During the fiscal year in review two steel-hull snag boats were engaged in removing such obstructions between the mouth of the Missouri River and New Orleans, La., a distance of about 1,270 miles, and 4,526 snags were destroyed, 27 drift piles and 23 wrecks were removed, 2,406 trees were cut, and 13,068 miles patrolled.

In addition to this work part of the funds appropriated for the removal of obstructions was expended in the partial removal of Beaver Dam rock, an obstructive and dangerous rock lying in mid-channel about 1 mile below Commerce, Mo. A beginning was made upon this work (which can only be done economically at low and favorable river stages) during the preceding fiscal year (1908), when about one-sixth of the drilling and blasting were completed. During the past fiscal year as much more was done, so that about one-third of the whole is now accomplished. Work will be continued at each low-water season as opportunity offers and funds are available, until the entire rock is removed to the plane desired.

For information as to the commerce benefited by work under this appropriation, reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri rivers and in the reports of the Mississippi River Commission and the district officers thereunder. The amount expended during the year was $100,021.03.

(See Appendix X 1.)

2. Mississippi River between Ohio and Missouri rivers.—In its original condition, prior to any improvement, the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which a considerable part of the volume of the flow was diverted to the detriment of navigation.

The first systematic effort to improve this condition was begun by the Federal Government in 1872, and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone, to confine the low-water volume in the vicinity to a single channel, and of revetments to hold and preserve the banks where it was thought necessary or advisable.

The project followed in later years and up to the present time has been practically that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, contemplating the confinement of the flow of the river below St. Louis 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 secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river, the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. 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 should be improved each season by the use of dredges and other temporary expedients.

Under the provisions of the river and harbor act of June 13, 1902, and special resolutions of the Committee on Rivers and Harbors of April 25, 1903, the special engineer board considered and submitted a report upon the conditions, best methods of work, and cost of a suitable channel in this part of the Mississippi River. This report, under date of November 12, 1903, recommended a channel which would have at low water at least 200 feet width with 8 feet depth from Cairo to St. Louis, and with 6 feet depth from St. Louis to the mouth of the Missouri, to be secured by side contraction works and shore protection, assisted by dredging, the permanent construction work to cost about $20,000,000, in addition to all expenditures already made, and its maintenance to cost about $400,000 per year; and, with a view to the prompt execution of such project, this report further recommended an immediate appropriation of $450,000 for additional dredging plant and $250,000 per year for three years' operation of the same, together with $300,000 per year for permanent construction works and temporary expedients until the results of such dredging should be known and should allow a revision of the project. The river and harbor acts of March 3, 1905, and of March 2, 1907, appropriated or authorized contracts and work to the amount of $1,450,000 for the new plant and for its operation for five years (1906, 1908 to 1911), and the latter act provides that the sums now available shall be expended in the operation and maintenance of dredging plants already constructed and in temporary expedients of channel regulation connected with such operation, and in maintenance and repair of the permanent works already constructed, and that such portion of the $250,000 per year as is not necessary for the above work may be expended in construction of permanent works of channel regulation. The dredging has required annually so much of this appropriation that only about $30,000 to $50,000 per year has been available for the less urgent work. The action of Congress up to the present time has therefore followed the recommendations of the Board's report of November 12, 1903, except that it has allowed only a small portion (about $150,000 total during four years) of the appropriations to be used upon the repair and maintenance and new construction of permanent works instead of $300,000 per year recommended therefor by the 1903 Board for the years of experimental dredging. The results of the dredging work above authorized and done now show that the 1881 project, as revised by the 1903 Board, needs no further revision other than to add urgent recommendations for annual appropriations large enough to allow of the completion of the $20,000,000 project within a reasonable term of years. This view is also confirmed by the recent report of the special Board on Examination and Survey of the Mississippi River from the Lakes to the Gulf, dated March 20, 1909, which virtually recommends the early completion of the 1881 project as indorsed and modified by the 1903 Board, and which puts its cost at about $21,000,000 ($1,000,000 being added to compensate for the deterioration of permanent works during recent years while their repair has been prevented by lack of recommended appropriations).

Continuing contracts for $250,000 for the year commencing July 1, 1910, are already authorized by the act of March 2, 1907, to be provided for in the next sundry civil act; but in addition thereto

the $300,000 per year for repair, maintenance, and new construction of permanent works recommended by the 1903 Board, after increase to $400,000 to partially compensate for deficiencies since 1903, should also be authorized for the coming year to provide for checking further serious destruction and depreciation of existing works.

The object of the previous and present plans of improvement is to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1909, was $12,718,126.03, exclusive of $180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor.

The result of the expenditure of this amount has been the partial permanent improvement of the entire extent of the river from St. Louis to Cairo, and during recent years practically the maintenance of the depths required.

The new appropriation asked for is the estimated expenditure for one year only, and should be increased by authorization under continuing contracts for other years by at least the same sum annually until a new plan is authorized by Congress.

It is proposed to expend the new appropriation asked for in dredging and in such temporary and permanent improvements as may be necessary and authorized by law.

The amount expended during the fiscal year ending June 30, 1909, was $341,824.44, and includes $213,932.76 expended for dredges and dredging, the remainder going to the care of plant and to the maintenance and repair of existing works of revetment, which had been much damaged by the action of the river and were urgently in need of such work. The total amount thus far expended for temporary channel improvement is $1,422,541.32, much of which has been for dredging plant that is now on hand and available for future work. The approximate value of this dredging plant is $509,890.42, having been considerably augmented by the completion and addition of the two new dredges referred to.

This improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

During the past year there was maintained a channel depth of 8 feet during the entire season when the river was unobstructed by ice, except 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; and at two places, Chain of Rocks and Grand Tower, where 7 feet was the maximum obtained, due, at the former to the location of the channel across the solid rock, and at the latter to the natural silting up and closing of the chute east of Grand Tower Island, forcing the boat channel to the west of that island over a bar of gravel and small bowlders which could not be moved by the suction type of dredges in use.

The river at St. Louis reached a high-water stage of 26.9 feet above standard low water (4 feet St. Louis gauge) on July 1, 1908, and a low-water stage of 5.4 feet below standard low water on January 12, 1909.

With the present appliances and such others as are authorized for the temporary improvement of low-water channels and for works of permanent improvement, it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages of river open to navigation.

Recapitulation of commercial statistics.

	1905.	1906.	1907.	1908.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Receipts and shipments at St. Louis	370,425	416,855	368,075	365,920
Transferred by ferries at St. Louis	6,684,949	7,374,978	8,905,542	5,600,765
Shipped from landings between St. Louis and Cairo	69,729	62,238	65,467	8,173
Total	7,125,103	7,854,071	9,339,084	5,974,858

July 1, 1908, balance unexpended	$376,703.86
Amount appropriated by sundry civil act approved March 4, 1909	250,000.00
June 30, 1909, miscellaneous receipts	23,232.22
	649,936.08
June 30, 1909, amount expended during fiscal year, for maintenance of improvement	[a] 341,843.07
July 1, 1909, balance unexpended	[b] 308,093.01
July 1, 1909, outstanding liabilities	16,519.03
July 1, 1909, balance available	[b] 291,573.98
Amount (estimated) required for completion of existing project	[c] 17,501,654.55
Amount that can be profitably expended in fiscal year ending June 30, 1911, for works of improvement and for maintenance, exclusive of the balance unexpended July 1, 1909. Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	[d] 250,000.00

(See Appendix X 2.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILLINOIS, DISTRICT.

This district was in the charge of Maj. C. S. Riché, Corps of Engineers. Division engineer, Col. W. H. Bixby, Corps of Engineers.

1. Operating snag boats and dredge boats on upper Mississippi River and tributaries.—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed $25,000 annually.

[a] Deduct $18.63 expended in June, 1909, on account of inspections for the Isthmian Canal Commission, which had not been refunded at the end of the fiscal year, leaving net amount of $341,824.44 expended upon the improvement.

[b] From this amount deduct $10,000, allotment carried to the surplus fund June 30, 1909.

[c] Project of 1881 as modified in 1905.

[d] This estimate refers only to the work which Congress has specifically provided for under the continuing-contract authorization of March 2, 1907, and is the full amount allowed by said authorization. For the reasons given in the text of this report the appropriation of the additional sum of $400,000 is recommended

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883, 1903, AND 1905.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1906, page 462, as well as on page 2631 of the Report of the Chief of Engineers for 1900.

Reference should be made to the Report of the Chief of Engineers, United States Army, for 1894, pages 1577 et seq., for information relating to the development of the various forms of construction and for a résumé of the various types employed between 1872 and 1894, and to the Reports of the Chief of Engineers, United States Army, for 1895, page 2059; 1896, page 1717; 1897, page 2012; 1898, page 1698; 1900, page 2632; and 1901, page 2169, for minor details as to forms of construction.

Since the adoption of this project work has been done, substantially according to the methods referred to above, at the following localities: Mouth Missouri River, Sawyer Bend, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail bar, Carroll Island, Twin Hollows, Pulltight, Beards Island, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Herculaneum, Calico Island, Cornice Island, Forest Home, Osborne Field, Michaels Landing, Rush Tower, Fish Bend, Danby Landing, Ames Island, Rush Towhead, Penitentiary Point, Sycamore Landing, Fort Chartres, Crooks, Turkey Island, Mudd Landing, Moro Island, Ste. Genevieve, Fairy Island, Kaskaskia Island, Horse Island, Chester, Crain Island, Liberty Island, Liberty Bend, Lacours Island, Willard, Hamburg, Devil Island, Minton Point, Cape Girardeau, Commerce Island, Burnham Island, Powers Island, Goose Island, Philadelphia Point, Commercial Point, Prices Landing, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Beechridge, Hurricane Field, Eliza Towhead, Eliza Point, Greenfield Bend, and vicinity of Cairo.

During the fiscal year ending June 30, 1909, work for the permanent improvement of the river has been carried on for maintenance and repair to existing works as hereinafter described at James Landing, Liberty Bend, Beechridge, Eliza Towhead, and Cairo Protection. (See Pls. 1, 2, and 3.)

The project adopted for the permanent improvement of the Mississippi River between the mouths of the Ohio and Missouri rivers was approved by the Chief of Engineers, United States Army, March 31, 1881. The estimate of the cost, as revised in 1883, was $16,397,500. The project was modified by the river and harbor act of June 3, 1896, to permit the construction and operation of dredges. It was again modified to some extent in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, the dredging recommendation of which was adopted by Congress in the river and harbor act of March 3, 1905, as the principal means of improvement.

By the report of 1903 the cost is increased $20,000,000 in addition to expenditures already made, provided the projects in force be adhered to throughout. The cash expenditures to December 31, 1903,

are considered as approximately the cost of the work up to the date of the report of the Board. They were $10,476,654.53. The total estimated cost as last revised is therefore $30,476,654.53.

The total amount appropriated to June 30, 1909, was $13,144,-999.98. Of this amount $180,000 was allotted by acts and projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, leaving a balance of $12,964,999.98 to be applied to the project for the general improvement between the mouths of the Ohio and Missouri rivers. The balance of the last revised estimate not appropriated June 30, 1909, is therefore $17,511,654.55.

WORKS OF IMPROVEMENT.

Because of the small balance of funds available for the construction of works of permanent improvement, operations were confined to the fall low-water season and to the repair and maintenance of bank revetments already placed under the original project. In this work the standard forms of construction were used.

Three dredges were in commission through the entire low-water season, August 14 to December 31, 1908, and another, *No. 6*, which was in course of construction at the beginning of the year was completed and delivered August 6 at the engineer depot, where the pumping machinery and outfit was installed and the dredge sent out into service, October 14 until December 31. The dredges operated upon 16 obstructing bars which developed during the low-water season of navigation.

Such local surveys and examinations were made as needed.

Gauges were maintained and read throughout the year.

The plant was repaired and cared for at the engineer depot, St. Louis, and in fleet at Santa Fe, Ill.

Materials were procured by contract and by hired labor as was deemed most economical and advantageous to the United States.

The engineering operations during the year have been executed under the able and efficient supervision of Mr. Wm. S. Mitchell, assistant engineer, aided by Messrs. C. D. Lamb, W. M. Penniman, F. Y. Parker, and J. W. Skelly, assistant engineers.

Reports from assistants, giving details and accompanied by charts showing locations of the various works, are on file.

CONSTRUCTION WORKS.

JAMES LANDING, ILL. (34 MILES BELOW ST. LOUIS).

[Nov. 24-29.]

Repairs to bank protection.—The revetment placed in 1906 and 1907 was found in good condition, with the exception of a small dry pocket 150 feet below hurdle No. 3, and several small slides between hurdles Nos. 3 and 4. These were repaired by the construction in the pocket of a brush mattress weighted with stone and by replacing the stonework where the slides occurred.

In the work 17,885 square feet of stone paving and 3,500 square feet of mattress were placed.

The location of the work is shown upon plate No. 1.

LIBERTY, ILL. (85 MILES BELOW ST. LOUIS).

[Nov. 30-Dec. 30.]

Repairs to bank protection.—Along this protection, between stations 49–10 and 128–35, caving of the bank had practically destroyed upper portions of the revetment. In the caves (ten in all) pocket mattresses of brush were constructed and sunk, and the stonework between these stations was strengthened and repaired. In this repair work 182,185 square feet of stone paving and 69,325 square feet of mattress were placed; and 2,457 cubic yards of earth were moved in grading the bank for the reception of the stone.

The location of the work is shown on plate No. 2.

BEECH RIDGE, ILL. (163 MILES BELOW ST. LOUIS).

[Nov. 1-23.]

Repairs to bank protection.—In a large bank slide, between stations 82–20 and 89–55, a brush mattress was constructed and sunk; and adjoining this a smaller slide in the bank was covered with brush, weighted with stone.

The original stonework, except between stations 17–75 and 91–50, was found in good condition. It was replaced between these stations and given a coating of spalls.

In this work 63,805 square feet of stone paving and 54,000 square feet of mattress were placed; and 1,114 cubic yards of earth were moved in grading the bank.

The location of the work is shown on plate No. 3.

ELIZA TOWHEAD, ILL. (169 MILES BELOW ST. LOUIS).

[Oct. 6-31.]

The work of 1907 at this locality was found in good condition except below station 21–75; from this station to the downstream end of the work (station 31–450) the bank had been cut away inside the protection mattress, with maximum recession of 250 feet.

To prevent further damage and restore the shore line to the old revetment, which was still in place, two hurdles reaching from the bank to the old work were built at stations 32–20 and 29–00, respectively, and carried to the elevation of a stage of 23 feet. A single row of staggered piles interspersed with a few pile clumps was used in the construction of each hurdle, the piling being driven through a foundation mattress of brush previously constructed and placed along each line. The bank at the shore end of each hurdle was revetted with stone to the 15-foot contour for about 75 feet above and 100 feet below the hurdle line. No other stone revetment was considered necessary as the old work afforded protection up to about the same stage.

A shore mattress of brush 85 feet wide was placed along the eroded bank (stations 21–75 to 31–45) to the usual level of standard low water (4 feet, St. Louis gauge).

Between the upstream hurdle and the head of the caving the entire space was covered to the 15-foot stage with brush mattress and timber cut from the bank and weighted with stone.

In these repairs, 32,075 square feet of stone paving and 126,130 square feet of mattress were placed; 125 piles were driven and 11 stringers were hung.

The location of the work is shown on plate No. 3.

CAIRO PROTECTION, ILL. (170 MILES BELOW ST. LOUIS).

[October 6-31.]

Repairs to bank protection.—A large circular bank cave and two small slides had taken place about 1,500 feet below the upper end of the old work.

The repairs were undertaken simultaneously with those at Eliza Towhead. The sides and bottom of the cave were covered with brush and weighted with stone. Stone was placed well up on the sides of the cave and in it a few piles were driven in the form of a spur hurdle 70 feet in length to catch drift, the piles being strengthened with a double row of stringers.

In this work 7,500 square feet of stone paving and 12,150 square feet of mattress were placed; 7 piles were driven and 4 stringers were hung; 210 cubic yards of earth were moved in grading.

The location of the work is shown on plate No. 3.

DREDGING.

Dredges *Nos. 3, 4, 5,* and *6,* were in commission as follows: *No. 3,* August 24 to December 15; *No. 4,* August 13 to December 10; *No. 5,* August 20 to December 31; and *No. 6,* October 14 to December 31, a total of four hundred and forty-seven days.

Throughout the low-water season the dredges were operated wherever necessary and were withdrawn from service and sent to winter quarters as soon as danger from ice threatened.

The new dredges, *Nos. 5* and *6,* both of which were completed during the fall, were given thorough tests before being placed at work in the channel.

Work was done upon 16 bars and shoals, upon all of which most beneficial results were obtained and the desired depth of 8 feet secured with the exception of the crossings at Chain of Rocks and Grand Tower, Ill., where but 7 feet depth was had. At the former, the low-water channel this year passed over the rock ledge, which, of course, could not be deepened with a suction dredge; and at the latter, the usual low-water channel in the bend east of Grand Tower Island silted up for several miles, completely closing that chute and forcing the water down the west side of the island over the upper bar composed of cemented gravel and small bowlders, which also could not be handled by dredges of the type in use. Seven feet, maintained at both of these places, was easily sufficient for all the navigation of the season. The shoals dredged were at Chain of Rocks; foot of Bremen avenue (Stock Yards Landing) and Sidney Street ferry landing, east side, St. Louis, Mo.; Arsenal Island (Test); Pulltight; Chesley Island; Kennett; Rubicon Hollow; Ste. Genevieve; Seventysix; Grand Tower; Bennett; Bainbridge; Schoenimann; Commerce (Landing); Price Towhead.

The location of the dredged channels are shown on plate No. 4.

The total number of channels dredged at the 16 localities named was 23, with a combined length of 36,850 feet and an average width

of 150 feet. The total amount of material dredged was about 1,335,350 cubic yards, in one thousand six hundred and fifteen working hours, or at an average rate of 830 cubic yards per hour.

The dredged channels were in constant use by the river craft after their completion and maintained the 8-foot depth required throughout the district, except for short intervals where the depths decreased slightly until a dredge was available for work, when the obstructing bar was quickly cut away.

Fluctuations in the stage of river caused the shifting of the shoals at Pulltight, Chesley Island, Seventysix, and Bainbridge, necessitating repetition of dredging at all these localities.

The dredges were engaged in actual excavation less than one-sixth of their time in commission. The final cost of dredging was about 10 cents per cubic yard of sand moved, which includes the cost of all idle time of the dredges and their crews, and the upkeep and repairs to the former during the entire year. If the dredges had been run for the entire time in commission, the expense would have been augmented only by the increased amount of fuel, oil, etc., consumed and the cost for such continuous operation with the same average output would have been reduced below 2 cents per cubic yard. As dredges must be held in readiness for work as it offers, depending upon the fluctuations in river conditions, such variations in the cost of the work can not be avoided.

The prevailing stages of the river, 10.3 in September to 3.1 in December, average 6.7 feet during the low-water season, were somewhat lower than for several years past.

PLANT.

The efficiency of the plant was maintained by ordinary or extraordinary repairs as were required.

No addition, except dredge *No. 6*, already referred to, was made to the number of vessels in any class of the floating plant.

The six barges loaned in September, 1907, to the Memphis office, were retained there, and in addition two quarter boats, one derrick boat, and a steel tender were loaned that office in August, 1908; one pile driver was transferred permanently to the Mississippi River Commission.

One steam tender was altered by the addition of a cabin for the accommodation of a survey party for channel observation and charting with reference to the future operation of the dredges.

Three barges, built in 1891, were condemned and sold, being unserviceable, not worth rebuilding, and a source of expense for care.

Dredges Nos. 5 and 6.—Dredge *No. 5*, received from the contractors late in the preceding fiscal year, and *No. 6*, which was received August 6, were outfitted with dredging machinery with exception of the condensing plants and steam steering gears, and were at once put into service—*No. 5*, September 4; and *No. 6*, October 14. In the spring and summer (1909) the condensing plants and steam steerers were added, fully completing the dredges in accordance with the original plans.

Engineer depot, etc.—The shop buildings, machinery, tools and appliances, at the engineer depot and at the Little Rock quarries, and the fleet, together with all vessels, other floating plant and their equipment, were kept in order; but only ordinary repairs and those absolutely necessary were made.

MATERIALS.

Of the materials required for the repairs to revetments, the stone, 10,756 cubic yards, was purchased by contract, and the brush, 1,250 cords, was procured by hired labor.

PHYSICAL DATA.

The gauges were maintained and read daily throughout the year and their records have been plotted on the hydrograph.

During the year the river oscillated between stages 5.4 feet (Jan. 12, 1909) below and 26.9 feet (July 1, 1909) above standard low water (4 feet, St. Louis gauge).

At the time of extreme low water, unobstructed by ice, two discharge measurements were made. The results are given in the following table:

Measurements of discharge.

Date.	Locality.	St. Louis gauge O—166.26 feet above St. Louis datum.	Elevations of water surface above St. Louis datum.		Oscillations.
			St. Louis gauge.	Local gauge engineer depot O—165.91.	
1909.					
Jan. 5	St. Louis: Foot of Arsenal street	3.00	169.3	168.7	S.
Jan. 6	.....do	2.70	169.0	168.6	F.

Date.	Locality.	Width of waterway.	Area of entire cross section.	Mean depth.	Elevation of mean bottom above St. Louis datum.	Total volume of discharge.	Mean velocity.	Number of stations.	Method.
1909.		*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Cu. ft. per sec.*	*Feet per sec.*		
Jan. 5	St. Louis: Foot of Arsenal street	1,822	27,983	15.4	153.3	63,412	2.27	11	Rod floats.
Jan. 6	.....do.....	1,821	27,499	15.1	153.5	62,210	2.22	10	Do.

As the result of observations of many years of the gauge records and discharge measurements for the district, a decided lowering of the low-water plane of the river at St. Louis has been noted.

Study of the causes leading to this condition has been made, and the following memorandum prepared by William M. Penniman, assistant engineer, is presented in explanation, and in suggestion for correction of change of plane:

MEMORANDUM CONCERNING THE RECENT LOWERING OF THE LOW-WATER PLANE IN ST. LOUIS HARBOR, MISSISSIPPI RIVER, WITH SUGGESTIONS FOR ITS CORRECTION IN CONNECTION WITH FURTHER IMPROVEMENT OF THIS SECTION OF RIVER.

The zero of the St. Louis (Market street) gauge perpetuates the low water of December 21, 1863, a stage caused by extremely heavy ice and, until 1895, the lowest recorded at that point. The term "low water of 1863" has frequently been used in this district to designate a datum surface for works of river improvement, but so far as known the low water of that year was not determined at any other point than St. Louis. The fact that the low-water plane at St. Louis

has lowered about 3.6 feet since 1863 (i. e., the low-water volume of to-day corresponding to that of 1863 will read on the St. Louis gauge about 3.6 feet below the zero then established) is shown by the following comparisons of gauge records, profiles of slopes, and discharge measurements.

GAUGE RECORDS.

The following table (I) has been compiled from the gauge records for St. Louis, Grays Point, and Cairo, and from the levels of the earlier hydrographic surveys.

TABLE I.

Stages of Mississippi River at St. Louis, Grays Point, and Cairo for the years 1872 and 1874, and from 1878 to 1908, inclusive; at times when the river was approximately stationary and also lowest for the year over the entire St. Louis-Cairo district, tabulated for gauge comparisons.

Year.	St. Louis.		Grays Point.		Grays Point–St. Louis differences.	Cairo.		Grays Point–Cairo differences.
	Month and day.	Gauge readings.	Month and day.	Gauge readings.		Month and day.	Gauge readings.	
		Feet.		*Feet.*			*Feet.*	
1872	Nov. 4	4.9	Nov. 6	[a]4.7	−0.2	Nov. 6	2.5	2.2
1874	Oct. 12–15	8.2	Oct. 13	[a]8.5	0.3	Oct. 13	5.9	2.6
1878	Nov. 20–21	9.2	Nov. 21–22	[b]7.9	−1.3	Nov. 20	7.5	0.4
1879	Oct. 7	7.7	Oct. 8	5.4	−2.3	Oct. 10	*2.7	2.7
1880	Nov. 29	*2.8	Dec. 1	2.1	−0.7	Nov. 29–30	*5.7	−3.6
1881	Sept. 3	8.6	Sept. 5	8.3	−0.3	Sept. 5	[c]5.7	2.6
Means.	1872–1881				−0.8			1.1
1882	Oct. 8–9	7.1	Oct. 11	7.0	−0.1	Oct. 11	9.5	−2.5
1883	Sept. 28–29	7.0	Oct. 1	[d]8.3	1.3	Sept. 30	*4.7	3.6
1884	Sept. 21	9.4	Sept. 22	11.1	1.7	Sept. 23	*7.1	4.0
1885	Oct. 18	8.8	Oct. 19	10.7	1.9	Oct. 20	*8.3	2.4
1886	Sept. 15–16	6.0	Sept. 17–18	7.4	1.4	Sept. 17	5.3	2.1
1887	Nov. 12–21	5.1	Nov. 17–18	6.1	1.0	Nov. 20	*2.1	4.0
	Dec. 27	*1.0	Dec. 31	*1.3	0.3	Jan. 1, 1888	*1.8	−0.5
1888	Oct. 17–18	5.0	Oct. 19	6.1	1.1	Oct. 19	[e]5.6	−0.5
1889	Oct. 20	3.7	Oct. 19–24	4.9	1.2	Oct. 21–23	*2.6	2.3
1890	Aug. 22	8.0	Aug. 23	8.9	0.9	Aug. 25	9.1	−0.2
1891	Oct. 6–10	4.0	Oct. 7–11	5.6	1.6	Oct. 9–13	[f]2.1	3.5
Means.	1882–1891				1.2			2.0
	1872–1891							1.9
1892	Oct. 24–25	5.0	Oct. 25–28	7.2	2.2	Oct. 27–29	*3.9	3.3
1893	Nov. 6–13	3.4	Nov. 5–14	6.2	2.8	Nov. 11–12	6.1	0.1
1894	Oct. 29–30	2.5	Oct. 31–Nov. 1	5.5	3.0	Oct. 31–Nov. 1	*2.8	2.7
1895	Nov. 6–7	2.3	Nov. 7–8	5.0	2.7	Nov. 5–6	*1.1	3.9
1896	Oct. 29–Nov. 1	4.4	Nov. 2–3	7.1	2.7	Nov. 1–2	7.6	−0.5
1897	Oct. 22–26	2.8	Oct. 24–28	5.9	3.1	Oct. 21–28	*2.5	3.4
1898	Oct. 17	3.0	Oct. 19–20	7.3	4.3	Oct. 21	8.8	−1.5
1899	Oct. 24–26	3.1	Oct. 26–27	6.5	3.4	Oct. 27	*3.0	3.5
1900	Sept. 19	6.1	Sept. 20–21	8.9	2.8	Sept. 21–22	*5.8	3.1
1901	Nov. 18–25	3.4	Nov. 20–24	6.7	3.3	Nov. 20–22 and 24.	*2.9	3.8
Means.	1892–1901				3.0			2.7
1902	Sept. 24	7.6	Sept. 25	10.6	3.0	Sept. 26	7.3	3.3
1903	Dec. 18	0.6	Dec. 19	4.3	3.7	Dec. 20	*2.9	1.4
1904	Oct. 19–22	6.6	Oct. 20–23	10.0	3.4	Oct. 23–24	6.8	3.2
	Dec. 23	0.1	Dec. 24	4.2	4.1	Dec. 25	*3.1	−1.0
1905	Oct. 17	8.3	Oct. 18	10.9	2.6	Oct. 18–19	11.0	−0.1
1906	Nov. 12–24	8.3	Nov. 13–16	10.9	2.6	Nov. 16	*11.9	−1.0
1907	Nov. 1	7.0	Nov. 1	10.2	3.2	Nov. 1	*9.5	0.7
1908	Oct. 15–17	3.4	Oct. 16–19	7.3	3.9	Oct. 18	*4.3	3.0
Means.	1902–1908				3.3			1.4
1892–1908								2.3
1872–1908		4.8		7.1	2.2		4.9	2.1

* Annual lowest stationary stage.
[a] Surveys of 1872 and 1874 (adjusted levels).
[b] United States Engineers gauge, 1.2 miles upstream, for 1878 to 1882, inclusive, and for 1888.
[c] Lowest stage, 5.4 September 9–10.
[d] Mississippi River Commission gauge, 1883–1908, except for 1888; this gauge maintained by United States Engineer Office, St. Louis, since 1896.
[e] Lowest stage 5.1, October 15–16.

Elevations of gauges of zeros referred to the Memphis datum plane (regarded as 420.84 feet below the St. Louis city directrix and approximately 6.8 feet below mean sea or gulf level), are: For St. Louis, 387.10; for Grays Point, 308.15; and for Cairo, 277.71 feet.

Recent precise levels (1908) indicate an elevation of 309.25 for the zero of the Grays Point gauge.

St. Louis (Market street) gauge is 0.4 mile, and Grays Point gauge is 136.8 miles below Eads Bridge; Cairo gauge is in the Ohio River, and 2 miles above its mouth, which is 182.5 miles below Eads Bridge; low-water channel distances.

Grays Point gauge, 137 miles below St. Louis, is at the head of a 7-mile rocky gorge, and Commerce gauge, 144 miles below St. Louis, is at the foot. In this gorge, as confirmed by the hydrographic surveys, only slight changes in river-bed have taken place in recent years. Therefore, for the purposes of this study, both Grays Point and Commerce may be considered as fixed points.

Only approximately stationary stages occurring during the annual low-water season have been used. Of the 34 stages considered, 21 are lowest at Cairo, but only 2 are lowest at St. Louis, where annual lowest water is generally caused by ice. The differences of gauge heights are given with reference to the Grays Point gauge, which generally reads about 2 feet higher than the St. Louis and Cairo gauges. Considering these differences of gauge heights by ten-year periods and weighting the observations according to the number of days duration of stage, the St. Louis gauge read, 1872–1881, 0.8 foot higher than the Grays Point gauge; 1882–1891, 1.2 feet lower; 1892–1901, 3 feet lower; and 1902–1908, 3.3 feet lower. This total difference of 4.1 feet is indicative of the amount of lowering of the low-water plane at St. Louis since the period 1872–1881; but 3.4 feet appears to be the total lowering according to the observations of 1872, 1874, 1881, and 1882, when the river at St. Louis was in an almost normal condition uninfluenced by systematic improvement works.

The table (I) shows that the low-water plane at St. Louis was abnormally high during 1878 and 1879, probably due to the local influence of extensive works of side contraction just constructed at Horsetail bar, about 10 miles below, which produced a damming effect that is plainly manifest; and further to the effect of a solid dam completed in September, 1879, across the channel in Cahokia Chute. The dam was raised to the 9-foot stage and is about 3 miles below the St. Louis gauge.

The Grays Point–Cairo differences do not compare well by ten-year periods because of the greater fluctuations of the combined rivers at Cairo, but the mean difference for the 17 stages in the period 1872–1891 is 1.9 feet; and for the 18 stages in the period 1892–1908, 2.3 feet; or for the total period, 2.1 feet. These differences confirm what might have been assumed as a fact, viz, that the low-water planes at Grays Point and Cairo remain, relatively, almost constant.

Mean annual low water for the last thirty-seven years, with the river open to navigation, is, according to the table (I), about 5 feet on the gauge at St. Louis, 7 feet at Grays Point, and 5 feet at Cairo; the lowest open-river stages being about 3 feet less. Had there been a gauge at Grays Point when normal conditions obtained, prior to 1875, it would probably have read about the same as the St. Louis gauge.

The gauge relations and differences just discussed are shown graphically in plate 5, Diagram A.

TABLE II.

Annual lowest stages of Mississippi River at St. Louis, Mo., and their corresponding stages at Grays Point; tabulated for comparison of mean differences of gauge readings for the periods 1878–1891 and 1892–1909.

Year.	St. Louis.		Grays Point.		Grays Point–St. Louis differences.
	Month and day.	Gauge readings.	Month and day.	Gauge readings.	
		Feet.		*Feet.*	*Feet.*
1878	Dec. 25	5.7	Dec. 26	2.3	−3.4
1879	Dec. 26	3.5	....do	4.0	−.5
1880	Nov. 29	2.8	Dec. 1	2.2	−.6
1881	Feb. 5–6	7.6	Feb. 7	5.9	−1.7
1882	Dec. 18	2.9	Dec. 19	3.2	.3
1883	Jan. 12	4.5	Jan. 15–16	4.3	−.2
	Dec. 29	4.6	Dec. 29	6.7	2.1
1884	Jan. 5	3.2	Jan. 8	7.9	4.7
	Dec. 25	4.1	Dec. 27	4.3	.2
1885	Dec. 15	2.1	Dec. 19	5.6	3.5
1886	Dec. 5	1.5	Dec. 8	3.6	2.1
1887	Dec. 27	1.0	Dec. 31	1.3	.3
1888	Dec. 25	3.3	Dec. 26–27	5.1	1.8
1889	Feb. 26	2.5	Feb. 28	6.3	3.8
	Oct. 20	3.7	Oct. 19–24	4.9	1.2
1890	Dec. 17–19	3.0	Dec. 18–22	4.6	1.6
1891	Dec. 3	2.6	Dec. 6	4.8	2.2
Mean for period					1.1
1892	Dec. 24–25	1.2	Dec. 30	1.8	.6
1893	Dec. 8	.1	Dec. 9	3.1	3.0
1894	Feb. 3	.2	Feb. 3–5	3.7	3.5
1895	Dec. 9	−.1	Dec. 11–12	3.2	3.3
1896	Dec. 11–12	3.8	Dec. 14	6.8	3.0
1897	Dec. 24	−.4	Dec. 27	2.9	3.3
1898	Dec. 11	.3	Dec. 15	4.2	3.9
1899	Feb. 1	−.5	Feb. 2–4	6.4	5.9
1900	Jan. 2	−2.5	Jan. 3–5	1.5	4.0
1901	Dec. 19	−1.9	Dec. 21	3.8	5.7
1902	Jan. 30	−1.1	Feb. 1	2.9	4.0
1903	Dec. 18	.6	Dec. 19	4.3	3.7
1905	Jan. 1	−.3	Jan. 3	3.9	4.2
1906	Dec. 28	3.0	Dec. 29	7.1	4.1
1907	Dec. 29–30	4.3	Jan. 1–3, 1908	9.0	4.7
1908	Feb. 4	1.7	Feb. 4	5.8	4.1
1909	Jan. 12	−1.4	Jan. 15	.2	1.6
Mean for period					3.7
Difference of means					2.6

Table II shows that 17 annual lowest stages at St. Louis prior to and including the year 1891 and 17 such stages since 1891, when compared with their corresponding stages at Grays Point, give a mean difference of −1.1 feet for the former group and of −3.7 for the latter. These differences indicate, as regards the two periods, a mean lowering of 2.6 feet for the extreme low-water plane at St. Louis. In considering these annual stages it must be noted that the year 1891 marked a radical change in conditions; as by that date the river between St. Louis and Ste. Genevieve had been extensively improved and confined to a single channel of fairly uniform width of 2,500 feet, and during that year further works of side contraction narrowed St. Louis Harbor, between the Eads and Merchants bridges, from a maximum width of 4,000 feet to a uniform width of about 2,000 feet.

All recorded stages falling below zero on the St. Louis gauge have occurred since 1891; and with corresponding readings on the gauges at Chain of Rocks, Grays Point, and Commerce, are as follows:

TABLE III.

Dates for St. Louis.	Chain of Rocks.	St. Louis.	Grays Point.	Commerce.
	Feet.	*Feet.*	*Feet.*	*Feet.*
January 27, 1895	75.30	−0.6	3.0	.....
December 9, 1895	75.40	−.1	3.2	(a)
December 24, 1897	75.10	−.4	2.9	1.6
February 1, 1899	75.60	−.5	[b]6.4	[b]5.3
January 2, 1900	75.10	[c]−2.5	1.5	−.5
December 19, 1901	74.60	−1.9	3.8	2.2
January 30, 1902	75.20	−1.1	2.9	1.4
January 1, 1905	75.30	−.3	3.9	1.5
January 12, 1909	[c]72.80	−1.4	[c].2	[c]−1.7
Elevation of gauge zero	321.18	387.10	308.15	308.84

[a] Commerce gauge, established 1896.
[b] Cairo gauge, 22.3 feet.
[c] The lowest known stage.

Until 1909, the lowest reliably recorded stage at Grays Point was 1.3 feet, December 31, 1887.

This data is given here because the records of Chain of Rocks and Commerce gauges do not antedate 1892, and it was thought best not to include these gauges in Table II. The record if continued for these fixed points for several years will be valuable.

SLOPE—PROFILE.

A profile of slopes embracing the planes of principal floods and low waters and the mean planes of characteristic intermediate stages (these last being for recent years and referred to the St. Louis gauge) has been compiled from various sources as a part of this study and is shown on plate 5, Diagram B.

This profile includes the harbor of St. Louis and its approaches, and extends from Grafton, Ill., on the Mississippi River, 38 miles above Eads Bridge and 22 miles above the mouth of the Missouri River, to Cornice Rock, Mo., 33 miles below Eads Bridge. It shows that the low-water plane at Chain of Rocks (also considered a fixed point), 10 miles above Eads Bridge, remains practically unchanged since 1872. But in the middle harbor of St. Louis this plane has lowered; the greatest change—5.1 feet—occurring at Bissell Point, just above the Merchants Bridge at the head of the reach severely contracted by bridges and encroachments; while at the Market street gauge the lowering of plane amounts to 4 feet, from which the deduction is drawn that the volume of water passing at the zero stage of to-day corresponds to the volume that did pass at the 4-foot stage in 1872.

Low water of December, 1872, is the lowest known at Alton, and about 2 feet above the lowest known at Chain of Rocks and Grays Point; at Market street this stage was 2.3 feet on December 4; and it is probable that the volume of water then passing approximated the volume passing during the extreme low water of January 2, 1900 (St. Louis gauge, −2.5 feet) since the gauge heights at the fixed points—Chain of Rocks, Grays Point, and Commerce—averaged about the same for these two low stages.

The slope profile, as well as the discharge curves hereinafter discussed, also shows that in a reach unduly contracted as is St. Louis Harbor, a much greater than normal range of river will prevail. Not only is the low-water plane lowered but the flood plane is raised; and both conditions are serious disadvantages to navigation.

Based upon the slope of the flood of 1903, and upon differences in gauge heights for the flood planes of 1844, 1858, and 1903, a hypothetical or probable plane for a flood equal in volume to that of 1844 has been indicated on the profile. The indicated raise of plane at Market street is about 3 feet, at Bissell Point and at Chain of Rocks, 4 feet, and at Alton, 3½ feet.

Natural mean slope line.—A natural mean slope line for the volume of water passing St. Louis at the zero stage (34,000 second cubic feet, discharge curve 1897–1904), when drawn between mean gauge heights for that volume at the fixed points (Chain of Rocks and Commerce), intersects the St. Louis gauge at a height of 4.1 feet.

DISCHARGE CURVES.

Curves showing, for the various stages, the volumes of discharge of the river at St. Louis for the years 1873 to 1881 and for the years 1897 to 1904 have been compiled from all available data and are shown in plate 5, Diagram C.

These curves show that the volume of water passing St. Louis at a 4-foot stage in 1873 now passes at a 1-foot stage; that is, the low-water plane has lowered 3 feet; also the curves show that a flood equal in volume to that of 1881, gauge 33 feet, now reaches a gauge height of 25 feet in passing through the contracted harbor.

SUMMARY.

The lowering of the low-water plane at the Market street gauge as shown by the table of low annual stages is 4.1 feet; as shown by the table of means of lowest annual stages for two long periods of time, 2.6 feet; by the slope profile, 4 feet; by the natural mean slope line 4.1 feet; and by the discharge curves, 3 feet. The mean of these results, equal weight being given to each, is 3.6 feet, which may be considered a fair determination of the amount of lowering of the low-water plane at Market street, St. Louis Harbor, due to the influence of the improvements in the river reach between Chain of Rocks and Grays Point.

The foregoing study shows that the low-water plane at St. Louis (Market street) gauge has lowered about 3.6 feet during the last thirty-five years, entailing a loss of slope throughout the contracted reach—Merchants Bridge to Arsenal Island—and that this loss of slope in the middle harbor of St. Louis is offset near its upper end, immediately below Chain of Rocks, by an abnormally steep slope which threatens to become a barrier to navigation from St. Louis into the upper rivers.

To remedy these conditions and improve navigation through the harbor of St. Louis, past Chain of Rocks, and as far north as the mouth of the Missouri River, it appears desirable and necessary to raise the low-water plane wherever too low and thus produce uniformity of its slope throughout this reach by restoring the river bed to

approximately its former good slope, while completing the works of side-contraction and bank-protection under the existing project.

It is estimated that this will require the construction of perhaps seven submerged weirs or sills extending across the entire river bed and up the banks as far as the bank-full stage, and connecting, if necessary, with the levees. In construction, such cross sectional area of river would be provided over these weirs as to make certain that each volume of flow would always reach the same desired local gauge height. Such work will be in harmony with the existing project and will be of the nature of repair or maintenance of the river bed from the time when it had begun to scour below the full project depth. The proposed works will effectively regulate the low-water plane and will not raise the flood plane.

To allow for possible increase in the draft of future boats operating in the harbor a navigable pass section of 18-feet depth below low water (34,000 second cubic feet volume) with minimum channel width of 200 feet is proposed; but for the remainder of the harbor width (1,500 feet) the depth should be about 8 feet below low water.

The lower weirs of the series should be constructed first and those above as the necessity for their effects may arise.

The locations chosen for these weirs are as follows:

Head of Cabaret Island (1 mile below Chain of Rocks), 9 miles above Eads Bridge.
Sawyer Bend, 7 miles above Eads Bridge.
Foot of Cabaret Island, 4¼ miles above Eads Bridge.
Tyler street, St. Louis, 1¼ miles above Eads Bridge.
Lynch street, St. Louis, 2¾ miles below Eads bridge.
Foot of Arsenal Island, 6 miles below Eads Bridge.
Jefferson Barracks, 10 miles below Eads Bridge.

The amount that the low-water plane is to be raised is indicated by a heavy vertical line at the location of each cross weir on the slope profile; plate 5, Diagram B. The locations of the proposed improvement works are shown on the small scale map, plate 6.

The wing dams and revetments given in the following estimate will be required to build new banks out to the harbor limit lines at the sites of the cross weirs and to hold permanently the sections of alluvial banks at these sites.

ESTIMATED COST.

Seven cross weirs, 15,000 linear feet, at $60	$900,000
Eight wing dams, 8,000 linear feet, at $25	200,000
Six revetments, 10,000 linear feet, at $20	200,000
Total	1,300,000

Estimate of additional funds required.

Amount that can be profitably expended in fiscal year ending June 30, 1911, for maintenance of improvement, exclusive of the balance unexpended July 1, 1909:		
For existing constructions	$400,000	
For dredged channels	250,000	
		$650,000

Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.

APPROPRIATIONS.

(As shown on p. 347, H. Doc. No. 421, 57th Cong.)

Missouri River to Mouth of Yellowstone River, June 10, 1872	$100,000.00
Missouri River to Ohio River, March 3, 1873	200,000.00
Illinois River to Ohio River, June 23, 1874, to March 3, 1881	1,890,000.00
Since adoption of project:	
August 2, 1882	600,000.00
July 5, 1884	520,000.00
August 5, 1886	375,000.00
August 11, 1888	300,000.00
September 19, 1890	400,000.00
July 13, 1892	525,000.00
March 3, 1893	658,333.33
August 18, 1894	758,333.33
March 2, 1895	758,333.33
June 3, 1896	275,000.00
June 4, 1897	673,333.33
July 19, 1897	325,000.00
July 1, 1898	[a] 673,333.33
March 3, 1899	663,333.33
June 6, 1900	100,000.00
June 13, 1902	650,000.00
March 3, 1903	650,000.00
April 28, 1904	650,000.00
March 3, 1905	650,000.00
March 2, 1907	250,000.00
May 27, 1908	250,000.00
March 4, 1909	250,000.00
	13,144,999.98
Miscellaneous receipts, sales of property, etc	51,237.69
	13,196,237.67

COMMERCIAL STATISTICS.

Receipts and shipments at St. Louis, Mo., during the year 1908.

Receipts:	Tons.
Coal and coke	185,000
Cotton and cotton products	2,355
Groceries and dairy products	896
Hay, seed, grain, flour, meal, etc	15,135
Live stock and products	24,597
Lumber	2,941
Merchandise and sundries	56,416
Vegetables and fruits	5,608
Wines and liquors	6
Wool	126
Total	293,180
Shipments:	
Barbed wire, ores, and metals (pig and manufactured)	987
Cotton and cotton products	1,039
Groceries and dairy products	5,185
Hay, seed, grain, flour, meal, etc	5,168
Live stock and products	3,575
Lumber	1,932
Merchandise and sundries	45,659
Vegetables and fruits	2,986
White lead, oils, etc	1,109
Wines and liquors	5,100
Total	72,740

[a] $10,000 allotment for Wittenberg, Mo., carried to surplus fund.

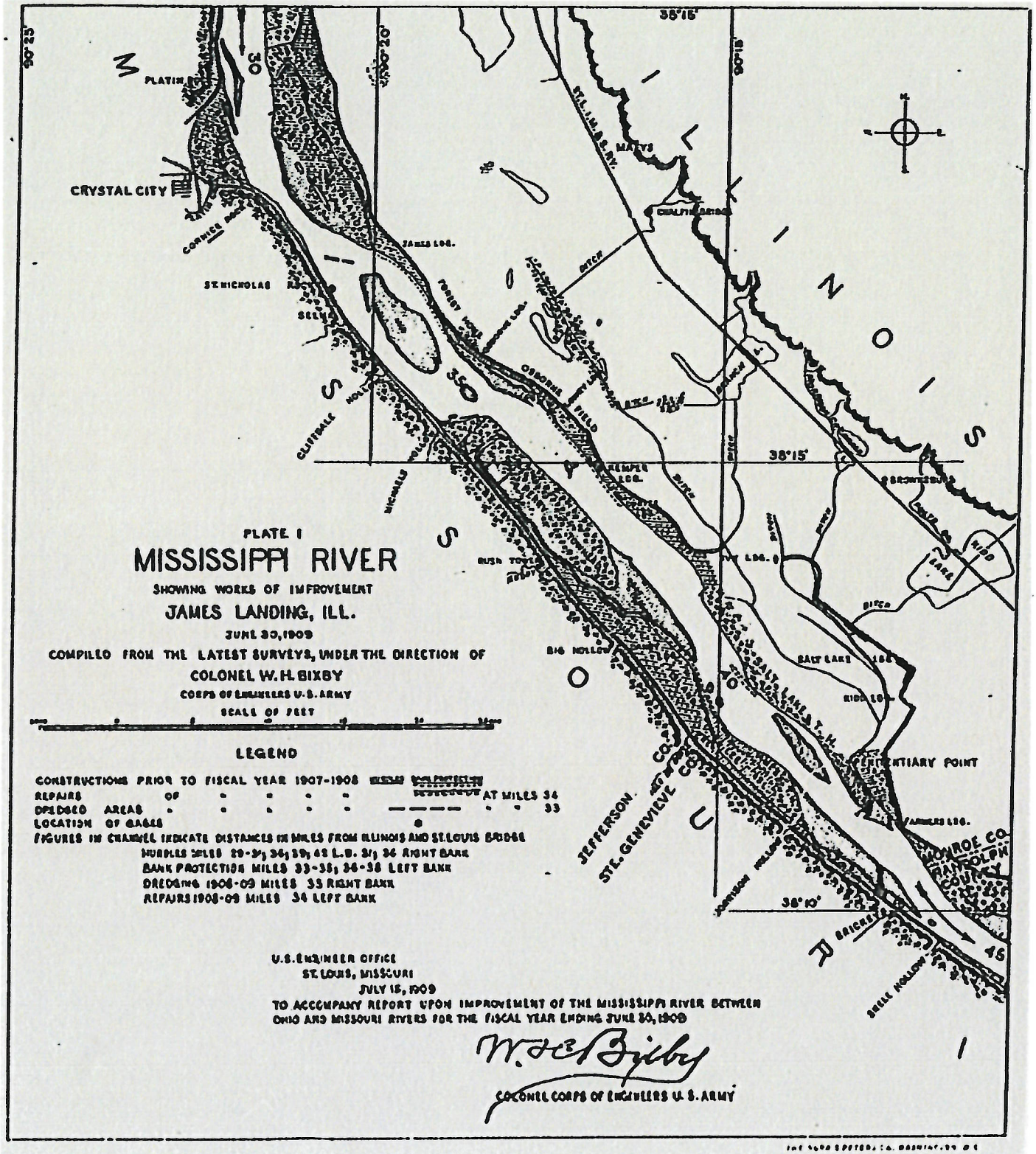
PLATE I
MISSISSIPPI RIVER
SHOWING WORKS OF IMPROVEMENT
JAMES LANDING, ILL.
JUNE 30, 1909
COMPILED FROM THE LATEST SURVEYS, UNDER THE DIRECTION OF
COLONEL W. H. BIXBY
CORPS OF ENGINEERS U. S. ARMY
SCALE OF FEET
LEGEND
CONSTRUCTIONS PRIOR TO FISCAL YEAR 1907-1908
REPAIRS OF
DREDGED AREAS
LOCATION OF GAGES
AT MILES 34
33
FIGURES IN CHANNEL INDICATE DISTANCES IN MILES FROM ILLINOIS AND ST. LOUIS BRIDGE
HURPLES MILES 29-3/4, 36, 38, 42 L.B. 3/4, 34 RIGHT BANK
BANK PROTECTION MILES 33-38, 34-38 LEFT BANK
DREDGING 1908-09 MILES 35 RIGHT BANK
REPAIRS 1908-09 MILES 34 LEFT BANK
U.S. ENGINEER OFFICE
ST. LOUIS, MISSOURI
JULY 15, 1909
TO ACCOMPANY REPORT UPON IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN
OHIO AND MISSOURI RIVERS FOR THE FISCAL YEAR ENDING JUNE 30, 1909
W. H. Bixby
COLONEL CORPS OF ENGINEERS U. S. ARMY
CRYSTAL CITY
ST. NICHOLAS
CLIFFDALE
JAMES LDG.
OSBORNE
FIELD
KEMPER LDG.
IVY LDG.
BIG HOLLOW
SALT LAKE
SALT LAKE & T. M.
PENITENTIARY POINT
JEFFERSON
STE. GENEVIEVE CO.
MONROE CO.
RANDOLPH COUNTY
BRICKEY
SHELLE HOLLOW
38°15'
38°10'
90°15'
90°20'
ILLINOIS
MISSOURI

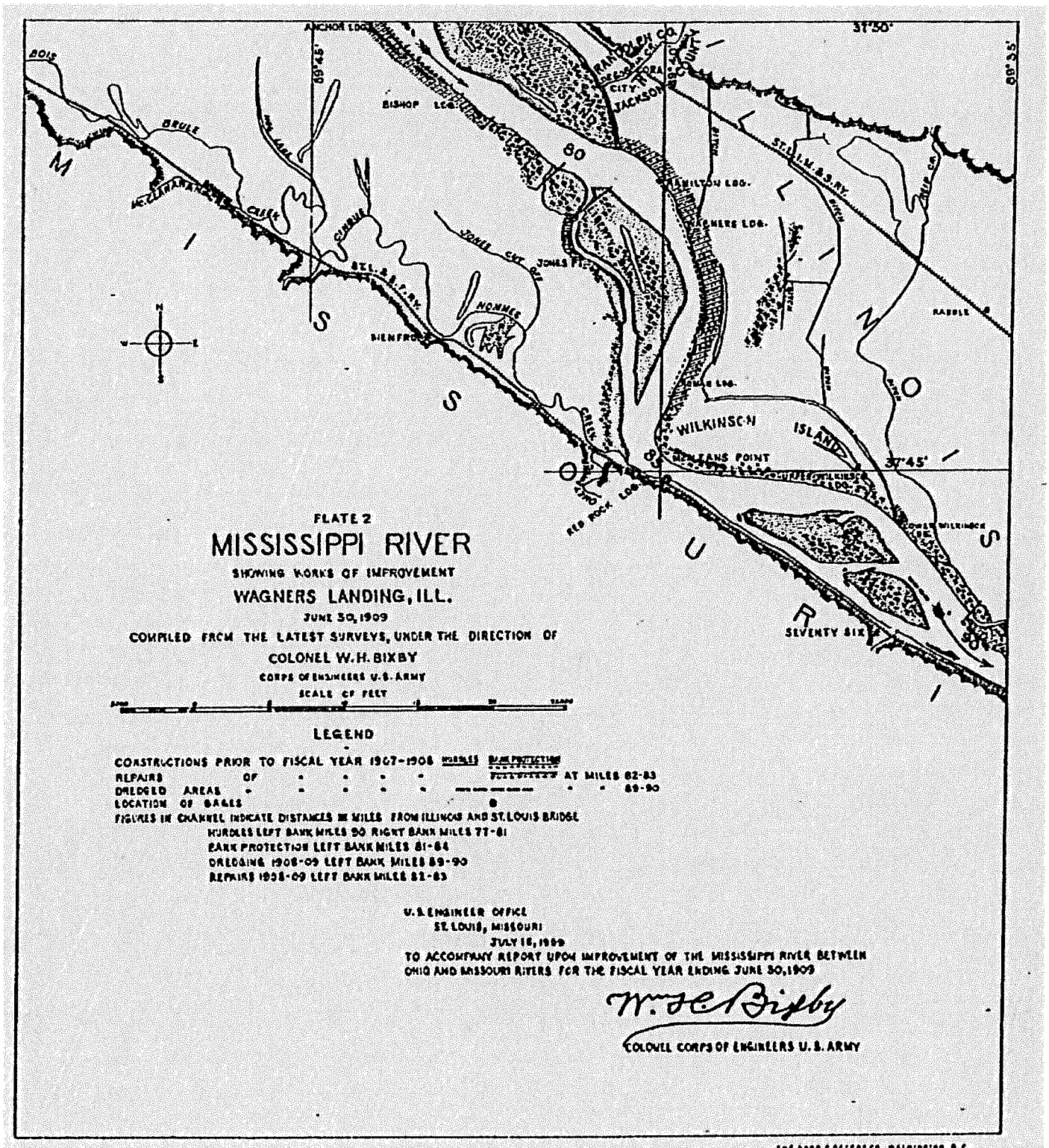

PLATE 2

MISSISSIPPI RIVER

SHOWING WORKS OF IMPROVEMENT

WAGNERS LANDING, ILL.

JUNE 30, 1909

COMPILED FROM THE LATEST SURVEYS, UNDER THE DIRECTION OF

COLONEL W. H. BIXBY

CORPS OF ENGINEERS U. S. ARMY

SCALE OF FEET

LEGEND

CONSTRUCTIONS PRIOR TO FISCAL YEAR 1907-1908 HURDLES BANK PROTECTION

REPAIRS OF . . . . . FASCINE WORK AT MILES 82-83

DREDGED AREAS 89-90

LOCATION OF GAGES ●

FIGURES IN CHANNEL INDICATE DISTANCES IN MILES FROM ILLINOIS AND ST. LOUIS BRIDGE

HURDLES LEFT BANK MILES 90 RIGHT BANK MILES 77-81

BANK PROTECTION LEFT BANK MILES 81-84

DREDGING 1908-09 LEFT BANK MILES 89-90

REPAIRS 1908-09 LEFT BANK MILES 82-83

U. S. ENGINEER OFFICE
ST. LOUIS, MISSOURI
JULY 15, 1909

TO ACCOMPANY REPORT UPON IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS FOR THE FISCAL YEAR ENDING JUNE 30, 1909

W. H. Bixby

COLONEL CORPS OF ENGINEERS U. S. ARMY

THE JUDD & DETWEILER CO., WASHINGTON, D. C.

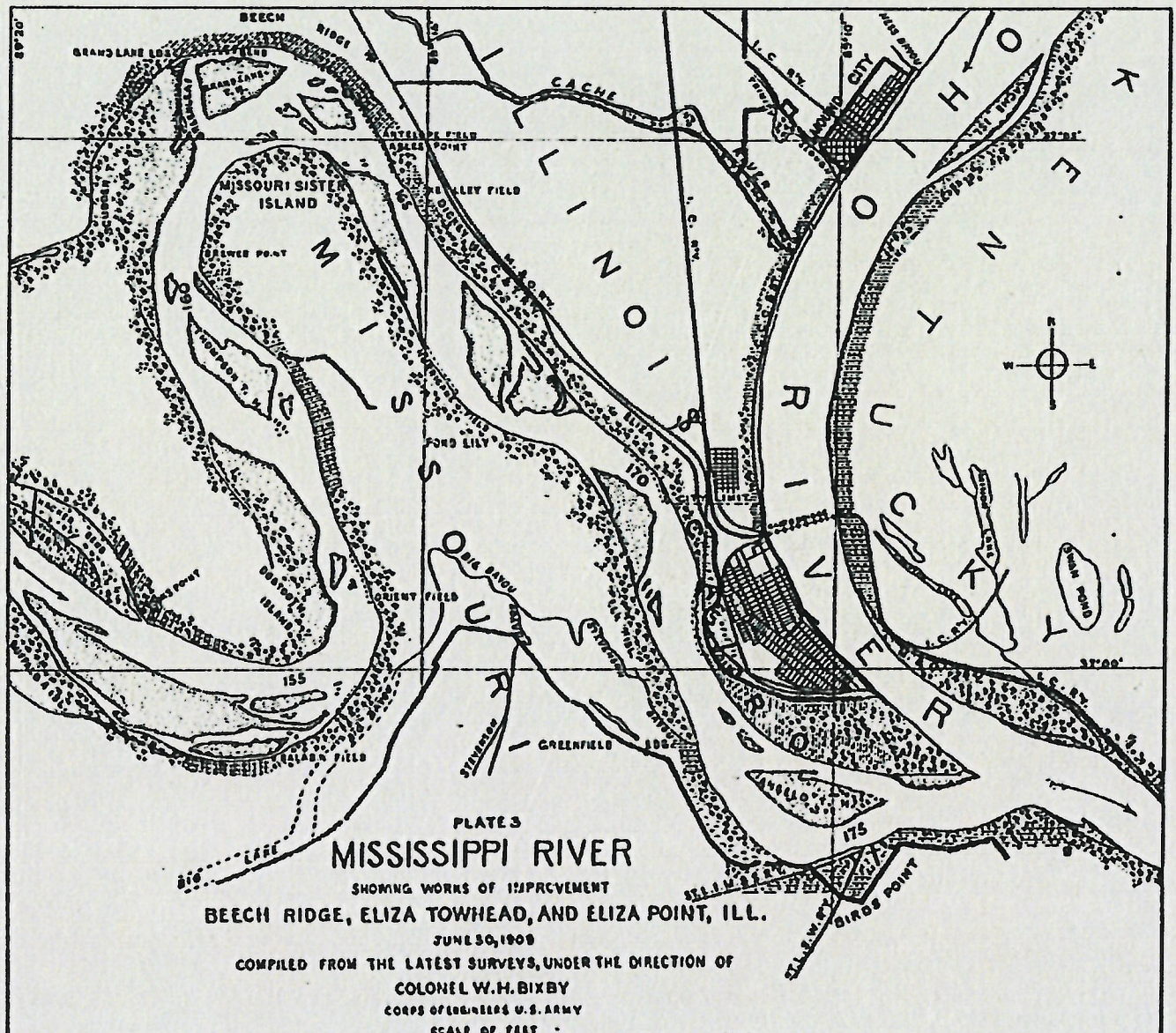

PLATE 3

MISSISSIPPI RIVER

SHOWING WORKS OF IMPROVEMENT

BEECH RIDGE, ELIZA TOWHEAD, AND ELIZA POINT, ILL.

JUNE 30, 1909

COMPILED FROM THE LATEST SURVEYS, UNDER THE DIRECTION OF

COLONEL W.H. BIXBY

CORPS OF ENGINEERS U.S. ARMY

SCALE OF FEET

LEGEND

CONSTRUCTIONS PRIOR TO FISCAL YEAR 1907-1908 WORK DONE / WORK CONTRACTED FOR AT MILES 163-165, 170, 171

REPAIRS OF

DREDGED AREAS

LOCATION OF GAGES

FIGURES IN CHANNEL INDICATE DISTANCES IN MILES FROM ILLINOIS AND STLOUIS BRIDGE

U.S. ENGINEER OFFICE
ST. LOUIS, MISSOURI
JULY 15, 1909

MURPHYS LEFT BANK MILES 183

BANK PROTECTION LEFT BANK MILES 163-165, 170, 171, 172 RIGHT BANK 155, 156, 161.

REPAIRS LEFT BANK MILES 163-165, 170, 171.

TO ACCOMPANY REPORT UPON IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS FOR THE FISCAL YEAR ENDING JUNE 30, 1909

W. H. Bixby

COLONEL CORPS OF ENGINEERS U.S. ARMY.

THE BYRON S. PETERSON CO. WASH'GTON, D. C.

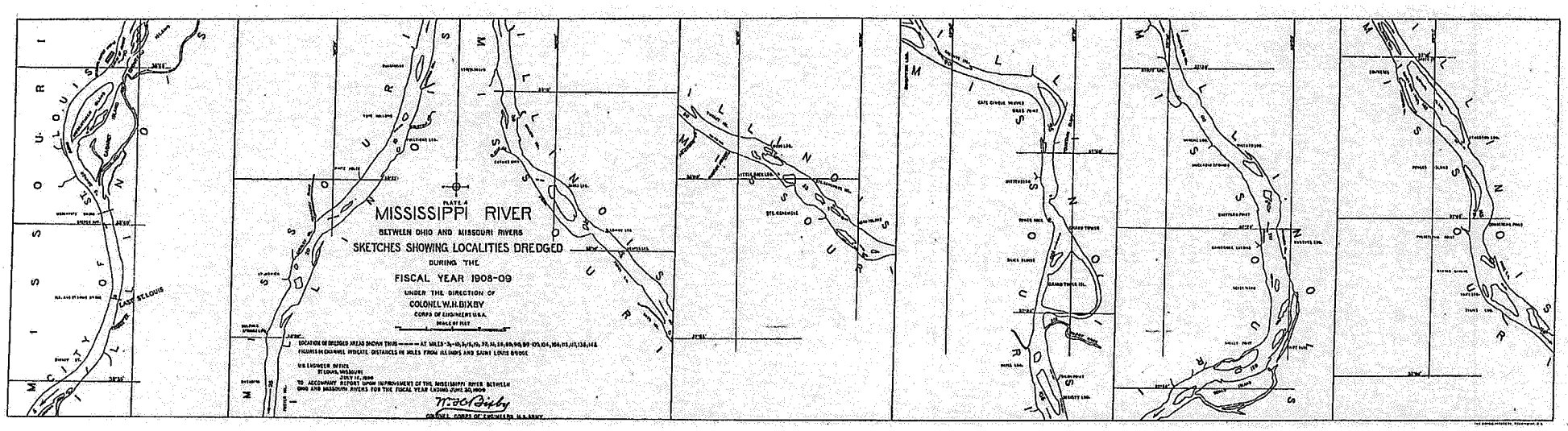
PLATE 1
MISSISSIPPI RIVER
BETWEEN OHIO AND MISSOURI RIVERS
SKETCHES SHOWING LOCALITIES DREDGED
DURING THE
FISCAL YEAR 1908-09
UNDER THE DIRECTION OF
COLONEL W.H.BIXBY
CORPS OF ENGINEERS U.S.A.
SCALE OF FEET
U.S. ENGINEER OFFICE
ST LOUIS, MISSOURI
JULY 15, 1909
TO ACCOMPANY REPORT UPON IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS FOR THE FISCAL YEAR ENDING JUNE 30, 1909
W.H.Bixby
COLONEL CORPS OF ENGINEERS U.S.ARMY

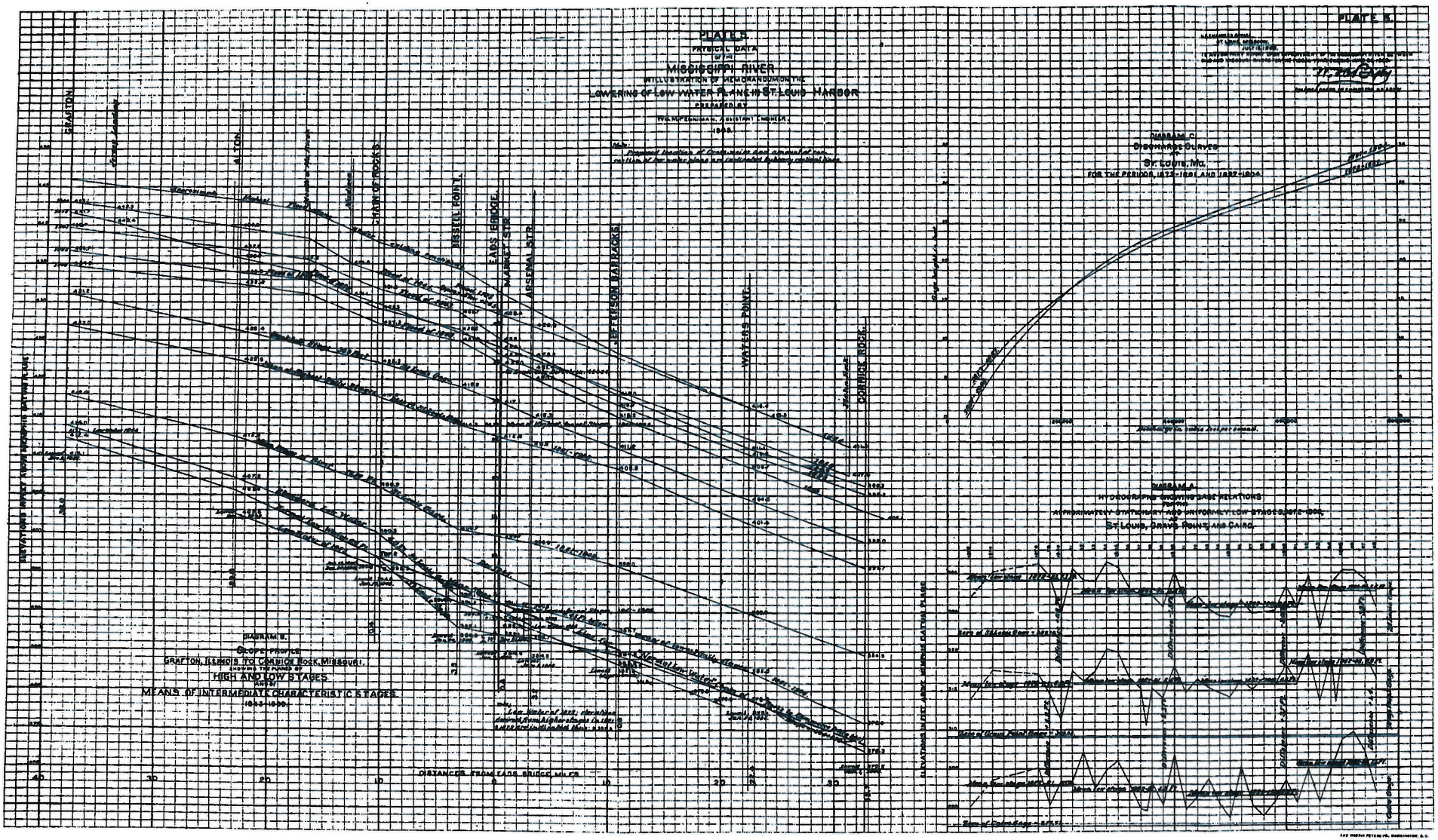
PLATE 5.
PHYSICAL DATA
OF THE
MISSISSIPPI RIVER
WITH ILLUSTRATION OF MEMORANDUM ON THE
LOWERING OF LOW WATER PLANES IN ST. LOUIS HARBOR
PREPARED BY
WM. McPHERSON, ASSISTANT ENGINEER.
1903.
DIAGRAM B.
SLOPE PROFILES
GRAFTON, ILLINOIS TO COMMERCE ROCK, MISSOURI.
SHOWING THE PLANES OF
HIGH AND LOW STAGES
AND
MEANS OF INTERMEDIATE CHARACTERISTIC STAGES.
1843-1903.
DIAGRAM C.
DISCHARGE CURVES
AT
ST. LOUIS, MO.
FOR THE PERIODS 1873-1881 AND 1882-1904.
DIAGRAM D.
HYDROGRAPHS SHOWING GAGE RELATIONS
OF
APPROXIMATELY STATIONARY AND UNIFORMLY LOW STAGES OF 1901.
AT
St. Louis, Grays Point, and Cairo.
GRAFTON
ALTON
CHAIN OF ROCKS
BISSELL POINT
EADS BRIDGE
ARSENAL ST.
JEFFERSON BARRACKS
WATER'S POINT
COMMERCE ROCK
DISTANCES FROM EADS BRIDGE MILES
ELEVATIONS ABOVE MEAN GULF LEVEL

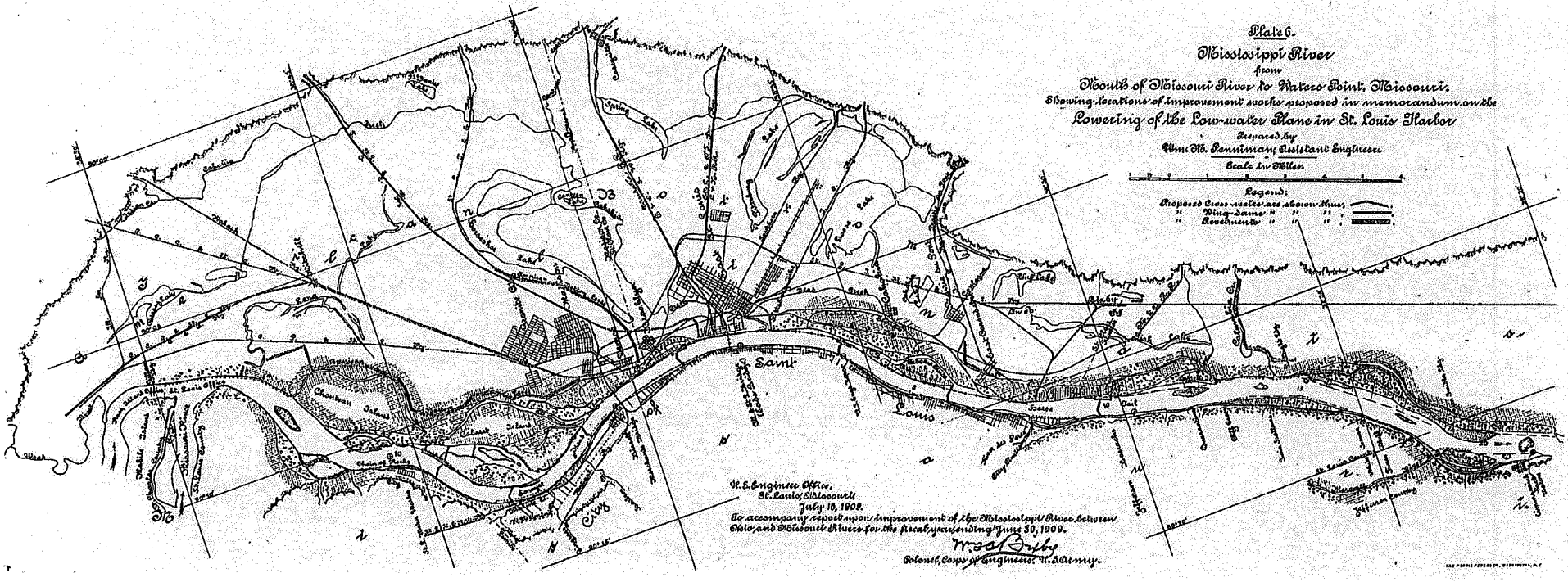
Plate 6.
Mississippi River
from
Mouth of Missouri River to Matero Point, Missouri.
Showing locations of improvement works proposed in memorandum on the
Lowering of the Low-water Plane in St. Louis Harbor
Prepared by
Wm. M. Sanitmary, Assistant Engineer.
Scale in Miles
Legend:
Proposed Cross-works see above Mine.
" Wing-dams " " "
" Revetments " " "
St. Louis
U.S. Engineer Office,
St. Louis, Missouri
July 15, 1909.
To accompany report upon improvement of the Mississippi River between
Ohio and Missouri Rivers for the fiscal year ending June 30, 1909.
Colonel, Corps of Engineers U.S. Army.

1910
(Do not have App. X 2)

from July 1, 1880, to June 30, 1910, was $2,300,759.89, making the total of approximate and known expenditures to date $2,794,197.12.

From March 28, 1868 (the earliest date of available record of work done), to June 30, 1910, 99,609 snags, 104 wrecks, and 653 drift piles were destroyed, and 446,641 trees were cut, greatly improving the river and lessening the dangers of navigation.

During the fiscal year in review two steel-hull snag boats were engaged in removing such obstructions between the mouth of the Missouri River and New Orleans, La., and Old River and the Atchafalaya to Melville, La., a total distance of about 1,200 miles, and 3,245 snags, 17 drift piles, and 23 wrecks were destroyed, 2,571 trees were cut, and 13,705 miles patrolled.

In addition to this work, part of the funds appropriated for the removal of obstructions was expended in the partial removal of Beaver Dam rock, an obstructive and dangerous rock lying in mid-channel about 1 mile below Commerce, Mo. Beginning was made upon this work (which can only be done economically at low and favorable river stages) during the fiscal year 1908. During 1909 and the past fiscal year the work was continued, so that about one-half of the whole is now accomplished. Work will be continued at each low-water season as opportunity offers and funds are available, until the entire rock is removed to the plane desired.

For information as to the commerce benefited by work under this appropriation, reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri rivers and in the reports of the Mississippi River Commission and the district officers thereunder.

The amount expended during the year was $96,782.04.

(See Appendix X 1.)

2. Mississippi River between Ohio and Missouri rivers.—In its original condition, prior to any improvement, the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which a considerable part of the volume of the flow was diverted to the detriment of navigation.

The first systematic effort to improve this condition was begun by the Federal Government in 1872, and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone, to confine the low-water volume in the vicinity to a single channel, and of revetments to hold and preserve the banks where it was thought necessary or advisable.

The project followed in later years and up to the present time has been practically that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, and sought to obtain eventually within the district, at standard low water, a minimum navigable channel depth of 6 feet above St. Louis and 8 feet below that city by confining 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 secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bot-

tom by the river, the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent improvement, the required low-water channel depth should be maintained each season by the use of dredges and other temporary expedients.

The river and harbor act of March 3, 1905, radically changed the project by limiting work of improvement to dredging only, adopting one of the recommendations of the Board of Engineers, November 12, 1903, to the exclusion of the others. The recommendation of the Board fixed the channel depth to be obtained at 8 feet for the river reach below St. Louis, with a minimum width of 200 feet.

This change in plan was modified by joint resolution of Congress, June 29, 1906, authorizing, after all dredging expenses were provided for, the application of the balance of funds remaining to the credit of the appropriation of 1905 to the repair or completion of improvements under the former projects or to the construction of other works useful to navigation.

The river and harbor act of March 2, 1907, confirmed the change of plan to dredging and temporary expedients as principal means of channel improvement and limited expenditure for works of permanent character first to that necessary for the maintenance and repair of works already constructed, and thereafter, with any funds remaining, to that for the construction of other works of channel regulation; but the small amounts appropriated yearly under this act almost precluded any extension of the existing system of permanent works.

The river and harbor act approved June 25, 1910, restores the plan adopted in 1881, together with dredging, as the plan to be followed in prosecuting the improvement, with a view to its completion within a period of twelve years.

The recent report of the special board on examination and survey of the Mississippi River from the Lakes to the Gulf, March 20, 1909, which virtually recommends the early completion of the 1881 project as indorsed and modified by the 1903 Board, puts the cost of such completion at $21,000,000, in addition to all amounts already expended. Of this sum $750,000 has just been appropriated in the river and harbor and sundry civil acts of June 25, 1910, leaving the balance yet to be appropriated $20,250,000.

The object of the previous and present plans of improvement is, therefore, to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1910, was $11,532,440.15, exclusive of $180,000 allotted by acts to projects for improvement between the Illinois and Missouri rivers, including Alton Harbor, and $1,400,000 for methods of improvement under the acts of 1905 and 1907.

The result of the expenditure of this amount has been the partial permanent improvement of the entire extent of the river from St. Louis to Cairo, and during recent years practically the maintenance of the depths required.

The improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be

lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

The new appropriation asked for is the estimated expenditure for one year only, and should be followed by such amounts annually as will permit the completion of the improvement within the period specified.

It is proposed to expend the new appropriation asked for in such permanent and temporary improvements as may be necessary and authorized by law.

The amount expended during the fiscal year ending June 30, 1910, was $280,619.15; for dredges and dredging, care of plant, and for maintenance and repair of existing works of revetment which had been much damaged by the action of the river and were urgently in need of such work.

During the past year there was maintained a channel depth of 8 feet during the entire season when the river was unobstructed by ice, except 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.

At Grand Tower, Ill., natural silting up and closing of the chute east of Grand Tower Island forced the boat channel to the west of that island over a bar of gravel and small bowlders which could not be moved by the suction type of dredges in use. Contract, therefore, was made for dipper dredging to remove the bowlders and gravel in a channel 200 feet wide across this bar, down to a depth 3 feet below the zero of the Grand Tower gauge. This contract was partly completed during the low-water season of the fall, but the work was much interrupted by high river stages and finally stopped by winter conditions. The work will be resumed and probably completed during the coming low-water season.

The river at St. Louis reached a high-water stage of 31.25 feet above standard low water (4 feet St. Louis gauge) on July 16, 1909, and a low-water stage of 0.1 foot below standard low water on December 24, 1909.

With the present appliances and such others as are authorized for the temporary improvement of low-water channels and for works of permanent improvement, it is expected that a navigable depth of about 8 feet can be maintained between St. Louis and Cairo during all stages of river open to navigation.

July 1, 1909 balance unexpended	$298 093.01
Amount appropriated by sundry civil act approved June 25, 1910	250,000.00
Amount appropriated by river and harbor act approved June 25, 1910	500,000.00
Miscellaneous receipts	15,085.97
	1,063,178.98
June 30, 1910, amount expended during fiscal year, for maintenance of improvement	[a]280,619.15
July 1, 1910, balance unexpended	782,559.83
July 1, 1910, outstanding liabilities	16,384.37
July 1, 1910, balance available	766,175.46

[a] Deduct $96.35 expended in June, 1909, on account of inspections for the Isthmian Canal Commission, which had not been refunded at the end of the fiscal year, leaving net amount of $280,522.80 expended upon the improvement.

July 1, 1910, amount covered by uncompleted contracts	$7,302.19
Amount (estimated) required for completion of existing project 1881	[a] 20,250,000.00
Amount required for expenditure in fiscal year ending June 30, 1912, for works of improvement and for maintenance. Submitted in compliance with requirements of sundry civil act of June 4, 1897, and of section 7 of the river and harbor act of 1899.	[a] 1,000,000.00

(See Appendix X 2.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILLINOIS, DISTRICT.

This district was in the charge of Maj. C. S. Riché, Corps of Engineers, to March 15, 1910, and in the charge of Maj. Charles Keller, Corps of Engineers since that date. Division engineer, Col. W. H. Bixby, Corps of Engineers (now brigadier-general, Chief of Engineers, U. S. Army).

1. Operating snag boats and dredge boats on upper Mississippi River and tributaries.—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed $25,000 annually.

By river and harbor act of March 2, 1907, the annual appropriation for operating snag boats on the upper Mississippi River was made available for similar purposes on the Illinois River from its mouth to Copperas Creek.

By river and harbor act of March 3, 1909, the annual appropriation for operating snag boats was also made available for similar purposes on the Minnesota River and other tributaries of the upper Mississippi River now or heretofore improved by the United States. This act extends the snag-boat jurisdiction on the Illinois River from Copperas Creek to La Salle, and on the Minnesota, the St. Croix, Chippewa, Wisconsin, Black, Galena, and Rock rivers.

During the past fiscal year the snag boat *David Tipton* was employed from July 1 to December 12, 1909, and from April 1 to June 30, 1910, in removing snags and other obstructions and otherwise assisting the interests of navigation in the Mississippi River between Minneapolis and the mouth of Missouri River, in the Illinois River from its mouth to La Salle, and in the Minnesota and Illinois rivers.

The total amount expended for snag-boat service to June 30, 1910, is $1,074,584.

The total quantity of freight transported on the upper Mississippi River during the calendar year 1909 was about 1,916,904 short tons and the ton-miles 131,290,621; in 1908, 2,581,587 short tons and 227,761,355 ton-miles. The decrease in freight tonnage is principally due to the decline of business in logs and lumber.

The amount expended during the fiscal year ending June 30, 1910, was $25,000.

(See Appendix Y 1.)

[a] Exclusive of the balance unexpended July 1, 1910.

1911
(Do not have App X2)

an obstructive and dangerous rock lying in midchannel about 1 mile below Commerce, Mo., and about one-half of the necessary work was accomplished. During the past fiscal year no funds for the removal of obstructions were thus expended, but the work was continued under the appropriation for general improvement of the river between the mouths of the Missouri and Ohio Rivers.

For information as to the commerce benefited by work under this appropriation, reference should be made to the commercial statistics in the report upon improving the Mississippi River between the Ohio and Missouri Rivers and in the reports of the Mississippi River Commission and the district officers thereunder.

The amount expended during the year was $103,157.94.

(See Appendix X 1.)

2. Mississippi River between Ohio and Missouri Rivers.—In its original condition, prior to any improvement, the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which a considerable part of the volume of the flow was diverted, to the detriment of navigation.

The first systematic effort to improve this condition was begun by the Federal Government in 1872, and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone to confine the low-water volume to a single channel and of revetments to hold and preserve the banks where necessary or advisable.

The project followed in later years to the present time has been practically that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, which sought to obtain eventually within the district, at standard low water, a minimum navigable channel depth of 6 feet above St. Louis and 8 feet below that city by confining 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 secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river, the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent improvement, the required low-water channel depth should be maintained each season by the use of dredges and other temporary expedients.

The river and harbor act of March 3, 1905, radically changed the project by limiting work of improvement to dredging only, adopting one of the recommendations of the board of engineers, November 12, 1903, to the exclusion of the others. The recommendation of the board fixed the channel depth to be obtained at 8 feet for the river reach below St. Louis, with a minimum width of 200 feet.

This change in plan was modified by joint resolution of Congress, June 29, 1906, authorizing, after all dredging expenses were provided for, the application of the balance of funds remaining to the credit

of the appropriation of 1905 to the repair or completion of improvements under the former projects or to the construction of other works useful to navigation.

The river and harbor act of March 2, 1907, confirmed the change of plan to dredging and temporary expedients as principal means of channel improvement and limited expenditure for works of permanent character, first, to the maintenance and repair of works already constructed, and thereafter, with any funds remaining, to the construction of other works of channel regulation; but the small amounts appropriated yearly under this act almost preclude extension of the existing system of permanent works.

The river and harbor act approved June 25, 1910, restored the plan adopted in 1881, together with dredging, as the plan to be followed in prosecuting the improvement, with a view to its completion within a period of 12 years.

The report of the special board on examination and survey of the Mississippi River from the Lakes to the Gulf, March 20, 1909, which virtually recommended the early completion of the 1881 project as indorsed and modified by the 1903 board, put the cost of such completion at $21,000,000, in addition to all amounts already expended. Of this sum $750,000 was appropriated in the river and harbor and sundry civil acts of June 25, 1910, and $1,000,000 in the river and harbor act of February 27, 1911, leaving the balance yet to be appropriated $19,250,000.

The object of the previous and present plans of improvement is, therefore, to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

The amount expended to June 30, 1911, was $12,329,890.72, exclusive of $180,000 allotted by acts to projects for improvement between the Illinois and Missouri Rivers, including Alton Harbor, and of $1,400,000 for methods of improvement under the acts of 1905 and 1907.

The result of the expenditure of this amount has been the partial permanent improvement of the entire extent of the river from St. Louis to Cairo, and during recent years practically the maintenance of the channel depths required.

The improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

The new appropriation asked for is the estimated expenditure for one year only, and should be followed by such amounts annually as will permit the completion of the improvement within the period specified.

It is proposed to expend the new appropriation asked for in such permanent and temporary improvements as may be necessary and are authorized.

The amount expended during the fiscal year ending June 30, 1911, was $797,450.57; for dredges and dredging, care and increase of plant, and for maintenance and repair of existing works of revetment and contraction, and for the extension of such works of both kinds, in pursuance of the project referred to.

During the past year the river stages have been remarkably low, yet there was maintained a channel depth of 8 feet during the entire season when the river was unobstructed by ice, except for short periods at several places where the depths were reduced to 6½ feet until dredges could be brought into action upon these shoals, when the required depth was quickly obtained.

At Grand Tower, Ill., natural silting up and closing of the chute east of Grand Tower Island had forced the boat channel to the west of that island over a bar of gravel and small bowlders which could not be moved by the suction type of dredges in use. Contract had been made in 1909 for dipper dredging to remove the bowlders and gravel in a channel 200 feet wide across this bar, down to a depth 3 feet below the zero of the Grand Tower gauge. This contract was partly completed during the low-water season of the fall of 1909, but the work was much interrupted by high river stages and finally stopped by winter conditions. The work was resumed and completed during the fall low-water season of the past fiscal year.

The river at St. Louis reached a high-water stage of only 15.9 feet above standard low water (4 feet, St. Louis gauge) February 23, 1911, and a low-water stage of 5.4 feet below standard low water on December 16 and 25, 1910.

With the present appliances and works of permanent improvement, it is expected that a navigable depth of about 8 feet will be maintained between St. Louis and Cairo during all stages of river open to navigation.

July 1, 1910, balance unexpended		$782,559.83
Amount appropriated by river and harbor act approved Feb. 27, 1911		1,000,000.00
Miscellaneous receipts		10,452.86
		1,793,012.69
June 30, 1911, amount expended during fiscal year:		
For works of improvement	$303,031.21	
For maintenance of improvement	494,419.36	
		[1]797,450.57
July 1, 1911, balance unexpended		995,562.12
July 1, 1911, outstanding liabilities		34,736.97
July 1, 1911, balance available		960,825.15
July 1, 1911, amount covered by uncompleted contracts		305,666.06
Amount (estimated) required to be appropriated for completion of existing project		[2]19,250,000.00
Amount required for expenditure in fiscal year ending June 30, 1913, for works of improvement and for maintenance		[2]1,000,000.00

(See Appendix X 2.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILL., DISTRICT.

This district was in the charge of Maj. Charles Keller, Corps of Engineers. Division engineer, Col. W. L. Fisk, Corps of Engi-

[1] Deduct $244.47 expended in June, 1911, on account of inspections for the Isthmian Canal Commission, which had not been refunded at the end of the fiscal year, leaving net amount of $797,206.10, expended upon the improvement.
[2] Exclusive of the balance unexpended July 1, 1911.

1912
(Do Not have App. X 2)

War may deem necessary for the removal of snags and other floating and sunken obstructions in the Atchafalaya and Old Rivers from their junction with the Mississippi and Red Rivers down the Atchafalaya River as far as Melville, La.

No modification of the project has been made since its adoption, the plan being continuous, and new obstructions being brought down by each freshet in the river. So much of the continuous appropriation as may be required each year hereafter will be applied to their removal.

The amount expended upon this work prior to June 30, 1872, can not now be ascertained, for the reason that during that time and to March 3, 1879, appropriations were made in lump sums, principally under the title "Improvement of Mississippi, Missouri, and Arkansas Rivers," to be applied to the several streams as their needs or the terms of the law required. The available records do not show the amount applied to each stream.

The approximate amount expended from July 1, 1872, to June 30, 1880, was $493,437.23, and the definitely known amount expended from July 1, 1880, to June 30, 1912, was $2,501,896.41, making the total of approximate and known expenditures to date $2,995,333.64.

From March 28, 1868 (the earliest available record of work done), to June 30, 1912, 104,949 snags, 139 wrecks, and 670 drift piles were destroyed, and 449,073 trees were cut, greatly improving the river and lessening the dangers of navigation.

During the fiscal year two steel-hull snagboats were engaged in removing such obstructions between the mouth of the Missouri River and New Orleans, La., and Old River and the Atchafalaya to Melville, La., a total distance of about 1,200 miles; 1,517 snags, 11 drift piles, and 14 wrecks were destroyed, 1,698 trees were cut, and 10,147 miles patrolled.

During 1908–1910 part of the funds appropriated for the removal of obstructions was expended for the removal of Beaver Dam Rock, an obstructive and dangerous rock lying in midchannel about 1 mile below Commerce, Mo., and about one-half of the necessary work was accomplished. During the fiscal year 1911 the work was completed, except for the removal of débris from the shattered rock, under the appropriation for general improvement of the river between the mouths of the Ohio and Missouri Rivers.

For information as to the commerce benefited by work under this appropriation reference should be made to the commercial statistics in the report of the district officer upon improving the Mississippi River between the Ohio and Missouri Rivers and in the reports of the Mississippi River Commission and the district officers thereunder.

The amount expended during the year was $97,978.58.

(See Appendix X 1.)

2. *Mississippi River between Ohio and Missouri Rivers.*—In its original condition, prior to any improvement, the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which a considerable part of the volume of the flow was diverted, to the detriment of navigation.

The first systematic effort to improve this condition was begun by the Federal Government in 1872, and was continued for a number of years as appropriations were made, the works of improvement consisting of dikes and dams of brush and stone to confine the low-water volume to a single channel and of revetments to hold and preserve the banks where necessary or advisable.

The project followed in later years to the present time has been practically that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, which sought to obtain eventually within the district, at standard low water, a minimum navigable channel depth of 6 feet above St. Louis and 8 feet below that city by confining 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 secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river, the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency. Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent improvement, the required low-water channel depth should be maintained each season by the use of dredges and other temporary expedients.

The river and harbor act of March 3, 1905, radically changed the project by limiting work of improvement to dredging only, adopting one of the recommendations of the board of engineers, November 12, 1903, to the exclusion of the others. The recommendation of the board fixed the channel depth to be obtained at 8 feet for the river reach below St. Louis, with a minimum width of 200 feet.

This change in plan was modified by joint resolution of Congress, June 29, 1906, authorizing, after all dredging expenses were provided for, the application of the balance of funds remaining to the credit of the appropriation of 1905 to the repair or completion of improvements under the former projects or to the construction of other works useful to navigation.

The river and harbor act of March 2, 1907, confirmed the change of plan to dredging and temporary expedients as principal means of channel improvement and limited expenditure for works of permanent character, first, to the maintenance and repair of works already constructed, and thereafter, with any funds remaining, to the construction of other works of channel regulation; but the small amounts appropriated yearly under this act almost precluded extension of the existing system of permanent works.

The river and harbor act approved June 25, 1910, restored the plan adopted in 1881, together with dredging, as the plan to be followed in prosecuting the improvement, with a view to its completion within a period of 12 years.

The report of the special board on examination and survey of the Mississippi River from the Lakes to the Gulf, March 20, 1909, which virtually recommended the early completion of the 1881 project as indorsed and modified by the 1903 board, put the cost of such completion at $21,000,000, in addition to all amounts already expended. Of this sum $2,750,000 has been appropriated in the river and harbor

and sundry civil acts of 1910, 1911, and 1912, leaving the balance yet to be appropriated $18,250,000.

The object of the previous and present plans of improvement is, therefore, to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

References to examination or survey reports and maps or plans not in project documents.

Section covered.	Congressional documents.				Annual reports of Chief of Engineers.	
	House or Senate.	No.	Congress.	Session.	Year.	Page.
Between Missouri and Ohio Rivers [1]	House	168	Fifty-eighth	Second	1904	2144 et seq.
St. Louis to mouth of Mississippi River [2]	do	50	Sixty-first	First		

[1] No maps. [2] Contains maps.

The total amount appropriated to June 30, 1912, is $14,894,999.98, of which $180,000 was alloted by acts and projects for improvement between the mouths of the Illinois and Missouri Rivers, including Alton Harbor, $10,000 was allotted for Wittenberg, Mo., and $1,400,000 was for methods of improvement under the acts of 1905, 1907, 1908 and 1909.

The total amount expended to June 30, 1912, for improvement between the Ohio and Missouri Rivers, project of 1881, is $13,364,269.50. The $10,000 for Wittenberg, Mo., was carried to the surplus fund.

The balance unexpended June 30, 1912, is $22,680.52.

The result of the expenditure of this amount has been the partial permanent improvement of the entire extent of the river from St. Louis to Cairo, and during recent years practically the maintenance of the channel depths required.

The improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

The new appropriation asked for is the estimated expenditure for one year only, and should be followed by such amounts annually as will permit the completion of the improvement within the period specified.

It is proposed to expend the new appropriation asked for in such permanent and temporary improvements as may be necessary and are authorized.

The amount expended by vouchers and by the auditor during the fiscal year ending June 30, 1912, was $978,055.12, which includes $18,322.63, expended for other appropriations for which reimbursements are pending, leaving $959,732.49 expended on the improvement; for dredges and dredging, care and increase of plant, and for maintenance and repair of existing works of revetment and contraction, and for the extension of such works of both kinds, in pursuance of the project referred to.

During the past year the river stages have been favorable, and there was maintained a channel depth of 8 feet below St. Louis during the entire season when the river was unobstructed by ice, except for very short periods at two places where the depths were reduced to 6 feet until dredges could be brought into action, when the required depth was quickly obtained.

At Grand Tower, Ill., natural silting up and closing of the channel east of Grand Tower Island had forced the boat channel to the west of that island over a bar of gravel and bowlders which could not be moved by the suction dredges in use. A channel 200 feet wide, down to a depth of 3 feet below the zero of the Grand Tower gauge, had been made across this bar under contract during the fiscal year 1910–11, but during the abnormally low-water season of 1910, the channel proved to be of insufficient width and depth on account of outcropping bowlders, and it was decided to widen the channel to 300 feet and deepen it to 5 feet below the zero of the gauge. The enlarged channel was about one-half completed during the fall season, using a dipper dredge borrowed from the Rock Island engineer district.

During the fiscal year the river at St. Louis reached a high-water stage of 26.8 feet above standard low water (4 feet, St. Louis gauge) April 6, 1912, and a low-water stage of 2.0 feet below standard low water on January 8, 1912.

With the present appliances and works of permanent improvement, it is expected that a navigable depth of about 8 feet will be maintained between St. Louis and Cairo during all stages of river open to navigation.

July 1, 1911, balance unexpended		$995,562.[illegible]
Miscellaneous receipts		5,173.[illegible]
		1,000,735.[illegible]
June 30, 1912, amount expended during fiscal year:		
For works of improvement	$674,858.04	
For maintenance of improvement	303,197.08	
		978,055.[illegible]
July 1, 1912, balance unexpended		22,680.[illegible]
July 1, 1912, outstanding liabilities		9,064.[illegible]
July 1, 1912, balance available		13,616.[illegible]
Amount appropriated by river and harbor act approved July 25, 1912		1,000,000.00
Amount available for fiscal year ending June 30, 1913		1,013,616.[illegible]
Amount (estimated) required to be appropriated for completion of existing project		[1] 18,250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1914, for works of improvement and for maintenance		[1] 1,000,000.00

(See Appendix X 2.)

EXAMINATION AND SURVEY REQUIRED BY RIVER AND HARBOR ACT APPROVED JUNE 25, 1910.

The local officer was also charged with the duty of making a preliminary examination and survey, respectively, of *Mississippi River*

[1] Exclusive of amount available for fiscal year 1913.

1913
(Do Not have App. X 2)

March 3, 1879, appropriations were made in lump sums, principally under the title "Improvement of Mississippi, Missouri, and Arkansas Rivers," to be applied to the several streams as their needs or the terms of the law required. The available records do not show the amount applied to each stream.

The approximate amount expended from July 1, 1872, to June 30, 1880, was $493,437.23, and the definitely known amount expended from July 1, 1880, to June 30, 1913, was $2,603,338.84, making the total of approximate and known expenditures to date, $3,096,776.07.

For information as to the commerce benefited by work under this appropriation reference should be made to the commercial statistics in the report of the district officer upon improving the Mississippi River between the Ohio and Missouri Rivers and in the reports of the Mississippi River Commission and the district officers thereunder.

The plan being continuous, and new obstructions being brought down by each freshet in the river, so much of the continuous appropriation as may be required each year hereafter will be applied to their removal.

The amount expended during the year was $101,442.43.

(See Appendix X 1.)

2. Mississippi River between Ohio and Missouri Rivers.—In its original condition, prior to any improvement, the navigable channel of this section of the Mississippi River had a natural depth in many places of only 3½ to 4 feet at low water. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which a considerable part of the volume of the low-water flow was diverted, to the detriment of navigation.

The first systematic effort to improve this condition was begun by the Federal Government in 1872, and was continued for a number of years as appropriations were made, the works of improvement consisting of solid dikes and dams of brush and stone to confine the low-water volume to a single channel and of revetments to hold and preserve the banks where necessary or advisable. The amount expended on this project was $1,495,000.

The project followed in later years to the present time has been practically that adopted in 1881, approved by letter of the Chief of Engineers dated March 31, 1881, which sought to obtain eventually within the district, at standard low water, a minimum navigable channel depth of 6 feet above St. Louis and 8 feet below that city by confining 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, this result to be secured by closing sloughs and secondary channels and by building out new banks where the natural width is excessive, using for the purpose permeable dikes or hurdles of piling to collect and hold the solid matter carried in suspension or rolled on the bottom by the river, the banks, both new and old, to be revetted or otherwise protected where necessary to secure permanency.

Modifications of the project in the river and harbor acts of 1896 and 1902 provided that, pending the completion of the permanent

improvement, the required low-water channel depth should be maintained each season by the use of dredges and other temporary expedients.

The river and harbor acts of March 3, 1905, and March 2, 1907, and joint resolution of June 29, 1906, radically changed the project, making dredging the principal means of improvement to maintain a channel depth of 8 feet, with a minimum width of 200 feet throughout this district, and limiting expenditures for the construction or repair of works of permanent character to the balances which might remain from the various appropriations after all dredging expenses were provided for.

There were expended for methods of improvement under the acts of 1905, 1907, 1908, and 1909, inclusive, $1,400,000.

The river and harbor act approved June 25, 1910, restored the plan adopted in 1881, together with dredging, as the plan to be followed in prosecuting the improvement with a view to obtaining and maintaining a minimum depth of 8 feet from the mouth of the Ohio River to St. Louis, and of 6 feet from St. Louis to the mouth of the Missouri River, and to the completion of the improvement within a period of 12 years.

In the river and harbor and sundry civil acts of 1910 to 1913, inclusive, there has been appropriated $3,750,000.

The object of the previous and present plans of improvement is, therefore, to obtain and maintain a minimum depth at standard low water of 6 feet from the mouth of the Missouri to St. Louis and of 8 feet from St. Louis to the mouth of the Ohio.

References to examination or survey reports and maps or plans (including project documents).

Section covered.	Date of report.	Congressional documents.				Annual reports of Chief of Engineers.	
		House or Senate.	No.	Congress.	Session.	Year.	Page.
Mississippi River from Alton to mouth of Meramec River (survey).[1]	Feb. 17, 1871	.....	.....	.....	.....	1871	312
Reopening Cabaret Slough in the Mississippi River a short distance above the city of St. Louis (survey).[1]	Oct. 2, 1871	Senate..	10	Forty-first....	Third...	1872	349
Mississippi River opposite the mouth of the Missouri River (survey).[1]	Feb. 8, 1872	.....	.....	.....	.....	1872	355
Mississippi River between mouth of the Illinois and Meramec Rivers (survey) (Board of Engineers).[1]	Apr. 13, 1872	.....	.....	.....	.....	1872	358
Mississippi River from Kimmswick to Cairo (survey).[1]	Dec. 18, 1872	.....	25	Forty-second..	Third...	1873	460
Mississippi River, Missouri to Ohio River (survey).[1]	Aug. 1, 1874	.....	.....	.....	.....	1874	339, Pt. I
Mississippi River, Illinois to Ohio (survey).[1]	Jan. 20, 1875	Senate..	19, Pt. III	Forty-third...	Second..	1875	451, Pt. I

[1] No maps.

References to examination or survey reports and maps or plans, etc.—Continued.

Section covered.	Date of report.	Congressional documents.				Annual reports of Chief of Engineers.	
		House or Senate.	No.	Congress.	Session.	Year.	Page.
Improvement of the channel of the Mississippi River opposite St. Louis by closing Cahokia Chute.[1]	Jan. 23, 1875	House...	165	Forty-third...	Second..	1875	497, Pt. I
Mississippi River near Kaskaskia, Ill. (survey).[1]	Apr. 28, 1876	.....	.....	.....	.....	1876	649, Pt. I
Mississippi River in the vicinity of Cairo (survey).[1]	Feb. 5, 1876	.....	.....	.....	.....	1876	651, Pt. I
Survey and estimate of the damages to riparian owners in front of the town of Venice, Ill., by reason of Government improvement made or to be made at or near said town.[1]	Apr. 10, 1878	Senate..	20	Forty-sixth...	Second..	1880	1396
Survey of the Mississippi River to ascertain the practicability, cost, and utility of a dike from Bloody Island opposite the city of St. Louis, Mo., north to the dike or dam opposite Brooklyn on the Illinois shore (survey).[1]	Feb. 8, 1879	.....	.....	.....	.....	1879	1045
Survey of the Mississippi River opposite the mouth of the Missouri River (survey).[1]	Mar. 25, 1880	.....	145	Forty-sixth...	Second..	1880	1400
Ice harbor at St. Louis, Mo.[2]	Aug. 16, 1880	Senate..	43	.....do.....	Third...	1881	1574
Mississippi River near Cape Girardeau, Mo., and Minton Point, Ill. (survey).[1]	Jan. 12, 1881	.....	.....	.....	.....	1881	1585
Mississippi River at Ste. Genevieve, Mo. (survey).[1]	Dec. 6, 1880	Senate..	44	Forty-sixth...	Third...	1881	1594
Mississippi River—Fish Bend near Fort Chartres in the Mississippi River (preliminary).[1]	Dec. 31, 1881	...do....	76	Forty-seventh	First....	1882	1670
Preliminary examination of Mississippi River at Rush Island Bend and Ivy Landing, Ill., with a view to confining and deepening the channel.[1]	Feb. 24, 1888	House...	216	Fiftieth.....	...do....	1888	1452
Harbor at St. Louis, Mo.[1]...	Dec. 22, 1888	.....	.....	.....	.....	1889	1711
Examination and survey of Mississippi River below Rockwood, Ill.[2]	Oct. 4, 1899	House...	85	Fifty-sixth....	First....	1900	2667
Examination and survey of Mississippi River at or near Beechridge, Ill.[2]	Sept. 1, 1899	...do	90	.....do.....	...do....	1900	2672
Preliminary examination of Harrisonville Harbor, Ill., in the Mississippi River, with a view to restoring it.[1]	Aug. 31, 1900	...do....	71	.....do.....	Second..	1901	2226
Establishment of harbor lines along the Mississippi River at and near St. Louis, Mo.[1]	Mar. 6, 1903	.....	.....	.....	.....	1903	1455
Board of Engineers for Rivers and Harbors relative to establishing and maintaining in the Mississippi River, between the mouths of the Missouri and Ohio Rivers, a suitable channel at less expense than that under the existing project.[3]	Nov. 12, 1903	House...	168	Fifty-eighth...	Second..	1904	2145

[1] No maps. [2] Contains maps. [3] Basis of project adopted by Congress.

References to examination or survey reports and maps or plans, etc.—Continued.

Section covered.	Date of report.	Congressional documents.				Annual reports of Chief of Engineers.	
		House or Senate.	No.	Congress.	Session.	Year.	Page.
Preliminary examination of Missouri Chute with a view to ascertaining whether the closing of the same is required in the interest of navigation.[1]	Sept. 11, 1902	House..	76	Fifty-eighth..	Second..	1904	2150
Examination and survey of St. Louis Harbor and approaches.[1]	Dec. 2, 1905	...do....	772	Fifty-ninth...	First....	1906	464
14-foot waterway from Lockport, Ill., to St. Louis.[2]	Aug. 26, 1905	...do....	263	.....do.....	...do....	1906 1907	862 812
Do.[1]	Dec. 8, 1906	...do....	437	.....do.....	Second..	1908 1907	862 812
Do.[2 3]	Mar. 20, 1909	...do....	50	Sixty-first.....	First....	1910 1909	1014 908
Mississippi River, Ill., opposite the city of St. Louis, from the south end of Cabaret Island to the north end of Arsenal Island for the purpose of building a suitable channel by revetment of the banks (survey).[1]	Nov. 4, 1911	...do....	1059	Sixty-second..	Third...	.....	.....
Do. (preliminary examination.[1]	Sept. 15, 1910	...do....	1059	.....do.....	...do....	.....	.....
TRIBUTARIES.							
Examination of Meramec River from mouth to point opposite Meramec Iron Works (preliminary).[3]	Dec. 1, 1880	Senate..	44	Forty-sixth...	Third...	1881	1806
Preliminary examination of Kaskaskia River, Ill., from New Athens to its mouth (survey).[1]	Feb. 24, 1888	House...	216	Fiftieth.....	First....	1888	1453

[1] No maps. [2] Contains maps. [3] Basis of project adopted by Congress.

During the fiscal year works of permanent improvement were in progress August 7, 1912, to December 20, 1912, and April 14, 1913, to June 30, 1913. The amounts and varieties of work done are shown in the following table:

For channel contraction.

Permeable dikes or hurdles:		
New	linear feet	5,059
Completion or restoration	do	2,105
Ordinary repairs	do	2,283
Total	do	9,447
Cost		$254,279.48

Bank protection.

Mattress:		
New (10,545 linear feet)	square feet	1,379,725
Completion or restoration	do	361,500
Total	do	1,738,225
Cost		$135,992.40

Paving:		
New	square feet	1,141,515
Ordinary repairs	do	151,350
Total		1,292,865
Cost		$146,608.30

Four suction dredges were in commission during the low-water season between August 1, 1912, and December 23, 1912, and operated on 19 channel bars which developed in that time. The amount and cost of work done by each dredge is shown in the following table:

Dredge.	Time.			Amount dredged.		Cost.
	In commission (days).	Dredging.		Per hour average (cubic yards).	Total (cubic yards).	
		Days.	Hours.			
Selma	121	27	200	740	147,700	$28,392.89
Thebes	140	30	332	460	150,300	29,318.91
Fort Gage	170	66	801	660	526,200	40,260.41
Fort Chartres	145	19	182	1,400	255,300	43,314.67
Total	576	142	1,515	.....	1,079,500	141,286.88

The total amount appropriated for this district to June 30, 1913, is $16,894,999.98, of which $13,819,999.98 was available for improvement under the project of 1881 and its revisions. The amount expended to June 30, 1913, on these projects was $12,436,773.51. Amount received from sales and miscellaneous sources, $104,216.59.

Amount expended during fiscal year	$659,852.96
Reimbursable	14,896.11
Net expenditures	644,956.85
Amount applied to maintenance of improvement, repairs, and dredging	291,037.51

The balance unexpended June 30, 1913, is $1,383,226.47; outstanding liabilities, $77,547.93, leaving $1,305,678.54, which, adding $14,896.11 to be refunded from other appropriations, makes $1,320,574.65 available June 30, 1913.

The result of the expenditure of this amount has been the partial permanent improvement of the entire extent of the river from St. Louis to Cairo, and during recent years practically the maintenance of the channel depths required.

At the end of the fiscal year 30 per cent of the project had been completed. The river is navigable throughout its entire length (200 miles) within the district. The least draft over the shoalest part has been increased about 4 feet, from a minimum of 4 feet at the beginning of the improvement to 8 feet, the minimum draft at the end of the fiscal year and the project requirement at standard low water (4 feet, St. Louis gauge).

The amount, character, and value of the river commerce at St. Louis, Mo., during the calendar year 1912 is as follows: 265,720 short tons, composed of live stock, grain and feed, groceries and provisions, fruits and vegetables, tobacco, boots and shoes, coal, cotton, lumber, merchandise, and sundries, having a total value of $12,621,810.

The improvement has probably had a beneficial influence on freight rates, as the rates to localities reached by water are well known to be lower than those remote from this advantage, but an accurate estimation of such effect is impracticable.

The new appropriation asked for is the estimated expenditure for one year only, and should be followed by such amounts annually as will permit the completion of the improvement within the period specified.

It is proposed to expend the new appropriation asked for in such permanent and temporary improvements as may be necessary and are authorized.

The amount expended during the fiscal year ending June 30, 1913, was for improvement, dredging, care and increase of plant, and for maintenance and repair of existing works of revetment and contraction, and for the extension of such works of both kinds, in pursuance of the project referred to.

During the past year the river stages have been favorable, and there was maintained a channel depth of 8 feet below St. Louis during the entire season when the river was unobstructed by ice, except for very short periods at several places where the depths were reduced to not less than 6 feet until dredges could be brought into action, when the required depth was quickly obtained.

During the fiscal year the river at St. Louis reached a high-water stage of 23.2 feet above standard low water (4 feet, St. Louis gauge) April 16–17, 1913, and a low-water stage of 5.4 feet below standard low water on January 14, 1913.

With the present appliances and works of permanent improvement, it is expected that a navigable depth of about 8 feet will be maintained between St. Louis and Cairo during all stages of river open to navigation.

July 1, 1912, balance unexpended		$22,680.52
Amount appropriated by river and harbor act approved July 25, 1912		1,000,000.00
Amount appropriated by river and harbor act approved Mar. 4, 1913		1,000,000.00
Miscellaneous receipts		20,398.91
		2,043,079.43
June 30, 1913, amount expended during fiscal year	$659,852.96	
Reimbursable	14,896.11	
Net expenditures	644,956.85	
For works of improvement	353,919.34	
For maintenance of improvement	291,037.51	
		[1] 644,956.85
July 1, 1913, balance unexpended		1,398,122.58
July 1, 1913, outstanding liabilities		77,547.93
July 1, 1913, balance available		1,320,574.65

[1] Net cash expenditures for the fiscal year ending June 30, 1913:

Construction work	$238,841.54
Plant	115,077.80
Repair and maintenance	163,151.10
Dredging	127,886.41
Total	644,956.85

July 1, 1913, amount covered by uncompleted contracts	$193,993.44
Amount (estimated) required to be appropriated for completion of existing project	[1] 17,250,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1915, for works of improvement and for maintenance	[1] 1,000,000.00

(See Appendix X 2.)

EXAMINATION AND SURVEY MADE IN COMPLIANCE WITH RIVER AND HARBOR ACT APPROVED JUNE 25, 1910.

Reports dated September 15, 1910, and November 4, 1911, on preliminary examination and survey, respectively, of *Mississippi River opposite the city of St. Louis, from the south end of Cabaret Island to the north end of Arsenal Island, for the purpose of providing a suitable channel by revetment of the bank*, required by the river and harbor act approved June 25, 1910, were duly submitted by the district officer. They were reviewed by the Board of Engineers for Rivers and Harbors, pursuant to law, and were transmitted to Congress and printed in House Document No. 1059, Sixty-second Congress, third session. The improvement of this locality by the United States in the manner proposed is not deemed advisable at the present time.

IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILL., DISTRICT.

This district was in charge of Maj. Charles Keller, Corps of Engineers. Division engineers: Lieut. Col. Charles L. Potter to August 23, 1912, and Col. C. McD. Townsend from that date to end of fiscal year.

1. Operating snag boats and dredge boats on upper Mississippi River and tributaries.—By the river and harbor act of August 11, 1888, provision was made for securing the uninterrupted work of snag boats and dredge boats on the upper Mississippi River under a permanent appropriation, the sum so expended not to exceed $25,000 annually.

By river and harbor act of March 2, 1907, the annual appropriation for operating snag boats on the upper Mississippi River was made available for similar purposes on the Illinois River from its mouth to Copperas Creek.

By river and harbor act of March 3, 1909, the annual appropriation for operating snag boats was also made available for similar purposes on the Minnesota River and other tributaries of the upper Mississippi River now or heretofore improved by the United States. This act extends the snag-boat jurisdiction on the Illinois River from Copperas Creek to La Salle, and on the Minnesota, the St. Croix, Chippewa, Wisconsin, Black, Galena, and Rock Rivers.

During the past fiscal year the snag boat *David Tipton* was employed from July 1 to November 9, 1912, and from April 17 to June 30, 1913, in removing snags and other obstructions and otherwise assisting the interests of navigation in the Mississippi River between the mouth of the Missouri River and Minneapolis.

[1] Exclusive of the balance unexpended July 1, 1913.

1914
(ONLY have App. X2)

X 2.

IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

PROJECT OF 1881, REVISED IN 1883, 1903, AND 1905, AND RESTORED 1910.

A concise statement of the project for and history of this work will be found in the Annual Report of the Chief of Engineers for 1906, page 462, as well as on page 2631 of the Report of the Chief of Engineers for 1900.

Reference should be made to the Report of the Chief of Engineers. 1894, pages 1577 et seq., for the development of the various forms of construction and for a résumé of the types employed between 1872 and 1894, and to the Reports of the Chief of Engineers for 1895, page 2059; 1896, page 1717; 1897, page 2012; 1898, page 1698; 1900, page 2632; and 1901, page 2169, for minor details of construction.

The project adopted for the permanent improvement of the Mississippi River between the mouths of the Ohio and Missouri Rivers was approved by the Chief of Engineers, March 31, 1881. The project was modified June 3, 1896, to permit the construction and operation of dredges. It was again modified in 1903 by the Board of Engineers for Rivers and Harbors in report dated November 12, 1903, and the dredging recommendation of the board was adopted by Congress in the river and harbor act of March 3, 1905, as the principal means of improvement. In the river and harbor act approved June 25, 1910, the plan of 1881 and dredging was reverted to as the plan to be followed with a view to completion of the improvement within 12 years.

The estimate of cost as revised in 1883 was $16,397,500.

By the board report of 1903 the estimate of cost was increased $20,000,000 in addition to expenditures, $10,476,654.53, already made, provided the projects in force were to be adhered to throughout. The report, March 20, 1909, of the Board on Examination and Survey of Mississippi River from the Lakes to the Gulf put the cost of completion of the project of 1881 at $21,000,000, adding $1,000,000 to the estimate of the 1903 board to compensate for deterioration of permanent works during years in which there had been no funds available for their repair.

The river and harbor and sundry civil acts of 1910 to 1913, inclusive, appropriated $3,750,000, leaving a balance of $17,250,000 to be appropriated to complete the project in accordance with the estimate of 1909.

The total amount appropriated to June 30, 1914, is $16,894,999.98; $13,819,999.98 of this was available for improvement under the project of 1881 and its revisions. The amount expended to June 30, 1914, was $13,443,662.43.

The balance unexpended June 30, 1914, is $376,337.55 (which includes $601.01 due from other appropriations); $74,005.49 is covered by outstanding liabilities, which leaves $302,332.06 available June 30, 1914.

The amount expended by vouchers was $1,012,895.78, and by the auditor $5.47, a total of $1,012,901.25 during the fiscal year, which

includes $1,873.77 expended for other appropriations, leaving a net expenditure of $1,011,027.48 on the improvement.

The work is being done by hired labor with Government plant, and procurement of materials by hired labor, and by purchase by contract and in open market.

Since the adoption of the project, work has been done substantially according to the methods referred to at the following localities within the present district:

Mouth of Missouri River, Sawyer Bend, Venice, St. Louis Harbor, Cahokia Chute, Arsenal Island, Horsetail Bar, Carroll Island, Twin Hollows, Pulltight, Beard Island, Meramec River, Chesley Island, Jim Smiths, Sulphur Springs, Foster Island, Lucas, Herculaneum, Calico Island, Cornice Island, James Landing, Osborne Field, Michaels Landing, Fish Bend, Danby Landing, Rush Towhead, Penitentiary Point, Sycamore Landing, Fort Chartres, Bruce Island, Crooks, Turkey Island, Ste. Genevieve, Kaskaskia Island, Chester, Horse Island, Claryville, Crain Island, Liberty Island, Liberty Bend, Wilkinson, Lacour Island, Grand Tower, Union Point, Crawford, Hanging Dog Island, Willard, Hamburg, Devils Island, Minton Point, Cape Girardeau, East Cape Girardeau, Commerce Island, Burnham Island, Beaver Dam Rock, Powers Island, Goose Island, Philadelphia Point, Commercial Point, Price Landing, Buffalo Island, Dogtooth Bend, Greenleaf Bend, Beechridge, Hurricane Field, Eliza Towhead, Cairo, Eliza Point, and Greenfield Bend.

WORKS OF IMPROVEMENT.

The standard forms of construction were used.

During the fiscal year, works of permanent improvement were in progress July 1, 1913, to January 5, 1914, and April 1, 1914, to June 30, 1914, as hereinafter described at Mouth of Missouri River, Sawyer Bend, Twin Hollows, Pulltight, Sulphur Springs, James Landing, Osborne Field, Fort Chartres, Turkey Island, Ste. Genevieve, Kaskaskia Island, Horse Island, Crain Island, Liberty, Wilkinson, Lacour Island, Union Point, Hanging Dog Island, Willard, Devils Island, Minton Point, Price Landing, Beechridge, Eliza Point, and Greenfield Bend.

These localities are shown on the accompanying plates, 1–4.[1]

The four suction dredges under this office were in commission during the low-water season from July 7, 1913, to December 31, 1913, and were operated on 19 channel bars which developed in that time, and in addition, when not needed in the main channel, at the landing of the Independent Stock Yards Co., St. Louis, at the winter harbors for vessels of this engineer district at the engineer depot, St. Louis, and Bushberg, Mo., and in hydraulic grading for bank paving at Fort Chartres, East, Crain Island, Mo., Devils Island, Ill., and Eliza Point, Ill.

Surveys were made of all dredged channels and shoal crossings, caving banks, and harbor encroachments.

River gauges were maintained and read throughout the year, and were inspected and repaired as was necessary.

The plant was repaired and cared for at the engineer depot, St. Louis, and in fleets at Establishment Island, Mo., and Fayville, Ill.;

[1] Not printed.

the six new steel hulls purchased under contract during 1913 were completed by hired labor into four steam hammer pile drivers and two hydraulic grading and derrick boats, by assemblage and installation of machinery and steam plant.

Materials were procured by contract and open-market purchase and by hired labor, as was deemed most advantageous to the department.

The engineering operations during the year were executed under the supervision of Mr. William S. Mitchell, assistant engineer, by Messrs. C. D. Lamb, W. M. Penniman, F. Y. Parker, and J. W. Skelly, assistant engineers, and E. C. Constance and Robert G. Wallace, junior engineers.

The office records and accounts were kept by Mr. S. G. Clark, chief clerk, and his assistants.

Reports from assistants, giving details, and accompanied by charts showing the locations of the various works, are on file.

CONSTRUCTION WORKS.

MOUTH OF MISSOURI RIVER, ILL. (15 MILES ABOVE EADS BRIDGE, ST. LOUIS).

[July 1–22, 1913.]

Bank paving, repair, and extension.—Between stations 166 and 176+20 (the lower end of the revetment mattress built in 1904), the stone paving was extended from the elevation of the 24-foot (St. Louis gauge) river stage to the top of the bank (30-foot stage), 36,200 square feet being placed. Between stations 0 and 112, 28,500 square feet of paving were placed in repair.

SAWYER BEND, MO. (7 MILES ABOVE EADS BRIDGE, ST. LOUIS).

[July 22–Oct. 4, 1913.]

Bank paving, repair, and extension.—Between stations —30+85 and 48+71 the paving was extended from the 21-foot stage to the 26-foot stage. Between stations —5+70 and 0+50, where the bank is exposed to severe attack by waves and ice during high river stages, and has twice been denuded of the riprap protection, concrete paving was laid in slabs 10 feet square by 4 inches thick on a foundation of 2 inches of quarry spalls. The proportions of the concrete mixture were 1:3:6. The bank slope was 3 horizontal to 1 vertical, and a total of 143,200 square feet of paving was placed, of which 70,600 square feet was repair work and 17,400 square feet was concrete as referred to.

TWIN HOLLOWS, WEST (14 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 8–Oct. 8, 1913; June 1–3, 1914.]

Hurdles, new and restoration.—The hurdles at this locality, built 1893, have been gradually worn away at their outer or river ends, resulting in considerable widening of the river, and in order to confine the river channel again to the opposite shore four of these hurdles—Nos. 3, 4, 5, and 6—were restored to their original lengths,

and three of them—Nos. 4, 5, and 6—were further extended 260 feet, 360 feet, and 715 feet, respectively. One new hurdle, No. 5½, also was constructed. All were constructed in the usual manner, with bank paving at their shore ends and T-heads at their outer ends. The elevation of the tops of the piling was the 25-foot stage at the shore ends, and on Nos. 3, 5½, and 6 was decreased gradually to the 20-foot stage at the outer ends. The detail lengths of hurdles constructed were as follows:

Hurdle No. 3, restoration.—Total length, 250 feet; T-head length, 40 feet.

Hurdle No. 4, new and restoration.—Total length, 390 feet; new work, 260 feet; restoration, 130 feet; T-head length, 70 feet.

Hurdle No. 5, new and restoration.—Total length, 610 feet; new work, 360 feet; restoration, 250 feet; T-head length, 60 feet.

Hurdle No. 5½, new.—Total length, 780 feet; T-head length, 50 feet.

Hurdle No. 6, new and restoration.—Total length, 940 feet; new work, 715 feet; restoration, 225 feet; T-head length, 50 feet.

Aggregate length of hurdles at this locality, 2,970 feet; new work, 2,115 feet; restoration, 855 feet; in which were placed 2,012 piles, 146 stringers, 275,700 square feet of foundation mattress, and 77,500 square feet of stone paving.

PULLTIGHT, ILL. (16 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Aug. 29–Nov. 8, 1913; May 1–June 30, 1914.]

Hurdles, new, restoration, and repair.—In conformity with the plans decided upon for the rectification of the bank at this locality, begun 1911, hurdles Nos. 1, 2, 4, 5, 6, and 8 were restored or repaired, and new hurdles Nos. 1¼, 3, and 4½ were constructed. Nos. 2 and 4 had been much broken by ice during the winter of 1911–12. The tops of piling in the new work in hurdles Nos. 2, 3, 4, and 8 were sloped from a 20-foot stage at their shore ends to 15-foot stage at their outer ends; Nos. 1, 4½, 5, and 6 are at the 25-foot stage at the shore, Nos. 1 and 4½ sloping to 20-foot at their outer ends.

Hurdle No. 1, repair.—A gap 60 feet wide, near the shore end, was closed, and 65 feet of the hurdle, in addition, were strengthened with pile clumps.

Hurdle No. 1¼, new.—This short-spur hurdle (approximately 200 feet in length) is designed to destroy an eddy and rectify the bank alignment near the head of the bank protection placed in 1911. The foundation mattress only had been finished at the end of the fiscal year.

Hurdle No. 2, restoration and repair.—Total length, 130 feet; T-head length, 40 feet. The restoration was made during the fall season, but because of damage suffered during a high river stage in April repairs were required in the spring also.

Hurdle No. 3, new.—Total length, 380 feet; T-head length, 40 feet.

Hurdle No. 4, restoration.—Total length, 380 feet; T-head length, 30 feet. This work was divided between the fall and spring seasons. The drift collected in the junction between the work of the two sea-

sons was sunk, a light drift mattress, 130 linear feet, being constructed for this purpose.

Hurdle No. 4½, new.—Total length, 1,180 feet; T-head length, 100 feet.

Hurdle No. 5, new and restoration.—Total length, 1,360 feet; new work, 180 feet; restoration, 1,180 feet; 90 per cent complete at the close of the fiscal year, a further extension of 20 feet remaining to be made at a lower river stage.

Hurdle No. 6, new and restoration.—Projected length, 1,410 feet; new work, 400 feet; restoration, 1,010 feet; 60 per cent completed. During the fall season only 530 feet could be built because of low-river stages. In the spring extremely deep water was found for a short distance at the outer end of the hurdle, while beyond and within the limit of the projected hurdle the water was very shoal, both conditions rendering more difficult the mattress construction, which, however, was completed. In order to reduce the extreme depth of water encountered along part of the line to afford better stability to the piling, "cribbed" mattresses, 2½ feet to 3½ feet thick, were placed, through which the piling was driven.

Hurdle No. 8, restoration and repair.—Total length, 650 feet; new work, 285 feet; restoration, 365 feet; T-head length, 60 feet. This work was completed during the fall season, but during the spring 40 feet of the line was repaired where damaged by scour under accumulated drift.

Aggregate length of hurdles constructed at this locality, 5,020 feet; new work, 2,140 feet; restoration, 2,620 feet; repairs, 260 feet. There were placed 4,400 piles, 287 stringers, 661,000 square feet of foundation mattress, and 163,700 square feet of stone paving.

Bank protection, new and repair.—Three small sections of mattress (16,700 square feet) were placed in a large eddy at the downstream end of the revetment mattress placed 1911, and the paving along the entire revetment was extended to the top of the bank, 67,700 square feet being placed.

SULPHUR SPRINGS, ILL. (23 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Oct. 14–Dec. 10, 1913; June 15–30, 1914.]

Hurdles, restoration and repair.—The hurdles at this locality, Nos. 1 to 17, constructed 1887–88, 1895–1897, have been nearly destroyed by erosion of the bank. Excessive depth of water below No. 6 prevented its complete restoration, but by removal of a dry bar by dredge *Selma*, in front of No. 5, the restoration of the latter hurdle was accomplished. Hurdles Nos. 9 and 12 were partially restored.

Hurdle No. 5, restoration.—Total length, 1,015 feet; T-head length, 75 feet; elevation of piling, 23-foot stage at the shore end, sloping to 15-foot stage at outer end.

Hurdle No. 9, repair.—To check bank caving in progress at the shore end of this hurdle, the shore mattress was made unusually long—640 feet—and the water being excessively deep, further restoration of this line was not attempted, but two short spur hurdles were placed in large eddies near by to prevent further destruction of the bank in the vicinity.

Hurdle No. 12, restoration and repair.—Total length, 350 feet. The shore mattress was made unusually long, extending 380 feet above the hurdle line. No other work was attempted.

Aggregate length of hurdles, 1,365 feet, in which were placed 1,285 piles, 96 stringers, 295,200 square feet of foundation mattress, and 36,400 square feet of stone paving.

Bank protection, new.—In order to prevent further destruction of hurdles Nos. 10½ and 11, two sections of bank mattress, total length, 1,005 feet (128,600 square feet), were placed. The bank was paved to the 22-foot stage, 57,000 square feet being placed. In the spring, to check an eddy, a spur hurdle 175 feet in length was constructed, 39 piles and 5 stringers being placed.

JAMES LANDING, ILL. (35 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Aug. 24–Oct. 4, 1913.]

Hurdle No. 4½, new.—Hurdles Nos. 2, 3, 4, and 5, built 1891–92, have been practically destroyed during the years intervening to the present, leaving the river excessively wide at this locality, with impaired navigable depths at Selma, Forest Home, and Michael Towhead. Hurdle No. 4½ was built to deflect to the Missouri channel the large volume of water found passing down the Illinois shore, the tops of piling sloping from the 22-foot stage at the shore end to the 14-foot stage at the outer end. Length of hurdle, 2,600 feet; T-head length, 25 feet; and there were placed 1,675 piles, 75 stringers, 291,300 square feet of foundation mattress, and 6,400 square feet of stone paving.

OSBORNE FIELD, ILL. (36 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 20–23, 1913.]

Bank paving, repair.—Several small breaks in the paving near the lower end of the revetment were repaired, and the paving was raised to the 15-foot stage for about 1,000 feet in length above Kemper Landing, 18,500 square feet being placed.

FORT CHARTRES, WEST (48 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–28; Oct. 8–21; Nov. 4–7, 1913.]

Hurdle Dam No. ½, new.—A small shore mattress (600 square feet) was placed at the island end of the hurdle to form a better connection with the old island bank-protection work.

Bank protection, new and repair.—To connect the revetment mattress built 1910–11, with the bank which since had receded considerably because of caving, two sections of narrow mattress (720 linear feet, 36,400 square feet) were placed; 3,950 linear feet (102,400 square feet) of bank were paved with stone to the 18-foot stage; and 57,100 square feet of stone paving were laid in repair.

FORT CHARTRES, EAST (49 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 29–Aug. 6; Dec. 1–20, 1913; June 10–30, 1914.]

Bank protection, repair and extension.—The bank mattress was extended downstream between stations 57+65 and 60 at the head of Turkey Island, and a narrow mattress was placed between stations —15+7 and —11+47, where the bank had receded slightly from the original mattress. The total length of protected bank is 7,500 feet, of which 32,500 square feet of mattress were placed during the year. Between stations —14+85 and 7+50, the stone paving was raised

from the 15-foot stage to the 28-foot stage, and between stations 35 and 55+43, from the 10-foot stage to the 15-foot stage, 137,000 square feet being placed in new work, and 12,000 square feet in repair. Grading of the bank in preparation for paving was done by the dredge *Fort Chartres*.

TURKEY ISLAND, ILL. (81 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Aug. 6–Oct. 14; Nov. 8–Dec. 1, 1913; May 9–June 25, 1914.]

Bank protection, new.—The mattress of Fort Chartres, East, which terminated at station 60, was extended along the Turkey Island bank from that station downstream to station 96+16, 3,616 linear feet (423,100 square feet) being placed. During the fall the paving was completed to the 15-foot stage and during the spring to the 27-foot stage, 287,800 square feet being placed.

STE. GENEVIEVE, ILL. (55 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–Aug. 22, 1913; May 4–9, 1914.]

Hurdle No. 2, new and restoration.—About 350 linear feet of this hurdle was complete at the beginning of the fiscal year. To this was added in the fall season 1,450 feet, 200 feet of which is new work, the remainder being restoration to the channel limit formerly attained. In the spring, to stop a scouring action at the outer end of the line, and which had destroyed about 80 feet of the hurdle, six pile clumps were driven and two barges of stone were massed among the piling.

In all, 2,005 piles, 93 stringers, 186,400 square feet of foundation mattress, and 11,500 square feet of paving were placed.

STE. GENEVIEVE BEND, MO. (61 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 21–31, 1913; Jan. 1–5, Apr. 1–May 6, May 21–June 10, 1914.]

Bank paving, repair and extension.—Between stations 1+67 and 44+50, 2,800 linear feet (93,500 square feet) of paving were placed in repair and a small pocket mattress (6,600 square feet) was placed between stations 12 and 13+28. Between stations 0+15 and 51+25, 5,100 linear feet, the paving was raised from the 15-foot stage to the 28-foot stage (top of bank), 233,600 square feet being placed.

KASKASKIA ISLAND, ILL. (71 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 29–31, 1913; Jan. 1–3, Apr. 2–May 21, 1914.]

Bank paving, repair and extension.—Between stations 0 and 36+95 the stone paving below the 12-foot stage was repaired as required, 55,700 square feet being placed, and was raised to the 28-foot stage (top of bank), 232,300 square feet of new paving being placed. A small pocket mattress (4,200 square feet) was placed at station 3.

CHESTER, MO. (HORSE ISLAND) (72 MILES BELOW EADS BRIDGE, ST. LOUIS).

[June 17–30, 1914.]

Bank paving, repair and extension.—The paving from stations 8 to 18 and 24+45 to 26+45 was raised from the 20-foot to the 30-foot stage (top of bank), 65,200 square feet being placed, of which 1,500 square feet was repair work.

CRAIN ISLAND, MO. (76 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Oct. 15–Dec. 27, 1913; Apr. 22–June 30, 1914.]

Hurdles, new.—For several years navigation at the head of Crain Island has been difficult by reason of the large middle bar, called Belle Memphis Towhead, the navigable channel between it and the Missouri shore having become narrow and tortuous. Recently, however, the channel has changed to the Illinois side of the towhead, which is wider and better, and to make this desirable channel permanent a series of nine hurdles, ranging in length from 200 feet to 3,200 feet, were planned for this locality, extending from 4,000 feet above Block Landing to the Missouri Chute, behind Pucket and Crain Islands.

During the fiscal year five of these hurdles have been under construction, of which Nos. 3 and 4 were completed during the fall season, No. 9 was begun during the fall and continued during the spring season, and Nos. 2 and 6 also were nearly completed at the end of the fiscal year. The tops of the piling in all these hurdles are at the level of the 25-foot river stage at their shore ends and slope to about 18 feet at the outer ends. The foundation mattresses of Nos. 3 and 4 were extended 250 feet beyond the T-heads or outer ends. The detail lengths of the hurdles constructed are as follows:

Hurdle No. 2.—Projected length, 475 feet; completed, 325 feet.

Hurdle No. 3.—Fully completed; length, 685 feet; T-head length, 25 feet.

Hurdle No. 4.—Fully completed; length, 850 feet; T-head length, 25 feet.

Hurdle No. 6.—Fully completed; length, 1,650 feet; T-head length, 50 feet.

Hurdle No. 9.—Projected length, 3,200 feet; completed, 2,275 feet. In December the work was stopped at a dry bar, having been extended 1,300 feet from the Missouri shore. Before resuming work in the spring this bar was washed away toward the east for a distance of 1,000 feet, over which the hurdle was at once extended, and a drift mattress 820 linear feet (20,500 square feet) was added at the Missouri shore end of the line to prevent scour there under the foundation mattress.

Aggregate length of hurdles 5,785 feet, in which were placed 4,795 piles, 273 stringers, 806,300 square feet of foundation mattress, and 37,900 square feet of stone paving.

Bank protection, repair and extension.—In order to hold the Crain Island bank, which, as a result of the change of channel referred to, was caving rapidly at the lower end of the protection placed in 1904, the island protection mattress was extended 1,718 linear feet (181,800 square feet) downstream to station 69+18, and 81,500 square feet of stone paving were placed, the latter to the 20-foot stage. Bank grading was done by the dredge *Fort Chartres*. Two spur hurdles (80 piles, 11 stringers) were driven to connect the lower end of the old revetment, which by erosion had been separated from the bank, with the present bank line.

LIBERTY, MO. (85 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–7, 1913.]

Hurdle No. 15, new.—Construction of this hurdle, in progress at the beginning of the fiscal year, was completed by placing 20 piles and 2 stringers.

LIBERTY, ILL. (86 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–7; Sept. 5–Oct. 5, 1913; May 19–June 30, 1914.]

Bank paving, new and repair.—The paving in this revetment was repaired as required along the entire reach and was raised to the 25-foot stage along an aggregate of 8,800 linear feet of bank, a total of 381,500 square feet being placed.

WILKINSON, ILL. (92 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Oct. 17–Dec. 27, 1913; Apr. 1–30, 1914.]

Bank protection, new.—For a number of years the Illinois bank at this locality has been caving slowly from McLeans Point to Lacour Island hurdle, and as the long bend thus formed had reached an excellent channel alignment in an easy curve, a protection mattress 3,180 linear feet (407,000 square feet) in length was constructed along part of the bend below the foot of Wilkinson Island to hold the bank to its present location. During the fall and spring seasons the stone paving was completed to the top of the bank (about 30-foot stage), 276,600 square feet being placed.

LACOUR ISLAND, ILL. (94 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Nov. 20–Dec. 18, 1913; Apr. 2–29, 1914.]

Hurdle, repair and restoration.—This hurdle, constructed in 1898, has been broken by ice and practically destroyed for about 800 feet at the outer end. During the fall and spring seasons the hurdle was completely restored, the shore protection (1,800 square feet of mattress) was repaired, and a considerable accumulation of drift above the hurdle was sunk, a small drift mattress (6,000 square feet) being placed for that purpose. In all, 645 piles, 39 stringers, 70,100 square feet of mattress, and 10,600 square feet of paving were placed.

UNION POINT, ILL. (100 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 9–14, 1913.]

Hurdle No. 9, repair.—At the Illinois or shore end of the hurdle, where the top of the bank above the paving had been washed away during the high water of 1912, 4,700 square feet of paving were placed in repair.

HANGING DOG ISLAND, ILL. (114 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–14, 1913; May 27–28, 1914.]

Hurdles, new and repair.—Work on these hurdles was completed during the fall season as far as was permitted by the prevailing low stages of the river.

Hurdle No. 10, new.—The bank paving was completed, finishing this hurdle.

Hurdle No. 14, repair.—The bank paving was completed and a small mattress was placed in an eddy at the lower end of the bank protection.

Hurdle No. 18, new.—Projected length, 1,600 feet, of which, owing to the low stage of the river, only 110 feet could be built, which, in addition to that built in 1913, makes the total length constructed 230 feet.

An aggregate of 81 piles, 12 stringers, 13,200 square feet of mattress, and 11,800 square feet of paving were placed.

Bank protection, new.—In May a section of bank protection mattress constructed by a contractor for the city of St. Louis at Chouteau Island, Ill. (13 miles above), broke its fastenings and floated downstream until it was landed by a steamer of this office at the caving bank at this locality, where it was sunk as protection work. The amount thus utilized was 240 linear feet (30,000 square feet), or about 75 per cent of the original length.

During the fall the bank above the old protection mattress at this locality (1913) was graded and paved, 9,300 square feet being placed.

WILLARD, ILL. (115 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–21, 1913.]

Hurdle No. 1, new.—The continuous destruction of Vancill Towhead during several years past has exposed the outer end of this hurdle dam, an extension of which for 1,200 feet has become necessary to the proper alignment of the channel, but owing to the low river stage the foundation mattress could be extended only 400 feet (38,900 square feet) and the piling 200 feet, with 250 feet additional in repair, 293 piles and 18 stringers being placed.

DEVILS ISLAND, ILL. (126 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 22–Nov. 11, 1913; Apr. 2–May 9, 1914.]

Bank protection, new.—In order to prevent further caving of the bank, which was proceeding rapidly as the result of the complete destruction of hurdle No. 9, and was a menace to No. 11 (both built 1898), construction of a protection mattress was begun opposite the lower end (station 151) of the protection mattress placed 1898, and was continued to hurdle No. 11 (station 201+70), 5,075 linear feet (549,300 square feet) of mattress being placed, including several pocket mattresses in deep recesses in the bank. Paving was completed during the fall and spring seasons to the top of the bank (about 30-foot stage), 355,600 square feet being placed. Bank grading was done by the dredge *Fort Gage*. A spur hurdle (61 piles, 8 stringers) was placed in an eddy at station 176.

Along the protection near the head of Devils Island 23,500 square feet of paving were placed in repair.

MINTON POINT, ILL. (129 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 14–17, 1913.]

Hurdle No. 3, repair.—This hurdle, built 1904, has suffered slightly from the usual deterioration, and was repaired for a length of 360 feet at its outer end, and the T-head for a length of 90 feet, 173 piles and 16 stringers being placed. The prevailing low stage of the river

prevented repairs to two small gaps in this hurdle and to hurdle No. 1.

PRICE LANDING, MO. (153 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–21, Sept. 1–4, 1913.]

Bank protection, new and repair.—The pocket mattress between stations 182+40 and 183+86 (14,600 square feet) under construction at the beginning of the fiscal year was completed.

The paving was repaired at several places between stations 166+50 and 186+50 where small bank slips had occurred, 17,000 square feet being placed. Between stations 136 and 150 and 186+50 and 191+25 the paving was raised to the top of the bank and completed, 64,400 square feet being placed.

BEECHRIDGE, ILL. (164 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 22–Aug. 31, 1913.]

Bank, paving, repair.—Between stations 41+50 and 104+50 the paving was repaired and restored to limits varying from the 27-foot to 32-foot stage, 260,400 square feet being placed. A dry bar connecting with the shore at station 41 prevented work above this point.

CAIRO, ILL. (ELIZA POINT, 177 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Oct. 30–Dec. 16, 1913.]

Bank protection, repair, and extension.—The protection mattress, placed 1911, was extended downstream between stations 72+20 and 91, except between stations 82+50 and 85, where the old work was found intact, 176,200 square feet being placed. Between stations 72+20 and 92+75 the paving was completed to the 20-foot stage, 102,700 square feet being placed. Bank grading was done by the dredge *Fort Gage*.

GREENFIELD BEND, MO. (180 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Aug. 25–30; Dec. 16, 1913; June 3–8, 1914.]

Bank paving, new and repair.—The river stage being low in August, the paving, which had been placed at higher stages, was extended down to the water's edge, 47,400 square feet being placed. Breaks in the paving between stations 52+50 and 60+30 were repaired in December, 1913, and June, 1914, 8,400 square feet of stonework being placed.

DREDGING.

During July the river stage had declined to such an extent (10.8 feet, St. Louis gauge, on the 2d to 5.9 feet on the 26th) that it became necessary to place in commission three of the four suction dredges of this office to improve three crossings, foot of Chesley Island (22), Danby (41), and Thompson (164), which had become obstructive to navigation with depths less than the 8 feet required by law, and to watch and improve, if necessary, other bars which threat-

ened to become obstructive within the district. The fourth dredge was placed in commission during August, and all dredges were thereafter operated, as required, for a total of 1,638 hours, or slightly more than one-ninth of their total time in commission.

In addition to the above two dredges were utilized, when not required in the main channel, in hydraulic grading for bank paving for a total of 994 hours.

At the close of the fall season, when threatened by ice, the dredges were placed in Establishment and Fayville, winter harbors.

Dredges were in commission and performed services as follows: *Selma*, July 24 to December 23 (153 days), dredged one channel bar twice, 13 days; winter harbors at engineer depot (3) and Bushberg, Mo. (27), 19 days; at McKinley Bridge, Missouri side (—2½), 4 days and at construction works, Pulltight, Ill. (17), and Sulphur Springs, Ill. (24), 17 days; *Thebes*, July 15 to December 15 (154 days), dredged 6 channel bars, 58 days; *Fort Gage*, July 7 to December 31 (178 days), dredged 9 channel bars, 35 days, and graded bank, 41 days; *Fort Chartres*, August 1 to December 31 (153 days), dredged 5 channel bars, 35 days, and graded bank, 84 days.

The *Selma* dredged at McKinley Bridge, Missouri side (—2½), for the purpose of increasing the depth of water from the main channel to the steamer landing of the Independent Stock Yards Co., St. Louis, but the work was discontinued when partly completed because of the company's refusal to return the coal expended therefor, as has been usual in such work in aid of navigation beyond the main river channel. The *Selma* also worked at construction works at Pulltight, Ill. (17), and Sulphur Springs, Ill. (24), for the purpose of increasing the depth of water sufficiently for the construction of hurdles at those places by pile drivers and mattress parties.

The *Fort Gage* and *Fort Chartres*, when not needed in the main channel, were engaged in hydraulic grading for bank paving for a total of 41 days and 84 days, respectively, at Fort Chartres, East Crain Island, Devils Island, and Eliza Point.

All other dredging, excepting the other two winter harbors mentioned above, was for maintenance of required depth in steamer channel between St. Louis (0) and the mouth of the Ohio River (183).

During the low-water period of main channel operations, July 17 to November 18 (125 days), there were 4 days when all four dredges were working, 12 days when three were working, 17 days when two were working, 56 days when one was working, and on 36 days no dredging was done.

Nineteen main channel bars were dredged, of which five were dredged twice and two a third time. Beneficial results were obtained in all these channels, the gain in depth varying from 1 to 5 feet. (See table.) The total number of channels dredged through these 19 bars was 26, having a combined length of 4.6 miles and a mean width of 220 feet; the total amount of material thus removed from the main channel was 1,384,000 cubic yards in 1,365 hours' actual dredging time.

Table of work done by U. S. dredges "Selma," "Thebes," "Fort Gage," and "Fort Chartres" during the fiscal year ending June 30, 1914.

Name of dredge.	Bars dredged and mileage from St. Louis (Eads Bridge).	Miles.	Inclusive dates (1913).	Days dredging.	Actual time dredging.	Material removed.	Cuts made.	Total length of cuts.	Dredged channel.			Gain in depth.
									Length.	Depth.	Width.	
				Number.	*Hours.*	*Cubic yards.*	*Number.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Selma	McKinley Bridge, Missouri side [1]	2½	Oct. 6–9	4	27½	20,400	5	3,430	800	8	150	4
Do	Engineer depot	3	Oct. 11–14	4	6½	1,600	1	320	320	8	30	3
Do	do		Dec. 5–17	11	93½	19,200	[2] 22	3,820	350	14	120	8
Fort Chartres	Pulltight	15	Sept. 5–6	2	8	14,600	5	1,970	420	10½	200	3½
Selma	do [1]	17	Oct. 1–4	4	27½	11,200	3	4,330	1,800	9	90	4
Fort Gage	Foot, Chesley Island	22	July 26–27	2	13	16,600	3	2,080	690	10½	200	2½
Fort Chartres	do		Aug. 28–Sept. 4	8	78½	126,600	[3] 10	14,350	1,920	11	200	4
Selma	Sulphur Springs, Ill [1]	24	Oct. 15–27	13	83½	38,300	[4] 21	3,170		9		9
Do	Bushberg, Mo [1]	27	Nov. 5–8	4	35	22,900	3	2,850	1,240	12		9
Fort Chartres	Michaels	37	Aug. 19–26	8	91	131,200	[5] 14	20,420	3,470	11	300	3½
Do	do		Nov. 15–18	4	32	45,100	6	9,570	1,700	12	280	2
Do	Kemper	39	Oct. 5–10	6	60½	95,600	[6] 9	10,520	1,700	12	200	5
Fort Gage	Danby	41	July 17–22	6	64	71,100	6	10,330	1,720	12	200	5
Selma	do		Aug. 14–23	10	90½	82,700	9	11,900	1,320	12	200	4½
Do	do		Sept. 2–4	3	21½	13,500	5	2,660	500	11	200	4
Fort Chartres	Stanton	62	Sept. 9–15	7	59	66,600	[7] 7	11,520	2,200	12	280	4½
Fort Gage	Okaw	64	Sept. 3–5	3	17	30,200	4	3,450	860	12	200	5
Do	Fort Gage, upper	65	Aug. 29–Sept. 1	4	27½	47,100	5	6,270	1,250	10	200	4
Do	Fort Gage, lower	66	Aug. 18–20	3	17	20,300	5	2,870	530	12	200	5
Do	Blocks	75	Aug. 11–15	5	48	78,400	[7] 6	10,130	1,690	12	200	4½
Thebes	Belle Memphis, Illinois side	76	Oct. 22–27	6	69	45,600	8	11,480	1,400	10½	240	3
Do	do		Nov. 2–6	5	57	37,100	7	9,610	1,400	9½	210	4
Do	do		Nov. 13–17	5	52	31,900	6	8,340	1,400	12	180	1
Do	Seventysix	94	Sept. 29–Oct. 5	7	89	53,500	8	16,730	2,100	9½	240	2½
Do	Grand Tower	105	Sept. 18–27	10	109	22,100	[8] 8	10,500	1,800	9	200	1
Do	Hanging Dog	112	Aug. 29–Sept. 5	7	88	72,900	[7] 9	13,270	2,000	10	200	3
Fort Gage	Bee Blunt	118	Oct. 9–10	2	14½	34,230	6	4,980	880	9½	200	2½
Do	Price Towhead	154	Sept. 27–30	4	25	30,400	5	6,350	1,270	10½	200	3½
Thebes	Thompson, upper way	164	July 24	1	9	6,800	1	1,080			30	
Do	Thompson, lower way	165	Aug. 5–15, 18–23	17	183	127,700	[9] 18	30,770	4,100	10½	200	4
Fort Gage	Ables Point	171	Sept. 8–10	3	18	19,300	5	3,850	770	10½	200	3½
Do	do		Nov. 4–6	3	23½	52,800	6	5,080	850	12	200	5
				181	1,638	[10] 1,497,500	238	263,000	42,450			

GRADING OF RIVER BANK FOR REVETMENTS.

Fort Chartres	Fort Chartres, East	49–51	Aug. 7–15; Sept. 17–Oct. 3; Oct. 13–Nov. 13; Nov. 26–28.	69	470	48,300		8,956				
Do	Crain Island, Mo	77	Dec. 10–23	15	107	26,400		1,286				
Fort Gage	Devils Island, Ill	126	Sept. 17–25	8	91	13,900		1,120				
Do	do		Oct. 2–7	5	40	7,100		630				
Do	do		Oct. 13–19	7	70½	15,000		1,080				
Do	Eliza Point, Ill	177	Nov. 7–24	15	170½	19,500		1,450				
Do	do		Nov. 28–29	2	18	3,300		270				
Do	do		Dec. 1–2	2	8½	600		150				
Do	do		Dec. 8–9	2	19	1,000		200				
				125	994½	135,100		15,142				

[1] Not in main steamer channel.
[2] Includes 19 cuts redredging.
[3] Includes 3 clean-up cuts and 2 cuts redredging.
[4] Includes 6 cuts redredging.
[5] Includes 4 clean-up cuts.
[6] Includes 3 clean-up cuts.
[7] Includes 1 clean-up cut.
[8] Includes 2 clean-up cuts.
[9] Includes 3 redredging and 2 clean-up cuts.
[10] 1,383,900 cubic yards from main channel in 1,365 hours.

River stage.—The river stage was unusually low throughout the entire year. At no time was flood stage approached, and during only three months—December, April, and the latter part of June—were the mean daily stages for those months equaled or exceeded. From July to November the hydrograph (St. Louis gauge) was approximately 3 to 6 feet lower than the hydrograph of mean daily stages; during a slight rise in December the stage was 4 feet above this curve. From January to July the stages showed greater variation, but, except during very short periods in April and June, were always below the mean stage, and during January and February established new low records, reaching the very low reading of —2.3 feet on February 15, under the influence of ice gorges. The lowest known reading on the St. Louis gauge is —2.52 feet, on January 2, 1900, also under the influence of ice gorges.

St. Louis gauge, 1913–14.

Highest monthly readings.		Lowest monthly readings.		Normal range, 50 years' continuous record.
Date.	Gauge.	Date.	Gauge.	
1913.	*Feet.*	1913.	*Feet.*	*Feet.*
July 1	15.9	July 31	10.0	20.5-15.0
Aug. 1	9.5	Aug. 31	5.1	15.0-10.0
Sept. 2, 3	5.2	Sept. 28	3.5	10.0- 9.0
Oct. 25	5.0	Oct. 1-3	3.6	9.0- 8.5
Nov. 17	8.0	Nov. 24	4.2	8.5- 7.0
Dec. 11	10.0	Dec. 31	3.2	7.0- 5.5 5.5- 6.5
1914.		1914.		
Jan. 1	2.8	Jan. 15	0.0	6.5- 7.5
Feb. 24	9.4	Feb. 15	—2.3	7.5-12.0
Mar. 9	10.4	Mar. 1	7.1	12.0-16.5
Apr. 3	19.1	Apr. 28, 30	8.3	16.5-19.5
May 18	13.7	May 1	8.7	19.5-18.5
June 21	20.4	June 1	11.6	18.5-20.5

Channel conditions.—Channel conditions were under constant surveillance by the towboats of this office, while in commission, from July to December and from April to June. During the first half year between the mouth of the Missouri River (—16) and St. Louis (0), the required 6-foot depth was maintained by natural action of the river; between St. Louis (0) and the mouth of Ohio River (183) a channel of required dimensions, 8-foot depth and 200 feet width, was maintained, except for very short periods of time at 14 localities, where the required dimensions were quickly obtained by dredging or by the action (natural scour) of the river itself. During the period of navigation unobstructed by ice in the second half year, the least depths found were always equal to or in excess of the legal requirements.

The least depths throughout the year were as follows: In July, 7 feet at Chesley Island (22), 3 days, and Danby (40), 7 days. In August, 7 feet at Chesley Island (22), 1 day; Michaels Towhead (37), 2 days; Danby (40), 5 days; Fort Gage, upper (65), 3 days; Fort Gage, lower (66), 1 day; and Thompson (165), 3 days. In September, 7 feet at Chesley Island (22), 2 days; Seventysix (94), 4 days; and Ables Point (171), 3 days; and 7½ feet at Stanton (62), 5 days; and Okaw (64), 2 days. In October, 7 feet at Kemper (39),

3 days; Blocks (75), 1 day; and Belle Memphis Towhead (76), 1 day. During November, 7 feet at Michaels (37) and Ables Point (171), 2 days. In December, 7 feet at Little Rock Landing (57), 1 day, and Stanton (62), 2 days.

Steamer channel reports giving steering directions and least depths on bars, as ascertained by pilots of this office on through trips, were issued to vessels and the public through the Lighthouse Service.

SURVEYS, EXAMINATIONS, AND CHANNEL MARKS.

Surveys, general and special, were made as required, and included all localities where construction works and dredging were in progress or immediately prospective; also where considerable changes due to caving banks and shifting channels had taken place. Dredged channels were also marked with buoys and steering ranges in addition to the regular beacon lights of the Lighthouse Service.

Retriangulation of the river was made from Wagners Landing to Fountain Bluff (85¾–100) and from Kinney Point to Cape Girardeau (124–131) from which the old triangulation points had disappeared. Twenty-eight new triangulation stations were established and marked by iron pipes.

Aided by surveyors on the dredges and construction parties, the regular survey party of this district completed a hydrographic survey of the entire district (200 miles) between the mouths of Ohio and Missouri Rivers, with the exception of two localities (total only 26 miles) where new surveys were deemed unnecessary, as practically no changes had taken place since the complete survey of 1907.

PHYSICAL DATA.

The river gauges were maintained and read daily throughout the year and their records were checked by platting on the official hydrograph.

During the year the river at St. Louis oscillated 22.7 feet, between stages 16.4 feet (June 21) above and 6.3 feet (Feb. 15) below standard low water (4 feet, St. Louis gauge). The normal yearly oscillation is about 24.5 feet, between 22.7 feet above and 1.8 feet below standard low water.

During the winter season, when the river was very low, nine measurements of discharge were made at the United States engineer depot (3), St. Louis, with results as follows:

Measurement of discharge of Mississippi River at engineer depot, St. Louis, Mo.

Date.	St. Louis gauge.	Area of cross section.	Mean depth.	Width of waterway.	Mean velocity.	Discharge.	Method.	Oscillations.
1914.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Ft. sec.*	*Sec. ft.*		
Jan. 7	1.2	26,400	13.6	1,938	1.88	49,500	Rod floats...	F.
8	1.1	26,600	13.7	1,935	1.85	49,000	.....do.....	F.
10	.9	26,300	13.6	1,928	1.89	49,500	.....do.....	F.
15	−.1	24,700	12.8	1,925	1.75	[1] 43,500	.....do.....	S.
	−.1	24,700	12.8	1,925	1.77	43,500	.....do.....	
17	.6	25,600	13.1	1,950	1.92	49,000	.....do.....	R.
23	1.1	27,000	13.7	1,981	1.91	52,500	.....do.....	R.
26	2.1	29,400	14.7	2,004	2.00	58,500	.....do.....	R.
Feb. 2	3.7	30,800	15.3	2,021	2.30	71,000	.....do.....	R.

[1] Slush ice.

MATERIALS.

For the permanent works of improvement, construction, and repair of hurdle dikes and bank revetments, 63,616 cubic yards of stone and spalls, 19,194 cords of brush, 234,622 linear feet (5,675 sticks) of pile timber, and 607,199 bushels of coal were supplied by contract; 42,767 cubic yards of stone and spalls, 546,197 linear feet (13,035 sticks) of pile timber, and 108,468 bushels of coal were purchased in open market, and 96,418 cubic yards of stone and spalls and 11,221 cords of brush were procured and loaded on Government barges by hired labor.

The stone procured by hired labor was obtained from the quarry at Little Rock Landing, Mo., which has been controlled and operated by this office since 1892. Active operations at the quarry were continued throughout the year, the force of laborers being reduced and loading of barges suspended during the winter months.

All other materials, supplies, stores, subsistence, etc., were purchased under competitive bids therefor or in open market and were assembled and tested at the engineer depot, St. Louis, Mo., and thence distributed to the various field parties.

Numerous inspections were made, as required, of materials and appliances purchased in this vicinity by the Panama Canal.

PLANT.

All plant required for service was maintained in condition by repairs in ordinary upkeep and received extraordinary repairs and rebuilding necessary to fit it for present and future service.

The towboats of this office, the *William R. King* and *General J. H. Simpson*, and the *Nokomis*, borrowed from the Mississippi River Commission, were kept in good repair.

Four new steam-hammer pile drivers and two combined hydraulic graders and derricks for bank-revetment work were completed during the year upon six steel hulls constructed under contract during the previous year. The pile drivers were equipped with machinery from dismantled plant, each with a single boiler, a double cylinder hoisting engine, and a steam hammer, of which the hammers proper weigh 3,000 pounds to 5,000 pounds. The hydraulic grader and derrick boats are each equipped with two boilers, a four-stage belt-driven centrifugal pump with 7-inch suction and 6-inch discharge, a derrick with mast and boom operated with double cylinder hoisting engine and a slewing engine, and a powerful electric searchlight and an arc light for night work. These boats, although completed late in the fall, and therefore not in use throughout the entire year, have been found very satisfactory in service.

Repairs incident to active service were made to the four suction dredges.

Repairs under way at the beginning of the fiscal year were completed on one wooden barge and one quarter boat and one office and survey boat. Repairs were also made to two other quarter boats and one office and survey boat and one wooden barge.

At the Little Rock Quarry, as well as at the engineer depot, St. Louis, derricks, drills, tracks, cars, and all machinery, tools, and appliances and buildings were kept in good condition.

APPROPRIATIONS.

[As shown on p. 347, H. Doc. No. 421, 57th Cong., 2d sess.]

Missouri River to Meramec River, June 10, 1872		$100,000.00
Missouri River to Ohio River, Mar. 3, 1873		200,000.00
Illinois River to Ohio River, June 23, 1874, to Mar. 3, 1881		1,890,000.00
Since adoption of project:		
Aug. 2, 1882		600,000.00
July 5, 1884		520,000.00
Aug. 5, 1886		375,000.00
Aug. 11, 1888		300,000.00
Sept. 19, 1890		400,000.00
July 13, 1892		525,000.00
Mar. 3, 1893		658,333.33
Aug. 18, 1894		758,333.33
Mar. 2, 1895		758,333.33
June 3, 1896		275,000.00
June 4, 1897		683,333.33
July 19, 1897		325,000.00
July 1, 1898		673,333.33
Mar. 3, 1899		673,333.33
June 6, 1900		100,000.00
June 13, 1902		650,000.00
Mar. 3, 1903		650,000.00
Apr. 28, 1904		650,000.00
Mar. 3, 1905		650,000.00
Mar. 2, 1907		250,000.00
May 27, 1908		250,000.00
Mar. 4, 1909		250,000.00
June 25, 1910		250,000.00
June 25, 1910		500,000.00
Feb. 27, 1911		1,000,000.00
July 25, 1912		1,000,000.00
Mar. 4, 1913		1,000,000.00
Oct. 2, 1914		250,000.00
Total appropriations		17,144,999.98
Miscellaneous receipts from sales, etc		[1] 78,182.96
		17,223,182.94
Expended on original project under acts of June 10, 1872, to June 14, 1880, inclusive	$1,495,000.00	
Allotted for work above mouth of Missouri River (outside of present district), acts of 1874, 1875, 1876, 1878, 1879, 1880, 1882, 1890	180,000.00	
Expended for methods of improvement under the acts of 1905, 1907, 1908, 1909	1,400,000.00	
		3,075,000.00
Available for project of 1881 and its modifications, acts of 1881 to 1904, inclusive, and 1910 to 1913, inclusive		14,148,182.94
Expended on project of 1881		13,521,845.39
Balance unexpended		626,337.55

CONTRACTS IN FORCE.

Name: Albert Bussen.
Work: Furnishing 8,000 cubic yards stone and 2,000 cubic yards spalls.
Cost: $7,000.
Date: May 26, 1914.
Date of commencement: May 26, 1914.
Date of completion: December 31, 1914.
Delivered to June 30, 1914: 2,706 cubic yards stone, 475 cubic yards spalls.

[1] The amount, $104,216.50, in annual report, fiscal year 1913, was an error, as it included reimbursable amounts on account of other appropriations, etc.

1915

IMPROVEMENT OF RIVERS AND HARBORS IN THE ST. LOUIS, MO., DISTRICT.

REPORT OF MAJ. WILDURR WILLING, CORPS OF ENGINEERS.

IMPROVEMENTS.

FOR DESCRIPTION OF IMPROVEMENTS IN THIS DISTRICT, SEE PAGES 1012 TO 1017.

1. IMPROVING MISSISSIPPI RIVER BETWEEN MOUTHS OF OHIO AND MISSOURI RIVERS.

WORKS OF IMPROVEMENT.

The standard forms of construction were used. During the year works of permanent improvement by hired labor were in progress July 1 to August 25, and October 27 to December 14, 1914, as hereinafter described, at Twin Hollows, Pulltight, Meramec River, Sulphur Springs, Osborne Field, Danby Landing, Fort Chartres, Ste. Genevieve, Horse Island, Crain Island, Liberty, Price Landing, Beechridge, and Greenfield Bend, and under contract, May 10 to 27, 1915, at Kaskaskia Island. Three of the four suction dredges under this office were in commission during the low-water season from August 3, 1914, to December 15, 1914, and were operated on 17 channel bars which developed in that time. A hydrographic survey of the entire district, with exception of 7 miles with rocky shores in which no changes occur, was made, including all dredged channels and shoal crossings, caving banks, and harbor encroachments. River gauges were maintained and read throughout the year, and were inspected and repaired as required. The plant was repaired and cared for at the engineer depot, St. Louis, and in fleets at Ames Island, Mo., and Fayville, Ill.

Materials were procured by contract and open-market purchase and by hired labor, as was deemed most advantageous to the department.

CONSTRUCTION WORKS—HIRED LABOR.

TWIN HOLLOWS, WEST (14 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Nov. 17–25, 1914.]

Hurdle dikes, drift sinking.—Much drift had accumulated above the entire length of the five hurdle dikes at this locality, which were

constructed or repaired, 1914. In order to sink this drift, and thus reinforce the dikes, it was overlaid at the outer ends of the dikes with woven wire fencing and weighted with stone, but the low river stage and accretions prevented such work near the inshore ends. The linear quantities of drift sinking done at each hurdle were as follows: No. 3, 90 feet; No. 4, 150 feet; No. 5, 255 feet; No. 5½, 130 feet; No. 6, 115 feet; total, 740 linear feet, 15,100 square feet.

Bank revetment, repair.—Repairs aggregating 1,500 square feet were made to the stone paving on the upper slope of the bank, along this revetment.

PULLTIGHT, ILL. (16 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–Aug. 3; Nov. 25, 1914.]

Hurdle dikes, new and repair.—Five hurdles under construction at the beginning of the fiscal year, Nos. 1¼, 4½, 5, 6, and 8 were completed, and the drift accumulated above Nos. 1, 4, 5, and 8 was sunk. The quantities of work done were as follows:

Hurdle No. 1.—Drift, 155 linear feet (3,100 square feet), was sunk.

Hurdle No. 1¼, new.—Projected length 140 feet; fully completed; foundation mattress was completed during the previous fiscal year.

Hurdle No. 4.—Drift, 615 linear feet (10,100 square feet), was sunk.

Hurdle No. 4½, new.—A small quantity of stone for reinforcement was distributed among the piling.

Hurdle No. 5, new.—Projected length 1,380 feet; previously completed 1,360 feet; extended and fully completed, 20 feet; T-head length 80 feet. Near the outer end 260 linear feet (2,600 square feet) of drift was sunk.

Hurdle No. 6, new and restoration.—Projected length 1,360 feet; previously completed 565 feet; extended 795 feet and fully completed; T-head length 90 feet. Mattress for T-head (25,600 square feet) was placed and drift (4,400 square feet) was sunk.

Hurdle No. 8, new.—Projected length 800 feet; previously completed 650 feet; extended 150 feet and fully completed; T-head length 90 feet. Mattress for T-head (26,200 square feet) was placed, and drift (8,200 square feet) was sunk.

Aggregate length of hurdles constructed, 990 feet, in which were placed 41,600 square feet of foundation mattress, 665 piles, 58 stringers, and 24,000 square feet of drift were sunk.

Bank revetment, repair.—Repairs, aggregating 500 square feet, were made to the paving.

MERAMEC RIVER, MO. (10 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 21–Aug. 18; Nov. 10–17, 1914.]

Hurdle dikes, new, extensions.—Increased depth of water at the outer ends of these hurdles, constructed 1913, permitted their extension in July and August, as follows:

Hurdle No. 2.—Piling, 275 feet; foundation mattress, 117,600 square feet.

Hurdle No. 3.—Piling, 740 feet; foundation mattress, 110,700 square feet.

In November 760 linear feet (14,300 square feet) of the accumulated drift were covered with woven-wire fencing, weighted with stone and sunk.

Aggregate length of hurdles constructed, 1,015 feet, in which were placed 228,300 square feet of foundation mattress, 750 piles, and 44 stringers; and 14,300 square feet of drift were sunk.

SULPHUR SPRINGS, ILL. (23 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 7–Aug. 25; Oct. 26–Nov. 9; Nov. 25–27, 1914.]

Hurdle dike No. 12, repair.—A weak place, which developed in this dike during the June rise, was strengthened with an additional row of pile clumps (31 piles) and 5 stringers; 65 linear feet (1,300 square feet) of drift at the shore end of this hurdle were overlaid with woven-wire fencing and sunk with stone.

Bank revetment, new.—As the bank in this vicinity was caving rapidly, two sections of revetment mattress, aggregating 1,470 linear feet (226,300 square feet), were placed between stations 100 and 109+75, and 118+40 and 123+35. New stone paving, 145,800 square feet, was placed along the mattress, and 4,800 square feet were laid in repair to old work.

OSBORNE FIELD, ILL. (30 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Nov. 28–Dec. 6, 1914.]

Bank revetment, repair.—Stone paving, 1,500 linear feet (22,400 square feet), was laid in the vicinity of Kemper Landing, between stations 77 and 112, covering exposed mattress at the base of the old stonework, and raising the paving to a 16-foot stage, St. Louis gauge.

DANBY LANDING, MO. (41 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 7, 1914.]

Bank revetment, repair.—Several exposed places in the paving between stations 35 and 85+50, the lower end of the work, were covered with stone (1,500 square feet).

FORT CHARTRES, WEST (48 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 15–31; Dec. 5–12, 1914.]

Hurdle dike No. ½, new.—To sink the drift accumulated above this hurdle, woven-wire fencing, 685 linear feet (17,800 square feet) was laid over it and sunk with stone.

Bank revetment, repair.—The stone paving between stations 0+30 and 15+50 (8,800 square feet) was repaired, and a pocket mattress (8,600 square feet) was placed between stations 12 and 15.

FORT CHARTRES, EAST (49 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–Aug. 11; Nov. 21–Dec. 4, 1914.]

Bank revetment, new and repair.—New stone paving, 5,000 linear feet (207,500 square feet), was placed between stations 7+50 and 57+50, raising the revetment to stages varying from 12 to 28 feet, and between stations —12+25 and 50, 49,100 square feet of paving were placed in repair.

STE. GENEVIEVE, ILL. (55 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Nov. 12–20, 1914.]

Hurdle dike, No. 2, new.—Woven-wire fencing, 1,625 linear feet (27,900 square feet), was placed on the drift above the entire length of this hurdle and was then sunk with stone.

STE. GENEVIEVE BEND, MO. (61 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 8–11, 1914.]

Bank revetment, repair.—Stone paving (6,000 square feet), was placed along 665 linear feet of bank, covering exposed places along the edge of the protection mattress.

CHESTER, MO. (HORSE ISLAND, 72 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1; July 7–14; Nov. 7–11, 1914.]

Bank revetment, new.—Stone paving, 1,200 linear feet (60,100 square feet), was placed between stations 17+90 and 36, raising the revetment to stages varying from 18 feet to 33 feet.

CRAIN ISLAND, MO. (76 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–Aug. 25; Oct. 27–Nov. 9, 1914.]

Hurdle dikes, new and repair.—Additional work was done on four of the five hurdles constructed at this locality during the fiscal year 1914, and a new hurdle, No. 14, was constructed across the chute between Belle of Memphis Towhead and Crain Island at a point about 3,500 feet below the head of the island.

Hurdle No. 2.—Projected length, 475 feet; previously completed, 325 feet; extended 150 feet and fully completed; T-head length 50 feet.

Hurdle No. 4.—The drift (16,000 square feet) accumulated along 300 linear feet of this hurdle was covered by woven wire fencing and sunk with stone.

Hurdle No. 6.—The bank paving, 7,900 square feet, at the shore end of the hurdle, was completed; drift accumulated along the entire hurdle length (1,650 linear feet, 39,700 square feet) was sunk, and a section, 100 feet in length, of the piling near the shore was strengthened by placing 27 piles and 3 stringers. A second accumulation of drift (436 linear feet) was sunk along the shore end of this hurdle.

Hurdle No. 9.—Projected length, 3,200 feet; previously completed, 2,275 feet; extended 225 feet.

Hurdle No. 14.—Length, 1,150 feet; fully completed.

The aggregate length of hurdle dikes constructed at this locality was 1,525 feet, in which were placed 1,000 piles, 80 stringers, 158,200 square feet of foundation mattress, 36,800 square feet of stone paving, and 45,700 square feet of sunken drift.

LIBERTY, ILL. (86 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 1–31; Dec. 12–14, 1914.]

Bank revetment, new and repair.—New paving, 17,800 square feet, was placed along 850 linear feet of bank between stations 143+50 and 152, and 7,000 linear feet (115,200 square feet) of bank were repaired between stations 36 and 150. Practically all the paving at this locality is now above the 20-foot stage, and the greater part of it is above the 25-foot stage.

PRICE LANDING, MO. (153 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 13–14, 1914.]

Bank revetment, repair.—The paving was extended from the 7-foot stage down to the 4-foot stage (Commerce gauge) between stations 149 and 162; 1,240 linear feet (13,400 square feet) were placed.

BEECHRIDGE, ILL. (164 MILES BELOW EADS BRIDGE, ST. LOUIS).

[Dec. 12, 1914.]

Bank revetment, repair.—Between stations 57 and 95, 3,300 square feet of stone paving were placed along 250 linear feet of bank.

GREENFIELD BEND, MO. (180 MILES BELOW EADS BRIDGE, ST. LOUIS).

[July 11–31; Oct. 28–Dec. 13, 1914.]

Bank protection, new and repair.—This protection, placed during the fall season of 1911, has been difficult to maintain, the varying stages and frequently accelerated velocities consequent to the proximity of the Ohio River causing several breaches in the paving and probably also in the subaqueous mattress. During this season a heavy mattress of width (175 feet) greater than usual was placed in front of the region of greatest caving, between stations 57+20 and 63+65, and a small pocket mattress was placed at station 69, the total quantity of mattress work being 120,700 square feet.

Stone paving, 38,900 square feet, was extended below the 7-foot stage (Cairo gauge) along 3,000 linear feet of bank between stations 8 and 69, and 41,600 square feet of paving were laid in repair along 1,600 linear feet of bank between stations 44+50 and 65.

CONSTRUCTION WORKS—CONTRACT.

KASKASKIA ISLAND, ILL. (69 MILES BELOW EADS BRIDGE, ST. LOUIS).

[May 10–27, 1915.]

Bank revetment, new.—Under contract with Rust & Swift, of St. Louis, 1,067 linear feet (133,400 square feet) of bank protection

mattress of lumber were placed along the east bank of Kaskaskia Island about 1 mile south of Farmers Landing, between stations 100 and 110+40. On the 27th the sudden rise in the river to very high stage forced temporary suspension of the work, and at the end of the year the river had not fallen sufficiently to permit resumption of work.

DREDGING.

Good boating stages and ample depths for navigation prevailed throughout July (mean stage for month 15 feet, St. Louis gauge), but on August 3 the stage had fallen to 9 feet, and channel depths were reduced to such an extent that several crossings threatened to become obstructive to 8-foot navigation. The two self-propelling dredges *Fort Gage* and *Fort Chartres* were thereupon placed in commission for the season's work. The *Thebes*, nonpropelling, was also used during the latter part of August and early part of September. The fourth dredge (*Selma*, nonpropelling) was prepared for service, but was not placed in commission.

Dredges were in commission and performed service as follows: *Fort Gage*, August 3 to December 15 (135 days), dredged 9 channel bars, 37 days; *Fort Chartres*, August 3 to December 15 (135 days), dredged 13 channel bars, 67 days; *Thebes*, August 20 to September 11 (23 days), dredged 2 channel bars, 9 days. The three dredges were operated for a total of 1,003 hours, or one-seventh of their total time in commission, and maintained a good 8-foot channel throughout the low-water season until navigation was closed by running ice December 14.

During the low-water period of 135 days there were no days when all three dredges were working simultaneously, there were 38 days when two were working, 37 days when only one was working, and on 60 days no dredging was done. On account of sharp rises in the river which made dredging unnecessary the *Fort Gage* and *Fort Chartres* were at the bank September 6–30 and October 12–25; the *Thebes* was at the bank September 4–11, and on the latter date was put out of commission.

Seventeen main channel bars were dredged, of which two were dredged twice (Michaels and Danby) and two were dredged three times (Chesley Island and Allen Towhead). Beneficial results were obtained in all cases, although the second dredging at Chesley Island and the first dredging at Allen Towhead were not fully completed. Work in the upper way at Thompson was abandoned when about half completed, and the lower way, showing natural scour, was quickly improved. The gain in depth due to dredging varied from 2 feet to 6 feet. The total number of complete channels dredged through the 17 bars was 21, each having a width of 200 feet or more, and their combined length was 6½ miles. The total amount of material removed was 1,141,800 cubic yards in 1,003 hours actual dredging time. Other details will be found in the accompanying table.

Table of work done by U. S. dredges "Thebes," "Fort Gage" and "Fort Chartres," during the fiscal year ending June 30, 1915.

Dredge.	Bars dredged and mileage from St. Louis (Eads Bridge).	Miles.	Inclusive dates.	Days dredging	Actual dredging time.	Quantity dredged.	Total length of cuts.	Dredged channel.			Gain in depth.
								Length.	Width.	Depth.	
			1914.		*Hours.*	*Cubic yards.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Fort Chartres	Whitehouse	17	Dec. 3–5	3	16	20,700	3,800	750	200	9	2½
Thebes	Meramec	20	Aug. 29–Sept. 3	6	52	31,200	10,600	1,200	200	10½	3
Fort Chartres	Chesley Island	21	Aug. 5–11	6	49	49,200	7,900	1,300	275	10½	4
Thebes	do	21	Aug. 26–28	3	20	19,300	4,400	1,550	[1] 150	10	4
Fort Chartres	do	21	Oct. 7–11, Oct. 26–Nov. 2.	13	134	214,400	29,900	3,600	250	11	5
Do	Michaels	37	Aug. 12–19	8	82	133,000	17,200	3,000	225	10½	6
Fort Gage	do	37	Dec. 1–5	5	44	28,200	7,800	1,600	200	10	3
Fort Chartres	Danby	41	Aug. 29–Sept. 2	5	42	39,000	9,900	1,300	250	10½	3½
Do	do	41	Nov. 29–Dec. 2	4	34	48,300	7,500	1,400	200	10	4
Do	Morrison	44	Nov. 5–8	3	32	44,500	7,800	2,100	200	10½	2½
Do	Magnolia	53	Aug. 20–23	4	39	53,600	8,400	2,000	200	10½	4½
Do	Head, Ste. Genevieve Island	59	Aug. 24–27	2	20	28,500	3,600	1,300	[2] 125	10½	5
Do	Stanton	61	Sept. 3–5	3	28	28,300	5,100	1,200	225	12	3½
Do	Okaw	64	Nov. 21–27	5	50	70,800	11,500	2,200	200	9	2
Do	Marys River	76	Nov. 13–19	7	62	45,900	14,100	2,200	250	11	4
Do	Seventysix	94	Dec. 8–12	4	43	46,800	8,100	1,600	200	10½	3½
Fort Gage	Big Muddy	107	Dec. 10–12	3	26	32,100	6,600	1,100	200	10½	4
Do	Tentable	114	Dec. 7–9	3	28	23,000	5,300	900	200	10½	4
Do	Allen Towhead (upper)	146	Oct. 9–11	3	16	10,800	2,200	1,300	[3] 100	13	3
Do	Allen Towhead (lower)	146	Nov. 3–6	4	28	28,200	6,100	1,100	200	10½	3
Do	Allen Towhead (upper)	146	Nov. 18–24	7	68	39,600	9,500	1,500	200	10½	4½
Do	Thompson (upper)	165	Aug. 10–16	5	34	29,500	5,600	1,800	[4] 125	9	4
Do	Thompson (lower)	165	Aug. 17–21	5	47	63,000	9,600	1,900	200	9	4½
Do	Scudder	167	Nov. 13–14	2	9	12,900	2,500	800	200	12	4½
				113	1,903	1,141,800	205,000	[5] 38,650			

[1] Not fully completed, dredge more urgently needed at Meramec (20).
[2] Not fully completed, due to breakdown of machinery; resulting scour quickly gave the required width and depth.
[3] Not completed, due to sharp rise in river stage.
[4] Abandoned in favor of better location, the lower way.
[5] Length of completed channels (200 feet or more in width) 6½ miles.

The two self-propelling dredges, each with several pieces of construction plant in tow en route to winter harbors, were obliged, because of large quantities of floating ice, to go into temporary winter quarters at Hanging Dog Rock (111) and West Horsetail (9); they suffered no damage from the ice, and about one month later brought their tows into the regular winter harbors at Fayville, Ill. (144), and Engineer Depot, St. Louis (3).

RIVER STAGE.

During the fall season, with exception of short rises in September and October, during both of which the St. Louis gauge failed to reach 20 feet, the river stage was unusually low, while the spring season was marked by a tendency to extremes, being low during January, high in February and the first 10 days of March, then low until near the end of May, after which flood stages prevailed throughout June. The mean stage for the year was 12.2 feet, or 0.4 foot below the mean stage for 50 years, St. Louis gauge.

St. Louis gauge, 1914–15.

Highest monthly readings.		Lowest monthly readings.		Normal range, 50 years' continuous records.
Date.	Gauge.	Date.	Gauge.	
1914.	*Feet.*	1914.	*Feet.*	*Feet.*
July 12	17.8	July 31	10.0	20.5-15.0
Aug. 1	9.6	Aug. 22	4.4	15.0-10.0
Sept. 21	19.3	Sept. 1	5.0	10.0- 9.0
Oct. 14	17.2	Oct. 8, 31	7.0	9.0- 8.5
Nov. 1	6.8	Nov. 30	3.0	8.5- 7.0
Dec. 29	4.8	Dec. 26	−1.8	7.0- 5.5 5.5- 6.5
1915.		1915.		
Jan. 22	7.1	Jan. 30	1.7	6.5- 7.5
Feb. 27	23.4	Feb. 1	4.2	7.5-12.0
Mar. 1	22.9	Mar. 29	13.2	12.0-16.5
Apr. 15, 16	20.8	Apr. 30	13.5	16.5-19.5
May 31	20.0	May 19	10.7	19.5-18.5
June 24	31.6	June 19	27.5	18.5-20.5

CHANNEL CONDITIONS.

Channel conditions were under constant surveillance by the district towboats while in commission from July 1 to December 15, except from September 12 to 26, when the boats were laid up on account of lack of funds and high water. During the spring season the steamers were not in commission, with the exception of one towboat employed in towing plant during the latter half of May.

During the fall season between the mouth of the Missouri River (−16) and St. Louis (0), the required 6-foot depth was maintained by natural action of the river; between St. Louis (0) and the mouth of the Ohio River (183) a channel of required dimensions, 8 feet depth and 200 feet width, was maintained, except for short periods of time at 17 localities previously noted, where the required dimen-

sions were quickly obtained by dredging or by the action (natural scour) of the river itself.

The least depths throughout the year were as follows: In July, 8½–9 feet, at Chesley Island (21), 3 days; Michaels (37), 3 days; Cambria (52), 2 days; Magnolia (53), 2 days; and Stanton (62), 1 day. In August, 5½–6 feet, at Magnolia (53), 1 day; Michaels (37), 1 day; and Brewer Point (166), 1 day. In September, 7½ feet, at Chesley Island (21), 2 days, and Stanton (62), 4 days. In October, 8 feet, at Chesley Island (21), 1 day; Danby (41), 1 day; and Allen Towhead (146), 3 days. In November, 6½ feet, at Michaels (37), 5 days. In December, before navigation was suspended on the 15th, 6–6½ feet, at Big Muddy (107), 5 days; Teatable (114), 5 days; and Stanton (62), 1 day. The river stages always being higher during the spring season, the channel depths reported were equal to or greater than project requirements.

Steamer channel reports giving steering directions and least depth on bars, as ascertained by pilots of this office on through trips, were issued during the fall season to vessels and the public through the Lighthouse Service.

SURVEYS, EXAMINATIONS, AND CHANNEL MARKS.

A hydrographic survey of the entire district (200 miles) between the mouths of Ohio and Missouri Rivers was completed, with the exception of 7 miles of rocky gorge, Grays Point to Commerce, throughout which the channel is practically unchanging.

Retriangulation of the river was made from Ste. Genevieve Bend to Fort Gage (58–67), where most of the old triangulation stations had disappeared. Eight new stations were established and marked with iron pipes.

Surveys, general and special, were also made as required, and included all localities where construction works and dredging were in progress or immediately prospective; also where considerable changes due to caving banks and shifting channels had taken place. Dredged channels were also marked with buoys and steering ranges in addition to the regular beacon lights of the Lighthouse Service.

PHYSICAL DATA.

The river gauges were maintained and read daily throughout the year and their records were checked by platting on the official hydrograph.

During the year the river at St. Louis oscillated 33.4 feet, between stages 27.6 feet (June 24) above and 5.8 feet (Dec. 26) below standard low water (4 feet, St. Louis gauge). The normal yearly oscillation is about 24.5 feet, between 22.7 feet above and 1.8 feet below standard low water.

During the winter and spring seasons 17 measurements of discharge of Mississippi River were made at the United States engineer depot (3) and River des Peres (8), St. Louis, with results as follows:

Date.	St. Louis gauge.	Area of cross section.	Mean depth.	Width of waterway.	Mean velocity.	Volume of discharge.	Method.	Oscillations.
1915.	*Feet.*	*Sq. ft.*	*Feet.*	*Feet.*	*Ft. sec.*	*Sec. cu. ft.*		
Jan. 13	2.45	28,950	15.5	1,805	2.25	65,000	Rod floats.....	F.
14	2.40	28,920	15.5	1,805	2.26	65,600	.....do.....	S.
June 1	30.50	75,400	42.7	1,769	8.52	642,700	.....do.....	R.
2	30.90	78,040	44.4	1,778	9.30	734,400	.....do.....	R.
3	31.25	78,040	43.9	1,779	9.09	708,900	.....do.....	S.
4	31.25	81,920	46.0	1,779	8.20	671,700	.....do.....	S.
4	31.25	81,290	45.7	1,779	8.32	676,700	Meter.....	S.
5	30.75	80,940	45.4	1,781	8.29	670,600	Rod floats.....	F.
11	27.55	72,670	41.4	1,755	7.34	533,500	.....do.....	F.
11	27.55	74,090	42.2	1,755	7.28	539,100	Meter.....	F.
16	28.60	75,240	42.7	1,763	7.40	557,000	.....do.....	F.
16	28.60	77,250	43.8	1,763	7.17	553,700	Rod floats.....	F.
24	31.55	78,160	43.8	1,783	8.11	634,000	.....do.....	S.
24	31.55	79,710	44.7	1,783	8.04	641,100	Meter.....	S.
25	31.45	79,600	44.7	1,782	8.19	652,100	.....do.....	F.
25	31.45	78,600	44.1	1,782	8.19	643,500	Rod floats.....	F.

MATERIALS.

For the permanent works of improvement, construction, and repair of hurdle dikes and bank revetments 25,033 cubic yards of stone and spalls, at 70 cents per cubic yard; 193,287 linear feet (4,556 sticks), of pile timber, at an average cost of 10½ cents per linear foot, and 11,733 tons (2,000 pounds) of coal, at from $1.50 to $2.23 per ton were supplied by contract; 8,860 cubic yards of stone and spalls, at 70 cents per cubic yard, were purchased in open market, and 17,431 cubic yards of stone and spalls, at 84.5 cents per cubic yard, and 4,083 cords of brush, at $1.97 per cord, were procured and loaded on Government barges by hired labor.

The stone procured by hired labor was obtained from the quarry at Little Rock Landing, Mo., which has been controlled and operated by this office since 1892. Active operations at the quarry were suspended August 14 on account of curtailing of field work.

In construction of bank revetment at Kaskaskia Island under contract, 114,900 feet b. m. of mattress lumber, at $34 per M. feet b. m., and 1,480 cubic yards of stone and spalls, at $1.59 per cubic yard, were furnished and expended by the contractor in completed work.

All other materials, supplies, stores, subsistence, etc., were purchased under competitive bids therefor or in open market, and were assembled and tested at the engineer depot, St. Louis, Mo., and thence distributed to the various working parties. All coal was tested for payments on the British thermal unit basis.

Numerous inspections were made, as required, of materials and appliances purchased in this vicinity by the Panama Canal.

PLANT.

All plant required for service was maintained in condition by repairs in ordinary upkeep and received extraordinary repairs and rebuilding as necessary to fit it for present and future service. The towboats of this office, *William R. King* and *General J. H. Simpson*, and *Nokomis* (the latter borrowed from the Mississippi River Commission), three steel steam tenders and three smaller wooden tenders, were kept in good repair. Two small wooden tenders, the *Cinque*

Hommes and *Joachim*, built 1893, were condemned as unserviceable and were sold. Repairs incident to active service were made to the four suction dredges. Repairs were made to 9 quarter boats, 4 office and survey boats, 27 wood hull barges, 1 wood hull pile driver, 2 steel hull pile drivers, and 2 steel hull grader and derrick boats. Connections were made to new boilers on the steamer *Oleander*, belonging to the Lighthouse Service, with other alterations and repairs required thereon.

At the Little Rock Quarry, as well as at the engineer depot, St. Louis, derricks, drills, tracks, cars, and all machinery, tools, and appliances, and buildings were kept in good condition.

The total amount appropriated for this district to June 30, 1915, is $17,264,999.98, of which $1,495,000 was expended on the original project under the acts of June 10, 1872, to June 14, 1880, inclusive, and $1,400,000 was expended for improvements under the acts of 1905, 1907, 1908, 1909, leaving $14,369,999.98, to which should be added $86,469.87 received from sales, etc., making a total of $14,456,469.85 available for improvement under the project of 1881 and its revisions. The amount expended to June 30, 1915, from the amount available for the project of 1881 by appropriations and miscellaneous receipts was $13,939,554.48, leaving a balance of $516,915.37 unexpended. The outstanding liabilities are $4,934.55 and amount covered by existing contract $118,453.34, a total of $123,387.89, leaving $393,527.48 available June 30, 1915.

Amount expended during fiscal year	$420,190.13
Reimbursable	2,481.04
Net expenditures	417,709.09

APPROPRIATIONS.

[As shown on p. 847, H. Doc. No. 421 57th Cong., 2d sess.]

Missouri River to Meramec River, June 10, 1872	$100,000.00
Missouri River to Ohio River, Mar. 3, 1873	200,000.00
Illinois River to Ohio River, June 23, 1874, to Mar. 3, 1881	1,795,000.00
Since adoption of project:	
Aug. 2, 1882	565,000.00
July 5, 1884	520,000.00
Aug. 5, 1886	375,000.00
Aug. 11, 1888	300,000.00
Sept. 19, 1890	350,000.00
July 13, 1892	525,000.00
Mar. 3, 1893	658,333.33
Aug. 18, 1894	758,333.33
Mar. 2, 1895	758,333.33
June 3, 1896	275,000.00
June 4, 1897	663,333.33
July 19, 1897	325,000.00
July 1, 1898	673,333.33
Mar. 3, 1899	673,333.33
Since adoption of project—Continued.	
June 6, 1900	$100,000.00
June 13, 1902	650,000.00
Mar. 3, 1903	650,000.00
Apr. 28, 1904	650,000.00
Mar. 3, 1905	650,000.00
Mar. 2, 1907	250,000.00
May 27, 1908	250,000.00
Mar. 4, 1909	250,000.00
June 25, 1910	250,000.00
June 25, 1910	500,000.00
Feb. 27, 1911	1,000,000.00
July 25, 1912	1,000,000.00
Mar. 4, 1913	1,000,000.00
Oct. 2, 1914	250,000.00
Mar. 4, 1915	300,000.00
Total appropriations	17,264,999.98
Miscellaneous receipts from sales, etc	86,469.87
	17,351,469.85

nett, Mo., 25 miles below St. Francis, was taken as the head of improvement for St. Francis River, Ark., in order to avoid confusion or overlap as to the limitation of the project for the improvement of the St. Francis River, Mo. This project continued until by the river and harbor act of June 13, 1902, its scope was enlarged to that of the present project, which includes the L'Anguille River up to Marianna. An abstract of the work done prior to the fiscal year 1896 is given on page 1692 of the Annual Report of the Chief of Engineers for 1896.

(*b*) L'ANGUILLE RIVER.

The original project, which was for improvement by snagging operations, at an estimated cost of $15,000, was adopted by the river and harbor act of June 18, 1878. Appropriations ceased with that made by the river and harbor act of June 4, 1880. The river and harbor act of June 13, 1902, enlarged the St. Francis River project to include this stream.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE ST. LOUIS, MO., DISTRICT.

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1. IMPROVEMENT OF MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS.

Project of 1872, superseded 1881; project of 1881, revised 1883; modified 1895, 1896, 1902, 1905, 1906, 1907, and restored, together with dredging, 1910.

In its original condition, prior to any improvement, the navigable channel of the Mississippi River at low water had a natural depth in many places of only 3½ to 4 feet. The main channels were divided by islands and bars, which formed chutes, sloughs, and secondary channels, through which considerable parts of the low-water flow were diverted, to the detriment of navigation.

The first appropriation for work of improvement was included in the river and harbor act, July 4, 1836, "for a pier to give direction to the current of the Mississippi River, near the city of St. Louis," and subsequently, 1837 and 1844, other appropriations were made for work in the harbor of that city. In 1852 an appropriation was made for work on the Mississippi River between St. Paul and the Ohio River. The expenditures within this district under these old appropriations are now not known.

The original project for the general improvement of the river in this engineer district for the benefit of navigation was recommended by a board of engineers in report dated April 13, 1872. Work was begun in that year and continued for a number of years as appropriations were made. The works consisted of solid dikes and dams of brush and stone, to confine the low-water volume of the river to a single channel, and of revetments to hold and preserve the banks from erosion where necessary and advisable to do so.

Under this project work was done at the following localities: Sawyer Bend, Venice, Cahokia Chute, Arsenal Island, Horsetail Bar,

Fort Chartres, Turkey Island, Kaskaskia, Liberty Island, Devils Island, and Cairo, and the total amount expended was $1,495,000 for new work.

2. REMOVING SNAGS AND WRECKS FROM THE MISSISSIPPI RIVER BELOW THE MOUTH OF THE MISSOURI RIVER AND OLD AND ATCHAFALAYA RIVERS.

When this work was originally begun the navigation of the river was seriously obstructed by numerous snags, logs, etc., which had lodged in the channel, and to which additions were made with each rise of the river. A large number of wrecks of flatboats, barges, steamboats, and other river craft also obstructed the navigable channels and menaced life and property.

For the removal of these obstructions, appropriations were made as early as 1824. The project adopted consisted of building boats suitable for removing snags, logs, drift heaps, wrecks, etc., and operating them whenever the stage of the river was favorable and funds were available, and in cutting trees from caving banks to prevent their falling into the river and becoming obstructions to navigation.

Appropriations for this work were made at irregular intervals in lump sums, under the general style of "Western rivers, dredging, removal of snags, wrecks, and other obstructions, including Arkansas, Mississippi, Missouri, and Ohio Rivers."

In the river and harbor act approved March 3, 1879, the first definite allotment to each river was made, and work was done under these uncertain appropriations until August 11, 1888, when the present project was placed on a definite basis by the adoption of the river and harbor act of that date, which provided a definite annual amount, $100,000, for removal of obstructions in the Mississippi River below the Missouri River.

The approximate amount expended on the previous projects to March 3, 1879, was $358,627.35, and the work done to that date was 12,003 snags destroyed, 53,299 trees cut, 82 drift piles destroyed, and 1 wreck removed.

HISTORICAL SUMMARY GIVING SCOPE OF PREVIOUS PROJECTS FOR IMPROVEMENT OF RIVERS AND HARBORS IN THE ROCK ISLAND, ILL., DISTRICT.

MISSISSIPPI RIVER.

1. *Rock Island Rapids improvement, Mississippi River.*—The Rock Island Rapids extend from Le Claire, Iowa, to Rock Island, Ill., a distance of about 14 miles. The initial appropriation for their improvement was made by act of June 23, 1866. A board of engineers in 1866 advised the cutting of a channel through the chains of rock. Based on a survey of Capt. P. C. Hains, Corps of Engineers, made in 1866, the original project was approved. This project contemplated "the connection of the deep pools by channels cut through the chains 200 feet wide with depth of 4 feet at low water." These plans were carried out and virtually completed in 1882. A full report of this improvement is in Annual Report of the Chief of Engineers for 1886,