also prepare plans, specifications, and make estimates of the cost of said improvement, and define the channel or the course of said canal, and shall take into account and make report upon any proposition by local interests for participation in the expense of said project in connection with the reclamation of contiguous lands or other land subject to overflow by said stream.

2. Black River, Ark. and Mo.

3. Black River, Ark. and Mo., above Black Rock, Ark., etc.

4. Canadian River, N. Mex., Tex., and Okla., with a view to control of the floods.

5. North Fork Canadian, Tex. and Okla., with a view to control of the floods.

6. Deep River, Okla., with a view to control of the floods.

7. Verdigris River, Okla., with a view to control of the floods.

8. Little River, Okla., with a view to control of the floods.

9. Cimarron River, N. Mex. and Okla., with a view to control of the floods.

10. Arkansas River, Kans., Okla., and Ark., with a view to control of the floods.

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

This district includes the Mississippi River between the Ohio and Missouri Rivers, and removing snags and wrecks from the Mississippi River below the mouth of the Missouri River and from Old and Atchafalaya Rivers.

District engineer: Maj. Lunsford E. Oliver, Corps of Engineers, to May 5, 1924, and Maj. John C. Gotwals, Corps of Engineers, since that date.

Division engineer: Col. Charles L. Potter, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis engineer district embraces the 200-mile section, known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and 1,078 to 1,278 miles from the Gulf. The drainage area of the valley down to the Ohio and discharging through the district is about 707,000 square miles. At St. Louis the discharge in cubic feet per second for the low-water plane,[1] 1-foot gauge, is 40,000; at mean stage, 12.4-foot gauge, 150,000; at bank-full

[1] One foot on St. Louis gauge, 3 feet on Commerce gauge, and 4 feet on Cairo gauge, the plane of reference, adopted in 1918, for district operations. "Standard low water," adopted in 1881, was 4 feet on the St. Louis gauge, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at the 1-foot stage.

stage, 30-foot gauge, 600,000; and for the maximum flood plane about 1,250,000. The average natural depths available for navigation at the same stages are about 4½, 9, and 16 feet; i. e., the crests of the bars rise and fall with the stage in the ratio of 1 to 2½. The oscillation between annual low and high waters averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below mouth of Missouri River; the extreme range is 55.7 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.6 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. The low-water plane at the mouth of Ohio River is 274 feet above mean sea level and at the mouth of Missouri River it is 395 feet, the average slope being six-tenths foot per mile. The current at mean stage is about 2½ miles per hour and the average width between banks is 4,300 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The amount expended thereunder was $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of 8 feet at low water from the mouth of Ohio River (1,078 miles from the Gulf) to St. Louis, 183 miles, and 6 feet thence to the mouth of Missouri River, 17 miles, with a minimum width of channel of 200 feet, to be obtained by regulating works and dredging, as follows:

First. By regulating works, for closing sloughs and secondary channels, narrowing the river to a uniform width of about 2,500 feet at bank-full stage, building new banks where the natural width is excessive, and by protecting new and old banks from erosion where necessary to secure permanency.

Second. By dredging or other temporary expedients, pending the completion of the permanent improvement, so as to maintain each season the required low-water depth of channel.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropriations "with a view to the completion of the improvement within twelve years," at an estimated cost of $21,000,000, exclusive of amounts previously expended, and $400,000 annually thereafter for maintenance. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.)

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

In addition to the $10,000 contributed May 3, 1923, the Missouri-Illinois Railroad Co., Bonne Terre, Mo., contributed $100,000 toward the construction of new and the restoration of old regulating works in the vicinity of Little Rock Landing, Mo., for the purpose of removing a sand bar obstructing the railroad incline at that point, thus incidentally improving the alignment of the banks and channel and protecting from erosion the alluvial bank opposite in Illinois. This work was completed and all contributed funds were expended during the fiscal year.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto, reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223, and 1923, pages 1080–1081.

A large concrete grain elevator, capacity 1,750,000 bushels, loading capacity into barges 20,000 bushels per hour, and total cost $1,350,000, was constructed at the foot of Primm Street, St. Louis, Mo., by the Missouri Pacific Elevator Co.; this elevator was put into operation December 1, and the first barge load of grain therefrom, 64,000 bushels, was shipped April 21, 1924. The $35,000,000 plant of the Union Electric Light and Power Co., having a river front of 1,000 feet at Cahokia, Ill., opposite St. Louis, has been provided with a concrete dock, costing about $75,000, for receiving coal from river barges in emergencies.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, 8-foot navigation throughout the lowest of low-water seasons being an accomplished fact; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the rivers; freight rates by water are generally 80 per cent of the rail rates.

Operations and results during fiscal year.—Maintenance of existing regulating works, including such minor extensions and new works as were required for that purpose, was continued by hired labor, July 1 to December 31, 1923, and after February 24, 1924. Nine permeable dikes of piling, 1,040 linear feet, were repaired at a cost of $71.901.11; and 8 new extensions were built, 5,610 linear feet costing $185,757.96. Bank revetments were repaired at 8 localities, 3,957 squares of mattress and 2,647 squares of stone paving,

costing $100,265.01, and 2 new extensions, 3,795 linear feet, 3,827 squares of mattress and 2,412 squares of stone paving, cost $92,630.48. The total thus expended for maintenance of regulating works was $172,166.12, and for new work $278,388.44. The 4 hydraulic pipeline dredges of the district and the dipper dredge *Davenport*, leased from the St. Paul district, all operated by hired labor, maintained the required or project dimensions of channel; 1,632,100 cubic yards of sand and gravel were dredged from 17 main channel areas having a combined length of more than 10 miles and an average width of 240 feet; the average gain in depth due to all dredging was 4½ feet, and the total cost thereof, including rebuilding the dredge *Selma* and an unusually thorough heavy repair of all dredges, was $405,440.94. Surveys were made covering 130 miles of river, including all dredged channels; 63 miles were resurveyed, making a total of 193 river miles of hydrographic surveys at a cost of $25,301.07. Including $68,027.28 for liabilities July 1, 1923, the total expenditures were $881,296.57, of which $278,388.44 was for new work and $602,908.13 for maintenance from United States funds. In addition, $110,000 was expended from contributed funds for improvement of Mississippi River at Little Rock Landing, Mo., repairing 455 linear feet and constructing 2,125 linear feet of dikes.

Condition at end of fiscal year.—The existing project is about 35.5 per cent completed. For physical extent of work accomplished and status and requirements of the project, see Annual Report, 1921, page 1198.

The expenditures on regulating works in this district between 1914 and 1921 were insufficient to repair seasonal damages and considerable deterioration occurred. However, during 1922 and 1923 existing structures were maintained with but little deterioration. Between the mouth of Ohio River and St. Louis dredging is always required during the fall or low-water season, from July or August to the close of navigation by ice or winter conditions, usually in December, and is occasionally required in the spring season; project dimensions of channel in that section of river have been maintained throughout navigation seasons since 1907, except for short periods of time when river stage was very low and dredges were attacking the obstructive bars. Between St. Louis and the mouth of Missouri River the project dimensions of channel have been maintained by action of the river itself with but very infrequent aid from dredging when river stage was unusually low. From the opening of the navigation season, usually in February, to July, inclusive, or, when river stage is above 10 feet on the St. Louis gauge, a minimum channel depth of 8 feet generally prevails throughout the entire district without dredging or other artificial aid. For the natural depths available to navigation see Annual Report for 1918, page 2733. The least channel depths last observed during the low-water season were: From mouth of Ohio River to St. Louis, 8 feet, December 3, 1923, St. Louis gauge, 4.9 feet; from St. Louis to mouth of Missouri River, 9½ feet, September 26, 1923, St. Louis gauge, 4.1 feet. The total expenditures, under the existing project from 1881 to date are $10,208,407.63 for new work and $9,720,127.88 for maintenance, including dredging and surveys, a total sum of $19,928,535.51. In addition $110,000 has been expended from contributed funds for improvement of Mississippi River near Little Rock Landing, Mo. The

amount expended on the existing project since the estimate was revised in 1910 is $2,048,281.85 for new work, from United States funds.

Proposed operations.—With the funds unexpended the project dimensions of channels will be maintained throughout the year; needed repairs to the regulating works and a limited amount of new work tending toward the rectification of the channel and its easier maintenance will be done. These operations, including upkeep of floating plant, are to be carried on continuously, with dredging as needed, except in winter when navigation is stopped by ice and during floods. Construction of some new plant is also provided for. During the low-water season, July to December, inclusive, when the construction and maintenance of regulating works and dredging are being actively prosecuted, funds will be expended at the rate of about $75,000 per month; a total of $50,000 will be expended in January and February on repair and care of floating plant in winter harbor; for the period March to June, inclusive, expenditures for regulating works, new plant and repair of plant, and possibly some dredging, should be about $350,000. All funds will be exhausted by June 30, 1925. The balance ($958,064.47) unexpended July 1, 1924, will be applied in the ensuing fiscal year, as follows:

(*a*) Maintenance of project dimensions of channel, dredging by United States plant and hired labor, operation of 4 hydraulic pipe-line dredges during low-water season, August to December, inclusive, and upkeep of same	$275,000.00
(*b*) Construction of new and maintenance of existing regulating works—dikes and revetments—by United States plant and hired labor, July 1 to Sept. 30, 1924	200,000.00
(*c*) New plant: By contract, 6 steel barges, $140,000; 10 steel barges, $25,000; and 10 steel pontons for pipe line for dredge *Thebes*, $35,000; and by purchase, 1 small towboat, $50,000	250,000.00
(*d*) Upkeep and care of plant other than dredges	70,000.00
(*e*) Office; engineering, surveys, and gauges	37,560.00
(*f*) Contingencies	10,000.00
(*g*) Outstanding liabilities and contract obligations	115,504.47
Total	958,064.47

Commercial interests have become such as to demand the assurance of an easily navigated channel of full project dimensions, and steps to that end are now being taken. The sum of $3,000,000 can be profitably expended during the fiscal year ending June 30, 1926, as follows:

	Maintenance	Improvement
(*a*) Construction of new, and maintenance of existing regulating works, by United States plant and hired labor	$300,000	$350,000
(*b*) Maintenance of full project dimensions of channels, dredging by United States plant and hired labor, operation and upkeep of 4 hydraulic pipe-line dredges	300,000	
(*c*) New plant: Items required in fiscal year 1926 for 3 piling-dike units and 2 revetment units, taking into account plant provided for in 1925 and the plant now on hand		1,850,000
(*d*) Upkeep and care of plant, other than dredges	100,000	
(*e*) Office, engineering, surveys, and gauges	25,000	25,000
(*f*) Contingencies	25,000	25,000
Totals	750,000	2,250,000

Commercial statistics.—River traffic in the calendar year 1923 was 174,954 tons greater in total tonnage than in 1922, of which 113,671 tons were downbound and 61,283 tons upbound. For detailed information concerning the commodities and tonnage handled reference is made to the commercial statistics report of this district published in a separate volume. The full project dimensions of channel were utilized, the drafts of loaded barges being generally 5 feet to 8 feet and occasionally 9 feet. The improvement has greatly facilitated the traffic, which shows a general increase in the last five years as indicated by the following:

Comparative statement

Calendar year	Short tons	Approximate value	Passengers	Calendar year	Short tons	Approximate value	Passengers
1919	288,286	$22,684,001	422,603	1922	[1] 548,114	43,193,152	1,945,642
1920	[1] 363,062	30,870,399	447,704	1923	[1] 723,068	38,962,069	2,689,258
1921	[1] 481,151	47,481,764	832,963				

[1] Includes Government materials for river improvement work not included in previous years: 70,088 tons in 1920, 80,799 tons in 1921, 95,274 tons in 1922, and 120,769 tons in 1923.

Financial summary

UNITED STATES FUNDS

Amount expended on all projects to June 30, 1924, after deducting receipts from sales, etc., amounting to $410,703.86:	
New work	$11,703,407.63
Maintenance	9,720,127.88
Net total expended	21,423,535.51
Total appropriations to date of this report	22,381,599.98

Fiscal year ending June 30	1920	1921	1922	1923	1924
Expended for new work [1]	$25,761.85		$7,731.09	$75,004.83	$278,388.44
Expended for maintenance [1]	490,874.65	$487,922.09	491,684.30	653,596.91	602,908.13
Total expended [1]	516,636.50	487,922.09	499,415.39	728,601.74	881,296.57
Appropriated or allotted	400,000.00	400,000.00	915,000.00	810,000.00	700,000.00

July, 1923, balance unexpended		$1,101,482.40
Amount allotted from War Department appropriations act approved June 7, 1924		700,000.00
Receipts from sales, etc., during fiscal year 1924		37,878.64
		1,839,361.04
June 30, 1924, amount expended during fiscal year: [1]		
For new work	$278,388.44	
For maintenance	602,908.13	
		881,296.57
July 1, 1924, balance unexpended		958,064.47

[1] Not deducting receipts from sales, etc.

July 1, 1924, outstanding liabilities	$74,696.47	
July 1, 1924, amount covered by uncompleted contracts	40,808.00	
		$115,504.47
July 1, 1924, balance available		842,560.00
Amount (estimated) required to be appropriated for completion of existing project		[2]16,980,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1926:		
For new work		[2]2,250,000.00
For maintenance		[2]750,000.00
Total		[2]3,000,000.00

CONTRIBUTED FUNDS

Amount expended on all projects to June 30, 1924:	
New work	$87,171.69
Maintenance	22,828.31
Net total expended	110,000.00
Total contributions to date of this report	110,000.00

Fiscal year ending June 30	1920	1921	1922	1923	1924
Expended for new work					$87,171.69
Expended for maintenance					22,828.31
Contributed				$10,000.00	100,000.00

July 1, 1923, balance unexpended		$10,000.00
Amount contributed by local interests for work at Little Rock Landing, Mo		100,000.00
		110,000.00
June 30, 1924, amount expended during fiscal year:		
For new work	$87,171.69	
For maintenance	22,828.31	
		110,000.00

CONSOLIDATED FINANCIAL SUMMARY FOR MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Amount expended on all projects to June 30, 1924, after deducting receipts from sales, etc., amounting to $410,703.86:		
New work		$11,790,579.32
Maintenance		9,742,956.19
Net total expended		21,533,535.51
Total appropriations to date of this report		22,491,599.98

Fiscal year ending June 30	1920	1921	1922	1923	1924
Expended for new work [1]	$25,761.85		$7,731.09	$75,004.83	$365,560.13
Expended for maintenance [1]	490,574.65	$487,922.09	491,684.30	653,596.91	625,736.44
Total expended [1]	516,636.50	487,922.09	499,415.39	728,601.74	991,296.57
Appropriated or allotted	400,000.00	400,000.00	915,000.00	810,000.00	800,000.00

[1] Net deducting receipts from sales, etc. [2] Exclusive of available funds.

July 1, 1923, balance unexpended		$1,111,482.40
Funds contributed for improving Mississippi River, near Little Rock Landing, Mo.		100,000.00
Amount allotted from War Department appropriation act approved June 7, 1924		700,000.00
Receipts from sales, etc., during fiscal year 1924		37,878.64
		1,949,361.04
June 30, 1924, amount expended during fiscal year:[1]		
For new work	$365,560.13	
For maintenance	625,736.44	
		991,296.57
July 1, 1924, balance unexpended		958,064.47
July 1, 1924, outstanding liabilities	$74,696.47	
July 1, 1924, amount covered by uncompleted contracts	40,808.00	
		115,504.47
July 1, 1924, balance available		842,560.00
Amount (estimated) required to be appropriated for completion of existing project		[2]16,980,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1926:		
For new work		[2]2,250,000.00
For maintenance		[2]750,000.00
Total		[2]3,000,000.00

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

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis snagging district embraces that portion of the river between Head of Passes, and the mouth of Missouri River, 1,265 miles, 8 miles of Old River (present mouth of Red River), and 27 miles of Atchafalaya River from Red River to Melville, La.: total, 1,300 miles.

Original condition.—Navigation of the river was seriously obstructed by numerous snags, drift-heaps, etc., which had lodged in the channel and to which additions were made with each rise of the river.

Many wrecks of flatboats, barges, and steamboats also obstructed the navigable channel and menaced life and property, the sinking of steamboats and other river craft by such obstructions having been of common occurrence.

Previous projects.—For the removal of these obstructions general appropriations were made at irregular intervals as early as 1824. The amount expended prior to 1879, when the first definite allotment was made for the work, was approximately $358,627.35. For further details of previous projects see page 1880 Annual Report for 1915.

Existing project.—This is a continuation of the plan adopted in 1879 and provides for the removal and destruction of snags, wrecks,

[1] Not deducting receipts from sales, etc. [2] Exclusive of available funds.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis engineer district embraces the 200-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and 1,078 to 1,278 miles from the Gulf. The drainage area of the valley down to the Ohio and discharging through the district is about 707,000 square miles. At St. Louis the discharge in cubic feet per second for the low-water plane,[1] 1-foot gauge, is 40,000; for mean stage, 12.4-foot gauge, 150,000; for bank-ful stage, 30-foot gauge, 600,000; and for maximum flood plane, 1,250,000; mean discharge of river being 175,000 cubic feet per second. The average natural depths available for navigation at low-water, mean, and bank-full stages are about 4½, 9, and 16 feet, respectively; i. e., crests of bars rise and fall with stage as 1 to 2½. The oscillation between annual low and high waters averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below mouth of Missouri River; the extreme range is 55.7 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.6 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. The low-water plane at the mouth of Ohio River is 274 feet above mean sea level and at the mouth of Missouri River it is 395 feet, the average slope being six-tenths foot per mile. The current at mean stage is about 2½ miles per hour and the average width between banks is 4,300 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The amount expended thereunder was $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of 8 feet at low water from the mouth of

[1] One foot on St. Louis gauge, 3 feet on Commerce gauge, and 4 feet on Cairo gauge, the plane of reference, adopted in 1918, for district operations. "Standard low water," adopted in 1881, was 4 feet on the St. Louis gauge, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the 1-foot stage.

Ohio River (1,078 miles from the Gulf) to St. Louis, 183 miles, and 6 feet thence to the mouth of Missouri River, 17 miles, with a minimum width of channel of 200 feet, to be obtained by regulating works and dredging, as follows:

First. By regulating works, for closing sloughs and secondary channels, narrowing the river to a uniform width of about 2,500 feet at bank-full stage, building new banks where the natural width is excessive, and by protecting new and old banks from erosion where necessary to secure permanency.

Second. By dredging or other temporary expedients, pending the completion of the permanent improvement, so as to maintain each season the required low-water depth of channel.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropriations "with a view to the completion of the improvement within twelve years," at an estimated cost of $21,000,000, exclusive of amounts previously expended, and $400,000 annually thereafter for maintenance. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.)

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 80. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

The Missouri-Illinois Railroad Co., Bonne Terre, Mo., contributed $110,000 in the fiscal years 1923 and 1924 toward the construction of new and the restoration of old regulating works in the vicinity of Little Rock Landing, Mo., for the purpose of removing a sand bar obstructing the railroad incline at that point, thus incidentally improving the alignment of the banks and channel and protecting from erosion the alluvial bank opposite in Illinois.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; and 1923, pages 1080–1081.

A large concrete grain elevator, capacity 1,750,000 bushels, loading capacity into barges 20,000 bushels per hour, and total cost $1,350,000, was constructed at the foot of Primm Street, St. Louis, Mo., by the Missouri Pacific Elevator Co.; this elevator was put into

operation December, 1923, and shipments of grain therefrom were made throughout the navigation season of 1924. The $35,000,000 plant of the Union Electric Light & Power Co., having a river front of 1,000 feet at Cahokia, Ill., opposite St. Louis, has been provided with a concrete dock, costing about $75,000, for receiving coal from river barges in emergencies.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, 8-foot navigation throughout the lowest of low-water seasons being an accomplished fact; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the rivers; freight rates by water are generally 80 per cent of the rail rates.

Operations and results during fiscal year.—Existing regulating works were maintained in good condition and new construction of greater amount than in any single year since 1914 was undertaken to the full extent of available plant and organization, favorable weather, a good labor market, moderate river stages, and increased appropriations all being conducive to the progress of the work, which was continued by hired labor, using the district's standard forms of construction, July 1 to December 11, and after March 2, as follows:

Class of work	Permeable dikes of piling (hurdles)			Revetments (bank protection)				
					Mattress			
	No.	Linear feet	Expenditure	No.	Linear feet	Squares	Paving squares	Expenditure
New	6	7,925	$290,756.31	2	2,690	2,995	1,883	$62,430.29
Maintenance	16	5,545	145,737.42	11		3,794	4,126	114,827.13

The total thus expended for new regulating works was $353,186.60, and for maintenance of works $260,564.55.

The floating plant was maintained in condition and additional plant was procured as follows: By contract, 6 steel barges, 12 steel pontoons, and pipe line for dredge; and by purchase, towboat *Tuscumbia*, launch *Black Prince*, and 9 wooden barges. Total cost of plant purchased $165,040 and charged as follows: $148,864 to new work, and $16,176 to maintenance of dredges.

The 4 pipe-line dredges of the district were operated by hired labor and maintained the required or project dimensions of channel; 1,725,800 cubic yards of sand and gravel were dredged at 19 localities from 30 main channel areas, having a combined length of almost 10 miles and an average width of 240 feet; average gain in depth due to dredging, 4 feet. Expenditure for dredging, including thorough heavy repair of all dredges, $262,169.26. Hydrographic surveys were made covering 142 miles of river, including the dredged channels, and 37 miles were resurveyed; expenditure therefor, $22,304.06.

The total expenditures were $1,118,156.40; $552,744.81 for new work and $565,411.59 for maintenance, including dredging and surveys, and including $71,067.93 of obligations from the previous year paid in 1925.

Condition at end of fiscal year.—The existing project is about 37 per cent completed. The regulating works required to complete the project are estimated as follows: 323 dikes or hurdles, 359,900 linear feet; 58 revetments, mattress and paving, 291,860 linear feet, and mattress alone, 141,160 linear feet. The old hurdles and revetments have been maintained since 1921 with little or no deterioration, and together with the new works constructed during the last two years have had a beneficial effect upon the channel. To supplement the action of incomplete regulating works, dredging is required during the fall or low-water season, from July or August to the close of navigation by ice or winter conditions, and occasionally in the spring season; project dimensions of channels have been maintained throughout navigation seasons since 1907, except for short periods of time when river stages were low and dredges were attacking the obstructive bars. From the opening of navigation, usually in February to July, inclusive, or, when river stage is above 10 feet on the St. Louis gauge, a minimum channel depth of 8 feet generally prevails throughout the entire district without dredging. (Annual Report, 1918, p. 2733.) The least channel depths observed during the last low-water season were: From mouth of Ohio River to St. Louis, 6 feet, September 15–18, 1924, St. Louis gauge, 9½ feet; from St. Louis to mouth of Missouri River, 8 feet, October 8, 1924, St. Louis gauge, 7.7 feet. The total expenditures under the existing project from 1881 to date are $10,753,046.68 for new work and $10,285,539.47 for maintenance including dredging and surveys; a total of $21,038,586.15. The amount expended on the existing project since the estimate was revised in 1910 is $2,592,920.90 for new work.

Proposed operations.—Project dimensions of channels will be maintained throughout the year. Regulating works will be repaired so that all structures are safeguarded. New work will be prosecuted as rapidly as the limited plant available makes possible. Construction of a substantial amount of new plant will also be carried out. These operations, which will include the upkeep of floating plant, will be carried on continuously except during wintertime when navigation is usually interrupted by ice conditions.

Dredging will be continued to maintain the project dimensions of channel as required by the stage of water in the river. The low-water season, July to December, inclusive, is the most favorable time for the construction and maintenance of regulating works. Throughout this period of active operations, funds will be expended at the rate of about $150,000 per month. In January and February, when most of the floating plant is held in winter harbor, a total of $50,000 will be expended for repair and care of floating plant. During the period, March to June, inclusive, expenditures for regulating works, for the construction of new plant, and for repair of plant will be at the rate of $150,000 per month. All funds will be exhausted by June 30, 1926. The balance, $1,698,013.83, unexpended July 1, 1925, will be applied in the ensuing fiscal year as follows:

(*a*) Construction of new, and maintenance of existing regulating works, dikes, and revetments, by United States plant and hired labor		$678,013.83
(*b*) Maintenance of full project dimensions of channel, dredging by United States plant and hired labor, operation and upkeep of 4 hydraulic pipe-line dredges		340,000.00
(*c*) New plant, by contracts:		
1 small towboat (Diesel electric)	$120,000	
6 standard barges	125,000	
20 small barges (flats)	60,000	
5 steel pile drivers	100,000	
1 quarter boat	40,000	
1 store boat	30,000	
		475,000.00
(*d*) Upkeep and care of plant other than dredges		95,000.00
(*e*) Office, engineering, surveys, and gauges		50,000.00
(*f*) Contingencies		60,000.00
Total		1,698,013.83

Commercial interests demand the provision of a channel for navigation in this portion of the Mississippi River, Cairo to St. Louis, of assured depth and stabilized location. The work of reestablishing old works of contraction and revetment is being energetically put under way. New works have been planned and a few are being executed to the great benefit of navigation. The sum of $2,000,000 can be profitably expended during the fiscal year ending June 30, 1927, as follows:

(*a*) Construction of new and maintenance of existing regulating works by United States plant and hired labor	$1,150,000
(*b*) Maintenance of full project dimensions of channel, dredging by United States plant and hired labor, operation and upkeep of 4 hydraulic pipe-line dredges	300,000
(*c*) New plant	300,000
(*d*) Upkeep and care of plant other than dredges	100,000
(*e*) Office, engineering, surveys, and gauges	50,000
(*f*) Contingencies	100,000
Total	2,000,000

Commercial statistics.—River traffic in the calendar year 1924 was 15,660 tons greater in total tonnage than in 1923, but a decrease in value of $2,217,852, due principally to decreased tonnage and value of chemicals upbound. For detailed information concerning the commodities and tonnage handled, of which 300,009 tons were upbound and 438,719 tons were downbound, reference is made to the commercial statistics report of this district published in a separate volume.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound, sugar, molasses, and sirup; logs and bauxite ore. Downbound, grain, concentrates, and iron and steel.

The full project dimensions of channel were utilized, the drafts of loaded barges being generally 5 feet to 8 feet and occasionally 9 feet. The improvement has greatly facilitated the traffic, which shows a gradual increase in the last five years as indicated by the following:

Comparative statement

Calendar year	Short tons	Approximate value	Passengers	Calendar year	Short tons	Approximate value	Passengers
1920	[1] 363,082	$30,870,399	447,704	1923	[1] 723,068	$38,952,689	2,689,258
1921	[1] 481,151	47,481,764	532,963	1924	[1] 738,728	36,734,217	1,771,971
1922	[1] 546,114	43,193,152	1,946,642				

[1] Includes Government materials for river improvement work not included in previous years; 70,058 tons in 1920, 80,799 tons in 1921, 95,274 tons in 1922, 120,769 tons in 1923, and 130,913 tons in 1924.

Financial summary

Amount expended on all projects to June 30, 1925, after deducting receipts from sales, etc., amounting to $418,809.62:		
New work		$12,248,046.68
Maintenance		10,285,539.47
Net total expended		22,533,586.15
Total appropriations to June 30, 1925		24,231,599.98

Fiscal year ending June 30	1921	1922	1923	1924	1925
Expended for new work [1]		$7,731.09	$75,004.83	$278,388.44	$552,744.81
Expended for maintenance [1]	$487,922.09	491,684.30	653,596.91	602,908.13	565,411.59
Total expended [1]	487,922.09	499,415.39	728,601.74	881,296.57	1,118,156.40
Appropriated or allotted	400,000.00	915,698.00	810,000.00	700,600.00	1,850,000.00

July 1, 1924, balance unexpended		$958,064.47
Amount allotted from War Department appropriation act approved June 7, 1924		300,000.00
Amount allotted from War Department appropriation act approved February 12, 1925		1,550,000.00
Receipts from sales, etc., during fiscal year 1925		8,105.76
		2,816,170.23
June 30, 1925, amount expended during fiscal year: [1]		
For new work	$552,744.81	
For maintenance	565,411.59	
		1,118,156.40
July 1, 1925, balance unexpended		1,698,013.83
July 1, 1925, outstanding liabilities	174,210.72	
July 1, 1925, amount covered by uncompleted contracts	10,300.00	
		184,510.72
July 1, 1925, balance available		1,513,503.11
Amount (estimated) required to be appropriated for completion of existing project		[2] 16,320,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1927:		
For new work		[2] 1,400,000.00
For maintenance		[2] 600,000.00
Total		[2] 2,000,000.00

[1] Not deducting receipts from sales, etc.
[2] Exclusive of available funds.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis engineer district embraces the 200-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and 1,078 to 1,278 miles from the Gulf. The drainage area of the valley down to the Ohio and discharging through the district is about 707,000 square miles. At St. Louis the discharge in cubic feet per second for the low-water plane,[1] 1-foot gauge, is 40,000; for mean stage, 12.4-foot gauge, 150,000; for bank-full stage, 30-foot gauge, 600,000; and for maximum flood plane, 1,250,000; mean discharge of river being 175,000 cubic feet per second. The average natural depths available for navigation at low-water, mean, and bank-full stages are about 4½, 9, and 16 feet, respectively; i. e., crests of bars rise and fall with stage as 1 to 2½. The oscillation between annual low and high waters averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below mouth of Missouri River; the extreme range is 55.7 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.6 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. The low-water plane at the mouth of Ohio River is 274 feet above mean sea level and at the mouth of Missouri River it is 395 feet, the average slope being six-tenths foot per mile. The current at mean stage is about 2½ miles per hour and the average width between banks is 4,300 feet.

Original conditon.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The amount expended thereunder was $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of 8 feet at low water from the mouth of Ohio River (1,078 miles from the Gulf) to St. Louis, 183 miles, and

[1] One foot on St. Louis gauge, 3 feet on Commerce gauge, and 4 feet on Cairo gauge, the plane of reference, adopted in 1918, for district operations. "Standard low water," adopted in 1881, was 4 feet on the St. Louis gauge, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the 1-foot stage.

6 feet thence to the mouth of Missouri River, 17 miles, with a minimum width of channel of 200 feet, to be obtained by regulating works and dredging, as follows:

First. By regulating works, for closing sloughs and secondary channels, narrowing the river to a uniform width of about 2,500 feet at bank-full stage, building new banks where the natural width is excessive, and by protecting new and old banks from erosion where necessary to secure permanency.

Second. By dredging or other temporary expedients, pending the completion of the permanent improvement, so as to maintain each season the required low-water depth of channel.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropriations "with a view to the completion of the improvement within twelve years," at an estimated cost of $21,000,000, exclusive of amounts previously expended, and $400,000 annually thereafter for maintenance. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.)

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historial sketch see Annual Report, 1912, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

The Missouri-Illinois Railroad Co., Bonne Terre, Mo., contributed $110,000 in the fiscal years 1923 and 1924 toward the construction of new and the restoration of old regulating works in the vicinity of Little Rock Landing, Mo., for the purpose of removing a sand bar obstructing the railroad incline at that point, thus incidentally improving the alignment of the banks and channel and protecting from erosion the alluvial bank opposite in Illinois.

The Union Electric Light & Power Co. contributed $8,500 in the fiscal year of 1926 toward the construction of new regulating works at Calico Island, Ill., for the protection of one of their transmission towers, and thus incidentally improving the alignment of the banks at that locality.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921,

pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; and 1924, page 1081.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, 8-foot navigation throughout the lowest of low-water season being an accomplished fact; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the rivers; freight rates by water are generally 80 per cent of the rail rates.

Operations and results during fiscal year.—Extensive construction of regulating works, resumed actively in 1924 and 1925, was continued with increased resources and efforts, and about 25 per cent more new work was accomplished than in both of those years. Maintenance of regulating works and of project dimensions of channel was also accomplished. Work was carried on by United States plant and hired labor and by contract July 1 to December 6 and after March 5. The district's standard forms of construction were used and in addition thereto three experimental types of concrete dike ends were constructed, mostly by contract, with a view to making the outer portions of dikes more enduring against ice and channel attack. Quantities and expenditures for regulating works follow:

Class of work	Permeable dikes of piling (hurdles)			Revetments (bank protection)				
					Mattress			
	Number	Linear feet	Expenditure	Number	Linear feet	Squares	Paving squares	Expenditure
New	12	15,160	$448,934.00	1	11,920	12,853	4,795	$236,573.25
New (concrete)		1,070	178,370.00					
Maintenance	16	3,405	93,886.00	11		609	1,946	38,100.00

The total thus expended for new regulating works was $863,877.25, including $101,211.30 by contract, and for maintenance of works $131,986.

The floating plant of the district received extensive repairs and was maintained in thoroughly serviceable condition. Additional new plant was procured by contract as follows: Diesel-electric towboat *Gouverneur*, an innovation on the western rivers, and six standard steel barges; the cost of new plant, $248,000, is charged to new work.

The four pipe-line dredges of the district maintained the required 8-foot channel except for very short periods of time and with only slight delays to navigation; 2,170,000 cubic yards of sand and gravel were dredged at 23 localities from 34 main-channel areas having a combined length of 11½ miles, an average width of 250 feet, and an average gain in depth of 4 feet. Expenditures therefor, including extensive repairs to dredging plant, were $307,787.41. Hydrographic surveys were made covering 146 miles of river, including all dredged channels and a special survey with slope and discharge observations

in St. Louis Harbor. An aerial survey depicting the entire stretch of river between the Ohio and Missouri was made by the Army Air Service.

The total expenditures were $1,581,650.66 from United States funds, $1,111,877.25 for new work, and $469,773.41 for maintenance, including dredging and surveys, and $79,384.21 of obligations from the previous year paid in 1926. In addition $8,500 was expended from contributed funds for improvement of Mississippi River at Calico Island, Ill., constructing 300 linear feet of piling dike.

Condition at end of fiscal year.—The regulating works are about 40 per cent completed, the quantities required to complete the project being estimated as follows: Three hundred and twelve dikes, 343,400 linear feet, and 56 revetments, 421,000 linear feet. The old dikes and revetments have been thoroughly repaired, and with the extensive new construction of the last three years have had a beneficial effect upon the channel. To supplement the action of regulating works and remove temporary shoals from the channel dredging is required during the fall or low-water season and occasionally in the spring season. Project dimensions of channels have generally been maintained throughout navigation seasons since 1907 with only slight and infrequent delays to navigation. For two-thirds of the average navigation season river stage is above 10 feet on the St. Louis gauge and a minimum channel depth of 8 feet generally prevails throughout the entire district without dredging. (Annual Report, 1918, p. 2733.) The navigation season is usually closed because of ice from latter part of December to early part of February. The least channel depths observed during the last low-water season were: From the mouth of Ohio River to St. Louis, 5½ feet, September 4, 1925, St. Louis gauge, 3 feet; from St. Louis to the mouth of Missouri River, 4 feet, September 2, 1925, St. Louis gauge, 3.7 feet. The total expenditures under the existing project from 1881 to date are $11,859,204.68 for new work and $10,755,312.88 for maintenance, including dredging and surveys, a total of $22,614,517.56. The amount expended on the project since the estimate was revised in 1910 is $3,699,078.90 for new work.

Proposed operations.—The present project dimensions of steamer channels will be maintained. Work upon regulating structures, first, will be those necessary to safeguard all structures and, second, will include an extension of regulating works at the points most seriously requiring contraction of the river or bank protection. The substantial new work now being done aims at the performance of such works continuously downstream from fixed points and, wherever possible, removing the most serious obstructions in the steamer channel or protecting the most rapidly caving banks. Some new plant will also be constructed. Effort will be made to minimize the new plant required by performing all work possible by contract. All of these operations will be carried on at the same time and will include the maintenance of all floating plant. The work will be prosecuted continuously except during midwinter, when navigation and work on the river are interrupted by ice conditions.

Dredging will be required, depending upon the river stage, to maintain the project dimensions of channel. The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works. Throughout this period of active operations funds will be expended at the rate of about $325,000 per month. During December, January, and February, when most of the plant is tied up in winter harbor, expenditures will amount to about $65,000 per month, covering the repair and safeguarding of floating plant and the construction of new plant under way. During the period March to June, inclusive, expenditures for regulating works and for the construction of new plant will be at the rate of $325,000 per month. All funds will be exhausted by June 30, 1927. The balance, $3,122,082.42, unexpended July 1, 1926, will be applied in the ensuing fiscal year, as follows:

(*a*) Regulating works—dikes and revetments:		
Construction, by contract		$982,500.00
Construction, by United States plant and hired labor		980,000.00
Maintenance, by United States plant and hired labor		220,000.00
(*b*) Maintenance of project dimensions of channel, dredging by United States plant and hired labor, operation and upkeep of 4 pipe-line dredges		300,000.00
(*c*) New plant, by contract:		
1 small towboat	$80,000	
6 standard barges	100,000	
20 small barges (flats)	80,000	
5 pile drivers	100,000	
2 grader and derrick boats	50,000	
1 quarter boat	30,000	
		440,000.00
(*d*) Upkeep and care of plant other than dredges		100,000.00
(*e*) Office, engineering, surveys, and gauges		50,000.00
(*f*) Contingencies		49,582.42
		3,122,082.42

The growing use of the Mississippi River, Cairo to St. Louis, requires the provision of a channel for navigation of assured depth and stabilized location. The work of reestablishing old works of contraction and revetment and of constructing similar new works is steadily progressing. The extension and reestablishment of these works are already greatly benefiting navigation. The sum of $3,000,000 can be profitably expended during the fiscal year ending June 30, 1928, as follows:

(*a*) Regulating works—dikes and revetments:	
Construction, by contract	$500,000
Construction, by United States plant and hired labor	1,000,000
Maintenance, by United States plant and hired labor	300,000
(*b*) Maintenance of project dimensions of channel, operation, and upkeep of 4 United States pipe-line dredges by hired labor	300,000
(*c*) New plant, including: 1 large towboat, 1 small towboat, 6 standard barges, 20 small barges, 2 grader and derrick boats, and 1 quarter boat	650,000
(*d*) Upkeep and care of plant other than dredges	100,000
(*e*) Office, engineering, surveys, and gauges	50,000
(*f*) Contingencies	100,000
	3,000,000

Commercial statistics.—River traffic in the calendar year 1925 was 264,841 tons greater in total tonnage than in 1924, an increase

in value of $7,508,784, due principally to increased tonnage and value of vegetable food products, textiles, wood and paper, nonmetallic minerals, and ores and metals, and manufactures. For detailed information concerning the commodities and tonnage handled, of which 420,246 tons were upbound and 583,323 tons were downbound, reference is made to the commercial statistics report of this district published in a separate volume.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound, vegetable food products, ores, metals, and manufactures; downbound, vegetable food products, nonmetallic minerals.

The full project dimensions of channel were utilized, the drafts of loaded barges being generally 5 feet to 8 feet and occasionally 9 feet. The improvement has greatly facilitated the traffic, which shows a gradual increase in the last five years, as indicated by the following:

Comparative statement

Calendar year	Short tons	Approximate value	Passengers	Calendar year	Short tons	Approximate value	Passengers
1921	[1] 481,151	$47,481,764	832,963	1924	[1] 738,728	$36,734,217	1,771,971
1922	[1] 548,114	43,193,152	1,945,642	1925	[1] 1,003,569	44,242,901	533,484
1923	[1] 723,068	38,952,069	2,689,258				

[1] Includes Government materials for river improvement work not included in previous years—80,799 tons in 1921, 95,274 tons in 1922, 120,769 tons in 1923, 130,913 tons in 1924, and 200,349 tons in 1925.

Financial summary

UNITED STATES FUNDS

Amount expended on all projects to June 30, 1926, after deducting receipts from sales, etc., amounting to $424,528.87:	
New work	$13,354,204.68
Maintenance	10,755,312.88
Net total expended	24,109,517.56
Total appropriations to June 30, 1926	27,231,599.98

Fiscal year ending June 30	1922	1923	1924	1925	1926
Expended for new work [1]	$7,731.09	$75,004.83	$278,388.44	$552,744.81	$1,111,877.25
Expended for maintenance [1]	491,684.30	653,596.91	602,908.13	565,411.59	469,773.41
Total expended [1]	499,415.39	728,601.74	881,296.57	1,118,156.40	1,581,650.66
Appropriated or allotted	915,000.00	800,000.00	700,000.00	1,850,000.00	3,000,000.00

[1] Not deducting receipts from sales, etc.

July 1, 1925, balance unexpended	$1,698,013.83
Amount allotted from War Department appropriation act approved Apr. 15, 1926	3,000,000.00
Receipts from sales, etc., during fiscal year 1926	5,719.25
	4,703,733.08

June 30, 1926, amount expended during fiscal year:[1]		
For new work	$1,111,877.25	
For maintenance	469,773.41	
		$1,581,650.66
July 1, 1926, balance unexpended		3,122,082.42
July 1, 1926, outstanding liabilities	$111,861.47	
July 1, 1926, amount covered by uncompleted contracts	174,095.95	
		285,957.42
July 1, 1926, balance available		2,836,125.00
Amount (estimated) required to be appropriated for completion of existing project		[2]15,200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1928:		
For new work		[2]2,225,000.00
For maintenance		[2]775,000.00
Total		[2]3,000,000.00

CONTRIBUTED FUNDS

Amount expended on all projects to June 30, 1926:		
New work		$95,671.69
Maintenance		22,828.31
Net total expended		118,500.00
Total contributions to June 30, 1926		118,500.00

Fiscal year ending June 30	1922	1923	1924	1925	1926
Expended for new work			$87,171.69		$8,500.00
Expended for maintenance			22,828.31		
Total			110,000.00		$8,500.00
Contributed		$10,000.00	100,000.00		8,500.00

Amount contributed by local interests for work at Calico Island, Ill.	$8,500.00
June 30, 1926, amount expended during fiscal year for new work	8,500.00

CONSOLIDATED FINANCIAL SUMMARY FOR MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS

Amount expended on all projects to June 30, 1926, after deducting receipts from sales, etc., amounting to $424,528.87:		
New work		$13,449,876.37
Maintenance		10,778,141.19
Net total expended		24,228,017.56
Total appropriations and contributions to June 30, 1926		27,350,099.98

[1] Not deducting receipts from sales, etc. [2] Exclusive of available funds.

Fiscal year ending June 30	1922	1923	1924	1925	1926
Expended for new work [1]	$7,731.09	$75,004.83	$365,560.13	$552,744.81	$1,120,377.25
Expended for maintenance [1]	491,684.30	653,596.91	625,736.44	565,411.59	469,773.41
Total expended [1]	499,415.39	728,601.74	991,296.57	1,118,156.40	1,590,150.66
Appropriated, allotted, or contributed	915,000.00	810,000.00	800,000.00	1,850,000.00	3,008,500.00

July 1, 1925, balance unexpended		$1,698,013.83
Amount contributed by local interests for work at Calico Island, Ill		8,500.00
Amount allotted from War Department appropriation act approved Apr. 15, 1926		3,000,000.00
Receipts from sales, etc., during fiscal year 1926		5,719.25
		4,712,233.08
June 30, 1926, amount expended during fiscal year: [1]		
For new work	$1,120,377.25	
For maintenance	469,773.41	
		1,590,150.66
July 1, 1926, balance unexpended		3,122,082.42
July 1, 1926, outstanding liabilities	$111,861.47	
July 1, 1926, amount covered by uncompleted contracts	174,095.95	
		285,957.42
July 1, 1926, balance available		2,836,125.00
Amount (estimated) required to be appropriated for completion of existing project		[2] 15,200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1928:		
For new work		[2] 2,225,000.00
For maintenance		[2] 775,000.00
Total		[2] 3,000,000.00

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

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis snagging district embraces that portion of the river between Head of Passes and the mouth of Missouri River, 1,265 miles, 8 miles of Old River (present mouth of Red River), and 27 miles of Atchafalaya River from Red River to Melville, La.; total, 1,300 miles.

Original condition.—Navigation of the river was seriously obstructed by numerous snags, drift heaps, etc., which had lodged in the channel and to which additions were made with each rise of the river.

Many wrecks of flatboats, barges, and steamboats also obstructed the navigable channel and menaced life and property, the sinking of

[1] Not deducting receipts from sales, etc. [2] Exclusive of available funds.

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

This district includes the Mississippi River between the Ohio and Missouri Rivers, and removing snags and wrecks from the Mississippi River below the mouth of Missouri River and from Old and Atchafalaya Rivers.

District engineer: Maj. John C. Gotwals, Corps of Engineers.

Division engineer: Col. Charles L. Potter, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis engineer district embraces the 200-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and 1,078 to 1,278 miles from the Gulf. The drainage area of the valley down to the Ohio and discharging through the district is about 707,000 square miles. At St. Louis the discharge in cubic feet per second for the low-water plane,[1] —2-foot gauge, is 40,000; for mean stage, 12.4-foot gauge, 150,000; for bank-full stage, 30-foot gauge, 600,000; and for maximum flood plane, 1,250,000; mean discharge of river being 175,000 cubic feet per second. The average natural depths available for navigation at low-water, mean, and bank-full stages are about 4½, 9, and 16 feet, respectively; i. e., crests of bars rise and fall with stage as 1 to 2½. The oscillation between annual low and high waters averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below mouth of Missouri River; the extreme range is 55.7 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.6 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. The low-water plane at the mouth of Ohio River is 274 feet above mean sea level and at the mouth of Missouri River it is 395 feet, the average slope being six-tenths foot per mile. The current at mean stage is about 2½ miles per hour and the average width between banks is 4,300 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural

[1] Minus 2 feet on St. Louis gauge, 2 feet on Commerce gauge, and 4 feet on Cairo gauge, the plane of reference, adopted in 1927, for district operations. "Standard low water," adopted in 1881, was 4 feet on the St. Louis gauge, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the minus 2-foot stage.

width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The amount expended thereunder was $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet with additional width in bends, at low water, from the mouth of the Ohio River (1,078 miles from the Gulf) to the northern boundary of the city of St. Louis, 194 miles, and with a minimum depth of 6 feet and a minimum width of 200 feet, thence to the mouth of the Missouri River, 6 miles. All to be obtained by regulating works and dredging as follows:

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river, as shown in the following table:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,000	23.3
Commerce to Commercial Point	7.2	3,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	11.0	4,800	21.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1890 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropriations "with a view to the completion of the improvement within twelve years," at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.) The latest (1927) approved estimate for annual cost of maintenance is $900,000. The river and harbor act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.)

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

The Missouri-Illinois Railroad Co., Bonne Terre, Mo., contributed $110,000 in the fiscal years 1923 and 1924 toward the construction of new and the restoration of old regulating works in the vicinity of Little Rock Landing, Mo., for the purpose of removing a sand bar obstructing the railroad incline at that point, thus incidentally improving the alignment of the banks and channel and protecting from erosion the alluvial bank opposite in Illinois.

The Union Electric Light & Power Co. contributed $8,500 in the fiscal year of 1926 toward the construction of new regulating works at Calico Island, Ill., for the protection of one of their transmission towers, and thus incidentally improving the alignment of the banks at that locality.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; and 1924, page 1081.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, 8-foot navigation throughout the lowest of low-water seasons being an accomplished fact; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the rivers; freight rates by water are generally 80 per cent of the rail rates.

The middle Mississippi is of peculiar importance in the interior river system. Its improvement is related in economic value to that of the Ohio. Its channel is the focal waterway that ties together all the great tributaries of the Mississippi.

Operations and results during fiscal year.—Extensive construction of regulating works was carried on throughout the year, though the extremely long period of high water during the fall and spring seasons greatly reduced the expected amount of work. Regulating works were maintained and project dimensions of channel were secured by dredging. Work was carried on by United States plant and hired labor and by contract from July 1 to December 21, 1926, and from March 2 to April 14, and May 4 to 28, 1927. The district's standard form of construction was used, and, in addition

thereto, current retards were experimented with at two localities. Quantities and expenditures for regulating works follows:

Class of work	Piling dikes or hurdles			Revetments (bank protection)				
	Number	Linear feet	Expenditures	Number	Mattress and retards		Paving squares	Expenditures
					Linear feet bank protected	Squares		
New	11	14,813	$572,405.11	1	9,655	11,663	2,317	$213,983.88
New retards		2,782½		18	8,700			164,422.44
Maintenance	22	3,097	106,910.97	4		3,637	846	83,933.05

The total expended for new regulating works was $950,811.43, including $180,564.24 by contract, and for maintenance of works $190,844.02.

Extensive repairs were made to the plant and it was maintained in a highly efficient working condition. Stokers which were installed on the steamer *Tuscumbia* showed a large saving of fuel. Extensive repairs were made to the hulls, cabins, and machinery of the tenders *Kaskaskia* and *Salvisi*. Ice machines and electric-light plants were installed on quarter boats and office boats, and stills for furnishing pure drinking water were provided for each construction party. A new machine shop was built at the engineer depot. Most of the machinery in this shop was renewed and the machinery in all the shops was electrified, with a great improvement in efficiency. The dredge *Fort Gage* is being reconditioned and equipped with new water-tube boilers, economizers, evaporators, and a new single-suction sand pump, driven by a 1,000-horsepower turbine. The cost of the new plant, $294,121.15, is charged to new works.

Additional plant was procured by contract as follows: Six 152-foot steel barges, two 100-foot steel barges, twenty small steel barges, seven steel pile-driver hulls, and four motor boats.

The four pipe-line dredges maintained the required 8-foot channel; 879,000 cubic yards of sand and gravel were dredged from 13 bars at 11 localities. The channel dredged had a combined length of 4.6 miles, an average width of 250 feet, and an average gain in depth of 4.7 feet. Expenditures were $275,862.07, including $88,405.10 for reconditioning the dredge *Fort Gage*.

Hydrographic surveys were made covering 160 miles of river, and 185 discharge observations were made at Chester, Ill.

The towboats *Wm. R. King* and *Tuscumbia* were engaged in flood-relief work on the lower Mississippi, the former from April 25 to June 2, and the latter from April 24 to June 25. These boats, with their attendant plant, quarter boats, barges, etc., were of great value in the rescue and relief work in the flooded districts.

The total expenditures were $1,781,010.02—$1,244,932.58 for new work and $536,077.44 for maintenance, including dredging, surveys, and $31,924.79 for flood relief.

Condition at end of fiscal year.—The regulating works are about 42 per cent completed. The quantities required to complete the

project are estimated as follows: 304 dikes, 326,972 linear feet; 55 revetments, 402,745 linear feet. The old work is in excellent repair, and with new work of recent years has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths. In recent years project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river generally being closed by ice the remainder of the year. For two-thirds of the navigating season the river is above a 10-foot stage, and a minimum channel depth has generally prevailed throughout the district without dredging. (An. Rept. 1918, p. 2733.)

The total expenditures under the existing project from 1881 to date are $13,101,033.15 for new work, $11,290,049.19 for maintenance, including dredging, surveys, and $31,924.79 for flood relief; a total of $24,391,082.34. The amount expended on the project since the estimate was revised in 1910 is $4,940,907.37 for new work.

Proposed operations.—The present project dimensions of steamer channels will be maintained. Work upon regulating structures will be, first, those necessary to safeguard all such structures and, second, will include an extension of regulating works at the points most seriously requiring contraction of the river or bank protection. The substantial new work now being done aims to work continuously downstream from fixed points and, wherever possible, removes the most serious obstructions in the steamer channel or protects the most rapidly caving banks. A minor amount of new plant will also be constructed. All of these operations will be carried on at the same time and will include the maintenance of all floating plant. The work will be prosecuted continuously except during midwinter when navigation and work on the river are interrupted by ice conditions.

Dredging will be required, depending upon the river stage, to maintain the project dimensions of channel. The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works. Throughout this period of active operations, funds will be expended at the rate of about $500,000 per month. During December, January, and February, when most of the plant is tied up in winter harbor, expenditures will amount to about $80,000 per month, covering repair and safeguarding of floating plant and the construction of new plant. During the period, March to June, inclusive, expenditures for regulating works and for the construction of new plant will be at the rate of $400,000 per month. All funds will be exhausted by June 30, 1928. The balance, $4,345,517.64 unexpended July 1, 1927, will be applied in the ensuing fiscal year, as follows:

(*a*) Construction of new and maintenance of existing regulating works, dikes, and revetments, by United States plant and hired labor	$1,645,517.64
(*b*) Construction of new regulating works, dikes, and revetments, by contract	1,750,000.00

(*c*) Maintenance of full project dimensions of channel, dredging by United States plant and hired labor, operation and upkeep of 4 hydraulic pipe-line dredges		$300,000.00
(*d*) New plant:		
By contract—		
1 small towboat	$150,000	
6 barges, 5 by 25 by 100 feet	50,000	
20 small barges (flats)	50,000	
New machinery for dredge	200,000	
Total		450,000.00
(*e*) Upkeep and care of plant other than dredges		100,000.00
(*f*) Office, engineering, surveys, and gauges		50,000.00
(*g*) Contingencies		50,000.00
Total		4,345,517.64

The growing use of the Mississippi River, Cairo to St. Louis, requires the provision of a channel for navigation of assured depth and stabilized location. The work of reestablishing old works of contraction and revetment and of constructing similar new works, is making substantial progress. The extension and reestablishment of these works is already greatly benefiting navigation. The sum of $2,500,000 can be profitably expended during the fiscal year ending June 30, 1929, as follows:

(*a*) Construction of new and maintenance of existing regulating works by United States plant and hired labor	$1,150,000
(*b*) Construction of new regulating works by contract	850,000
(*c*) Maintenance of full-project dimensions of channel, dredging by United States plant and hired labor, operation and upkeep of 4 hydraulic pipe-line dredges	300,000
(*d*) Upkeep and care of plant other than dredges	100,000
(*e*) Office, engineering, surveys, and gauges	50,000
(*f*) Contingencies	50,000
Total	2,500,000

Commercial statistics.—River traffic in the calendar year 1926 was slightly greater in total tonnage than in 1925. The increase in values was about $5,000,000 over 1925, due principally to increased tonnage of higher class commodities. For detailed information concerning the commodities and tonnage handled, of which 420,379 tons were upbound and 585,600 tons were downbound, reference is made to the commercial statistics report of this district published in a separate volume.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound—Vegetable food products, ores, metals, and manufactures. Downbound—Vegetable food products, nonmetallic minerals, and manufactures.

A notable increase occurred in the ferry traffic, including movements of sand products in the Mississippi River. The total of all traffic occurring on this portion of the river during 1926 was about 9,500,000 tons, including through-local ferry traffic and sand transportation. The full project dimensions of channel were utilized, the drafts of loaded barges being generally 5 to 8 and occasionally 9 feet. The improvement has greatly facilitated the traffic, which has shown a gradual increase in the last five years, as shown by the following:

Comparative statement

Calendar year	Short tons	Approximate value	Passengers	Calendar year	Short tons	Approximate value	Passengers
1922	[1] 548,114	$43,193,152	1,946,642	1925	[1] 1,003,569	$44,242,901	533,484
1923	[1] 723,068	38,952,069	2,689,258	1926	[1] 1,005,979	49,025,466	1,336,920
1924	[1] 738,728	36,734,217	1,771,971				

[1] Includes Government materials for river improvement work not included in previous years: 95,274 tons in 1922; 120,769 tons in 1923; 130,912 tons in 1924; 200,349 tons in 1925; 184,705 tons in 1926.

Financial summary

Amount expended on all projects to June 30, 1927, after deducting receipts from sales, etc., amounting to $428,974.11:	
New work	$14,596,033.15
Maintenance	11,290,049.19
Net total expended	[4] 25,886,082.34
Total appropriations to June 30, 1927	30,231,599.98

Fiscal year ending June 30	1923	1924	1925	1926	1927
Expended for new work [1]	$75,004.83	$278,388.44	$552,744.81	$1,111,877.25	$1,244,933.58
Expended for maintenance [2]	653,596.91	602,908.13	565,411.59	469,773.41	536,077.44
Total expended [3]	728,601.74	881,296.57	1,118,156.40	1,581,650.66	1,781,010.02
Allotted	800,000.00	700,000.00	1,850,000.00	3,000,000.00	3,000,000.00

July 1, 1926, balance unexpended		$3,122,082.42
Amount allotted from War Department appropriation act approved Feb. 23, 1927		3,000,000.00
Receipts from sales, etc., during fiscal year 1927		4,445.24
		6,126,527.66
June 30, 1927, amount expended during fiscal year: [3]		
For new work	$1,244,932.58	
For maintenance	536,077.44	
		[3] 1,781,010.02
July 1, 1927, balance unexpended		4,345,517.64
July 1, 1927, outstanding liabilities	$90,398.88	
July 1, 1927, amount covered by uncompleted contracts	1,120,797.85	
		1,211,196.73
July 1, 1927, balance available		3,134,320.91
Amount (estimated) required to be appropriated for completion of existing project		[4] 13,500,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1929:		
For new work		[4] 1,900,000.00
For maintenance		[4] 600,000.00
Total		[4] 2,500,000.00

[1] In addition $118,500 has been expended from contributed funds.
[2] Not deducting receipts from sales, etc.
[3] Of this amount $81,024.79 was expended for flood-relief work, which will be reimbursed should Congress make an appropriation for that purpose.
[4] Exclusive of available funds.

4. Canadian River, N. Mex., Tex., and Okla., with a view to the control of the floods.

5. North Fork Canadian River, Tex. and Okla., with a view to the control of the floods.

6. Deep River, Okla., with a view to the control of the floods.

7. Verdigris River, Okla., with a view to the control of the floods.

8. Little River, Okla., with a view to the control of the floods.

9. Cimarron River, N. Mex. and Okla., with a view to the control of the floods.

10. Arkansas River, Kans., Okla., and Ark., with a view to the control of the floods.

11. Cache River, Ark.

12. Arkansas River and its tributaries, Ark. and Okla.

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

This district includes the Mississippi River between the Ohio and Missouri Rivers, and removing snags and wrecks from the Mississippi River below the mouth of Missouri River, and from Old and Atchafalaya Rivers.

District engineer: Maj. John C. Gotwals, Corps of Engineers.

Division engineer: Brig. Gen. Charles L. Potter, U. S. Army, retired, to June 12, 1928, and Brig. Gen. T. H. Jackson, Corps of Engineers, since June 19, 1928.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into Gulf of Mexico. The St. Louis engineer district embraces the 200-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, 1,078 to 1,278 miles from the Gulf. Drainage area of valley down to the Ohio and discharging through the district is 713,000 square miles. At St. Louis the discharge in cubic feet per second for low-water plane,[1]—2-foot gauge, is 40,000; for mean stage, 12.4-foot gauge, 180,000; for bank-full stage, 30-foot gauge, 650,000; and for maximum flood, 1,350,000; mean discharge of river is 185,000 cubic feet per second. The average natural depths available for navigation at low-water, mean, and bank-full stages are about 4, 9, and 16 feet, respectively; i. e., crests of bars rise and fall with stage as 1 to 2½. Oscillation between annual low and high water averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet

[1] Minus 2 feet on St. Louis gauge, 2 feet on Commerce gauge, and 4 feet on Cairo gauge, the plane of reference, adopted 1927, for district operations. "Standard low water," adopted 1881, was 4 feet on St. Louis gauge, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the minus 2-foot stage.

at St. Louis, 17 miles below mouth of Missouri River; extreme range is 57.3 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.4 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. Low-water plane at mouth of Ohio River is 274 feet above mean sea level and at mouth of Missouri River, 393 feet; average slope, 0.6 foot per mile. Current at mean stage is about 2½ miles per hour and the average width between banks, 4,300 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The cost and expenditures were $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet with additional width in bends, at low water, from mouth of Ohio River (1,078 miles from Gulf) to the northern boundary of St. Louis, 194 miles, and with a minimum depth of 6 feet and minimum width of 200 feet, thence to mouth of Missouri River, 6 miles. All to be obtained by regulating works and dredging as follows:

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river, as shown in the following table:

Subdivision of river	Length	Low water		Mean stage		Bank full	
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Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropria-

tions "with a view to the completion of the improvement within twelve years," at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.) The latest (1927) approved estimate for annual cost of maintenance is $900,000. The river and harbor act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.)

Recommended modifications of project.—Under date of May 11, 1928, the Chief of Engineers recommended modification of the project above St. Louis so as to provide for a channel 9 feet deep and 200 feet wide. (See H. Com. Doc. No. 12, 70th Cong., 1st sess.)

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

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All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; and 1924, page 1081.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, 8-foot navigation throughout the lowest of low-water seasons being an accomplished fact; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the rivers; freight rates by water are generally 80 per cent of the rail rates.

The middle Mississippi is of peculiar importance in the interior river system. Its improvement is related in economic value to that of the Ohio. Its channel is the focal waterway that ties together all the great tributaries of the Mississippi.

Operation and results during fiscal year.—Extensive construction works were carried on throughout the year. Regulating works were maintained, and project dimensions of channels were secured by dredging. Work was carried on by hired labor with United States plant and by contract from July 1, 1927, to June 30, 1928. The district's standard forms of construction were used and in addition thereto, current retards were experimented with at one localtiy and concrete pile dikes at three localities. The amount of regulating works constructed was the greatest ever completed by this district in a single year. Quantities and costs of regulating works follows:

Class of work	Dikes or hurdles			Bank protection (revetments)				
					Mattress		Paving: Squares, 100 square feet	
	Number	Linear feet	Costs	Number	Linear feet bank protected	Squares, 100 square feet		Costs
NEW								
United States plant and hired labor	10	26,875	$782,564.78	1	12,005	13,475	4,736	$213,505.46
Contract:								
Timber	15	25,248	1,314,854.98					
Concrete	11	2,267	173,244.58					
Retards				1	[1] 6,000			169,374.46
Total	36	54,390	2,270,664.34	1	18,005	13,475	4,736	382,879.92
MAINTENANCE								
United States plant and hired labor	17	8,455	197,102.21	3		7,489	4,530	172,165.81

[1] 21 retards, 3,086 linear feet.

The cost of new regulating works was $2,653,544.26, including $1,657,474.02 for contract work; the cost of maintenance was $369,268.02. Extensive improvements were made to the plant and it was maintained in a high state of efficiency. The pumping machinery of the dredge *Fort Gage* is being renewed, a 750-kilowatt, 250-volt direct-current turbo generator set and a 940-horsepower direct current motor with a new single suction dredging pump is being installed by hired labor. The dredge *Fort Chartres* is being reconditioned and equipped with new water tube boilers, economizers, and evaporators. The hull of the small towboat *Kaskaskia* was replated. The machinery was installed on five new steel hull pile drivers, two steel hull grader and derrick boats, and seven launches. Additional plant was procured by contract as follows: The Diesel electric stern-wheel towboat *Tecumseh*, six 100-foot steel barges, and 20 small steel barges. The expenditure for the new plant was $556,766.59, including $58,453.75 for rehabilitating the dredges *Fort Gage* and *Fort Chartres*.

The three pipe-line dredges and one dipper dredge (leased) maintained the required 9-foot channel; 1,330,300 cubic yards of sand and

gravel were dredged from 20 bars at 13 localities. The channels dredged had a combined length of 5.07 miles, an average width of 250 feet, and an average gain in depth of 4.8 feet. The total cost of dredging was $169,859.61.

Hydrographic surveys were made covering 298 miles of river, 11 discharge observations were made at St. Louis and 8 at Chester, all at a cost of $39,774.69. The three new highway bridges under construction across the Mississippi in this district were carefully inspected.

The total cost of the work was $3,232,446.58, of which $2,653,544.26 was for new work and $578,902.32 for maintenance, including dredging and surveys. The total expenditures were $3,455,048.71, including $13,947.29 for flood relief.

Condition at end of fiscal year.—The regulating works are about 46 per cent completed. The quantities required to complete the project are estimated as follows: 268 dikes, 272,582 linear feet; 53 revetments, 384,700 linear feet. All work is in excellent repair and the channel has been greatly improved by it. Dredging is required at low stages to remove temporary shoals and maintain required channel depths. In recent years the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. For two-thirds of the navigating season the river is above a 10-foot stage, and minimum channel depth has generally prevailed throughout the district without dredging. (Annual Report 1918, p. 2733.)

The total cost under the existing project from 1881 to date is $14,679,571.13 for new work and $10,989,942.24 for maintenance, including dredging and surveys, a total of $25,669,513.37. The cost of the new work since the estimate was revised in 1910 is $7,969,573.78. The total expenditures on the existing project are $27,846,131.05.

Proposed operations.—The balance unexpended July 1, 1928, $3,765,146.92, will be applied in the ensuing fiscal year as follows:

Maintenance of project dimensions of channels by dredging: United States plant operated by hired labor, and upkeep of four hydraulic pipe-line dredges		$300,000.00
Construction of new regulating works, dikes, and revetments:		
By contract (dikes only)	$1,800,000.00	
By United States plant and hired labor	1,165,146.92	
		2,965,146.92
Maintenance of regulating works: By United States plant and hired labor		250,000.00
Maintenance and care of plant other than dredges		100,000.00
Rehabilitation of dredge *Fort Chartres* (completion)		40,000.00
Office, engineering, surveys, and gauges		60,000.00
Contingencies		50,000.00
Total (new work $3,015,146.92, maintenance $750,000)		3,765,146.92

Project dimensions of steamer channels will be maintained. Work upon regulating structures will be, first, those necessary to safeguard all such structures, and, second, will include an extension of regulating works at the points most urgently requiring contraction and protection of river banks. The substantial new work now being done

aims to advance continuously downstream from fixed points and, wherever possible, to improve the more difficult passages in the steamer channel and protect the most rapidly caving banks. These operations will be carried on simultaneously and continuously except during midwinter, when navigation and river work are interrupted by ice conditions, and will include the maintenance of floating plant. No new plant will be constructed.

Dredging will be required, depending upon river stage, to maintain the channels at their full project dimensions. The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works, especially for laying revetment foundation. Permeable dikes of piling (contraction works) are most efficient, however, when constructed during the early spring, the higher river stages that follow causing rapid accretions which protect the dikes from ice attack. During these periods of active operations, funds will be expended at the rate of about $450,000 per month. During the winter (3 months) expenditures will amount to about $80,000 per month, covering repair and safeguarding of floating plant in winter harbor. It is believed that all funds will be exhausted by June 30, 1929.

The growing use of the Mississippi River throughout the district requires the provision of navigable channels of assured depth and stabilized location. The substantial progress made in recent years in reestablishing the old works of contraction and revetment and constructing similar new works has already greatly benefited navigation. The sum of $2,500,000 can be profitably expended during the fiscal year ending June 30, 1930, as follows:

Maintenance of project dimensions of channels by dredging: United States plant operated by hired labor and upkeep of 4 hydraulic pipe-line dredges		$300,000
Construction of new regulating works—dikes and revetments:		
By contract (dikes only)	$750,000	
By United States plant and hired labor	980,000	
		1,730,000
Maintenance of regulating works: By United States plant and hired labor		250,000
Maintenance and care of plant other than dredges		100,000
Office, engineering, surveys, and gauges		60,000
Contingencies		60,000
Total (new work $1,780,000, maintenance $720,000)		2,500,000

Commercial statistics.—River traffic in the calendar year 1927 showed an increase over 1926. The values of shipments were slightly less than 1926, due to lower commodity prices in 1927. Of the commodities and tonnage handled, 448,459 tons were upbound and 659,743 tons were downbound.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound—vegetable food products, ores, metals, and manufactures; downbound—vegetable food products, nonmetallic minerals, and manufactures.

The ferry traffic, including movement of sand products, continued in heavy volume through 1927. The total of all traffic using the Mississippi within this district during 1927 was about 7,600,000 tons,

including through traffic, ferries, and transportation of sand. The full project dimensions were utilized, the drafts of loaded barges being generally 8 feet and occasionally 9 feet. The improved condition of the river has facilitated this traffic, which has shown a gradual increase in the last five years as shown by the following statement:

Calendar year	Short tons	Approximate value	Passengers	Calendar year	Short tons	Approximate value	Passengers
1923	723,068	$38,952,069	2,689,258	1926	1,005,979	$49,025,466	1,336,920
1924	738,728	30,734,217	1,771,971	1927	1,110,402	45,257,625	1,313,293
1925	1,003,569	44,242,901	533,484				

Cost and financial summary

Cost of new work to June 30, 1928	$16,174,571.13
Cost of maintenance to June 30, 1928	10,989,942.24
Total cost of permanent work to June 30, 1928	27,164,513.37
Value of plant, materials, etc., on hand June 30, 1928	2,321,353.21
Net total cost to June 30, 1928	29,485,866.58
Add accounts receivable June 30, 1928	52,031.47
Gross total costs to June 30, 1928	29,537,898.05
Minus accounts payable June 30, 1928	196,767.00
Net total expenditures	29,341,131.05
Unexpended balance June 30, 1928	3,765,146.92
Total amount appropriated to June 30, 1928	33,106,277.97

Fiscal year ending June 30	1924	1925	1926	1927	1928
Cost of new work					$2,653,544.26
Cost of maintenance					578,902.32
Total cost					3,232,446.58
Total expended	$881,206.57	$1,118,156.40	$1,581,650.66	$1,781,010.02	3,455,048.71
Allotted	700,000.00	1,850,000.00	3,000,000.00	3,000,000.00	2,874,677.99

Balance unexpended July 1, 1927		$4,345,517.64
Amount allotted from War Department appropriation act approved March 23, 1928		2,875,000.00
Amount to be accounted for		7,220,517.64
Deduction on account of revocation of allotment		322.01
Net amount to be accounted for		7,220,195.63
Gross amount expended	$3,459,337.16	
Less receipts from sales	4,288.45	
		3,455,048.71
Balance unexpended June 30, 1928		3,765,146.92
Outstanding liabilities June 30, 1928	60,687.99	
Amount covered by uncompleted contracts	1,867,069.69	
		1,927,757.68
Balance available June 30, 1928		1,837,389.24

Amount (estimated) required to be appropriated for completion of existing project	[1] $10,850,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1930:	
For new work	[1] 1,780,000.00
For maintenance	[1] 720,000.00
Total [1]	2,500,000.00

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

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,477 miles, and empties into the Gulf of Mexico. The St. Louis snagging district embraces that portion of the river between Head of Passes and the mouth of Missouri River, 1,265 miles, 8 miles of Old River (present mouth of Red River), and 27 miles of Atchafalaya River from Red River to Melville, La.; total, 1,300 miles.

Original condition.—Navigation of the river was seriously obstructed by numerous snags, drift heaps, etc., which had lodged in the channel and to which additions were made with each rise of the river.

Many wrecks of flatboats, barges, and steamboats also obstructed the navigable channel and menaced life and property, the sinking of steamboats and other river craft by such obstructions having been of common occurrence.

Previous projects.—For the removal of these obstructions general appropriations were made at irregular intervals as early as 1824. The amount expended prior to 1879, when the first definite allotment was made for the work, was approximately $358,627.35. For further details of previous projects see page 1880, Annual Report for 1915.

Existing project.—This is a continuation of the plan adopted in 1879, and provides for the removal and destruction of snags, wrecks, drift heaps, and other obstructions to navigation in the Mississippi River between Head of Passes (13 miles from mouth of South Pass) and mouth of Missouri River, and in Old and Atchafalaya Rivers (35 miles) to Melville, La.; also for the felling of large trees on or near caving banks, thereby decreasing the number of snags to be destroyed thereafter.

The work is done by the department's two large steel-hull snag boats, *J. N. Macomb*, built 1874, and *H. G. Wright*, built 1881, fitted with the necessary equipment and appliances and operated by Government employees. Description of these boats may be found in Annual Report for 1894, pages 1568–1569, and for 1895, page 2054, et seq.

Annual appropriations or allotmnets were made for this work, 1879 to 1886, inclusive, except in 1883 and 1885. A continuous annual expenditure of $100,000, or as much thereof as might be necessary for the maintenance of this service, was authorized by section 7 of the river and harbor act of August 11, 1888, and has been available each year to the present time. In addition thereto, and to cover costs

[1] Exclusive of available funds.

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

This district includes the Mississippi River between the Ohio and Illinois Rivers, and removing snags and wrecks from the Mississippi River below the mouth of Missouri River, and from Old and Atchafalaya Rivers.

District engineer: Maj. John C. Gotwals, Corps of Engineers.

Division engineer: Brig. Gen. T. H. Jackson, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,470 miles, and empties into Gulf of Mexico. This part of the St. Louis engineer district embraces the 200-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, 1,078 to 1,278 miles from the Gulf. Drainage area of valley down to the Ohio and discharging through the district is 713,000 square miles. At St. Louis the discharge in cubic feet per second for low-water plane,[1]—2-foot gage, is 40,000; for mean stage, 12.4-foot gage, 180,000; for bank-full stage, 30-foot gage, 650,000; and for maximum flood, 1,350,000; mean discharge of river is 185,000 cubic feet per second. The average natural depths available for navigation at low-water, mean, and bank-full stages are about 4, 9, and 16 feet, respectively; i. e., crests of bars rise and fall with stage as 1 to 2½. Oscillation between annual low and high water averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below mouth of Missouri River; extreme range is 57.3 feet at Cairo and 44.4 feet at St. Louis. Considering annual averages, river stage at St. Louis oscillates between low water (1.4 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days. Low-water plane at mouth of Ohio River is 274 feet above mean sea level and at mouth of Missouri River, 393 feet; average slope, 0.6 foot per mile. Current at mean stage is about 2½ miles per hour and the average width between banks, 4,300 feet.

[1] Minus 2 feet on St. Louis gage, 2 feet on Commerce gage, and 4 feet on Cairo gage, the plane of reference, adopted 1927, for district operations. "Standard low water," adopted 1881, was 4 feet on St. Louis gage, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the minus 2-foot stage.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet.

Previous projects.—The original project for the general improvement of this river section was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. The cost and expenditures were $1,495,000 for new work. For further details of previous projects see page 1879 of Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet with additional width in bends, at low water, from mouth of Ohio River (1,078 miles from Gulf) to the northern boundary of St. Louis, 194 miles, and with a minimum depth of 6 feet and minimum width of 200 feet, thence to mouth of Missouri River, 6 miles. All to be obtained by regulating works and dredging as follows:

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river, as shown in the following table:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,800	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896 and 1902. The part of the project which proposed regulating works was practically abrogated by the acts of March 3, 1905, March 2, 1907, and joint resolution of June 29, 1906. The river and harbor act of June 25, 1910, restored the regulating works to the project and began appropriations "with a view to the completion of the improvement within 12 years," at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess., 1909; also H. Doc. No. 168, 58th Cong., 2d sess., 1903.) The latest (1927) approved estimate for annual cost of maintenance is $900,000. The river and harbor act of Janu-

ary 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.)

Recommended modifications of project.—Under date of May 11, 1928, the Chief of Engineers recommended modification of the project above St. Louis so as to provide for a channel 9 feet deep and 200 feet wide. (See H. Com. Doc. No. 12, 70th Cong., 1st sess.)

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described, as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; and 1924, page 1081.

A river house was constructed for the belt elevator at East St. Louis, Ill., and a marine leg for unloading grain from barges is under construction at the Checkerboard Central B Elevator, at the foot of Chouteau Avenue, St. Louis, Mo.

Effect of improvement.—Some of the resultant benefits to commerce from the improvement are: (*a*) Larger and deeper draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, a 9-foot channel being available during the navigation season; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the river; freight rates by water are generally 80 per cent of the rail rates.

The middle Mississippi is of peculiar importance in the interior river system. Its improvement is related in economic value to that of the Ohio. Its channel is the focal waterway that ties together all the great tributaries of the Mississippi.

Operation and results during fiscal year.—Extensive construction works were carried on throughout the first half of the fiscal year, but owing to the high stage prevailing during the last half of the fiscal year practically no construction work was done. Work was carried on by hired labor with Government plant and by contract from July 1 to November 20, 1928, and by contract from June 20 to 30, 1929. Regulating works were maintained and project dimensions of channels were secured by dredging. Quantities and costs of regulating works follow:

Class of work	Dikes or hurdles			Bank protection (revetments)				
					Mattress		Paving	
	Number	Linear feet	Costs	Number	Linear feet bank protected	Squares, 100 square feet	Squares, 100 square feet	Costs
NEW								
United States plant and hired labor	13	13,300	$332,253.41	8	15,939	17,325	3,879	$223,108.30
Contract: Timber	29	35,677	1,370,165.62					
Total	42	48,977	1,702,419.03	8	15,939	17,325	3,879	223,108.30
MAINTENANCE								
United States plant and hired labor	26	3,740	83,059.64	0	(1)	1,043	978	31,544.04

[1] Repairs to 70 feet of retards, cost $2,684.20, included here.

The cost of new regulating works was $1,925,527.33, including $1,370,165.62 for contract work; the cost of maintenance was $114,603.68. The plant was maintained in a high stage of efficiency. The turbogenerator set, motor and single suction dredging pump installed on the dredge *Fort Gage* showed greatly increased efficiency and output. The repairs to the dredge *Fort Chartres* were completed. The hull of the towboat *Salvisi* was replated. Additional plant procured by contract was: One, 36-foot steel hull, 45 horsepower, Diesel driven propeller boat, and two, 36-foot steel hull, 85 horsepower, gasoline propeller boats. The dipper dredge *St. Paul* was procured by transfer from the Rock Island district. A new steel hull was built for the machinery of the launch *Black Prince*. The expenditure for the new plant was $101,697.90, including $60,052.02 for rehabilitating the dredges *Fort Gage* and *Fort Chartres*.

The three pipe-line dredges maintained the required 9-foot channel; 1,110,800 cubic yards of sand and gravel were dredged from 13 bars at 11 localities. The channels dredged had a combined length of 3.41 miles, an average width of 300 feet and an average gain in depth of 5.4 feet. The total cost of dredging was $136,589.49.

Hydrographic surveys were made covering 127 miles of river. An airplane survey was made from the mouth of the Ohio to the Missouri River. The cost of surveys was $34,548, including $3,697 for airplane survey.

The total cost of the work was $2,257,140.58, of which $1,925,527.33 was for new work, and $331,613.25 was for maintenance, including dredging, surveys, and $45,872.08 for flood-relief work. The total expenditures were $2,689,198.96, including $31,924.79 for flood relief.

Condition at end of fiscal year.—The regulating works are about 48 per cent completed. The quantities required to complete the project are estimated as follows: 226 dikes, 223,605 linear feet; 45 revetments, 368,800 linear feet. All work is in excellent repair, and it has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years, the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. For six months the river is above a 10-foot stage, and the minimum channel depth has generally prevailed throughout the district without dredging. (Annual Report for 1918, p. 2733.)

The cost under the existing project from 1881 to date is $16,554,892.06 for new work and $11,371,761.89 for maintenance, including dredging, surveys, and flood relief, a total of $27,926,653.95. The cost of the new work since the estimate was revised in 1910 is $9,895,101.11. The total expenditures on the existing project are $30,535,330.01.

Proposed operations.—The balance unexpended July 1, 1929, $3,200,947.96, will be applied in the ensuing fiscal year as follows:

Maintenance of project dimensions of channels by dredging: United States plant operated by hired labor, and upkeep of 4 hydraulic pipe-line dredges and 1 dipper dredge		$250,000.00
Construction of new regulating works—dikes and revetments:		
By contract—		
Dikes	$1,100,000	
Revetment	200,000	
By United States plant and hired labor—		
Dikes	600,000	
Revetment	400,000	
		2,300,000.00
New plant (dipper dredge) by transfer		40,000.00
Maintenance of regulating works: By United States plant and hired labor		400,000.00
Maintenance and care of plant other than dredges		100,000.00
Office, engineering, surveys, and gages		60,000.00
Contingencies		50,947.96
Total (new work $2,300,000, maintenance $800,947.96)		3,200,947.96

Project dimensions of steamer channels will be maintained. Work upon regulating structures will be, first, that necessary to safeguard such structures, and, second, will include extension of regulating works, at the points most urgently requiring contraction and protection of river banks. The new work now being done aims to advance continuously downstream from fixed points, and, where possible, to improve first the most difficult crossings in the steamer channel, and protect the most rapidly caving banks. These operations, including maintenance of plant, will be carried on continuously except in midwinter, when navigation and river work are interrupted by ice conditions.

Dredging will be required, depending upon river stages, to maintain the channels at their full project dimensions. The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works, especially for placing revetment and repairing paving. Early spring is, however, the most favorable time for the construction of permeable dikes (contraction works) as rapid accretions are secured during summer high water which protect the dikes from ice attack. During the period of active operations, funds will be expended at the rate of $340,000 per month; during the winter (three months) in repair-

ing and caring for plant in winter harbor, $50,000 per month will be expended. It is believed that all funds will be expended by June 30, 1930.

The rapidly increasing commerce on the Mississippi River in this district requires navigable channels of assured depth and stabilized location. The large amount of contraction work and revetment constructed in recent years has done much to achieve this result, and thus has greatly benefited navigation.

The sum of $2,000,000 can be profitably expended during the fiscal year ending June 30, 1931, as follows:

Maintenance of project dimensions of channels by dredging; United States plant operated by hired labor, and upkeep of 4 hydraulic pipe-line dredges and 1 dipper dredge		$250,000
Construction of new regulating works—dikes and revetments:		
By contract—		
Dikes	$450,000	
Revetments	150,000	
By United States plant and hired labor—		
Dikes	270,000	
Revetments	370,000	
		1,240,000
Maintenance of regulating works: By United States plant and hired labor		300,000
Maintenance and care of plant other than dredging		100,000
Office, engineering, surveys, and gages		60,000
Contingencies		50,000
Total (new work $1,385,000, maintenance $615,000)		2,000,000

Commercial statistics.—River traffic in the calendar year 1928 showed an increase of more than 25 per cent over 1927. The values of shipments for 1928 were greater than those of 1927 by even a greater proportion due to higher classes of commodities shipped, as well as greater volume. For detailed information concerning the commodities and tonnage handled, of which 474,173 tons were upbound and 956,010 tons were downbound, reference is made to the commercial statistic report of this district published in a separate volume.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound—Vegetable food products, ores, metals, and manufactures. Downbound—Vegetable food products, nonmetallic minerals, and manufactures.

The ferry traffic, including movement of sand products, continued in heavy volume. The total of all traffic using the Mississippi within this district during 1928 was about 8,800,000 tons, including through traffic, ferries, and transportation of sand. The full project dimensions were utilized, the drafts of loaded barges being 8 feet and occasionally 9 feet. Improved condition of the river has facilitated traffic which has shown a substantial although gradual increase in the last five years, as shown by the following table:[1]

Calendar year	Short tons	Value	Passengers	Calendar year	Short tons	Value	Passengers
1924	738,728	$30,734,217	1,771,971	1927	1,110,402	$45,257,625	1,313,295
1925	1,003,569	44,242,901	533,484	1928	1,430,183	69,090,428	1,320,230
1926	1,005,979	49,025,466	1,336,920				

[1] Years 1924–1927 show commerce for section between Ohio and Missouri Rivers. Year 1928 shows commerce for section between Ohio and Illinois Rivers.

Cost and financial summary

Cost of new work to June 30, 1929	$18,049,892.06
Cost of maintenance to June 30, 1929	11,371,761.89
Total cost of permanent work to June 30, 1929	29,421,653.95
Value of plant, materials, etc., on hand June 30, 1929	2,648,505.52
Net total cost to June 30, 1929	32,070,159.47
Add accounts receivable June 30, 1929	20,916.75
Gross total costs to June 30, 1929	32,091,076.22
Minus accounts payable June 30, 1929	60,746.21
Net total expenditures	32,030,330.01
Unexpended balance June 30, 1929	3,200,947.96
Total amount appropriated to June 30, 1929	35,231,277.97

Fiscal year ending June 30	1925	1926	1927	1928	1929
Cost of new work				$2,653,544.26	$1,925,627.33
Cost of maintenance				578,902.32	331,613.25
Total cost				3,232,446.58	2,257,140.58
Total expended	$1,118,156.40	$1,581,050.66	$1,781,010.02	3,455,048.71	2,689,198.90
Allotted	1,850,000.00	3,000,000.00	3,000,000.00	2,874,677.99	2,125,000.00

Balance unexpended July 1, 1928		$3,765,146.92
Amount allotted from War Department appropriation act approved Feb. 28, 1929		2,125,000.00
Net amount to be accounted for		5,890,146.92
Gross amount expended	$2,693,888.77	
Less receipts from sales	4,680.81	
		2,689,198.96
Balance unexpended June 30, 1929		3,200,947.96
Outstanding liabilities June 30, 1929	54,330.50	
Amount covered by uncompleted contracts	836,855.71	
		891,186.21
Balance available June 30, 1929		2,309,752.75
Amount (estimated) required to be appropriated for completion of existing project [1]		8,700,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1931:		
For new work [1]		1,385,000.00
For maintenance [1]		615,000.00
Total [1]		2,000,000.00

2. MISSISSIPPI RIVER BETWEEN THE MISSOURI AND ILLINOIS RIVERS

Location and description.—The length of the section of the upper Mississippi included between the Missouri and Illinois Rivers is 22.8 miles, and is 1,278 to 1,300.8 miles from the Gulf. Drainage area of the valley down to the Missouri is 164,100 square miles. At Grafton, mouth of the Illinois, the discharge in cubic feet per second

[1] Exclusive of available funds.

1929, as follows, and reports thereon will be duly submitted when received:

1. Black River, Ark. and Mo.

2. Black River, Ark. and Mo., above Black Rock, Ark., etc.

3. Canadian River, N. Mex., Tex., and Okla., with a view to the control of the floods.

4. North Fork Canadian River, Tex. and Okla., with a view to the control of the floods.

5. Deep River, Okla., with a view to the control of the floods.

6. Verdigris River, Okla., with a view to the control of the floods.

7. Little River, Okla., with a view to the control of the floods.

8. Cimarron River, N. Mex. and Okla., with a view to the control of the floods.

9. Arkansas River, Kans., Okla., and Ark., with a view to the control of the floods.

10. Cache River, Ark.

11. Arkansas River and its tributaries, Ark. and Okla.

12. Mayfield Creek, Ky.

13. Wolf River and Nonconnah River, Tenn.

14. Hatchie River, Tenn.

MISSISSIPPI RIVER BETWEEN THE OHIO RIVER AND MINNEAPOLIS, MINN.

The section of the river covered in this report is divided into three reaches under the supervision and direction of district engineers at St. Louis, Mo., Rock Island, Ill., and St. Paul, Minn.

The St. Louis district extends from the mouth of the Ohio River to the mouth of the Illinois River, a distance of 223 miles; the Rock Island district extends from the mouth of the Illinois River to the mouth of the Wisconsin River, a distance of 423 miles; and the St. Paul district extends from the mouth of the Wisconsin River to the head of navigation at the Washington Avenue Bridge, Minneapolis, Minn., a distance of 223 miles.

District engineers: At St. Paul, Minn., Maj. R. C. Williams, Corps of Engineers, to August 8, 1929, and Lieut. Col. Wildurr Willing, Corps of Engineers, after that date; at Rock Island, Ill., Maj. C. L. Hall, Corps of Engineers; at St. Louis, Mo., Maj. John C. Gotwals, Corps of Engineers.

Division engineer: Brig. Gen. T. H. Jackson, Corps of Engineers, to October 10, 1929, and Lieut. Col. George R. Spalding, Corps of Engineers, after that date.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO RIVER AND MINNEAPOLIS, MINN.

Location and description.—The Mississippi River has its source in numerous lakes in the northern part of Minnesota, its origin being traced to Lake Itasca. It flows in a southerly direction for about

2,470 miles into the Gulf of Mexico. The portion included in this report extends from the mouth of the Ohio River at Cairo, Ill., to the Washington Avenue Bridge, Minneapolis, Minn., a distance of 869 miles.

The following table gives important physical characteristics of the river.

	Low-water discharge navigation season	High-water discharge	Average width	Extreme stage fluctuation	Drainage area	Distance
	Cubic feet per second	*Cubic feet per second*	*Feet*	*Feet*	*Square miles*	*Miles*
Minneapolis	1,800	45,000	500	19.0	19,980	
Above Mouth of Wisconsin River	7,500	112,000	1,400		68,380	223
Below	16,300	137,600	1,500	21.5	79,200	
Above Mouth of Illinois River	21,900	235,000	5,000		143,000	423
Below	30,000	260,000	5,000	32.4	170,000	
Above Mouth of Missouri River	30,000	260,000	5,000		170,100	23
Below	40,000	650,000	4,300	36.7	699,000	
Above Mouth of Ohio River	40,000	650,000	4,300		713,000	200
				57.3		
Total						869

The river is nontidal; the average fall is about 0.4 foot to the mile in the St. Paul district; 0.47 foot to the mile in the Rock Island district, with the exception of the Rock Island Rapids, where the fall is 1.48 feet to the mile for a distance of 14.5 miles; and 0.6 foot to the mile in the St. Louis district.

Original condition.—St. Paul was the head of continuous navigation for steamboats, and the floating of logs was possible between there and the headwaters. From a narrow channel made more hazardous by swift currents near St. Paul the river widened below the mouth of the St. Croix River and became divided by islands and bars which distributed the flow through chutes, secondary channels, and sloughs. Bars forming on the average of one in 3 miles seriously obstructed navigation during the low-water season and often limited depths available to 3 feet and less. Generally, the river wandered along its alluvial bed between bluffs several miles apart, losing in depth by the unrestricted width. The Rock Island Rapids, about 14 miles in length, and the Des Moines Rapids, 12 miles, were unnavigable at low stages, but both of the rapids were improved prior to commencement of the general improvement, the former to 4 feet at extreme low water by rock excavation and the latter to 5 feet by a lateral canal with three locks and rock excavation.

Previous projects.—The first project for the general improvement of the Mississippi River above Cairo was recommended by a board of engineers in a report dated April 13, 1872, concurred in by the Chief of Engineers. It provided for the improvement between the Ohio and Missouri Rivers only. The first appropriation for this work was made in the river and harbor act, June 10, 1872.

The river and harbor act of June 18, 1878, appropriated funds for the improvement of the Mississippi River from St. Paul to the Des Moines Rapids, and from the Des Moines Rapids to the mouth of the Ohio River. This project was intended to provide a channel 4½ feet deep at low water. Several minor projects, including the improvement of the Rock Island and Des Moines Rapids were adopted.

The original project for the section between Minneapolis and the Twin City Lock and Dam was adopted by the river and harbor act of August 18, 1894, and modified by the act of March 2, 1907. The cost and expenditures on the different projects prior to the commencement of work on the existing projects were as follows:

New work:	
Between Ohio and Missouri Rivers	$1,495,000.00
Between Missouri and Illinois Rivers	592,455.68
Between Illinois and Wisconsin Rivers	14,626,456.15
Wisconsin River to Minneapolis	5,431.973.73
Total	22,145,885.56
Maintenance (Wisconsin River to Minneapolis)	2,792.43
Grand total	22,148,677.99

For further details of previous projects, see pages 1879, 1880, and 1887 of the Annual Report for 1915.

Existing project.—This provides for a channel 9 feet deep, with various widths, from the mouth of the Ohio River to Minneapolis, Minn., to be obtained by open channel work between the mouth of the Ohio and the mouth of the Illinois Rivers, and by open-channel work and locks and dams above the mouth of the Illinois River.

Mouth of Ohio River to mouth of Illinois River.—A project, originated in 1881 (Annual Report, 1881, p. 1536), amended by river and harbor acts of 1896 and 1902, had for its object eventually to obtain by regulation works and dredging a minimum depth of 8 feet from the mouth of the Ohio River to St. Louis, and a minimum depth of 6 feet from St. Louis to the mouth of the Missouri River. After the practical abandonment of the use of regulating works in river and harbor acts of 1905 and 1907, and joint resolution of June 29, 1906, regulation was restored by the river and harbor act of 1910 under a new estimate of $21,000,000 with a view to the completion of the improvement within 12 years. (H. Doc. No. 50, 61st Cong. 1st sess., and H. Doc. No. 168, 58th Cong., 2d sess.)

The river and harbor act of January 21, 1927, further altered the project to provide for a channel 9 feet deep and a width of 300 feet, with additional widths in bends, by the accepted combination of methods from the mouth of the Ohio River to the northern boundary of the city of St. Louis. The annual cost of maintenance for this section was increased to $900,000. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.)

The river and harbor act of July 3, 1930, modified the project between the northern boundary of St. Louis and Grafton (mouth of Illinois) to provide for a channel 9 feet deep and generally 200 feet wide, at an estimated cost of $1,500,000, with $125,000 annually for maintenance. (R. and H. Com. Doc. No. 12, 70th Cong., 1st sess.)

Mouth of Illinois River to Minneapolis, Minn.—A project adopted by the river and harbor act March 2, 1907, provided for improvement

The total cost of all work (Rock Island district) during the fiscal year was $2,007,284.76, of which amount $1,409,167.79 was for new work and $598,116.97 was for maintenance. The total expenditures were $1,934,340.85.

Mouth of Missouri River to mouth of Illinois River (St. Louis district).—Repair work was carried on by hired labor with Government plant from November 1, 1929, to April 12, 1930. Project dimensions of channels were secured by dredging, and regulating works were maintained as needed. Eight hundred linear feet of solid dikes was maintained by hired labor, at a cost of $59,887.75. No new regulating works were constructed. The pipe-line dredge *Fort Gage* maintained the required 6-foot channel; 293,050 cubic yards of material were dredged from one bar. The dredge *Thebes* dredged a channel into Alton slough. The channel had a combined length of 0.5 mile, an average width of 300 feet, and an average gain in depth of 7 feet. The total cost of dredging was $18,430.23.

Hydrographic surveys were made covering 22 miles of river at a cost of $8,285.12.

The total cost for the work of this section (St. Louis district) was $86,603.10, all for maintenance. The total expenditures were $80,000.

Mouth of the Ohio River to mouth of Missouri River (St. Louis district).—The low river stage which prevailed through both the fall and spring season has permitted an unusual amount of construction work during the year. Work was carried on by hired labor with Government plant from July 1 to December 20, 1929, and from April 8 to June 30, 1930. Project dimensions of channels were secured by dredging, and regulating works were maintained as needed. Quantities and costs of regulating works follow:

Class of work	Dikes or hurdles			Bank protection (revetments)				
					Mattress		Paving	
	Number	Linear feet	Costs	Number	Linear feet bank protected	Squares 100 square feet	Squares 100 square feet	Costs
NEW (TIMBER)								
By hired labor with United States plant	24	19,760	$760,059.91	2	12,055	13,430	7,196	$278,871.68
Contract	21	21,575	827,338.41	1	4,155	5,195	2,041	131,258.35
Total	45	41,335	1,587,398.32	3	16,210	18,075	9,237	410,130.03
MAINTENANCE								
By hired labor with United States plant	65	6,160	186,149.17	3	11,845	5,744	6,101	[1] 213,564.38

[1] Repairs to 150 feet of retards, cost $15,411.13, included here.

The cost of new regulating works was $958,596.76 by contract and $1,038,931.59 for hired labor with Government plant; total, $1,997,528.35. The cost of maintenance was $399,713.55, all done by hired labor with Government plant. The plant was maintained in a high state of efficiency. The hull of the towboat *Tuscumbia* is being re-

EXAMINATIONS AND SURVEYS REQUIRED BY THE RIVER AND HARBOR ACTS APPROVED AUGUST 8, 1917, JANUARY 21, 1927, JULY 3, 1930, AND THE FLOOD CONTROL ACTS APPROVED MAY 31, 1924, AND FEBRUARY 12, 1929

The local engineer was charged with the duty of making preliminary examinations and surveys provided for by the river and harbor acts approved August 8, 1917, January 21, 1927, July 3, 1930, and the flood control acts approved May 31, 1924, and February 12, 1929, as follows, and reports thereon will be duly submitted when received.

1. Black River, Ark. and Mo.

2. Black River, Ark. and Mo., above Black Rock, Ark., etc.

3. Canadian River, N. Mex., Tex., and Okla., with a view to the control of the floods.

4. North Fork Canadian River, Tex. and Okla., with a view to the control of the floods.

5. Deep River, Okla., with a view to the control of the floods.

6. Verdigris River, Okla., with a view to the control of the floods.

7. Little River, Okla., with a view to the control of the floods.

8. Cimarron River, N. Mex. and Okla., with a view to the control of the floods.

9. Arkansas River, Kans., Okla., and Ark., with a view to the control of the floods.

10. Cache River, Ark.

11. Arkansas River and its tributaries, Ark. and Okla.

12. Mayfield Creek, Ky.

13. Wolf River and Nonconnah River, Tenn.

14. Hatchie River, Tenn.

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

This district includes the Mississippi River between the Ohio and Illinois Rivers, Missouri River, Hermann to mouth, and removing snags and wrecks from the Mississippi River below the mouth of Missouri River, and from Old and Atchafalaya Rivers between the mouths of the Missouri and Ohio Rivers.

District engineer: Maj. John C. Gotwals, Corps of Engineers, to July 19, 1930; Capt. Sylvester E. Nortner, Corps of Engineers, July 19, 1930, to November 4, 1930; and Maj. William A. Snow, Corps of Engineers, since that date.

Division engineer: Col. George R. Spalding, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS

Location and description.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,470 miles, and empties into the Gulf of Mexico. The portion included in this report embraces two sections—the 197-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and the 21.3-mile part of the upper Mississippi between the Missouri and Illinois Rivers, 1,078 to 1,296.3 miles from the Gulf. The drainage area of the valley to the Ohio and discharging through the district is 713,000 square miles. At St. Louis the discharge in cubic feet per second for the low-water plane,[1] minus 2-foot gage, is 40,000; for mean stage, 12.2-foot gage, 180,000 cubic feet per second; for bank-full stage, 30-foot gage, 650,000; and for maximum flood, 1,350,000; mean discharge of river is 185,000 cubic feet per second. At Grafton, mouth of the Illinois, the discharge in cubic feet per second for mean low water, 2.2-foot gage, is 30,000; for mean stage, 8.5-foot gage, 100,000; bank-full stage, 18-foot gage, 256,000; and for maximum flood, 450,000.

In the middle Mississippi the average natural depths available for navigation at low water, mean, and bank-full stages are about 4, 9, and 16 feet, respectively; i. e., crest of bars rise and fall with stage as 1 to 2½. In the section above the mouth of Missouri the average natural depths available for navigation at low water and bank-full stages are about 3 and 8 feet, respectively. Oscillation between annual low and high water averages 40 feet at Cairo, mouth of Ohio River, and 25½ feet at St. Louis, 17 miles below the Missouri River, and 17.7 feet at Grafton, mouth of Illinois River. The extreme range is 57.3 feet at Cairo, 44.4 feet at St. Louis, 38.1 feet at mouth of Missouri River, and 33 feet at Grafton, mouth of the Illinois River. Considering annual averages, the river stage at St. Louis oscillates between low water (1.4 feet) and mean stage for 200 days and between mean stage and high water (27.1 feet) for 152 days; and at Grafton the river stage oscillates between low water (2.2 feet) and mean stage for 215 days and between mean stage and high water (19.6 feet) for 150 days. The low-water plane, mouth of Ohio River, is 274 feet above mean sea level and at mouth of Missouri River, 393 feet, with an average slope of 0.6 foot per mile. The low-water plane at the mouth of the Illinois is 405 feet above mean sea level, average slope 0.5 foot per mile between that and the Missouri River. Current at mean stage is about 2½ miles per hour and the average width between banks is about 4,500 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of the river was 1 to 1½ miles and the maximum usable channel depth at low water was only 3½ to 4 feet; above the mouth of the Missouri the natural channel depth at low water was only 2½ to 4 feet.

Previous projects.—The original project for the improvement of the Mississippi River between the Ohio and Illinois Rivers was

[1] Minus 2 feet on St. Louis gage, 2 feet on Commerce gage, and 4 feet on Cairo gage, the plane of reference, adopted 1927, for district operations. "Standard low water," adopted 1881, was 4 feet on St. Louis gage, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the minus 2-foot stage.

recommended by a board of engineers in a report dated April 18, 1872, and concurred in by the Chief of Engineers. The cost and expenditures for the middle Mississippi prior to the adoption of the present project in 1881 were $1,495,000 for new work.

For that part of the river between the Illinois and Missouri Rivers the first appropriation was made in the river and harbor act of June 10, 1872, and appropriations were continued intermittently until the adoption of the project authorized by the river and harbor act of March 2, 1907, which provided for a 6-foot channel to be obtained by contraction works consisting of wing or spur dams for narrowing the main channel of the river and closing dams for side chutes and by dredging. The cost and expenditures were $592,455.68 prior to the adoption of the 1907 project and $671,603.10 under that project, or a total of $1,264,058.78 for this section of the river, of which $1,122,455.68 was for new work and $141,603.10 for maintenance.

The total cost of previous projects for the entire section between the Ohio and Illinois Rivers was $2,759,058.78, of which $2,617,455.68 was for new work and $141,603.10 for maintenance. The total expenditure was $2,759,058.78.

For further details of previous projects see pages 1879 and 1880 of the Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet at low water, with additional width in bends from the mouth of the Ohio River (1,078 miles from the Gulf) to the northern boundary of the city of St. Louis, 191 miles; thence 200 feet wide, with additional width in bends to the mouth of the Illinois River, 27.3 miles, all to be obtained by regulating works and dredging.

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river. The following table shows the project width for middle Mississippi:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,600	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896, 1902, 1907, and 1922, the latter of which provides for dredging channels to landing places on the main river and subsidiary sloughs for the river above the mouth of the Missouri River. That part of the project for the middle

Mississippi which proposed regulating works, was practically abrogated by acts of March 3, 1905, March 2, 1907, and the joint resolution of June 9, 1906. The river and harbor act of June 25, 1910, restored regulating works to the project and began appropriations with a view to the completion of the improvement between the Ohio and Missouri Rivers within 12 years, at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess.; and H. Doc. No. 168, 58th Cong., 2d sess.) The river and harbor act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.) The river and harbor act of July 3, 1930, modified the project between the northern boundary of the city of St. Louis and Grafton (mouth of Illinois River) to provide for a channel 9 feet deep and generally 200 feet wide with additional width around bends, at an estimated cost of $1,500,000, with $125,000 annually for maintenance. (R. and H. Com. Doc. No. 12, 70th Cong., 1st sess.)

The estimated cost of new work, revised in 1931, is $35,650,000 with $1,100,000 for annual maintenance.

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838, private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; 1924, page 1081; 1929, page 1104; and 1930, page 1193. Additional data for terminal facilities is also contained in Transportation Series No. 2, 1929, Transportation in the Mississippi and Ohio Valleys.

Effect of improvement.—Some of the resultant benefits to commerce from the improvements are: (*a*) Larger and deeper-draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, a 9-foot channel being generally available during the navigation season from the mouth of the Ohio River to the northern boundary of the city of St. Louis, and a 6-foot channel generally being available from that point to the mouth of the Illinois River; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the river; freight rates by water are generally 80 per cent of the rail rates. Barge-line rates are now available

throughout this section of the Mississippi River and the advantage of joint rail-water rates are being exploited.

Operations and results during fiscal year.—Extensive construction works were carried on throughout the year with unusually low river stages prevailing; work was carried on by hired labor with Government plant and by contact from July 1, 1930, to June 30, 1931. The district's standard forms of construction were used. Regulating works were maintained and project dimensions of channels were secured by dredging. Quantities and costs of regulating works follow:

Class of work	Dikes or hurdles			Bank protection (revetments)				
					Mattress		Paving, squares 100 square feet	
	Number	Linear feet	Costs	Number	Linear feet bank protected	Squares 100 square feet		Costs
NEW								
By hired labor with United States plant:								
Crib	21	12,150	$388,745.45	7	24,610	26,120	11,786	$425,255.79
Dikes	1	1,500	68,478.14					
Contract:								
Timber	46	28,235	1,188,177.24	2	11,885	14,201	7,039	290,778.93
Crib	2	4,350	187,487.96					
Total	70	46,235	1,832,888.79	9	36,495	40,321	18,825	716,034.72
MAINTENANCE								
Concrete		410	9,528.53					
By hired labor with United States plant		6,235	111,800.69	10	[1] 855	2,443	4,574	154,351.03
Crib		935	27,186.36					
Contract		260	8,627.97	1		105	136	4,693.38
Total		7,840	157,143.55	11	855	2,548	4,710	159,044.41

[1] Repairs to 855 linear feet retards, cost $30,007.15, included here.

The cost of new regulating works was $2,548,923.51, including $1,666,444.13 for contract work; the cost of maintenance was $316,187.96, including $13,321.35 for contract maintenance. The plant was maintained in a high stage of efficiency. A new turbo-generator set has been purchased for the dredge *Fort Chartres* and will be installed by hired labor during the coming winter. The hulls of the dredges *Selma* and *Thebes* were replated. The cabins of two office and survey boats were placed on steel hulls. One electric derrick was erected on steel barge. Additional plant procured by contract was 3 steel-hull, 70-horsepower, Diesel-driven propeller boats and 44 steel pontoons. The following plant was procured by transfer from the Kansas City district: Towboat *McIndoe*, 2 quarter boats, 3 pile drivers, 4 mattress barges, 1 derrick barge, 11 wood barges, 6 steel barges, 5 pontoons, steel launch *Indian*, wood launches *Blackbird*, *Deer*, *Buck Elk*, *Owl*, and *Burlington*. Expenditures for new plant were $166,989.50, including $55,515.72 for rehabilitating the dredges *Selma* and *Thebes*.

The one dipper and five pipe-line dredges maintained the required 9-foot channel, except for short periods, until a dredge could get

to the shoal; 9,837,900 cubic yards of sand and gravel were dredged from 94 channels through 71 bars; in addition, 52,200 cubic yards were dredged from the winter harbor in Alton Slough. The channels dredged had a combined length of 34.6 miles, an average width of 290 feet, and an average gain in depth of 4.4 feet. The total cost of dredging was $698,619, including $17,055.30 for contract dredging in Alton Slough.

Hydrographic surveys were made covering 436.1 miles of river. The cost of surveys and gages were $100,394.36.

The total cost of the work was $3,664,124.83, of which $2,548,923.51 was for new work and $1,115,201.32 was for maintenance, including dredging and surveys. The total expenditures were $3,938,013.40.

Condition at end of fiscal year.—The regulating works are about 61 per cent completed. The quantities required to complete the project are estimated as follows: 164 dikes, 192,405 linear feet; 38 revetments, 327,585 linear feet. All work is in excellent repair and has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. For six months the river is usually above a 10-foot stage, and the minimum channel depth has generally prevailed throughout the district without dredging.

The cost under the existing project is $21,132,953.96 for new work and $13,498,099.30 for maintenance, including dredging and surveys, a total of $34,631,053.26. The total expenditures on the existing project are $36,882,496.87.

Proposed operations.—The balance unexpended July 1, 1931, $3,158,178, will be applied in the ensuing fiscal year as follows:

Maintenance of project dimensions of channel by dredging: United States plant operated by hired labor, and upkeep of 4 hydraulic pipe-line dredges, 1 dipper dredge, and contract dredging		$750,000
Construction of new regulating works, dikes, and revetments:		
By contract—		
Dikes	$1,150,000	
Revetment	425,000	
		1,575,000
By United States plant and hired labor—		
Dikes	100,000	
Revetment	100,000	
		200,000
Maintenance of regulating works—		
By United States plant and hired labor		450,000
Engineering and contingencies		183,178
Total (new work, $1,775,000; maintenance, $1,383,178)		3,158,178

Project dimensions of steamer channels will be maintained. Work upon regulating structures will be, first, that necessary to safeguard such structures, and second, will include extension of regulating works at the points most urgently requiring contraction and protection of river banks. The new work now being done aims to advance continuously downstream from fixed points and where possible, to improve first the most difficult crossings in the steamboat channel,

and protect the most rapidly caving banks. These operations, including maintenance of plant, will be carried on continuously except in midwinter, when navigation and river work are interrupted by ice conditions.

The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works, especially for placing revetment and repairing paving. Early spring is, however, the most favorable time for the construction of permeable dikes (contraction works), as rapid accretions are secured during summer high water which protect the dikes from ice attack. Dredging will be required, depending upon river stages, to maintain the channels at their full project dimensions. During the period of active operations funds will be expended at the rate of $330,000 per month; during the winter (3 months) in repairing and caring for plant in winter harbor, $60,000 per month will be expended. It is believed that all funds will be expended by June 30, 1932.

The commerce on the Mississippi River in this district requires navigable channels of assured depth and stabilized location. The large amount of contraction work and revetment constructed in recent years has done much to achieve this result and has greatly benefited navigation.

The sum of $3,775,000 can be profitably expended during the fiscal year ending June 30, 1933, as follows:

Maintenance of project dimensions of channels by dredging: United States plant operated by hired labor, upkeep of 4 hydraulic pipe-line dredges, 1 dipper dredge, and contract dredging		$800,000.00
Construction of new regulating works, dikes, and revetments:		
By contract—		
Dikes	$800,000.00	
Revetment	700,000.00	
		1,500,000.00
By United States plant and hired labor—		
Dikes	100,000.00	
Revetment	100,000.00	
		200,000.00
New plant, by contract: 20-inch pipe-line cutter-head dredge		500,000.00
Maintenance of regulating works: By United States plant and hired labor		600,000.00
Engineering and contingencies		175,000.00
Total (new work, $2,200,000; maintenance, $1,575,000)		3,775,000.00

Commercial statistics.—The freight traffic of the Mississippi River on the stretch between the mouths of Illinois and Ohio Rivers amounted to 926,957 tons in 1930. Of this amount 341,158 tons was upbound, consisting largely of sugar, cement, logs, sulphur, stone, burlap and bagging, sisal, coffee, and lumber. Downbound traffic amounted to 585,799 tons, which included 230,730 tons of stone, 123,056 tons of wheat, besides such other commodities as iron and iron products, logs, coal, fruits and vegetables, cement, and other package freight.

Comparative statement

Year	Tons	Value	Passengers	Year	Tons	Value	Passengers
1926	1,005,979	$49,025,466	1,336,920	1929	891,756	$67,362,890	1,560,386
1927	1,110,402	45,257,625	1,313,295	1930	926,957	63,068,513	1,267,141
1928	1,430,183	68,660,891	1,320,230				

Cost and financial summary

Cost of new work to June 30, 1931	$23,750,409.64
Cost of maintenance to June 30, 1931	13,639,702.40
Total cost of permanent work to June 30, 1931	[1] 37,390,112.04
Value of plant, materials, etc., on hand June 30, 1931	2,245,953.02
Net total cost to June 30, 1931	39,636,065.06
Plus accounts receivable June 30, 1931	224,680.36
Gross total costs to June 30, 1931	39,860,745.42
Minus accounts payable June 30, 1931	219,189.77
Net total expenditures	39,641,555.65
Unexpended balance June 30, 1931	3,158,178.00
Total amount appropriated to June 30, 1931	42,799,733.65

Fiscal year ending June 30	1927	1928	1929	1930	1931
Cost of new work	$1,244,922.58	$2,653,544.26	$1,925,527.73	$2,029,138.39	$2,548,922.52
Cost of maintenance	536,077.44	578,902.32	331,613.25	1,097,739.19	1,115,201.31
Total cost	1,781,010.02	3,232,446.58	2,257,140.58	[3] 3,126,877.58	3,664,124.83
Total expended	1,781,010.02	3,455,048.71	2,689,198.96	2,495,756.86	3,938,013.40
Allotted	3,000,000.00	2,874,677.99	2,175,000.00	2,060,000.00	4,281,000.00

[1] Due to excessive debit balances on form No. 23, in the amount of $247,337.42, being charged into prior costs, the costs to June 30, 1930, are increased by this amount, of which $31,610.04 is new work and $215,727.38 is maintenance.

Balance unexpended July 1, 1930		$2,815,191.40
Amount allotted from War Department appropriation act approved May 28, 1930	$485,000.00	
Amount allotted from emergency appropriation act approved Dec. 20, 1930	1,050,000.00	
Amount allotted from War Department appropriation act approved Feb. 23, 1931	2,831,000.00	
		4,366,000.00
Amount to be accounted for		7,181,191.40
Deductions on account of revocation of allotment		85,000.00
Net amount to be accounted for		7,096,191.40
Gross amount expended	$3,955,067.03	
Less receipts from sales	17,053.63	
		3,938,013.40
Balance unexpended June 30, 1931		3,158,178.00
Outstanding liabilities June 30, 1931	$547,618.09	
Amount covered by uncompleted contracts	140,468.85	
		688,086.94
Balance available June 30, 1931		2,470,091.06
Accounts receivable June 30, 1931		224,680.36
Unobligated balance available June 30, 1931		2,694,771.42
Amount (estimated) required to be appropriated for completion of existing project [1]		12,800,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1933:		
For new work [1]		2,200,000.00
For maintenance [1]		1,575,000.00
Total [1]		3,775,000.00

2. MISSOURI RIVER, HERMANN TO MOUTH

For report on this improvement see page 1242.

[1] Exclusive of available funds.

liminary examination, were received. They are being held by the Board of Engineers for Rivers and Harbors for the purpose of securing additional information and for further study.

Reports on the following localities, called for by the flood control act approved May 31, 1924, and the river and harbor act approved January 21, 1927, are combined with report on survey of the Arkansas River and tributaries, made under the provisions of House Document No. 308, Sixty-ninth Congress, first session, and section 10 of the flood control act of May 15, 1928, now receiving consideration by the Board of Engineers for Rivers and Harbors:

1. Canadian River, N. Mex., Tex., and Okla., with a view to the control of the floods.

2. North Fork Canadian River, Tex. and Okla., with a view to the control of the floods.

3. Deep River, Okla., with a view to the control of the floods.

4. Verdigris River, Okla., with a view to the control of the floods.

5. Little River, Okla., with a view to the control of the floods.

6. Cimarron River, N. Mex. and Okla., with a view to the control of the floods.

7. Arkansas River, Kans., Okla., and Ark., with a view to the control of the floods.

8. Arkansas River and its tributaries, Ark. and Okla.

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

This district includes the Mississippi River between the Ohio and Illinois Rivers, Missouri River, Hermann to mouth, and removing snags and wrecks from the Mississippi River between the mouths of the Missouri and Ohio Rivers, and from Old and Atchafalaya Rivers.

District engineer: Maj. William A. Snow, Corps of Engineers.

Sector engineer: Lieut. Col. R. C. Moore, Corps of Engineers.

Division engineer: Col. George R. Spalding, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS

Location and description.—The Mississipi River rises in Lake Itasca, Minn., flows south 2,470 miles, and empties into the Gulf of Mexico. The portion included in this report embraces two sections—the 195-mile section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and the 23.3-mile part of the upper Mississippi between the Missouri and Illinois Rivers, 1,078 to 1,296.3 miles from the Gulf. The drainage area of the valley to the Ohio and discharging through the district is 713,000 square miles.

At St. Louis the discharge in cubic feet per second for the low-water plane,[1] minus 2-foot gage, is 40,000; for mean stage, 12.2-foot gage, 180,000; for bank-full stage, 30-foot gage, 650,000; and for maximum flood, 1,350,000; mean discharge of river is 185,000 cubic feet per second. At Grafton, mouth of the Illinois, the discharge in cubic feet per second for mean low water, 2.2-foot gage, is 30,000; for mean stage, 8.5-foot gage, 100,000; bank-full stage, 18-foot gage, 256,000; and for maximum flood, 450,000.

In the middle Mississippi the average natural depths available for navigation at low water, mean, and bank-full stages are about 4, 9, and 16 feet, respectively; i. e., crest of bars rise and fall with stage as 1 to 2.5. In the section above the mouth of Missouri the average natural depths available for navigation at low water and bank-full stages are about 3 and 8 feet, respectively. Oscillation between annual low and high water averages 40 feet at Cairo, mouth of Ohio River, and 25.7 feet at St. Louis, 17 miles below the Missouri River, and 17.7 feet at Grafton, mouth of Illinois River. The extreme range is 57.4 feet at Cairo, 44.4 feet at St. Louis, 38.3 feet at mouth of Missouri River, and 33 feet at Grafton, mouth of the Illinois River. Considering annual averages, the river stage at St. Louis oscillates between low water (1.4 feet) and mean stage (12.2 feet) for 200 days and between mean stage and high water (27.1 feet) for 152 days; and at Grafton the river stage oscillates between low water (2.2 feet) and mean stage (8.5 feet) for 215 days and between mean stage and high water (19.6 feet) for 150 days. The low-water plane, mouth of Ohio River, is 274 feet above mean sea level and at mouth of Missouri River, 393 feet, with an average slope of 0.6 foot per mile. The low-water plane at the mouth of the Illinois is 406 feet above mean sea level, average slope 0.5 foot per mile between that and the Missouri River. Current at mean stage is about 2.5 miles per hour and the average width between banks is about 4,500 feet.

Original condition.—The waterway of the middle Mississippi was divided by numerous islands and bars, which distributed large portions of the flow through chutes, sloughs, and secondary channels to the detriment of navigation; at many of these localities the natural width of the river was 1 to 1.5 miles and the maximum usable channel depth at low water was only 3.5 to 4 feet; above the mouth of the Missouri the natural channel depth at low water was only 2.5 to 4 feet.

Previous projects.—The original project for the improvement of the Mississippi River between the Ohio and Illinois Rivers was recommended by a board of engineers in a report dated April 13, 1872, and concurred in by the Chief of Engineers. The cost and expenditures for the middle Mississippi prior to the adoption of the present project in 1881 were $1,495,000 for new work.

For that part of the river between the Illinois and Missouri Rivers the first appropriation was made in the river and harbor act of June 10, 1872, and appropriations were continued intermittently

[1] Minus 2 feet on St. Louis gage, 2 feet on Commerce gage, and 4 feet on Cairo gage, the plane of reference, adopted 1927, for district operations. "Standard low water," adopted 1881, was 4 feet on St. Louis gage, the discharge being approximately 40,000 cubic feet per second; because of locally contracted waterway and consequent lowering of low-water plane that volume now passes at about the minus 2-foot stage.

until the adoption of the project authorized by the river and harbor act of March 2, 1907, which provided for a 6-foot channel to be obtained by contraction works consisting of wing or spur dams for narrowing the main channel of the river and closing dams for side chutes and by dredging. The cost and expenditures were $592,455.68 prior to the adoption of the 1907 project and $671,603.10 under that project, or a total of $1,264,058.78 for this section of the river, of which $1,122,455.68 was for new work and $141,603.10 for maintenance.

The total cost of previous projects for the entire section between the Ohio and Illinois Rivers was $2,354,058.78, of which $2,212,455.68 was for new work and $141,603.10 for maintenance. The total expenditure was $2,354,058.78.

For further details see pages 1879 and 1880 of the Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet at low water, with additional width in bends from the mouth of the Ohio River (1,078 miles from the Gulf) to the northern boundary of the city of St. Louis, 191 miles; thence 200 feet wide, with additional width in bends to the mouth of the Illinois River, 27.3 miles, all to be obtained by regulating works and dredging.

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river. The following table shows the project width for middle Mississippi:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,600	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the river and harbor acts of 1896, 1902, 1907, and 1922, the latter of which provides for dredging channels to landing places on the main river and subsidiary sloughs for the river above the mouth of the Missouri River. That part of the project for the middle Mississippi which proposed regulating works was practically abrogated by acts of March 3, 1905, March 2, 1907, and the joint resolution of June 9, 1906. The river and harbor act of June 25, 1910, restored regulating works to the project and began appropriations with a view to the completion of the improvement between the Ohio and Missouri Rivers within 12 years, at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompany-

ing atlas, 61st Cong., 1st sess.; and H. Doc. No. 168, 58th Cong., 2d sess.) The river and harbor act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (R. and H. Com. Doc. No. 9, 69th Cong., 2d sess.) The river and harbor act of July 3, 1930, modified the project between the northern boundary of the city of St. Louis and Grafton (mouth of Illinois River) to provide for a channel 9 feet deep and generally 200 feet wide with additional width around bends, at an estimated cost of $1,500,000, with $120,000 annually for maintenance. (R. and H. Com. Doc. No. 12, 70th Cong., 1st sess.)

The estimated cost of new work, revised in 1931, is $35,650,000, with $1,100,000 for annual maintenance.

Recommended modifications of project.—None.

Local cooperation.—Although no local cooperation has ever been required by law, the United States participated with local interests in some of the first confining or regulating works of the district. For historical sketch see Annual Report, 1902, page 2607, and House Document No. 1067, Sixty-first Congress, third session, page 30. Since 1838 private and corporate interests at their own expense have constructed 45,700 linear feet of solid and permeable dikes or wing dams costing $1,100,000, and 85,000 linear feet of bank protection, including various revetments, paved wharves, railroad inclines, terminal docks, and improved landings, costing $8,600,000.

All of these structures contribute to the confinement and general improvement of the river and to the completion of the existing project.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239; in addition thereto reference is made to Annual Reports, 1921, pages 1199–1200; 1922, pages 1222–1223; 1923, pages 1080–1081; 1924, page 1081; 1929, page 1104; and 1930, page 1193. Additional data for terminal facilities is also contained in Transportation Series No. 2, 1929, Transportation in the Mississippi and Ohio Valleys.

Effect of improvement.—Some of the resultant benefits to commerce from the improvements are: (*a*) Larger and deeper-draft boats and barges are now being used; (*b*) the difficulties and hazards of navigation have been reduced, a 9-foot channel being generally available during the navigation season from the mouth of the Ohio River to the northern boundary of the city of St. Louis, and a 6-foot channel generally being available from that point to the mouth of the Illinois River; (*c*) freight rates by rail to points on Mississippi River and tributaries are much lower than to points only a few miles back from the river; freight rates by water are generally 80 per cent of the rail rates. Barge-line rates are now available throughout this section of the Mississippi River, and the advantage of joint rail-water rates are being exploited.

Operations and results during fiscal year.—Extensive construction works were carried on throughout the year with river stages suitable for construction; work was carried on by hired labor with Government plant and by contract from July 1, 1931, to June 30, 1932. The district's standard forms of construction were used.

Regulating works were maintained and project dimensions of channels were secured by dredging. Location, quantities, and costs of regulating works follow:

Class of work and locality	Miles above mouth of Ohio River	Dikes or hurdles			Bank protection (revetment)				
						Mattress		Paving, squares, 100 square feet	
		Number	Linear feet	Costs	Number	Linear feet, bank protected	Squares, 100 square feet		Costs
New work, by contract									
Elk Island	7					1,475	1,433	543	$23,801.90
Eliza Towhead	8		1,200	$28,778.20					
Buffalo Island	19					325	325	131	9,866.09
Dogtooth	25		500	19,340.92					
Burnham Island	36					2,550	2,618	1,295	39,204.80
Commerce Island	38		2,985	82,209.46					
Cape Girardeau	43					1,450	1,450	501	15,928.04
Little Flora Creek	56					3,000	2,764	1,103	35,050.07
Kinney Point	58		1,490	27,672.61					
Brunkhorst	85					890	890	401	8,863.29
Rockwood	102		5,805	141,147.80					
Klondike Landing	112		1,575	36,010.41					
Ste. Genevieve	123		410	5,527.17					
Osborne Field	142					2,500	2,200	1,510	37,509.07
Wilson Island	143		2,400	63,831.68					
Harlow Island	143		800	22,825.15					
James Landing	146		490	19,831.10					
Meramec River	161					3,790	3,413	1,514	49,225.96
Total		80	16,655	447,174.50	8	15,980	15,193	6,998	219,449.22
New work; United States plant and hired labor									
Elk Island	6							367	8,354.52
Prices Landing	30							30	737.00
Commercial Point	34					2,260	2,507	983	37,634.83
Powers Island	36					100	100		792.45
Swift Sure Towhead	60					1,495	1,370	682	27,806.35
Hamburg Island	63							211	5,308.45
Union Point	74		790	19,660.23					
Grand Tower	80		1,480	21,927.84					
Brunkhorst	85		650	23,865.59					
Rockwood	102		1,065	27,858.34					
Crain Island	103		1,250	33,199.63					
Illinois State Farm	113					200	141		1,214.98
Moro Island	121		950	30,515.67					
Ste. Genevieve	123			18,841.72					
Penitentiary Point	136		465	16,250.44					
Danby Island	139					215	215	227	843.94
Fish Bend	140		330	10,797.04					
Pulltight	163		450	15,782.45					
Wood River	198		500	34,507.18		2,640	1,655	638	25,988.74
Maple Island	200		2,835	163,489.13				245	4,072.96
Alton Reach	208		325	82,613.80					
Portage Island	212					500	250		2,603.66
Total		27	11,090	449,309.06	6	7,410	6,238	3,383	115,357.88
Maintenance by United States plant and hired labor									
Total			6,530	109,328.45			2,334	2,222	75,355.25

The cost of new regulating works was $1,231,290.66, including $666,623.72 for contract work; the cost of maintenance was $184,683.70.

The plant was maintained in a high stage of efficiency. The dredge *Fort Gage* was equipped with a new condenser unit and pump, the turbine was rebladed, and a new head installed. The new

24-inch pipe-line dredge *Dundee*, under construction at Pittsburgh throughout the year, will be of the *Fort Gage* dustpan suction type, 224 feet long, 45 foot beam, 4 foot draft, pumping machinery powered by 1,200 horsepower turbo-electric generators; two 20-inch cutter head suction dredges are under construction; 20 steel pontoons were completed by contract for use with the dredge *Dundee;* additional plant secured by contract was two steel quarterboat hulls, 152 by 34 by 4 feet; four 18-foot motor launches and one 24-foot sedan launch. Ten small launches are under construction. The following towboats were acquired by transfer—the *Guyandot* from the Cincinnati district, the *Mamie Barrett*, and the *Minneapolis* from the Rock Island district. Twenty barges were secured by transfer from the Rock Island district, and the towboat *Tecumseh* was transferred to the Pittsburgh district. Expenditures for new plant were $1,129,508.64, including repairs to the dredge *Fort Gage.*

The required 9-foot channel was maintained by the six United States and five contract dredges, except for short periods, until a dredge could get to the shoal; during the spring season there was at no time less than a 9-foot channel below the mouth of the Missouri River. During the year 122 shoals developed—60 required dredging once, 23 required dredging twice, 8 required dredging three times, 4 required dredging four times, 2 required dredging six times, and the balance, 25, disappeared without dredging; 10,617,421 cubic yards of sand and gravel were dredged by United States dredges from 81 channels through 69 bars. In addition, 2,465,137 cubic yards were dredged by contract from 16 channels through 9 bars, and 146,686 cubic yards from the winter harbor in Alton Slough. The channels dredged had a combined length of 39.2 miles, an average width of 330 feet, and an average gain depth of 4.9 feet. The total cost of dredging was $1,009,529.28, which includes $211,598.08 for contract dredging in channels and $36,720.75 for dredging a winter harbor in Alton Slough.

Hydrographic surveys were made covering 576.2 miles of river. The cost of surveys and gages was $187,088.47, including $23,007.60 for aerial survey.

The total cost of the work was $2,653,187.79, of which $1,271,886.34 was for new work, including $40,595.68 expended in preliminary surveys for locks and dams and $1,381,301.45 for maintenance, including dredging and surveys. The total expenditures were $3,228,742.78.

Condition at end of fiscal year.—The regulating works are about 67 per cent completed. The quantities required to complete the project are estimated as follows: 107 dikes, 164,660 linear feet; 24 revetments, 304,198 linear feet. All work is in excellent repair and has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. For six months the river is usually above a 10-foot stage, and the

minimum channel depth has generally prevailed throughout the district without dredging.

The following table gives condition of channel:

Sections	Length of section	Affording less than 9 feet	Period [1]	Affording more than 9 feet	Period [1] [2]	Proposed low water width	Controlling depth June 30, 1932
	Miles	*Miles*	*Days*	*Miles*	*Days*		*Feet*
Mouth of Ohio to Commercial Point	32.2	1.1	18	31.1	282	2,000	9
Commercial Point to Commerce	7.2	0.9	4	6.3	296	2,500	9
Commerce to Gray's Point	6.9	0.0	0	6.9	300	2,085	9
Gray's Point to Grand Tower	33.5	3.5	22	30.0	278	2,250	9
Grand Tower to Fort Gage	36.2	2.5	31	33.7	269	2,250	9
Fort Gage to Little Rock	9.5	[3] 2.0	35	7.5	265	2,250	9
Little Rock to River Des Peres	46.5	6.7	28	39.8	262	2,250	9
River Des Peres to Northern Boundary, city of St. Louis	19.0	0.2	3	18.8	297	1,700	9
Northern Boundary to mouth of Missouri River	4.1	0.0	0	4.1	300	2,250	9
Mouth of Missouri River to Illinois River	23.2	17.7	102	5.5	198	1,400	8

[1] Total days but not continuous.
[2] Navigation season, Feb. 15 to Dec. 15, 300 days.
[3] Channel diversion.

The total costs under the existing project to the end of the fiscal year were $22,404,840.30 for new work and $14,889,843.81 for maintenance, including dredging and surveys, a total of $37,294,684.11. The total expenditures on the existing project are $40,111,239.65.

Proposed operations.—The balance unexpended at the end of the year, including accounts receivable, together with an allotment of $2,257,000 made during July, 1932, will be applied as follows:

Accounts payable June 30, 1932		$50,075.05
New work:		
By contract—		
Dikes, July, 1932, to June, 1933	$635,000.00	
Revetment, July, 1932, to December, 1932	645,000.00	
2 cutterhead pipe-line dredges, July 1, 1932, to Feb. 1, 1933	417,625.46	
Pontoons and auxiliary equipment for new dredges, Oct. 1, 1932, to Mar. 1, 1933	119,500.00	
10 motor boats, July 5, 1932, to Aug. 20, 1932	10,000.00	
By hired labor with United States plant—		
Dikes, July, 1932, to June, 1933	55,000.00	
Revetment, July, 1932, to December, 1932	1,000.00	
		1,883,125.46
Maintenance:		
By hired labor with United States plant—		
Dikes and revetments, July, 1932, to June, 1933	270,000.00	
Surveys, gages, and studies, July, 1932, to June, 1933	115,000.00	
By contract and hired labor with United States plant—		
Project dimensions of channel by dredging, July, 1932, to June, 1933	315,000.00	
		700,000.00
Total for all work		2,633,200.51

Project dimensions of steamer channels will be maintained. Work upon regulating structures will be, first, that necessary to safeguard

such structures, and, second, will include extension of regulating works at the points most urgently requiring contraction and protection of river banks. The new work now being done aims to advance continuously downstream from fixed points, and, where possible, to improve first the most difficult crossings in the steamboat channel, and protect the most rapidly caving banks. These operations, including maintenance of plant, will be carried on continuously except in midwinter, when navigation and river work are interrupted by ice conditions.

The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works, especially for placing revetment and repairing paving. Early spring is, however, the most favorable time for construction of permeable dikes (contraction works), as rapid accretions are secured during summer high water which protect the dikes from ice attack. Dredging will be required, depending upon river stages, to maintain the channels at their full project dimensions. During the period of active operations funds will be expended at the rate of $270,000 per month; during the winter (three months) in repairing and caring for plant in winter harbor, $50,000 per month will be expended. It is believed that all funds will be expended by June 30, 1933.

In addition, the sum of $457,000 is held in reserve for allotment to this project during the fiscal year 1933.

The commerce on the Mississippi River in this district requires navigable channels of assured depth and stabilized location. The large amount of contraction work and revetment constructed in recent years has done much to achieve this result and has greatly benefited navigation.

The additional sum of $3,700,000 can be profitably expended during the fiscal year ending June 30, 1934, as follows:

New work:		
By contract—		
Dikes, July, 1933, to June, 1934	$1,100,000	
Revetment, July, 1933, to Dec., 1933	1,100,000	
By hired labor with United States plant—		
Dikes, July, 1933, to June, 1934	250,000	
Revetment, July, 1933, to Dec., 1933	250,000	
		$2,700,000
Maintenance:		
By hired labor with United States plant—		
Dikes and revetment, July, 1933, to June, 1934	250,000	
Project dimensions of channel by dredging, July, 1933, to June, 1934	500,000	
Surveys, gages, and studies, July, 1933, to June, 1934	250,000	
		1,000,000
Total for all work		3,700,000

Commercial statistics.—For detailed information concerning the commodities and tonnage handled, of which 467,685 tons were upbound and 835,349 tons were downbound, reference is made to the commercial statistics report of this district published in a separate volume.

Analysis of the tonnage statement shows the principal commodities handled as follows: Upbound—Vegetable food products, ores,

Status of reports called for by river and harbor acts and committee resolutions

Locality	Authorization	Transmitted to Congress	House document	Recommendation
Arkansas River and tributaries, Ark. and Okla.	River and Harbor Act, Jan. 21, 1927.			
Arkansas River, Kans., Okla., and Ark., flood control.	Act, May 31, 1924			
Black River, Ark. and Mo., and Black River, Ark. and Mo., above Black Rock, Ark. (flood control).	River and Harbor Act, Aug. 8, 1917.	Jan. 18, 1933		Unfavorable.
Cache River, Ark.	River and Harbor Act, Jan. 21, 1927.			
Canadian River, N.Mex., Tex., and Okla. (flood control).	Act, May 31, 1924			
Cimarron River, N.Mex. and Okla. (flood control).	do			
Deep River, Okla. (flood control).	do			
Little River, Okla. (flood control).	do			
North Fork Canadian River, Tex. and Okla. (flood control).	do			
Verdigris River, Okla. (flood control).	do			

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

This district includes the Mississippi River between the Ohio River and Clarksville, Mo.; Missouri River, mouth to Hermann, Mo.; and removing snags and wrecks from the Mississippi River between the mouths of the Ohio and Missouri Rivers, and from Old and Atchafalaya Rivers.

On March 24, 1933, the Mississippi River between the mouth of the Illinois River and Clarksville, Mo., was transferred to this district from the Rock Island, Ill., district. This section is included in the report of Mississippi River between the Illinois River and Minneapolis, Minn.

District engineer: Maj. William A. Snow, Corps of Engineers.

Sector engineer: Lieut. Col. R. C. Moore, Corps of Engineers.

Division engineer: Col. George R. Spalding, Corps of Engineers; Lieut. Col. R. C. Moore, Corps of Engineers, acting division engineer since May 19, 1933.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND ILLINOIS RIVERS

Location.—The Mississippi River rises in Lake Itasca, Minn., flows south 2,470 miles, and empties into the Gulf of Mexico. The portion included in this report embraces two sections—the 195-mile

section known as the middle Mississippi, between the tributary Ohio and Missouri Rivers, and the 23.3-mile part of the upper Mississippi between the Missouri and Illinois Rivers, 1,078 to 1,296.3 miles from the Gulf.

Previous projects.—The original project for the improvement of the Mississippi River between the Ohio and Illinois Rivers was recommended by a board of engineers in a report dated April 13, 1872, and concurred in by the Chief of Engineers. The cost and expenditures for the middle Mississippi prior to the adoption of the present project in 1881 were $1,495,000 for new work.

For that part of the river between the Illinois and Missouri Rivers adopted in the River and Harbor Acts of June 10, 1872, and March 2, 1907, the cost and expenditures were $1,264,058.78.

The total costs and expenditures of previous projects for the entire section between the Ohio and Illinois Rivers were $2,354,058.78, of which $2,212,455.68 was for new work and $141,603.10 for maintenance.

For further details see pages 1879 and 1880 of the Annual Report for 1915.

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet at low water, with additional width in bends from the mouth of the Ohio River (1,078 miles from the Gulf) to the northern boundary of the city of St. Louis, 191 miles; thence 200 feet wide, with additional width in bends to the mouth of the Illinois River, 27.3 miles, all to be obtained by regulating works and dredging.

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river. The following table shows the project width for middle Mississippi:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,600	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the River and Harbor Acts of 1896, 1902, 1907, and 1922, the latter of which provides for dredging channels to landing places on the main river and subsidiary sloughs for the river above the mouth of the Missouri River. That part of the project for the middle Mississippi which proposed regulating works was practically abro-

gated by acts of March 3, 1905, March 2, 1907, and the joint resolution of June 29, 1906. The River and Harbor Act of June 25, 1910, restored regulating works to the project and began appropriations with a view to the completion of the improvement between the Ohio and Missouri Rivers within 12 years, at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H.Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess.; and H.Doc. No. 168, 58th Cong., 2d sess.) The River and Harbor Act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (Rivers and Harbors Committee Doc. No. 9, 69th Cong., 2d sess.) The River and Harbor Act of July 3, 1930, modified the project between the northern boundary of the city of St. Louis and Grafton (mouth of Illinois River) to provide for a channel 9 feet deep and generally 200 feet wide with additional width around bends, at an estimated cost of $1,500,000, with $125,000 annually for maintenance. (Rivers and Harbors Committee Doc. No. 12, 70th Cong., 1st sess.)

The estimated cost of new work, revised in 1931, is $35,650,000, with $1,100,000 for annual maintenance.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239. Additional data for terminal facilities is also contained in Transportation Series No. 2, 1929, Transportation in the Mississippi and Ohio Valleys.

Operations and results during fiscal year.—Extensive construction works were carried on throughout the year with river stages suitable for construction; work was carried on by hired labor with Government plant and by contract from July 1, 1932, to June 30, 1933. The district's standard forms of construction were used. Regulating works were maintained and project dimensions of channels were secured by dredging. Location, quantities, and costs of regulating works follow:

Class of work and locality	Miles above mouth of Ohio River	Dikes or hurdles			Bank protection (revetment)				
						Mattress		Paving squares, 100 square feet	
		No.	Linear feet	Costs	No.	Linear feet, bank protected	Squares, 100 square feet		Costs
NEW WORK, BY CONTRACT									
Greenfield Bend	5				2	9,690	12,929	4,252	$257,183.79
Elk Island, Mo.	8				1	795	901	523	15,738.45
Beechridge-Elk Island	11	3	875	$4,820.28		3,605	3,950	879	13,946.34
Buffalo Island	17				1	1,240	1,311	928	18,629.79
Sliding Towhead	24				1	2,400	3,775	1,837	54,434.82
Brooks Point, Ill.	24	3	2,720	57,019.65					
Do	25	2	600	33,551.65					
Do	26				1	3,265	3,592	1,291	51,854.54
Powers Island	36								129.49
Burnham Island, Ill.	38				1	1,700	1,698	1,001	25,109.22
Clear Creek-Graysboro	45				1	1,765	1,357	797	27,120.24
Cape Girardeau, Mo.	48				1	1,500	2,287	522	32,983.04
Do	50				2	7,185	6,600	4,268	93,562.35
Giboney Island	50	5	5,265	65,441.47					

Class of work and locality	Miles above mouth of Ohio River	Dikes or hurdles			Bank protection (revetment)				
						Mattress		Paving squares, 100 square feet	Costs
		No.	Linear feet	Costs	No.	Linear feet, bank protected	Squares, 100 square feet		
NEW WORK, BY CONTRACT—CON.									
Devils Island - Kinney Point	57	5	3,910	$87,525.50					
Grand Tower Island	78				1	2,750	2,200	1,482	$51,020.53
Brunkhorst	85				1	2,505	2,075	1,082	39,652.56
Liberty Bend, Ill	95				1	2,000	2,053	994	31,434.20
Red Rock-Liberty Island	96	6	3,025	98,295.10					
Rockwood-Crain Island	103	3	270	7,685.14					
Crain Island	106	5	1,705	63,765.30					
Kaskaskia Island	114	3	1,190	49,254.47					
Fort Chartres	131	2	2,090	102,183.78	1	6,605	6,751	2,661	137,225.42
Fort Chartres West	133				1	3,430	3,710	1,397	59,041.61
James Island	146				1	6,000	5,910	2,624	130,109.57
Cornice Island	149				1	2,800	2,931	1,463	44,292.34
Herculaneum, Mo	152	3	1,500	48,131.25					
Chesley Island	160	3	1,500	48,292.64					
Twin Hollows-Pulltight	164	9	6,540	261,928.35					
Wood River	199	5	2,665	88,848.69	1	6,300	6,185	3,121	103,838.02
Total		57	33,865	1,016,746.33	10	65,535	70,824	31,122	1,218,206.41
NEW WORK, UNITED STATES PLANT AND HIRED LABOR									
Beechridge	13				1	685	685	67	10,019.33
Grand Lake-Towhead	14								26.40
Sliding Towhead	25				1	1,560	1,948	268	24,583.19
Kinney Point	58	2	2,530	8,180.45					
Hamilton Landing	99				1	980	974	376	19,588.52
Rockwood, Ill	102	1	740	24,048.97					1,704.76
Illinois State Farm	111	1	180	14,851.13	1	1,030	1,021	193	12,997.13
Old River, Mo	118	1	300	13,113.46					
Ste. Genevieve Isl., Ill	122	4	1,000	22,002.51					
Fort Chartres West	133				1	330	330		5,550.39
Sycamore Landing	134	2	850	30,928.84					
Penitentiary Point	136	4	1,035	40,610.06					
Fish Bend	140	2	770	19,409.01					
Harlow Island	140	1	415	17,593.92					
Osborne Field	143				1	200	200	113	3,406.89
James Landing	146	1	475	11,459.32					
Sulphur Springs	157	2	940	31,757.55					
Wood River	199	1	50	581.11					
Maple Island	200	2	845	40,050.27					
Total		21	10,430	274,586.60	6	4,785	5,158	1,017	77,876.61
Maintenance by United States plant and hired labor			16,315	139,992.32			1,121	8,283	160,624.06

The cost of new regulating works was $2,587,415.95, including $2,234,952.74 for contract work; the cost of maintenance was $300,616.38.

The required 9-foot channel was maintained by the 8 United States and 3 contract dredges, except for short periods, until a dredge could get to the shoal; during the spring season there was at no time less than a 9-foot channel below the mouth of the Missouri River. During the year 91 shoals developed, 42 required dredging once, 18 required dredging twice, 1 required dredging 3 times, 2 required dredging 4 times, 1 required dredging 6 times, and the balance, 27, disappeared without dredging. There were 12,831,843 cubic yards of sand and gravel dredged by United States

dredges from 63 channels through 44 bars, and 537,879 cubic yards dredged outside the channels. In addition, 895,217 cubic yards were dredged by contract from 6 channels through 4 bars. The channels dredged had a combined length of 36.7 miles, an average width of 330 feet, and an average gain depth of 5.3 feet. The total cost of dredging was $820,869.16, which includes $90,626.51 for contract dredging in channels.

Hydrographic surveys were made covering 624.3 miles of river. The cost of surveys and gages was $152,501.36, including $12,373.28 for aerial survey.

The total cost of the work was $3,879,394.42, of which $2,605,407.52 was for new work, including $17,991.57 expended in preliminary surveys for locks and dams and $1,273,986.90 for maintenance, including dredging and surveys. The total expenditures were $4,173,239.29.

Condition at end of fiscal year.—The regulating works are about 77 percent completed. The quantities required to complete the project are estimated as follows: 75 dikes, 114,490 linear feet; 15 revetments, 233,878 linear feet. All work is in excellent repair and has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually extends from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. For 6 months the river is usually above a 10-foot stage, and the minimum channel depth has generally prevailed throughout the district without dredging.

The following table gives condition of channel:

Sections	Length of section	Affording less than 9 feet	Period [1]	Affording more than 9 feet	Period [1] [2]	Proposed low water width	Controlling depth June 30, 1933
	Miles	*Miles*	*Days*	*Miles*	*Days*		*Feet*
Mouth of Ohio to Commercial Point	32.2	0.9	8	31.3	292	2,000	9.0
Commercial Point to Commerce	7.2	.3	2	6.9	298	2,500	9.0
Commerce to Grays Point	6.9			6.9	300	2,085	9.0
Grays Point to Grand Tower	33.5	2.4	16	31.1	284	2,250	8.5
Grand Tower to Fort Gage	36.2	2.0	18	34.2	282	2,250	9.0
Fort Gage to Little Rock	9.5	2.5	38	7.0	262	2,250	9.0
Little Rock to River Des Peres	46.5	5.1	18	41.4	282	2,250	8.5
River Des Peres to northern boundary, city of St. Louis	19.0			19.0	300	1,700	9.0
Northern boundary to mouth of Missouri River	4.1	.2	4	3.9	296	2,250	9.0
Mouth of Missouri River to Illinois River	23.2	11.1	73	12.1	227	1,400	8.0

[1] Total days but not continuous.
[2] Navigation season, Feb. 15 to Dec. 15, 300 days.

The total costs under the existing project to the end of the fiscal year were $24,969,652.14 for new work and $16,208,390.68 for maintenance, including dredging and surveys, a total of $41,178,042.82. The total expenditures on the existing project are $44,284,478.94.

Proposed operations.—The balance unexpended, $1,722,205.84, including accounts receivable at the end of the year, $65,266.03, together

with an allotment of $1,220,000 made since June 30, 1933, $3,007,471.87, will be applied as follows:

Accounts payable		$76,027.94
Outstanding checks, June 30, 1933		10,448.14
New work (completion of existing contracts):		
Pile dikes:		
Brooks Point	$157,240.00	
Red Rock & Liberty Island	9,097.00	
Beechridge-Elk Island	224,347.28	
Fort Chartres	190,225.85	
Kaskaskia Island	87,265.00	
Twin Hollows	2,759.14	
Sand dams: Wood River	26,627.58	
Revetment:		
Cape Girardeau	15,556.00	
Sliding Towhead	5,491.15	
Wood River	46,509.00	
Greenfield Bend	289,835.00	
Beechridge-Elk Island	68,861.00	
Brooks Point	103,526.92	
Fort Chartres	24,012.00	
Powers Island	46,500.00	
Clear Creek-Graysboro	35,379.00	
Fort Chartres West	27,692.00	
		1,360,923.92
Maintenance:		
Accounts payable, June 30, 1933		44,506.15
Outstanding checks, June 30, 1933		64,048.62
Dikes and revetment, various localities	356,000.00	
Snagging	75,000.00	
Surveys, gages, and studies	95,945.23	
Dredging	905,000.00	
		1,431,945.23
Balance remaining		19,571.87
Total		3,007,471.87

The funds allotted from the National Industrial Recovery Act ($3,000,000) will be applied as follows:

New work, by contract:		
Piling dikes:		
Cairo Protection, Ill	$80,000	
Brooks Point, Ill	120,000	
Giboney, Island, Ill	160,000	
Devils Island, Ill., and Kinney Point, Mo	160,000	
Union Point, Ill	120,000	
Brunkhorst, Ill	120,000	
Liberty, Mo	120,000	
Ste. Genevieve, Ill	160,000	
Harlow Island, Mo	80,000	
Calico Island, Ill	120,000	
Chouteau Island, Ill	240,000	
		$1,480,000
Revetment:		
Elk Island, Mo., and Boston Bar, Ill	90,000	
Sliding Towhead, Mo	60,000	
Little Flora Creek, Mo., and Swiftsure, Ill	90,000	
Liberty, Ill	60,000	
Horse Island, Mo., and Kaskaskia Island, Ill	270,000	
Ellis Grove, Ill., and Ste. Genevieve, Mo	180,000	
Turkey Island, Ill	240,000	
Establishment Island, Mo	180,000	
Sawyer Bend, Mo., and Chouteau Island, Ill	135,000	
Seventy Six, Mo	215,000	
		1,520,000
Total		3,000,000

Project dimensions of steamer channels will be maintained. Work upon regulating structures will be that necessary for their proper maintenance. The new work now being performed under contract aims to improve the most difficult crossings in the steamboat channel, and protect the most rapidly caving banks. These operations, including maintenance of plant, will be carried on continuously except in midwinter, when navigation and river work are interrupted by ice conditions.

The low-water season, July to November, inclusive, is the most favorable time for the construction and maintenance of regulating works, especially for placing revetment and repairing paving. Dredging will be required, depending upon river stages, to maintain the channels at their full project dimensions.

The additional sum of $4,500,000 can be profitably expended during the fiscal year ending June 30, 1935, as follows:

New work:		
By contract:		
Dikes, July 1934 to June 1935	$1,134,000	
Revetment, July 1934 to December 1934	1,760,000	
By hired labor with United States plant:		
Dikes, July 1934 to June 1935	60,000	
Revetment, July 1934 to December 1934	46,000	
		$3,000,000
Maintenance:		
By hired labor with United States plant: Dikes and revetment, July 1934 to June 1935	480,000	
Project dimensions of channel by dredging, July 1934 to June 1935	840,000	
Surveys, gages, and studies, July 1934 to June 1935	180,000	
		1,500,000
Total for all work		4,500,000

Cost and financial summary

Cost of new work to June 30, 1933	[1] $27,182,107.82
Cost of maintenance to June 30, 1933	16,349,993.78
Total cost of permanent work to June 30, 1933	43,532,101.60
Value of plant, materials, etc., on hand June 30, 1933	3,537,114.03
Net total cost to June 30, 1933	47,069,215.63
Plus accounts receivable June 30, 1933	65,266.13
Gross total costs to June 30, 1933	47,134,481.76
Minus accounts payable June 30, 1933	[2] 495,944.04
Net total expenditures	46,638,537.72
Unexpended balance June 30, 1933	1,722,205.84
Total amount appropriated to June 30, 1933	48,360,743.56

Fiscal year ending June 30	1929	1930	1931	1932	1933
Cost of new work	$1,925,527.33	$2,020,138.39	$2,548,923.51	[1] $1,271,886.34	$2,605,407.52
Cost of maintenance	331,613.25	1,097,739.19	1,115,201.32	1,381,301.45	1,273,986.90
Total cost	2,257,140.58	3,120,877.58	3,664,124.83	2,653,187.79	3,879,394.42
Total expended	2,689,198.96	2,495,756.56	3,938,013.40	3,228,742.78	4,173,239.29
Allotted	2,125,000.00	2,060,000.00	4,281,000.00	269,578.67	5,696,431.24

[1] Reduced $40,595.68, account work on locks and dams transferred to examinations, surveys, and contingencies, general.
[2] Includes $375,409.95 for dredge *Dundee*.

Balance unexpended July 1, 1932		$199,013.89
Amount allotted from War Department Appropriation Act approved February 23, 1931	$6,317.66	
Amount allotted from War Department Appropriation Act approved July 14, 1932	3,354,000.00	
Amount alloted from Emergency Relief and Construction Act approved July 21, 1932	2,500,000.00	
Amount allotted from War Department Appropriation Act approved March 4, 1933	60,000.00	
		5,920,317.66
Amount to be accounted for		6,119,331.55
Deductions on account of revocations (includes $192,567.29 impounded funds revoked)		223,886.42
Net amount to be accounted for		5,895,,445.13
Gross amount expended	$5,845,896.76	
Less:		
Reimbursements collected $1,564,680.98		
Receipts from sales 107,976.49		
	1,672,657.47	
		4,173,239.29
Balance unexpended June 30, 1933		1,722,205.84
Outstanding liabilities June 30, 1933	139,557.80	
Amount covered by uncompleted contracts	1,419,791.46	
		1,559,349.26
Balance available June 30, 1933		162,856.58
Accounts receivable June 30, 1933		65,266.13
Unobligated balance available June 30, 1933		228,122.71
Amount allotted from War Department Appropriation Act approved Mar. 4, 1933		1,220,000.00
Amount allotted from the National Industrial Recovery Act		3,000,000.00
Balance available for fiscal year 1934		4,448,122.71
Amount (estimated) required to be appropriated for completion of existing project [1]		6,340,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1935:		
For new work [1]		3,000,000.00
For maintenance [1]		1,500,000.00
Total [1]		4,500,000.00

2. MISSISSIPPI RIVER BETWEEN MOUTH OF ILLINOIS RIVER AND CLARKSVILLE, MO.

See report "Mississippi River between the Illinois River and Minneapolis, Minn.", page 674.

3. MISSOURI RIVER, HERMANN TO THE MOUTH

See report "Missouri River, Kansas City to the mouth", page 707.

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

The section of the Mississippi River covered in this report was formerly in charge of the St. Louis engineer district, but for the

[1] Exclusive of available funds.

Status of reports called for by river and harbor acts and committee resolutions

Locality	Authorization	Transmitted to Congress	Document no.	Recommendation
Arkansas River and tributaries, Ark. and Okla.	River and Harbor Act, Jan. 21, 1927.			
Arkansas River, Kans., Okla. and Ark. (preliminary examination for flood control)	Flood Control Act, May 31, 1924.			
Cache River, Ark	River and Harbor Act, Jan. 21, 1927.			
Canadian North Fork, Tex. and Okla. (preliminary examination for flood control).	Flood Control Act, May 31, 1924.			
Canadian River, N. Mex., Tex., and Okla. (preliminary examination for flood control).	do			
Cimarron River, N. Mex. and Okla. (preliminary examination for flood control).	do			
Deep Fork, Okla. (preliminary examination for flood control).	do			
Hatchie River, Tenn	Rivers and Harbors Committee resolution, Feb. 9, 1934.	May 25, 1934		Unfavorable.
Little River, Okla. (preliminary examination for flood control).	Flood Control Act, May 31, 1924.			
Obion and Forked Deer Rivers, Tenn.	Rivers and Harbors Committee resolution, Feb. 9, 1934.			
Verdegris River, Okla. (preliminary examination for flood control).	Flood Control Act, May 31, 1924.			

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

This district includes the Mississippi River between the Ohio River and Clarksville, Mo., and the Missouri River between the mouth and Hermann, Mo. That section of Mississippi River between Missouri River and Clarksville is included in the report of Mississippi River between Missouri River and Minneapolis, Minn., and that portion of Missouri River in this district is included in report of Missouri River, Kansas City to the mouth.

District engineer: Maj. William A. Snow, Corps of Engineers, to December 1, 1933; Capt. Bartley M. Harloe, Corps of Engineers, since that date.

Division engineer: Col. George R. Spalding, Corps of Engineers, to November 27, 1933, and Lt. Col. Edmund L. Daley, Corps of Engineers, since that date; Lt. Col. Richard C. Moore, Corps of Engineers, was acting division engineer, July 1 to 28, 1933.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location.—The Mississippi River rises in Lake Itasca, Minn., flows in a southerly direction 2,484 miles, and empties into the Gulf of Mexico. The portion included in this report embraces the 195-mile

section known as the "middle Mississippi", between the tributaries Ohio and Missouri Rivers, 1,078 to 1,273 miles from the Gulf.

Previous projects.—The original project for the improvement of the Mississippi River between the Ohio and Missouri Rivers was recommended by a board of engineers in a report dated April 13, 1872, and concurred in by the Chief of Engineers. The cost and expenditures for the middle Mississippi prior to the adoption of the present project in 1881 were $1,610,000 for new work.

(For further details see p. 1879 of the Annual Report for 1915.)

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet at low water, with additional width in bends from the mouth of the Ohio River (1,078 miles from the Gulf) to the northern boundary of the city of St. Louis, 191 miles; thence 200 feet wide, with additional width in bends to the mouth of the Missouri River, 4 miles, all to be obtained by regulating works and dredging.

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river. The following table shows the project width for middle Mississippi:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,600	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency.

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the River and Harbor Acts of 1896, 1902, 1907, and 1922, the latter of which provides for dredging channels to landing places on the main river and subsidiary sloughs for the river above the mouth of the Missouri River. That part of the project for the middle Mississippi which proposed regulating works was practically abrogated by acts of March 3, 1905, March 2, 1907, and the joint resolution of June 29, 1906. The River and Harbor Act of June 25, 1910, restored regulating works to the project and began appropriations with a view to the completion of the improvement between the Ohio and Missouri Rivers within 12 years, at an estimated cost of $21,000,000, exclusive of amounts previously expended. (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess.; and H. Doc. No. 168, 58th Cong., 2d sess.) The River and Harbor Act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually. (Rivers and Harbors Committee Doc. No. 9, 69th Cong., 2d sess.) The River and Harbor Act of July 3, 1930, modified the project between the northern bound-

ary of the city of St. Louis and Grafton (mouth of Illinois River) to provide for a channel 9 feet deep and generally 200 feet wide with additional width around bends, at an estimated cost of $1,500,000, with $125,000 annually for maintenance. (Rivers and Harbors Committee Doc. No. 12, 70th Cong., 1st sess.)

The estimated cost of new work, revised in 1934, is $43,000,000, with $1,300,000 for annual maintenance.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239. Additional data for terminal facilities is also contained in Transportation Series No. 2, 1929, Transportation in the Mississippi and Ohio Valleys.

Operations and results during fiscal year.—River stages were very favorable to construction work, which was carried on extensively by hired labor with Government plant and by contract throughout the year. The districts standard specifications for construction work were used. Regulating works were maintained, and project dimensions of channels were secured by dredging. Location, quantities, and costs of regulating works follow:

Class of work and locality	Miles above mouth of Ohio River	Dikes or hurdles		
		No.	Linear feet	Costs
New work, by contract:				
Greenfield Bend	5			
Cairo Protection	7	2	2,380	$64,313.75
Elk Island-Boston Bar	9			
Beechridge-Elk Island	11	15	7,655	198,947.21
Sliding Towhead	24			
Dogtooth Island-Brooks Point	24	4	4,340	107,440.39
Brooks Point, Ill	25	6	5,480	156,709.74
Powers Island	30			
Clear Creek-Graysboro	45			
Cape Girardeau, Mo	49			
Olhoney Island	50	5	4,530	88,925.17
Little Flora-Swiftsure	57			
Devils Island-Kinney Point	60	6	6,000	153,620.59
Hanging Dog Island	70	6	4,500	99,369.07
Wittenberg, Mo	82			
Brunkhorst, Ill	80	7	3,540	106,984.36
Seventy-Six, Mo	92			
Liberty Bend, Ill	97			
Liberty, Mo	99	8	3,080	96,265.03
Rockwood, Ill	100	4	1,795	51,764.57
Kaskaskia Island	113	4	2,810	85,719.27
Kaskaskia Island and Ste. Genevieve, Ill	120	4	3,000	83,454.73
Ellis Grove, Ill.-Ste. Genevieve, Mo	121			
Establishment Island	120			
Fort Chartres, Ill. and Mo	131	6	7,070	177,884.90
Establishment-Sycamore-Harlow	135	7	5,615	215,561.39
Danby Landing-James Landing	141			
Calico Island-Sulphur Springs	153	12	4,500	145,309.97
Chesley Island-Pulltight	161	6	3,145	111,917.66
Total		102	69,440	1,944,187.80
New work by United States plant and hired labor:				
Dogtooth Bend	22			
Sliding Towhead	24			
Cape Girardeau, Mo	49			
Brunkhorst	85	(1)	(1)	3,093.62
Seventy-Six, Mo	90			
Rockwood, Ill	102	2	860	11,004.78
Total		2	860	14,098.40
Maintenance by United States plant and hired labor			3,240	86,734.95

[1] Work completed during fiscal year 1933.

Class of work and locality	Miles above mouth of Ohio River	Bank protection (revetment)				
		No.	Mattress		Paving squares 100 square feet	Costs
			Linear feet, bank protected	Squares 100 square feet		
New work, by contract:						
Greenfield Bend	5	2	3,595	4,866	4,235	$214,588.17
Cairo Protection	7					
Elk Island-Boston Bar	9	3	4,040	4,359	2,778	150,085.76
Beechridge-Elk Island	11	2	1,395	1,603	2,212	67,035.67
Sliding Towhead	24		(1)	(1)	(1)	2,392.56
Dogtooth Island-Brooks Point	24					
Brooks Point, Ill	25	1	3,160	3,389	2,582	103,721.74
Powers Island	36	1	2,150	2,150	935	44,225.70
Clear Creek-Graysboro	45	1	1,335	985	852	34,330.16
Cape Girardeau, Mo	49	1	660	552	330	7,259.76
Giboney Island	50					
Little Flora-Swiftsure	57	2	4,500	4,480	2,160	122,879.88
Devils Island-Kinney Point	60					
Hanging Dog Island	70					
Wittenberg, Mo	82	1	4,150	4,185	1,958	79,058.08
Brunkhorst, Ill	86					
Seventy-Six, Mo	92	1	4,875	3,331	5,668	171,816.64
Liberty Bend, Ill	97	1	2,345	1,933	1,162	54,098.04
Liberty, Mo	99					
Rockwood, Ill	100					
Kaskaskia Island	113					
Kaskaskia Island and Ste. Genevieve, Ill	120					
Ellis Grove, Ill.-Ste. Genevieve, Mo	121	2	9,000	9,340	6,717	320,043.91
Establishment Island	129	1	9,000	9,356	6,120	278,791.15
Fort Chartres, Ill. and Mo	131	2	1,165	1,114	1,234	41,865.39
Establishment-Sycamore-Harlow	135	[2] 1	[2] 535	[2] 614	[2] 133	
Danby Landing-James Landing	141	1	4,000	2,955	1,827	73,225.32
Calico Island-Sulphur Springs	153					
Chesley Island-Pulltight	161	1	3,385	3,640	2,533	113,614.08
Total		24	59,290	58,852	43,436	1,879,032.01
New work by United States plant and hired labor:						
Dogtooth Bend	22	1	1,700	1,735	801	34,273.14
Sliding Towhead	24	1	4,080	3,926	2,799	133,106.62
Cape Girardeau, Mo	49	1	2,035	2,034	1,224	49,223.69
Brunkhorst	85					
Seventy-Six, Mo	90				377	13,078.72
Rockwood, Ill	102	1	430	350	262	13,073.30
Total		4	8,245	8,045	5,463	242,755.47
Maintenance by United States plant and hired labor				4,842	16,970	472,549.82

[1] Work completed during fiscal year 1933.
[2] Cost included with dikes; as dikes were not built work listed as bank protection.

The cost of new regulating work was $4,080,073.68, including $3,823,219.81 for contract work; the cost of maintenance was $1,659,616.53.

The above new work included the following operations conducted with allotment from the Federal Emergency Administration of Public Works: 71 dikes totaling 46,425 feet in length were built under contract at a cost of $1,324,926.68; 14 revetments totaling 45,830 feet in length, consisting of 44,173 squares of mattress and 31,056 squares of paving, were built under contract at a cost of $1,363,612.86; and 2 revetments totaling 5,100 feet in length, consisting of 5,485 squares of mattress and 2,209 squares of paving, were built by hired labor with Government plant at a cost of $114,065.97, all Public Works funds. The total cost, Public Works funds, was $2,802,605.51, all new work. All projects for which funds were allotted by the Public Works Administration were completed during the fiscal year.

The following maintenance work was conducted with regular funds. The required 9-foot channel was maintained except for short periods needed to move a dredge to the shoal by 1 contract and 10 United States dredges. During the year 112 shoals developed, of which 89 were dredged once, 22 were dredged twice, and 1 required dredging three times. There were 17,980,633 cubic yards of sand and gravel removed by United States dredges from 112 channels through 89 bars, and 2,616,861 cubic yards of material removed in outside-the-channel dredging. In addition 1,307,884 cubic yards of material were dredged by contract from outside the channel. The channels dredged had combined length of 65 miles, an average width of 320 feet, and an average gain in depth of 4.4 feet. The total cost of dredging was $933,157.25, including $108,372.04 for contract dredging, all charged to maintenance.

During the year 17 wrecks and miscellaneous obstructions were removed at a total cost of $71,798.79, charged to maintenance.

Hydrographic surveys were made covering 333 miles of river. The cost of surveys and gages was $95,375.72, charged to maintenance.

The total cost of the work was $5,739,690.21, of which $1,277,468.17, maintenance and improvement funds, and $2,802,605.51, Public Works funds, a total of $4,080,073.68, was for new work, including $3,823,219.81 for contract work; and $1,659,616.53, from maintenance and improvement funds, was for maintenance, including dredging, surveys, and removal of snags. The total expenditures were $5,725,543.35, of which $2,819,258.11 was from Public Works funds.

Condition at end of fiscal year.—The regulating works are about 70 percent completed. The quantities required to complete the projects are estimated as follows: 28 dikes, 77,700 linear feet, and 71 revetments, 291,800 linear feet. All work is in very good repair and has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years, notwithstanding the unusual low water that has prevailed, the project dimensions of channels have generally been maintained throughout the navigation season with only slight and infrequent delays to navigation. The navigation season usually lasts from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. The river is usually above a 10-foot stage, St. Louis gage, for 6 months of the year, during which time the minimum channel depth generally prevails without dredging.

The total costs under the existing project to the end of the fiscal year are $28,224,409.61 (including $2,802,605.51 Public Works funds), for new work and $17,057,793.29 for maintenance, including dredging, surveys, and snagging, a total of $45,282,202.90. The total expenditures on the existing project are $48,374,492.16, of which $2,819,258.11 was from Public Works funds.

Proposed operations.—The balance unexpended, including accounts receivable at the end of the year, will be applied as follows:

Regular funds: Accounts payable June 30, 1934	$103,427.30
Maintenance:	
Dikes and revetments	226,500.00
Dredging	746,000.00
Surveys, gages, and studies	105,000.00
Balance remaining	2,651.06
Total regular funds	1,183,578.36

Public Works funds.—The balance unexpended, $98,122.36, and account receivable, $37,175.40, together with an allotment of $640,000, made during July 1934, will be applied as follows:

New Work:		
By contract: Account payable June 30, 1934	$20,522.80	
Piling dikes:		
Giboney Island, Ill	90,000.00	
Willard	70,000.00	
Liberty, Mo., Crain Island	105,000.00	
		$285,522.80
Revetment:		
Hurricane Field-Boston Bar	84,000.00	
Dogtooth Bend	96,000.00	
Giboney Island	56,000.00	
Cape Girardeau	28,000.00	
Devils Island	60,000.00	
Grand Tower Island	56,000.00	
		380,000.00
By United States plant and hired labor—Dikes:		
Danby Landing	34,000.00	
Crain Island	75,000.00	
Balance remaining	774.96	
		109,774.96
Total N. I. R. A. funds		775,297.76

The additional sum of $3,500,000 can be profitably expended during the fiscal year ending June 30, 1936, as follows:

New work by contract:	
Dikes	$935,000
Revetments	1,265,000
Total new work	2,200,000
Maintenance by hired labor with United States plant:	
Dikes and revetments	345,000
Dredging	780,000
Snagging	65,000
Surveys, gages, and studies	110,000
Total maintenance	1,300,000
Total for all work, fiscal year 1936	3,500,000

Cost and financial summary

MAINTENANCE AND IMPROVEMENT FUNDS

Cost of new work to June 30, 1934	$27,031,804.10
Cost of maintenance to June 30, 1934	17,057,793.29
Total cost of permanent work to June 30, 1934	44,089,597.39
Value of plant, materials, etc., on hand June 30, 1934	3,054,970.43
Net total cost to June 30, 1934	47,144,567.82
Plus accounts receivable June 30, 1934	124,093.53
Gross total costs to June 30, 1934	47,268,661.35
Minus accounts payable June 30, 1934	103,427.30
Net total expenditures	47,165,234.05
Unexpended balance June 30, 1934	1,059,484.83
Total amount appropriated to June 30, 1934	48,224,718.88

Fiscal year ending June 30	1930	1931	1932	1933	1934
Cost of new work	$2,029,138.39	$2,238,192.43	$1,008,610.87	$2,354,097.86	$1,277,468.17
Cost of maintenance	1,011,136.09	888,250.60	1,120,165.37	951,859.78	1,659,616.53
Total cost	3,040,274.48	3,126,443.03	2,128,776.24	3,305,957.64	2,937,084.70
Total expended	2,409,153.40	3,400,331.60	2,704,331.23	3,599,802.51	2,906,285.24
Allotted	1,973,396.90	3,218,906.65	269,578.67	5,122,994.46	2,243,564.23

Balance unexpended July 1, 1933		$1,722,205.84
Amount allotted from War Department Appropriation Act approved Apr. 26, 1934	$865,600.00	
Amount allotted from War Department Appropriation Act approved July 14, 1932	675,027.84	
Amount allotted from War Department Appropriation Act approved Feb. 23, 1931	370,000.00	
Amount allotted from War Department Appropriation Act approved Mar. 4, 1933	660,806.50	
		2,571,434.34
Amount to be accounted for		4,293,640.18
Deductions on account of revocation of allotment (includes $140,400.97 impounded funds)		327,870.11
Net amount to be accounted for		3,965,770.07
Gross amount expended	$5,344,247.51	
Less:		
Reimbursements collected	$2,423,528.16	
Receipts from sales	14,434.11	
	2,437,962.27	
		2,906,285.24
Balance unexpended June 30, 1934		1,059,484.83
Outstanding liabilities June 30, 1934		255,918.20
Balance available June 30, 1934		803,566.63
Accounts receivable June 30, 1934		124,093.53
Unobligated balance available June 30, 1934		927,660.16
Amount (estimated) required to be appropriated for completion of existing project [1]		11,585,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1936:		
For new work [1]		2,200,000.00
For maintenance [1]		1,300,000.00
Total [1]		3,500,000.00

PUBLIC WORKS FUNDS

Cost of new work to June 30, 1934	$2,802,605.51
Cost of maintenance to June 30, 1934	----------
Total cost of permanent work to June 30, 1934	2,802,605.51
Plus accounts receivable June 30, 1934	37,175.40
Gross total costs to June 30, 1934	2,839,780.91
Minus accounts payable June 30, 1934	20,522.80
Net total expenditures	2,819,258.11
Unexpended balance June 30, 1934	98,122.36
Total amount appropriated to June 30, 1934	2,917,380.47

[1] Exclusive of available funds.

Fiscal year ending June 30	1930	1931	1932	1933	1934
Cost of new work					$2,802,605.51
Cost of maintenance					
Total expended					2,819,258.11
Allotted					2,917,380.47

Amount allotted from National Industrial Recovery Act approved June 16, 1933		$2,917,380.47
Gross amount expended	$2,890,443.60	
Less reimbursements collected	71,185.49	
		2,819,258.11
Balance unexpended June 30, 1934		98,122.36
Amount covered by uncompleted contracts		20,522.80
Balance available June 30, 1934		77,599.56
Accounts receivable June 30, 1934		37,175.40
Unobligated balance available June 30, 1934		114,774.96
Amount allotted by Public Works Administration Emergency Appropriation Act, fiscal year 1935		640,000.00
Balance available for fiscal year 1935		754,774.96

CONSOLIDATED COST AND FINANCIAL SUMMARY FOR MISSISSIPPI RIVER BETWEEN OHIO AND MISSOURI RIVERS

Cost of new work to June 30, 1934	$29,834,409.61
Cost of maintenance to June 30, 1934	17,057,793.29
Total cost of permanent work to June 30, 1934	46,892,202.90
Value of plant, materials, etc., on hand June 30, 1934	3,054,970.43
Net total cost to June 30, 1934	49,947,173.33
Plus accounts receivable June 30, 1934	161,268.93
Gross total costs to June 30, 1934	50,108,442.26
Minus accounts payable June 30, 1934	123,950.10
Net total expenditures	49,984,492.16
Unexpended balance June 30, 1934	1,157,607.19
Total amount appropriated to June 30, 1934	51,142,099.35

Fiscal year ending June 30	1930	1931	1932	1933	1934
Cost of new work	$2,029,138.39	$2,238,192.43	$1,008,610.87	$2,354,097.86	$4,080,073.68
Cost of maintenance	1,011,136.09	888,250.60	1,120,165.37	951,859.78	1,659,616.53
Total cost	3,040,274.49	3,126,443.03	2,128,776.24	3,305,957.64	5,739,690.21
Total expended	2,409,153.46	3,400,331.60	2,704,331.23	3,599,802.51	5,725,543.35
Allotted	1,973,396.90	3,218,906.65	269,578.67	5,122,994.46	5,160,944.70

Balance unexpended July 1, 1933		$1,722,205.84
Amount allotted from War Department Appropriation Act approved Apr. 26, 1934	$865,600.00	
Amount allotted from War Department Appropriation Act approved July 14, 1932	675,027.84	
Amount allotted from War Department Appropriation Act approved Feb. 23, 1931	370,000.00	

Amount allotted from War Department Appropriation Act approved Mar. 4, 1933	$660,806.50	
Amount allotted from National Industrial Recovery Act approved June 16, 1933	2,017,380.47	
		$5,488,814.81
Amount to be accounted for		7,211,020.65
Deductions on account of revocation of allotment (includes $140,409.07 impounded funds)		327,870.11
Net amount to be accounted for		6,883,150.54
Gross amount expended	$8,234,691.11	
Less:		
Reimbursements collected $2,494,713.65		
Receipts from sales 14,434.11		
	2,509,147.76	
		5,725,543.35
Balance unexpended June 30, 1934		1,157,607.19
Outstanding liabilities June 30, 1934	$255,918.20	
Amount covered by uncompleted contracts	20,522.80	
		276,441.00
Balance available June 30, 1934		881,166.19
Accounts receivable June 30, 1934		161,268.93
Unobligated balance available June 30, 1934		1,042,435.12
Amount allotted by Public Works Administration Emergency Appropriation Act, fiscal year 1935		640,000.00
Balance available for fiscal year 1935		1,682,435.12
Amount (estimated) required to be appropriated for completion of existing project [1]		11,585,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1936:		
For new work [1]		2,200,000.00
For maintenance [1]		1,300,000.00
Total [1]		3,500,000.00

2. MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND CLARKSVILLE, MO.

See report, "Mississippi River between the Missouri River and Minneapolis, Minn.", page 783.

3. MISSOURI RIVER, HERMANN TO THE MOUTH

See report, "Missouri River, Kansas City to the mouth", page 823.

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

The section of the Mississippi River covered in this report was formerly in charge of the St. Louis engineer district, but for the purpose of administration on July 1, 1930, it was divided into three reaches, which are under the supervision and direction of the district engineers at St. Louis, Mo., Memphis, Tenn., and Vicksburg, Miss.

[1] Exclusive of available funds.

Cost and financial summary

Amount allotted from Emergency Relief Appropriation Act approved Apr. 8, 1935	$4,500,000
Amount (estimated) required to be appropriated for completion of existing project [1]	4,191,000
Amount that can be profitably expended in fiscal year ending June 30, 1937, for new work [1]	2,000,000

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

This district includes the Mississippi River between the Ohio River and Clarksville, Mo., and the Missouri River between the mouth and Hermann, Mo. That section of Mississippi River between Missouri River and Clarksville is included in the report of Mississippi River between Missouri River and Minneapolis, Minn., and that portion of Missouri River in this district is included in report of Missouri River, Kansas City to the mouth.

District engineer: Capt. Bartley M. Harloe, Corps of Engineers.

Division engineer: Lt. Col. Edmund L. Daley, Corps of Engineers.

IMPROVEMENTS

1. MISSISSIPPI RIVER BETWEEN THE OHIO AND MISSOURI RIVERS

Location.—The Mississippi River rises in Lake Itasca, Minn., flows in a southerly direction 2,440 miles, and empties into the Gulf of Mexico. The portion included in this report embraces the 195-mile section known as the "middle Mississippi", between the tributary Ohio and Missouri Rivers, 1,078 to 1,273 miles from the Gulf.

Previous projects.—The original project for the improvement of the Mississippi River between the Ohio and Missouri Rivers was recommended by a Board of Engineers in a report dated April 13, 1872, and concurred in by the Chief of Engineers. The cost and expenditures for the middle Mississippi prior to the adoption of the present project in 1881 were $1,610,000 for new work.

(For further details see p. 1879 of the Annual Report for 1915.)

Existing project.—This provides for obtaining and maintaining a minimum channel depth of not less than 9 feet, a minimum width of not less than 300 feet at low water, with additional width in bends from the mouth of the Ohio River (1.078 miles from the Gulf) to the northern boundary of the city of St. Louis, 191 miles; thence 200

[1] Exclusive of available funds.

feet wide, with additional width in bends to the mouth of the Missouri River, 4 miles, all to be obtained by regulating works and dredging.

First, by regulating works, for closing sloughs and secondary channels, and narrowing the river; by building new banks where the natural width is excessive and protecting new and old banks from erosion where necessary to secure permanency. The following table shows the project width for middle Mississippi:

Subdivision of river	Length	Low water		Mean stage		Bank full	
		Width	Mean depth	Width	Mean depth	Width	Mean depth
	Miles	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
River Des Peres to Grays Point	125.7	2,250	8	3,250	14.8	4,600	23.3
Commerce to Commercial Point	7.2	2,500	8	4,500	13.0	6,000	20.3
Commercial Point to Ohio River	32.2	2,000	8	3,500	14.0	4,800	24.9

Second, by dredging or other temporary expedients to maintain channels of project dimensions.

The project for regulating works was adopted in 1881 (Annual Report, 1881, p. 1536). Dredging was introduced as a part of the project by the River and Harbor Acts of 1896, 1902, 1907, and 1922, the latter of which provides for dredging channels to landing places on the main river and subsidiary sloughs for the river above the mouth of the Missouri River. That part of the project for the middle Mississippi which proposed regulating works was practically abrogated by acts of March 3, 1905, March 2, 1907, and the joint resolution of June 29, 1906. The River and Harbor Act of June 25, 1910, restored regulating works to the project and began appropriations with a view to the completion of the improvement between the Ohio and Missouri Rivers within 12 years, at an estimated cost of $21,000,000, exclusive of amounts previously expended (H. Doc. No. 50, with accompanying atlas, 61st Cong., 1st sess.; and H. Doc. No. 168, 58th Cong., 2d sess.). The River and Harbor Act of January 21, 1927, provided for a depth of 9 feet and width of 300 feet from the Ohio River to the northern boundary of St. Louis and increased the estimate for maintenance to $900,000 annually (Rivers and Harbors Committee Doc. No. 9, 69th Cong., 2d sess.). The River and Harbor Act of July 3, 1930, modified the project between the northern boundary of the city of St. Louis and Grafton (mouth of Illinois River) to provide for a channel 9 feet deep and generally 200 feet wide with additional width around bends, at an estimated cost of $1,500,000, with $125,000 annually for maintenance (Rivers and Harbors Committee Doc. No. 12, 70th Cong., 1st sess.).

The estimated cost of new work, revised in 1934, is $43,000,000, with $1,300,000 for annual maintenance.

Terminal facilities.—The water terminal and transfer facilities of the district are fully described as of December 31, 1918, in House Document No. 652, Sixty-sixth Congress, second session, pages 1211–1239. Additional data for terminal facilities is also contained in Transportation Series No. 2, 1929, Transportation in the Mississippi and Ohio Valleys.

Operations and results during fiscal year.—River stages were favorable to construction work, which was carried on extensively by hired labor with Government plant and by contract throughout the fall of 1934; river stages were unfavorable during the spring of 1935. The districts standard specifications for construction work were used. Regulating works were maintained, and project dimensions of channels were secured by dredging. Location, quantities, and costs of regulating works follow:

Class of work and locality	Miles above mouth of Ohio River	Dikes (hurdles)		
		Number	Linear feet	Costs
New work by contract:				
Hurricane Field-Boston Bar	8			
Dogtooth Bend	23			
Giboney Island-Cape Girardeau	50	4	2,970	$89,325.74
Giboney Island-Devils Island	56			
Willard-Grand Tower Island	70	6	2,180	64,018.75
Liberty, Mo.-Crain Island	101	4	3,375	101,480.02
Calico Island-Sulphur Springs	148		(1)	300.00
Total		14	8,525	255,724.51
New work by United States plant and hired labor:				
Cairo protection	7	4	1,060	41,884.03
Goose Island	35			
Giboney Island	50	1	90	2,774.59
Wilkinson	85	1	40	1,214.38
Crain Island	108	5	1,675	48,204.25
Danby Landing	144	1	470	22,619.52
Total		12	3,335	116,696.77
Maintenance by United States plant and hired labor				2,096.40

Class of work and locality	Miles above mouth of Ohio River	Bank protection (revetments)				
		Number	Linear feet bank protected	Squares (100 square feet)		Costs
				Mattress	Paving	
New work by contract:						
Hurricane Field-Boston Bar	8	2	2,525	2,525	1,006	$51,705.42
Dogtooth Bend	23	1	2,260	2,504	1,090	65,056.80
Giboney Island-Cape Girardeau	50					
Giboney Island-Devils Island	56	2	2,895	2,495	1,061	54,271.01
Willard-Grand Tower Island	70	1	2,200	1,807	874	43,685.18
Liberty, Mo.-Crain Island	101					
Calico Island-Sulphur Springs	148					
Total		6	9,880	9,331	4,091	214,718.41
New work by United States plant and hired labor:						
Cairo protection	7					
Goose Island	35	1	400	410	58	6,739.49
Total		1	400	410	58	6,739.49
Maintenance by United States plant and hired labor				827	570	21,801.53

[1] Work done fiscal year, 1934.

The cost of new regulating work was $593,879.18, including $470,442.92 for contract work; the cost of maintenance was $899,974.77.

Public Works funds—New work.—The following operations were conducted: Fourteen dikes totaling 8,525 feet in length were built

under contract at a cost of $255,724.51; six revetments totaling 9,880 feet in length, consisting of 9,331 squares of mattress and 4,091 squares of paving, were built under contract at a cost of $214,718.41; and nine dikes totaling 2,735 feet in length were built by hired labor with Government plant at a cost of $90,088.28; the total cost, Public Works funds, was $560,531.20, all new work.

Regular funds.—The following new work was done with regular funds by hired labor with Government plant: Three dikes totaling 600 linear feet in length at a cost of $26,608.49; and one revetment totaling 400 linear feet in length, consisting of 410 squares of mattress and 58 squares of paving at a cost of $6,739.49. The total cost of new work with regular funds was $33,347.98.

In addition to completed work, there was under construction by contract 2 dikes to total 1,080 linear feet and 4 revetments to total 3,715 linear feet, all to be paid for with Public Works funds.

The following maintenance work was conducted with regular funds.

The required 9-foot channel was maintained, except for short periods needed to move a dredge to the shoal, by 10 United States dredges. During the year 99 shoals developed, of which 83 were dredged once, 13 were dredged twice, and 3 required dredging three times. There were 10,207,185 cubic yards of sand and gravel removed by United States dredges from 83 channels through 99 bars, and 2,298,940 cubic yards of material removed in outside-the-channel dredging. The channels dredged had combined length of 44 miles, an average width of 300 feet, and an average gain in depth of 6.3 feet. The total cost of dredging was $748,095.76, all charged to maintenance.

Hydrographic surveys were made covering 169 miles of river. The cost of surveys and gages was $127,981.08, charged to maintenance.

The total cost of the work was $1,493,853.95, of which $33,347.98 maintenance and improvement funds and $560,531.20 Public Works funds, a total of $593,879.18 was for new work, including $470,442.92 for contract work; and $899,974.77 from maintenance and improvement funds, was for maintenance, including dredging and surveys. The total expenditures were minus $1,435,477.18, of which $527,455.75 was from Public Works funds. There were no costs nor expenditures under Emergency Relief funds.

Condition at end of fiscal year.—The regulating works are about 75 percent completed. The quantities required to complete the project are estimated as follows: Sixty-six dikes, 66,000 linear feet, and sixty revetments, 282,000 linear feet. All work is in very good repair and has greatly improved the channel. Dredging is required at low stages to remove temporary shoals and maintain the required channel depths.

In recent years, notwithstanding the unusual low water that has prevailed, the project dimensions of channels have generally been maintained throughout the navigation season. The navigation season usually lasts from the early part of February to the latter part of December, the river being generally closed by ice the remainder of the year. The river is usually above a 10-foot stage, St. Louis gage, for 6 months of the year during which time the minimum channel depth generally prevails without dredging.

The following table gives condition of the channel:

Fiscal year 1935

	Length of section	Affording less than 9 feet	Period [1]	Affording more than 9 feet	Period [1] [2]	Proposed low water width	Controlling depth June 30, 1935
	Miles	*Miles*	*Days*	*Miles*	*Days*	*Feet*	*Feet*
Mouth of Ohio to Commercial Point	32.2	0.5	6	31.7	269	2,000	9.0
Commercial Point to Commerce	7.2	.3	10	6.9	265	2,500	8.5
Commerce to Grays Point	6.9	.2	3	6.7	272	2,085	9.0
Grays Point to Grand Tower	33.5	1.0	26	32.5	249	2,250	8.0
Grand Tower to Fort Gage	36.2	1.4	40	34.8	235	2,250	7.0
Fort Gage to Little Rock	9.5	.8	28	8.7	247	2,250	7.5
Little Rock to River Des Peres	40.5	2.0	90	44.5	185	2,250	7.5
River Des Peres to northern boundary, city of St. Louis	19.0	.8	68	18.2	207	1,700	7.5
Northern boundary to mouth of Missouri River	4.1	.1	14	4.0	261	2,250	6.5

[1] Total days but not continuous.
[2] Navigation season, Mar. 1 to Dec. 1, 275 days.

The total costs under the existing project to the end of the fiscal year are $28,818,219.84, including $25,455,083.13 regular funds and $3,363,136.71 Public Works funds for new work and $17,915,179.84, regular funds, for maintenance, including dredging and surveys, a total of $46,733,399.68. The total expenditures on the existing project are $46,939,014.98, of which $43,592,301.12 were regular funds and $3,346,713.86 were Public Works funds. There are no costs nor expenditures under Emergency Relief funds.

Proposed operations.—The unexpended balance, including accounts receivable at the end of the year, and excluding revocation of $300,000 made since June 30, 1935, will be applied as follows:

Regular funds:		
Accounts payable, June 30, 1935		$96,418.37
Maintenance by hired labor with United States plant, July 1, 1935, to June 30, 1936:		
Dikes and revetments	$50,000.00	
Project channel dredging	359,000.00	
Surveys, gages, and studies	100,915.05	
		509,915.05
Total, regular funds		606,333.42

PUBLIC WORKS FUNDS

The balance unexpended, including accounts receivable at the end of the fiscal year and excluding revocation of $79,000 made since June 30, 1935, will be applied as follows:

Accounts payable June 30, 1935		$17,437.85
New work by contract, July 1, 1935, to June 30, 1936:		
Dikes and revetments, Giboney Island-Cape Girardeau	$38,300.00	
Revetments:		
Hurricane Field-Boston Bar	15,000.00	
Dogtooth Bend	25,000.00	
Giboney Island-Devils Island	21,072.76	
		99,372.76
Total Public Works funds		116,810.61

EMERGENCY RELIEF FUNDS

The balance unexpended at the end of the fiscal year, consisting of an allotment of $1,000,000, will be applied as follows:

New work by contract, July 1, 1935, to June 30, 1936:	
Piling dikes:	
Goose Island	$42,000
Seventy-Six-Crain Island	46,800
Kaskaskia Island-Ste. Genevieve	54,600
Chester	85,800
Calico Island-Sulphur Springs	78,000
Wilson Island	54,600
Revetments:	
Price Landing	63,000
Thebes Reach	35,000
Cape Girardeau	91,000
Devils Island	161,200
Wilkinson	49,000
Kaskaskia Island	56,000
Ste. Genevieve, Island	35,000
Pulltight	105,000
Cabaret Island	43,000
Total Emergency Relief funds	1,000,000

The sum of $1,900,000 can be profitably expended during the fiscal year 1937 as follows:

New work:	
By contract, July 1, 1936, to June 30, 1937:	
Dikes	$300,000
Revetments	200,000
By hired labor, July 1, 1936, to June 30, 1937:	
Dikes	300,000
Revetments	200,000
Total new work	1,000,000
Maintenance by hired labor with United States plant, July 1, 1936, to June 30, 1937:	
Dikes and revetments	112,500
Project channel dredging	675,000
Snagging	37,500
Surveys, gages, and studies	75,000
Total maintenance	900,000
Total for all work	1,900,000

It is expected that, with the proposed expenditures, the project will be 75 percent complete.

Cost and financial summary

REGULAR FUNDS

Cost of new work to June 30, 1935	$27,065,083.13
Cost of maintenance to June 30, 1935	17,915,179.84
Total cost of permanent work to June 30, 1935	44,980,262.97
Value of plant, materials, etc., on hand June 30, 1935	145,059.48
Net total cost to June 30, 1935	45,125,322.45
Plus accounts receivable June 30, 1935	173,397.04
Gross total costs to June 30, 1935	45,298,719.49

Minus accounts payable June 30, 1935	$96,418.37
Net total expenditures	45,202,301.12
Unexpended balance June 30, 1935	732,936.38
Total amount appropriated to June 30, 1935	45,935,237.50

Fiscal year ending June 30	1931	1932	1933	1934	1935
Cost of new work	$2,238,192.44	$1,008,610.87	$2,354,097.86	$1,277,468.17	$33,347.98
Cost of maintenance	888,250.59	1,120,165.37	951,859.78	1,659,616.53	899,974.77
Total cost	3,126,443.03	2,128,776.24	3,305,957.64	2,937,084.70	933,322.75
Total expended	3,400,331.60	2,704,331.23	3,599,802.51	2,906,285.24	−1,962,932.93
Allotted	3,218,906.65	269,578.67	5,122,994.46	2,243,564.23	−2,269,481.38

Balance unexpended July 1, 1934		$1,059,484.83
Amount allotted from War Department Appropriation Act approved Apr. 9, 1935		675,000.00
Amount to be accounted for		1,734,484.83
Deductions on account of revocation of allotments		2,964,481.38
Net amount to be accounted for		−1,229,996.55
Gross amount expended	$2,845,413.78	
Less:		
Reimbursements collected	$1,935,375.00	
Receipts from sales	2,872,971.71	
	4,808,346.71	
		−1,962,932.93
Balance unexpended June 30, 1935		732,936.38
Outstanding liabilities June 30, 1935		155,420.97
Balance available June 30, 1935		577,515.41
Accounts receivable June 30, 1935		173,397.04
Unobligated balance available June 30, 1935		[1] 750,912.45
Amount (estimated) required to be appropriated for completion of existing project [2]		13,083,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1937:		
New work [2]		1,000,000.00
Maintenance [2]		900,000.00
Total [2]		1,900,000.00

PUBLIC WORKS FUNDS

Cost of new work to June 30, 1935	$3,363,136.71
Cost of maintenance to June 30, 1935	
Total cost of permanent work to June 30, 1935	3,363,136.71
Value of plant, materials, etc., on hand June 30, 1935	871.00
Net total cost to June 30, 1935	3,364,007.71

[1] Less $300,000 revoked since June 30, 1935.
[2] Exclusive of available funds.

Plus accounts receivable June 30, 1935	$144.00
Gross total costs to June 30, 1935	3,364,151.71
Minus accounts payable June 30, 1935	17,437.85
Net total expenditures	3,346,713.86
Unexpended balance June 30, 1935	195,666.61
Total amount appropriated to June 30, 1935	3,542,380.47

Fiscal year ending June 30	1931	1932	1933	1934	1935
Cost of new work				$2,802,605.51	$560,531.20
Cost of maintenance					
Total expended				2,810,258.11	527,455.75
Allotted				2,917,380.47	625,000.00

Balance unexpended July 1, 1934		$98,122.36
Amount allotted from Emergency Appropriation Act approved June 19, 1934		640,000.00
Amount to be accounted for		738,122.36
Deductions on account of revocation of allotment		15,000.00
Net amount to be accounted for		723,122.36
Gross amount expended	$599,192.41	
Less reimbursements collected	71,736.66	
		527,455.75
Balance unexpended June 30, 1935		195,666.61
Amount covered by uncompleted contracts		116,810.61
Balance available June 30, 1935		78,856.00
Accounts receivable June 30, 1935		144.00
Unobligated balance available June 30, 1935		[1] 79,000.00

EMERGENCY RELIEF FUNDS

Cost of new work to June 30, 1935	
Cost of maintenance to June 30, 1935	
Net total expenditures	
Unexpended balance June 30, 1935	$1,000,000.00
Total amount appropriated to June 30, 1935	1,000,000.00

Fiscal year ending June 30	1931	1932	1933	1934	1935
Cost of new work					
Cost of maintenance					
Total expended					
Allotted					$1,000,000

Amount allotted from Emergency Relief Appropriation Act, approved Apr. 8, 1935	$1,000,000
Balance unexpended June 30, 1935	1,000,000

[1] Revoked since June 30, 1935.

CONSOLIDATED COST AND FINANCIAL SUMMARY FOR MISSISSIPPI RIVER, OHIO RIVER TO MISSOURI RIVER

Cost of new work to June 30, 1935	$30,428,219.84
Cost of maintenance to June 30, 1935	17,915,179.84
Total cost of permanent work to June 30, 1935	48,343,399.68
Value of plant, materials, etc., on hand June 30, 1935	145,930.48
Net total cost to June 30, 1935	48,489,330.16
Plus accounts receivable June 30, 1935	173,541.04
Gross total costs to June 30, 1935	48,662,871.20
Minus accounts payable June 30, 1935	113,856.22
Net total expenditures	48,549,014.98
Unexpended balance June 30, 1935	1,928,602.99
Total amount appropriated to June 30, 1935	50,477,617.97

Fiscal year ending June 30	1931	1932	1933	1934	1935
Cost of new work	$2,238,192.44	$1,008,610.87	$2,354,097.86	$4,080,073.68	$593,879.18
Cost of maintenance	888,250.59	1,120,165.37	951,859.78	1,659,616.53	899,974.77
Total cost	3,126,443.03	2,128,776.24	3,305,957.64	5,739,690.21	1,493,853.95
Total expended	3,400,331.60	2,704,331.23	3,599,802.51	5,725,543.35	−1,435,477.18
Allotted	3,218,906.65	269,578.67	5,122,904.40	5,160,944.70	−664,481.38

Balance unexpended July 1, 1934		$1,157,607.19
Amount allotted from War Department Appropriation Act approved Apr. 9, 1935	$675,000.00	
Amount allotted from Emergency Appropriation Act approved June 19, 1934	640,000.00	
Amount allotted from Emergency Relief Appropriation Act approved Apr. 8, 1935	1,000,000.00	
		2,315,000.00
Amount to be accounted for		3,472,607.19
Deductions on account of revocation of allotments		2,979,481.38
Net amount to be accounted for		493,125.81
Gross amount expended	$3,444,606.19	
Less:		
Reimbursements collected $2,007,111.66		
Receipts from sales 2,872,971.71		
	4,880,083.37	
		−1,435,477.18
Balance unexpended June 30, 1935		1,928,602.99
Outstanding liabilities June 30, 1935	$155,420.97	
Amount covered by uncompleted contracts	116,810.61	
		272,231.58
Balance available June 30, 1935		1,656,371.41
Accounts receivable June 30, 1935		173,541.04
Unobligated balance available June 30, 1935[1]		1,829,912.45
Amount (estimated) required to be appropriated for completion of existing project[2]		13,083,000.00

[1] Less $379,000 revoked since June 30, 1935.
[2] Exclusive of available funds.

Amount that can be profitably expended in fiscal year ending June 30, 1937:

New work[2]	$1,000,000.00
Maintenance[2]	900,000.00
Total[2]	1,900,000.00

2. MISSISSIPPI RIVER BETWEEN MOUTH OF MISSOURI RIVER AND CLARKSVILLE, MO.

See report, "Mississippi River between the Missouri River and Minneapolis, Minn.", page 893.

3. MISSOURI RIVER, HERMANN TO THE MOUTH

See report, "Missouri River, Kansas City to the mouth", page 987.

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

The section of the Mississippi River covered in this report was formerly in charge of the St. Louis engineer district, but for the purpose of administration on July 1, 1930, it was divided into three reaches, which are under the supervision and direction of the district engineers at St. Louis, Mo., Memphis, Tenn., and Vicksburg, Miss.

The St. Louis district extends from the mouth of the Missouri River to the mouth of the Ohio River, a distance of 195 miles. The Memphis district extends from the mouth of the Ohio River to the mouth of the Arkansas River, a distance of 398 miles. The Vicksburg district extends from the mouth of the Arkansas River to the Head of Passes, 671 miles, and includes 8 miles of Old River and 30 miles of the Atchafalaya River.

District engineers: St. Louis, Mo., Capt. Bartley M. Harloe, Corps of Engineers; Memphis, Tenn., Maj. W. M. Hoge, Corps of Engineers, to May 1, 1935; Lt. Col. Eugene Reybold, Corps of Engineers, since that date; Vicksburg, Miss., Maj. Lunsford E. Oliver, Corps of Engineers.

Division engineers: For the river below the mouth of the Ohio, Brig. Gen. H. B. Ferguson, Corps of Engineers; for the river above the mouth of the Ohio, Lt. Col. Edmund L. Daley, Corps of Engineers.

Location.—The snagging district embraces that portion of the river between Head of Passes and the mouth of Missouri River, 1,265 miles, 8 miles of Old River (present mouth of Red River), and 30 miles of Atchafalaya River from Red River to Melville, La.; total, 1,295 miles.

Previous projects.—For the removal of these obstructions general appropriations were made at irregular intervals as early as 1824. The amount expended prior to 1879, when the first definite allotment was made for the work, was approximately $358,627.35. For further details, see page 1880, Annual Report for 1915.

Existing project.—This is a continuation of the plan adopted in 1879, and provides for the removal and destruction of snags, wrecks,

[2] Exclusive of available funds.