.

Mississippi River Commission, 1883; redetermined, United States engineer office, St. Louis, Mo., 1899. (Chart No. 13, station not plotted.)
Latitude 37° 14′ 59″.21; meters +1,825, −25.
Longitude 89° 27′ 53″.45; meters +1,317, −161.
Elevation: 334.20.
To△Rock Island, azimuth 301° 51′ 31″, distance 1,017.7 meters.
Iron bolt leaded in solid rock, on right bank; 50 feet east of Grays Point gauge, near bulletin board.
Elevation determined in December, 1908, by precise levels from precise level bench marks 61 and 58, 335.25.

◎ CAPE LA CROIX=⊡ 11/3

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 14′ 53″.51; meters +1,650, —200.
Longitude 89° 28′ 05″.76; meters +142, —1,337.
Elevation: 480.67
To◎Floral, azimuth 176° 57′ 22″.76, distance 11,016.98 meters.
To◎Sextons, azimuth 260° 04′ 41″.47, distance 2,070.64 meters.
To◎Grand Chain, azimuth 8° 57′ 09″.63, distance 3,461.35 meters.
To◎Day, azimuth 322° 45′ 28″.89, distance 2,070.31 meters.
To△Cape Girardeau, azimuth 145° 35′ 21″, distance 7,979.4 meters.
To△Flag 57, azimuth 136° 17′ 32″, distance 3,409.8 meters.
To△Flag 55, azimuth 149° 24′ 02″, distance 6,543 meters.
To⊡11/2, azimuth 218° 16′, distance 1,140 meters.

Stone post, on top of Missouri bluffs just above Grays Point, and on land of Capt. Edw. Gray; 1,000 feet from river bank. To reach station land at first little ravine above Grays Point and climb bluff to the left. Stone is on point of ridge and a small cemetery is on low ridge, toward river from stone.

⊙ P. B. M. 57.

Mississippi River Commission, 1881 and 1884. (Chart No. 13.)
Latitude 37° 14′ 53″.47; meters +1,648, —202.
Longitude 89° 29′ 05″.49; meters +135, —1,344.
Elevation: 350.74.

Center of horizontal copper bolt, set in smooth vertical face of Missouri bluff; 350 meters below mouth of Cape La Croix Creek, and about 1,800 meters above Grays Point gauge, being just in view of the lower part of Cape Girardeau; in ledge of blue or gray limestone, at its upper or western extremity, on land of the Taylor estate. It is 0.8 meter above the ground; 1 meter below top of vertical part, and 10 meters downstream from point where the ledge disappears under the ground. The letters "U. S. P. B. M." are cut in the face of the rock.

△ ROCK ISLAND.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 13, station not plotted.)
Latitude 37° 14′ 41″.78; meters +1,288, —562.
Longitude 89° 27′ 18″.38; meters + 452, —1,027.
To⊡B. M. E.=△Grays, azimuth 121° 51′ 53″, distance 1,017.7 meters.

Wire nail in center of triangle cut in large flat bowlder, on lower side of Rock Island, on left side of channel; about 100 feet from high bank and opposite Grays Point, Mo.; station is about 150 feet downstream from government light tree on the island, and about on line with the tree and the shore end of "Cotton Belt" incline, just below Graysboro, Mo.

◎ NORTH BASE.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 14′ 26″.69; meters +823, —1,027.
Longitude 89° 27′ 49″.10; meters +1,210, —269.
To◎Day, azimuth 314° 17′ 15″.39, distance 1,176.47 meters.
To◎South Base, azimuth 21° 08′ 51″.48, distance 1,240.22 meters.

Cross on copper bolt leaded into stone marking post, 1 foot under ground, at the upper end of Graysboro, Mo.; 1,400 meters above mouth of Dorrity Creek; 150 meters northeastwardly from railroad roundhouse; between railroad track to incline and track to roundhouse; on land of Capt. Edw. Gray, and 500 feet above line fence between Gray and Houck.

Magnetic bearing to dome of court-house at Thebes, Ill., south 13° east; to ◎ South Base, south 15¼° west; to ◎Cape La Croix, north 32° west. Surface mark is a black walnut post 6 inches square branded "U. S." with mound built around it.

◎ DAY.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 14′ 00″.04; meters +1, —1,849.
Longitude 89° 27′ 14″.93; meters +368, —1,111.
Elevation: 473.67

To ◎ North Base, azimuth 134° 17′ 32″.83, distance 1,176.47 meters.
To ◎ South Base, azimuth 75° 26′ 03″.12, distance 1,332.46 meters.
To ◎ Sextons, azimuth 201° 26′ 02″.91, distance 2,153.77 meters.
To ◎ Cape La Croix, azimuth 142° 45′ 59″.65, distance 2,070.31 meters.
To ◎ Thebes, azimuth 0° 19′ 03″.47, distance 2,747.74 meters.
To ◎ Grand Chain, azimuth 45° 20′ 19″.68, distance 2,519.18 meters.

Stone post, in cleared spot on Illinois bluffs, about three-quarters of a mile above Thebes and 1,000 feet from the river. It is on land owned by Mr. Day, and directly back from prominent point where rock exposed at low water projects out into river. A small house close to river bank stands at upper end of bluff.

◎ SOUTH BASE.

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 13′ 49″.17; meters +1,516, −334.
Longitude 89° 28′ 07″.25; meters +179, −1,300.
To ◎ Day, azimuth 255° 25′ 31″.47, distance 1,332.46 meters.
To ◎ Thebes, azimuth 332° 08′ 48″.96, distance 2,728.50 meters.
To ◎ North Base, azimuth 201° 08′ 37″.27, distance 1,240.22 meters.

Cross on copper bolt leaded into stone marking post, 1 foot under ground; on center line, prolonged, of road leading to bluffs from lower end of Graysboro, Mo.; near top of river bank; on land owned by Lawyer Houck; about 100 feet above line fence between Houck and Hinman. Magnetic bearing to dome of court-house at Thebes, Ill., south 37½° east; to dome on schoolhouse, at Thebes, south 48° east; to ◎ North Base, north 15¼° east. Surface mark is a black locust post 6 inches square branded "U. S.," with a mound built around it.

△ THEBA.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 13, station not plotted.)
Latitude 37° 13′ 23″.37; meters +720, −1,129.
Longitude 89° 27′ 47″.96; meters +1,182, −297.
To △ Dorrity, azimuth 84° 22′ 27″, distance 690.9 meters;
To △ Chain, azimuth 4° 49′ 02″, distance 936.4 meters.

Hole in large rock or bowlder, below high left bank and nearly in line with north line of schoolhouse at upper end of Thebes, Ill.

△ DORRITY.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 13, station not plotted.)
Latitude 37° 13′ 21″.17; meters +653, −1,197.
Longitude 89° 28′ 15″.85; meters +391, −1,088.
To △ Theba, azimuth 264° 22′ 10″, distance 690.9 meters.
To △ Chain, azimuth 324° 51′ 40″, distance 1,058.1 meters.

Hole surrounded by triangle in largest bowlder of first group below Manning Landing, Mo.; 1,000 feet below lower end of warehouse, and 150 feet out from high bank.

△ GABLE OF COURT-HOUSE.

United States engineer office, St. Louis, 1899. (Chart No. 13.)
Latitude 37° 13′ 10″.23; meters +315, −1,535.
Longitude 89° 27′ 37″.50; meters +925, −555.
Front gable of court-house at Thebes, Ill.

◎ GRAND CHAIN— ⊡ $\frac{10}{4}$

Mississippi River Commission, 1880–81. (Chart No. 13.)
Latitude 37° 13′ 02″.59; meters +80, −1,770.
Longitude 89° 28′ 27″.61; meters +681, −798.
Elevation: Stone, 435.08; pipe, 439.03.
To ◎ Day, azimuth 225° 19′ 35″.71, distance 2,519.18 meters.
To ◎ Uncle Joe, azimuth 347° 04′ 48″.60, distance 2,252.82 meters.
To ◎ Thebes, azimuth 298° 47′ 37″.35, distance 2,027.48 meters.
To ⊡ 10/3, azimuth 272° 33′, distance 103 meters.

Tile and iron pipe (originally a stone post), on Missouri bluffs; about 300 feet north of point of curve of west approach of Thebes Bridge; and on edge of cleared field.

⊡ $\frac{10}{3}$

Mississippi River Commission, 1884. (Chart No. 13.)
Latitude 37° 13′ 02″.44; meters +75, −1,775.
Longitude 89° 28′ 23″.45; meters +578, −901.
Elevation: Stone, 349.05; pipe, 353.
To◎Grand Chain, azimuth 92° 33′, distance 103 meters.
To⊡10/2, azimuth 272° 36′, distance 1,088 meters.
Tile and iron pipe, on Missouri bank; in woods and 110 meters back from river; 20 meters east of road; on edge of railroad right of way; about 100 meters north of Thebes Bridge and almost on line with tangent of "Frisco" railroad that passes under the bridge.

⊡ U. S. B. M. 44.

United States engineer office, St. Louis, Mo., 1872. (Chart No. 13.)
Latitude 37° 12′ 34″.86; meters +1,075, −775 (scaled from map).
Longitude 89° 28′ 18″.08; meters +446, −1,034 (scaled from map).
Elevation: 325.05. (Precise levels, December, 1908, 325.33.)
Square knob on first large bowlder of "Grand Chain," on Missouri shore; 125 feet below second creek below Thebes Bridge; 60 feet east of blazed 8-inch cottonwood tree; and on line with second bridge pier, from Illinois side, and Thebes Hotel.

⊡ $\frac{10}{2}$

Mississippi River Commission, 1884. (Chart No. 14.)
Latitude 37° 13′ 00″.84; meters +26, −1,824.
Longitude 89° 27′ 39″.38; meters +971, −508.
Elevation: 358.27.
To⊡10/3, azimuth 92° 36′, distance 1,088 meters.
Stone post, on front slope of bluffs, in Thebes, Ill.; about 100 meters below lower house at foot of bluffs; a few meters back of road; and directly in front of a large blazed beech tree. A vertical face of rocks 200 meters from river bank is just back of station.

△ CHAIN.

United States engineer office, St. Louis, Mo., 1896 and 1899. (Chart No. 14.)
Latitude 37° 12′ 53″.10; meters +1,637, −213.
Longitude 89° 27′ 51″.15; meters +1,261, −218.
Elevation: 321.25.
To△Theba, azimuth 184° 49′ 06″, distance 936.3 meters (1896).
To△Theba, azimuth 184° 49′ 00″, distance 936.4 meters (1899).
To△Hut, azimuth 338° 09′ 50″, distance 1,421.6 meters (1896).
To△Dorrity, azimuth 144° 51′ 55″, distance 1,058.1 meters (1899).
To△Grand, azimuth 22° 25′ 50″, distance 928.6 meters (1896).
Hole surrounded by triangle in large bowlder, in outer group of rocks just below Thebes, Ill. Station is nearly opposite the head of Grand Chain and is under water at about a 12-foot stage, St. Louis gauge.

◎ THEBES.

Mississippi River Commission, 1880–81. (Chart No. 14.)
Latitude 37° 12′ 30″.91; meters +953, −897.
Longitude 89° 27′ 15″.55; meters +383, −1,097.
To◎South Base, azimuth 152° 09′ 20″.24, distance 2,728.50 meters.
To◎Day, azimuth 180° 19′ 03″.10, distance 2,747.74 meters.
To◎Grand Chain, azimuth 118° 48′ 20″.93, distance 2,027.48 meters.
To◎Lassar, azimuth 330° 52′ 21″.01, distance 3,002.37 meters.
To◎Uncle Joe, azimuth 46° 15′ 00″.83, distance 1,762.76 meters.
Stone post, on highest point of Illinois bluffs, 1 mile below the village of Thebes; one-third of a mile from river bank; on land owned by Rowling and Marchildon; near center of cultivated field with an orchard in northwest corner; and back of timber belt on slope along river. The road in first ravine below Thebes leads to the top of the bluff.

△ GRAND.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 12′ 25″.26; meters +779, −1,071.
Longitude 89° 28′ 05″.52; meters +136, −1,344.
To △ Chain, azimuth 202° 25′ 41″, distance 928.6 meters.
To △ Hut, azimuth 297° 34′ 41″, distance 996.3 meters.
To △ Joe, azimuth 344° 10′ 45″, distance 1,190.5 meters.
Hole surrounded by triangle, in top of large flat-topped bowlder, on right bank and near middle of the Grand Chain (Missouri shore); about 1 mile below Thebes, Ill.; about 200 meters out from high bank and fence. Station is on one of three largest bowlders in southern part of the chain.

△ HUT.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 12′ 10″.30; meters +318, −1,532.
Longitude 89° 27′ 29″.70; meters +732, −748.
To △ Grand, azimuth 117° 35′ 03″, distance 996.3 meters.
To △ Chain, azimuth 158° 10′ 03″, distance 1,421.6 meters.
To △ Joe, azimuth 39° 13′ 55″, distance 883.2 meters.
Hole surrounded by triangle on large flat rock, on Illinois shore; about 1 mile below Thebes and opposite Counterfeit Rock in Missouri; above old lithograph stone quarry; just below small log house on high bank. It is exposed at a 10-foot stage, St. Louis gauge.

⊙ P. B. M. 58.

Mississippi River Commission, 1881 and 1884. (Chart No. 14.)
Latitude 37° 12′ 01″.76; meters +54, −1,796.
Longitude 89° 28′ 00″.86; meters +21, −1,459.
Elevation: 349.99.
To ◎ Uncle Joe, azimuth 25° 56′, distance 357 meters.
Center of horizontal copper bolt, leaded in the vertical face, toward the river, of the middle one of three large rocks, the lowest and largest of which forms a part of the Missouri bank of the river, and is known as "Counterfeit Rock." It is 10 meters from the top of the river bank; 80 meters above the line between Matthew Roe and H. S. Wray; 600 meters above Uncle Joe Landing; on land of Matthew Roe; and about 3 miles above Commerce, Mo. It is about 0.8 meter above the ground and the letters "U. S. P. B. M." are cut in the rock.

◎ UNCLE JOE.

Mississippi River Commission, 1880-81. (Chart No. 14.)
Latitude 37° 11′ 51″.36; meters +1,583, −267.
Longitude 89° 28′ 07″.18; meters +177, −1,303.
To ◎ Hafner, azimuth 335° 16′ 45″.95, distance 3,594.48 meters.
To ◎ Thebes, azimuth 226° 14′ 29″.61, distance 1,762.76 meters.
To ◎ Lassar, azimuth 297° 09′ 43″.56, distance 3,074 meters.
To ◎ Grand Chain, azimuth 167° 05′ 00″.95, distance 2,252.82 meters.
Stone post, on right bank of river; about 3 miles above Commerce, Mo.; about 1,000 feet from river bank and a little above government light near Uncle Joe Landing; near the summit of a partly cleared bluff on land owned by Samuel Wray.

△ JOE.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14, station not plotted.)
Latitude 37° 11′ 48″.10; meters +1,483, −367.
Longitude 89° 27′ 52″.35; meters +1,291, −189.
To △ Hut, azimuth 219° 13′ 41″, distance 883.2 meters.
To △ Grand, azimuth 164° 10′ 53″, distance 1,190.5 meters.
To △ Bowlder, azimuth 342° 05′ 01″, distance 1,672.9 meters.
Hole surrounded by triangle in top of large bowlder, about 150 meters above Uncle Joe Landing, Mo.; about 35 feet from government light; under high bank and exposed at a 20-foot stage, St. Louis gauge.

◎ LASSAR.

Mississippi River Commission, 1880-81. (Chart No. 14.)
Latitude 37° 11′ 05″.83; meters +180, −1,670.
Longitude 89° 26′ 16″.30; meters +402, −1,078.
To◎Uncle Joe, azimuth 117° 10′ 50″.59, distance 3,074 meters.
To◎Santa Fe, azimuth 327° 48′ 51″.09, distance 2,209.33 meters.
To◎Thebes, azimuth 150° 52′ 56″.83, distance 3,002.37 meters.
To◎Hafner, azimuth 33° 30′ 30″.68, distance 2,232.38 meters.
Stone post, on left bank of river; about 1½ miles above Fayville (Santa Fe), Ill.; 750 meters back from river; on land owned by Mrs. Lassar; in timber and close to a woods road that leaves the county road (running along river bank) near an old shanty.

△ BOWLDER.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14, station not plotted.)
Latitude 37° 10′ 56″.47; meters +1,741, −109.
Longitude 89° 27′ 31″.49; meters +777, −703.
To△Joe, azimuth 162° 05′ 14″, distance 1,672.9 meters.
To△Muddy Creek, azimuth 274° 41′ 47″, distance 1,133.1 meters.
To△Simpson 369, azimuth 323° 26′ 31″, distance 1,581.5 meters.
Hole surrounded by triangle in top of bowlder, on right bank and in middle of Hancock Rocks (fourth group above Commerce, Mo.); about 1,000 feet above government light and under water at a 10-foot stage, St. Louis gauge.

△ MUDDY CREEK.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14, station not plotted.)
Latitude 37° 10′ 53″.46; meters +1,648, −202.
Longitude 89° 26′ 45″.75; meters +1,129, −351.
To△Bowlder, azimuth 94° 42′ 14″, distance 1,132.1 meters.
To△Simpson 369, azimuth 8° 59′ 52″, distance 1,192.3 meters.
Hole surrounded by triangle in shaly rock ledge; on Illinois shore and opposite third group of rocks on right bank and above Commerce, Mo.; 150 feet out from high bank and exposed at a 6-foot stage, St. Louis gauge.

⊡ 9/2

Mississippi River Commission, 1884. (Chart No. 14.)
Latitude 37° 10′ 27″.08; meters +835, −1,015.
Longitude 89° 26′ 14″.57; meters +359, −1,121.
Elevation: 367.30.
To◎Hafner, azimuth 62° 23′, distance 1,439 meters.
To⊡9/3, azimuth 62° 23′, distance 1,150 meters.
Stone post, on left bank of river and 1,300 meters above Fayville (Santa Fe), Ill.; 75 meters above a ravine; 115 meters back from river bank; and 600 meters below trestle of Chicago and Eastern Illinois Railroad; 3 meters west of well defined and traveled road and 1 meter east of fence.

△ STONE LINE.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 10′ 25″.34; meters +781, −1,069.
Longitude 89° 26′ 18″.31; meters +452, −1,028.
Elevation: 331.98.
To◎Hafner, azimuth 62° 35′ 23″, distance 1,332.4 meters.
To△Simpson 369, azimuth 70° 12′ 45″, distance 917.6 meters.
To△Simpson 371, azimuth 17° 30′ 56″, distance 1,510.7 meters.
To△Brother, azimuth 16° 51′ 14″, distance 1,501.6 meters.
To△Mill (Commerce), azimuth 15° 57′ 21″, distance 1,596.2 meters.
Iron pipe, in Illinois; about 1,300 meters above Fayville (Santa Fe) and 3 meters below the Hafner stone line (No. 9); under high bank, on outer edge of timber; 6 feet downstream from an 18-inch blazed cottonwood tree; 14 feet upstream from a 6-inch blazed sycamore tree, and nearly in line with them.

△ SIMPSON 369.

United States engineer office, St. Louis, Mo., 1878; redetermined, 1896. (Chart No. 14, station not plotted.)
Latitude 37° 10′ 15″.26; meters +470, —1,379.
Longitude 89° 26′ 53″.31; meters +1,315, —165.
To △ Simpson 371, azimuth 340° 06′ 23″, distance 1,201.6 meters.
To △ Muddy Creek, azimuth 188° 59′ 48″, distance 1,192.3 meters.
To △ Brother, azimuth 339° 11′ 11″, distance 1,205 meters.
To △ Bowlder, azimuth 143° 26′ 54″, distance 1,581.5 meters.
To △ Stone Line, azimuth 250° 12′ 24″, distance 917.6 meters.
Hole surrounded by triangle in top of bowlder, on right bank and in first group of rocks above Commerce, Mo. It is almost directly in front of ◎ Hafner on the Missouri bluffs.

⊡ $\frac{9}{3}$

Mississippi River Commission, 1884. (Chart No. 14.)
Latitude 37° 10′ 09″.79; meters +302, —1,548.
Longitude 89° 26′ 55″.87; meters +1,378, —102.
Elevation: Stone, 350.19; pipe, 355.27.
To ◎ Hafner, azimuth 62° 22′, distance 289 meters.
To ⊡ 9/2, azimuth 242° 23′, distance 1,150 meters.
Flat stone and iron pipe on right bank and about 1,200 meters above Commerce, Mo.; on slope of bluffs at edge of timber; in front of ◎ Hafner on top of bluffs; 100 meters from river bank; 20 meters above a ravine, and 50 meters above fence at upper edge of field.

◎ HAFNER=⊡ $\frac{9}{4}$

Mississippi River Commission, 1880–81. (Chart No. 14.)
Latitude 37° 10′ 05″.44; meters +168, —1,682.
Longitude 89° 27′ 06″.25; meters +154, —1,326.
Elevation: 516.40.
To ◎ Commerce, azimuth 336° 32′ 38″.83, distance 3,290.22 meters.
To ◎ Lassar, azimuth 213° 30′ 00″.50, distance 2,232.38 meters.
To ◎ Uncle Joe, azimuth 155° 17′ 22″.78, distance 3,594.48 meters.
To ◎ Santa Fe, azimuth 270° 11′ 32″.66, distance 2,409.26 meters.
To △ Stone Line, azimuth 242° 34′ 54″, distance 1,332.4 meters.
To ⊡ 9/2, azimuth 242° 23′, distance 1,439 meters.
To ⊡ 9/3, azimuth 242° 22′, distance 289 meters.
Stone post on right bank of river; at eastern edge of field on top of hill, three-quarters of a mile above Commerce, Mo.; directly back from chain of large bowlders jutting into the river. Small oak with branches trimmed off near the top, east 35 feet; small oak, south 27 feet. To reach station: Go up the hill (from the chain of bowlders) alongside the fence to a road; follow road up to the field, then turn to the left, and follow a fence about 200 feet.

◎ SANTA FE.

Mississippi River Commission, 1880–81. (Chart No. 14.)
Latitude 37° 10′ 05″.16; meters +159, —1,691.
Longitude 89° 25′ 28″.60; meters +706, —774.
To ◎ Commerce, azimuth 20° 04′ 58″.13, distance 3,204.80 meters.
To ◎ Hafner, azimuth 90° 12′ 31″.65, distance 2,409.26 meters.
To ◎ Lassar, azimuth 147° 49′ 19″.92, distance 2,209.33 meters.
To ⊡ 8/2, azimuth 338° 43′ 29″, distance 3,256 meters.
Iron pipe, on top of Illinois bluffs; directly back of Fayville (Santa Fe), Ill., and about 550 meters from river bank; on land of J. H. Storey, on the highest peak in the vicinity. Pipe set about 3 inches above the surface of the ground.

⊕ 4 H_2.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 14.)
Latitude 37° 10′ 04″.80; meters +148, —1,702.
Longitude 89° 21′ 10″.79; meters +266, —1,214.
Elevation: 349.67.
Iron pipe, at Olive Branch, Ill., 10 feet east of northeast corner of Chicago and Eastern Illinois Railroad station and near edge of platform; on line with south rail of tangent below (northeast of) Olive Branch. (Station marked on map thus: ⊙Target 4—H.)

⊕ 1 H₂.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 14.)
Latitude 37° 09′ 41″.32; meters +1,274, −576.
Longitude 89° 25′ 13″.56; meters +335, −1,146.
Elevation: 359.75.
To △ Burnham '07, azimuth 29° 47′, distance 1,491 meters.
To ⊡ 8/2, azimuth 340° 35′, distance 2,438 meters.
Iron pipe, about one-half mile below Fayville (Ill.) railroad station, at point where second creek below Fayville was diverted to pass under track at bridge 450 meters above; in line with north rail of tangent (Chicago and Eastern Illinois Railroad) below the point and 210 meters above a road crossing. (Station marked on map thus: ⊙Target 1—H.)

△ BROTHER.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 09′ 38″.72; meters +1,194, −656.
Longitude 89° 26′ 35″.96; meters +887, −594.
Elevation: 319.67.
To △ Stoneline, azimuth 196° 51′ 04″, distance 1,501.6 meters.
To △ Simpson 369, azimuth 159° 11′ 21″, distance 1,205 meters.
Hole surrounded by triangle in rock, on river bank at Commerce, Mo. Sixty-five feet east of △ Simpson 371 and 5 feet lower (the 12-foot stage, St. Louis gauge); and 225 feet above northern part of elevator at Commerce.

⊙ P. B. M. 61.

Mississippi River Commission, 1881. (Chart No. 14.)
Latitude 37° 09′ 38″.70; meters +1,193, −657 (scaled from chart).
Longitude 89° 26′ 39″.43; meters +973, −508 (scaled from chart).
Elevation: 369.52.
Center of horizontal copper bolt, in front or east face of foundation of William Anderson's brick residence at upper end of Commerce, Mo. It is 2 meters north of center of front entrance and 36 centimeters above the ground.

△ SIMPSON 371.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 09′ 38″.60; meters +1,190, −660.
Longitude 89° 26′ 36″.74; meters +907, −574.
Elevation: 327.01.
To △ Stoneline, azimuth 197° 30′ 45″, distance 1,510.7 meters.
To △ Simpson 369, azimuth 160° 06′ 33″, distance 1,201.6 meters.
Hole surrounded by triangle on top of bowlder, in a group, on right bank and immediately above Commerce, Mo.; 260 feet above elevator; and 65 feet back from △ Brother. Bench mark is lowest edge of hole and elevation given on chart is in error.

△ MILL. (Commerce.)

United States engineer office, St. Louis, Mo., 1896. (Chart No. 14.)
Latitude 37° 09′ 35″.55; meters +1,096, −754.
Longitude 89° 26′ 36″.09; meters +890, −590.
Flagstaff on Anderson's mill or warehouse at Commerce, Mo.

⊡ $\frac{8}{1}$

Mississippi River Commission, 1884. (Chart No. 14.)
Latitude 37° 08′ 46″.90; meters +1,446, −404.
Longitude 89° 24′ 05″.09; meters +126, −1,355.
Elevation: Stone, 333.17; pipe, 338.27.
To ⊡ 8/2, azimuth 54° 45′, distance 1,077 meters.
Flat stone and iron pipe, in Illinois; about 2 miles below Fayville; 400 meters from bank of Santa Fe chute; 180 meters out from line of timber; about 1,400 meters above foot of Burnham Island; on land of William Woods and 25 meters northeast of fence.

◎ COMMERCE.

Mississippi River Commission, 1880-81. (Chart No. 14.)
Latitude 37° 08′ 27″.52; meters +848, −1,002.
Longitude 89° 26′ 13″.19; meters +326, −1,155.
Elevation: 336.83.
To◎Hafner, azimuth 156° 33′ 10″.88, distance 3,290.22 meters.
To◎Powers Island, azimuth 309° 11′ 57″.11, distance 2,977.70 meters.
To◎Santa Fe, azimuth 200° 04′ 31″.20, distance 3,204.80 meters.
To⊡8/2, azimuth 270° 36′ 00″, distance 2,282 meters.
To△Burnham '07, azimuth 216° 42′, distance 1,223 meters.
To△Martin, azimuth 173° 35′, distance 441.5 meters.
To△Buecher, azimuth 238° 02′, distance 1,094.1 meters.
Stone post, with corners chipped off, in field, near middle of Commerce Island, on right bank of river and 1 mile below Commerce, Mo.; 60 feet west of top of ridge, and 6 inches above surface of ground. References: To large burned pecan stump, 353° 53′—225 feet; to blazed trees: 24-inch pecan, 11° 45′—274 feet, 18-inch pecan, east side of field, near top of bank, 193° 13′—490 feet.

⊡ $\frac{8}{2}$

Mississippi River Commission, 1884; redetermined, United States engineer office, St. Louis, Mo., 1903. (Chart No. 14.)
Latitude 37° 08′ 26″.73; meters +824, −1,026.
Longitude 89° 24′ 40″.73; meters +1,005, −476.
Elevation: 340.47.
To◎Powers Island, azimuth 359° 13′ 26″, distance 1,858.3 meters.
To◎Commerce, azimuth 90° 36′ 56″, distance 2,282 meters.
To◎Santa Fe, azimuth 158° 43′ 58″, distance 3,256 meters.
To△Burnham '07, azimuth 122° 57′, distance 1,848 meters.
To⊡8/1, azimuth 234° 45′, distance 1,077 meters.
Stone post, in lower field on Burnham Island, on left side of main river and 2 miles below Commerce, Mo.; on slope of ridge, 6 meters east of its crest, and 4 inches above surface of ground; 375 meters from main river bank and 200 meters from bank of chute. Blazed trees: 30-inch pecan, 74° 28′—145 meters; 30-inch pecan, 16° 22′—164 meters; 36-inch pecan, 162° 47′—184 meters; other references: 36-inch cottonwood tree, 91° 17′; small coffee tree on top of ridge, 134° 32′—16 meters; gable of house, on same ridge, 156° 27′—574 meters.

△ BURNHAM '07.

Board on Examination and Survey of Mississippi River, 1907. (Chart No. 14.)
Latitude 37° 08′ 59″.33; meters +1,829, −21.
Longitude 89° 25′ 43″.57; meters +1,075, −406.
Elevation: 340.76.
To◎Commerce, azimuth 36° 42′, distance 1,223 meters.
To⊡8/2, azimuth 302° 56′, distance 1,848 meters.
To△Buecher, azimuth 333° 49′, distance 447.4 meters.
To△Martin, azimuth 55° 13′, distance 949.9 meters.
Iron pipe, on high ridge, on western side of Burnham Island, on left side of main river, and about 1 mile below Commerce, Mo.; east from government light, on shoulder of island; about 140 meters from western high bank of island; and 300 meters above barn or outbuilding of house owned by C. I. Anderson, of Commerce.

△ BUECHER.

Board on Examination and Survey of Mississippi River, 1907. (Chart No. 14.)
Latitude 37° 08′ 46″.29; meters +1,427, −423.
Longitude 89° 25′ 35″.56; meters +878, −603.
To◎Commerce, azimuth 58° 03′, distance 1,094.1 meters.
To△Burnham '07, azimuth 153° 49′, distance 447.4 meters.
To△Martin, azimuth 81° 50′, distance 987.6 meters.
Iron pipe, in cultivated field, on Burnham Island, on left side of main river, and 1 mile below Commerce, Mo.; about 30 meters from western high bank of island; 200 meters below a house; and near middle of clearing on river bank.

△ MARTIN.

Board on Examination and Survey of Mississippi River, 1907. (Chart No. 14.)
Latitude 37° 08′ 41″.74; meters +1,287, —563.
Longitude 89° 26′ 15″.18; meters +375, —1,106.
To ◎ Commerce, azimuth 353° 35′, distance 441.5 meters.
To △ Burnham '07, azimuth 235° 13′, distance 949.9 meters.
To △ Buecher, azimuth 261° 49′, distance 987.6 meters.
One-inch iron pipe, on eastern high bank of Commerce Island (right bank of river); 1 mile below Commerce, Mo.; about 800 meters below main line of hurdle at upper end of island; near a wire fence, and 2 meters west from an 8-inch blazed cottonwood tree.

◎ POWERS ISLAND.

Mississippi River Commission, 1880-81. (Chart No. 14.)
Latitude 37° 07′ 26″.46; meters +816, —1,034.
Longitude 89° 24′ 39″.71; meters +980, —501.
Elevation: 334.11 (pipe).
To ◎ Atherton, azimuth 271° 36′ 26″.57, distance 2,880.98 meters.
To ◎ Commerce, azimuth 129° 12′ 53″.54, distance 2,977.70 meters.
To ⊡ 8/2, azimuth 179° 13′ 27″, distance 1,858.3 meters.
Iron pipe, on northeast bank or shoulder of Powers Island (right bank of river); in cultivated field of Doctor Coffman; 130 feet from river bank and opposite lower end of Allen Towhead; just inside limit line of large cottonwood stumps and 280 feet outside of abrupt rise. Original stone post found broken off in 1903, was reset 29 inches below surface of ground and flanged iron pipe with cap was set over it. References: Gable of small frame dwelling, 318° 35′—1,378 feet; two blazed cottonwood trees at top of bank, 147° 44′—258 feet.

⊡ $\frac{8}{3}$

Mississippi River Commission, 1884. (Chart No. 14.)
Latitude 37° 07′ 17″.28; meters +533, —1,317.
Longitude 89° 26′ 42″.93; meters +1,060, —421.
Elevation: 339.19.
To ◎ Commerce, azimuth 198° 44′, distance 2,286 meters.
To ⊡ 8/4, azimuth 54° 50′, distance 617 meters.
Stone post, in Missouri and 2½ miles below Commerce; about 600 meters back from Doolan Slough; on land of William Price; 0.5 meter east of fence on west side of road; 235 meters above fence corner; and 200 meters below Price's house.

⊕ 7 H_3

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 11′ 11″.93; meters +368, —1,482.
Longitude 89° 19′ 41″.28; meters +1,018, —462.
Iron pipe, near Clank, Ill.; on the Chicago and Eastern Illinois Railroad; 20 feet westwardly from center of track; and about 1,000 feet below road crossing at station.

⊕ 8 H_3

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 09′ 28″.43; meters +876, —973.
Longitude 89° 19′ 59″.06, meters +1,457, —24.
Elevation: 341.09.
Two-inch iron pipe, in Illinois; about 1½ miles below Olive Branch, and 5⅞ miles above Cache; 9.5 feet northwardly from center of track of the Illinois Central Railroad, and 4,100 feet below a private road crossing; and near point of intersection of curve. (Elevation on map 7 feet too high.)

⊕ 10 H_3

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 08′ 19″.85; meters +612, —1,238.
Longitude 89° 18′ 50″.92; meters +1,257, —224.
Elevation: 338.95.

Two-inch iron pipe, about 4 miles above Cache, Ill.; 15 feet northwardly from center of track of Illinois Central Railroad; about 225 feet above head block to spur track; 1,350 feet above milepost "Cairo 14 miles," and about 1,400 feet below schoolhouse on eastern side of Horseshoe Lake.

⊙ P. B. M. 64.

Mississippi River Commission, 1881 and 1884. (Chart No. 15.)
Latitude 37° 07′ 40″.42; meters +1,246, —604.
Longitude 89° 22′ 54″.58; meters +1,347, —134.
Elevation: 339.70.
To ⊛ Atherton, azimuth 330° 56′, distance 586 meters.
Copper bolt in top of stone post, in Illinois; 1,100 meters back from river, at Atherton Landing, about 19 miles above Cairo; and 1 meter north of fence, on north side of road leading eastwardly to Goose Island post-office.

△ CHIMNEY.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 15.)
Latitude 37° 07′ 30″.37; meters +936, —914.
Longitude 89° 23′ 30″.07; meters +742, —739.
Chimney in middle of Atherton's house; about 210 meters back from Atherton Landing, Ill.

⊕ 11 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 07′ 29″.62; meters +913, —937.
Longitude 89° 17′ 52″.33; meters +1,292, —189.
Elevation: 334.11.
To ⊕ 10 H_2, azimuth 136° 58′, distance 2,118 meters.
Two-inch iron pipe, about 2½ miles above (westwardly from) Cache, Ill.; 16.6 feet northwardly from center of track of Illinois Central Railroad; 28 feet below second road crossing above Cache; 41 feet below switchstand; and 670 feet above milepost "Cairo 13 miles."

⊛ ATHERTON.

Mississippi River Commission, 1880–81. (Chart No. 15.)
Latitude 37° 07′ 23″.82; meters +734, —1,116.
Longitude 89° 22′ 43″.05; meters +1,063, —418.
Elevation: 336.75.
To ⊛ Powers Island, azimuth 91° 37′ 36″.98, distance 2,880.98 meters.
To ⊙ P. B. M. 64, azimuth 150° 56′, distance 586 meters.
Stone post, in Illinois and about three-quarters of a mile east of Atherton Landing; on land owned by estate of F. D. Atherton; near the middle of section 18, Goose Island Township, Alexander County; and just on edge of cypress swamp and cultivated field.

⊕ 12 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 06′ 53″.81; meters +1,659, —191.
Longitude 89° 17′ 10″.55; meters +260, —1,222.
Elevation: 333.38.
To ⊕ 11 F, azimuth 136° 57′, distance 1,511 meters.
Two-inch iron pipe, about 1¼ miles westwardly from Cache, Ill.; 17 feet northwardly from center of track of Illinois Central Railroad; 2,000 feet below railroad trestle across swamp; about 1,000 feet above milepost "Cairo 12 miles;" and one-quarter of a mile southwest from the Alexander County Poor Farm.

△ WEATHER VANE.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 15, station not plotted.)
Latitude 37° 06′ 10″.72; meters +330, —1,519.
Longitude 89° 22′ 25″.85; meters +638, —844.
Brass ball on weather vane, or lightning rod, on Greely's house, above Commercial Point, Ill., and back of Goose Island Towhead.

⊕ 13 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 06′ 07″.80; meters +240, −1,609.
Longitude 89° 16′ 17″.17; meters +424, −1,058.
Elevation: 334.36.
To⊕12 F, azimuth 137° 07′, distance 1,936 meters.
Two-inch iron pipe, about one-half mile west of Cache, Ill.; 100 feet southwardly from center of track of Illinois Central Railroad; 75 feet below milepost "Cairo 11 miles;" and at road crossing to charcoal kilns.

⊕ 14 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 15.)
Latitude 37° 06′ 06″.00; meters +185, −1,665.
Longitude 89° 16′ 08″.42; meters +208, −1,274.
Elevation: 333.40.
To⊕13 F, azimuth 104° 27′, distance 223 meters.
Two-inch iron pipe, about 1,600 feet west of Cache, Ill., railroad station; 30 feet south from center of track of Illinois Central Railroad; near charcoal kiln; and between siding to the kilns and the main tracks.

△ WHITE CHIMNEY.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 15.)
Latitude 37° 05′ 59″.81; meters +1,844, −6.
Longitude 89° 17′ 06″.96; meters +172, −1,310.
Center of chimney of Ike Johnson's house, about one-half mile east of Telle and Horrell store; on south side of public road; and 1⅛ miles west of Cache, Ill.

△ GRAND LAKE '02.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 15.)
Latitude 37° 05′ 48″.59; meters +1,498, −352.
Longitude 89° 17′ 48″.42; meters +1,196, −286.
To△Greenleaf '02, azimuth 50° 17′ 26″, distance 1,267.6 meters.
To△Fence '98, azimuth 272° 18′ 19″, distance 1,839.2 meters.
Iron pipe, 10 inches below surface of ground, in Illinois and on land of George and Andrew Hornburger; 775 feet above old Grand Lake Landing; and 15.9 feet south of small frame shanty. Blazed trees: 19-inch elm stump, 130°—13.3 feet; 6-inch water oak, 56°—17.8 feet; 24-inch elm, 60°—29.4 feet.

△ FENCE '98.

United States engineer office, St. Louis, Mo., 1898; redetermined, 1902. (Chart No. 15.)
Latitude 37° 05′ 46″.18, meters +1,424, −426.
Longitude 89° 16′ 34″.01; meters +840, −642.
Elevation: 328.60.
To△Pecan '98, azimuth 304° 03′ 16″, distance 1,602.8 meters.
To△Grand Lake '02, azimuth 92° 19′ 04″, distance 1,839.2 meters.
To△Greenleaf '02, azimuth 75° 21′ 07″, distance 2,907.5 meters.
To⊙P. B. M. 65, azimuth 292° 14′ 08″, distance 1,405.2 meters.
To△White Chimney, azimuth 117° 18′ 07″, distance 915.8 meters.
Iron pipe, 6 inches above surface of ground, near left bank and about three-quarters mile westwardly from Cache, Ill.; on west side of road, at turn and a short distance below the head of the Beechridge revetment; 75 feet west of the southwest corner of a cabin; 20 feet back from edge of revetment; and 8 feet east of rail fence.

⊡ $\frac{7}{4}$

Mississippi River Commission, 1888. (Chart No. 15.)
Latitude 37° 05′ 33″.84, meters +1,043, −807.
Longitude 89° 24′ 22″.89; meters +565, −917.
Elevation: Stone, 334.7; pipe, 339.8.
Flat stone and iron pipe, on Powers Island (now on right bank of river) and about 1,300 meters above foot of island; on ridge in field of William Anderson; about 75 meters in front of fence at rear edge of field; and about 800 meters from slough back of Anita Towhead.

△ GREENLEAF '02.

United States engineer office, St. Louis, Mo., 1902. (Chart No. 15.)
Latitude 37° 05′ 22″.32; meters +688, —1,162.
Longitude 89° 18′ 27″.91; meters +689, —793.
Elevation: 330.42.
To△Grand Lake '02, azimuth 230° 17′ 03″, distance 1,267.6 meters.
To△Fence '98, azimuth 255° 19′ 59″, distance 2,907.5 meters.
Iron pipe 6 inches above surface of ground, in Illinois and near head of the Greenleaf Bend revetment; on land of Jeff Tillman and south of his house; on slight ridge inside of wire fence on east side of and at angle in public road; 216.5 feet south of 13-inch maple tree near same fence, and 50 feet from top of bank.

⊡ $\frac{6}{2}$

Mississippi River Commission, 1888. (Chart No. 15.)
Latitude 37° 03′ 04″.96; meters +153, —1,697.
Longitude 89° 21′ 26″.55; meters +656, —827.
Elevation: 331.58.
Stone post, in Illinois; on old high bank, back of Price Towhead; nearly opposite Elkins Landing, Mo.; in cottonwood timber, on land owned by John Milford; 800 meters back of main river bank; 70 meters back from east bank of chute and 140 meters out from road and clearing.

⊡ $\frac{6}{4}$

Mississippi River Commission, 1888. (Chart No. 15.)
Latitude 37° 01′ 55″.30; meters +1,705, —145.
Longitude 89° 22′ 55″.78; meters +1,379, —104.
Elevation: Stone, 328.95; pipe, 334.06.
Flat stone and iron pipe, 1,200 meters back (westwardly) from Elkins Landing, Mo.; and about 900 meters southwardly from Price Landing, Mo.; in northwest corner of field of Joseph Moore; 20 meters south of fence corner; 3 meters east of fence on east side of road; and 125 meters toward the river from a church.

◎ MISSOURI SISTER.

Mississippi River Commission, 1880–81. (Chart No. 16.)
Latitude 37° 04′ 41″.99; meters +1,294, —555.
Longitude 89° 17′ 00″.56; meters +14, —1,468.
To◎Rouse, azimuth 312° 10′ 53″.60, distance 3,090.50 meters.
Stone post, on north side of Missouri Sister Island, on right bank of river; nearly opposite Grand Lake Landing, Ill.; and in timber, 300 meters from river bank.

⊡ $\frac{2}{4}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 04′ 16″.81; meters +518, —1,332.
Longitude 89° 16′ 51″.89; meters +1,282, —200.
Elevation: Stone, 328.23; pipe, 333.32.
Flat stone and iron pipe, on Missouri Sister Island, on right bank of river; about 1,500 meters eastwardly from Brewer Point; in timber, 150 meters back from two small fields; and 3 or 4 meters east of southern prolongation of fence at west end of east field.

◎ ROUSE.

Mississippi River Commission, 1880–81. (Chart No. 16.)
Latitude 37° 03′ 34″.67; meters +1,069, —781.
Longitude 89° 15′ 27″.87; meters +689, —794.
Elevation: 325.76.
To◎Missouri Sister, azimuth 132° 11′ 49″.48, distance 3,090.50 meters.
To◎Dickey, azimuth 226° 52′ 50″.93, distance 1,511.30 meters.
To△Darkey, azimuth 251° 57′ 26″, distance 1,350.3 meters.
Stone post, on right bank of river; about 900 feet below the mouth of old chute behind Missouri Sister Island; and 1,400 meters above Hurricane Field; about 500 feet

from river bank; in heavy timber on land owned by Mrs. Rouse; and 400 feet below small clearing that comes up to road along chute. References to blazed trees: 3-foot ash, 27° 40′ —12.5 feet; 3-foot elm, 41° 35′ —39 feet; 14-inch sycamore, 308° 50′ —29 feet.

⊡ $\frac{1}{3}$

Mississippi River Commission, 1888; reestablished, United States engineer office, St. Louis, Mo., 1904. (Chart No. 16.)
Latitude 37° 03′ 06″.97; meters +215,—1,635.
Longitude 89° 15′ 04″.55; meters +112,—1,370.
Elevation: 328.74.
Stone post, in upper end of Hurricane Field, on right bank; 425 feet above upper end of old revetment; 1,60[illegible] feet below upper end of new section of bank protection; 250 feet below point of timber and 110 feet from top of bank. Stone was set back from caving bank and above coordinates determined by plane-table survey of United States engineer office, St. Louis, Mo., 1904.

⊡ $\frac{1}{4}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 02′ 58″.55; meters +1,805,—45.
Longitude 89° 15′ 18″.55; meters +458,—1,025.
Elevation: Stone, 327.20; pipe, 332.29.
Flat stone and iron pipe, on right bank; about 300 meters west of Hurricane Field and in woods, 430 meters from river; 270 meters west of fence, at west edge of cultivated field; 360 meters south and 270 meters west from northwest corner of said field and 230 meters northeast from a prominent slough.

△ DUSKY.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 16.)
Latitude 37° 02′ 56″.45; meters +1,740,—110.
Longitude 89° 16′ 29″.65; meters +733,—750.
Elevation: 332.5.
To △ Pickaninny, azimuth 319° 38′ 03″, distance 1,180.6 meters.
Iron pipe, in Missouri; 290 meters from river bank; on top of levee, below Newcums, and 1 mile below Thompson Landing, Mo.; on line with pecan trees in middle of field; and about one-quarter of a mile back of the Thompson Cemetery.

⊡ $\frac{3}{4}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 02′ 44″.65; meters +1,376,—473.
Longitude 89° 15′ 53″.72; meters +1,328,—155.
Elevation: Stone, 323.78; pipe, 328.87.
Flat stone and iron pipe, in Missouri; 870 meters from river bank; on top of ridge at edge of willows around Ash Pond; near foot of inner slope of levee; at east edge of cultivated field, about three-quarters of a mile below Thompson Landing, Mo.; and about 500 meters north from road leading to river.

△ PICKANINNY.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 16.)
Latitude 37° 02′ 27″.27; meters +841,—1,009.
Longitude 89° 15′ 58″.71; meters +1,451,—32.
Elevation: 326.85.
To △ Dusky, azimuth 139° 38′ 22″, distance 1,180.6 meters.
Iron pipe, in Missouri; about ½ mile below Thompson Landing; 600 meters from river bank; on left side of road leading back from river at Newcums, and about 1,250 feet back from house in northeast angle of roads; 23 feet from a walnut tree; 18 feet from northwest corner of old house; and 60 feet from a pecan tree back of house.

⊡ $\frac{3}{1}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 01′ 55″.54; meters +1,712,—138.
Longitude 89° 17′ 43″.96; meters +1,087,—396.

Elevation: Stone, 326.01; pipe, 331.10.
Flat stone and iron pipe, in Illinois; 800 meters below a point opposite Thompson Landing, Mo.; 225 meters back from high river bank; in woods and underbrush on western side of prominent slough.

△ TRIPOD.

United States engineer office, St. Louis, Mo., 1898. (Chart No. 16.)
Latitude 37° 01′ 45″.97; meters +1,417, —433.
Longitude 89° 19′ 58″.38; meters +1,443, —40.
To△Cuba, azimuth 341° 25′ 59″, distance 1,118.3 meters.
Top of pile driven to the 22-foot stage, St. Louis gauge; in Illinois, outside old high bank line and 200 feet from road; 1,700 feet above hurdle dam to head of Hacker Towhead. The station pile is surrounded by observing tripod of piles driven to a lower stage.

⊡ $\frac{5}{1}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 01′ 34″.66; meters +1,068, —781.
Longitude 89° 18′ 28″.75; meters +711, —772.
Elevation: Stone, 324.28; pipe, 329.36.
Flat stone and iron pipe, in Illinois; 900 meters back from old high bank in Hacker Bend; at fence, edge of woods, and east side of field; 45 meters south of northeast corner of field; 6 meters from small log house, and just back of small orchard.

△ CUBA.

United States engineer office, St. Louis, Mo., 1898. (Chart No. 16.)
Latitude 37° 01′ 11″.58; meters +357, —1,493.
Longitude 89° 19′ 43″.97; meters +1,087, —396.
Elevation: 329.72.
To△Tripod, azimuth 161° 26′ 08″, distance 1,118.3 meters.
To△Cuba No. 2, azimuth 293° 17′, distance 48.1 meters.
Iron pipe, on Hacker Towhead, on left bank of river; at top of revetment, on original head of towhead and securing outer end of hurdle dam; back of United States gauge; nearly flush with surface of ground and surrounded by mound of stone.

△ CUBA No. 2.

United States engineer office, St. Louis, Mo., 1898. (Chart No. 16.)
Latitude 37° 01′ 10″.96; meters +338, —1,512.
Longitude 89° 19′ 42″.18; meters +1,043, —440.
Iron pipe, surrounded by mound of stone, on Hacker Towhead, on left bank of river; 157.85 feet below△Cuba; on high bank and about 250 feet below the original revetted head of the island.

△ MASCOTTE No. 2.

United States engineer office, St. Louis, Mo., 1898. (Chart No. 16.)
Latitude 37° 01′ 01″.70; meters +52, —1,797.
Longitude 89° 20′ 24″.20; meters +598, —885.
Iron pipe, on Buffalo Island, on right bank of river; 25 meters back from high bank and 1,500 feet below a point on line with hurdle No. 5 in Illinois. Blazed trees: 29-inch boxelder, 10.65 meters; 8-inch elm, 572 meters, and 1.1 meters toward river from a sycamore stump.

△ MAINE No. 3.

United States engineer office, St. Louis, Mo., 1903. (Chart No. 16.)
Latitude 37° 00′ 36″.17; meters +1,115, —735.
Longitude 89° 19′ 55″.42; meters +1,370, —113.
Wood post (built up) 6 inches square, on Buffalo Island, on right bank of river; 140 feet back from high bank, near top bank of slough and 12 inches above surface of ground.

⊡ $\frac{5}{3}$

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 00′ 30″.96; meters +954, —895.
Longitude 89° 19′ 56″.55; meters +1,398, —86.

Elevation: 327.71.
To ⊡5/4, azimuth 48° 01′, distance 936 meters.
Stone post, on Buffalo Island, on right bank of river; on west bank of slough; about 170 meters back from high bank; and about 2½ miles below head of island.

⊡ 4/2

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 00′ 17″.31; meters +534, −1,316.
Longitude 89° 17′ 15″.68; meters +388, −1,096.
Elevation: 326.10.
Stone post, in Illinois, and 1 mile below Brooks Point; at fence on north edge of lower clearing on Dogtooth Island; 320 meters back from river bank, and 170 meters from fence—corner near the river.

⊡ 5/4

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 37° 00′ 10″.65; meters +328, −1,522.
Longitude 89° 20′ 24″.68; meters +610, −874.
Elevation: Stone, 329.33; pipe, 334.44.
To ⊡5/3, azimuth 228° 01′, distance 936 meters.
Flat stone and iron pipe, in Missouri; back of and 4,000 meters below head of Buffalo Island; 1,100 meters from main river bank; at road fence on western bank of chute; on land owned by F. M. Brown; 50 meters southeast of lane running back to woods and 50 meters northwest of orchard.

⊡ 4/4

Mississippi River Commission, 1888. (Chart No. 16.)
Latitude 36° 59′ 11″.92; meters +368, −1,482.
Longitude 89° 15′ 56″.29; meters +1,392, −92.
Elevation: Stone, 322.47; pipe, 327.58.
Flat stone and iron pipe, in Missouri; 600 meters from river bank in Dogtooth Bend; at fence, on southern bank of Big Bayou; and 105 meters west of intersection of fences between fields on an old island.

⊕ 20 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 06′ 22″.83; meters +704, −1,146.
Longitude 89° 12′ 27″.87; meters +688, −794.
Elevation: 330.8.
To ⊕19 F, azimuth 82° 50′, distance 1,554 meters.
Two-inch iron pipe, about three-quarters of a mile southwest of Mounds, Ill.; at end of first curve, west of main line and 51.5 feet north of center of track of the Illinois Central Railroad (Carbondale and Cairo division); about 250 feet below road crossing, which is 470 feet above culvert G. G. No. 145/64; also about 30 feet below the upper end of a 2-acre strip of cultivated land and 3 feet from edge of borrow pit.

⊕ 22 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 06′ 17″.39; meters +536, −1,314.
Longitude 89° 11′ 45″.67; meters +1,128, −354.
Elevation: 329.2.
To ⊕21 F, azimuth 89° 49′, distance 550 meters.
Two-inch iron pipe, 23.2 feet north of center of track of the Illinois Central Railroad (Mound City division); about three-quarters of a mile southeast of Mounds, Ill.; 20 feet south of road to Mound City; about 10 feet above a private road crossing, and nearly opposite east end of house, south of tracks and occupied by Mr. Walbridge.

⊕ 21 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 06′ 17″.33; meters +534, −1,316.
Longitude 89° 12′ 07″.96; meters +197, −1,285.

Elevation: 330.5.
To⊕20 F, azimuth 109° 01′, distance 520 meters.
To gable of house, azimuth 202° 58′.
To semaphore, azimuth 3° 18′.
Two-inch iron pipe, about three-quarters of a mile south of Mounds, Ill.; in the lower end of railroad yards and east of right-of-way fence of Illinois Central Railroad (main line); 10 feet west of an old fence line; about 150 feet above edge of timber and 400 feet west of south line of orchard.

⊕ 19 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 06′ 16″.54; meters +510, −1,340.
Longitude 89° 13′ 30″.37; meters +750, −732.
Elevation: 333.3.
To⊕18 F, azimuth 83° 03′, distance 2,179 meters.
Two-inch iron pipe, about 1½ miles southwest of Mounds, Ill.; 22.4 feet south of center of track of Illinois Central Railroad; 28 feet inside of south right-of-way fence; 538 feet above road crossing and about 10 feet west from burnt stump, on edge of ditch, at first cut above Mounds.

⊕ 18 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 06′ 07″.96; meters +245, −1,604.
Longitude 89° 14′ 57″.99; meters +1,432, −50.
Elevation: 333.5.
To⊕14 F, azimuth 88° 01′, distance 1,740 meters.
Two-inch iron pipe, in Illinois; about 1¼ miles back from river at Beechridge and 2¾ miles westwardly from Mounds; 22 feet south of center of track of Illinois Central Railroad; 1,000 feet east from bridge over Cache River; and on upper edge of cultivated strip.

⊕ 23 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 05′ 43″.81; meters +1,351, −499.
Longitude 89° 10′ 49″.94; meters +1,233, −249.
Elevation: 327.3.
To⊕22 F, azimuth 126° 57′, distance 1,722 meters.
Two-inch iron pipe, about half-way between Mounds and Mound City, Ill., and 1 mile from Mound City; 24 feet north of center of track of Illinois Central Railroad; 1,950 feet east of levee; 1,400 feet above bridge No. 1/59; about midway between right-of-way fence and track; and 4 feet east of borrow pit.

⊙ P. B. M. 65.

Mississippi River Commission, 1881; redetermined, United States engineer office, St. Louis, Mo., 1902. (Chart No. 17, station not plotted.)
Latitude 37° 05′ 28″.93; meters +892, −958.
Longitude 89° 15′ 41″.34; meters +1,021, −461.
Elevation: 326.31.
To△Fence '98, azimuth 112° 14′ 40″, distance 1,405.2 meters.
To△Pecan '98, azimuth 355° 45′ 16″, distance 366.8 meters.
Copper bolt in stone post, near Beechridge, Ill.; in cultivated field of C. P. Martin; about 350 feet south of road running west from Beechridge and 1,300 feet west of Mobile and Ohio Railroad; nearly in line with two large oak trees on the north, the one in the field, the other in the south fence along road, and 185 feet and 362 feet distant, respectively; 95 feet west of abandoned road; and 180 feet east of Martin's barn. Blazed trees; 10-inch pecan, east, 43 feet; 18-inch gum, south, 72 feet.

⊕ 24 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 05′ 23″.55; meters +726, −1,124.
Longitude 89° 10′ 24″.67; meters +609, −873.
Elevation: 327.
To⊕23 F, azimuth 135° 02′, distance 883 meters.

A stake, 25 feet south of center of track and 14 feet north of right-of-way fence of Illinois Central Railroad; about one-half mile northwest of intersection of railroad and levee at Mound City, Ill.; and near the point of intersection of first curve from Mound City.

△ PECAN '98.

United States engineer office, St. Louis, Mo., 1898; redetermined, 1902. (Chart No. 17, station not plotted.)
Latitude 37° 05′ 17″.06; meters +526, −1,324 (1902).
Longitude 89° 15′ 40″.24; meters +994, −488 (1902).
To⊙P. B. M. 65, azimuth 175° 45′ 17″, distance 366.8 meters (1902).
To△Fence '98, azimuth 124° 03′ 48″, distance 1,602.8 meters (1902).
To△Fence '98, azimuth 124° 03′ 50″, distance 1,602.9 meters (1898).
Iron pipe, 6 inches below surface of ground, about one-half mile south of Beechridge, Ill.; in cultivated field of C. P. Martin; 3.7 feet west of 22-inch blazed pecan tree, which is the second one, from the north, of four pecan trees nearly in line, on west side of abandoned road and 550 feet from river bank.

⊕ 25 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 05′ 12″.69; meters +391, −1,459.
Longitude 89° 10′ 00″.73; meters +18, −1,464.
Elevation: 333.6.
To⊕24 F, azimuth 119° 31′, distance 679 meters.
A stake, in center of back or western levee at Mound City, Ill.; about 12 feet north of center of track of Illinois Central Railroad crossing levee; and opposite shanties on the east side of levee.

⊕ 26 F.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17.)
Latitude 37° 05′ 01″.81; meters +56, −1,794.
Longitude 89° 09′ 38″.81; meters +959, −523.
Elevation: 330.7.
To⊕25 F, azimuth 121° 48′, distance 637 meters.
Two-inch iron pipe, on wharf at Mound City, Ill.; on an old abandoned log track; 4 feet upstream from south line and 130 feet out from southeast corner of the Mound City Furniture Factory, and 130 feet above storage shed of same factory.

◎ DICKEY.

Mississippi River Commission, 1880-81. (Chart No. 17.)
Latitude 37° 04′ 08″.17; meters +252, −1,598.
Longitude 89° 14′ 43″.21; meters +1,068, −414.
Elevation: 328.8.
To◎Nimbus, azimuth 306° 16′ 05″.67, distance 3,080.67 meters.
To◎Rouse, azimuth 46° 53′ 17″.85, distance 1,511.30 meters.
To△Darkey, azimuth 343° 37′ 33″, distance 640.8 meters.
Stone post, on old high bank in Illinois, back from and a short distance above head of Dickey Island, 1,000 feet from left bank of river, in cultivated field and east of fence on east side of old Cairo road, and a short distance below a small wagon bridge.

⊡ $\frac{1}{1}$

Mississippi River Commission, 1888. (Chart No. 17.)
Latitude 37° 03′ 59″.14, meters +1,823, −27.
Longitude 89° 13′ 55″.58; meters +1,373, −110.
Elevation: Stone, 319.47, pipe, 324.56.
Flat stone and iron pipe, in south edge of woods on the "Six Mile Place," back of Dickey Island, Ill.; and about 920 meters from left bank of river; 340 meters back (northeast) from the Mobile and Ohio Railroad, 235 meters east and 85 meters north of northwest corner of cultivated field; 510 meters east from first curve in railroad below Beechridge. Large tree near by is blazed. Two cabins stand in small field 60 meters southwest of railroad, and 70 meters north of where stone line crosses tracks.

△ DARKEY.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 17.)
Latitude 37° 03′ 48″.23; meters +1,487, −363.
Longitude 89° 14′ 35″.90; meters +887, −596.
To◎Rouse, azimuth 71° 57′ 58″, distance 1,350.3 meters.
To◎Dickey, azimuth 163° 37′ 37″, distance 640.8 meters.
Iron pipe, on Dickey Island, on left bank of river about 5 miles above Cairo, Ill., and 1¼ miles below Ables Point; a short distance above locality originally known as Dickey Field. Blazed trees are located as follows: South, 22 feet; west, 13 feet; north, 23.5 feet; east, 17 feet.

◎ NIMBUS.

Mississippi River Commission, 1880-81. (Chart No. 17.)
Latitude 37° 03′ 09″.04; meters +279, −1,571.
Longitude 89° 13′ 02″.69; meters +67, −1,416.
Elevation: 323.7.
To◎Dickey, azimuth 126° 17′ 06″.25, distance 3,080.67 meters.
Stone post, in Illinois; back of Dickey Island; about 2¾ miles above Cairo Bridge; about one-half mile from main river bank; about 225 meters east of Mobile and Ohio Railroad; about 330 meters south of east-and-west road and 300 meters west of north-and-south road. A small house occupied by Thomas Brown stands about 200 feet northwest of station.

⊡ B. M. CAIRO NO. 2.

United States Lake Survey, 1877. (Chart No. 17.)
Latitude 37° 01′ 22″.33; meters +688, −1,161.
Longitude 89° 09′ 31″.31; meters +774, −709.
Elevation: 323.1.
Sandstone post, 4 inches by 8 inches, on high knoll, in Kentucky; 50 meters south of fence on edge of timber and cultivated field; opposite (at right angles with tangent) and 250 meters from point of curve of Kentucky approach to Cairo Bridge. (Latitude and longitude determined by stadia, Board on Examination and Survey of Mississippi River, 1908.)

△ STANDPIPE '99.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 17.)
Latitude 37° 01′ 15″.09; meters +465, −1,385.
Longitude 89° 10′ 50″.20; meters +1,241, −242.
Standpipe of Cairo, Ill., waterworks, near Cairo Bridge.

△ REDMAN ELEVATOR.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17, station not plotted.)
Latitude 37° 01′ 05″.18; meters +160, −1,690.
Longitude 89° 11′ 24″.01; meters +594, −889.
Flagstaff on Redman-Magee elevator in northwestern part of Cairo, Ill.

△ ELEVATOR SMOKESTACK.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 17.)
Latitude 37° 00′ 51″.61; meters +1,591, −259.
Longitude 89° 10′ 34″.31; meters +848, −635.
Smokestack on elevator in northeast part of Cairo, Ill., on the Ohio River.

△ ELIZA.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 17.)
Latitude 37° 00′ 31″.43; meters +969, −881.
Longitude 89° 11′ 40″.01; meters +989, −495.
Elevation: 334.63.
To△Bourgois, azimuth 344° 20′ 52″, distance 688.0 meters (1899).
To△Standpipe '99, azimuth 222° 26′ 22″, distance 1,824.6 meters (1899).

To △ Elevator Smokestack, azimuth 249° 01′ 20″, distance 1,739.4 meters (1899).
To △ Catholic Church Spire, azimuth 289° 37′ 57″, distance 1,572.3 meters (1896).
To △ Catholic Church Spire, azimuth 289° 37′ 09″, distance 1,573.1 meters (1899).
To △ Redman Elevator, azimuth 200° 50′, distance 1,113 meters (1908).

Iron pipe, 8 inches above surface of ground, outside of track of Mobile and Ohio Railroad embankment at Eliza Point, Ill.; 50 feet downstream from second or low switchstand; in line with upstream side of cross levee above sawmill and with center of track above switches. Station called "Levee" in 1896.

⊙ U. S. P. B. M. 3.

United States Lake Survey, 1877. (Chart No. 17.)
Latitude 37° 00′ 17″.84; meters +550, −1,300.
Longitude 89° 10′ 08″.01; meters +198, −1,286.
Elevation: 334.07.

Hole in copper bolt, in southeast end of Illinois Central Railroad freight depot, at junction of Fourteenth street and Ohio River at Cairo, Ill.; 0.49 meter southwest of east corner. The letters "U. S. B. M." are cut in stone near bolt. (Elevation by precise levels, Mississippi River Commission, 1881; latitude and longitude scaled from United States Lake Survey Chart No. 1.)

⊙ U. S. P. B. M. 2.

United States Lake Survey, 1877. (Chart No. 17.)
Latitude 37° 00′ 15″.90; meters +490, −1,360.
Longitude 89° 10′ 29″.68; meters +734, −750.
Elevation: 326.13.

Hole in copper bolt, leaded horizontally in east side of the building containing offices of the trustees of Cairo city public property, on Washington avenue, between Eighteenth and Nineteenth streets, Cairo, Ill. The bolt is 4.44 meters from southeast corner, and 1.12 meters below lower surface of water table. Marked by letters "U. S. B. M." cut in stone. (Elevation by precise levels, Mississippi River Commission, 1881; latitude and longitude scaled from United States Lake Survey Chart No. 1.)

△ CATHOLIC CHURCH SPIRE.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 17.)
Latitude 37° 00′ 14″.29; meters +441, −1,409.
Longitude 89° 10′ 40″.11; meters +992, −492.
Spire of Catholic Church in Cairo, Ill.

⊙ U. S. P. B. M. 1.

United States Lake Survey, 1877. (Chart No. 17.)
Latitude 37° 00′ 11″.06; meters +341, −1,509.
Longitude 89° 10′ 19″.37; meters +479, −1,005.
Elevation: 324.80.

Hole in center of copper bolt, leaded horizontally in northwest side of custom-house, Cairo, Ill. It is 7.18 meters from northwest corner and 0.37 meter below the junction of the sandstone and limestone, and 0.93 meter above surface of cement walk. The letters "U. S. B. M." are cut in the stone near the bolt. The custom-house is in the square bounded by Fourteenth, Fifteenth, Poplar, and Washington avenue. Station is also known as U. S. B. M. 1. According to level net of 1907, United States Coast and Geodetic Survey, the best elevation available is 96.9227 meters or 317.99 feet above mean sea or gulf level. (Elevation by precise levels, Mississippi River Commission, 1881; latitude and longitude scaled from United States Lake Survey Chart No. 1.)

⊛ CAIRO ASTRONOMICAL STATION.

United States Coast and Geodetic Survey, 1877. (Chart No. 17; station not plotted.)
Latitude 37° 00′ 10″.87; meters +335, −1,515.
Longitude 89° 10′ 15″.32, meters +379, −1,105.

Station is located within the easternmost corner of the custom-house square, Cairo, Ill. Meridian telescope was mounted on a double-column brick pier, 6.568 meters south of and 9.254 meters east of the southeast corner of the custom-house.

Geographical position given is that of the United States Coast and Geodetic Survey. It does not agree with the Mississippi River Commission triangulation.

△ BOURGOIS.

United States engineer office, St. Louis, Mo., 1899. (Chart No. 17.)
Latitude 37° 00′ 09″.92; meters +306, —1,544.
Longitude 89° 11′ 32″.50; meters +804, —680.
To△Catholic Church Spire, azimuth 264° 04′ 54″, distance 1,303.0 meters.
To△Elevator Smokestack, azimuth 228° 13′ 20″, distance 1,929.0 meters.
To△Standpipe '99, azimuth 207° 29′ 46″, distance 2,264.8 meters.
To△Eliza, azimuth 164° 20′ 56″, distance 688.0 meters.
Iron pipe, 6 inches below surface of ground, outside of track on Mobile and Ohio Railroad embankment near Eliza Point, Ill.; near point of tangent of second curve below△Eliza; 6.2 feet from outside rail; 44.5 feet diagonally across track from sign-post "Levee Junction," being 30 feet downstream from a point opposite this post; 124 feet below south line of long shed near windmill on Bourgois' place.

△ HALLIDAY ELEVATOR.

Board on Examination and Survey of Mississippi River, 1908. (Chart No. 17; station not plotted.)
Latitude 36° 59′ 50″.66; meters +1,562, —288.
Longitude 89° 09′ 35″.93; meters +889, —595.
Flagstaff on Halliday Elevator, at lower end of Cairo, Ill.

△ CORN MILL.

United States engineer office, St. Louis, Mo., 1896. (Chart No. 17; station not plotted.)
Latitude 36° 59′ 49″.97; meters +1,540, —309.
Longitude 89° 10′ 34″.51; meters +853, —631.
Iron smokestack of corn mill in southern part of Cairo, Ill.

◎ CAIRO (DEFIANCE).

United States Lake Survey, 1876–77. (Chart No. 17.)
Latitude 36° 59′ 47″.99; meters +1,479, —370.
Longitude 89° 09′ 31″.20; meters +772, —712.
This station was a triangulation station of the Mississippi River Survey made by the United States Lake Survey in 1876–77, and was the station on which the geodetic positions of the Mississippi River Commission triangulation are based.
It was situated on the site of Fort Defiance in the extreme southeastern part of Cairo, Ill., and although it has been destroyed for many years it is described and plotted on account of its historical importance.

⊡ B. M. OHIO MOUTH.

Mississippi River Commission, 1905. (Chart No. 17.)
Latitude 36° 59′ 05″.56; meters +171, —1,678.
Longitude 89° 06′ 36″.80; meters +910, —574.
Elevation: Tile (bolt) 315.17; pipe, 319.17.
Tile and pipe, on Kentucky shore opposite junction of Ohio and Mississippi rivers; between wagon road and railroad; about 17 meters from top of left bank; about 25 meters from Mobile and Ohio Railroad and 9 rail lengths below block signal. Blazed trees: 14-inch cottonwood, 216° —2.8 meters; 18-inch cottonwood, 292° —9.2 meters; 18-inch sycamore, 27° —5.2 meters.

◎ PRICE.

United States Lake Survey, 1876–77. (Chart No. 17; station not plotted.)
Latitude 36° 58′ 12″.06; meters +372, —1,478.
Longitude 89° 07′ 03″.30; meters +82, —1,402.
Elevation: Top of stone, 317.92; pipe, 321.96.
Stone post, in timber, about one-half mile below Bird Point, Mo.; about 300 meters back of high right bank and about one-third mile above a point opposite Wickliffe, Ky. Stone is covered with about 3 feet of earth and has an iron pipe (marked 1891) placed over it. Blazed trees: 8-inch sycamore, 321° —4.2 meters; 7-inch sycamore, 23° —5.1 meters; 6-inch sycamore, 242° —3 meters; 10-inch sycamore, 131° —6.4 meters.

⊡ B. M. FILMORE C.

Mississippi River Commission, 1905. (Chart No. 17; station not plotted.)
Latitude 36° 58′ 07″.80; meters +240, —1,609.
Longitude 89° 07′ 35″.44; meters +877, —607.
Elevation: Tile (bolt) 317.98; pipe, 321.98.
Tile and pipe, about one-half mile below Bird Point, Mo.; on west bank of old slough containing pond; one-half meter east of the east side of cultivated field; about 20 meters west of edge of pond; 100 meters south of north end of pond; and one-half mile west of ⓐ Price.

⊡ B. M. WICKLIFFE.

Mississippi River Commission, 1905. (Not in limits of Board on Examination and Survey of Mississippi River charts.)
Latitude 36° 58′ 04″.17; meters +129, —1,721.
Longitude 89° 05′ 33″.56; meters +830, —654.
Elevation: Tile (bolt) 370.92; pipe, 374.96.
Tile and pipe, in upper end of Wickliffe, Ky.; on hill, 30 meters back of east side of cut of Illinois Central Railroad; one block toward river, from corner of Second and Cumberland streets; in northwest corner of yard of J. C. Du Poyster; and about 30 meters south of gully.

HISTORY AND DESCRIPTION OF THE PERMANENT GAUGES OF THE MISSISSIPPI RIVER BETWEEN ST. LOUIS, MO., AND CAIRO, ILL.

CHAIN OF ROCKS, MO.

St. Louis water department gauge.
Elevation, zero of gauge: 321.18.
Miles above Eads Bridge, midbank, 9.7; low water, 10.4.
The gauge was established by the St. Louis water department in April, 1892. Gauge readings are furnished to the United States engineer office, St. Louis, Mo., where a complete record is on file.
Readings for the periods April to November, 1892, and from April, 1893, to July 31, 1908, are given in Appendix No. 15 of this report.
The gauge is vertical, reads from 107 to 78 feet, and is fastened to the downstream side of the intake tower at Chain of Rocks, about 1,600 feet from the Missouri shore.
Reference bench marks.—No. 1 (⊙P. B. M. 12), elevation above zero of gauge, 143.58 feet, is top of copper bolt in stone post, in corner of grove; 66 feet west of Columbia Bottom road; 1¼ miles upstream from Chain of Rocks; on land of B. M. Chambers; and 2,300 feet upstream from bridge on Columbia Bottom road over Watkins Creek.

BISSELL POINT, MO.

St. Louis water department gauge.
Elevation, zero of gauge: 320.36.
Miles above Eads Bridge, midbank, 3.3; low water, 3.3.
The gauge was established by the St. Louis water department in 1872. Gauge readings are furnished to the United States engineer office, St. Louis, Mo., where a record complete from June, 1880, is on file. Readings for the period June, 1880, to December, 1884, and from April, 1887, to July 31, 1908, are given in Appendix No. 15 of this report.
The gauge consists of four vertical wooden sections fastened to the iron inlet tower at the Bissell Point pumping station.
Gauge sections.—Two sections, reading from 110 to 84 feet, are on the west face of the tower; the other two, reading from 85 to 65 feet, are on the south face.
Reference bench marks.—No. 1 (⊙P. B. M. 14), elevation above zero of gauge, 113.10 feet, is small hole in center of copper bolt, leaded horizontally in third course of stone on north side of western engine room of St. Louis waterworks, Bissell Point, and 4.8 feet west of west coping to main entrance to building. The letters "U. S. P. B. M." are cut near the bolt.
No. 3, elevation above zero of gauge, 110.40 feet, is the northeast corner of a rectangular stone which was formerly the sill of door in center of north side of chimney of the Bissell Point low-service pumping station. The chimney was torn down to the foundation in 1907, leaving the stone in place.

ST. LOUIS, MO.

United States engineers' gauge. In charge of Mississippi River Commission.
Elevation, zero of gauge: 387.10.
Miles below Eads Bridge, midbank, 0.4; low water, 0.4.

Records for the years 1860 to 1873, inclusive, obtained from the city engineer of St. Louis, are on file in the United States engineer office, St. Louis, Mo. These records were obtained independently by the Mississippi River Commission and published by them in "Stages of the Mississippi River."

From 1860 to 1871 readings were obtained by leveling from the St. Louis city directrix to the water surface. When leveling could not be done the stage was estimated. From October, 1871, to December, 1873, readings were taken on a gauge on the St. Louis elevator between Biddle and Ashley streets, and when the "new iron gauge" was established in December, 1873, on the paved wharf at the foot of Market street, about 4,500 feet downstream, synchronous readings were taken on both gauges covering a period of several months and all the readings on the "Elevator gauge" were reduced to correspond to the readings on the Market street gauge by the following table of corrections:

Between 4 and 11 feet, subtract	0.80 foot.
Between 11 and 14 feet, subtract	0.90 foot.
Between 14 and 17 feet, subtract	1.00 foot.
Between 17 and 19 feet, subtract	1.05 feet.
Above 19 feet, subtract	1.10 feet.

(See Annual Report, Chief of Engineers, U. S. Army, 1874, pt. 1, p. 488.)

Records from 1873 to date are published in "Stages of the Mississippi River."

The differences between Mississippi River Commission and United States Weather Bureau records from 1880 to 1895, inclusive, are due mainly to the fact that their readings were taken at different hours. The errors found in the gauge since 1890 by inspections have been corrected in the Mississippi River Commission record.

The zero of the gauge, when established by the United States Engineer Department in 1871, was the low water of 1863, 33.81 feet below the city directrix; the line of precise levels by the Mississippi River Commission in 1880 found the elevation of the 30-foot mark to be 3.74 feet below the directrix, and the zero of the gauge was changed to 33.74 below the directrix to correspond with the elevation of the 30-foot mark.

Gauge sections.—The gauge consists of three sections, graduated from 41.5 feet to 5 feet, on the wharf, near Market street.

The highest section, 41.5 to 34 feet, is painted on west face of southwest steel pillar of the elevated railroad at the foot of Market street.

The next, a vertical section, 36 to 30 feet, is a steel bar on south stone wall of the "Harbor office."

The main section, inclined, 31.4 to 5 feet, of concrete and steel, is flush with the surface of the wharf paving.

Below the 5-foot mark readings are taken on temporary stakes.

Reference bench marks.—⊙P. B. M. 15, elevation above zero of gauge, 36.44 feet, is a small hole in copper bolt leaded into east side of west pier of fourth stone arch from river of the Eads Bridge at St. Louis. It is 20 feet south of north end of pier and 0.46 foot above top course of granite. The letters "U. S." are cut in the granite below the bench mark.

B. M. A. (Ewens, 1894), elevation above zero of gauge, 34.04 feet, is top of upstream rivet on horizontal leg of angle iron on foot plate of elevated-railroad column at the south sidewalk, foot of Market street, and on west (land) side of column.

B. M. Ringbolt, elevation above zero of gauge, 18.49 feet, is small square cut on top of heavy iron staple or ringbolt on paved wharf; about 30 feet south of south line of Pine street and 180 feet east of building on Wharf street.

ENGINEER DEPOT, ST. LOUIS, MO.

United States engineer gauge.
Elevation, zero of gauge: 386.75.
Miles below Eads Bridge, midbank, 3.2; low water, 3.2.

The gauge was established in 1894 at the United States engineer depot, foot of Arsenal street, St. Louis, and the records are continuous and complete.

Gauge sections.—The gauge consisted originally of five vertical sections fastened on or near the landing gangway with graduations extending from 37 to 1 feet. At inspection on March 1, 1909, only two sections were in existence, one reading from 37 to 31.5

feet, on foundation pile of warehouse near upper end of gangway; the other, reading from 26 to 1 feet, on the first clump of mooring piles upstream from the gangway. These gauge sections are of wood, 2 by 6 inches, 14 feet long, and are set and replaced whenever necessary at convenient places along the gangway.

Reference bench marks.—No. 2, elevation above zero of gauge, 43.31 feet, is top of northeast corner of coping to sally port of river wall at United States engineer depot. The letters "B. M." are cut in the stone near the point.

JEFFERSON BARRACKS, MO.

United States engineer gauge.

Elevation, zero of gauge: 384.81.

Miles below Eads Bridge, midbank, 10.8; low water, 10.8.

The gauge was established in 1891, and discontinued February 1, 1908. It consists of seven sections with graduations from 38.6 to 2 feet. It is located on a rock point about 3,000 feet south of the St. Louis, Iron Mountain and Southern Railway new depot.

Gauge sections.—No. 1, 38.6 to 33.1 feet, is an inclined angle-iron section with the lower end bolted to the rock ledge, and the upper end bolted to angle-iron post set in concrete.

No. 2, 33.1 to 28 feet, is a strap-iron section on the face of the culvert under the St. Louis, Iron Mountain and Southern Railway tracks, 330 feet upstream from section No. 1.

Nos. 3 and 4, 28 to 15 feet, and 15 to 10 feet, respectively, are strap-iron sections on the rock ledge, in line with section No. 1.

Nos. 5, 6, and 7, 10 to 7.6 feet, 7.6 to 4.9 feet, and 4.9 to 2 feet, respectively, are strap-iron sections, on the rock ledge, 38 to 73 feet upstream from section No. 1.

Reference bench marks.—No. 1, elevation above zero of gauge, 26.44 feet, is the top of a three-quarter-inch iron bolt in center of a triangle in the rock ledge, 12 feet upstream from the 11-foot mark of gauge. The letters "B. M." are cut in the rock near the mark.

No. 2, elevation above zero of gauge, 15.01 feet, is the top of a three-quarter-inch iron bolt in center of a triangle in the rock ledge, 5 feet downstream from the 15-foot mark of the gauge. The letters "B. M." are cut in the rock near the mark.

No. 3, elevation above zero of gauge, 11.16 feet, is a three-quarter-inch iron bolt in the rock ledge 37 feet downstream from the 11-foot mark of gauge.

WATERS POINT, MO.

United States engineer gauge.

Elevation, zero of gauge: 377.54.

Miles below Eads Bridge, midbank, 21.5; low water, 22.4.

The gauge was established in 1891, and readings for the period September, 1891, to July, 1908, are given in Appendix No. 15 of this report. The gauge is located on Waters Point, just below Kimmswick, Mo. It consists of four strap-iron sections, graduated from 39.5 to 0.0 feet.

Gauge sections.—No. 1, 39.5 to 12.9 feet, is 50 feet downstream from △ Simpson 25, on a large elm tree, and the lower end is bolted to the rock ledge.

No. 2, 12.8 to 6.4 feet, is on the rock ledge 80 feet upstream from section No. 1.

No. 3, 6.3 to 2 feet, is on a large bowlder 95 feet upstream from section No. 1.

No. 4, 3.2 to 0.0 feet, is on a large bowlder 367 feet upstream from section No. 1.

Reference bench marks.—No. 2, elevation above zero of gauge, 14.58 feet, is an iron bolt in center of a triangle in rock 40 feet downstream from the 12.9-foot mark of gauge.

No. 3, elevation above zero of gauge, 6.40 feet, is an iron bolt in the top of the bowlder on which section No. 3 is placed.

No. 4, elevation above zero of gauge, 24.51 feet, is an iron bolt in rock 0.5 foot downstream from the 24.5-foot mark of gauge.

No. 5, elevation above zero of gauge, 10.69 feet, is an iron bolt in rock 0.5 foot downstream from the 10.7-foot mark of an old section of the gauge.

△Flag 10 (M. R. C.), elevation above zero of gauge, 34.32 feet, is a stone post 24 feet south of an 18-inch shellbark hickory tree, 44 feet east of 16-inch black hickory and 41 feet south of edge of rock bank and 23.8 feet west of 18-inch hickory.

△Simpson 25, elevation above zero of gauge, 36.80 feet, is top of a piece of railroad rail set on end near the fence at section No. 1.

ST. NICHOLAS ROCK, MO.

United States engineer gauge.
Elevation, zero of gauge: 220.84.
Miles below Eads Bridge, midbank, 33.0; low water, 34.3.
The gauge was established November, 1904, replacing the Cornice Rock gauge established in 1891 $1\frac{6}{10}$ miles upstream. Readings began in January, 1905, and were discontinued February 1, 1908. The gauge consists of five sections, strap and angle iron, fastened to the bowlders known as "St. Nicholas rocks," with graduations from 187.7 to 148.1 feet.
Gauge sections.—No. 1, 187.7 to 175.6 feet, is an almost vertical strap-iron section on a large bowlder.
No. 2, 176 to 172.6 feet, is an inclined strap-iron section on another bowlder 6 feet downstream from section No. 1.
No. 3, 172.5 to 164 feet, is a strap-iron section in line with section No. 1 on perpendicular river face of bowlder.
No. 4, 164.4 to 159 feet, is an almost vertical strap-iron section on a small bowlder, 57 feet downstream from section No. 1.
No. 5, 163.3 to 148.1 feet, is a slightly inclined angle-iron section on an isolated bowlder 240 feet downstream from section No. 1.
Reference bench marks.—No. 1, elevation above zero of gauge, 188 feet, is a round-head iron bolt in rock near the top of section No. 1.
No. 2, elevation above zero of gauge, 172.64 feet, is a round-head iron bolt in rock at the upper end of section No. 3.
No. 3, elevation above zero of gauge, 165.04 feet, is a round-head iron bolt in rock at the upper end of section No. 4.
No. 4, elevation above zero of gauge, 163.26 feet, is a round-head iron bolt in rock at the upper end of section No. 5.
⊡ 43/3, Stone post 300 feet above northwest corner of Kennett's Castle, at Selma, Mo.; 19 feet west of triangle formed with boat spikes in tie and in center of railroad track; 10.5 feet north of the fifth telegraph pole above Selma station; two blazed cottonwood trees east of track, 69 feet northeast and 81 feet southeast. Elevation above zero of gauge, 189.65 feet.

BRICKEYS MILL, MO.

United States engineer gauge.
Elevation, zero of gauge: 364.84.
Miles below Eads Bridge, midbank, 43.8; low water, 45.6.
The gauge was established in 1891, and readings were discontinued during the period from December, 1900, to April, 1904, and since January, 1908.
Readings for the period September, 1891, to December, 1900, and from April, 1904, to February, 1908, are given in Appendix No. 15 of this report.
The gauge consists of seven sections, with graduations from 35.5 to 1.1 feet, and is located on and near the old mill.
Before the establishment of the present gauge, a gauge in this locality, then known as Cliff, Mo., was in use from November 8, 1875, to June 30, 1879, the records of which are on file in the United States engineer office. Another gauge was in use by the Mississippi River Commission from June, 1884, to June, 1885. (See "Stages of Mississippi River, 1891.")
Gauge sections.—No. 1, 35.5 to 26.5 feet, is a strap-iron section on the northeast corner of the mill.
No. 2, 27 to 18.3 feet, is a wood and strap-iron section 24 feet downstream from section No. 1.
No. 3, 21 to 14.3 feet, is an inclined wood and strap-iron section in line with section No. 1.
No. 4, 14.5 to 9.9 feet, is a strap-iron section, 96 feet downstream from section No. 1.
No. 5, 10.3 to 9.3 feet, is a strap-iron section, 317 feet downstream from section No. 1.
No. 6, 9.2 to 5.6 feet, is a strap-iron section 326 feet downstream from section No. 1.
No. 7, 2.8 to 1.1 feet, is a strap-iron section 92 feet upstream from section No. 1.
Reference bench marks.—No. 1, ⊡ B. M. 18=41 Holman. Raised square with letters "U. S. B. M." above and the number "18" below, cut on horizontal surface of natural rock; 60 feet above the upstream corner of the mill. Elevation above zero of gauge, 19.71 feet.
No. 2, elevation above zero of gauge, 13.96 feet, is the top of an iron bolt in the rock near the gauge.

No. 3, elevation above zero of gauge, 5.06 feet, is the top of an iron bolt in the rock near the gauge.

No. 4, elevation above zero of gauge, 27.29 feet, is a square-head bolt in the masonry at the northeast corner of the mill.

No. 5, elevation above zero of gauge, 14.38 feet, is a roundhead iron bolt in the rock 12 feet south of the 14.5-foot mark of the gauge.

LITTLE ROCK, MO.

United States engineer gauge.

Elevation, zero of gauge: 220.84.

Miles below Eads Bridge: Midbank, 53.9; low water, 56.5.

The gauge was established in 1891, and the records are complete since March, 1894. Readings from that date to July, 1908, are given in Appendix No. 15 of this report.

The gauge consists of four sections, with graduations from 166.9 to 138 feet, located at the lower end of the quarries at Little Rock Landing, Mo., and is 2 miles above Ste. Genevieve, Mo.

Gauge sections.—No. 1, 166.9 to 157 feet, is a strap-iron section on the rock ledge 150 feet upstream from north corner of Wilder's warehouse.

No. 2, 157.6 to 156.2 feet, is a strap-iron section on the rock ledge 345 feet downstream from section No. 1.

No. 3, 156.2 to 152 feet, is a strap-iron section on the rock ledge 354 feet downstream from section No. 1.

No. 4, 152 to 138 feet, is a wood and strap-iron section on the rock ledge 111 feet upstream from section No. 1.

Reference bench marks.—No. 1, elevation above zero of gauge, 176.37 feet, is the center mark on brass bolt on south side of foundation, just east of door in landing warehouse.

No. 2, elevation above zero of gauge, 178.66 feet, is a knob of rock with the letters "B. M." cut above it, 5 feet north and 10 feet west of north corner of boiler house of mill at landing.

No. 3 (Holman 52), elevation above zero of gauge, 178.66 feet, is on the southeast corner of sill of door on south side of the Little Rock mill. It is marked by cut in door jamb and an arrow on face of sill under bench mark.

No. 4, elevation above zero of gauge, 160.53 feet, is the top of gauge bolt, in rock near the 160.5-foot mark of gauge.

No. 5, elevation above zero of gauge, 152.44 feet, is a bolt in the rock ledge 10.5 feet south of the 152.1-foot mark of gauge.

No. 6, elevation above zero of gauge, 152.17 feet, is a bolt in the rock ledge 1 foot from the 151.9-foot mark of gauge.

No. 7, elevation above zero of gauge, 155.98 feet, is the top of a 1¼-inch broken ring-bolt 9 feet south of the 156-foot mark of gauge.

EAST KASKASKIA, ILL.

United States engineer gauge.

Elevation, zero of gauge: 350.84.

Miles below Eads Bridge, midbank, 63.1; low water, 66.1.

The gauge was established in 1893, and readings were discontinued February, 1908. It consists of six sections with graduations from 33 feet to 1 foot. It is located about one-half mile above the railroad station at Fort Gage, Ill.

Gauge sections.—No. 1, 33 to 19 feet, is a vertical wooden section on the St. Louis, Iron Mountain and Southern Railway (Illinois Division) trestle below Fort Gage. This is a temporary section.

No. 2, 19.6 to 16.2 feet, is a strap-iron section on the rock ledge, 600 feet downstream from the old "Menard" warehouse.

No. 3, 16.7 to 11.6 feet, is a strap-iron section on the rock ledge 209 feet downstream from the old warehouse.

No. 4, 12.2 to 6.5 feet, is a strap-iron section on the rock ledge, 481 feet downstream from the old warehouse.

No. 5, 6.9 to 4.7 feet, is a strap-iron section on the rock ledge 79 feet downstream from section No. 2.

No. 6, 4.7 feet to 1 foot, is in two parts, of strap iron, on the rock ledge 423 and 415 feet downstream from old warehouse.

Reference bench marks.—No. 2, elevation above zero of gauge, 11.33 feet, is a three-quarter-inch iron bolt flush with the rock, 87.5 feet west of the northwest corner of the old warehouse. It is marked by a triangle and the letters "B. M."

No. 6, elevation above zero of gauge, 33.67 feet, is the head of a spike in the root of a locust tree south of the old warehouse.

No. 7, elevation above zero of gauge, 37.61 feet, is the head of a spike in white oak tree 30 feet southeast of the old warehouse.

No. 8, elevation above zero of gauge, 19.13 feet, is a roundhead iron bolt in the rock, 8.5 feet upstream from the 19-foot mark of the gauge.

No. 9, elevation above zero of gauge, 7.52 feet, is a roundhead iron bolt in the rock at the upper end of section No. 5.

CHESTER, ILL.

United States engineer gauge.

Elevation, zero of gauge: 348.13.

Miles below Eads Bridge, midbank, 69.6; low water, 72.9.

Established by the United States Weather Bureau in 1891 and maintained by the United States engineer office, St. Louis, Mo., since 1898.

Readings since 1891, furnished by the United States Weather Bureau, Cairo, Ill., to the Mississippi River Commission, are published in "Stages of the Mississippi River." Since April, 1899, the United States engineer office has obtained readings directly from the gauge observer.

The gauge consists of four sections, with graduations from 36 to —1 feet.

Gauge sections.—Nos. 1 and 2, 33 to 25 feet, and 24.9 to 22.5 feet, respectively, vertical, of wood, are secured to the north wall of the upper warehouse at the steamer landing.

No. 3, 24.4 to 3.1 feet, inclined, is of angle iron and located 42 feet upstream from the warehouse.

No. 4, 2.6 to —1 feet, inclined, is of wood and strap iron, located 10 feet upstream from the warehouse.

Reference bench marks.—B. M. Devine, elevation above zero of gauge, 37.95 feet, is a horizontal chisel mark in the head of a copper bolt leaded horizontally in the west vertical face of the stone water table above the foundation of a brick building owned by John Devine, at the southeast corner of Water and Wall streets, Chester, Ill. The bench mark is 0.4 foot south from the corner of the building and about 2 feet above the pavement.

No. 4, elevation above zero of gauge, 23.16 feet, is top of a round-head bolt in the masonry of the northwest corner of the warehouse on which gauge sections Nos. 1 and 2 are fastened.

No. 5 (1904), elevation above zero of gauge, 20.86 feet, is top of a ring bolt in wharf slope halfway between gauge sections Nos. 2 and 3.

No. 6 (1906), elevation above zero of gauge, 22.39 feet, is top of round-head bolt set in top of highest concrete pier of section No. 3.

RED ROCK, MO.

United States engineer gauge.

Elevation, zero of gauge: 335.84.

Miles below Eads Bridge, midbank, 84.9; low water, 89.2.

The gauge was established in 1896 and discontinued February 1, 1908. It consists of six sections, with graduations from 39 to 2.5 feet, located on and near the rock called "Devil's Backbone." Readings from November, 1896, to January, 1897, and from November, 1897, to January 31, 1908, are in Appendix No. 15, this report.

Gauge sections.—No. 1, 39 to 23 feet, is a vertical wooden section, with vertical angle-iron base, 500 feet downstream from the store at Red Rock Landing.

No. 2, 24.4 to 16 feet; No. 3, 17 to 13 feet; No. 4, 13.2 to 9.3 feet; No. 5, 9.7 to 5.6 feet; and No. 6, 5.5 to 2.5 feet, are strap-iron sections on the "Devil's Backbone."

Reference bench marks.—No. 1, elevation above zero of gauge, 14.25 feet, is a three-quarter-inch iron bolt flush with the rock, 26 feet southwest of 9.7-foot mark of gauge.

No. 2, elevation above zero of gauge, 14.33 feet, is a three-quarter-inch iron bolt, one-half inch above the rock ledge and 7 feet north of the 15-foot mark of gauge.

No. 3, elevation above zero of gauge, 22.40 feet, is a three-quarter-inch iron bolt, one-half inch above the rock ledge and 3 feet south of the 22.4-foot mark of gauge.

No. 4, elevation above zero of gauge, 41.40 feet, is a notch cut in the center and on top of the head wall on the south side of double pipe railroad culvert halfway between gauge and landing.

No. 6, elevation above zero of gauge, 20.50 feet, is an iron bolt on highest point of "Devil's Backbone" between sections Nos. 2 and 3.

GRAND TOWER, ILL.

United States engineer gauge.
Elevation, zero of gauge: 329.04.
Miles below Eads Bridge, midbank, 98.9; low water, 103.3.

The gauge was established by the United States Weather Bureau February, 1885, and the records to December 31, 1886, are published by that bureau. Records from January 1, 1889, to January 31, 1891, inclusive, and since January 1, 1905 (the latter furnished by the United States engineer office), are published in "Stages of the Mississippi River" by the Mississippi River Commission. Readings for the periods January, 1896, to December, 1904, and from January to July 31, 1908, are given in Appendix No. 15 of this report. Readings for the period from December, 1904, to January, 1908, are published by the Mississippi River Commission in "Stages of the Mississippi River."

The readings for the period from February 1, 1891, to June 30, 1896, tabulated from telegraphic reports in the St. Louis Globe-Democrat (daily) and for the period July 1, 1896, to January 22, 1897, from the records of the coal company at Grand Tower, are on file in the United States engineer office, St. Louis, Mo.

The gauge was reestablished by the United States engineer office, St. Louis, January 23, 1897, and has since been maintained by that office.

The zero of the gauge was 331.52 until about March 10, 1893, when it was changed by the observer to 329.04, the present value.

The gauge, graduated from 40 to 0 feet, is vertical, of wood sections 2 by 5 inches, and on a pile in the coal dump.

Reference bench marks.—No. 1, elevation above zero of gauge, 43.10 feet, is stone post in northeast corner of yard of office of Big Muddy Coal and Iron Company, Grand Tower.

No. 3, elevation above zero of gauge, 27.27 feet, is top of square-head bolt in bowlder 345 feet upstream from north end of coal dump, 97 feet west of 28-inch walnut tree, and 98 feet southwest of a 30-inch post oak, on hillside.

No. 4, elevation above zero of gauge, 31.41 feet, is top of square-head bolt in bowlder 175 feet upstream from reference bench mark No. 3, and 70 feet southwest from a 26-inch white oak, on hillside.

No. 5, elevation above zero of gauge, 43.99 feet, is top of boat spike in root of maple stump in northwest corner of yard of office of Big Muddy Coal and Iron Company.

MOCCASIN SPRINGS, MO.

United States engineer gauge.
Elevation, zero of gauge: 320.84.
Miles below Eads Bridge, midbank, 112.7; low water, 116.8.

The gauge was established in 1896 and discontinued on February 1, 1908. Readings from November, 1896, to January 31, 1908, and for the month of June, 1908, are given in Appendix No. 15 of this report.

The gauge consists of 10 sections, with graduations from 38 to 4.2 feet. It is located near the Moccasin Springs post-office.

Gauge sections.—No. 1, 38 to 26.8 feet, is a vertical wooden section on a tree 120 feet downstream from the landing warehouse.

No. 2, 29 to 22.1 feet, is a strap-iron section fastened to the rock ledge and to a large elm tree 500 feet downstream from section No. 1.

No. 3, 22.3 to 20.5 feet, is a strap-iron section on rock ledge 375 feet downstream from section No. 1.

No. 4, 20.6 to 18.5 feet, is a strap-iron section bolted to rock 10 feet toward river from section No. 2.

No. 5, 18.5 to 12.4 feet, is a strap-iron section on rock ledge 505 feet downstream from section No. 1.

No. 6, 14.9 to 10.8 feet, is not used.

No. 7, 12.6 to 9.2 feet, is a vertical angle-iron section on rock ledge on second projecting point, about 250 feet downstream from section No. 2.

No. 8, 10.6 to 8.5 feet, is a strap-iron section on rock ledge 522 feet upstream from section No. 1.

No. 9, 8.4 to 5.8 feet, is a strap-iron section on rock ledge 460 feet upstream from section No. 1.

No. 10, 7.5 to 4.2 feet, is a strap-iron section on rock ledge 550 feet downstream from section No. 1.

Reference bench marks.—No. 2 (U. S. B. M. 37), elevation above zero of gauge, 22.66 feet, is a square knob with the letters "U. S. B. M. 37" cut in rock ledge and 1 foot

from face, under the main bank,and a little south of the south line of first house above landing.

No. 3, elevation above zero of gauge 9.25 feet, is a bolt in the rock ledge 8 feet downstream from section No. 8.

No. 4, elevation above zero of gauge, 7.88 feet, is a bolt in the rock ledge 470 feet downstream from section No. 1.

No. 5, elevation above zero of gauge, 24.87 feet, is a bolt in the rock ledge 4 feet upstream from section No. 2.

CAPE GIRARDEAU, MO.

Mississippi River Commission gauge.

Elevation, zero of gauge: 311.84.

Miles below Eads Bridge, midbank, 126.5; low water, 130.8.

The gauge consists of an inclined section near the lower end of Themis street, and two vertical sections at the lower end of the city wharf, at the foot of Independence street.

The vertical sections are marked A, 26 to 36 feet, and F, 5 to 9 feet.

The inclined gauge was built in December, 1904. It runs from top of paved levee to 10 feet beyond foot of pavement, on a line with and a little south of the south side of Themis street extended, the total length being 115 feet.

The gauge consists of a wooden stringer 8 by 10 inches, resting on bents made of 8 by 8 inch, and 5 by 8 inches, 3 feet high, placed 8 feet apart. The lower end of wooden stringer is bolted into the natural rock.

On top of the stringer is * * * an iron strip * * * graduations * * * 31.5 feet * * * permanent graduations * * * to the 9.9-foot mark * * * strap-iron * * * fastened to one of the lower timbers of the gauge and graduated from 7.7-foot mark to 9.8-foot mark.—"Stages of the Mississippi River."

Reference bench marks.—⊙P. B. M. 54, elevation above zero of gauge, 41.67 feet, is center of horizontal copper bolt in the outer vertical face of stone step, which extends under buttress at the northeast corner, second entrance from the north, to the Riverview Hotel, on Water street, Cape Girardeau.

No. 1 (Harman, 1898), elevation above zero of gauge, 35.58 feet, is top of flat portion of bent boat spike driven horizontally into river face at southwest corner of E. W. Flentge's store building, north side of Independence street. It is 0.6 foot north of corner and is in the first joint of stone masonry above ground, and third joint below brickwork, and is about on level with paving of gutter at corner of building. Building is marked "Franklin House" on river front.

B. M. G. 1904, elevation above zero of gauge, 36.36 feet, is top of iron bolt leaded vertically in top face at east end of stone step which is on the east end of north side of Nicholas Scharff's wholesale grocery store, southwest corner of Themis and North Water streets.

GRAYS POINT, MO.

United States engineer gauge.

Elevation, zero of gauge, 308.15.

Miles below Eads Bridge, midbank, 132.4; low water, 136.8.

The Mississippi River Commission established the present gauge in 1883 and maintained it until August, 1896, when it was discontinued.

On November 2, 1896, the United States engineer office began using this gauge and abandoned the engineer's gauge 0.73 mile upstream, which was established in 1878, and the readings on this latter gauge from February, 1880, to August, 1883, were changed to agree with the zero of the commission's gauge, and are published in "Stages of the Mississippi River."

The readings on the present gauge, from November 2, 1896, to date, have not been published, but are on file in the United States engineer office, St. Louis. Readings from January, 1896, to July 31, 1908, are given in Appendix No. 15 of this report.

The present gauge consists of three sections, with graduations from 35.7 to 1.8 feet, located on the rock ledge at Grays Point, Mo.

Gauge sections.—No. 1, 35.7 to 19 feet, is a strap-iron section on rock ledge at the lowest part of the rock point.

No. 2, 23 to 5.5 feet, is a strap-iron section on the rock ledge 120 feet upstream from section No. 1.

No. 3, 5.5 to 1.8 feet, is a strap-iron section on the rock ledge 543 feet upstream from section No. 1.

Reference bench marks.—No. 1 (B. M. Ewens, 1883), elevation above zero of gauge, 26.05 feet, is the top of an iron bolt leaded vertically into the rock ledge 8.5 feet

upstream from the 26-foot mark of gauge. The letters "U. S. B. M. E." are cut in the rock 0.5 foot from the bench mark. (For elevation of this reference bench mark, see ⊡B. M. E.=△Grays, in Permanent Survey-Marks, this appendix.)

No. 2, elevation above zero of gauge, 15.16 feet, is an elevated square knob on the rock ledge 21 feet downstream from the 15-foot mark of gauge. The letters and number "U. S. B. M. 74" are cut in the rock near the bench mark.

No. 3, elevation above zero of gauge, 8.23 feet, is the top of a three-quarter-inch iron bolt 4.5 feet inshore from top of section No. 3.

COMMERCE, MO.

United States engineer gauge.

Elevation, zero of gauge, 308.84.

Miles below Eads Bridge, midbank, 139.4; low water, 143.7.

The gauge was established in September, 1896, and readings to July, 1908, are given in Appendix No. 15 of this report. The gauge consists of five sections, with graduations from 30 to 2 feet, located on the old mill and the bowlders immediately upstream from the landing.

Gauge sections.—No. 1, 30 to 21.3 feet, is a vertical wooden section on the upstream side of the mill and 30 feet from the river front of the building.

No. 2, 24 to 10.6 feet, is a vertical wooden section on a large pile at the northeast corner of the mill.

No. 3, 15.4 to 10 feet; No. 4, 10.5 to 7.2 feet, and No. 5, 7.1 to 2 feet, are on bowlders 255 feet upstream from the mill. Nos. 3 and 4 are strap-iron sections, and No. 5 is a vertical wooden section.

Reference bench marks.—No. 1, ⊙P. B. M. 61, elevation above zero of gauge, 60.68 feet, is the center of a horizontal copper bolt set in front or east face of foundation of Mr. Anderson's large brick dwelling at the upper end of Commerce. It is 6 feet north of center of front entrance and 1.2 feet above ground.

No. 2, elevation above zero of gauge, 18.51 feet, is an elevated square knob cut on a large bowlder 260 feet upstream from the mill at the landing. The letters and number "U. S. B. M. 74" are cut in the rock 1 foot west of the bench mark.

HACKER TOWHEAD, ILL.

United States engineer gauge.

Elevation, zero of gauge, 220.84.

Miles below Eads Bridge, midbank, 151.5; low water, 156.5.

The gauge was established in March, 1904, and was discontinued February 1, 1908. It is located on the head of Hacker Towhead (Blackbird Island), and consists of three sections with graduations from 114 to 80 feet.

Gauge sections.—No. 1, 114 to 107.3 feet, is a vertical wooden section on a tree on the revetted bank and 50 feet upstream from section No. 2.

No. 2, 107.6 to 87.8 feet. The upper portion, 107.6 to 96.4 feet, is an inclined wooden section with its top fastened to a stump; the lower portion, 96.4 to 87.8 feet, consists of an angle-iron section.

No. 3, 90 to 80 feet, is a vertical wooden section on a pile 200 feet upstream from section No. 2.

Reference bench marks.—No. 1, elevation above zero of gauge 108.98 feet, is top of a spike in the root of a 3-foot elm tree 200 feet north of a house in a 10-acre lot owned by Harry McColgan.

No. 3, elevation above zero of gauge 109.98 feet, is top of a spike in the root of a 6-inch sycamore 110 feet east of gauge section No. 1.

No. 4, elevation above zero of gauge 108.10 feet, is top of a round-head iron bolt in the concrete base of the iron post at the 88-foot mark of gauge.

No. 5 (△Cuba), elevation above zero of gauge 108.88 feet, is top of iron pipe, surrounded by loose stone, nearly flush with the surface of revetment at the outer end of hurdle No. 8, Hacker Towhead.

⊡5/1. Elevation of stone above zero of gauge, 103.44 feet; of pipe, 108.52 feet, is flat stone and iron pipe, in Illinois; about one-half mile back from old high bank in Hacker Bend; at fence, edge of woods, and east side of field; 150 feet south of northeast corner of field; 20 feet from small log house; and just back of small orchard.

BEECHRIDGE, ILL.

United States engineer gauge.

Elevation, zero of gauge, 289.73.

Miles below Eads Bridge, midbank, 162.5; low water, 169.5.

The gauge, established in 1900, originally consisted of only high and low water sections. It now consists of four sections, with graduations from 42 to 6.8 feet, placed on the revetted bank about 600 feet south of the road running east to Beechridge. Readings from October to December, 1901; January, September, and November, 1902; March and June, 1903, and November, 1903, to July 31, 1908, are given in Appendix No. 15 of this report.

Gauge sections.—No. 1, 42 to 38.5 feet, is a vertical wooden section on a small catalpa tree at the top of the bank.

No. 2, 39 to 24.5 feet, is an inclined angle-iron section bolted to angle-iron posts embedded in concrete 30 feet upstream from section No. 1.

No. 3, 24.5 to 13 feet, is an inclined angle-iron section 187 feet downstream from section No. 1.

No. 4, 13.9 to 6.8 feet, is an inclined angle-iron section about 100 feet upstream from section No. 1.

Reference bench marks.—No. 1 (⊙P. B. M. 65), elevation above zero of gauge 36.58 feet, is the top of copper bolt in stone post on land of C. P. Martin. Stone is south of road running west from Beechridge, and nearly in line with two large oak trees on north, one in the field, the other in south fence along road, and distant, respectively 185 and 362 feet. Stone is 95 feet west of the abandoned Cairo road and 180.5 feet east of Martin's barn.

No. 2, elevation above zero of gauge 35.74 feet, is a spike in the base of an elm tree in fence corner in south line of land belonging to the De Gelder estate.

No. 3, elevation above zero of gauge 33.43 feet, is a spike in the root of river side of small catalpa tree to which section No. 1 is secured.

BIRDS POINT, MO.

United States engineer gauge.

Elevation, zero of gauge: 279.19

Miles below Eads Bridge, mid bank, 173.2; low water, 181.4.

The gauge was established in 1901 and discontinued January, 1908. It consisted of four sections, with graduations from 52 to 0 feet, placed on guard piling of incline of the St. Louis Southwestern Railway.

Reference bench marks.—No. 2, elevation above zero of gauge, 43.20 feet, is a spike in river side of large elm tree in front of watchman's house on the south side of the track leading to lower incline.

CAIRO, ILL. (OHIO RIVER).

United States engineer's gauge, in charge of Mississippi River Commission.

Elevation, zero of gauge: 277.71.

Gauge is 2 miles above the mouth, in the Ohio River.

Mouth of Ohio River; miles below Eads Bridge, mid bank, 174.8; low water, 182.5.

The gauge, at the foot of Fourth street, is in three sections, and is graduated from 55 to 1 feet.

Gauge sections.—The section from 55 to 50 feet is a steel strap 5 by ½ inches, bolted to the upstream face of buttress at upstream side of roadway opening in concrete retaining wall, high levee, and upstream from the inclined section of the gauge.

The inclined section, 50 to 9 feet, consists of a 12-inch steel I beam embedded in concrete.

The inclined section from 9 to 1 feet consists of 10 by 12 inch oak timbers, laid nearly flush with the face of the levee; to the upper face of the timbers is spiked an iron strap 4½ by ⅜ inches.

Reference bench marks.—No. 1 (Hely), elevation above zero of gauge, 52.42 feet, is a cross cut in the corrugated iron sill of the Halliday House on the river side, near the northeast corner, under window. It is 1.7 feet south of the corner and near head of large bent nail.

⊙P. B. M. 1, elevation above zero of gauge, 47.09 feet, is a small hole in center of copper bolt set horizontally in northwest side of custom-house. It is 23.5 feet from the northeast corner and 1.2 feet below the junction of the sandstone and limestone. The letters "U. S. B. M." are cut in the stone.

⊙P. B. M. 2, elevation above zero of gauge, 48.42 feet, is hole in copper bolt set horizontally in east side of building containing offices of the trustees of Cairo city public property on Washington avenue, between Eighteenth and Nineteenth streets.

The bolt is 14.6 feet from southeast corner and 3.7 feet below lower surface of water table. The letters "U. S. B. M." are cut in the stone.

B. M. D., elevation above zero of gauge, 55.87 feet, is top of letter "D" in brass plate sunk in granitoid coping near upper end of inclined gauge. Plate bears the inscription: "Built by D. Sinclair, Kankakee, 1898."

RECORD OF THE HIGHEST KNOWN WATER MARKS OF THE MISSISSIPPI RIVER BETWEEN GRAFTON, ILL., AND COLUMBUS, KY.

FLOOD OF APRIL, 1785 ("L'ANNÉE DES GRANDES EAUX").

"The high water of 1785 from a chisel mark and date on the rock at Carondelet appears to have been 3.85+ our present directrix=(high water of 1826)".—Quoted from old gauge record by Jacob Leopold in harbor and wharf commissioners' office, St. Louis, Mo.

"High water 1785, April, about 42 feet."—Dr. George Engelmann, Transactions, Academy of Science, Volume II, pages 420–423.

"Flood of 1785.—A great flood at St. Louis in April, said to have been equal to that of 1844."—Humphreys and Abbot Report, 1861, page 168.

"The Mississippi rose twenty feet above the highest known watermarks. This deponent went in a boat, for the purpose of procuring plank, from St. Louis through the woods growing in the American Bottom, to Kaskaskia. This was in April, 1785. Auguste Chouteau, April 18, 1825.—Hunt's Minutes, Volume I, page 107.

"The following year after the commencement of the new village (Ste. Genevieve) was 'l'année des grandes eaux.' The old village was overflowed so as to be on the top of the houses. A boat by Mr. Chouteau arrived at this time, and they made the boat fast to the top of one of the chimneys, and dined on the roof of the house of old André. In the big field the water was in many places ten to fifteen feet deep. Julien Labriere, October 22, 1825.—Hunt's Minutes, Volume II, page 225."—History of St. Louis City and County, by J. Thomas Scharf, 1883, Volume I, page 210.

"The old town (Ste. Genevieve) was abandoned in 1785 on account of the great flood of the Father of Waters during that year, and known among its inhabitants as 'l'année des grandes eaux.' * * * The overflow of the Mississippi in the year 1785 has never been equaled since."—Rozier's History, Early Settlement of the Mississippi Valley.

"It is certain that at Kaskaskia the water attained a greater height in 1844 than was reached in 1785. This is not predicated upon the mere recollection of individuals, but was ascertained from existing marks of the height of the flood of that year after the subsidence of the water in 1844. It was then proved that in this latter mentioned year the water rose two feet and five inches above the high-water mark of 1785."—History of St. Louis City and County, by J. Thomas Scharf, 1883, Volume II, page 106.

Elevation of high-water mark of 1844 at Old Kaskaskia (Board on Examination and Survey of Mississippi River Survey, 1908) is 393.10, and subtracting 2 feet 5 inches gives 390.68 as the elevation of the high-water mark of 1785 at that point.

Elevation of St. Louis city directrix + 3.85=424.69. Assuming that the point "rock at Carondelet" was at Steins street, St. Louis, 6¼ miles below the St. Louis (Market street) gauge, using the slope of 1844 from St. Louis to Waters Point (0.57 foot per mile) and transferring this stage to the present St. Louis gauge, the high water of 1785 would have read 41.4 feet, which is practically the same gauge height as for the flood of 1844.

Considering this location for the "rock at Carondelet" and the elevation as recorded by Jacob Leopold (for many years the St. Louis gauge reader), the equivalent gauge reading of 41.4 feet is believed to be very nearly correct.

While this does not agree with the 1844 record for Kaskaskia (Scharf's History), great weight should be given to Humphreys and Abbot report and to the stage (about 42 feet) recorded by Doctor Engelmann; and it is probable that the record of 41.4 feet for the flood of 1785 at St. Louis is fully as reliable as the Kaskaskia record; also it is possible that owing to changes in the river bed the flood of 1844 was abnormally high at Kaskaskia, as compared with that of 1785.

FLOOD OF JUNE, 1844.

GRAFTON, ILL.

Miles above Eads Bridge, 38.

Elevation: 443.1.

Fourteen inches above top of lower end of stone wall on west side of street running from Main street to Black Crook House; elevation, 443.12; authority, John McClintock.—Report, "Waterway, Lockport to St. Louis," 1905.

According to R. C. Goodrich the water in 1858 came up nearly even with the bottom of step of church on Main street, and even with the sidewalk. Elevation of step, 443.13 (United States engineer office, St. Louis, Mo., levels of 1879 adjusted to precise levels). This high water is probably that of 1844.

ELSAH, ILL. (JERSEY LANDING).

Miles above Eads Bridge, 34.1.
Elevation: 442.3.
Mark on door on west side of brick building at upper end of trestle at Jersey Landing, Ill.; elevation, 442.34. On this same door is the mark of 1858.—Mississippi River Commission, survey 1891.

ALTON, ILL.

Miles above Eads Bridge, 23.4.
Elevation: 439.8.
According to the survey of 1879 (United States engineer office, St. Louis, Mo.) the original mark was a black stripe painted by G. D. Sidway, over water stain on a post in his saddlery shop located on the north side of Second street four doors from State street. Marks of 1851 and 1858 were also on the same post. Before this saddlery shop was rebuilt, City Engineer George Dixon transferred the 1844 mark to a round iron column set in the northeast corner of Alton rolling mill, corner of Second and State streets, cutting in that column a horizontal groove and the date 1844. On same column is a high-water mark of 1903, 33¼ inches lower.
That the 1844 mark was accurately transferred is shown by levels taken in 1908 to an old bench mark (Emerson's house) which had been connected with the original mark. Determination of original mark by United States engineer office (adjusted levels) in 1872, 439.78; in 1879, 440.06; of transferred mark, by Mississippi River Commission transalluvial levels in 1894, 439.78; by Board on Examination and Survey of Mississippi River single line of levels in 1908 from ⊡ 62/2, 439.77; and by closed line rom △ Alton, 439.50.

MADISON, ILL.

Miles above Eads Bridge, 12.8.
Elevation: 435.
Mark is notch cut in 39-inch burr oak tree, 1½ miles from the river and on the east bank of Chouteau Slough.
Marks for the floods of 1851 and 1858 are also cut in the same tree.
Mr. Pettingill's house (since destroyed by fire) stood immediately back from the tree, and it is stated that the water at its flood crest was 14 inches deep in the hall of the house. According to the United States engineer office survey of 1879 the elevation of floor plus 1.17 feet was 434.9, or 0.38 foot lower than the notch in the tree.
The elevation of notch on the tree, as determined by Board on Examination and Survey of Mississippi River levels, 1908, is 435.

ST. LOUIS, MO. EADS BRIDGE.

Miles from Eads Bridge, 0.
Elevation: 429.2.
Mark scored, with marks of 1851, 1858, 1881, 1882, 1883, and others, on wood post east of door to the Eagle Boat Store Company, No. 517 North Wharf. Elevation, 429.22.—Mississippi River Commission, survey, 1889.

ST. LOUIS, MO. MARKET STREET GAUGE.

Miles below Eads Bridge, 0.4.
Elevation: 428.4.
A mark 7 feet 7 inches above the St. Louis city directrix (elevation of directrix, 420.84) which was the curbstone of the wharf between Market and Walnut streets. Elevation, 428.42.

CAHOKIA, ILL.

Miles below Eads Bridge, 3.7.
Elevation: 426.9.
Water stain on black walnut door of old frame Catholic church. The door is the one leading to the room in the rear, and the stain is on the main room side of the door. Just above the stain was found penciled "1844;" elevation, 426.90. Stain for the flood crest of 1903 is 4 feet 3 inches lower. (United States engineer office, 1905, Penniman.)

A point, indicated by Mrs. Theresa Le Berch, on the east wall of her house; to the best of her memory this point was 5 feet above the window sill. Elevation, 426.92. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

WATERS POINT, MO.

Miles below Eads Bridge, 22.4.
Elevation: 416.4.
Mrs. Letitia Waters, widow of Capt. G. W. Waters, U. S. Army, said the flood crest of 1844 was just over the crotch of a 15-inch walnut tree which was on the bank of the river in line with north wall of her house. The elevation of the crotch of the tree (416.4 feet) was checked by levels to several water stains on trees in Montesano Park. These stains were very distinct and the mean elevation of four such marks was 416.72 feet. The park is about 0.8 mile above Waters Point. (United States engineer office, 1879, adjusted levels.)

OPPOSITE SULPHUR SPRINGS, MO.

Miles below Eads Bridge, 24.1.
Elevation: 415.3.
A point about 5 inches above the sill of a window in the north side of house owned by Victor Castelli, of Valmeyer, Ill. House is occupied by Mr. and Mrs. Vogel, and the latter is authority for the mark, having received her information from members of the family who lived in the house during the flood of 1844. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

RIVERSIDE, MO.

Miles below Eads Bridge, 27.9.
Elevation: 412.3.
Governor Dunklin's son remembered that the flood reached within an inch of the base of the chimney of their old house. Elevation of base of chimney, 412.63 (adjusted levels). (From records of the United States engineer office survey of 1879.)
Mr. C. B. Wallace indicated the approximate location of a mark on the stone chimney of a house almost directly opposite in Illinois, which was occupied at the time of that flood by his grandmother. Owing to whitewash and plaster being over the mark, an exact determination was not made. Elevation of approximate mark, 411.93. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)
The mark at Riverside, Mo., was in a ravine, and since the water striking against the prominent point of the lower bluff tended to pile up and make the crest elevation of the flood greater there than across the river, back of the timber, a mean of the two elevations has been used, which gives a fairly reliable determination of the flood crest at this point.

PLATIN ROCK, MO.

Miles below Eads Bridge, 31.3.
Elevation: 411.3.
James E. Jewett, who lived at Platin Rock, in southern one of row of houses north of stone house, said the flood crest of 1858, to the best of his memory, was even with the lowest part of rim of rectangular stone basin at bottom of down spout at southeast corner of row. Elevation of rim, 407.62. Leveler Sadler, of 1872 survey, United States engineer office, stated that at Hugs, a short distance downstream from Platin Rock, the flood crest of 1844 was 3.66 feet higher than the flood crest of 1858, from which the elevation of 411.28 is derived. (United States engineer office, surveys of 1872 and 1879, adjusted levels.)

RUSH TOWER, MO.

Miles below Eads Bridge, 39.4.
Elevation: 403.4.
"High Water Mark of 1844." (United States engineer office, 1872, Smith, adjusted levels.)

BRICKEYS, MO.

Miles below Eads Bridge, 45.6.
Elevation: 403.

According to United States engineer office survey of 1878, the flood crest of 1858 was up to the lower part of the planks of first floor of Brickey's mill and warehouse. Elevation of bottom of floor, 399.31, determined in 1908 by duplicate line of levels, Board on Examination and Survey of Mississippi River. From notebook, United States engineer office survey of 1872, the flood of 1844 at Brickeys was 3.66 feet higher than the flood of 1858, giving elevation 402.97 for flood of 1844.

John C. Brickey, who lived at Brickey's mill in 1844, said the mark of 1844 was 1 inch above the sill of the cellar window to the right of the front steps (approaching the house). Elevation, 403.34. (United States engineer office survey, 1879; single line, adjusted levels.) This house was moved since 1879.

ABOVE LITTLE ROCK LANDING, MO.

Miles below Eads Bridge, 56.2.
Elevation: 397.3.

The original mark, destroyed by quarrying in November, 1894, was an irregular triangular groove, about 1 inch wide, 1 inch deep, and 2 feet long, not horizontal, the upstream end being about 2 inches the higher, cut in the vertical face of the bluff one-quarter mile upstream from the landing. Above the mark was also cut "H. W. M. 1844 Maydwell." Elevation, 397.3 (United States engineer office, 1879, adjusted levels.) In October, 1894, the elevation of the center of the original mark was transferred by a closed line of levels to the south face of the south foundation wall of warehouse at the landing. At this elevation a copper bolt was leaded into the wall and the new inscription cut: "H. W. M. 1844 transferred from bluff 1,400 feet north, elevation 176.36" (United States engineer office datum) or 397.20; closed line of levels to ⊙ P. B. M. 41.

ONE MILE BELOW LITTLE ROCK LANDING, MO.

Miles below Eads Bridge, 57.4.
Elevation: 396.9.

According to Mr. Bantz, the crest of the flood was even with the top of the lowest one of the front steps of his house. Elevation, 396.93. (United States engineer office, 1879, adjusted levels.)

STE. GENEVIEVE, MO.

Miles below Eads Bridge, 58.8.
Elevation: 396.3.

A mark, with date "1844," cut in the brick chimney at the north end of the old Seibert house in south angle at the west end of South Fork street. Elevation, 396.25. The water of 1844 was on the lower bar of the top sash of the only front window on first floor of two-story frame house opposite east end of South Fork street. Elevation of bar, 396.38. (United States engineer office, 1880, adjusted levels.)

REILY LAKE, ILL.

Miles below Eads Bridge, 65.1.
Elevation: 393.9.

The original mark was made with lampblack on plastered wall in old flour mill, in first ravine above Reily Lake, Ill. To perpetuate the mark, a government surveyor made scratches in the plastering where the lampblack mark was. Peter Sternemann, the miller in 1844, pointed out a mark to the leveler in 1908. Elevation, 393.89. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

OLD KASKASKIA, ILL.

Miles below Eads Bridge, 65.6.
Elevation: 393.1.

The mark is a notch cut in the corner of northeast porch post and about 6.5 feet above the porch floor of the old Hotchkiss house, now the northernmost house on Kaskaskia Island. Elevation, 393.10. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

Alex Danis, who wrote the following letter, is authority for the mark.

FORT GAGE, ILL., *February 2, 1908.*

DER SIR: i Have located a Place in old Kas Kas Kia Ills a house facing the north with the Poarch it has seeder Post With a Cut in it 6 or 7 feet from the floor The house that they Call the old Boman House and allso a Nuther Place Ner Reily Lake Ner the old Mill in a Rock Bldg South East Corner with a Regnel Mark of 1844 Water mark the Bilding stands south of the Creek Runs North East and South West.

North East of a Waggon Bridge Rite by the side of a spring they Call the Reily spring.

i have reseved my infermation from som old Sittions ove KasKas Kia Ills.

Yours Truley,

From ALEX DANIS.

As the river bank near this house was caving, the elevation of the mark was transferred to the northwest corner of a house about 50 meters back, and over this new mark was carved "H W '44."

ST. MARYS, MO.

Miles below Eads Bridge, 69.5.

Elevation: 391.5.

Mr. Jules Rozier, sr., was told by the former occupant of the house that the flood crest of 1844 was even with bottom of large padlock hanging from staple into west post of cellar doorway on south side of the old Rozier house, now so-called, and about one-quarter mile below the railroad station. Elevation of staple, 391.80. (Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

CHESTER, ILL.

Miles below Eads Bridge, 72.9.

Elevation: 388.

A mark on the wainscoting of Gnaegy's saloon near the gauge at Chester, Ill. It is probably a transferred mark, as Mr. Gnaegy stated, in 1908, that the saloon was not built till the early fifties. Elevation, 387.99. (United States engineer office, 1903, Skelly.)

Elevation of top of window sill of old mill at Chester, said to be the crest of flood of 1844, is 386.41. (Board on Examination and Survey of Mississippi River, 1908, Harman.) At Coles Mill, 0.9 mile below this point, there is a mark of 1844 said to be reliable, elevation, 387.28. At St. Marys, Mo., the floods of 1844 and of 1858 are about 4 feet different in elevation, and at Wilkinson, Mo., 18 miles below Chester, the difference is 5.62 feet. (United States engineer office, 1872.) The elevation of 1858 flood crest at Chester is 383.8. Using elevation 386.41 for 1844, the difference between flood crests is only 2.61 feet; but by using elevation of mark in Gnaegy's saloon (388) the difference is 4.2 feet. The latter mark has been tentatively accepted.

COLES MILL, ILL.

Miles below Eads Bridge, 73.8.

Elevation: 387.3.

A chisel mark in masonry, east corner of Cole Milling Company's warehouse, 0.9 mile below gauge at Chester, Ill. The date "1844" is cut in the masonry over the mark. Elevation, 387.28. (Board on Examination and Survey of Mississippi River, 1907, Harman.)

The United States engineer office in 1903 determined elevation of a point, said to be height of water of 1844, 1 inch below floor of river warehouse, and transferred this elevation to sill of door facing railroad on southeast corner of river warehouse. Elevation, 383.82. (Probably flood mark of 1858.) Flood crest of 1844 said to have been 4 feet above top of doorsill of the front door of mill proper. Elevation of doorsill, 382.61, by single line of levels from B. M. Devine. (United States engineer office, 1903, Skelly.)

BAILEYS, MO.

Miles below Eads Bridge, 87.7.

Elevation: 380.6.

A horizontal mark, with inscription "High Water 1844" chiseled in face of rock bluff about 1½ miles below Menfro, Mo., and 0.9 mile above Grand Eddy, and near the "Frisco" railroad. The mark was verified by Jesse F. Delassus, county highway engineer of Perry County, Mo., a grandson of C. E. Delassus, who made the

mark. Elevation, 380.63, closed line to ⊙ P. B. M. 42, United States engineer office, 1901, Holman. (Elevation 380.4, Board on Examination and Survey of Mississippi River, 1908, Wolbrecht.)

WILKINSON, MO.

Miles below Eads Bridge, 90.9.
Elevation: 379.2.
Mark is center of elongated diamond 0.83 foot long and 0.09 foot high, on face of monument which formerly stood in the walk leading to front door of the Wilkinson house, about 1.9 miles above Seventysix, Mo. The monument was moved when the "Frisco" railroad was built, but was reset by a board on examination and survey of Mississippi River level party (Harman) in 1908 immediately northwest of brick chimney on upstream side of the house, with the center of the diamond at elevation 387.75, or 8.5 feet higher than the original elevation (closed line of levels from ⊙ P. B. M. 42). The monument has inscription "High Water" over the diamond, and "Mark, June 29, 1844" beneath, with a horizontal mark 0.6 foot below the diamond.
The United States engineer office (Smith) in 1872 determined elevation of diamond 379.24 from B. M. 32, adjusted to precise levels.
A leveler from the same office in 1897 determined the elevation of the horizontal mark (0.6 foot lower than the diamond) as 378.65, closed line from ⊙P. B. M. 42.
Mr. Hatch, of Seventysix, Mo., informed Assistant Engineer Holman that Captain Wilkinson recorded the height of flood crest by several temporary marks, and, after the monument was set, transferred to it, by sighting from the various marks, their average elevation to the position occupied by the diamond.

WITTENBERG, MO.

Miles below Eads Bridge, 101.8.
Elevation: 373.1.
An approximate elevation obtained by adding 5.62 feet to the local elevation for the flood of 1858; 5.62 feet is the difference, according to the survey of 1872, between the flood of 1844 and that of 1858 at Wilkinson, Mo. In 1908, a board on examination and survey of Mississippi River level party (Harman) was informed that the flood of 1844 was level with the floor of an old house back of the mill and railroad in Wittenberg, Mo. Elevation, 374.43, not accepted.

ABOVE GRAND TOWER, ILL.

Miles below Eads Bridge, 102.8.
Elevation: 370.9.
The mark was on a red oak tree about one-half mile above Grand Tower, Ill., on left bank of river, and its elevation was determined by water-level river crossing near this point. (United States engineer office, survey 1872, adjusted levels.)

ALDRIDGE, ILL.

Miles below Eads Bridge, 109.5.
Elevation: 367.4.
Mark is a knife cut, 2 inches long and about one-quarter inch deep, cut into log, and prolonged by pencil mark across the new east casing of door on south side of log house belonging to Willis Cauble. The house, occupied in March, 1908, by W. L. Lyerly (authority for the mark), is situated 320 meters east of Illinois Central Railroad and about 740 meters southeastwardly from Aldridge. The original mark was cut in the old east casing of the door and when the casing was replaced by a new one the mark was transferred to the abutting log. Elevation, 367.35 (Board on Examination and Survey of Mississippi River, 1908, Harman).

POE LANDING, MO.

Miles below Eads Bridge, 123.3.
Elevation: 357.9.
"Level of freshet 1844 at Mrs. Poe's house Mo. side" about 3 miles below Bainbridge, Mo. (Bowman, post-office) and 0.42 mile below the present Poe Landing. (United States engineer office, survey 1872, adjusted levels.) The bank where the house stood has caved into the river since the survey of 1872.

CAPE GIRARDEAU, MO.

Miles below Eads Bridge, 130.8.
Elevation: 354.4.
The directrix of the city is a level plane passing 50 feet below the height of the Mississippi River on the 4th of July, 1844.
The high-water mark of 1844, July 4, is on river side of James Carroll's brick building on the northeast corner of Independence and Acquamsi (now Water) streets. Elevation, 354.37.—Mississippi River Commission Precise Levels, 1881, Ferguson.

GRAYS POINT, MO.

Miles below Eads Bridge, 136.8.
Elevation: 352.1.
H. W. M. of July 4, 1844, Grays Point, Mo. Elevation, 352.11. (Mississippi River Commission Precise Levels, 1881.)
United States engineer office survey of 1878 described the mark as nail driven in chinquapin tree, near Captain Gray's garden; the elevation of this nail was transferred by that survey to a line cut on river face of rock about 15 feet northeast of old river gauge.

BELOW COMMERCE, MO.

Miles below Eads Bridge, 144.3.
Elevation: 339.6.
United States engineer office level notes of 1872 read: "Freshet of 1844, station 6559+95." This is about 0.6 mile below Commerce, Mo. (adjusted levels).

BELOW PRICE LANDING, MO.

Miles below Eads Bridge, 153.8.
Elevation: 335.6.
United States engineer office level notes of 1872 read: "High water of 1844, station 7074+50." Location is about 0.4 mile below Price Landing, Mo. (Adjusted levels.)

THOMPSON LANDING, MO.

Miles below Eads Bridge, 163.7.
Elevation: 331.5.
An approximate elevation derived from an assumed uniform slope line for the flood crest of 1844 between Price Landing, Mo., and Columbus, Ky. The elevation of flood of 1883 at this locality was also about 331.5; elevation derived from gauge records and a comparison of flood slopes of 1897 and of 1883.

CAIRO, ILL.

Miles below Eads Bridge, 180.5.
Elevation: 324.6.
An approximate elevation of flood crest of 1844, derived from a uniform slope line from Price Landing, Mo., to Columbus, Ky.
Highest known water at Cairo is that of February, 1883; elevation, 329.9 feet.

COLUMBUS, KY.

Miles below Eads Bridge, 202.1.
Elevation: 315.7.
According to Humphreys and Abbot Report, page 171, the flood of 1844 at Columbus was 0.9 foot below flood of 1858; elevation, 316.62. (See records of Mississippi River Commission, Discharge Observations, 1838 to 1894.)
Highest known water at Columbus is that of February, 1883; elevation, 319.3 feet.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

WASHINGTON, D. C., *June 3, 1909.*

SIR: 1. Having reviewed the accompanying report and its several appendixes on the subject of a 14-foot channel from St. Louis to the mouth of the Mississippi River, the Board of Engineers for Rivers and Harbors has the honor to submit its report thereon.

2. As authorized by the river and harbor act approved March 2, 1907, the Secretary of War appointed a board of five members, which board as provided by said act is composed of three members of the Mississippi River Commission, one of whom shall be the president of such commission, and of two engineer officers of the United States Army. As the president is by law an engineer officer, the resulting composition of the board is three engineer officers of the United States Army and two civilian members of the Mississippi River Commission.

3. The board was required, by the provisions of the act, to examine the Mississippi River below St. Louis and report to Congress upon the practicability and desirability of constructing and maintaining a navigable channel 14 feet deep and of suitable width from St. Louis to the mouth of the river, either by the improvement of said river or by a canal or canals for part of said route; to cover the probable cost of such improvement, the probable cost of maintenance, and the present and prospective commerce of said waterway, both local and general, upstream as well as downstream; to report whether other plans of improvement can be devised by which the probable demands of traffic, present and prospective, can be adequately met, and to also report upon six questions and subjects set forth in detail in the act. The board was also directed to consider in connection with the examination provided for, "the survey of a proposed waterway from Chicago to St. Louis, heretofore reported." See H. Doc. No. 263, Fifty-ninth Congress, first session.

4. Its report, having been submitted by the board to the Chief of Engineers, has been referred for examination and review to the Board of Engineers for Rivers and Harbors, organized under the river and harbor act approved June 13, 1902, in further compliance with the act of March 2, 1907.

5. Seven methods of obtaining and maintaining the 14-foot channel have been considered; in no case does the estimate of cost include interest or sinking-fund charges. For cost of 14-foot waterway from Chicago to the mouth of the Mississippi River all estimates of cost given below should be increased by $30,097,462, and of annual maintenance by $310,000, as estimated in connection with the survey from Chicago to St. Louis just referred to.

First. *Dredging.*—Bottom width of channel, 500 feet. Time required for assembling plant, not less than ten years, though with existing plant, and as new plant begins to be put in operation, a 14-foot channel could be expected in possibly five years, interrupted only for limited periods during extreme low stages.

Cost of dredges	$15,000,000
Annual cost of operation and maintenance of plant	4,100,000

Second. *Regularization.*—A channel 500 feet wide extending from St. Louis to Cairo *only.* Time required for completion, fifteen years, but with dredging to aid the partly completed regulation works a navigable channel may be available in about seven years from the start of active work.

Cost, including maintenance during construction	$53,216,480
Annual cost of maintenance after completion	500,000

Third. *Canalization with movable dams.*—Between St. Louis and Cairo *only*. Ten locks, each 600 by 80 feet in the clear; lifts varying from 5.2 to 15 feet, and averaging 9.87 feet.

Cost	$25,000,000
Annual cost of maintenance	400,000

Fourth. *Canalization and fixed dams.*—Between St. Louis and Cairo *only*. But one locality was found where satisfactory foundations for masonry dams exist except at depths so great as to preclude economic construction. An effective dam at this locality would cause to be flooded 30 towns and villages, over 240,000 acres of farming land, and over 220 miles of railroad. No project nor estimate for such a dam has been submitted.

Fifth. *Lateral canals.*—From the terminus of the proposed Alton-St. Louis canal to Cairo *only*. Projects not worked out in detail, costs having been considered excessive.

Cost if constructed on the Illinois side	$102,000,000
Annual cost of maintenance	600,000
Cost if constructed on Illinois side, except a short section on Missouri side	76,600,000
Cost of combined canal and river route	36,000,000
Annual cost of maintenance	450,000

Sixth. *Reservoirs.*—To hold the water at St. Louis at a stage corresponding to a controlling depth of 14 feet thence to Cairo, would require about ten times as much annual storage as has yet been found possible by construction of reservoirs in the Mississippi River Basin from the Illinois River upward.

Seventh. *Combination of methods.*—To complete the existing project for 8 feet depth between St. Louis and Cairo, secure the additional 6 feet by dredging; and below Cairo, to dredge as estimated above, but to also provide for permanence of bank lines and channels. The 14-foot channel, not permanent in location, and dependent upon continued dredging, might, subject to occasional interruptions at extreme low stages, be expected in possibly five years. With adequate appropriations the estimate of time of completion of improvement by combined dredging and fixation of banks and channels is stated as approximately eighteen years.

COST.

Completing 8-foot project between St. Louis and Cairo	$21,000,000
Dredging plant for use above Cairo	3,600,000
Contraction work below Cairo	5,000,000
Bank-protection work below Cairo	90,000,000
Dredging plant for use below Cairo	9,000,000
Total	128,600,000
Total annual cost of maintenance, after channels and banks have been made permanent in location, will reach approximately	6,500,000

6. All the methods considered for securing a 14-foot channel from St. Louis to the mouth of the Mississippi River, except that of reservoirs, are thought to be practicable; either singly, as that of dredging; combined, as those of complete regularization, canalization, or lateral canals above Cairo, with partial regularization and dredging below; or the combination of regularization and dredging, both above and below, which for brevity will be termed the combined method. All propositions requiring the abandonment of the already good open-river navigation, or the substitution of a lateral canal, for any part of the river below Cairo, are rejected as opposed to all reason. But all practicable methods, save by dredging *alone*, and the combined method are rejected for the reason, among others, that should increased depth be determined upon in the future, the canal structures and the cross sills of complete regularization work would have to be modified under great difficulties and at great cost.

7. The Board concludes that the most practicable method of obtaining and maintaining the 14-foot channel above Cairo is by completing the project now in force for securing an 8-foot channel

by regularization and relying upon dredging to secure and maintain any further increase; below Cairo, by dredging, bank protection, and, at certain localities, contraction works.

8. The combined method of obtaining a 14-foot channel at an initial cost of $128,600,000 is considered more practicable by the Board than the method of dredging *alone*, with an initial cost of but $15,000,000, for reasons substantially as follows: The one provides a complete improvement; the other but partial. The combined method looks to a channel permanently located in the river bed; the method by dredging, to one changing its position in that bed from season to season. The combined method contemplates not only permanence of depth of channels, but also permanence of location of channels, levees, wharves, and landing places; the method by dredging, only permanence of depth of channels. The combined method will provide for both through and local traffic; the method by dredging, with certainty for through traffic only. The combined method incidently furthers the welfare of the community bordering the river and affords protection to life and property; the method by dredging is indifferent to all these, including the destruction of local terminal facilities.

9. Commerce, past, present, and prospective, has been considered. As to this, reference may be made not only to the Board's report but to pages 154–159 of the preliminary report of the Inland Waterways Commission, published as S. Doc. No. 325, Sixtieth Congress, first session.

10. During the calendar year 1908 about 1,300,000 tons of coal came out of the Ohio River; of this about 180,000 tons went up the Mississippi River to St. Louis. Other than this, the amount of water freight during the year at all river points between St. Louis and New Orleans was about 400,000 tons downstream and 300,000 tons upstream. This river commerce has been rapidly diminishing in recent years. The entire commerce of the Mississippi River system, including all tributaries except the Ohio, was reported as follows:

Year	1889.	1906.
Tonnage	12,492,535	4,304,288

So far as reported, the river commerce of 1908 shows a slight decrease compared with that of 1906, except as to a few of the minor tributaries.

The total river tonnage at St. Louis was:

Year	1886.	1896.	1906.	1908.
Tonnage	1,332,885	1,244,175	416,855	365,920

The total receipts and shipments by rail at St. Louis were:

Year	1896.	1906.
Tonnage	16,163,844	44,964,623

Of the 1906 river tonnage, 160,120 tons were coal from the Ohio.

11. Of the 1908 river tonnage, as before stated, about 180,000 tons, or one-half the total, were coal from the Ohio, and not over 49,530 tons were with towns on the Mississippi below Cairo.

12. In 1880 there were shipped from St. Louis to New Orleans 15,762,664 bushels of grain; in each of the years 1901, 1902, and 1903 the shipments of grain were less than 3,000,000 bushels. The 1880 shipment is the largest annual shipment reported. It was

made in the year in which a minimum depth of 4 feet was reported as not uncommonly found in the channel between St. Louis and Cairo. In 1908 it was officially reported that a channel depth of 8 feet had been maintained during the entire season when unobstructed by ice, except in November, 1907, when for short periods at several places the depths were 7 feet until dredges could be brought into action upon these shoals, when the required depth was quickly obtained.

13. In 1890, 611,779 barrels of flour were received at St. Louis by river; in 1906, but 29,160 barrels. In 1880, 17,500,000 bushels of grain were received at New Orleans, of which 15,700,000 were shipped from St. Louis by river; in 1903, 28,100,000 were received at New Orleans, of which 2,700,000 were shipped from St. Louis by river.

14. The decline in the commerce of the river has not arisen from its lack of navigability. The Board states that the immense commerce of the Rhine could be carried more readily and cheaply on the Mississippi to-day than on the Rhine. It is stated in the report of the Inland Waterways Commission that 600-ton barges drawing 15½ inches light, and 6 feet when loaded to full capacity, are now common on the best waterways of Germany; and that express steamers are operated on the Elbe and Rhine which, when carrying 200 tons of freight and a supply of coal, draw 4 feet 11 inches, and with two barges, carrying 275 tons each, in tow their speed is reduced from 10 to 3 knots; yet the vessels are said to represent perhaps the most perfect type yet developed for waterways of Germany.

15. As to future commerce, after setting forth and discussing in more or less detail the claims made by various communities, the Board states that no actual future development is yet in sight. It invites attention to the fact that, as at present constructed, neither ocean nor lake vessels are as economic a means of transportation on rivers and canals as river barge tows, the cost of an ocean vessel being about $71 for each ton of freight carried, of a lake vessel about $41.50, and of a river boat and barges for 8½ feet draft about $12; and further, that a modern lake freighter while affording a most economical method of transporting freight on the Great Lakes would be a failure if employed in either ocean or river navigation. The board concludes that a 14-foot waterway is suitable for neither existing lake nor ocean vessels, and that freight originating on lake or gulf will require transshipment to vessels adapted to its navigation.

16. While, as above indicated, the board reports that a 14-foot channel from St. Louis to the mouth of the river is practicable, it is of the opinion, for reasons given at length, that the present demands of traffic are adequately met by the existing projects for improving the river, which have for their objects to obtain and to maintain a minimum depth at standard low water of 8 feet from St. Louis to the mouth of the Ohio, and of not less than 9 feet below; and that probable demands of traffic, present and prospective, not only between St. Louis and the mouth, but even between Chicago and the mouth, can be adequately met by a channel of 9 feet depth.

17. The Board reports as to the specific instructions contained in the act of March 2, 1907, as follows:

First. It is practicable to produce a channel of at least 10 feet depth between St. Louis and Cairo at low water by means of regulation works.

Second. A depth of at least 14 feet will obtain in such regulated channel, at the average stage of water for the year, 12.6 feet on the St. Louis gauge.

Third. Fourteen feet depth of water will obtain in such regulated channel for at least an average of one hundred and sixty-three days annually.

Fourth. At low-water stages, an increase of depth of not more than 6 inches will be obtained by an added volume of 10,000 cubic feet per second, nor more than 8 inches by 14,000 cubic feet per second between St. Louis and Cairo, while at high-water stages the increase of depth will be less. Below Cairo this increase in depth will be much reduced for low-water stages and inappreciable at high-water stages.

Fifth. It will not be practicable to produce at all seasons of the year a depth of 14 feet in such regulated channel by the aid of locks and dams similar to those projected and in use on the Ohio River improvement without extensive annual dredging. The cost of this dredging is included in the cost of annual maintenance of this system of improvement between St. Louis and Cairo, the third considered, and is estimated at about $200,000 annually.

Sixth. The Board submits no project which creates water power, or which will drain any lands on the portion of the river directed to be surveyed, hence no power is to be conserved, or paid for, nor are there lands drained which should bear any cost of improvement. As to the water power on the proposed waterway from St. Louis to Chicago heretofore surveyed, the value thereof, and lands which may be drained by it, the Board considers that the property owners along the canal and Illinois River are equitably entitled to the water power due to the natural flow alone of the Des Plaines and Illinois rivers; any power which results from an added flow diverted from Lake Michigan belongs to the people of the United States and Canada; 100,000 horsepower can be developed by the diversion of 10,000 cubic feet per second by modifications in the project of the former board in harmony with its report; accepting the valuation indorsed by the Sanitary District of Chicago, the Illinois State Internal Improvement Association, and the governor of Illinois, this horsepower should be assumed as worth $2,500,000 per year; the diversion of 10,000 cubic feet per second into the Illinois River, far from draining lands, would cause extensive damage to lands subject to overflow.

18. As to the Government receiving adequate compensation for such power, the Board favors opening the canal of the Sanitary District of Chicago to free navigation, and so maintaining it; the District to enjoy free use of the power until the aggregate value of said power shall equal the cost of canal and power construction; and after this, the United States to receive from the beneficiaries a percentage, to be fixed by Congress, of the net profits from the water power, as a compensation for the resulting injury to navigation on the Great Lakes and connecting waters and loss of water power on the Niagara and St. Lawrence rivers.

19. The Board calls attention to a plan proposed in 1907 by the Internal Improvement Association of Illinois, indorsed by the governor and the people of the State, proposing a development of 173,000 horsepower by diversion of 14,000 cubic feet per second from Lake Michigan. This plan calls for radical changes in the plan of the Board of 1905, reduces the number of locks from 9 to 5, and increases many

times the amount of excavation. The opinion is expressed that any attempt by the United States to conserve the power created under these plans, if carried out, would involve the General Government in serious legal difficulties.

20. The Board of Engineers for Rivers and Harbors now concludes this examination and review of the report before it, with the following opinions and recommendations:

21. It is practicable to construct and maintain a navigable channel 14 feet deep and of suitable width from St. Louis to the mouth of the Mississippi River by either of six methods considered; but is not by the remaining method—that of reservoirs. Of the six practicable methods, the most practicable, having in mind through and local traffic, permanence of location of improved channel, protection of landings, life, and property, the general welfare of the community, and possible future development, is the method termed the combined method. Of this, the estimated first cost is $128,600,000.

The annual cost of operation and maintenance will increase as work progresses, and may reach at completion $6,500,000.

These estimates do not include charges for interest and for sinking fund, nor the estimated cost of the waterway from Chicago to St. Louis, which is $30,097,462, with annual cost of maintenance of $310,000.

22. It is not desirable to construct a navigable channel 14 feet deep from St. Louis to the mouth of the Mississippi River or from Chicago to the mouth of the Mississippi River. Such a depth is greater than required for successful river navigation and is less than required for economical lake or ocean navigation, and if adopted would require for common use on lake, river, and gulf a type of vessel not now in existence and which if designed would be less economical than modern lake or ocean vessels in use on those waters, or than a towboat and barge navigation on the connecting waterway.

23. Present demands of commerce between St. Louis and the mouth of the Mississippi River are adequately met by existing projects having for their object to obtain and maintain an 8-foot channel from St. Louis to the mouth of the Ohio and a channel of not less than 9 feet in depth below the mouth of the Ohio. In reporting on the waterway from Lockport, Ill., to St. Louis, Mo., this Board stated "It * * * believes that the commercial interests of the Great Lakes are entitled to an outlet to the Gulf of Mexico of as great a capacity as can be obtained at reasonable cost. This capacity is now limited by the projected depth between St. Louis and Cairo—that is, 8 feet—a depth that will not only suffice for a large amount of through commerce, but will be sufficient to materially benefit and consequently aid in the development of the Illinois Valley." (H. Doc. No. 437, Fifty-ninth Congress, second session.) The Board believes that an 8-foot channel from Chicago to St. Louis, corresponding to the present 8-foot project from St. Louis to Cairo, is the least that would adequately meet the demands of commerce, and believes such a waterway would be desirable, provided its cost is reasonable. This cost is not now known, but will be obtained and submitted before the next session of Congress.

24. Present and prospective demands of commerce between Chicago and the Gulf will be adequately served by a through channel 9 feet in

depth, which may be obtained without violent changes of existing methods of improvement. Estimates of such a through channel have not been prepared and can not be submitted at this time. They will, however, be obtained and submitted to the department before the next session of Congress convenes, accompanied by an opinion as to whether this depth is advisable in the interests of commerce, having in mind the cost involved.

25. The report as to the first four of the specific instructions contained in the act of March 2, 1907, is concurred in. As to the fifth, it is believed to be practicable to maintain a depth of 14 feet in the regulated channel, except when interrupted by ice, by the aid of locks and dams similar to those in use on the Ohio River improvement, but this will require wickets 1 foot 8 inches longer than those used on the Ohio River, and are therefore larger than any that have heretofore been built for river canalization. The difficulties encountered in handling the wickets (already great) increase rapidly with the increase in height. Dredging will be required, possibly to the extent of $200,000 annually. In view of these facts, this Board is of the opinion that the estimates submitted for this system of improvement may be insufficient.

26. As to the sixth, including the views expressed as to cooperation by the General Government in the plan of the Internal Improvement Association of Illinois, referred to in paragraph 19 above, the report is concurred in, except as to the ownership by the people of the United States and Canada of the power resulting from water diverted from Lake Michigan, and except also, premising such ownership, as to the epoch at which compensation should be received by the Government of the United States. These two points are considered below.

27. Apart from the plant for its conversion and transmission, water power depends for its value upon the quantity of water and the height made effective by structures through which it falls. The three possible classes of cases are (*a*) United States owns water only; (*b*) United States owns structures only; (*c*) United States owns both water and structures. Should it be determined that the United States, other than as a riparian owner, has no ownership of water, there still remains to be determined whether the United States, when acquiring lands upon which to erect locks and dams as means to improve navigation, does not acquire such complete title to these lands as to make the United States a riparian owner with right to charge for water power created by its dams. But in this case, as the creation of water power is not essential to Government functions, how far may the use of the power created be regulated or controlled by the owners of the waters so far as such regulation or control does not interfere with navigation? Whether the United States, without riparian rights, owns any waters or has simply an easement giving it a right to improve channels and conserve the water flowing therein for purposes of navigation and to use them for power so far as necessary to operate structures necessary to such improvement is a subject for judicial determination. Should it be determined that the United States owns any waters used in the development of water power, any Government charge made for such use should commence with such use and should not be deferred until the cost of plant by which such use is made possible has been collected from consumers of the power. Compensation, if found due, should

be fixed by Congress. It should be uniform in the three possible classes of cases.

28. These questions seem proper for determination before rates for compensation to the United States for water power can be fixed. General rules, principles, or laws to enable decision to be made as to status of each particular case as it arises are most desirable.

For the Board:

Very respectfully,

D. W. LOCKWOOD,
Colonel, Corps of Engineers,
Senior Member of the Board.

The CHIEF OF ENGINEERS, U. S. ARMY.

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